Aug. 25, 1942. M. H. KUHNER ET AL 2,293,833

STEAM GENERATOR

Filed July 14, 1938 3 Sheets-Sheet 1

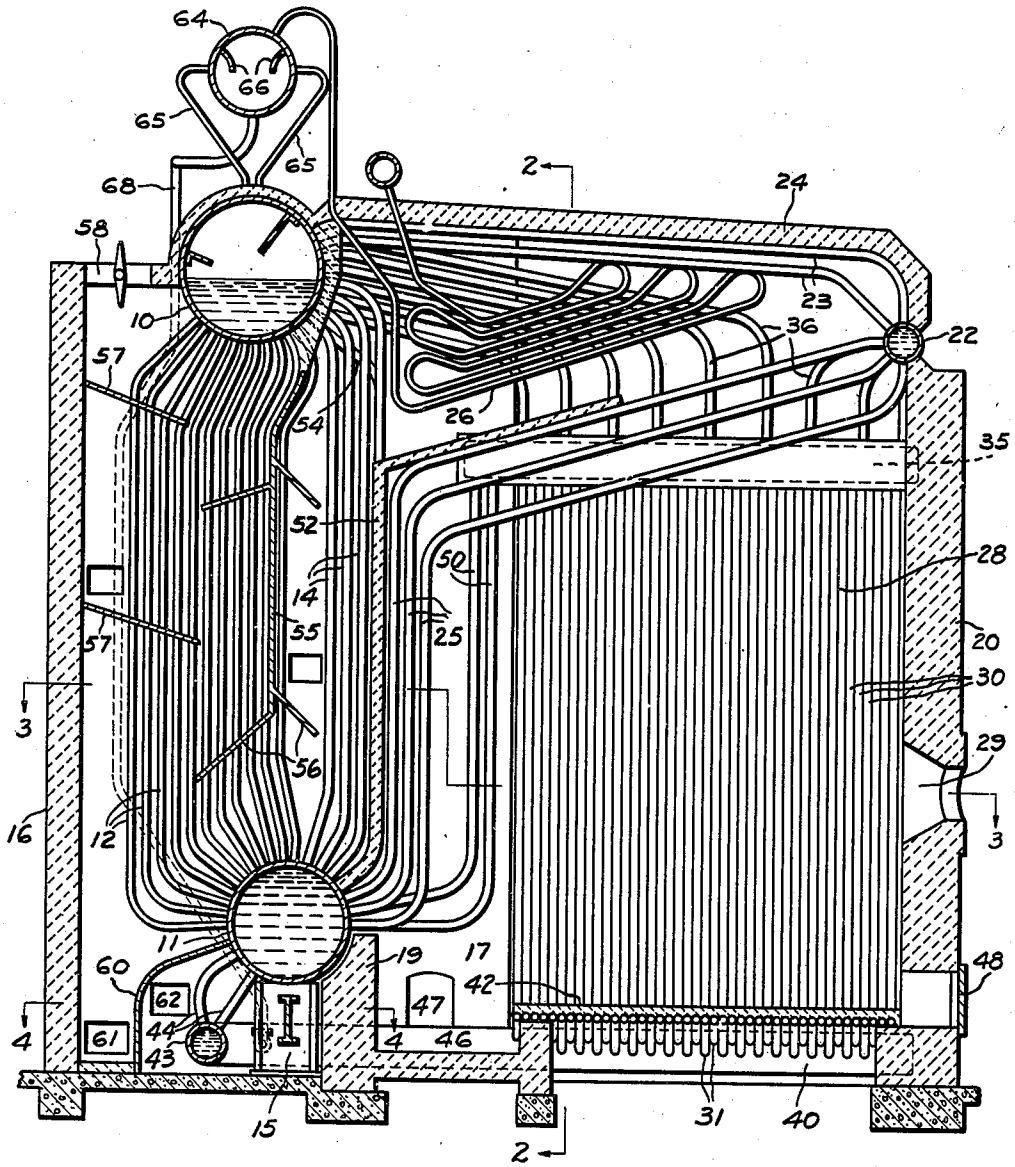


Fig. 1

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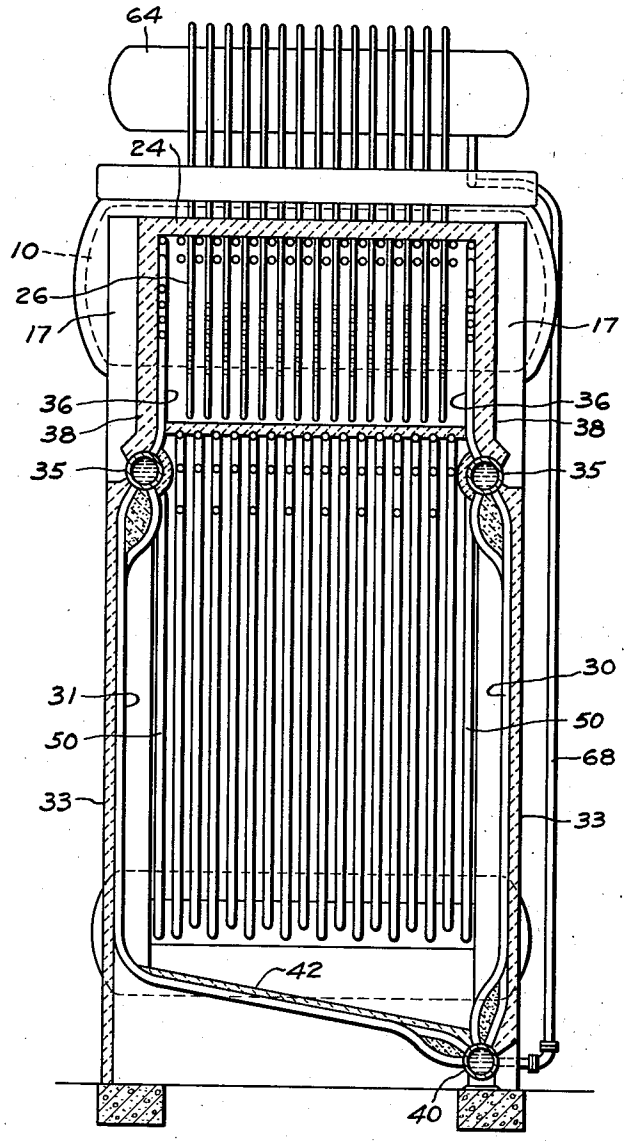


Fig. 2

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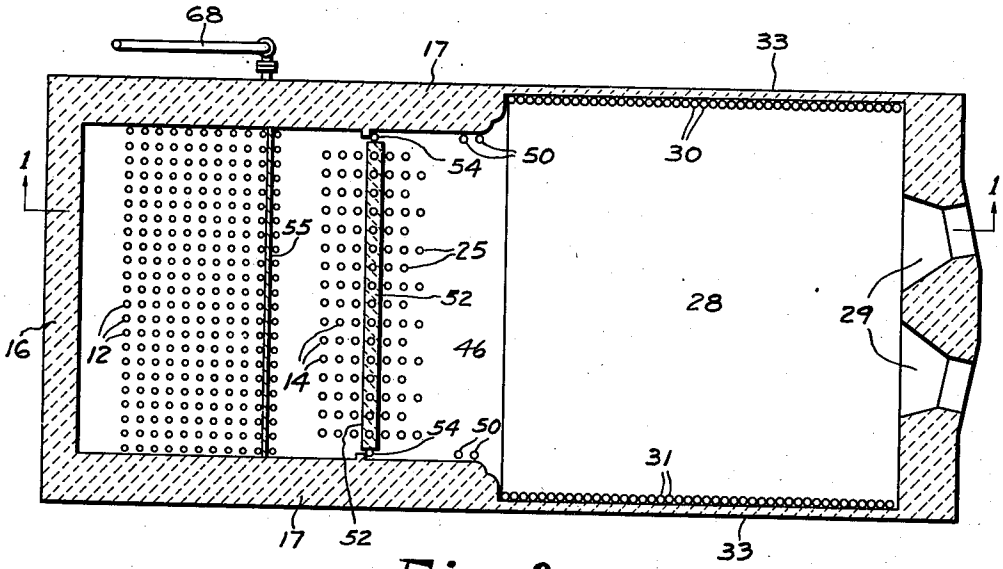


Fig. 3

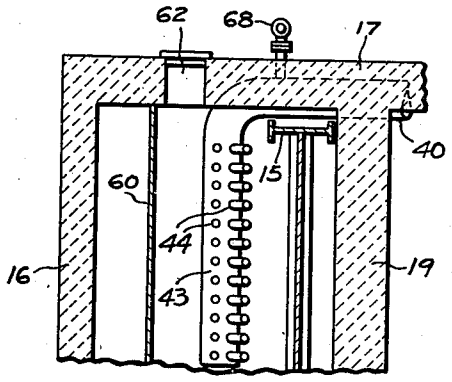


Fig. 4

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UNITED STATES PATENT OFFICE

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STEAM GENERATOR

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Application July 14, 1938, Serial No. 219,214

8 Claims. (Cl. 122—336)

This invention relates to steam generators, and more particularly to steam generators of the water tube type having water cooled walls at the sides of the combustion chamber.

