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[72] Inventor **Harendra Nath Sharan**
Seuzach, Switzerland

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[73] Assignee **Sulzer Borthers, Ltd.**
Winterthur, Switzerland
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[33] **Switzerland**
[31] **9522/68**

[54] **FORCED THROUGH FLOW STEAM GENERATOR**
14 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** ..... **122/235 R,** 122/406 R
[51] **Int. Cl.** **F22b 21/00**
[50] **Field of Search** ..... 122/235 R, 406, 406 S, 478

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Primary Examiner—Kenneth W. Sprague
Attorney—Kenyon & Kenyon Reilly Carr & Chapin

ABSTRACT: The walls of the steam generator are formed of tubes through which the working medium flows and which form at least a part of the preheater surfaces. The flue gas is produced in a turbulence combustion chamber outside the steam generator and fed into a chamber at the bottom. The evaporator, superheater and other such surfaces are formed as tube platens disposed in parallel to the longer walls of the steam generator.

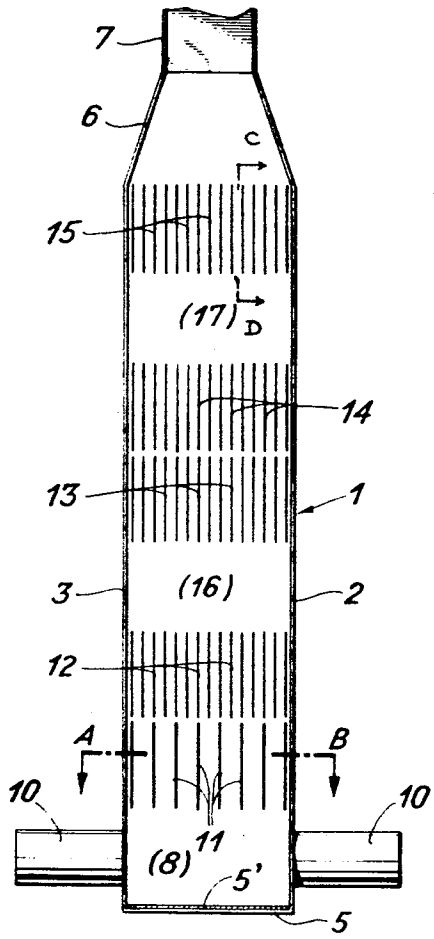


Fig. 1

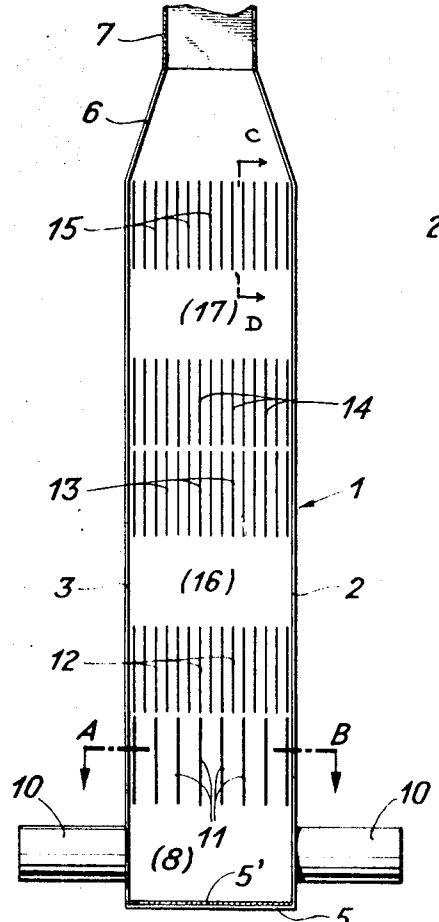


Fig. 3

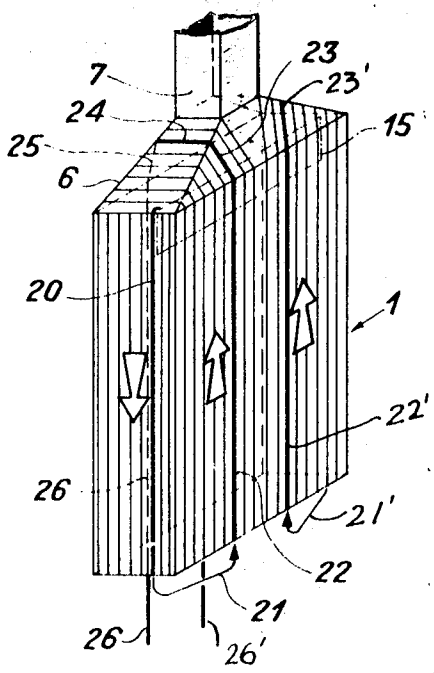


Fig. 2

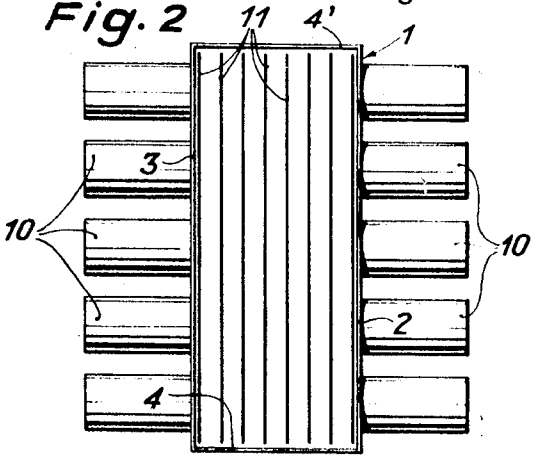
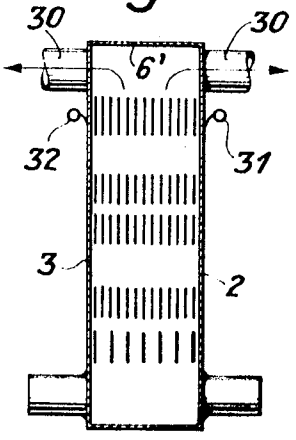


Fig. 4



Inventor:
HARENDRA NATH SHARAN

BY
Kenyon & Kenyon
ATTORNEYS

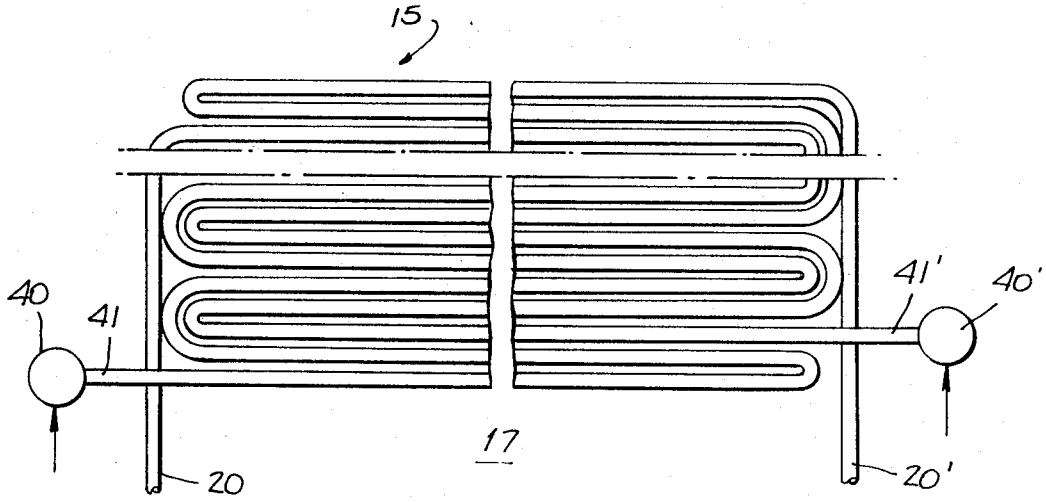


Fig. 5.

INVENTOR.
HARENDRA NATH SHARAN
BY
Kenyon & Kenyon
ATTORNEYS

FORCED THROUGH FLOW STEAM GENERATOR

This invention relates to forced through flow steam generators and more particularly to steam generators having bounded spaces for passage of flue gases and to the method of operating these steam generators.

