July 22, 1947. L. J. MARSHALL 2,424,476

RADIANT STEAM GENERATOR

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Fig. 1

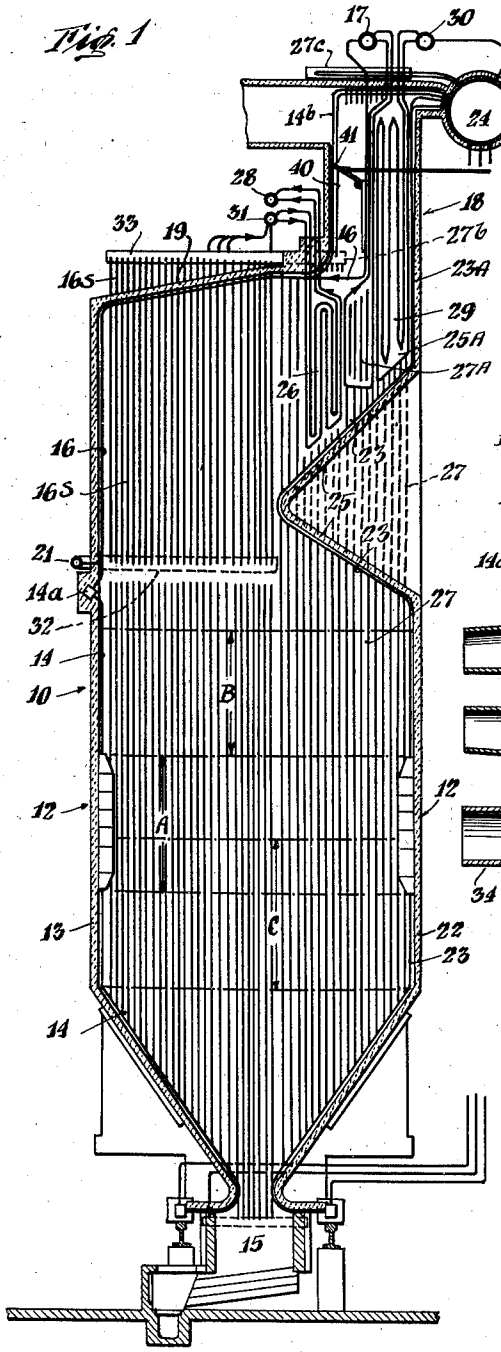


Fig. 2

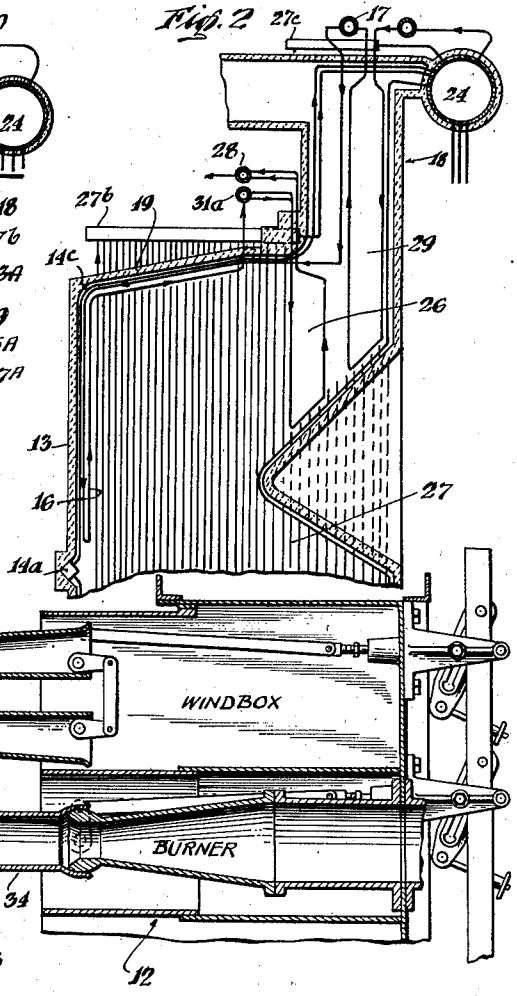


Fig. 3

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RADIANT STEAM GENERATOR

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2 Claims. (Cl. 122—478)

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This invention relates to steam generators and particularly to those equipped with superheaters.