It is one object of the invention to provide a water tube steam generator capable of producing steam at rates which are high in comparison with the floor space required for the installation.

It is a further object of the invention to provide a steam generator particularly adapted for operation with fuels such as oil, gas and pulverized coal, which are burned while in suspension in the combustion chamber.

It is a further object of the invention to provide a steam generator having a simple and effective means for supplying water to the lower ends of the water wall tubes.

It is a further object of the invention to provide a steam generator which will be free from difficulties caused by priming and foaming.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

Referring to the drawings illustrating one embodiment of the invention, and in which like reference numerals indicate like parts,

Fig. 1 is a longitudinal section through a steam generator, the section being taken on the line 1—1 of Fig. 3;

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

Fig. 3 is a section on the line 3—3 of Fig. 1; and

Fig. 4 is a fragmentary section on the line 4—4 of Fig. 1.

The embodiment illustrated comprises an upper transverse steam-and-water drum 10 and a lower transverse water drum 11 therebeneath, these drums being connected by a bank of upright water tubes 12 and by a second bank of upright water tubes 14 located in front of the tubes 12 and somewhat larger in diameter than the tubes 12. The lower drum 11 is supported on a saddle 15, and the upper drum 10 is supported by the water tubes. A wall 16 is provided in the rear of the tube bank 12, and two walls 17 extend forwardly from the rear wall 16 on opposite sides of the water tubes to a transverse vertical plane located a substantial distance in front of the tube bank 14. A bridge wall 19 is provided in front of and beneath the water drum 11, and a front wall 20 is provided a substantial distance in front of the side walls 17. The walls 16, 17, 19, and 20 are preferably formed of a self-supporting type of refractory masonry.

Near the top of the front wall 20 there is provided a transverse header 22 which is connected to the steam-and-water drum 10 by means of two rows of water tubes 23, the upper row of tubes serving to support a roof 24 of refractory material. A bank of water tubes 25 connects the lower water drum 11 with the header 22, these tubes being generally L-shaped, with upright lower portions located in front of the tubes 14, and with substantially horizontal upper portions which preferably slope slightly upwardly to the header. There are three rows of these tubes 25, the rows being comparatively closely spaced where the tubes are upright and comparatively widely spaced where the tubes are substantially horizontal. The tubes 25 in the front row are spaced apart more widely than the others, to form a slag screen. A superheater 26 is mounted above the upper sloping portions of the tubes 25.

The space 28 beneath the sloping portions of the tubes 25 is utilized as a combustion chamber into which a suitable fuel, such as pulverized coal, is introduced through one or more burner openings 29 in the front wall 20. In order to enclose the combustion chamber on opposite sides there are provided two groups 30 and 31 of closely spaced upright water tubes located between the front wall 20 and the front edges of the refractory side walls 17. These tubes are exposed on their inner surfaces to the heat of combustion and they are enclosed on their outer sides by means of refractory material 33. This refractory 33 may be comparatively thin, since it is supported and cooled by the water tubes. The outer surface of the refractory 33 is substantially flush with the outer surface of the adjacent side wall 17, and each group of water tubes 30 and 31 is offset outwardly from the inner surface of the adjacent side wall. This increases considerably the volume of the combustion space, and it utilizes the available floor space in an efficient manner. Furthermore, it facilitates the application of a steel casing to the outside of the setting.

At each side of the combustion chamber 28 and near the top thereof we provide a longitudinal header 35 to which the upper ends of the adjacent water wall tubes 30 and 31 are connected. The ends of the tubes are preferably staggered in order to maintain adequate ligaments in the headers. A row of tubes 36 extends upwardly from each header to provide steam releasers therefor, certain of these tubes extending forwardly to the header 22 and others extending rearwardly to enter the steam-and-water drum 10 in a circumferential row. As shown par-

ticularly in Fig. 3, a space is provided between each side wall 17 and the outermost tubes in the tube banks 14 and 25, so that the tubes 36 may extend along the inside of the side walls. These releaser tubes 36 are enclosed on their outer sides, in front of the side walls 17, by means of refractory material 38, which may be comparatively thin.

