

Nov. 14, 1967

R. CUNNINGHAM, JR., ETAL

3,352,289

STEAM GENERATOR

Filed June 13, 1966

5 Sheets-Sheet 1

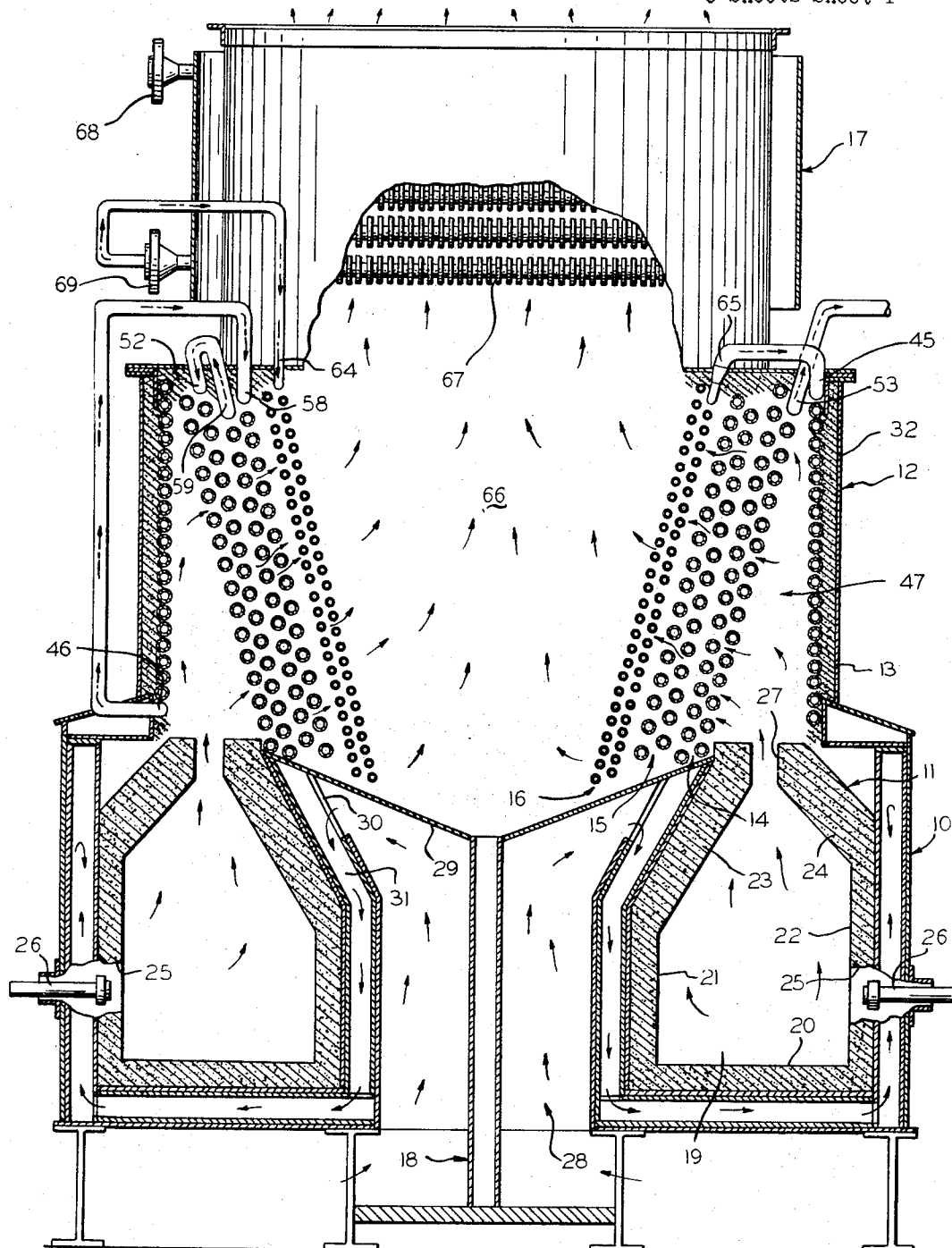


FIG. 1

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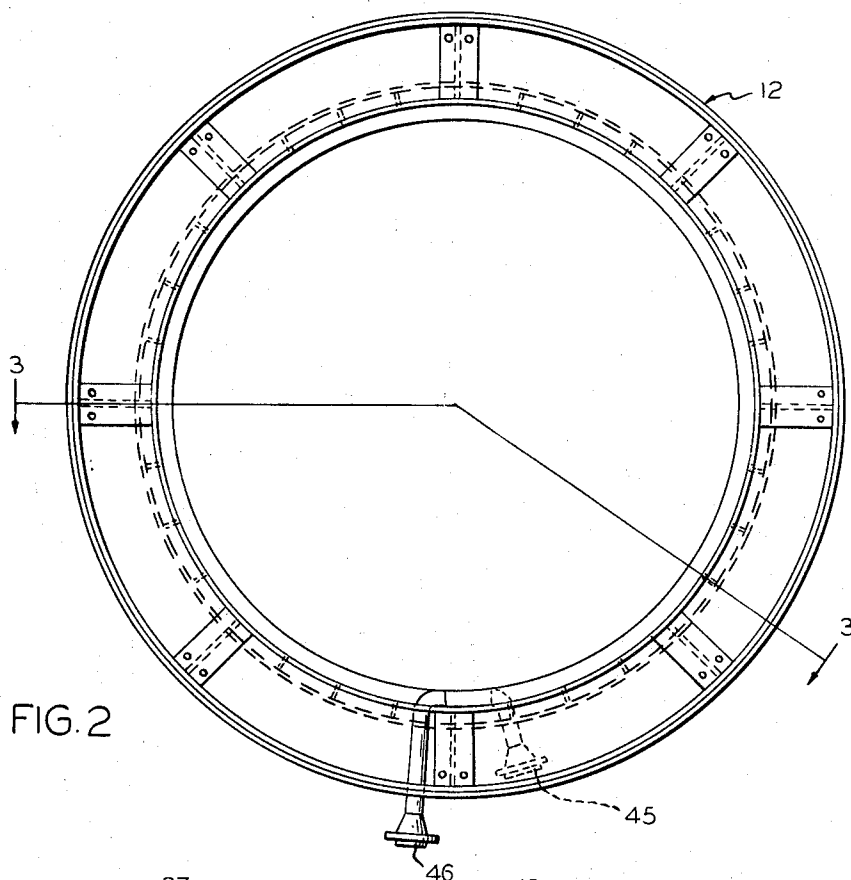


