

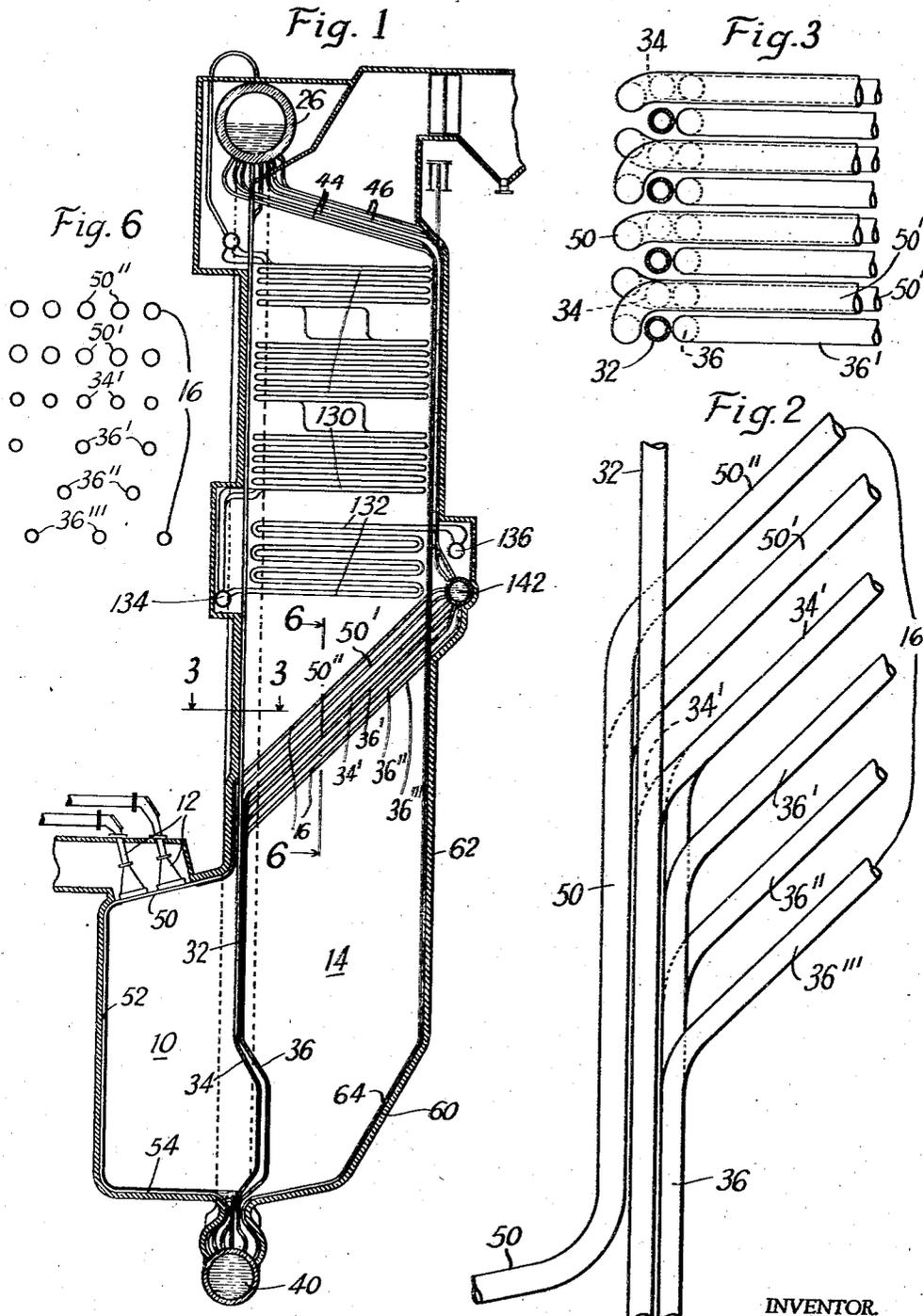
April 2, 1946.