The trend in steam generating units toward higher steam pressures and temperatures and high capacities has introduced new experiences into operation that indicate the necessity of essential changes in the apparatus and in the operation of the units. With the trend toward higher superheated steam temperatures, the combustion rates within the furnaces were increased in order to obtain hotter gases passing over the convection superheaters, and these were placed closer to the furnace. The higher combustion rates and higher furnace exit temperatures in turn produced more slag deposits on the superheater tubes thereby requiring greater cleaning efforts in order to keep the gas lanes between the tubes open and also added to the difficulties of controlling superheat temperatures. The higher combustion rates within the furnace and the higher steam pressures combined to reduce the allowable margin in temperature rise for the furnace water wall tubes before deterioration by overheating would occur. The higher combustion rates increased the rates of radiant heat input to the furnace wall tubes and the higher steam pressures contributed in increasing the tube temperatures because of the higher evaporating temperatures of the water and by the slower water circulation through the tube circuits due to greater densities of the steam and lesser densities of the water.

Although the furnaces become smaller with the increased combustion rates, the higher temperature of the gases leaving the furnace require an increased amount of boiler convection surface for absorbing the added heat. Correlated with the convection surface and the superheater surface are by-passes for conveying a portion of the gases around the superheater with by-pass dampers for controlling the gas flow, thereby regulating the temperature of the superheated steam. These by-passes are of substantial size to accommodate the quantity of by-passed gases required for adequate superheat control and it has been found that in some cases the range of control is not sufficient to meet the requirements of the users. As was to be anticipated, the draft loss through enlarged convection surfaces of the unit rose, causing an increase in the power required for overcoming this loss.

It is an object of this invention to provide an improved steam generating unit that will overcome the above described difficulties.

In the drawings Figures 1 and 2 are diagram-

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matic sectional elevations of steam generating units embodying the invention.

Figure 3 is an enlarged sectional elevation through the furnace wall to show the mounting of the burners.

The invention contemplates a radiation boiler in which the furnace is of such size in relation to the combustion rates and to the amount of heat absorbing tube surface in the form of steam generating tubes on the furnace walls that the heat absorption by said tubes suffices to evaporate all of the steam to be produced by the generator and yet not result in an excessive rate of heat absorption in any of such surface that would result in overheating the tubes. Further, the combustion within the furnace is principally confined to a "hot zone" which is controlled as to its location and extent, the zone being shifted upwardly and downwardly within the furnace in a manner that varies the amount of heat absorption by the whole boiler surface and therewith varies the temperature of the gases leaving the furnace. This temperature control of gases leaving the furnace has the dual purpose of maintaining the gases at a slag-free temperature when entering the superheater convection surface and of controlling the superheat temperature by varying the gas temperature. Due to the combination of the control of the location of the hot zone of combustion and to the relatively low combustion rates, the invention further contemplates supplementing the convection superheater by the use of radiant superheater tubing on the furnace walls located safely beyond injurious effects of the hot zone, thereby limiting the rate of heat radiation to any of the superheater tube surface and avoiding overheating said surface.

Furnace 10 of rectangular cross section is provided with fuel burners 12 preferably located at the corners within the bottom half of the furnace. On the front wall 13 of the furnace the lower portion adjacent the burners is provided with steam generating tubes 14 extending downwardly from a header 14a to the ash pit 15 and forming a portion of the sloping bottom. In Fig. 1 the upper portion of the front wall is provided with superheater tubes 16 located intermediate the upper parts 14b of the wall tubes and which extend from a header 17 downwardly through offtake 18 thence under the furnace roof 19 to front wall 13 and downwardly to enter a header 21.