FIG. 2

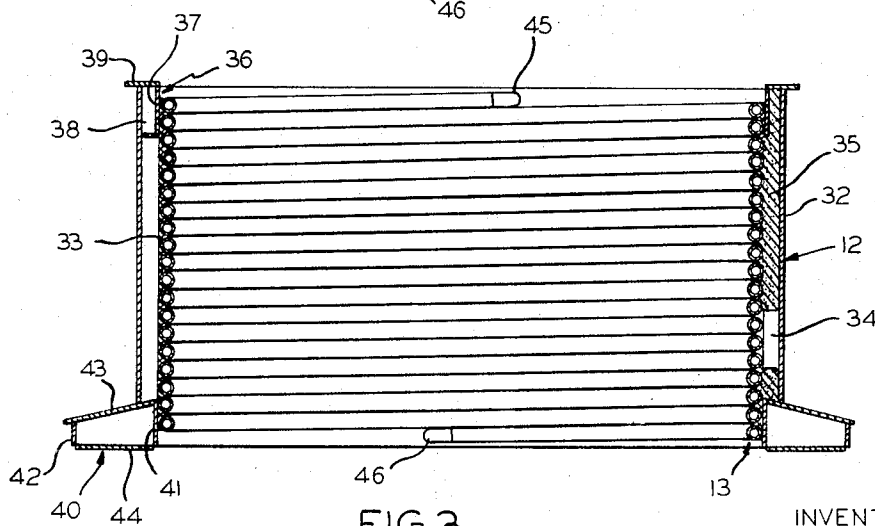


FIG. 3

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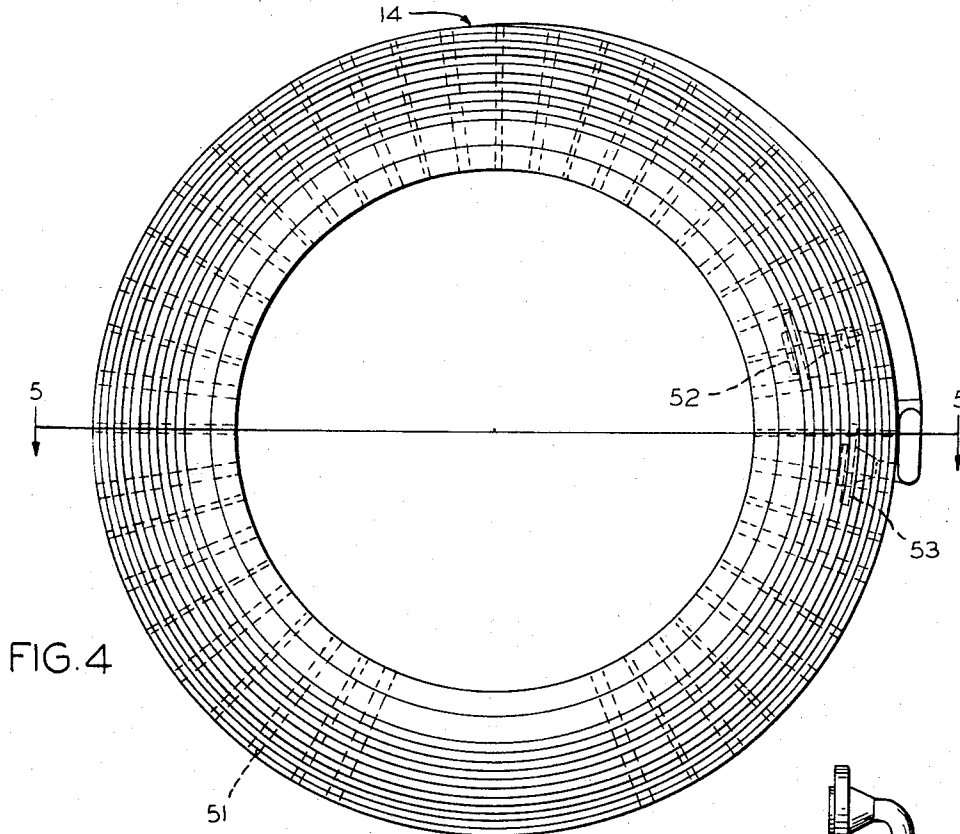