E. G. BAILEY
STEAM GENERATOR

2,397,523

Filed July 4, 1942

3 Sheets—Sheet 1



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Fig. 4

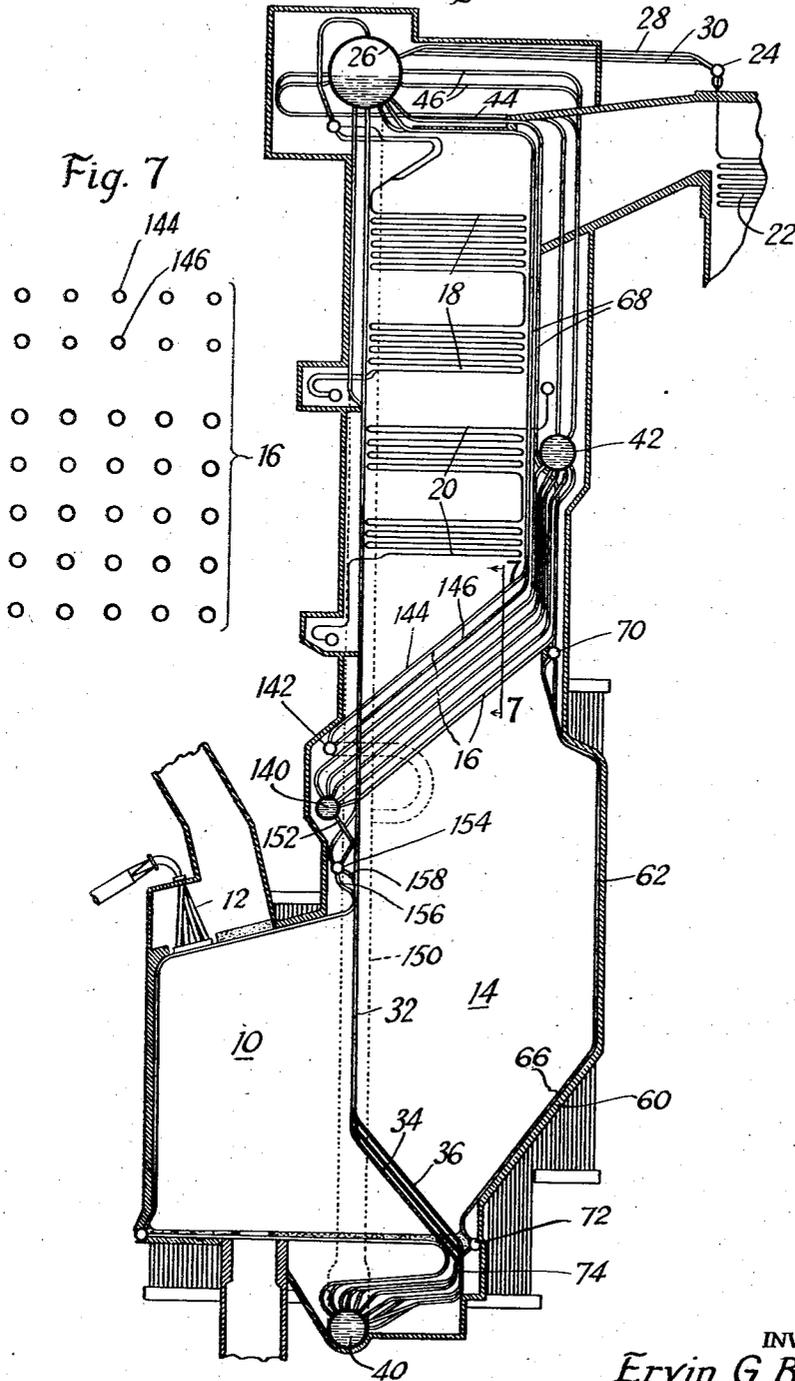
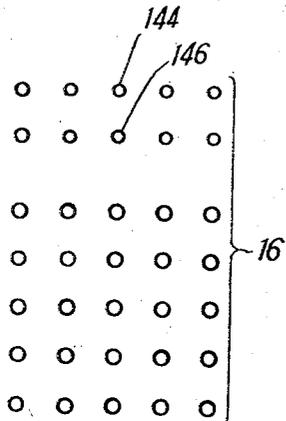


