Aug. 23, 1966 H. N. SHARAN 3,267,908

STEAM GENERATOR WITH FLUE GAS RETURN

Original Filed Dec. 17. 1963 2 Sheets-Sheet 1

Fig. 1

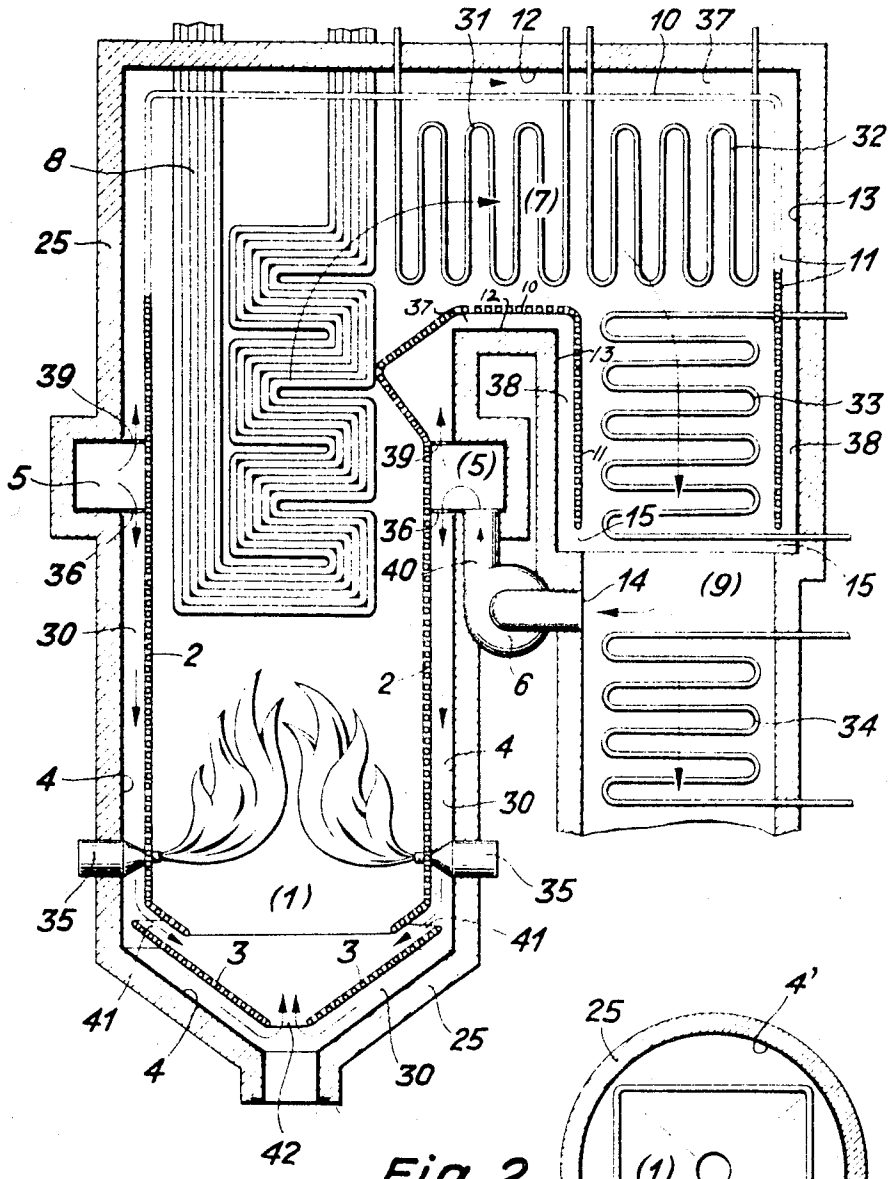


Fig. 2

Inventor:
HARENDRA NATH SHARAN

By R. H. Mayer
ATTORNEY

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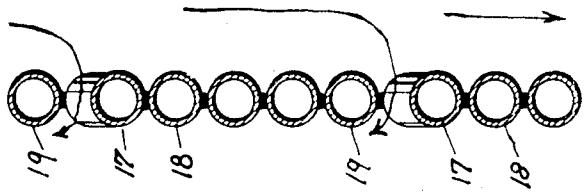