FIG. 4

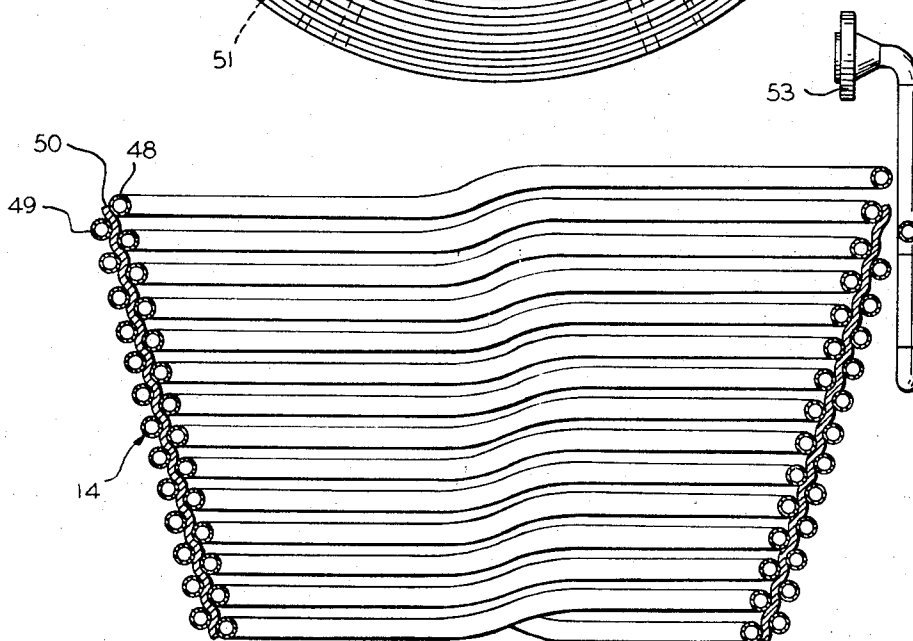


FIG. 5

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STEAM GENERATOR

Filed June 13, 1966

5 Sheets-Sheet 4

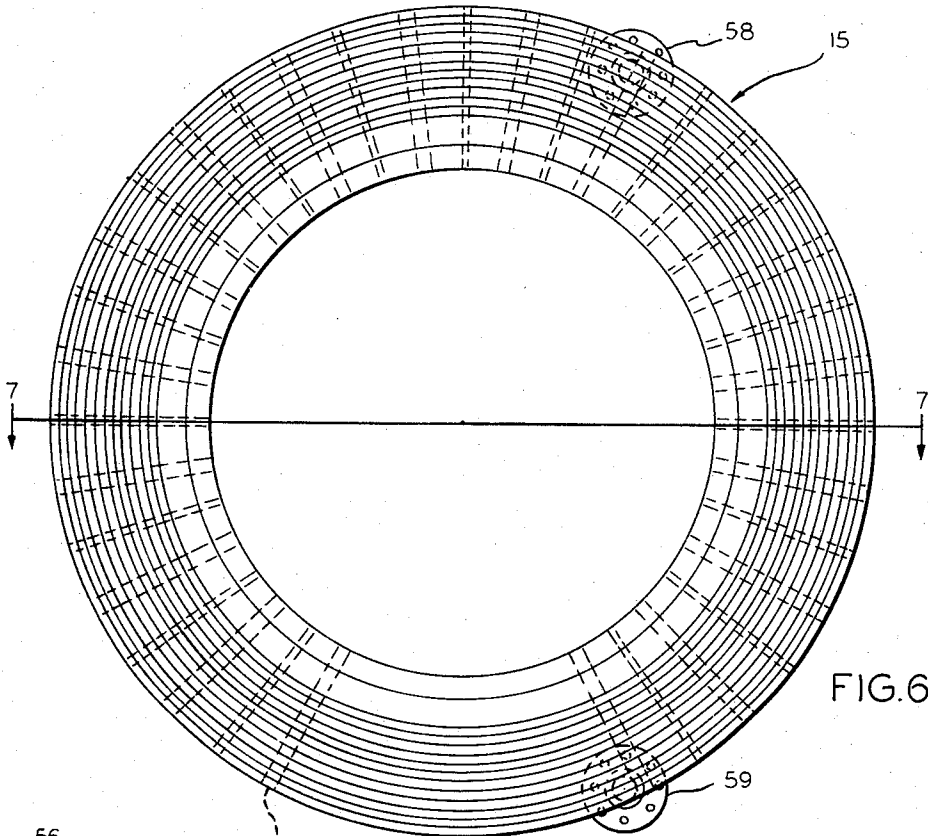


FIG. 6

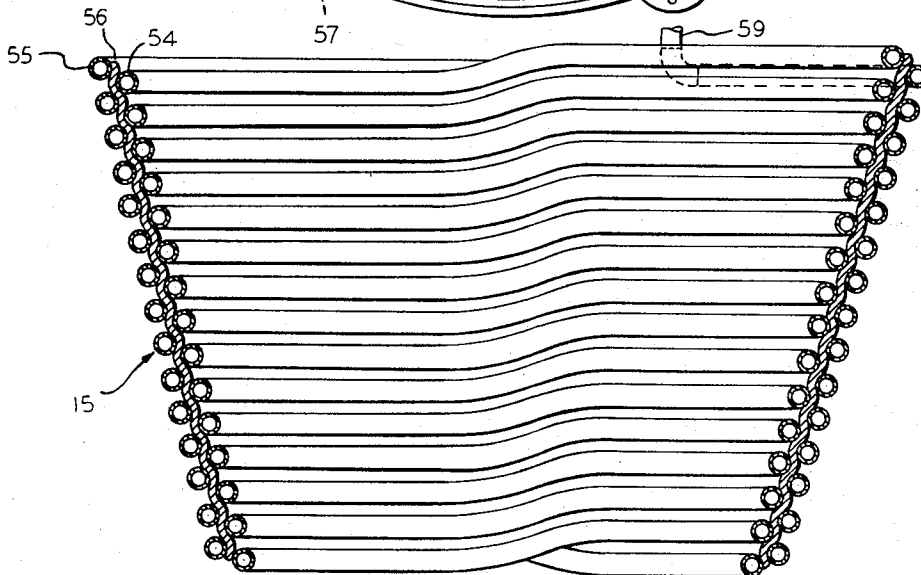


FIG. 7

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Filed June 13, 1966