Fig. 7



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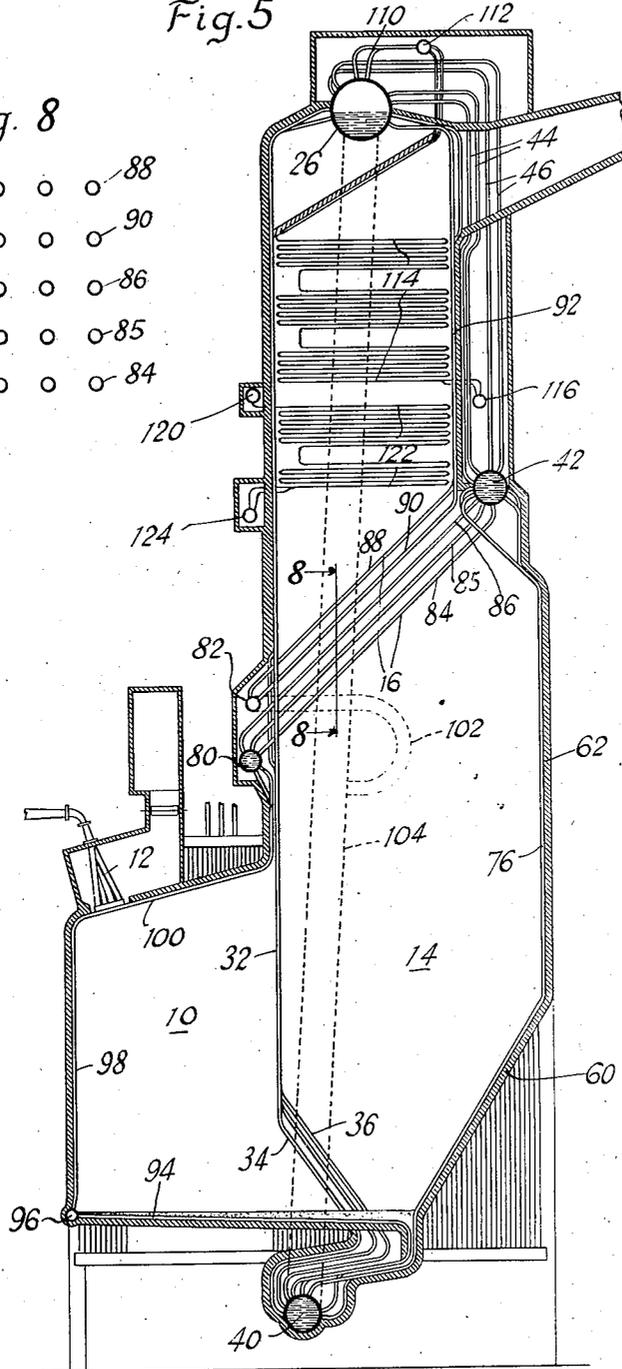
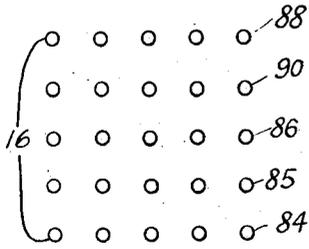
STEAM GENERATOR

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Fig. 5

Fig. 8



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UNITED STATES PATENT OFFICE

2,397,523

STEAM GENERATOR

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Application July 4, 1942, Serial No. 449,732

4 Claims. (Cl. 122-336)

My invention relates to improvements in high pressure steam generators of the natural circulation type. These improvements insure effective circulation through fluid cooled tubes located in high temperature furnace zones, while utilizing the same fluid streams to further cool the furnace gases by means of convection heat transfer.

My invention is particularly applicable to high capacity units which operate at pressures approaching the critical pressure of steam, where the density differential between water and steam (causing natural circulation) is reduced.

My invention is of particular advantage in its application to high pressure steam generating units having a plurality of furnace stages, with certain of the highly heated steam generating tubes cooling the walls of the primary stage.

I have found that in the interest of assured and adequate flow of water through the highly heated roof tubes of the primary furnace and the highly heated partition tubes between the primary furnace and the secondary furnace of a two-stage furnace boiler unit, it is of particular advantage to provide for the fluid flow from these tubes to continue upwardly through a bank of inclined steam generator tubes extending across the path of gas flow from the secondary furnace.

In order to insure the most effective use of the available water head to cause natural circulation through the distinct liquid flow paths, I utilize an outside unheated downcomer, and limit the use of junction headers which would retard circulation.

In compliance with the law relating to patents, and particularly Section 4888 R. S., the invention will be described with reference to preferred embodiments, and other objects of the invention will appear as the description proceeds.

The description has reference to the accompanying drawings in which:

Fig. 1 is a vertical section of a steam generating installation constructed in accordance with the teachings of this invention;

Fig. 2 is a detail view showing the arrangement of tubes just above the first furnace chamber;

Fig. 3 is a horizontal section of the line 3-3 of Fig. 1, showing the arrangement of the Fig. 2 tubes in plan; and

Figs. 4 and 5 are vertical sections through similar steam generators illustrating different modifications.

Figs. 6, 7, and 8 are vertical sections illustrating the tube arrangements in the steeply inclined convection tube banks of Figs. 1, 4, and 5, re-

spectively, taken on the correspondingly numbered section lines of those figures.

