May 27, 1947. M. H. KUHNER 2,421,074

STEAM GENERATOR

Filed Oct. 12, 1944 2 Sheets-Sheet 1

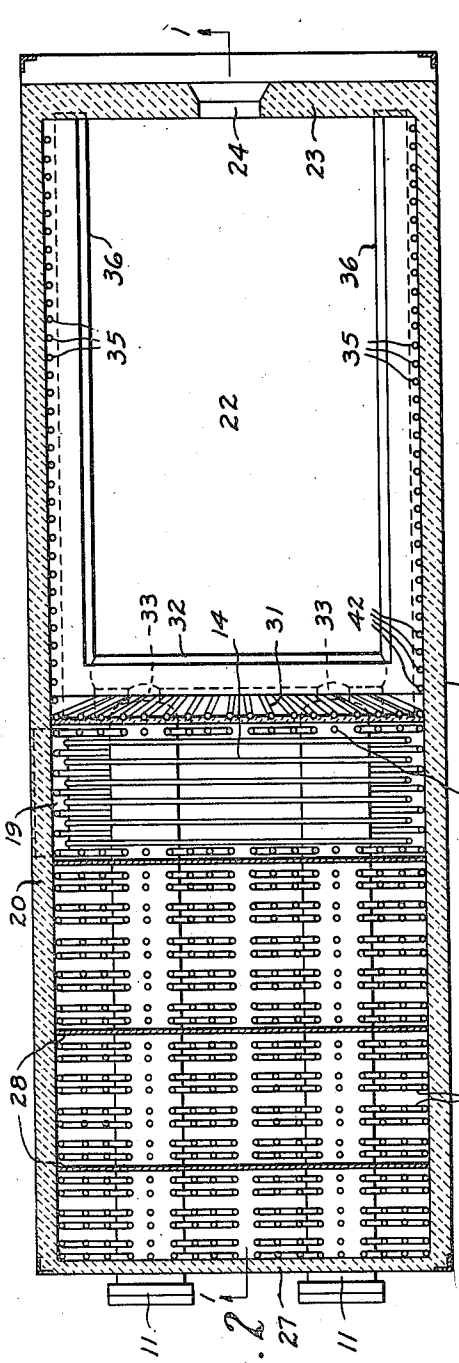

Fig. 2

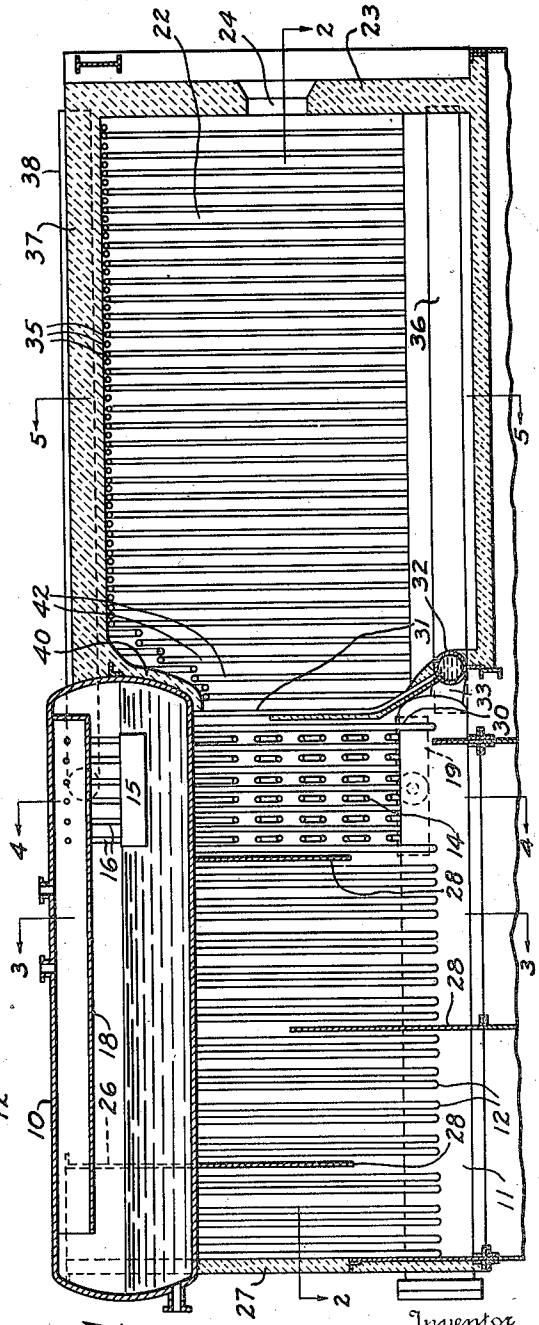

Fig. 1

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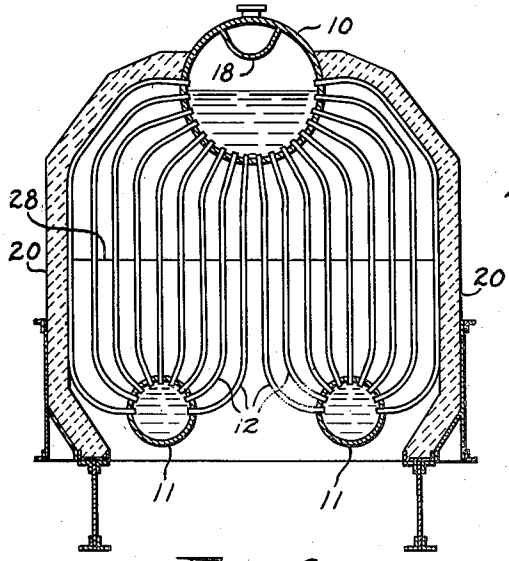


Fig. 3

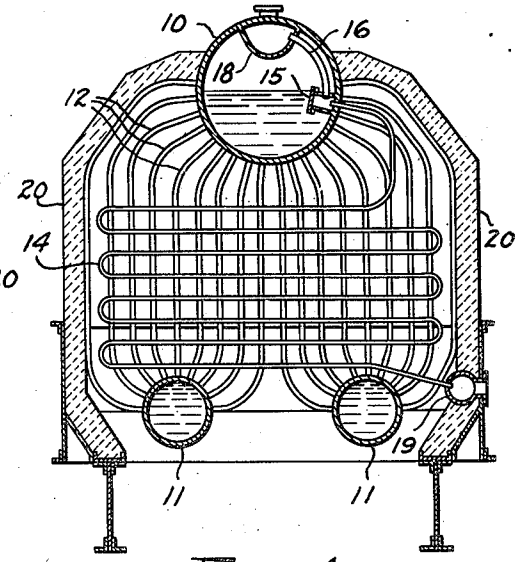


Fig. 4

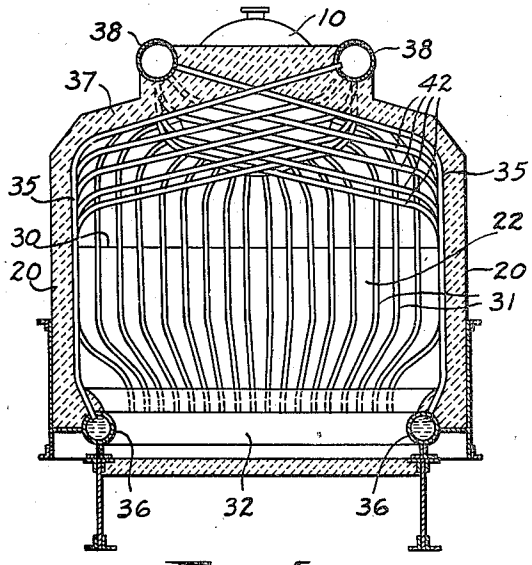


Fig. 5

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# UNITED STATES PATENT OFFICE

2,421,074

## STEAM GENERATOR

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Application October 12, 1944, Serial No. 558,321

8 Claims. (Cl. 122—347)

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This invention relates to steam generators, and more particularly to steam generators of the water tube type having a longitudinally extending steam-and-water drum and a combustion chamber located in front of the drum.

It is one object of the invention to provide a water tube steam generator of relatively high capacity which can be assembled as a unit and yet be sufficiently compact for railway shipment.