5 Sheets-Sheet 5

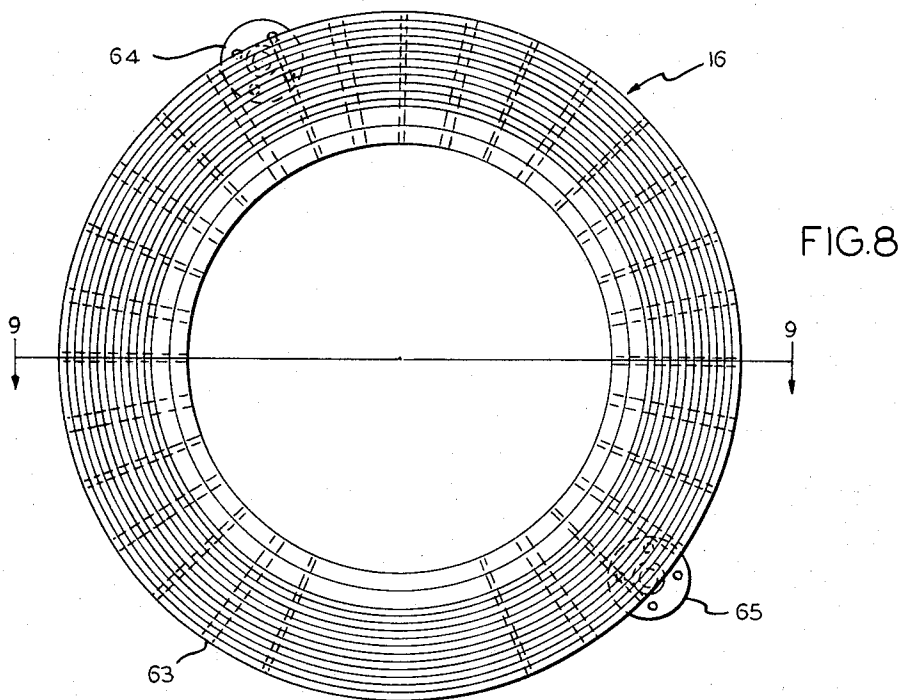


FIG. 8

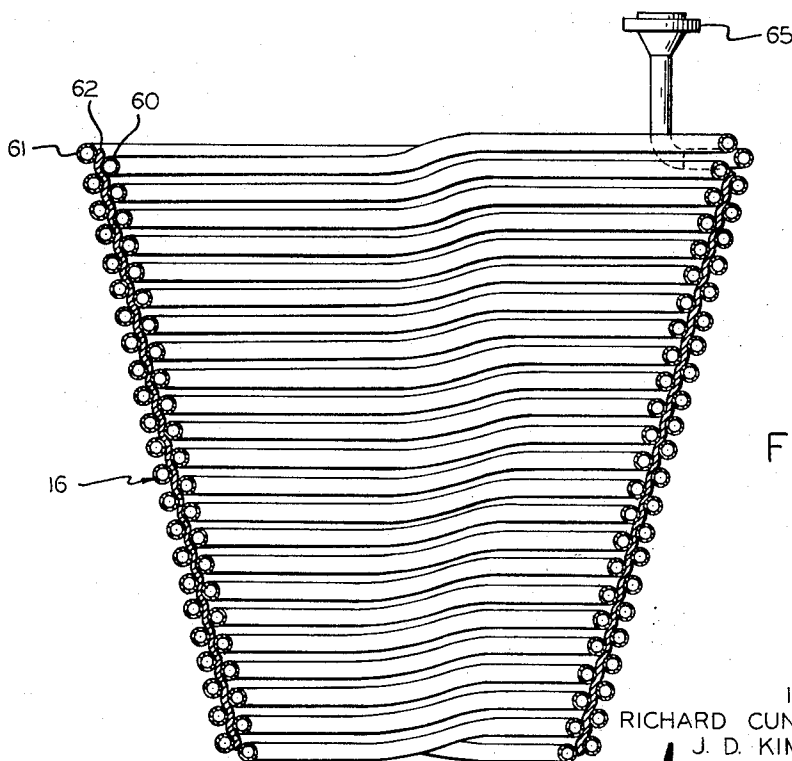


FIG. 9

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3,352,289

STEAM GENERATOR

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Filed June 13, 1966, Ser. No. 557,101