Fig. 4

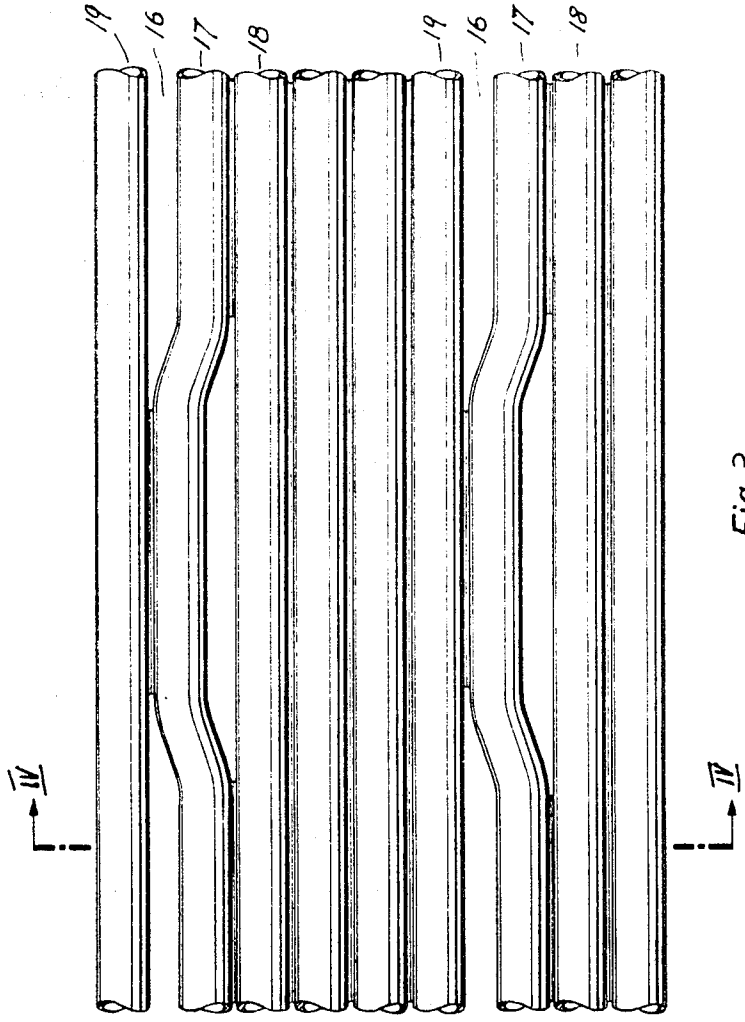


Fig. 3

INVENTOR.
HARENDRA NATH SHARAN
BY K. H. Mayr
ATTORNEY.

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STEAM GENERATOR WITH FLUE GAS RETURN

Harendra Nath Sharan, Winterthur, Switzerland, assignor to Sulzer Brothers, Limited, Winterthur, Switzerland, a corporation of Switzerland

Continuation of application Ser. No. 331,214, Dec. 17, 1963. This application Aug. 3, 1965, Ser. No. 479,043
4 Claims. (Cl. 122—235)

This application is a continuation of co-pending application Serial No. 331,214, filed December 17, 1963 now abandoned.

The present invention relates to a steam generator having a combustion chamber and a flue, at least the combustion chamber being provided with walls formed of tubes conducting operating medium of the steam generator, i.e. water, a mixture of water and steam, or steam. The steam generator is provided with means for returning at least a portion of the flue gases to the combustion chamber.

Flue gas is returned to the combustion chamber of a steam generator for influencing the flame temperature in the combustion chamber whereby temperature regulation and economy of operation of the steam generator are improved. In conventional steam generators which are provided with flue gas return to the combustion chamber, the flue gas is conducted directly into the combustion chamber.