The rear furnace wall 22 is faced with steam generating tubes 23 extending downwardly from steam and water drum 24 for the entire length

of the wall from drum 24 through the offtake 18 to the ash pit 15. On the upper half of rear wall 22 the tubes 23 are bent to form a ledge-like baffle 25 projecting into the furnace for shielding the offtake 18 and convection superheaters 26 and 29 from the radiant heat of the furnace. Baffle 25 lies wholly within the limits of furnace 10. The slide walls 27 are provided with steam generating tubes that extend from ash pit 15 to the furnace roof 19 and into a header 27b, and a portion of them continue upwardly on the side walls of the offtake 18 into a header 27c.

Located in the top of the furnace and above baffle 25 is a superheater section 26 which is connected to outlet header 31 for the radiant superheater and to steam outlet header 28. Located in the offtake 18 is another convection superheater section 29 which is ahead of radiant superheater 16 in the direction of steam flow, its tubes being connected to inlet header 30 and intermediate header 17, which is the inlet header for radiant superheater 16, the former header being connected to the steam and water drum 24. Note that the convection superheater section 29 is enclosed by extensions 23A, 27A of the water wall surfaces of the rear and side furnace walls and by superheater tubes 16 from the front wall 13. This construction does away with structures such as heretofore used employing heavy brick or sectionally supported walls at the sides of the superheater bank, which constructions were objectionable because they were costly, were subject to cracking and consequent leakage and required substantial insulation to prevent heat loss from the high temperatures within.

In some instances it may be desirable to provide a radiant superheater having three sections, as shown in Fig. 1, in place of one, the first section 16 being located on front wall 13 and the other two sections respectively on the two side walls. Steam flows from drum 24 to header 30 through convection superheater section 29 to intermediate header 17, thence through superheater section 16 down the front wall of offtake 18, along roof 19 and down the front wall 13 to a header 21. From header 21 the steam passes to the two side wall headers 32 at the bottom of the two side wall superheater sections 16S. From headers 32 steam flows upwardly through the side wall sections 16S to headers 33 that discharge into a common header 31. From header 31 the steam flows through convection superheater section 26 and up to outlet header 28.

The above described arrangement of radiant and convection superheaters in combination produce a superheat temperature that does not vary much from the normal.

The burners are of the type shown in a copending application of Kreisinger et al., Serial No. 420,356, filed November 25, 1941, and issued as U. S. Patent No. 2,363,875, dated November 28, 1944. At each corner of the furnace there are several superimposed burner nozzles 34, one of which is shown in Fig. 3; each burner is capable of vertical adjustment to direct the fuel stream issuing therefrom upwardly or downwardly into the furnace; a further horizontal adjustment enables the fuel streams to be directed at various angles in a horizontal plane so that in general the fuel streams are projected tangentially to an imaginary vertical cylindrical surface located preferably at the center of the furnace. This tangential direction of the fuel streams causes a turbulent combustion within a limited zone about the location where they impinge upon one another. When the fuel streams are pointed downwardly toward the lower portion of the furnace, the zone C of intense combustion is moved toward the bottom of the furnace and causes the maximum amount of heat to be absorbed by radiation by the bottom parts of steam generating tubes adjoining the zone. When the fuel streams are directed horizontally, the zone of combustion A is adjacent the burners and the maximum rate of heat absorption is by the tube portions adjacent the burners. When the fuel streams are directed upwardly the zone of combustion B at the upper part of the furnace will move to a location above the burners and the highest rate of heat absorption is by the tube portions above the burners. It will be seen that as the zone of combustion is shifted upwardly the lower parts of the furnace walls receive less heat and the upper portions receive more with the result that the temperature of gases leaving the furnace is higher. As the zone of combustion is shifted further upwardly the radiant portion 16, 16S of the superheater surface is exposed not only to hotter gases but also to a more direct radiation from the zone of combustion and the convection sections of the superheater receive hotter gases. In this manner a wide range in control of superheat may be obtained.

