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2,081,241

STEAM GENERATOR

Filed April 28, 1936

2 Sheets-Sheet 1

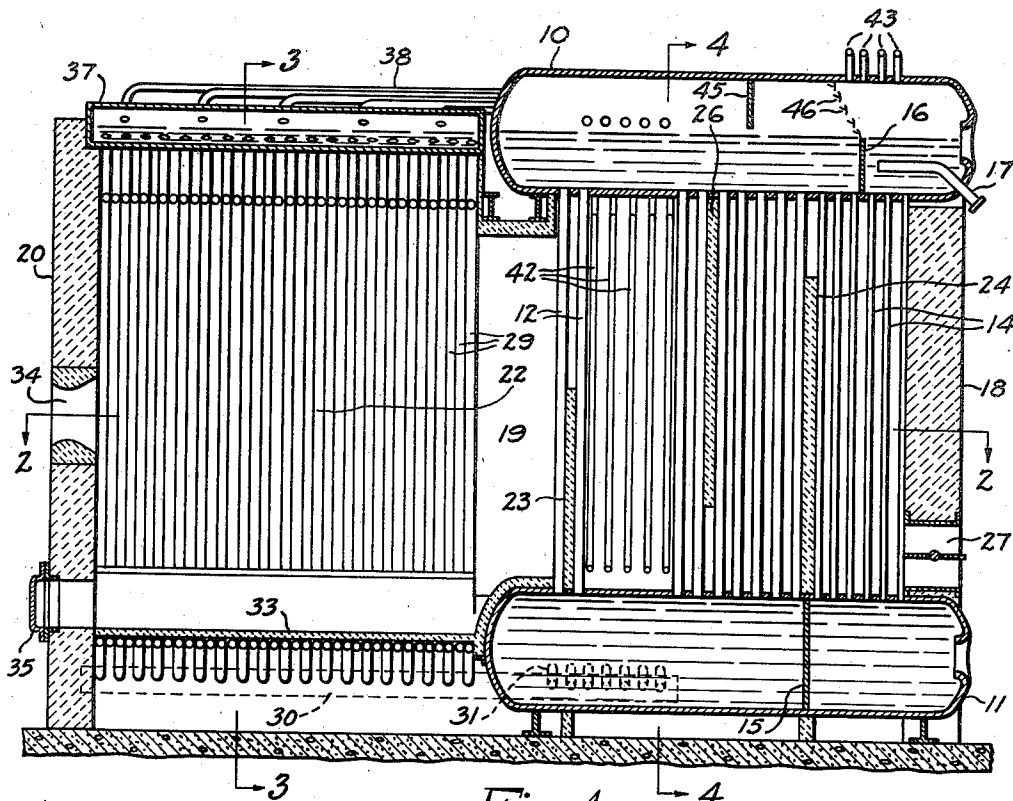
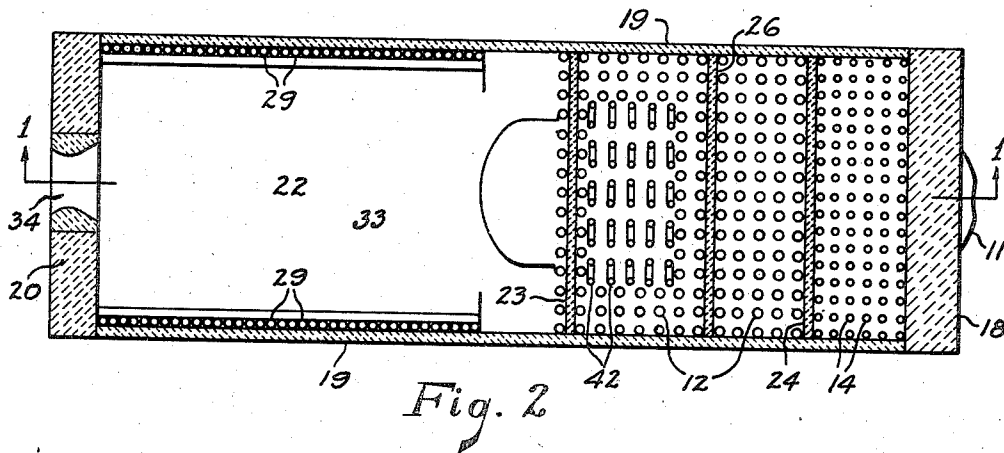


