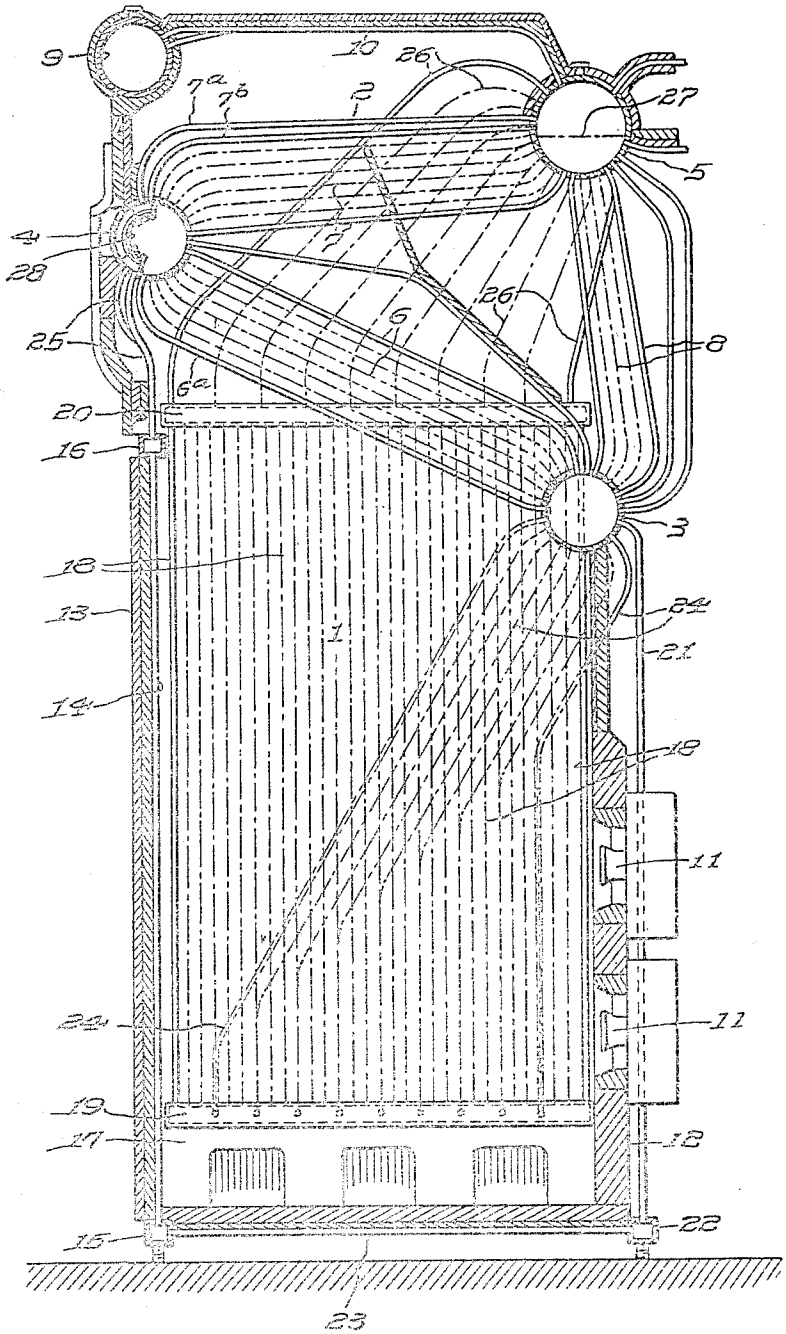
Jan. 28, 1936. J. P. BADENHAUSEN 2,029,010

STEAM GENERATOR

Filed Sept. 28, 1933 2 Sheets-Sheet 1

Fig. 1.



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STEAM GENERATOR

Filed Sept. 28, 1933 2 Sheets-Sheet 2

Fig. 2.