12 Claims. (Cl. 122—240)

ABSTRACT OF THE DISCLOSURE

A steam generator including a coil configuration and arrangement coacting with a firepot configuration and arrangement so that the coil is fired from the outside diameter to the inside diameter permitting easy control of flue gas velocity, a reduction in the high heat fluxes in the high heat zone, and a high centrifugal force to be exerted on the water and steam flowing through the coils.

This invention relates in general to a new and improved steam generator.

The steam generator of the present invention employs a particular coil configuration and arrangement to coact with a particular firepot configuration and arrangement to obtain many advantages over heretofore known steam generators, and particularly to more evenly balance the coil absorption rate. The steam generator includes an annular firepot having an upwardly opening choke through which combustion or flue gases are discharged into a flue gas receiving chamber defined in the coil housing by the arrangement of a plurality of coils so that the flue gases travel from the outside diameter of the coils to the inside diameter thereof. The coils are arranged to control the flue gas velocities and the steam and water mixture action and velocity in the coils to obtain a high heat transfer and thereby lower the metal temperature of the coils. These and other advantages will be apparent to one skilled in the art after consideration of the description of the invention.

Therefore, it is an object of this invention to provide a new and improved steam generator capable of more evenly balancing the coil absorption rate.

Another object of this invention is in the provision of a steam generator having a coil configuration and arrangement coacting with a firepot configuration and arrangement so that the coil is fired from the outside diameter to the inside diameter thereby permitting easy control of flue gas velocity, a reduction in the high heat fluxes in the high heat zone, and a high centrifugal force to be exerted on the water and steam flowing on the coils.

Still another object of this invention resides in the provision of a new and improved steam generator having a coil and firing arrangement capable of providing longer coil life.

Other objects, features and advantages of the invention will be apparent from the following detailed disclosure, taken in conjunction with the accompanying sheets of drawings, wherein like reference numerals refer to like parts, in which:

FIG. 1 is a vertical sectional view, somewhat diagrammatic, and with some parts broken away for purposes of clarity, of a steam generator of the present invention;

FIG. 2 is a bottom plan view of the water wall coil assembly from the steam generator of the present invention;

FIG. 3 is a sectional view taken substantially along line 3—3 of FIG. 2;

FIG. 4 is a bottom plan view of the outer coil for the steam generator of the present invention;

FIG. 5 is a sectional view taken substantially along line 5—5 of FIG. 4;

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FIG. 6 is a bottom plan view of the intermediate coil for the steam generator of the present invention;

FIG. 7 is a transverse sectional view of the coil of FIG. 6 taken substantially along line 7—7 of FIG. 6;

FIG. 8 is a bottom plan view of the inner coil for the steam generator of the present invention; and

FIG. 9 is a sectional view of the coil of FIG. 8 and taken substantially along line 9—9 thereof.

Referring now to the drawings and particularly to FIG. 1, the steam generator of the present invention generally includes an annular firepot housing 10 having an annular firepot 11 arranged therein, a coil housing 12 having a water wall coil 13, a first or outer coil 14, a second or intermediate coil 15, a third or inner coil 16 arranged therein, and a flue gas collector 17. The coils 14, 15 and 16 are supported by a pedestal coil mount 18 that is arranged so that the annular firepot housing and firepot extend along same.

The annular firepot 11 includes a combustion chamber 19 defined by a bottom wall 20, upwardly extending vertical walls 21 and 22, and inwardly directed inclined walls 23 and 24. All of the walls are annular in shape, and a plurality of circumferentially spaced combustion throats 25 are provided in the outer vertical wall 22 and adjacent the lower end thereof, and have projecting thereinto burner nozzles 26. The burner nozzles fire across one another in such a way as to complete combustion within the combustion chamber, and wherein the combustion gases emitted from the chamber through a choke 27 are such as to prevent direct flame impingement on the coils in the coil housing.