As shown particularly in Fig. 2, each header 35 is located in a vertical plane which is intermediate the plane of the releaser tubes 36 and the plane of the water wall tubes 30 or 31. In other words, the header is offset outwardly with respect to the releaser tubes and inwardly with respect to the water wall tubes. One advantage of this construction is that the header is located directly beneath the refractory material 38 and serves to support the weight thereof.

In order to supply water to the water wall tubes 30 and 31 we provide a longitudinal lower header 40 located at the bottom of the combustion chamber 28 and at the side thereof adjacent to the tubes 30. The lower ends of the tubes 30 are connected to this header, and the lower portions of the tubes 31 are bent laterally and extend at a slight downward slope across the combustion chamber and are likewise connected to the header. These sloping portions of the tubes 31 serve to support refractory material 42 which forms the floor of the combustion chamber. At the rear end of the header 40 there is provided a header 43 which is connected thereto at substantially a right angle and is arranged below and parallel to the lower water drum 11. The headers 40 and 43 may be integral with each other, or they may be joined by welding or otherwise. Two rows of water tubes 44 connect the water drum 11 to the transverse header 43.

When pulverized coal is to be used as a fuel, we preferably provide a depressed ash pocket 46 which extends across the rear of the combustion chamber directly in front of the bridge wall 19. A door 47 is provided in one or both sidewalls 17 to facilitate ash removal. One or more doors 48 are provided in the front wall 20, so that a steam lance may be inserted to blow the ashes rearwardly from the floor 42 into the pocket 46.

The refractory side walls 17 extend forwardly for a substantial distance in front of the upright portions of the tubes 25, and hence are subjected to considerable heat from the combustion chamber. In order to prevent overheating and slagging of these walls we provide two upright water tubes 50 at each side of the furnace, these tubes being located adjacent to the forwardly extending portions of the wall 17. The lower portions of these tubes are bent rearwardly to connect with the lower drum 11, and the upper ends of the tubes are connected to the adjacent water wall header 35.

In order to direct the hot gases from the combustion chamber 28 into proper contact with the water tubes, suitable baffles are provided. A baffle 52 of refractory material is supported by the front row of tubes 14 and fills the spaces between the tubes in this row. This baffle extends upwardly from the lower drum 11 to the tops of the upright portions of the rearmost tubes 25, and thence forwardly along the sloping portions of these tubes for about half their length. At each side the upright portion of the baffle is supported by a tube 54 connected at its lower end to the lower drum 11 and extending upwardly in alignment with the front row of tubes 14. The upper portion of this tube is bent rearwardly to avoid interference with the releaser tubes 36, as shown in Fig. 1, and enters the upper drum 10 in alignment with the upper ends of the rear row of tubes 14 and in the same circumferential row as the releaser tubes. A baffle 55 extends downwardly from the upper drum 10 immediately in the rear of the front row of tubes 12, this baffle having forwardly and rearwardly projecting branches 56. Baffles 57 extend forwardly from the rear wall 16 into the tube bank 12 in staggered relation to the rearwardly projecting branches 56. A gas outlet 58 is provided in the rear of the upper drum 10.

It will now be apparent that the hot gases from the combustion chamber 28 will flow upwardly around the front of the baffle 52 and thence rearwardly and downwardly between the baffles 52 and 55. The gases will then flow upwardly between the baffles 55 and 57 to the outlet 58. Most of the soot and fly ash which is carried out of the combustion chamber by the gases will be deposited at the rear of the lower drum 11. In order to prevent this material from piling up against the header 43 a partition or plate 60 (Fig. 1) is provided which extends downwardly from the drum 11 in the rear of the tubes 44 and header 43. Access to the fly ash deposit in the rear of this plate may be had through a door 61 in the side wall 17. This side wall is also provided with a door 62 in front of the plate 60 through which access may be had to the header 43 and tubes 44.

In order to prevent carry-over of excessive moisture from the steam-and-water drum 10 to the superheater 26, we have shown a transverse drum 64 mounted above the drum 10 and connected to the steam space thereof by means of tubes 65. The inlet ends of the superheater tubes 26 are connected to the upper portion of the drum 64. This steam drum 64 is provided with internal baffles 66 or other suitable means to separate water from the steam which is delivered to the drum by the tubes 65. The separated water is withdrawn from the drum through a tube 68 which leads downwardly along the outside of one side wall 17 to the lower water wall header 40.