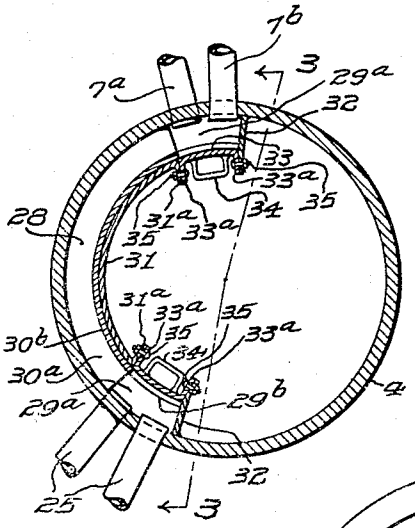


Fig. 3.

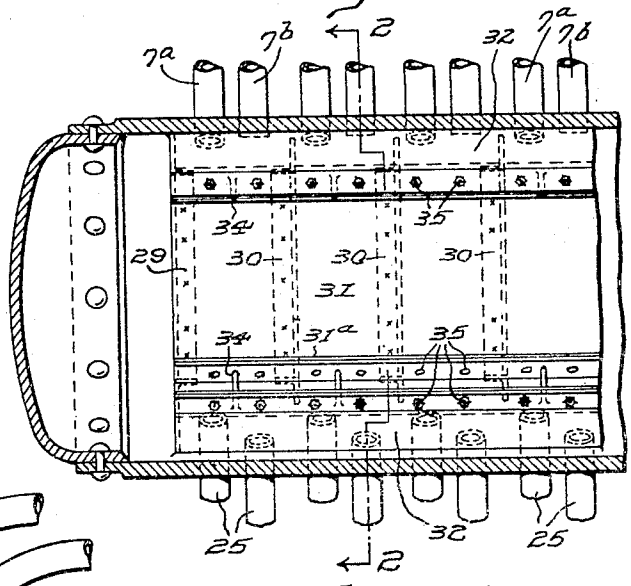


Fig. 5.

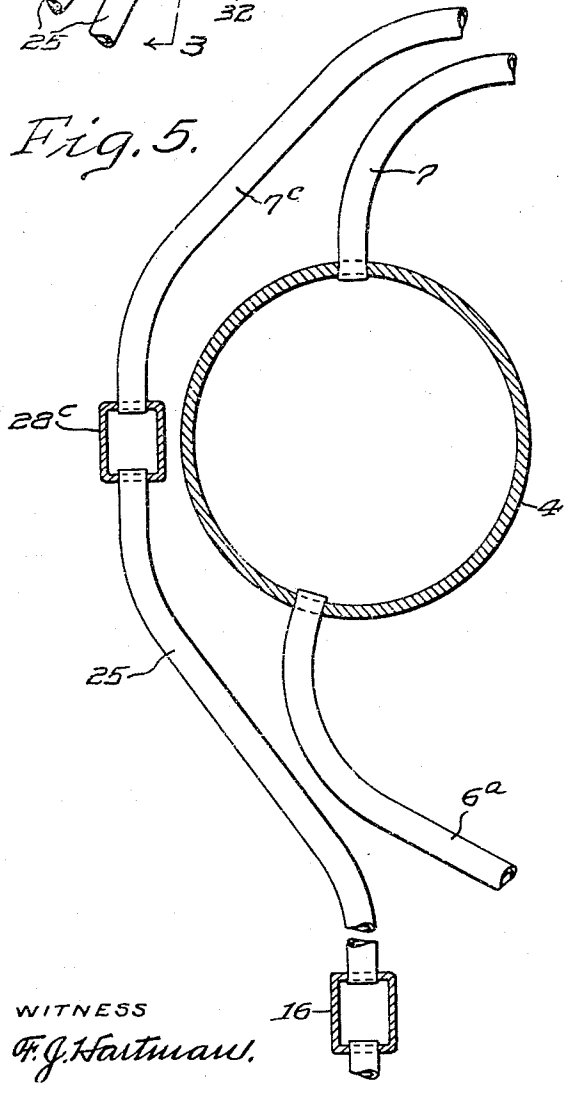
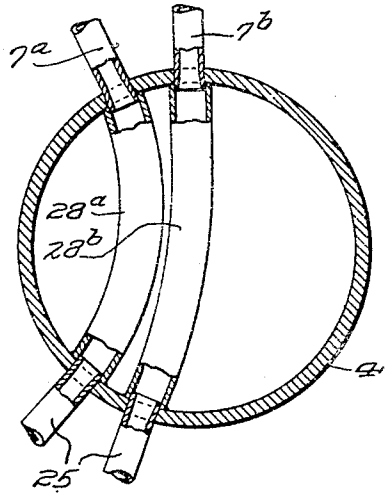