Combustion air is blower fed upwardly about the pedestal coil support 18 through a chamber 28 against an inverted conically-shaped wall 29 of the pedestal support and into an annular opening 30 of a combustion air chamber 31 that essentially surrounds the annular firepot 11. The combustion air is indicated by the dash line arrows and is preheated initially by scrubbing the surfaces of the pedestal support 18, and further by movement in the combustion air chamber 31 about the firepot 11 before entering the combustion chamber through the combustion throats 25. Thus, the combustion air is preheated and at the same time serves to cool the pedestal support 18 and the outer walls of the firepot and the firepot housing.

The water wall coil 13 is cylindrical in shape and includes a single lap or row of tubes wound in the usual fashion and mounted at the inside surface of the wrapper sheet 32 of the coil housing. As seen in FIGS. 1, 2 and 3, the coil housing includes upper wrapper sheet spacers 33 and lower wrapper sheet spacers 34 arranged along the inside surface of the wrapper sheet 32 to space the wall coil 13 from the wrapper sheet. The spacers are arranged circumferentially, and cement 35 is applied between the spacers and between the wrapper sheet and the outer surface of the wall coil 13. An upper support assembly 36 is provided at the upper end of the wall coil 13 and includes an inner support ring 37 along the outer surface of the coil, spacers 38 between the support ring and the wrapper sheet, and a top radially extending flange 39. Supporting the lower end of the coil 13 is a support assembly 40 including an inner support ring 41, a concentrically arranged outer support ring 42, an upper conically-shaped flange 43 and a lower or bottom wall 44. The coil 13 includes an inlet 45 arranged at the upper end and an outlet 46 arranged at the lower end.

The outer coil 14, the intermediate coil 15, and the inner coil 16 are conically-shaped with their small ends resting on the pedestal coil support 18 and their upper ends being arranged at the upper end of the coil housing. These coils, and particularly the outer coil 14,

define with the water wall coil 13 a flue gas receiving chamber 47 that is substantially triangularly-shaped in cross section including opposite side walls extending upwardly and converging at the upper end of the coil housing, the lower ends of the side walls being arranged on opposite sides of the firepot choke 27. The combustion gases and flue gases are shown by the solid arrows, and for purposes herein, it will be assumed that the gases in the combustion chamber are defined as combustion gases, and after they leave the combustion chamber they may then be defined as flue gases. By the arrangement of the coils relative to the firepot 11 and its discharge choke 27, it can be appreciated that none of the combustion flame impinges on any of the coils, and that the radiant zone is that which extends upwardly from the choke 27 toward the water wall coil 13 and the outer coil 14. The coil arrangement and manner of causing the flue gases to travel from the outside diameter to the inside diameter is such that a reduction in the high heat fluxes in the radiant zone is accomplished which will increase the coil life. This reduction of heat fluxes is accomplished by slowing the velocity of the flue gases through the outer coil 14 thereby decreasing the convective work in the area of high radiant work. The flue gas velocity is reduced due to the large diameter of the coil 14, and because a decreasing area is provided on successively inwardly arranged laps of the tubes of the coils.

The first or outer coil 14, as seen in FIGS. 1, 4 and 5, is conically shaped and includes inner and outer rows or laps of tubes 48 and 49 separated by a plurality of circumferentially spaced sinuous spacers 50. The tubes are in turn separated along the vertical into layers by block spacers 51, and the tubes in the inner row 48 are staggered from the outer row so that sinuous flue gas paths are defined from the outer diameter to the inner diameter. An inlet 52 and an outlet 53 are provided.

Similarly, the intermediate or second coil 15 includes inner and outer rows 54 and 55 separated by sinuous spacers 56. The tubes in the rows are staggered from each other and in turn separated along the vertical by block spacers 57. An inlet 58 and an outlet 59 are provided.

The inner or third coil 16 similarly includes inner and outer rows of tubes 60 and 61 separated by sinuous spacers 62. The tubes of the rows are staggered and separated along the vertical by block spacers 63, and thereby also define sinuous flue gas paths from the outer diameter to the inner diameter. An inlet 64 and an outlet 65 are provided.