The operation of the invention will now be apparent from the above disclosure. Pulverized coal or other suitable fuel is introduced through the burner openings 29 and burns in suspension in the combustion chamber 28. The hot gases flow upwardly into contact with the water tubes 25 and the superheater 26, thence downwardly in contact with the water tubes 14, and thence upwardly in contact with the water tubes 12 and through the outlet 58 to a suitable stack. Since the baffle 52 is located behind the water tubes 25, the upright portions of all these tubes are exposed to heat radiated rearwardly from the combustion chamber. This produces a rapid upward circulation through these tubes and avoids any possibility of steam-locking in the upper substantially horizontal portions of the tubes. Steam is generated very rapidly in the water tubes 25 and in the side wall tubes 30 and 31, this steam flowing upwardly to the steam-and-water drum 10 where most of the water is separated from the steam. The steam then passes upwardly through the tubes 65 to the drum 64 and thence to the superheater 26. Substantially all the water which is carried by the steam into the drum 64 is deposited in the bottom of the drum and withdrawn through the tube 68. A sudden increase in the demand for steam will

not cause a flooding of the drum **64**, since one effect of the steam generation in the water wall tubes **30** and **31** is to maintain a high water velocity and a comparatively low static pressure in the header **40** to which the tube **68** is connected. Consequently water will escape from the drum **64** as fast as it can collect therein. Much of the ash from the fuel will be deposited directly in the ash pocket **46**, from which it can be removed through the door **47**, and such ash as falls to the floor **42** can be blown rearwardly into this pocket by means of a steam lance. The fly ash which is carried over the top of the baffle **52** by the hot gases will be deposited at the rear of the plate **60** and can be removed through the door **61**. The tubes **44** and the transverse header **43** provide a simple means for supplying large quantities of water to the lower water wall header **40**, and they can be readily reached for inspection through the door **62**. The front portions of the refractory side walls **17** are well protected by the water tubes **50** from excessive heating or slagging. The arrangement of the water wall tubes **30** and **31** provides a maximum combustion space in a given floor area, and simplifies the application of a steel casing. The upper headers **35**, by reason of their offset positioning, provide ample support for the weight of the refractory **38**. The close spacing of the upright portions of the tube rows **25** aids in increasing the space available for the rearward travel of the combustion flame, while the wide spacing of the substantially horizontal portions of these tube rows aids in chilling any slag particles which may arise with the combustion gases and avoids the tendency of such particles to accumulate on the water tubes and superheater. The steam generator is of simple and inexpensive construction, and yet capable of efficient operation at comparatively high rates.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. A steam generator comprising a transverse steam-and-water drum, a transverse water drum therebeneath, a bank of tubes connecting the drums, means providing a combustion chamber in front of the tube bank, upright water wall tubes at one side of the combustion chamber, means connecting the upper ends of the water wall tubes to the steam-and-water drum, a longitudinally extending header to which the lower ends of the water wall tubes are connected, means to supply water from the water drum to the header, a steam drum mounted above the steam-and-water drum, means to conduct steam from the steam-and-water drum to the steam drum, means in the steam drum to separate water from the steam delivered thereto, and a conduit through which the water thus separated may flow downwardly to said header.

2. A steam generator comprising a transverse steam-and-water drum, a transverse water drum therebeneath, a bank of tubes connecting the drums, means providing a combustion chamber in front of the tube bank arranged for the combustion of pulverized fuel in suspension, a longitudinally extending header located at the bottom of the combustion chamber and adjacent one side thereof, means to supply water from the water drum to the header, means including a row of water tubes extending laterally from the header and across the bottom of the combustion chamber to provide a closed water cooled floor, the rear edge of the floor being spaced forwardly from the water drum, and means providing an ash pocket located between the rear edge of the floor and the water drum and opening upwardly into the rear portion of the combustion chamber.

3. A steam generator comprising a transverse steam-and-water drum, a transverse water drum therebeneath, a bank of tubes connecting the drums, means providing a combustion chamber in front of the tube bank arranged for the combustion of pulverized fuel in suspension, a longitudinally extending header located at the bottom of the combustion chamber and adjacent one side thereof, means to supply water from the water drum to the header, a row of water tubes extending upwardly from the header to provide a water cooled wall for the adjacent side of the combustion chamber, a row of water tubes extending laterally from the header and across the bottom of the combustion chamber to provide a water cooled floor and thence upwardly to provide a water cooled wall for the other side of the combustion chamber, the rear edge of the floor being spaced forwardly from the water drum, and means providing an ash pocket between the rear edge of the floor and the water drum.