Steam generators of various types have been known and constructed for various outputs. Generally, these steam generators have been built with combustion chambers in which a fuel has been combusted to produce a heated flue gas for heating of a working medium of the generator. Further, these combustion chambers have been cooled by the working medium so that detrimental heating effects are avoided. However, in the case of small outputs, for example, of the order of 300 tons of steam per hour, it has been difficult to cool a combustion chamber having a large circumference with the small flow of water corresponding to the small output without having to use pipes of very small bore.

Accordingly, it is an object of the invention to dispense with the need for a combustion chamber which is cooled by evaporator pipes.

It is another object of the invention to combust fuel in a combustion chamber spaced from a flue passage of a steam generator.

It is another object of the invention to maintain flow stability in the tube walls of a steam generator.

Briefly, the invention provides a forced through flow steam generator with tube walls which are formed from vertical tubes welded together, which form at least part of a preheater surface of the steam generator, and which bound a space through which flue gases flow in a vertical direction. In addition, the steam generator is provided with at least one combustion chamber which is located outside the space bounded by the tube walls and which opens into the space to conduct a heated combustion gas into the space and with a tube arrangement forming e.g. an evaporator which is located in the space.

This steam generator construction dispenses with the need for a combustion chamber which is cooled by evaporator pipes since the combustion of the fuel takes place in a separate combustion chamber from which the flue gases pass into the space bounded by the tube walls and only come into contact therein with the tubes through which the working medium flows. Consequently, there is little danger of flow instability as the tube walls of the generator are used as preheater surfaces.

Preferably, complete combustion takes place in the combustion chamber to ensure that practically no flame radiation occurs in the space bounded by the tube walls so that the danger of flow instability is further decreased.

Conveniently, additional preheater surfaces and superheating surfaces in the form of tube platens are arranged parallel to the direction of the flow of the flue gases within the space bounded by the tube walls. Further the space bounded by the tube walls is preferably rectangular and the tube platens are arranged parallel to the longer sides of the rectangular space.

A tube panel can also be disposed close to the tube wall adjacent the exit from the combustion chamber so that the tube walls near the exit to the combustion chamber are protected from the excessive heat.

The combustion chamber may be of the turbulence type and may be lined with a ceramic material. When the combustion chamber is of this type, a more compact form of steam generator can be made.

These and other objects and advantages of the invention will become more apparent from the following detailed description and appended claims taken in conjunction with the accompanying drawings in which:

FIG. 1 illustrates a longitudinal sectional view through a steam generator of tower construction according to the invention;

FIG. 2 illustrates a view taken on line A–B of FIG. 1;

FIG. 3 illustrates a perspective view of the upper part of the steam generator of FIG. 1;

FIG. 4 illustrates a longitudinal sectional view through a steam generator having a modified upper part according to the invention; and

FIG. 5 illustrates a view taken on line C–D of FIG. 1.

Referring to FIGS. 1 to 3, the forced flow once through steam generator 1 has a front wall 2, a rear wall 3 and two sidewalls 4 and 4', which bound a space of elongated rectangular cross section. The four walls 2, 3, 4, and 4' are formed by vertical tubes which are welded to each other either directly or by means of webs or fins provided therebetween and which are sized to carry a working medium therethrough. The floor 5 of the steam generator is also constructed of tubes which are covered with a layer 5' of ceramic material and which are connected to the vertical tubes. At the upper end of the steam generator 1 the vertical tubes of the wall tube nests merge into a truncated cone shaped ceiling 6 above which a flue 7 which may, for example, be constructed of sheet metal is mounted.

At the lower end of the steam generator and outside the space bounded by the tube walls 2, 3, 4 and 4', ten turbulence combustion chambers 10 are provided. These turbulence combustion chambers 10 are arranged opposite each other in pairs on each side of the steam generator with five combustion chambers in each of the longer walls 2, 3. The combustion chambers 10 are lined with a ceramic material and open into the space bounded by the tube walls 2, 3, 4, 4'. The tubes forming the longer walls 2, 3 are bent outwardly from the general plane of the wall near the exits from the combustion chamber 10 in order to accommodate the combustion chambers 10.

The lower end of the steam generator 1 has an internal chamber 8 which communicates with the combustion chambers 10 to receive the flue gases produced in the combustion chambers 10. The chamber 8 is oriented so that the flue gases flow in a vertical direction upwardly through the steam generator 1.