Fig. 4.



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UNITED STATES PATENT OFFICE

2,029,010

STEAM GENERATOR

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Application September 28, 1933, Serial No. 691,284

6 Claims. (Cl. 122—235)

In the construction of water tube boilers or steam generators having large heat absorptive surfaces, such as are provided in the water tube linings for the combustion chamber of a generator, it has been heretofore customary to connect the water tubes of the side walls of the combustion chamber to any convenient point in the boiler section of the generator without any particular regard to the circulation of the water in said boiler section. It had been thought that the circulation of the water in the boiler proper was so positive and strong that the circulation of the water of the water tube walls of the furnace would not affect it.

It has developed, however, that this assumption is unwarranted for when the water cooled walls of the combustion chamber are efficient they may generate more steam than the generator section of the boiler proper, or at least, it may be said that the volume of steam so generated in the water cooled walls of the furnace is so great that the circulation of the water in the water tubes of the boiler proper is detrimentally affected both as to the efficiency of the boiler and as to the life of the tubes of the boiler section.

It is to correct these defects that the present invention is directed, the object being to promote proper circulation of water in the boiler section proper and to generate a large proportion of the steam of the generator in the banks of water tubes which line the interior of the combustion chamber, and, in order to effect this, to deliver the steam generated in the water cooled walls to the top or upper side of the steam-and-water drum of the boiler above the level of the water in the boiler and to avoid discharging the steam generated in the furnace walls into the water of the circulatory system of the boiler proper, at any point below the steam-and-water drum.

A further object of this invention is to prevent the overheating of any of the water tubes or drums of the boiler section of the boiler due to variations in the flow of water therethrough and to maintain a substantially constant temperature in all the tubes of any bank of tubes of the boiler proper during the operation of the boiler and to thus prolong the life of the tubes.

A further object of the present invention is to provide a highly efficient steam generator plant of the water tube boiler type by providing ample combustion chambers wherein a substantially complete combustion of the fuel is effected within the combustion chamber and to utilize substantially all the radiant heat of combustion for the purpose of generating steam in the water-cooled walls of the furnace or combustion chamber, and to dispose of the steam so generated without interrupting any portion of the circulation of water in the boiler section proper.

A further object of the present invention is to provide a lower drum of the steam generating section of a boiler, and into which the cooling tubes of the front wall discharge, with a by-pass through said drum, said bypass being in turn directly connected to the upper part of the steam-and-water drum of the generator section and above the level of the level of the water therein so that the normal circulation of the water from the lower drum to the intermediate drum and from the intermediate drum to the steam-and-water-drum is uninterrupted, or undisturbed and normal.

Other objects of this invention will appear in the specification and claims below.

Referring now to the drawings forming a part of this specification and in which the same reference characters are employed throughout the various views to designate the same parts,

Fig. 1 is a vertical longitudinal section of a steam generator of the water tube type, showing the combustion chamber, the steam generator proper, and the banks of tubes for cooling the front and side walls of the combustion chamber as arranged in accordance with my invention.

Fig. 2 is a transverse sectional view of the intermediate drum of the boiler section proper, similar to that shown in Fig. 1, but on a somewhat enlarged scale, in order to clearly show the bypass therethrough forming a part of my invention.

Fig. 3 is a longitudinal view of the construction shown in Fig. 2 taken on the line 3—3 of Fig. 2.

