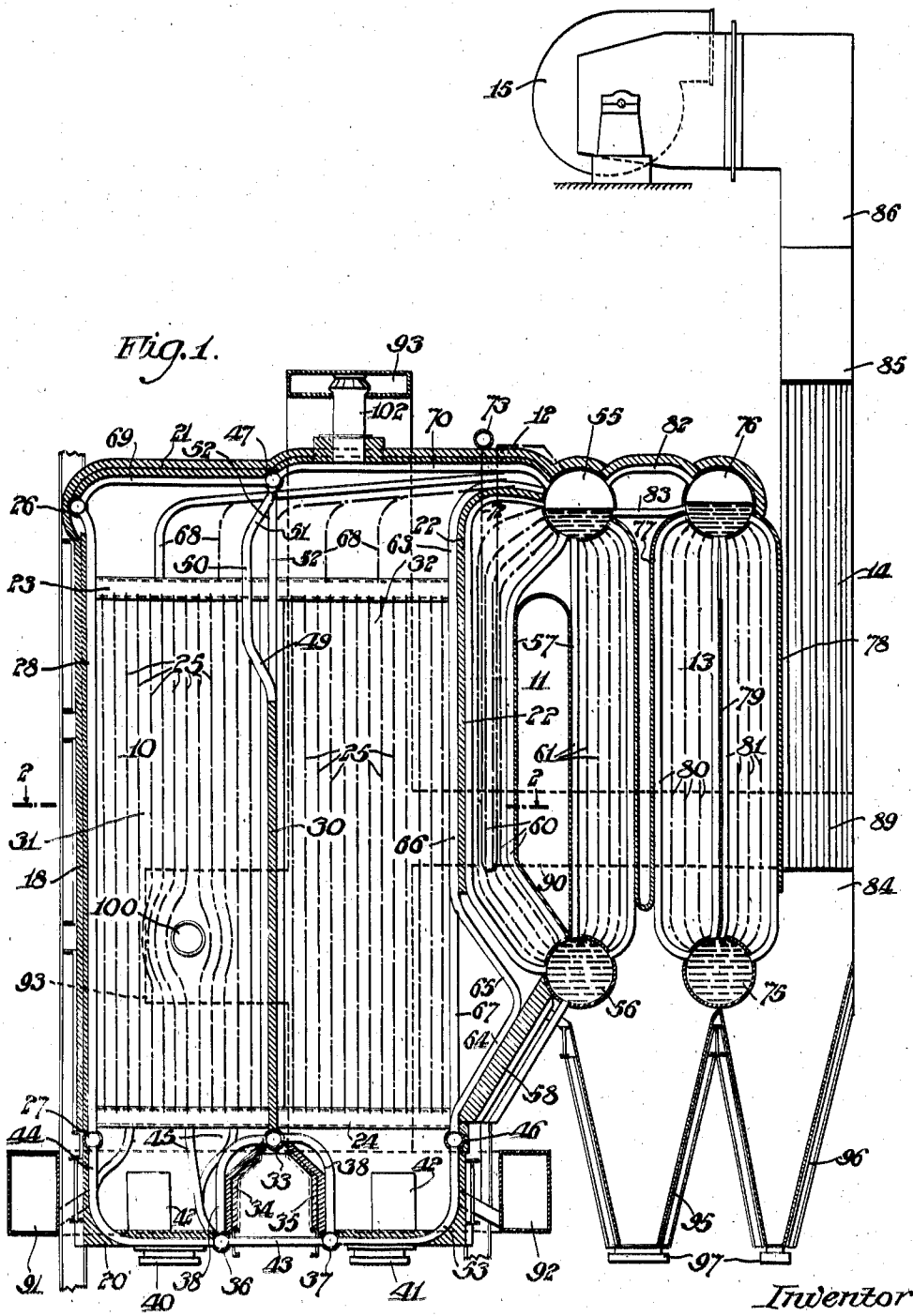
Dec. 6, 1938. J. P. BADENHAUSEN 2,139,348

STEAM GENERATOR

Filed March 22, 1938 2 Sheets-Sheet 1

Fig. 1.



Inventor:
John Phillips Badenhausen,
By J. T. Wolcott 2nd
Attorney.