Fig. 1

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2 Sheets-Sheet 2

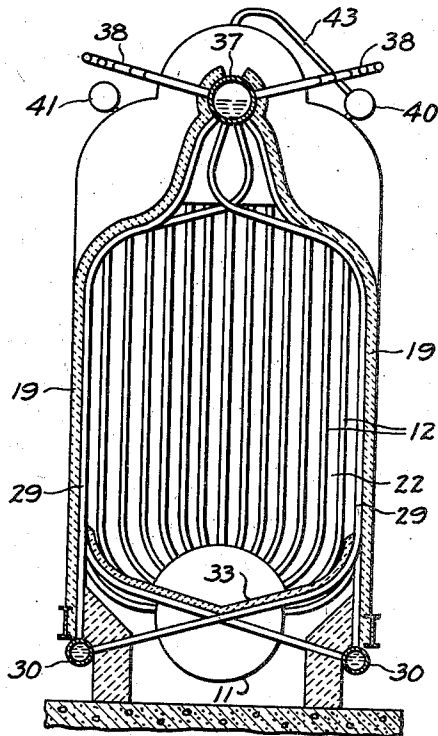


Fig. 3

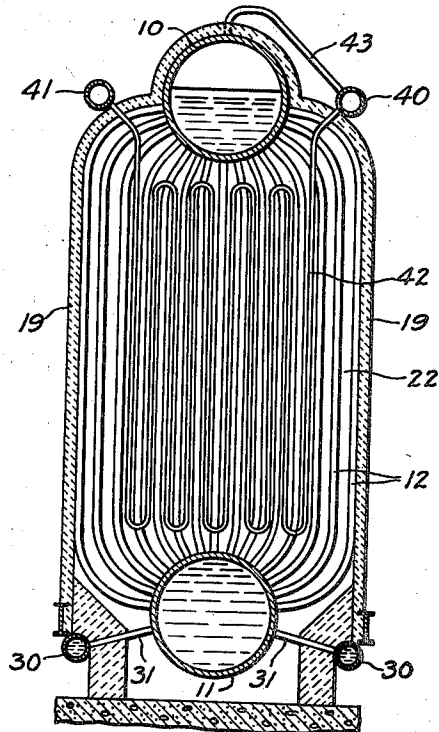


Fig. 4

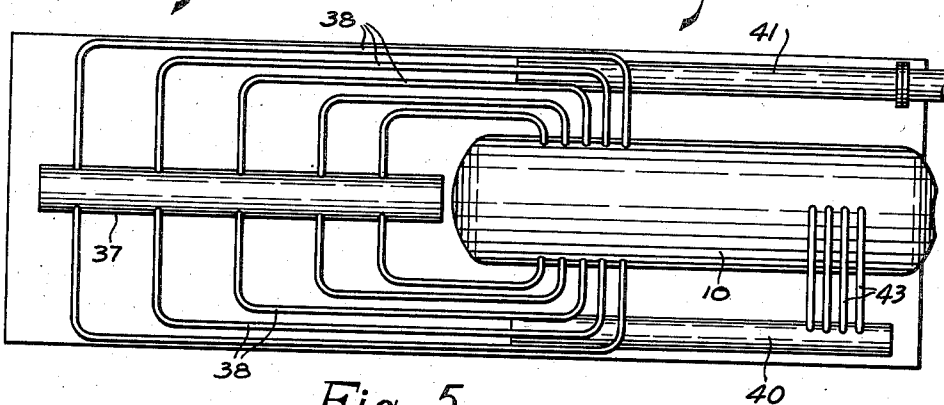


Fig. 5.

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## UNITED STATES PATENT OFFICE

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## STEAM GENERATOR

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Application April 28, 1936, Serial No. 76,779

8 Claims. (Cl. 122—347)

This invention relates to steam generators, and more particularly to steam generators of the water tube type.