In addition, a plurality of platens 11, 12, 13, 14, 15 which are formed from tubes are arranged within the steam generator space above the chamber 8 and turbulence combustion chambers 10 parallel to the flow of flue gas. These platens 11, 12, 13, 14, 15 are also parallel to the longer tube walls 2, 3 of the steam generator 1. The tube platens 11 nearest the turbulence combustion chambers 10 form an evaporator heating surface while the tube platens 12 immediately downstream of the platens 11 with respect to the flow of flue gas form a final superheater surface. The next group of tube platens 13, 14 form an intermediate superheater surface or a presuperheater surface and are disposed downstream of the final superheater surface platens 12 in the direction of the flow of flue gas within the steam generator. The last group of tube platens 15 are disposed in the upper end of the steam generator and form a further preheater surface. A chamber 16 for cleaning and inspection purposes is provided downstream of, i.e. above, the tube platens 12 between the tube platens 12, 13. The height of this chamber 16 corresponds to the height of the tube platens 12, 13 so that the tube platens 12, 13 can be easily inspected and repaired where appropriate by raising or lowering respectively. Another cleaning and inspection chamber 17 is provided downstream of the tube platens 13, 14 between the tube platens 14, 15. The outermost tube platens of each group are mounted close to the tube walls in order to protect the walls against excessive heat from the flue gas.

Referring to FIG. 3, the manner in which the working medium, for example, water, passes through the vertical tubes of the walls is such that the working medium flows in parallel flow paths (a pair of such parallel flow paths being indicated each by a thick line). As shown, the tube section 20 originates from the front tube platen 15 which is shown by dash-dot lines and extends along the sidewall 4, the working medium thus flows from the tube platen 15 downwardly through the tube section 20 and continues at the lower end through a bottom tube 21 (shown only diagrammatically) the position in practice being lower than that shown. The bottom tube 21 joins a vertical tube section 22 which forms part of the front wall 2 and which merges into an inclined tube section 23 in the ceiling 6 to further transmit the working medium flow. The tube section 23 is followed by a horizontal tube section 24 forming part of the ceiling 6 and continues into an inclined tube sec-

tion 25 also forming part of the ceiling 6. This tube section 25 is followed by a vertical tube section 26 forming part of the rear wall 3 and from which the working medium is ducted, in a suitable manner (not shown) into the tube platens 11 of the evaporator heating surface. The corresponding tube bundle passes symmetrically in the right half of the steam generator; the visible sections of this tube bundle in FIG. 3 are marked with the same reference numbers which are, however, provided with a prime. The remaining tubes of the tube walls are arranged and connected in a similar manner. Accordingly, the entire tube wall system represents a preheater surface in which no evaporation takes place.

The working medium then flows through the remaining tube platens in a known manner. Due to the elongated rectangular cross section of the steam generator, the tube platens 11–15 have a length such that only a few tube bends need be provided in the tube platens if the tube sections of the platens are arranged horizontally, i.e. transverse to the flow of flue gas. The tube platens 11–15 are suspended from supporting tubes (not shown) which preferably precede the preheater tubes in the flow path of the working medium. The tube platens 11–15 may be identically constructed. It is also possible for the tube platens of two adjacent heating surfaces to be telescoped into each other, that is, the tube platens can be so arranged that the tubes forming the platens 13, 14 alternate when seen in cross section.

Referring to FIG. 4, the modified steam generator has a plurality of horizontal pipe spigots 30 which are mounted on the walls 2, 3 instead of a single flue as above described in FIG. 1 in order to improve the flow of flue gas in the uppermost part of the steam generator. Further, the uppermost part of the walls 2, 3, 4 and 4' as well as the ceiling 6' are constructed of sheet metal and are not cooled by tubes through which water flows. The vertical tube walls terminate and commence from manifolds 31, 32 while the sidewalls terminate and commence in similar manifolds (not shown). In this construction, the supporting tubes can be more simply passed through the ceiling 6' than in the embodiment shown in FIGS. 1 to 3.