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Fig. 3.

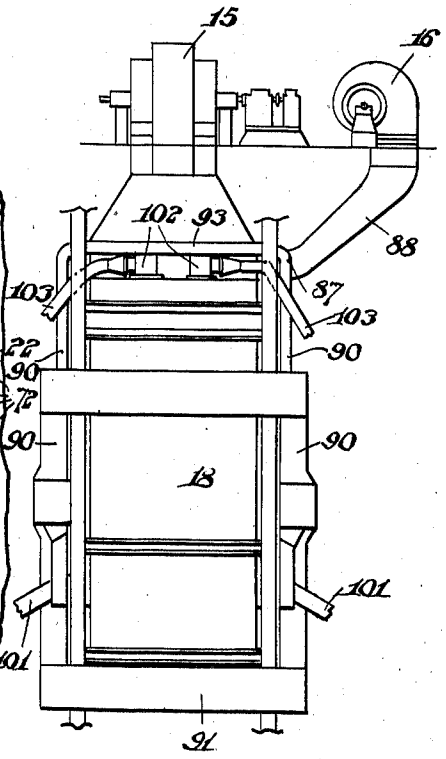
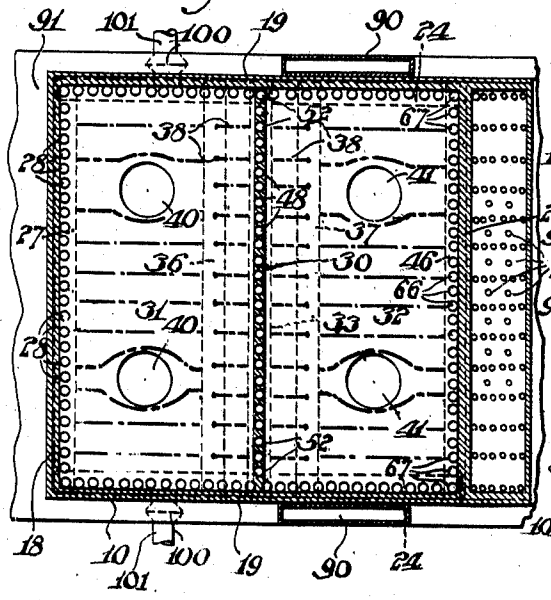


Fig. 2.



Inventor:
John Phillips Badenhausen,
By J. T. Wobensmith 2nd
Attorney.

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UNITED STATES PATENT OFFICE

2,139,348

STEAM GENERATOR

John Phillips Badenhausen, Philadelphia, Pa., assignor of one-half to Day and Zimmermann, Incorporated, Philadelphia, Pa., a corporation of Maryland

Application March 22, 1938, Serial No. 197,497

12 Claims. (Cl. 122—336)

This invention relates to steam generators and more particularly to steam generators suitable for utilizing a plurality of combustible materials at a plurality of locations.

It is one of the principal objects of the present invention to provide a steam generator having a wide range of capacity.

It is a further object of the present invention to provide a steam generator suitable for combustion of the combustible constituents of pulverized coal, oil, bark and other materials.

It is a further object of the present invention to provide a steam generator suitable for the combustion of the combustible constituents of a plurality of different materials.

It is a further object of the present invention to provide a steam generating unit having an improved character of heat absorbing and steam generating surface.

It is a further object of the present invention to provide a steam generating unit which is compact and which requires a minimum of space for the available capacity.

Other objects of the invention will appear from the annexed specification and claims.

The nature and characteristic features of the invention will be more readily understood from the following description, taken in connection with the accompanying drawings forming part hereof, in which:

Figure 1 is a vertical central sectional view taken from the front to the back of a preferred embodiment of the apparatus of the present invention;

Fig. 2 is a horizontal sectional view taken approximately on the line 2—2 of Fig. 1; and

Fig. 3 is a front elevational view of the apparatus shown in Fig. 1.

It will, of course, be understood that the description and drawings herein contained are illustrative merely, and that various modifications and changes may be made in the structure disclosed without departing from the spirit of the invention.