It is a further object of the invention to provide a water tube steam generator which will have a relatively high capacity in proportion to the vertical space occupied.

It is a further object of the invention to provide a water tube generator having a combustion chamber located in front of a longitudinally extending steam-and-water drum, and particularly to provide a novel and effective arrangement of water tubes to protect the front end of the drum from excessive heat.

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 vertical section through a steam generator, taken on the line 1—1 of Fig. 2;

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

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

Fig. 4 is a section taken on the line 4—4 of Fig. 1; and

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

The embodiment illustrated comprises a longitudinally extending steam-and-water drum 10 and two longitudinally extending water drums or headers 11 located therebeneath. These lower drums 11 are substantially coextensive in length with the upper drum 10, and they are considerably smaller in diameter than the upper drum, in fact approximately one-half the diameter thereof. The lower drums 11 are positioned at a common level and their axes are preferably spaced apart a distance somewhat exceeding the diameter of the upper drum 10. The upper drum is connected to the two lower drums by transverse rows of upright water tubes 12 forming the convection heating surface of the steam generator.

If superheated steam is required, some of the water tubes 12 may be omitted adjacent the front portions of the drums to provide a space for a tubular superheater 14. The upper ends of the superheater tubes are connected to the steam-and-water drum 10 and enclosed by a box 15 within the drum. This box is connected by tubes 16 to the interior of a chamber or conduit 18 in the steam space of the drum 10 and communicating with the rear portion thereof. The lower ends of the superheater tubes 14 are connected to a steam outlet header 19 spaced outwardly from one of the lower drums 11.

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The various parts as so far described are mounted with a setting including opposed upright side walls 20 which extend forwardly for a considerable distance beyond the drums to provide a furnace or combustion chamber 22. The front wall 23 of the combustion chamber is provided with a burner opening 24 for the introduction of air and a suitable fuel, such as oil, which is burned in suspension. The hot gaseous products of combustion flow rearwardly into contact with the superheater 14 and the water tubes 12, the gases eventually escaping upwardly through outlet ducts 26 on opposite sides of the drum 10 and adjacent to the rear wall 27 of the setting. Suitable transverse vertical baffles 28 are provided among the water tubes 12 to direct the gases into a tortuous path.

At the rear of the combustion chamber 22 there is provided a bridge wall 30 of refractory material with its upper edge spaced downwardly from the front portion of the upper drum 10. The lower part of this wall slopes forwardly and downwardly in front of the lower drums 11 to protect the front ends of these drums from the radiant heat of the furnace. This wall 30 is supported and cooled by a transverse row of upright water tubes 31 with thier upper ends connected to the drum 10 and their lower ends connected to a transverse header 32. This header is located immediately in front of the drums 11 and connected to each of these drums by a large tube or nipple 33.

The side walls 20 of the combustion chamber 22 are protected by upright water wall tubes 35 which are connected at their lower ends to longitudinally extending headers 36. The rear portions of the headers 36 are connected to the transverse header 32. The lower surfaces of the headers 32 and 36 are positioned at substantially the same level as the lower surfaces of the lower drums 11. The upper portions of the water wall tubes 35 are bent laterally inward to form a support for the roof 37 of the furnace 22, the tubes from opposite sides crossing one another along a

line corresponding approximately to a forward projection of the axis of the drum 10. The upper ends of the tubes 35 are connected to longitudinally extending headers 38 which are connected at their rear ends to opposite sides of the drum 10 above the normal water level therein. This construction provides a relatively high combustion space without adding anything to the overall height of the steam generator.

Because of the height of the furnace relative to the upper drum 10, it becomes important to protect the front end of this drum from excessive heat. For this purpose a layer of refractory material 40 is applied to this drum head, but a still further protection will ordinarily be required. Accordingly I preferably arrange a protecting screen of water tubes 42 in the upper rear portion of the furnace 22, close to the drum head. The lower portions of these tubes 42 form water wall tubes which extend upwardly from the headers 36 and adjacent the side walls 20, rearwardly of the tubes 35. The upper portions of the tubes 42 are bent laterally inward in a manner similar to the tubes 35, the tubes from opposite sides crossing one another and connecting at their upper ends with the headers 38. The tubes 42 however cross at lower elevations than the tubes 35, and the points of crossing are progressively lower toward the rear. Consequently the crossed portions of the tubes 42 form a very effective water cooled screen to shield the front end of the drum 10 from radiant heat, besides deflecting the hot gases downwardly away from the drum. In the embodiment illustrated there are eight of the tubes 42, but this number may be either increased or decreased without departing from the spirit of the invention.