A further advantage is that as the hot zone of combustion is moved downwardly with increased loads to increase the amount of heat absorbed by the furnace water walls to make more steam, the relative amount of heat absorbed by the radiant superheater tubes also decreases to control the superheat. In this manner the radiant superheater is protected from overheating at the higher ratings.

A relatively small by-pass 40 and damper 41 may be provided around superheater 29 which will permit a further refinement in superheat control.

Because of the relatively large furnace in which combustion rates have been deliberately kept low, the radiant heat absorption of the steam generating tubes, even at the hottest zone of combustion is kept relatively low and therefore does not tend to overheat the tubes. Because of the relatively large furnace the steam generating surface within the furnace has been made large so that it suffices to evaporate all of the steam to be produced by the generator and no further convection surface for steam generation is necessary. Because of the relatively large furnace and the amount of boiler surface, the temperatures of gases leaving the furnace are relatively low and the usual screen for shielding the convection superheater becomes unnecessary. The omission of such a screen has the advantage of eliminating the obstruction that it offers to the slag particles flowing down the baffle 25 to drop thence into the furnace. The low temperatures of gases leaving the furnace permit the use of a close spacing of the convection superheater tubes since the former slagging difficulties have been minimized.

Because the combination of a radiant superheater and convection superheater produces a relatively uniform superheat temperature over a considerable load variation, this characteristic combined with the ability of further controlling the superheat temperature by burner manipulation, as is the case in the improved generator, results in a wider range of superheat control.

In Fig. 2 the upper portion of the front wall is provided with superheater tubes 16 which extend

from header 17 downwardly through furnace offtake 18 thence under the furnace roof 19, in spaced relation, to front wall 13 and downwardly along its face to return bends 20. From bends 20, these tubes run upwardly intermediate the downwardly directed parts along the front wall 13 and roof 19 but before reaching the furnace offtake 18 rise through the roof 19 to enter header 31*a*. Risers 14*c* from header 14*a* and wall tubes 14, pass upwardly within the wall 13 and roof 19 where they lie adjacent the superheater tubes 16. After leaving roof 19 risers 14*c* pass up through offtake 18 along its front wall and into the steam and water drum 24. Although the side wall tubes adjacent the superheaters are not shown in full, they continue upwardly to form the inner face of the furnace offtake 18. Their partial omission in the drawing is to avoid conflict with the showing of the superheaters.

What I claim is:

1. In a steam boiler, means forming a vertical furnace chamber having a substantially horizontal gas outlet passage leading to a vertical boiler offtake within the horizontal limits of the chamber at the upper part thereof; steam generating means consisting of heat absorbing water circulating tubes mounted on all of the furnace walls extending continuously from the bottom to the roof of the furnace certain ones of which continue beyond the furnace to face some of the walls of the outlet passage; means for burning fuel in said furnace; a convection superheater for heating the steam leaving the boiler disposed wholly within said outlet and thereby shielded from direct exposure to the radiant heat of the burning fuel in said furnace; the amount of steam generation surface comprising wall tubes in the furnace and outlet passage being sufficient to evaporate all of the steam required from the boiler.

2. In a steam boiler; means forming a vertical furnace chamber having a substantially horizontal gas outlet passage leading to a vertical boiler offtake within the horizontal limits of the chamber at the upper part thereof; steam generating means consisting of heat absorbing water circulating tubes mounted on all of the furnace walls extending continuously from the bottom to the roof of the furnace certain ones of which continue beyond the furnace to face some of the walls of the outlet passage; means for burning fuel in said furnace; a convection superheater for heating the steam leaving the boiler disposed wholly within said outlet and thereby shielded from direct exposure to the radiant heat of the burning fuel in said furnace; the amount of steam generation surface comprising wall tubes in the furnace and outlet passage being sufficient to evaporate all of the steam required from the boiler, while the related heat released by the fuel within the furnace is below that at which the temperature of the gases entering the outlet will cause slagging of the ash to occur on the superheater tubes without the interposition of any water cooled screen.

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