July 18, 1944. G. A. REHM 2,354,059

STEAM GENERATOR

Filed May 15, 1942 2 Sheets-Sheet 1

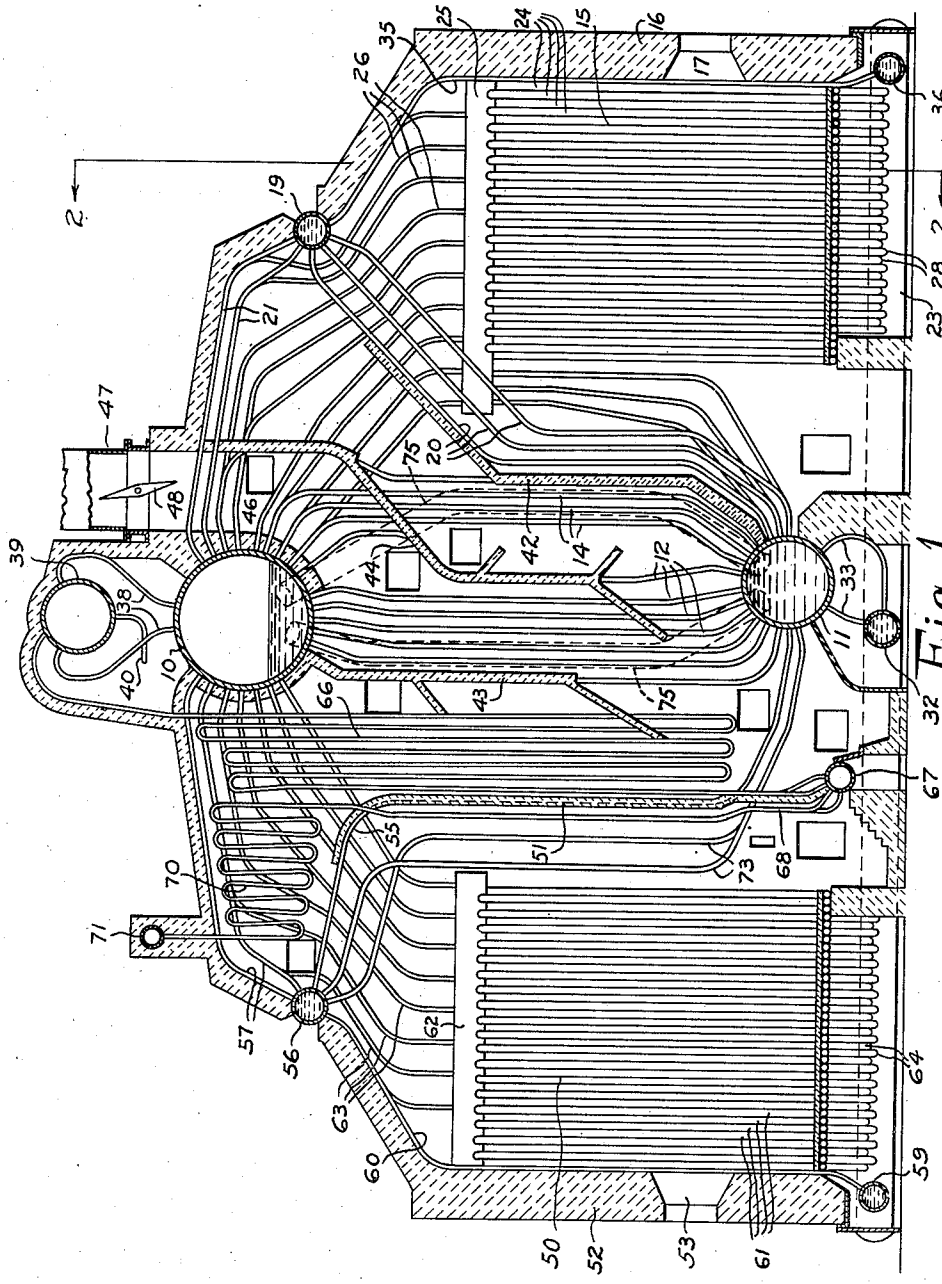


Fig. 1

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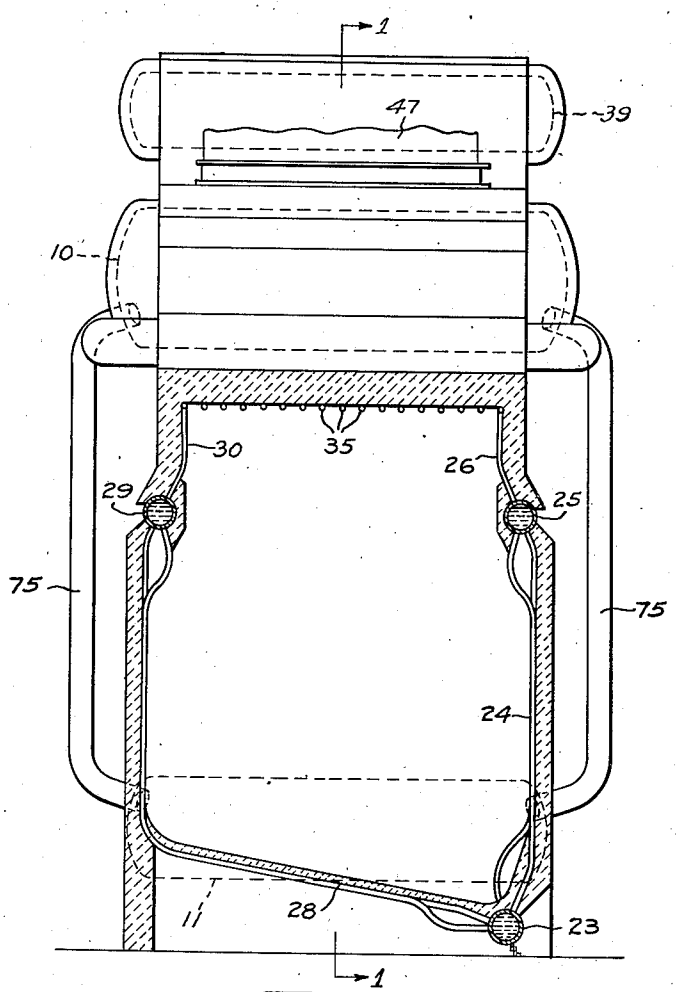


Fig. 2

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STEAM GENERATOR

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7 Claims. (Cl. 122—240)

This invention relates to steam generators, and more particularly to water tube steam generators combined with superheaters and having two separate furnaces so arranged that by varying the rate of combustion in one furnace relative to that in the other furnace the temperature of the superheated steam can be accurately controlled.

It is one object of the invention to provide a dual-furnace steam generator and superheater which can be operated efficiently at relatively high rates of steam generation, with accurate control of the superheated steam temperature.

It is a further object of the invention to provide a dual-furnace steam generator and superheater having provision for adequate water-cooling of both furnaces and so arranged that the gases from both furnaces flow in contact with sufficient convection tube surfaces to ensure comparatively high operating efficiency.

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; and

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

The embodiment illustrated comprises a transverse steam-and-water drum 10 and a transverse water drum 11 therebeneath, these drums being connected by a rear bank of upright water tubes 12 and by a front bank of upright water tubes 14. In front of these tube