In the operation of the apparatus, water from the lower drums 11 will flow through the nipples 33 to the header 32 and thence to the headers 36, thereby ensuring an adequate water supply to the lower ends of the water tubes 31, 35 and 42. Since these tubes are exposed to the radiant heat of the burning fuel, they will generate steam at a high rate and discharge this steam into the upper drum 10. Additional steam will be generated in the water tubes 12, particularly in those nearest the furnace. The steam will leave the upper drum through the conduit 18, tubes 16 and box 15, thence entering the superheater tubes 14 and escaping through the header 19 to a place of use. The hot gases from the furnace 22 will flow rearwardly over the top of the bridge wall 30 into contact with the superheater 14 and water tubes 12, eventually escaping through the outlet ducts 26.

The various pressure parts can be shop assembled into a structure having an over-all height determined by the distance from the bottom surfaces of the lower drums 11 to the top surface of the upper drum 10. With such a structure built within the limits of ordinary railway clearances, an unusually large steam generating capacity is obtainable. This is brought about largely by the novel arrangement of the water cooled combustion chamber 22. By providing the two lower drums 11 with diameters which are small in proportion to the diameter of the upper drum 10, it becomes feasible to widen the setting and to increase the number of convection water tubes 12. This is an additional feature which contributes to high capacity within a relatively low headroom. The high furnace 22 not only ensures a large fuel-burning capacity, but it also adds to the efficiency of combustion.

Having thus described my invention, what I



claim as new and desire to secure by Letters Patent is:

1. A steam generator comprising a longitudinally extending steam-and-water drum, transverse rows of upright water tubes beneath the drum and connected at their upper ends to the drum, means providing a combustion chamber in front of the water tubes and drum and arranged to supply hot gases for heating the water tubes, upright water wall tubes at one side of the combustion chamber, the upper portions of the water wall tubes being bent laterally to extend across the combustion chamber and support the roof thereof at a substantial distance above the lower surface of the drum, and other upright water wall tubes at one side of the combustion chamber with their upper portions bent laterally to extend beneath the roof and across the front end of the drum as a screen to shield the drum from the heat in said chamber.

2. A steam generator comprising a longitudinally extending steam-and-water drum, transverse rows of upright water tubes beneath the drum and connected at their upper ends to the drum, means providing a combustion chamber in front of the water tubes, upright water wall tubes at both sides of the combustion chamber, the upper portions of the water wall tubes being bent laterally to support the roof of the combustion chamber and crossing one another at a substantial distance above the lower surface of the drum, and other upright water wall tubes at both sides of the combustion chamber rearwardly of the first-mentioned water wall tubes, the upper portions of the said other water wall tubes being bent laterally to cross one another and form a screen so located as to shield the front end of the drum from the heat in said chamber.

3. A steam generator comprising a longitudinally extending steam-and-water drum, transverse rows of upright water tubes beneath the drum and connected at their upper ends to the drum, means providing a combustion chamber in front of the water tubes, upright water wall tubes at both sides of the combustion chamber, the upper portions of the water wall tubes being bent laterally to support the roof of the combustion chamber and crossing one another at approximately the height of the axis of the drum, and other upright water wall tubes at both sides of the combustion chamber rearwardly of the first-mentioned water wall tubes, the upper portions of the said other water wall tubes being bent laterally to cross one another at points which are successively lower from front to rear and form a screen so located as to shield the front end of the drum from the heat in said chamber.