As seen particularly in FIG. 1, the diameter of the tubes of the outer and intermediate coils 14 and 15 is identical, while the diameter of the inner coils 16 is smaller. Further, the diameter of the windings of the coils 14, 15 and 16 is successively smaller. Thus, the flue gases pass from the flue gas receiving chamber 47 inwardly through the first, second and third coils to the central chamber 66 and upwardly through the flue gas collector 17 and to atmosphere. The flue gas velocities are easy to control since the flue gas temperature decreases inwardly through the first, second and third coils with an increase in flue gas velocity due to the decreasing diameter of the coil windings. Further, the coils 14, 15 and 16 have the water and steam flow therein of such a velocity that the denser water and steam mixture is forced by centrifugal action against the section of each coil receiving the most heat, and therefore the outermost section of each coil. The denser mixture of steam and water provides a higher heat transfer rate, and therefore a lower metal temperature of the coil.

For further efficiency, feedwater preheating coils 67 are mounted in the flue gas collector to absorb heat from the expended flue gases and thereby preheat the water delivered to the coils. The feedwater preheating coils

includes an inlet 68 and an outlet 69 that is connected to the inlet 64 of the inner coil 16. The steam and water flow is indicated by the dot-dash arrows. From the inner coil 16, the steam and water flow is directed through the outlet 65 thereof to the inlet 45 of the wall coil 13. The outlet 46 of the wall coil 13 is connected to the inlet 58 of the intermediate coil 15. The water and steam mixture then flows from the outlet 39 of the intermediate coil and into the outer coil inlet 52 of the outer coil 14. Steam is then discharged from the outlet 53 of the outer coil 14.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention, but it is understood that this application is to be limited only by the scope of the appended claims.

This invention is hereby claimed as follows:

1. In a steam generator, an upstanding coil pedestal support, an annular firepot housing having an annular firepot therein arranged about said pedestal support, a plurality of combustion throats and burners at the lower end of the firepot and a choke at the upper end of the firepot for discharging flue gases upwardly, a coil housing above said firepot housing, a cylindrical wall coil along the inner surface of said coil housing, first, second and third conically shaped coils of successively smaller diameter and arranged successively inwardly of each other and spaced inwardly of said wall coil and having their smaller ends extending downwardly and defining with said wall coil an annular substantially triangular in cross section flue gas receiving chamber above said firepot choke, said coil housing and coils being arranged relative to the firepot so that the flue gases discharged from said choke enter said flue gas receiving chamber wiping said wall coil and then traversing inwardly through said conical coils to the center thereof, and a flue gas collector above said coil housing receiving the flue gases after they have passed inwardly through said conically shaped coils.

2. In a steam generator as defined by claim 1, and piping connections between said coils causing flow therein from said third coil to said wall coil to said second coil to said first coil.

3. In a steam generator as defined by claim 1, and a combustion air chamber about said firepot in communication with said combustion throats and having an inlet remote from said throats.

4. In a steam generator as defined by claim 3, and means directing combustion air upwardly around said coil pedestal support to said combustion air chamber inlet, whereby the air is preheated by the coil pedestal support and the exterior of the firepot.

5. In a steam generator as defined by claim 1, and feedwater preheating coils in said flue gas collection chamber connected to the coils in said coil housing.

6. In a steam generator as defined by claim 1, wherein said first and second coils include tubes of substantially the same diameter and said third coil includes tubes of a smaller diameter.

7. In a steam generator as defined by claim 1, wherein each of said conically shaped coils includes a plurality of laps.

8. In a steam generator as defined by claim 1, wherein each of said conically shaped coils includes two laps.

9. In a steam generator as defined by claim 1, and a combustion air chamber about said firepot in communication with said combustion throats and having an annular inlet at the upper inner side of said firepot housing.

10. In a steam generator as defined by claim 4, wherein said first and second coils include tubes of substantially the same diameter and said third coil includes tubes of a smaller diameter.

11. In a steam generator as defined by claim 6, wherein each of said conically shaped coils includes a plurality of laps, and wherein the tubes of adjacent laps are stag-

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gered to define inwardly extending sinuously-shaped flue gas paths.

12. In a steam generator as defined by claim 1, and means defining the velocity of the water and steam flowing through said conical coils to force the denser steam and water to the side of the coils receiving the greatest heat from the flue gases.

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