Referring more particularly to the drawings, it will be seen that in the present steam generator there is provided a furnace section 10 having steam generating tubes in and along the walls thereof, as hereinafter more fully referred to, a boiler section 11, a superheater section 12, an economizer section 13, an air preheater 14, an induced draft fan 15 for the withdrawal of the products of combustion, a forced draft fan 16 for the supplying of air preheated by the preheater 14 to the furnace section 10, and devices for introducing combustible material into the furnace section 10.

The furnace section 10 preferably has a front wall 18, side walls 19, a bottom wall 20, a top wall 21 and a rear wall 22, the exterior walls being suitably insulated.

The side walls 19 are each provided near the top thereof with an upper header 23 and near the bottom thereof with a lower header 24, the headers 23 and 24 extending from the front wall 18 to the rear wall 22, and being connected by a bank of tubes 25 lining the walls which is exposed to the radiant heat within the furnace section 10.

The front wall 18 is provided near the top thereof and near the top of the furnace section 10 with an upper header 26 and near the bottom thereof with a lower header 27, the headers 26 and 27 being connected by a bank of tubes 28 also exposed to the radiant heat of combustion.

The furnace section 10 is preferably divided centrally by a baffle or wall 30 which extends from the bottom thereof to a location spaced from the top wall 21 to provide within the furnace section 10 an upward pass 31 and a downward pass 32. The baffle or wall 30 terminates at the lower portion thereof at a lower header 33.

The floor 20 is preferably separated by baffles 34 and 35 into two sections, one of which is disposed below the upward pass 31 and the other of which is disposed below the downward pass 32. The floor 20 is preferably lined with suitable refractory material in accordance with the characteristics of the fuel employed.

The floor 20 has located therein a pair of lower headers 36 and 37 and banks of tubes 38 are provided for connecting the headers 36 and 37 with the header 33. Suitable gates 40 and 41 are provided in the floor 20 for the removal of ash or other non-combustible material depositing on the respective floor sections. Doors 42 may be provided for access to the interior of the furnace section 10. Another bank of tubes 43 is provided for connecting the header 36 with the header 37, a bank of tubes 44 is provided connecting the header 27 with the header 36, and additional tubes 45 are provided for connecting the lower headers 24 and 36. A lower header 46 is provided at the rear of the furnace section and is connected by a bank of tubes 53 to the header 37.

The top wall 21 of the furnace section is also provided with a header 47 and a bank of tubes 48 is provided preferably within the wall or baffle 30 and connected to the lower header 33. This

bank of tubes 48 has portions 49 bent outwardly, portions 50 extending vertically and inclined portions 51 which are connected to the header 47. Alternating with the tubes 48 are tubes 52 which extend from the lower header 33 to the header 47 in the top wall 21, these tubes 52 being substantially straight tubes. The alternate disposition of the tubes 52 and the tubes 48 and the shaping of the tubes 48 in this manner deflects a substantial portion of ash and other non-combustible material therein back into the upward pass 31 for collection and withdrawal at the bottom thereof.

To the rear of the furnace section 10 the boiler section 11 is provided, in communication with the furnace section 10.

The boiler section 11 preferably has an upper steam-and-water drum 55 and vertically therebelow a lower water drum 56 and a baffle 57 is provided for dividing the boiler section into an upward pass and a downward pass. The baffle or wall 22 separates the furnace section 10 from the boiler section 11 and extends forwardly from the steam-and-water drum 55 and downwardly and thus provides a rear wall for the furnace section 10 and the downward pass 32 thereof.

An inclined rear wall 58 is also preferably provided to close the space between the lower header 46 and the water drum 56.

A bank of tubes 60 is provided in the upward pass of the boiler section between the water drum 56 and the steam-and-water drum 55, with the forward line of tubes disposed close to the baffle or wall 22 for preventing the overheating of the baffle. A bank of tubes 61 is also provided in the downward pass of the boiler section between the water drum 56 and the steam-and-water drum 55. The banks of tubes 60 and 61 are preferably connected to the steam-and-water drum 55 below the water level thereof.