Fig. 4 is a cross-sectional view similar to Fig. 2 of a slightly modified construction; and

Fig. 5 is a similar transverse sectional view through the intermediate drum showing a still further modified arrangement.

In Fig. 1 are shown those essential parts of a water tube boiler and the combustion chamber therefor, with water cooled walls, that are essential to and which directly cooperate with the invention comprising my improvements therein. Thus in said Fig. 1 is indicated the furnace or combustion chamber 1, the water tube boiler section proper 2, comprising the mud drum 3, the intermediate drum 4 and the steam-and-water drum 5, the drums 3 and 4 being connected by a bank 6 of riser water tubes, the drums 4 and 5 by another bank 7 of riser tubes and the drums 5 and 3 by a bank 8 of downcomer tubes. At the top of the boiler is the main delivery or super-

heated drum 9 which is connected to the drum 5 by a bank of tubes 10, which may operate as superheater tubes. The combustion chamber 1 is shown as being provided with two burners 11—11 in the wall 12 thereof, the burners being directed substantially horizontally toward the front wall 13 of combustion chamber.

In order that the front wall 13, which is subjected to the intense heat of the burners 11, may be utilized for the generation of steam and to protect said wall from disintegration under the said intense heat to which it is subjected, the inside of the wall 13 is provided with a vertical bank 14 of tubes through which circulates the water from the boiler proper, said tubes being exposed to the radiant heat of combustion within the combustion chamber. The lower ends of the tubes of said bank communicates with a transverse header 15 at the bottom ends thereof and with a transverse header 16 at the upper ends thereof.

The side walls 17 of the combustion chamber (only one being shown in Fig. 1) are each provided with a bank 18 of water tubes also connected to the circulatory system of the boiler and exposed to the radiant heat of combustion within the chamber 1. The tubes of side wall banks 18 communicate at their lower ends with a longitudinal header 19 and at their upper ends with a parallel header 20.

Water for the bank 14 of the front wall is supplied by one or more pipes 21 connected to the mud drum 3 of the boiler and extending downwardly outside of the combustion chamber to the transverse header 22 from which one or more horizontal pipes 23 convey water from the header 22 to the header 15.

Water for the banks 18 of the side walls is supplied each by a bank of tubes 24, the upper ends of which are connected to the underside of the mud drum 3 and extend downwardly outside the combustion chamber 1 to communicate laterally with the lower headers 19 of the side walls. In this manner the coolest of the water in the circulatory system of the boiler, to wit, that in the lower or mud drum 3 is conveyed to the bank 14 of the front wall and to the banks 18 of the side walls respectively. The upper header 16 of the bank 14 of the front walls is connected by a series or bank of tubes 25 with the intermediate drum 4 and the upper headers 20 of the banks 18 of the side walls are connected by a bank or series of tubes 26 to the upper steam-and-water drum 5, but they are preferably so connected thereto and arranged that as many as possible of them discharge into the drum 5 in the same general direction as the bank 7 of tubes of the boiler proper discharge thereinto, particularly below the level of the water in the boiler, to avoid, as much as possible, the setting up in the drum 5 of cross currents, which might seriously interfere with the free circulation of the water in the boiler section.

It has heretofore been the practice to permit the bank of tubes 25 to discharge directly into the intermediate drum 4, but in actual operation this construction has not proven to be satisfactory or efficient. With a large combustion chamber and with the walls thereof lined or covered with water cooling tubes, a relatively large proportion of the total amount of steam generated in the generator is formed in the bank 14 of tubes in the front wall 13 with the result that the tubes 25 discharge into the drum 4 a large volume of steam and water (mostly steam) which takes the easiest course through the bank of tubes 7 to the steam-and-water drum 5. The easiest course is through the upper tubes 7^a and 7^b of the bank. Moreover, the large amount of steam and water pouring into the drum 4 from the tubes 25 substantially checks, blocks and interrupts the upward flow of the water circulating in the boiler proper through the lowest series of tubes 6^a in the bank 6, with the result that the tubes 7^a and 7^b of the upper bank 7 and lower tube 6^a of the riser bank 6 become exceedingly hot because a little or no water circulates through them, with attendant likelihood of a sagging or dropping or lowering of said tubes and an attendant weakening of them. So long as water and steam circulate through all tubes in a boiler of this kind or type, the tubes do not become overheated and maintain their normal positions. When, however, certain of them become overheated due to lack of circulation therethrough they erode rapidly and, moreover, are subject to vibration which tends to crack the tubes and make the replacement thereof necessary. It is to cure this defect that the present invention is directed.