It is one object of the invention to provide a steam generator which will have a large capacity and which will require comparatively little head-room.

It is a further object of the invention to provide a steam generator which can be operated with various fuels burned either in suspension or in solid form.

It is a further object of the invention to provide a steam generator which will afford a large water cooled combustion chamber.

It is a further object of the invention to provide a steam generator which will operate at high efficiency and which will be comparatively simple and inexpensive to manufacture.

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. 2;

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;

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

Fig. 5 is a top plan view of the apparatus with certain parts removed for clearness of illustration.

The embodiment illustrated comprises an upper longitudinal steam-and-water drum 10 and a lower longitudinal water drum 11 therebeneath. These drums are connected by a bank of substantially vertical water tubes 12 with their end portions bent to enter the drums radially, as shown in Fig. 4. The drums 10 and 11 are also connected by a second bank of substantially vertical water tubes 14 located in the rear of the tubes 12 and likewise provided with end portions bent to enter the drums radially. The tubes 14 are preferably somewhat smaller in diameter than the tubes 12.

The rear bank of tubes 14 is arranged to serve as an integral economizer. For this purpose a transverse baffle plate 15 (Fig. 1) is mounted within the lower drum 11 between the lower ends of the tubes 12 and the lower ends of the tubes 14, and a transverse baffle plate 16 is mounted within the upper drum 10 to separate the upper ends of certain of the tubes 14 from the others. The

plate 15 extends entirely across the lower drum 11, and the plate 16 is arranged with its upper edge at approximately the center of the upper drum 10. Feed water is supplied to the upper drum 10 in the rear of the plate 16 through a nozzle 17. With this construction the feed water flows downwardly through certain of the tubes 14 to the lower drum 11 and thence upwardly through the remainder of the tubes 14 to the upper drum 10 in front of the plate 16.

Provision is made for the burning of fuel, and the delivery of the hot gaseous products of combustion into contact with the tubes 12 and 14. For this purpose a wall 18 is located close to and in the rear of the tubes 14, and walls 19 are located on opposite sides of the tubes 12 and 14. These side walls 19 are extended forwardly to meet a front wall 20, thus forming a combustion chamber or furnace 22 in front of the water tubes 12. A transverse baffle wall 23 extends upwardly from the lower drum 11 between the first and second rows of tubes 12, and a similar baffle wall 24 extends upwardly from the lower drum between the tube banks 12 and 14. A third transverse baffle wall 25 extends downwardly from the upper drum 10 intermediate the walls 23 and 24. A dampered gas outlet opening 27 is provided in the rear wall 18 near the lower drum. With this construction the furnace gases are compelled to follow a tortuous path from the combustion chamber 22, into contact with the tubes 12 and 14, and thence through the outlet 27.

The forwardly extended portions of the walls 19, which form the side walls of the combustion chamber 22, are lined with vertical water tubes 29. These tubes are preferably closely spaced, and their lower ends are connected to a pair of horizontal longitudinal headers 30 located on opposite sides of the combustion chamber. The rear portion of each header 30 is connected to the lower water drum 11 by a row of tubes 31, these tubes entering the drum in front of the plate 15. If fuel is to be burned in suspension in the chamber 22, the lower ends of alternate tubes 29 on each side wall are preferably bent laterally and connected to the header 30 on the opposite side of the furnace, as shown particularly in Fig. 3, thus providing a crossed arrangement of tubes each of which slopes upwardly at a slight angle from the corresponding header. These sloping portions of the tubes may serve to support a layer of refractory material 33 which forms a floor or bottom for the combustion chamber. The front wall 20 is provided with a suitable burner opening 34 for the introduction of fuel

and air, and with a suitable door 35 (Fig. 1) near the floor 33 for the removal of ash therefrom.

At the top of the combustion chamber 22 the tubes 29 are bent inwardly and connected to a central longitudinal header 37 located in front of the upper drum 10 and in substantial alignment therewith. Certain of the tubes are preferably arranged in crossed relationship with tubes from the other side of the combustion chamber, just beneath the header 37, thereby protecting the header to a considerable extent from the heat of the furnace. The header 37 is connected to the front portion of the upper drum 10 by means of a series of tubes 38, these tubes entering the header from both sides and at points distributed along the length thereof.