A bank of tubes 63 is provided between the lower header 46 and the steam space of the steam-and-water drum 55 and preferably includes inclined portions 64 extending upwardly along the inclined rear wall 58, and portions 65 inclined forwardly for deflecting ash and other uncombustible material back towards the adjacent floor section for removal, and portions 66 extending upwardly along the baffle or rear wall 22 to the steam-and-water drum 55 for preventing the overheating of the baffle or rear wall 22.

Banks of tubes 67 may also be provided adjacent the side walls 19 from the lower header 46 to the steam space of the steam-and-water drum 55 with straight portions at the opening from the furnace section 10 to the boiler section 11.

The upper headers 23 in the side walls 19 are connected to the steam space of the steam-and-water drum 55 by banks of tubes 68. Banks of tubes 69 which line the portion of the top wall 21 above the upward pass 31 are provided between the upper header 26 and the top header 47 and an additional bank of tubes 70 lining the portion of the top wall 21 above the downward pass 32 is provided between the header 47 and the steam space of the steam-and-water drum 55.

The superheater section 12 comprises a bank of superheater tubes 72 which is connected to the steam space of the steam-and-water drum 55 and this bank preferably has the major portion of its length disposed within the upward pass of the boiler section 11, and may have a portion thereof extending through the furnace section 10. A superheater header 73 to which the bank of superheater tubes 72 is connected, is also provided for the withdrawal of the superheated steam.

The economizer section 13 is located to the rear of the boiler section 11 and in communication therewith, and includes a lower water drum 75 and an upper steam-and-water drum 76 substantially vertically disposed above the water drum 75.

Walls 77 and 78 are preferably provided at the front and rear extremities of the economizer section 13 and a baffle 79 centrally disposed within the economizer section 13 is also provided and extends upwardly from the water drum 75 to a location spaced from the steam-and-water drum 76 to provide upward and downward passes for the combustion gases. Banks of tubes 80 and 81 are preferably provided respectively within the passes and extend from the water drum 75 to the steam-and-water drum 76. The steam-and-water drum 76 of the economizer section 13 is preferably connected to the steam-and-water drum 55 of the boiler section 11 by a bank of tubes 82 connecting the steam spaces of these drums 55 and 76, and another bank of tubes 83 is provided between the steam-and-water drum 76 of the economizer section 13 and the steam-and-water drum 55 of the boiler section 11 below the water levels thereof.

The air heater 14 for preheating the air for combustion is preferably provided to the rear of the economizer section 13 and in communication therewith so that the heat in the combustion gases discharged from the economizer section 13 may be utilized for preheating the air for combustion. The air heater 14 has an inlet 84 for the combustion gases connected to the outlet of the economizer section, and an outlet 85 for the combustion gases, the outlet 85 being connected by a suitable duct 86 to the induced draft fan 15. The outlet of the fan 15 is connected to the stack (not shown).

The air heater 14 also has an air inlet 87 to which the forced draft fan 16 is connected by a suitable duct 88. The heated air outlet 89 of the air heater 14 is connected by a suitable duct 90 to the ducts 91 and 92, and a portion of this air may also be utilized with the fuel by means of the ducts 93.

Suitable collecting chambers 95 and 96 may be provided in communication with the outlet of the boiler section 11 and inlet of the economizer section 13 and with the outlet of the economizer section 13 and the hot gas inlet 84 of the air heater 14 for the cellecting and removal of ash or other non-combustible deposits which are carried over into these collecting chambers. Suitable gates 97 are provided for access to these chambers 95 and 96 for such removal.

Fuel inlet devices are provided and for this purpose each of the side walls 19 may be provided below the center thereof with suitable nozzles 100 which are supplied by supply pipes 101 for introducing pulverized coal, oil or other suitable fluent fuel.

The top wall 21 of the furnace section 11 above the downward pass 32 may also be provided with a plurality of fuel inlet nozzles 102 which are supplied by supply pipes 103 for introducing pulverized coal, oil or other suitable fuel downwardly into the top of the downward pass 32. It will, of course, be understood that air may be added with the fluent fuel in the well known manner, ducts 93 being provided for this purpose.

While in most instances the same kind of fluent fuel will be introduced at the fuel inlet nozzles

100 and at the fuel inlet nozzles 102 different kinds of fuel may, if desired, be introduced thereby. It will be understood that, if desired, fuel may be introduced only at the nozzles 100 and as a larger quantity of steam is required the nozzles 102 may be used in addition to supply fuel for combustion.