One of the steps which I have adopted for the prevention of these defects comprises the connection of the upper headers 20 of the side walls directly to the steam-and-water drum 5 with as many tubes of the bank 26 as possible, communicating with the drum 5 at a point above the level 27 of the water within the boiler and all discharging into the drum in substantially the same direction as the discharge from the adjacent tubes of the bank 7, thus avoiding, as much as possible the formation of cross currents and eddies in the drum 5.

The other means which I employ to cure the deficiencies above described, comprises the providing of the intermediate drum 4 with a chamber or a series of chambers 28 within the drum 4, whereby the tubes 25 from the upper header 16 communicate directly with the chamber 28, and wherein this chamber 28 extends around within the drum 4 a distance sufficient to include the pipes 7^a and 7^b of the upper bank 7 thereby putting the headers 16 of the upper bank of tubes of the front wall 13 substantially directly into communication with the steam-and-water drum 5 at a point above the water level 27 of the drum 5, so that the steam from the bank 14 is conducted directly to the drum 5 without traversing through the water contained in the drum 4 and disturbing the free circulation of water from the bank 6 into the drum 4 and from the drum 4 into the drum 5.

This partition in the drum 4 is more clearly shown in Figs. 2 and 3.

To form the chamber 28 or the series of chambers 28, a series of angle bars 29 and 30 are curved to conform to the interior of the surface of the drum 4 and the edge of one flange 29^a of the bars 29 and the flange 30^a of the bars 30 are secured, as by spot welding directly to the interior wall of the drum 4 and the other flanges 29^b of the bars 29 and 30^b of the bars 30 extend parallel to the axis of said drum. To the outside of the flanges 29^b and 30^b is secured a plate or series of plates 31 bent to circular form to fit flat against the flanges 29^b and 30^b of the angle irons 29 and 30 and it is secured thereto by spot welding. The two end angle bars 29 are long enough to extend beyond the ends of the tubes 25 and beyond the ends of the tubes 7^a and 7^b and the intermediate angle irons 30 are a little shorter and do not quite extend to the ends of the tubes 25 or to the

ends of the tubes 7a. To the opposite ends of the longer angle irons 29 and to the inside of the drum 4 are rigidly secured plates 32 to close the ends of the compartment or chamber 28, but the shorter angle irons 30, which do not extend up to the plates 32, provide continuous communicating passages throughout the length of the chamber 28 over the ends of the tubes 25 and over the ends of the tubes 7a and 7b.

The semicircular plate 31 is preferably as long as and is secured to the shorter of the angle irons 30, and is upturned or inturned at its end to provide flanges 31a at each end to fit against a cover or closure 33 which preferably extends the full length of the chamber and has upturned ears or flanges 33a which are respectively secured to the upwardly or outwardly extending flanges 31a and the adjacent side of the plate 31. This plate or closure 33 may be provided with handles 34 and may be held in place by bolts and nuts 35.

It will be understood that the removal of the bolts 31a permits the withdrawal or lifting of the plate 32 by its handle 34, thereby giving access to the interior of the tubes 25 and of the tubes 7a and 7b

I have thus provided within the drum 4 a nearly semi-circular, semi-annular chamber 28 through which the steam and water from the tubes 25 are free to pass to the tubes 7a and 7b and thence to the drum 5 in such a manner that the steam and water delivered by the pipes 25 do not discharge into the water in the drum 4 but passes in the drum 4 from the tubes 25 through the chamber 28 past or beyond the tubes 7a or 7b through which it is discharged to the drum 5, thereby preventing any water and steam from the bank 14 from interfering with the circulation of the water through the drum 4 and thereby also preventing any stagnation or lack of circulation in any of the tubes of either bank 6 and 7.