banks there is provided a furnace or combustion chamber 15 having a front wall 16 with an opening 17 therein for the introduction of fuel to be burned in suspension. A transverse header 19 is mounted above the furnace 15, this header being connected to the water drum 11 by a bank of water tubes 20 and to the steam-and-water drum 10 by two rows of tubes 21. A longitudinal lower header 23 is provided adjacent one side wall of the furnace 15, this header being connected by water wall tubes 24 to a longitudinal upper header 25 which in turn is connected by releaser tubes 26 to the steam-and-water drum 10. A row of water tubes 28 extend transversely from the lower header 23 across the furnace 15 to provide a water cooled floor therefor and thence upwardly adjacent the opposite side wall to provide water wall tubes, with their upper ends connected to a longitudinal upper header 29 (Fig. 2), this header being connected to the steam-and-water drum 10 by a row of releaser tubes 30. Water is supplied to the lower header 23 by a transverse header 32 located adjacent the water drum 11 and connected to this drum by water tubes 33. The header 32 connects directly with the header 23. The front wall 16 is cooled and protected by a row of water tubes 35 which extend upwardly from a lower transverse header 36 to the header 19, the header 36 being directly connected to the header 23 to receive water therefrom. Two rows of tubes 38 extend upwardly from the steam-and-water drum 10 to a transverse steam drum 39 thereabove, the steam drum having a drain tube 40 leading downwardly outside the setting and preferably connected to the header 23.