The steam generator according to the invention comprises a combustion chamber at least a portion of the side walls of which is formed by a gastight outside wall and an inside wall formed by tubes conducting operating medium of the steam generator and not absolutely gastight. The inside wall is placed in spaced relation to the gastight outside wall for forming a space inside the combustion chamber between the two walls which space is connected to a conduit conducting flue gas. The flue gas flows through said space prior to entering the combustion chamber so that the tubes forming the tube wall are heated also on the side averse to the side which is exposed to the flame in the combustion chamber and the tubes are more equally heated than in conventional combustion chambers whose walls are lined by tubes. Another advantage of the arrangement according to the invention is the maintenance of a more even temperature of the gastight wall. Overheating of the gastight wall is avoided because the pressure of the flue gas flowing in said space is higher than the pressure in the combustion chamber, preventing passage of hot gases from the combustion chamber through the wall formed by tubes. In case there are leakages in the gastight wall only relatively cool flue gas and no hot combustion gas passes therethrough. With the structure according to the invention the tube wall can expand and contract independently of the gastight wall.

The arrangement according to the invention is particularly suitable for combustion chambers operating at superatmospheric pressure.

The novel features which are considered characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, and additional objects and advantages thereof will best be understood from the following description of embodiments thereof when read in connection with the accompanying drawing wherein:

FIG. 1 is a schematic, vertical, sectional view of a steam generator according to the invention.

FIG. 2 is a schematic, horizontal, sectional view of a modified combustion chamber according to the invention.

FIG. 3 illustrates a sectional view of a modified wall of a combustion chamber according to the invention.

FIG. 4 illustrates a view taken at line IV—IV of FIG. 3.

Referring more particularly to FIG. 1 of the drawing,

numeral 1 designates the combustion chamber of a steam generator, the combustion chamber being confined by vertical walls 2 formed by tubes conducting operating medium of the steam generator. The bottom wall 3 of the combustion chamber has the shape of a funnel which is also formed by tubes conducting operating medium of the steam generator. A gastight wall 4 is placed outside of and in spaced relation to the walls 2 and 3. The wall 4 may be made, for example, of sheet metal forming the support of heat insulating material 25. In the illustrated example the combustion chamber 1 is vertical and the space 30 between the walls 2 and 3 and the gastight wall 4 surrounds a substantial part of the combustion chamber 1. A gas duct 7 is connected to the top of the combustion chamber for receiving hot combustion gas therefrom, the gas duct continuing into a vertical gas duct or flue 9. Tubular heating surfaces 31 to 34 receiving heat mostly by convection are placed in the duct 7 and in the flue 9 and conduct operating medium of the steam generator for preheating and superheating and, if desired, also steam which must be resuperheated.

Vertical, plane walls 8 formed by tubes conducting steam to be superheated are placed in parallel and spaced relation in the upper part of the combustion chamber. The walls 8 extend in the direction of flow of the combustion gas from the combustion chamber 1 to the gas duct 7 and the hot combustion gas passes through the spaces between the walls 8.

Burners 35 of suitable conventional design are placed in the lower part of the combustion chamber 1. The horizontal gas duct 7 and the vertical flue are at least in part provided with walls 10 and 11 formed of tubes conducting operating medium of the steam generator. Outside of and spaced from the walls 10 and 11 gastight walls 12 and 13, respectively, are arranged. In the illustrated example the entire horizontal gas duct 7 and the upper part of the vertical gas duct or flue 9 are surrounded by spaces 37 and 38 formed between the walls 10 and 12 and between the walls 11 and 13, respectively, the spaces 37 and 38 corresponding to the space 30 surrounding the combustion chamber 1.

A channel 5 surrounds the combustion chamber 1 at about one half of its height. The channel 5 is connected to the space 30 by apertures 36 and to the spaces 37 and 38 by apertures 39. Flue gas is withdrawn from the flue 9 at 14 and conducted through a conduit 40 provided with a blower 6 into the channel 5 wherefrom the flue gas flows through the apertures 36 into the space 30 and through the apertures 39 into the spaces 37 and 38. An inlet 41 is arranged between the lower end of the wall 2 and the upper rim of the funnel-shaped wall 3. An inlet aperture 42 is provided at the bottom of the wall 3.

The temperature of the flue gas flowing through the space 30 is higher than the temperature of the operating medium, i.e. water, steam, or a mixture thereof, flowing through the tubes forming the walls 2 and 3 and the portions of these tubes which face the space 30 receive heat from the flue gas so that the tubes are more evenly heated than in conventional arrangements wherein the tubes lining the combustion chamber wall are exposed on one side only to the very hot flame and combustion gas in the combustion chamber. After passing through the space 30 the flue gas enters the combustion chamber 1 through the inlets 41 and 42 and is mixed with the combustion air and gas in the combustion chamber for affecting the flame temperature in a desired manner.