Fig. 1 of the drawings shows a steam generator including a first furnace chamber 10 fired by one or more fuel burners 12. The furnace gases pass from the lower part of the chamber 10 into the lower part of a second furnace chamber 14, steam being generated in both furnace chambers by wall tubes defining boundary surfaces of the chambers.

The furnace gases pass from the upper part of the furnace chamber 14 over and between the steam generating tubes of a steeply inclined convection tube bank 16, and beyond this bank of tubes the tubular elements of convection superheater sections 130 and 132 are heated by the gases. The superheater may be limited to one of two parallel gas passes, and the control of superheat may then be effected by regulation of the gas flow through these passes. In that case one of the passes may be considered as a superheater bypass, and a part of the economizer surface may be located in the bypass.

The first furnace chamber 10 is separated from the chamber 14 by a partition wall 32 including steam generating tubes 34 and 36, at least some of which afford direct communication between the steam and water drum 26 and the lower drum 40. Near the lower parts of the furnace chambers the wall tubes 34 and 36 are separated as indicated in the drawings to provide a gas outlet for the combustion chamber or first furnace chamber 10.

The illustrative steam generator also includes an intermediate drum or header 142 having direct connection with the bank of steam generating tubes 16. Steam and water pass from the drum or header 142 to the steam and water drum 26 through the circulators 44 and 46. The roof tube sections 50, wall tube sections 52, and floor tube sections 54 form continuous conduits extending from the lower drum 40 to a position beyond the furnace chamber 10.

It will be understood that there are rows of closely spaced tubes along the various furnace boundary surfaces such as the floor, front wall, and roof of the chamber 10. Beyond this furnace chamber, some of the roof tubes 50 are bent so as to extend through spaces between some of the tubes 34, such tubes being bent to the right to form the tube sections 50' of the bank 16 (see Figs. 2 and 3). Others of the tubes 50 are bent so as to pass between successive tubes 34 at higher elevations to form the upper tube sections 50'' of the bank 16. Space for the tube sections 50' and

50'' is provided by bending alternate tubes 34 out of their wall forming alignment so as to form the inclined tube sections 34'. The lower tube sections 36', 36'', and 36''' of the bank 16 are formed by bending other tubes 36 in the manner indicated in Figs. 2 and 3.

The lower part 60 of the rear wall of the furnace chamber 14 is inclined downwardly toward the floor of the combustion chamber 10. This wall and the upright wall 62 above are cooled by wall tubes 64 directly connecting the water space of the drum 26 with the lower drum 40.

In the Fig. 4 embodiment, the walls 60 and 62 are cooled by tubes 66 connected into the fluid system of the generator by the circulator 68, the headers 70 and 72 and the water connections 74. In Fig. 5, the tubes 76 cooling walls 60 and 62 are directly connected to the drum 40 at their lower ends and to the drum 42 at their upper ends. The latter drum is in direct communication with the steam and water drum 26 through the circulators 44 and 46 as previously described.

The Fig. 5 modification additionally involves inlet headers 80 and 82 for the bank of tubes 16. The tubes 84—86 of the first three rows are connected at their lower end to the header 80 while the tubes 88 and 90 of the last two rows extend from the header 82 along the gas pass wall 92 to the drum 26.

Water flows from the header or drum 40 to the floor tubes 94 to the header 96, and then through the wall tube sections 98, and roof tube sections 100 to the header 80. The header 82 is supplied with water by a connection 102 extending from the large diameter outside downcomer 104 directly connecting the water space of the drum 26 and drum 40.

Steam from the Fig. 5 steam and water drum passes through the circulators 110 to a superheater inlet header 112 and thence through the tubes of a convection superheater 114 extending across the gas path and connected to the superheater outlet header 116. From this header the steam may pass to a desuperheater and thence to the inlet header 120 of the second stage superheater 122. From the outlet header 124 of this superheater the steam passes to a point of use.

The Fig. 1 arrangement involves two superheater sections 130—132. However, in this case the two superheater sections are in series as to steam flow through the header 134. To maintain a constant superheat at the outlet header 136, there may be a gas bypass control.

The Fig. 4 embodiment, shows two lower headers 140 and 142 for the bank of tubes 16, the last two rows of tubes 144 and 146 being connected to the header 142. The latter may be supplied with water through a direct connection with the large diameter downcomer 150, and the header 140 is supplied with water through its connection with some of the tubes defining the wall 32. Such a connection is illustrated at 152. Below the header 140 is a supplementary header 154 to which the roof tubes for the combustion chamber 10 are directly connected as indicated at 156 and 158.