4. A steam generator comprising a transverse steam-and-water drum, a transverse water drum therebeneath, a bank of tubes connecting the drums, refractory side walls located on opposite sides of the tube bank and extending forwardly beyond the tube bank, means providing a combustion chamber in front of the tube bank arranged for the combustion of pulverized fuel in suspension, a longitudinally extending lower header located at the bottom of the combustion chamber and adjacent one side thereof, means to supply water from the water drum to the header, an upper longitudinal header at each side of the combustion chamber, a row of water tubes extending upwardly from the lower header to the upper header on the same side to provide a water cooled wall for the adjacent side of the combustion chamber, a row of water tubes extending laterally from the lower header and across the bottom of the combustion chamber to provide a water cooled floor and thence upwardly to provide a water cooled wall for the other side of the combustion chamber, the rear edge of the floor being spaced forwardly from the water drum, and means providing an ash pocket in the rear of the floor and between the forwardly extending portions of the refractory side walls.

5. A steam generator comprising a transverse steam-and-water drum, a transverse water drum therebeneath, a bank of tubes connecting the drums, refractory side walls located on opposite sides of the tube bank and extending forwardly beyond the tube bank, means providing a combustion chamber in front of the tube bank, a longitudinal header at each side of the combustion chamber adjacent the upper portion thereof, a row of water wall tubes at each side of the combustion chamber to provide water cooled walls in front of the refractory walls, the water wall tubes being connected at their upper ends to the headers, means to supply water from the water drum to the lower ends of the water wall tubes, and water tubes leading from the end portions of the water drum to the rear portions of the headers to protect the forwardly extending portions of the refractory side walls from the heat of combustion.

6. A steam generator comprising a transverse steam-and-water drum, a transverse water drum

therebeneath, a bank of tubes connecting the drums, refractory side walls located on opposite sides of the tube bank, means providing a combustion chamber in front of the tube bank, a row of water wall tubes at each side of the combustion chamber to provide water cooled walls in front of the refractory walls, each row of water wall tubes being located in a plane which is offset outwardly from the plane of the inner surface of the adjacent refractory wall, means to supply water from the water drum to the water wall tubes, longitudinal headers to which the upper ends of the water wall tubes are connected, each header being located in a vertical plane intermediate the plane of the water wall tubes and the plane of the inner surface of the refractory wall, releaser tubes extending upwardly from the headers and thence rearwardly along the inner surfaces of the refractory walls to the end portions of the steam-and-water drum, and refractory material located outside the releaser tubes in front of the refractory walls and above the headers.

7. A steam generator comprising a transverse steam-and-water drum, a transverse water drum therebeneath, a bank of tubes connecting the drums, refractory side walls located on opposite sides of the tube bank, means providing a combustion chamber in front of the tube bank, a row of water wall tubes at each side of the combustion chamber to provide water cooled walls in front of the refractory walls, means to supply water from the water drum to the water wall tubes, longitudinal headers to which the upper ends of the water wall tubes are connected, releaser tubes extending upwardly from the headers and thence rearwardly between the tube bank and the refractory walls to connect with the end portions of the steam-and-water drum, a baffle of refractory material extending upwardly from the water drum, and two water tubes extending upwarlly from the water drum in supporting relation to the sides of the baffle, the upper portions of the last mentioned tubes being bent rearwardly and entering the steam-and-water drum below and rearwardly of the releaser tubes.

8. A steam generator comprising a transverse steam-and-water drum, a transverse water drum therebeneath, a bank of tubes connecting the drums, refractory side walls located on opposite sides of the tube bank, means providing a combustion chamber in front of the tube bank, a row of water wall tubes at each side of the combustion chamber to provide water cooled walls in front of the refractory walls, means to supply water from the water drum to the water wall tubes, longitudinal headers to which the upper ends of the water wall tubes are connected, releaser tubes extending upwardly from each header and thence rearwardly between the tube bank and the adjacent refractory wall to enter the adjacent end portion of the steam-and-water drum in a circumferential row, a baffle of refractory material extending upwardly from the water drum, and two water tubes extending upwardly from the water drum in supporting relation to the sides of the baffle, the upper portion of each of the last mentioned tubes being bent rearwardly and entering the steam-and-water drum below and rearwardly of the adjacent releaser tubes and in the same circumferential row therewith.

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CERTIFICATE OF CORRECTION.

Patent No. 2,293,833. August 25, 1942.

MAX H. KUHNER, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 30, for the words "the floor of" read --a closed floor for--; page 4, second column, line 5, for "upwarlly" read --upwardly--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 29th day of September, A. D. 1942.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)