Provision is also made for introducing air at the lower part of the upward pass 31 from the duct 91 and at the lower part of the downward pass 32 from the duct 92, these ducts being supplied with preheated air as heretofore indicated.

I claim:

1. In a steam generating unit, a combustion chamber, the walls of said combustion chamber being lined with water tubes exposed to the radiant heat of the burning fuel in said chamber, said combustion chamber having a vertical wall extending upwardly at the central part thereof and dividing said combustion chamber into an upward pass and a downward pass, fuel inlet devices for supplying fuel into said upward pass, and additional fuel inlet devices for supplying fuel into said downward pass.

2. In a steam generating unit, a combustion chamber, the walls of said combustion chamber being lined with water tubes exposed to the radiant heat of the burning fuel in said chamber, said combustion chamber having a vertical wall extending upwardly at the central part thereof and dividing said combustion chamber into an upward pass and a downward pass, steam generating tubes for cooling said wall, fuel inlet devices for supplying fuel into said upward pass, and additional fuel inlet devices for supplying fuel into said downward pass.

3. In a steam generating unit, a combustion chamber, the walls of said combustion chamber being lined with water tubes exposed to the radiant heat of the burning fuel in said chamber, said combustion chamber having a vertical wall extending upwardly at the central part thereof and dividing said combustion chamber into an upward pass and a downward pass, fuel inlet devices in said side walls for supplying fuel into said upward pass, and additional fuel inlet devices in said top wall for supplying fuel into said downward pass.

4. In a steam generating unit, a combustion chamber, the walls of said combustion chamber being lined with water tubes exposed to the radiant heat of the burning fuel in said chamber, said combustion chamber having a vertical wall extending upwardly at the central part thereof and dividing said combustion chamber into an upward pass and a downward pass, steam generating tubes for cooling said wall, fuel inlet devices for supplying fuel into said combustion chamber, separate collecting spaces at the bottom of each of said passes, and air inlet devices in the lower portions of each of said passes.

5. In a steam generating unit, the combination of a combustion chamber and a boiler section to the rear thereof, the walls of said combustion chamber being lined with water tubes exposed to the radiant heat of the burning fuel in said chamber, said boiler section including an upper steam-and-water drum and a lower water drum, banks of tubes in said boiler section connecting said upper and lower drums, means for connecting the tubes in said combustion chamber to said upper drum, said combustion chamber having a vertical transverse wall extending upwardly at the central part thereof and dividing said combustion chamber into an upward pass and a downward pass, fuel inlet devices for supplying fuel into said upward pass, and additional fuel inlet devices for supplying fuel into said downward pass.

6. In a steam generating unit, the combination of a combustion chamber and a boiler section to the rear thereof, the walls of said combustion chamber being lined with water tubes exposed to the radiant heat of the burning fuel in said chamber, said boiler section including an upper transverse steam-and-water drum and a lower transverse water drum substantially vertically below said first mentioned drum, banks of tubes in said boiler section connecting said upper and lower drums, means for connecting the tubes in said combustion chamber to said steam-and-water drum, said combustion chamber having a vertical wall extending upwardly at the central part thereof and dividing said combustion chamber into an upward pass and a downward pass, steam generating tubes for cooling said wall, means for connecting said tubes to said steam-and-water drum, fuel inlet devices for supplying fuel into said combustion chamber, and air inlet devices in the lower portion of each of said passes.

7. In a steam generating unit, the combination of a combustion chamber and a boiler section to the rear thereof, the walls of said combustion chamber being lined with water tubes exposed to the radiant heat of the burning fuel in said chamber, said boiler section including an upper transverse steam-and-water drum and a lower transverse water drum substantially vertically below said first mentioned drum, banks of tubes in said boiler section connecting said upper and lower drums, means for connecting the tubes in said combustion chamber to said steam-and-water drum, said combustion chamber having a vertical transverse wall extending upwardly at the central part thereof and dividing said combustion chamber into an upward pass and a downward pass, steam generating tubes for cooling said wall, means for connecting said tubes to said steam-and-water drum, fuel inlet devices in said side walls for supplying fuel into said upward pass, fuel inlet devices in said top wall for supplying fuel downwardly into said downward pass, and air inlet devices in the lower portion of each of said passes.