In Fig. 4 is shown a modification wherein the chamber formed with the angle iron and plates as above described in connection with Fig. 1 are dispensed with, and the interior of the drum 4 is provided with transverse tubes 28a and 28b, the ends of which may be spot welded or otherwise secured to the interior of the drum 4. These tubes afford direct communication between the tubes 25 from the header 16 and the tubes 7a and 7b repectively to drum 5 This structure absolutely prevents the intermingling of the steam and water from the front wall 13 from so agitating the water in the drum, that it interferes with the free circulation of the water through the steam generating section of the boiler.

Instead of providing the interior of the drum 4 with the intermediate compartment or chamber 28, or with the tubes 28a, I may provide a supplemental drum or header 28c outside of and to the rear of the drum 4, and into which the upper ends of the tubes 25 discharge, the upper side of the header 37 being connected by a bank of tubes 7c directly to the steam-and-water drum 5.

It will now be apparent that I have provided a construction wherein the rapid circulation of water through the front and side walls of the water cooled walls of the combustion chamber of a steam generator may be conducted to the steam-and-water drum 5 without passing through the intermediate drum 4 in such a manner as to impart agitation or cross current disturbance within the body of water which fills the drum 4 and that thereby I have eliminated the installation of any connections which disturb or interfere with the free circulation in a circular manner from drum 3 to drum 4; thence to drum 5; and thence back to drum 3. The steam generating section may operate as it would were there no water cooled walls in the furnace and the steam and water developed in the front and side walls of the furnace are conveyed directly to the top of the steam-and-water drum 5 and discharged at a point which offers no let or hindrance to the free circulatory movement of the water in the steam generating section of the boiler comprising the tubes 3, 4 and 5 and the banks of tubes 6, 7 and 8 respectively connecting said drums.

In this manner I have removed completely all interference with the circulatory flow of the water in the steam generating section of the boiler due to the introduction of the steam and water from the walls of the combustion chamber directly into the intermediate water drum 4. And while, as in the modification shown in Figs. 1 to 4 the steam from said banks may pass through the drum 4, it does not set up the objectionable eddies or cross-currents therein present in boilers of this type when such a bypass or closed chamber as I have provided is not employed. The water and steam are free, in using my invention, to circulate continually through all the drums and all the banks of tubes of the steam generating section rapidly and continuously, thereby keeping the tubes clean and not subject to rapid changes in temperature due to irregularities in the speed with which the water and steam flow therethrough as are incident in prior constructions.

Having thus described my invention, what I claim and desire to protect by Letters Patent of the United States is:

1. In a steam generator, the combination with a water tube boiler section, including a plurality of drums and a plurality of banks of water tubes connecting said drums in series to provide for a continuous circulating flow of water in a closed or endless path through said series of drums and banks of tubes, one of said drums being an upper steam-and-water drum and a second of said drums being a water drum continually filled with water during the operation of the boiler, of a combustion chamber, including a front wall, a bank of vertical tubes lining the inner surface of said front wall and exposed to the radiant heat of the combustion of fuel in said chamber, means to conduct water from a relatively cool point in the circulatory system of said boiler section to the lower ends of said bank of vertical tubes lining said front wall, means within said water drum providing a chamber closed to the interior of said drum, means to conduct steam and water from the upper ends of said bank of vertical tubes into said chamber, means to conduct the steam and water delivered to said chamber and to deliver the same into said steam-and-water drum in substantially the same direction that the circulating water of said boiler section enters said steam-and-water drum whereby the steam and water delivered from said vertical bank of tubes and passing through said water drum does not disturb the free movement of the water of said boiler section through said water drum.