An outlet 15 is provided at the lower ends of the tube walls 11 in the vertical duct 9. The flue gases flowing through the apertures 39 and through the spaces 37 and 38 are returned to the duct 9 through the outlet 15.

In the example shown in FIG. 1 the gastight wall 4 is substantially equally spaced from the wall 2 formed

by tubes and confining the combustion chamber 1. In a combustion chamber operated at superatmospheric pressure, a substantial pressure acts in the combustion chamber on the inside of the gastight wall 4 and it is desirable that the wall 4 is cylindrical for avoiding bending stress in the wall. A structure suitable for this situation is schematically shown in FIG. 2. The combustion chamber 1' confined by a wall 2' formed by tubes has a rectangular cross section and the gastight wall 4' surrounding the wall 2' has a circular cross section. A four-cornered, tubular wall of a large combustion chamber is easier to manufacture than a bent wall.

The temperature of the flame in the combustion chamber 1 depends on the structure of the furnace and on the type of fuel fired. In a steam generator according to the invention the flue gas is returned to the combustion chamber according to the aforementioned conditions. In addition to the inlet openings 41 and 42 apertures 16 may be provided in the wall 2 between the channel 5 and the lower end of the wall 2 (FIGS. 3 and 4, which are showing each a part of the wall 2 and a section thereof respectively) and may be suitably distributed so that flue gas is mixed with the burning mass at a larger area than in the arrangement illustrated in FIG. 1. The apertures 16 are formed in such a manner that a tube 17 of the wall 2 is bent more times between adjacent tubes 18 and 19 to form a series of horizontally elongated overlapping apertures on respective sides of the bent tube 17, as illustrated in FIG. 3. The size of these additional apertures 16 may be different so that different amounts of flue gas are introduced into different zones of the combustion chamber 1.

If a plurality of flue gas openings are provided over the height of the combustion chamber, contact between the hot combustion gas and the wall 2 may be avoided. Therefore, tinder deposited on the wall 2 which acts as a catalyst facilitating conversion of SO_2 to SO_3 in the combustion gas cannot act on the combustion gas which is still rich in oxygen and the SO_3 content of the flue gas is reduced and cold corrosion in the final flue of the steam generator is avoided.

The amount of flue gas returned to the combustion chamber by the blower 6 may be maintained constant or may be changed in response to the load on the steam generator, or in response to the temperature of the operating medium. The change of the amount of flue gas is made by a motor driving the blower 6 with variable speed.

I claim:

1. A steam generator comprising a combustion chamber, a plurality of tubes forming a wall of said combustion chamber, said wall having a plurality of horizontally elongated apertures uniformly disposed longitudinally and circumferentially thereof and said tubes conducting operating medium of the steam generator, means for heating said tubes in said combustion chamber, said heating means including a hot combustion gas, a gas-tight wall placed outside of and in spaced relation to said tubes for forming a space therebetween, a flue connected to said combustion chamber for conducting flue gas produced by said combustion gas in said combustion chamber, and conduit means connecting an intermediate part of said flue and the space between said tubes and gas-tight wall, said conduit means including a blower for returning flue gas from said flue through the space between said tubes and gas-tight wall to said combustion chamber at a pressure higher than the pressure in said combustion chamber whereby the returning flue gas passing through the apertures in said combustion chamber wall prevents contact of said hot combustion gas and said combustion chamber wall.

2. A steam generator as defined in claim 1 wherein said wall formed by tubes surrounds said combustion chamber, the latter having an angular cross section, and said gas-tight wall is cylindrical and surrounds said wall formed by tubes.

3. A steam generator as defined in claim 1 wherein said wall formed by tubes surrounds said combustion chamber, the latter having a quadratic cross section, and said gas-tight wall is cylindrical and surrounds said wall formed by tubes.

4. A steam generator as defined in claim 1 wherein said circumferentially disposed apertures are arranged in overlapping relation to each other.

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KENNETH W. SPRAGUE, *Primary Examiner.*