In case superheated steam is desired, I may provide a superheater comprising an inlet header 40 and an outlet header 41 located on opposite sides of the upper drum 10 and parallel therewith. These headers are connected by a plurality of sinuous tubes 42 which are positioned in transverse vertical planes in the path of the hot gases, between the baffles 23 and 26. Certain of the water tubes 12 near the superheater tubes are preferably omitted in order to avoid chilling of the superheater tubes and resultant decrease in superheat. Steam is delivered to the superheater inlet header 40 by means of tubes 43 which lead from the rear portion of the upper drum 10. In order to ensure delivery of substantially dry steam to the superheater, a deflector plate 45 is arranged to extend downwardly from the upper wall of the upper drum 10 in the rear of the tubes 38, as shown in Fig. 1, and a series of baffle elements 46 are provided between the baffle plate 16 and the upper wall of the drum in front of the tubes 43.

The operation of the invention will now be apparent from the above disclosure. A suitable fuel, such as pulverized coal, is burned in suspension in the combustion chamber 22, and the gaseous products of combustion flow over the baffle 23 into contact with the water tubes 12 and the superheater tubes 42. The gases then flow beneath the baffle 26 and over the baffle 24 into contact with the economizer tubes 14 and thence to the outlet 27. Feed-water enters the upper drum 10 in the rear of the plate 16 through the nozzle 17, and flows downwardly through certain of the tubes 14 to the drum 11 and thence upwardly through the remainder of the tubes 14 to the upper drum 10 in front of the plate 16, being heated during its passage through the tubes. Steam is generated in the tubes 12 and 29. The tubes 12 deliver steam directly to the upper drum 10, while the steam from the tubes 29 flows first into the header 37 and thence through the tubes 38 to the drum. It will thus be seen that the steam is released in the front portion of the drum 10 and flows rearwardly through the drum past the deflector plate 45, which tends to deflect moisture particles downwardly, and then past the baffle elements 46, which remove most of the water particles remaining in the steam. The steam then flows through the tubes 43 to the superheater 42, and thence to a place of use.

The water level in the rear portion of the drum 10 will remain comparatively quiet because of the shielding effect of the plate 16 and by reason of the fact that the steam is all released in the front part of the drum. This is of considerable assistance in obtaining the delivery of dry steam to the superheater. The entire apparatus is simple, inexpensive, and efficient in operation, and requires a minimum of headroom.

A stoker can be readily installed if desired, and in that case the water cooled floor would be omitted, all the tubes 29 on each side being connected to the corresponding lower header 30.

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

1. A steam generator comprising a longitudinal steam-and-water drum, a longitudinal water drum therebeneath, substantially vertical water tubes connecting the drums, walls providing a combustion chamber in front of the water tubes, means to direct hot gases from the combustion chamber into contact with the water tubes, a transverse baffle plate mounted within the steam-and-water drum in front of the upper ends of the rearmost of the water tubes, the upper edge of the baffle plate being spaced from the top of the drum, a series of baffle elements located within the steam-and-water drum between the upper edge of the baffle plate and the top of the drum, means to supply feed water to the steam-and-water drum in the rear of the baffle plate, and means to withdraw steam from the steam-and-water drum in the rear of the baffle elements.

2. A steam generator comprising a longitudinal steam-and-water drum, a longitudinal water drum therebeneath, substantially vertical water tubes connecting the drums, walls providing a combustion chamber in front of the water tubes, means to direct hot gases from the combustion chamber into contact with the water tubes, a longitudinal header in front of the steam-and-water drum and at the top of the combustion chamber, upright water wall tubes associated with the side walls of the combustion chamber and connected at their upper ends to the header, means to supply water from the water drum to the lower ends of the water wall tubes, and means to deliver steam from the header to the steam-and-water drum.