The gaseous products of combustion from the furnace 15 are directed into contact successively with the tubes 20, the tubes 14, and the tubes 12. For this purpose a baffle 42 extends upwardly from the water drum 11 behind the tubes 20, and a baffle 43 extends downwardly from the steam-and-water drum 10 behind the tubes 12. Between these two baffles there is provided a third or intermediate baffle 44 with its lower edge spaced above the water drum 11. This baffle 44 extends upwardly and forwardly in front of the steam-and-water drum 10 and in spaced relation therewith to provide a passage 46 through which the gases may escape upwardly to an offtake 47 having a damper 48. With this construction the gases are compelled to flow upwardly from the furnace 15 past the tubes 20, thence rearwardly over the top of the baffle 42 and downwardly in contact with the tubes 14. The gases then travel rearwardly beneath the lower edge of the baffle 44 and upwardly past the water tubes 12, past the upper portion of the tubes 14 and 21, and thence to the offtake 47.

Behind the water tube bank 12 there is provided a second furnace 50 having a front wall 51 and a rear wall 52, the latter having an opening 53 therein for the introduction of fuel to be burned in suspension. The front wall 51 is spaced rearwardly from the baffle 43 and supported by the upright intermediate portions of a row of Z-shaped water tubes 55 which connect the water drum 11 with a transverse header 56 located above the furnace 50. This header 56 is connected to the steam-and-water drum 10 by two rows of water tubes 57. The longitudinal header 23 extends rearwardly to connect

with a transverse header 59 located adjacent the bottom of the rear wall 52, this wall being cooled by water wall tubes 60 which extend upwardly from the header 59 to the header 56. The side walls and floor of the furnace 50 are cooled by a tube arrangement similar to that provided for the furnace 15. Thus, side water wall tubes 61 extend upwardly from the header 23 to a longitudinal header 62 which is connected by releaser tubes 63 to the steam-and-water drum 10. A row of water tubes 64 extend laterally from the header 23, in the same manner as the tubes 28, to cool the furnace floor and the opposite side wall.

The heat produced by the combustion of fuel in the rear furnace 50 is utilized not only for steam generation but also for the superheating of steam. For this purpose a superheater 66 is located in the space or passage between the baffle 43 and the wall 51. This superheater is constructed of tubes shaped to form a series of vertical loops, the inlet ends of the tubes being connected to the steam drum 39, and their outlet ends being connected to a transverse header 67 located adjacent the bottom of the wall 51. A row of tubes 68 extend upwardly from this header 67 in the rear of the wall 51 to a second superheater 70 likewise including vertically looped tubes, the outlet ends of these superheater tubes being connected to a transverse outlet header 71 from which the steam may be withdrawn to a place of use. The superheater 70 is located rearwardly of the superheater 66 and above the upper portions of the water tubes 55 and the furnace outlet.

In order to protect the superheater elements from excessive temperatures and from slag, I preferably provide a series of screen tubes 73 which connect the water drum 11 with the header 56. These tubes 73 are Z-shaped and they extend upwardly behind the superheater tubes 68 and then rearwardly beneath the upper portions of the tubes 55.

In some cases, particularly when the steam generator is to operate at high pressures, I may provide large external downcomer tubes 75 which connect the ends of the steam-and-water drum 10 with the ends of the water drum 11. This will ensure proper water circulation at all times.

The operation of the invention will now be apparent from the above disclosure. A suitable fuel, such as oil, gas, or pulverized coal, will be burned in suspension in both furnaces. The various water tubes exposed to the radiant heat in these furnaces will generate steam rapidly, and this steam will enter the steam-and-water drum 10. The gases from the front furnace 15 will flow upwardly past the tubes 20, downwardly past the tubes 14, and then upwardly past the tubes 12 and the upper portions of the tubes 14 and 21 to the offtake 47. Any steam generated in these tubes will flow into the drum 10, where most of the water will be separated therefrom. The steam will flow from the drum 10 through the tubes 38 to the upper drum 39, where additional moisture will be separated, the steam then flowing through the superheater tubes 66, header 67, and superheater tubes 68 and 70 to the outlet header 71. The gases from the rear furnace 50 will flow upwardly past the water tubes 73 and 55 into contact with the superheater 70, thence forwardly and downwardly in contact with the superheater 66 to the lower portion of the tube bank 12. At this point these gases will join the gases from the front furnace and flow upwardly therewith to the offtake 47. Thus the gases after leaving the respective furnaces take generally U-shaped paths of travel, with the upflow portions of the two paths common to both furnaces.