2. In a steam generator, the combination with a water tube boiler section, including a plurality of drums, a plurality of banks of water tubes connecting said drums in series to provide for a continuous circulating flow of water in a closed or endless path through the said series of drums and banks, one of said drums being an upper

steam-and-water drum and the second of said drums being a water drum continually filled with water during the operation of the boiler, of a combustion chamber, including a front wall and a bank of vertical tubes lining the inner wall of said front wall and exposed to the radiant heat of said combustion chamber, means to conduct water from a relatively cool point in the circulatory system of said boiler section to the lower ends of said bank of vertical tubes, and means to conduct the steam and water delivered from said upper ends of said vertical banks of tubes through said water drum without disturbing the free circulatory movement of the water of said boiler section through said water drum and on to said steam-and-water drum and connected to said steam-and-water drum at points above the level of the water in said steam-and-water drum.

3. In a steam generator, the combination with a water tube boiler section, including a steam-and-water drum, an intermediate water drum, a lower water drum and a plurality of banks of water tubes connecting said drums in series to provide for a continuous circulatory flow of water in a closed or endless path through said series of drums and banks of tubes during the operation of the boiler, a combustion chamber, a bank of tubes lining the face of the front wall of said combustion chamber and exposed to the radiant heat of said combustion chamber, and means to connect the upper ends of said bank of tubes with said intermediate water drum, said water drum being provided on the inside thereof with means for conducting the steam and water from said bank of vertical tubes through said water drum without commingling the same with the water of said boiler section in said water drum, and means to conduct the steam and water thus passed through said water drum directly to the upper part of said steam-and-water drum at a point above the level of the water in said steam-and-water drum.

4. In a steam generator, the combination with a water tube boiler section, including a steam-and-water drum, an intermediate water drum, a lower water drum and a plurality of banks of water tubes connecting said drums in series to provide for a continuous circulatory flow of water in a closed or endless path through said series of drums and banks of tubes during the operation of the boiler, a combustion chamber, a bank of tubes lining the face of a wall of said combustion chamber and exposed to the radiant heat of said combustion chamber, and means to connect the upper ends of said bank of tubes with said intermediate water drum, said water drum being provided on the inside thereof with means for conducting the steam and water from said bank of vertical tubes through said water drum without commingling the same with the water of said boiler section in said water drum, and means to conduct the steam and water thus passed through said water drum directly to said steam-and-water drum.

5. In a steam generator, the combination with a water tube boiler section, including a steam-and-water drum, an intermediate water drum, a lower water drum and a plurality of banks of water tubes connecting said drums in series to provide for a continuous circulatory flow of water in a closed or endless path through said series of drums and banks of tubes during the operation of the boiler, a combustion chamber, a bank of tubes lining the face of the front wall of said combustion chamber and exposed to the radiant heat of said combustion chamber, the upper ends of said bank of tubes being connected with said intermediate water drum, said water drum being provided on the inside thereof with means for conducting the steam and water from said bank of vertical tubes through said water drum without commingling the same with the water of said boiler section in said water drum, and means to conduct the steam and water thus passed through said water drum directly to said steam-and-water drum.

6. In a steam generator, the combination with a water tube boiler section, including a steam-and-water drum, an intermediate water drum, a lower water drum and a plurality of banks of water tubes connecting said drums in series to provide for a continuous circulatory flow of water in a closed or endless path through said series of drums and banks of tubes during the operation of the boiler, a combustion chamber, a bank of tubes lining the face of the front wall of said combustion chamber and exposed to the radiant heat of said combustion chamber, the upper ends of said bank of tubes being connected with said intermediate water drum, said water drum being provided on the inside thereof with a partition mounted within the drum and cooperating with the front wall of the drum to form a passage for conducting the steam and water from said bank of vertical tubes through said water drum without commingling the same with the water of said boiler section in said water drum, and means to conduct the steam and water thus passed through said water drum directly to said steam-and-water drum.

JOHN PHILLIPS BADENHAUSEN.