Alternatively, it is possible to provide only one combustion chamber at the lower end of the steam generator outside the space bounded by the tube walls with the tubes of the lowest part of the wall opposite to the combustion chamber aperture being covered with a layer of ceramic material, if necessary.

Referring to FIG. 5, each collector 40 and 40' is positioned outside of the steam generator besides the sidewalls 4 and 4' and is supplied with water by means of a feeding pump (not shown) and connected in parallel. The tube 41 originates from the collector 40 and penetrates the sidewall 4 to cross the flue gas flue of the steam generator 1 in several hairpin-shaped windings while changing on its upper end over into tube section 20. Correspondingly, tube 41' originates from a collector 40' and penetrates sidewall 4' and then also extends in hairpin-shaped windings through the steam generator space and then on its upper end changes over into tube section 20. Each tube 41 and 41' is at the same level and builds a tube panel 15. The other tube panels 15 are built in a similar manner and are connected with the collectors 40 and 40'. The same arrangement can also be used for the remaining panellike heating surfaces in the steam generator.

What is claimed is:

1. A forced through flow steam generator comprising

a plurality of walls defining a space for the flow of a flue gas in a vertical direction, each wall including a plurality of vertically disposed tubes secured together to form at least part of a preheater surface of the steam generator;

at least one combustion chamber disposed outside said space and connected to said walls in communication with said space to deliver a heated flue gas into said space; and

an evaporator located in said space within said walls for the initial flow of the heated flue gas thereover.

2. A forced through flow steam generator as set forth in claim 1 further comprising at least one other preheater surface within said space, said other preheater surface being formed of tube platens disposed in parallel to the direction of flow of the flue gas in said space.

3. A forced through flow steam generator as set forth in claim 2 further comprising a superheating surface in said space in the form of a tube platen disposed in parallel to the direction of flow of the flue gas in said space.

4. A forced through flow steam generator as set forth in claim 2 wherein said space is rectangular in horizontal cross section and said tube platens are parallel to the longer walls defining said space.

5. A forced through flow steam generator as set forth in claim 2 wherein at least one of said tube platens is close to said wall connected with said combustion chamber and adjacent said combustion chamber.

6. A forced through flow steam generator as set forth in claim 2 wherein each tube platen includes tubes arranged transversely to the direction of flow of the flue gas in said space.

7. A forced through flow steam generator as set forth in claim 1 wherein said combustion chamber is lined with ceramic material and is a turbulence combustion chamber.

8. A forced through flow steam generator as set forth in claim 1 wherein a plurality of said combustion chambers are in communication with said space, said combustion chambers being disposed in pairs on opposite sides of said space.

9. A method of operating a steam generator having a plurality of walls including a plurality of tubes therein for the flow of working medium and defining a flue for the flow of a flue gas, at least an evaporator disposed within the flue and at least one combustion chamber located outside the flue and in communication therewith, characterized in that complete combustion takes place in the combustion chamber with a produced flue gas being introduced into the flue for immediate flow over said evaporator without radiation heating of the tubes of the walls.

10. A forced through flow steam generator comprising

a plurality of walls defining a space for the flow of a flue gas in a vertical direction, each wall including a plurality of vertically disposed tubes for conducting a working medium therethrough;

at least one combustion chamber disposed outside said space and having an outlet in one of said walls in communication with said space to deliver a heated flue gas into said space; and

a plurality of tube arrangements disposed within said space between said walls for the passage of a flue gas thereover, the initial tube arrangement in said space being immediately adjacent said outlet of said combustion chamber.

11. In a forced through flow steam generator

a plurality of axially aligned tubes forming at least a part of a preheater in a flow of working medium therethrough and defining a space for the flow of a flue gas therethrough; and

an evaporator downstream of said tubes to receive a flow of working medium therefrom and disposed within said space for the passage of a flue gas thereover.

12. In a forced through flow steam generator as set forth in claim 11, said tubes are interconnected to form a plurality of gastight walls.

13. In a forced through flow steam generator as set forth in claim 11, said tubes being disposed to direct the working medium through selective parallel paths in opposed flow directions to form an economizer surface.

14. A method as set forth in claim 9 further comprising the step of preheating the flow of working medium in said tubes of said walls without evaporation of the working medium therein.