The front furnace 15 serves primarily as a steam generating or boiler furnace, and the rear furnace 50 serves primarily as a steam superheating furnace, although appreciable quantities of steam will of course be generated in the water wall tubes of the rear furnace. By varying the rate of firing in the front furnace the steam output of the unit may be controlled, and by varying the rate of firing in the rear furnace the temperature of the superheated steam may be controlled. In general, in order to maintain a constant superheat under conditions of varying demand for steam, it will be necessary to vary the firing rates in both furnaces. This is a comparatively simple matter. After leaving the superheater 66 the gases from the rear furnace 50 are not discharged, but they must first flow past the water tubes 12 and the upper portions of the water tubes 14 and 21 before reaching the offtake 47. Thus the temperature of these gases will be decreased to a relatively low value, and the efficiency of the unit will be correspondingly increased.

The terms "front," "rear," and the like as used in the claims appended hereto are not to be considered as limitations except in so far as they define the relative positions of the various parts.

Having thus described my invention, what I 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 upright water tubes connecting the drums, a baffle located in front of the tube bank, a rear baffle located behind the tube bank, the lower edges of both baffles being spaced from the water drum, and the upper portion of one baffle being spaced from the steam-and-water drum to provide a gas passage, an offtake connected with the said gas passage, a steam generating furnace spaced forwardly from the first-mentioned baffle and having an outlet in its upper portion, means to conduct hot gases from the outlet downwardly in front of the first-mentioned baffle and rearwardly beneath the lower edge thereof, a superheater furnace spaced rearwardly from the rear baffle and having an outlet in its upper portion, a superheater located between the superheater furnace and the tube bank, means to conduct hot gases from the superheater furnace outlet into contact with the superheater and downwardly behind the rear baffle and thence forwardly beneath the lower edge thereof, and means to conduct the gases from both furnaces upwardly in contact with the tube bank to the offtake.

2. A steam generator comprising a transverse steam-and-water drum, a transverse water drum therebeneath, a bank of upright water tubes connecting the drums, a baffle located in front of the tube bank with its lower edge spaced above the water drum and its upper portion spaced forwardly from the steam-and-water drum, a steam generating furnace spaced forwardly from the baffle and having an outlet in its upper portion, means to conduct hot gases from the outlet downwardly in front of the baffle and rearwardly beneath the lower edge thereof, a superheater furnace in the rear of the tube bank and having an outlet in its upper portion, a superheater located between the superheater furnace and the tube

bank, means to conduct hot gases from the superheater furnace outlet into contact with the superheater and downwardly to the lower portion of the tube bank, an offtake connected with the space between the baffle and the steam-and-water drum, and means to conduct the gases from both furnaces upwardly in contact with the tube bank to the offtake.

3. A steam generator comprising a transverse steam-and-water drum, a transverse water drum therebeneath, front and rear banks of upright water tubes connecting the drums, a rear baffle extending downwardly from the steam-and-water drum behind the rear tube bank, a front baffle extending upwardly from the water drum in front of the front bank, and intermediate baffle between the front and rear baffles with its upper portion spaced forwardly from the steam-and-water drum, an offtake connected with the space between the intermediate baffle and the steam-and-water drum, the lower edges of the rear and intermediate baffles being spaced from the water drum, a steam generating furnace in front of the front baffle having an outlet in its upper portion, the hot gases from the outlet flowing rearwardly and downwardly between the front and intermediate baffles and beneath the lower edge of the intermediate baffle, a superheater furnace behind the rear baffle and having an outlet in its upper portion, a superheater located between the superheater furnace and the rear baffle, means to conduct hot gases from the superheater furnace outlet into contact with the superheater and downwardly and forwardly beneath the lower edge of the rear baffle to mix with the gases from the steam generating furnace, and means to conduct the mixed gases upwardly in contact with the rear tube bank and to the offtake.

4. A steam generator comprising a transverse steam-and-water drum, a transverse water drum therebeneath, a bank of upright water tubes connecting the drums, a baffle in front of the tube bank with its lower edge spaced from the water drum and its upper portion spaced forwardly from the steam-and-water drum, an offtake connected with the space between the baffle and the steam-and-water drum, a rear baffle extending downwardly from the steam-and-water drum with its lower edge spaced from the water drum, a steam generating furnace in front of the tube bank having an outlet in its upper portion from which hot gases flow downwardly and rearwardly beneath the lower edge of the first-mentioned baffle, a superheater furnace behind the tube bank and having an outlet in its upper portion, the superheater furnace having a front wall which is spaced rearwardly from the rear baffle, a superheater located in the space between the said front wall and the rear baffle, the hot gases from the superheater furnace outlet flowing downwardly in contact with the superheater and forwardly beneath the rear baffle to mix with the gases from the steam generating furnace, and means to conduct the mixed gases upwardly in contact with the tube bank and to the offtake.