Fig. 4 indicates an economizer 22 having tubular elements disposed across a downflow of gases beyond the superheater 18 and connected to the outlet header 24. The latter is connected to the drum 26 by the tubes 28 and 30.

The general arrangement of first and second furnace chambers, fuel burners, and convection section, of each of the Fig. 4 and Fig. 5 modifica-

tions is, as indicated by the reference characters applied thereto, much the same as that shown in Fig. 1 and above described with reference thereto.

5 This application is a continuation-in-part of my earlier application 328,279 filed on April 6, 1940 and allowed on November 21, 1941 (now Patent 2,293,040, August 18, 1942).

What is claimed is:

10 1. In a steam generator, an upper transverse horizontally extending steam and water drum, a lower water drum, downflow water conduits formed by direct connections between the water space of the upper drum and the lower drum, 15 a fuel fired furnace positioned intermediate the upper drum and the lower drum, a horizontally extending multiple loop superheater arranged in an upwardly extending gas passage positioned below said steam and water drum and leading 20 from said furnace, a steam generating screen tube bank including a plurality of spaced inclined steam generating tube sections extending across said gas passage at a position below said superheater, a transversely extending water 25 chamber connected to the upper ends of said steam generating tube sections and to the steam and water drum, said furnace having a part below said superheater with a roof portion extending outwardly from a position below the lower ends 30 of the steam generating tube sections, roof cooling tube sections for said roof portion, means including upwardly extending tubular sections connecting the upper ends of roof tube sections to the lower ends of the steam generating tubes for 35 continuous upward fluid flow from the roof tube sections to and through the steam generating tube sections, and means connecting the lower ends of said roof cooling tubes to the lower drum whereby the roof tubes and screen tubes are con- 40 nected into the drum circulation.

2. In a steam generator, a steam and water drum disposed toward the top of the generator, means forming a water drum disposed at the lower 45 part of the generator, downcomer means connecting said drum and chamber, a primary furnace chamber in which combustion takes place, a secondary furnace chamber receiving furnace gases from the primary chamber, an intermediate 50 drum or header exteriorly of the second chamber, and tubes disposed along a wall between said furnace chambers and having upper parts extending as a vertically inclined bank of tubes across the path of the gases from the secondary 55 furnace chamber, said tubes having their upper ends connected to the intermediate drum or header and their lower ends connected to the water chamber.

3. In a steam generator; a combustion chamber having walls thereof defined by steam generating tubes; fuel burning means for said combustion chamber; a second furnace chamber disposed alongside the combustion chamber and receiving the furnace gases therefrom near its base; a bank of steeply inclined steam generating tubes 60 extending across the path of furnace gases at the upper part of the second furnace chamber and at a position above the combustion chamber; transverse headers or drums disposed on opposite sides 65 of the second furnace chamber and having the tubes of said bank connected thereto; a convection section including a superheater disposed above said bank of tubes; a steam and water drum above said convection section; a water drum below said furnace chambers; means connecting the 70 water drum and the steam and water drum; said

means including wall cooling tubes disposed at opposite sides of the said furnace chamber with some of said tubes defining a partition wall separating the combustion chamber from the second furnace chamber; some of the tubes of said bank extending between spaced wall tubes for the second furnace chamber; and means whereby wall cooling tubes for the combustion chamber discharge into the lower header or drum for said bank of tubes.

4. In a steam generator, an upper steam and water drum, a lower water drum, downcomers directly connecting the water space of the upper drum with the lower drum, a fuel fired furnace positioned at a level intermediate the upper drum and the lower drum, means forming an upwardly extending gas passage positioned below said steam and water drum and leading from said furnace, a superheater including tubes in a mul-

tiple loop arrangement and extending horizontally across said gas passage, a superheater screen including a bank of spaced and inclined steam generating tubes extending across said gas passage at a position below said superheater, a transversely extending water chamber connected to the upper ends of the screen tubes and to the steam and water drum, said furnace having a portion below said superheater with a roof extending outwardly from a position below the lower ends of the tubes of the bank, water cooling tubes for said roof portion having their upper ends connected to the lower ends of the tubes of the bank for continued upward flow through the roof tubes and the steam generating tubes, and means connecting the lower ends of the roof tubes to the lower drum whereby the roof tubes and screen tubes are connected into the drum circulation.

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