8. In a steam generating unit, the combination of a furnace section and a boiler section, the walls of said furnace section being lined with water tubes exposed to the radiant heat of the burning fuel in said furnace section, said furnace section having a transverse header centrally disposed in the lower part thereof and a transverse header in the upper part thereof, a wall extending upwardly from said lower header to a point adjacent but spaced from said upper header for dividing said furnace section into an upward pass and a downward pass, a bank of tubes within said wall extending from said lower header to said upper header, and fuel inlet devices for delivering fuel into said furnace section.

9. In a steam generating unit, the combination of a furnace section and a boiler section, the walls of said furnace section being lined with water tubes exposed to the radiant heat of the burning fuel in said furnace section, said furnace section having a header disposed in the lower part thereof and a header in the top thereof, a wall extending upwardly from said lower header to a point adjacent but spaced from said

upper header for dividing said furnace section into an upward pass and a downward pass, a bank of tubes within said wall extending from said lower header to said upper header, fuel inlet devices for delivering fuel into said furnace section, a downwardly extending wall for separating said furnace section from said boiler section, banks of tubes along each side of said wall, means for supplying air to said furnace section, and separate collecting means at the lower portion of each of said passes.

10. In a steam generating unit, the combination of a furnace section and a boiler section, the walls of said furnace section being lined with water tubes exposed to the radiant heat of the burning fuel in said furnace section, said furnace section having a transverse header centrally disposed in the lower part thereof and a transverse header in the top thereof, a wall extending upwardly from said lower header to a point adjacent but spaced from said upper header for dividing said furnace section into an upward pass and a downward pass, a bank of tubes extending from said lower header to said upper header and having the upper portions thereof projecting into said upward pass, fuel inlet devices for delivering fuel into said combustion chamber, a downwardly extending wall for separating said furnace section from said boiler section, and banks of tubes along each side of said wall, certain of said tubes having offset portions for deflecting backwardly into said furnace section solid material tending to pass from said furnace section to said boiler section.

11. In a steam generating unit, the combination of a furnace section and a boiler section, the walls of said furnace section being lined with water tubes exposed to the radiant heat of the burning fuel in said furnace section, said furnace section having a transverse header centrally disposed in the lower part thereof and a transverse header in the top thereof, a wall extending upwardly from said lower header to a point adjacent but spaced from said upper header for dividing said furnace section into an upward pass and a downward pass, a bank of tubes within said wall extending from said lower header to said upper header and having the upper portions thereof projecting into said upward pass, fuel inlet devices in the side wall for delivering fuel into said upward pass, fuel inlet devices in the top of said furnace section and above said downward pass for delivering fuel downwardly into said downward pass, a downwardly extending wall for separating said furnace section from said boiler section, banks of tubes along each side of said wall, certain of said tubes having offset portions for deflecting backwardly into said furnace section solid material tending to pass from said furnace section to said boiler section, and means for supplying air to said furnace section.

12. In a steam generating unit the combination of a furnace section and a boiler section, the walls of said furnace section being lined with water tubes exposed to the radiant heat of the burning fuel in said section, said furnace section having a transverse header centrally disposed in the lower part thereof and a transverse header in the top thereof, and a wall extending upwardly from said lower header to a point adjacent but spaced from said upper header for dividing said furnace section into an upward pass and a downward pass, a bank of tubes within said wall extending from said lower header to said upper header and having the upper portions thereof projecting into said upward pass, fuel inlet devices in the side wall for delivering fuel into said upward pass, fuel inlet devices in the top of said furnace section and above said downward pass for delivering fuel downwardly into said downward pass, a downwardly extending wall for separating said furnace section from said boiler section, banks of tubes along each side of said wall, certain of said tubes having offset portions for deflecting backwardly into said furnace section solid material tending to pass from said furnace section to said boiler section, means for supplying air to said furnace section, and separate collecting means for non-combustible material at the lower portion of each of said passes.

JOHN PHILLIPS BADENHAUSEN.