5. A steam generator comprising a transverse steam-and-water drum, a transverse water drum therebeneath, a bank of upright water tubes connecting the drums, a baffle in front of the tube bank with its lower edge spaced from the water drum and its upper portion spaced forwardly from the steam-and-water drum, an offtake connected with the space between the baffle and the steam-and-water drum, a rear baffle extending downwardly from the steam-and-water drum with its lower edge spaced from the water drum, a steam generating furnace in front of the tube bank having an outlet in its upper portion from which hot gases flow downwardly and rearwardly beneath the lower edge of the first-mentioned baffle, a superheater furnace behind the tube bank and having an outlet in its upper portion, the superheater furnace having a front wall which is spaced rearwardly from the rear baffle, a transverse header above the superheater furnace, tubes connecting the header with the steam-and-water drum, a row of Z-shaped water tubes connecting the water drum with the header and having upright intermediate portions arranged to support and cool the said front wall, a superheater located in the space between the said front wall and the rear baffle, the hot gases from the superheater furnace outlet flowing downwardly in contact with the superheater and forwardly beneath the rear baffle to mix with the gases from the steam generating furnace, and means to conduct the mixed gases upwardly in contact with the tube bank and to the offtake.

6. A steam generator comprising a transverse steam-and-water drum, a transverse water drum therebeneath, a bank of upright water tubes connecting the drums, a baffle in front of the tube bank with its lower edge spaced from the water drum and its upper portion spaced forwardly from the steam-and-water drum, an offtake connected with the space between the baffle and the steam-and-water drum, a rear baffle extending downwardly from the steam-and-water drum with its lower edge spaced from the water drum, a steam generating furnace in front of the tube bank having an outlet in its upper portion from which hot gases flow downwardly and rearwardly beneath the lower edge of the first-mentioned baffle, a superheater furnace behind the tube bank and having an outlet in its upper portion, the superheater furnace having a front wall which is spaced rearwardly from the rear baffle, a transverse header adjacent the lower portion of the front wall, superheater tubes located in front of the front wall with their discharge ends connected to the header, a superheater located above the outlet of the superheater furnace, tubes extending upwardly from the header and along the rear face of the front wall to the superheater, the hot gases from the superheater furnace outlet flowing in contact with the superheater and the superheater tubes and then forwardly beneath the rear baffle to mix with the gases from the steam generating furnace, and means to conduct the mixed gases upwardly in contact with the tube bank and to the offtake.

7. A steam generator comprising a transverse steam-and-water drum, a transverse water drum therebeneath, a bank of upright water tubes connecting the drum, a baffle in front of the tube bank with its lower edge spaced from the water drum and its upper portion spaced forwardly from the steam-and-water drum, an offtake connected with the space between the baffle and the steam-and-water drum, a rear baffle extending downwardly from the steam-and-water drum with its lower edge spaced from the water drum, a steam generating furnace in front of the tube bank having an outlet in its upper portion from which hot gases flow downwardly and rearwardly beneath the lower edge of the first-mentioned baffle, a superheater furnace behind the tube bank and having an outlet in its upper portion, the superheater furnace having a front wall which is spaced rearwardly from the rear baffle, a trans-

verse water header above the superheater furnace behind the outlet thereof, tubes connecting the header with the steam-and-water drum, a row of Z-shaped tubes connecting the water drum with the header and having upright intermediate portions arranged to support and cool the said front wall, a transverse steam header adjacent the lower portion of the front wall, superheater tubes located in front of the front wall with their discharge ends connected to the header, a superheater located above the outlet of the superheater furnace, tubes extending upwardly from the steam header and along the rear face of the front wall to the superheater, a row of Z-shaped tubes connecting the water drum with the water header and having upright intermediate portions located behind the last-mentioned tubes to protect them from excessive radiant heat, the hot gases from the superheater furnace outlet flowing in contact with the superheater and the superheater tubes and then forwardly beneath the rear baffle to mix with the gases from the steam generating furnace, and means to conduct the mixed gases upwardly in contact with the tube bank and to the offtake.

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