4. A steam generator comprising a longitudinally extending steam-and-water drum, two longitudinally extending water drums located beneath the steam-and-water drum, transverse rows of upright water tubes connecting the steam-and-water drum with the water drums, means providing a combustion chamber in front of the water tubes and arranged to supply hot gases for heating the water tubes, a transverse header in front of the water drums, nipples connecting the header to the front ends of the water drums, a transverse row of upright water tubes connecting the header with the steam-and-water drum, two longitudinally extending headers located at opposite sides of the combustion chamber and connected to the transverse header, and water wall tubes extending upwardly from the longitudinally extending headers, the upper ends of the said water

wall tubes communicating with the steam-and-water drum.

5. A steam generator comprising a longitudinally extending steam-and-water drum, two longitudinally extending water drums located beneath the steam-and-water drum on opposite sides of the axis thereof, the water drums being considerably smaller in diameter than the steam-and-water drum, transverse rows of upright water tubes connecting the steam-and-water drum with the water drums, means providing a combustion chamber in front of the water tubes, a transverse header in front of the water drums, nipples connecting the header to the front ends of the water drums, a transverse row of upright water tubes connecting the header with the steam-and-water drum, two longitudinally extending headers located at opposite sides of the combustion chamber and connected to the transverse header, the lower surfaces of the two longitudinally extending headers and of the transverse header being in approximately the same horizontal plane as the lower surfaces of the water drums, and water wall tubes extending upwardly from the longitudinally extending headers, the upper ends of the water wall tubes communicating with the steam-and-water drum.

6. A steam generator comprising a longitudinally extending steam-and-water drum, two longitudinally extending water drums located beneath the steam-and-water drum on opposite sides of the axis thereof, the water drums being considerably smaller in diameter than the steam-and-water drum, transverse rows of upright water tubes connecting the steam-and-water drum with the water drums, means providing a combustion chamber in front of the water tubes, a transverse header in front of the water drums, nipples connecting the header to the front ends of the water drums, a transverse row of upright water tubes connecting the header with the steam-and-water drum, two longitudinally extending headers located at opposite sides of the combustion chamber and connected to the transverse header, water wall tubes extending upwardly from the longitudinally extending headers, the upper portions of the water wall tubes being bent laterally to support the roof of the combustion chamber and crossing one another at a substantial distance above the lower surface of the steam-and-water drum, other water wall tubes extending upwardly from the longitudinally extending headers rearwardly of the first-mentioned water wall tubes, the upper portions of the said other water wall tubes being bent laterally to cross one another and form a screen so located as to shield the front end of the steam-and-water drum from the heat in said chamber, and means connecting the upper ends of the water wall tubes to the steam-and-water drum.

7. A steam generator comprising a longitudinally extending steam-and-water drum, two longitudinally extending water drums located beneath the steam-and-water drum on opposite sides of the axis thereof, the water drums being considerably smaller in diameter than the steam-and-water drum, transverse rows of upright water tubes connecting the steam-and-water drum with the water drums, means providing a combustion chamber in front of the water tubes, a transverse header in front of the water drums, nipples connecting the header to the front ends of the water drums, a transverse row of upright water tubes connecting the header with the steam-and-water drum, two longitudinally extending headers located at opposite sides of the combustion chamber and connected to the transverse header, water wall tubes extending upwardly from the longitudinally extending headers, the upper portions of the water wall tubes being bent laterally to support the roof of the combustion chamber and crossing one another at a substantial distance above the lower surface of the steam-and-water drum, other water wall tubes extending upwardly from the longitudinally extending headers rearwardly of the first-mentioned water wall tubes, the upper portions of the said other water wall tubes being bent laterally to cross one another at points which are successively lower from front to rear and form a screen so located as to shield the front end of the steam-and-water drum from the heat in said chamber, and two headers extending longitudinally above the combustion chamber and connected to opposite sides of the steam-and-water drum, the upper ends of the water wall tubes being connected to the last-mentioned headers.

8. A steam generator comprising a longitudinally extending steam-and-water drum, transverse rows of upright water tubes beneath the drum and connected at their upper ends to the drum, means providing a combustion chamber in front of the water tubes and drum and arranged to supply hot gases for heating the water tubes, the combustion chamber having a roof located at a substantial distance above the lower surface of the drum, and upright water wall tubes at one side of the combustion chamber with their upper portions bent laterally to extend beneath the roof and across the front end of the drum as a screen to shield the drum from the heat in said chamber.

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