3. A steam generator comprising a longitudinal steam-and-water drum, a longitudinal water drum therebeneath, substantially vertical water tubes connecting the drums, walls providing a combustion chamber in front of the water tubes, means to direct hot gases from the combustion chamber into contact with the water tubes, a longitudinal header in front of the steam-and-water drum and at the top of the combustion chamber, upright water wall tubes associated with the side walls of the combustion chamber and connected at their upper ends to the header, means to supply water from the water drum to the lower ends of the water wall tubes, and a series of tubes connecting the header with the steam-and-water drum and entering the header at points distributed along the length thereof.

4. A steam generator comprising a longitudinal steam-and-water drum, a longitudinal water drum therebeneath, substantially vertical water tubes connecting the drums, walls providing a combustion chamber in front of the water tubes, means to direct hot gases from the combustion chamber into contact with the water tubes, a longitudinal header in front of the steam-and-water drum and at the top of the combustion chamber, upright water wall tubes associated with the side walls of the combustion chamber and connected at their upper ends to the header, certain of the water wall tubes being arranged in crossed relationship with tubes from the other side of the combustion chamber, just beneath the header, thereby protecting the header from the heat, means to supply water from the water drum

to the lower ends of the water wall tubes, and means to deliver steam from the header to the steam-and-water drum.

5 5. A steam generator comprising a longitudinal steam-and-water drum, a longitudinal water drum therebeneath, substantially vertical water tubes connecting the drums, walls providing a combustion chamber in front of the water tubes, means to direct hot gases from the combustion chamber  
10 into contact with the water tubes, a longitudinal header in front of the steam-and-water drum and at the top of the combustion chamber, upright water wall tubes associated with the side walls of the combustion chamber and connected at  
15 their upper ends to the header, means to supply water from the water drum to the lower ends of the water wall tubes, means to deliver steam from the header to the front portion of the steam-and-water drum, and means to withdraw steam from  
20 the rear portion of the steam-and-water drum.

6. A steam generator comprising a longitudinal steam-and-water drum, a longitudinal water drum therebeneath, substantially vertical water tubes connecting the drums, walls providing a combustion chamber in front of the water tubes, means to direct hot gases from the combustion chamber  
25 into contact with the water tubes, a longitudinal upper header in front of the steam-and-water drum and at the top of the combustion chamber, a pair of longitudinal lower headers on opposite  
30 sides of the combustion chamber, upright water wall tubes connecting the lower headers with the upper header and associated with the side walls of the combustion chamber, means to supply water from the water drum to the lower headers, and  
35 means to deliver steam from the upper header to the steam-and-water drum.

7. A steam generator comprising a longitudinal steam-and-water drum, a longitudinal water drum therebeneath, substantially vertical water tubes connecting the drums, walls providing a combustion chamber in front of the water tubes, means to direct hot gases from the combustion

chamber into contact with the water tubes, a longitudinal upper header in front of the steam-and-water drum and at the top of the combustion chamber, a pair of longitudinal lower headers  
5 on opposite sides of the combustion chamber, upright water wall tubes connecting the lower headers with the upper header and associated with the side walls of the combustion chamber, the lower ends of certain of the water wall tubes  
10 being bent laterally and connected to the lower header on the opposite side of the combustion chamber, means to supply water from the water drum to the lower headers, and means to deliver steam from the upper header to the steam-and-water drum.  
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8. A steam generator comprising a longitudinal steam-and-water drum, a longitudinal water drum therebeneath, substantially vertical water tubes connecting the drums, walls providing a combustion chamber in front of the water tubes,  
20 means to direct hot gases from the combustion chamber into contact with the water tubes, a longitudinal upper header in front of the steam-and-water drum and at the top of the combustion chamber, a pair of longitudinal lower headers  
25 on opposite sides of the combustion chamber, upright water wall tubes connecting the lower headers with the upper header and associated with the side walls of the combustion chamber, the lower ends of alternate water wall tubes on each side  
30 wall being bent laterally and connected to the lower header on the opposite side of the combustion chamber, this construction providing a crossed arrangement of tubes each of which slopes upwardly at a slight angle from the correspond-  
35 ing lower header, a layer of refractory material supported by the sloping portions of the water wall tubes to form a floor for the combustion chamber, means to supply water from the water drum to the lower headers, and means to deliver  
40 steam from the upper header to the steam-and-water drum.

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