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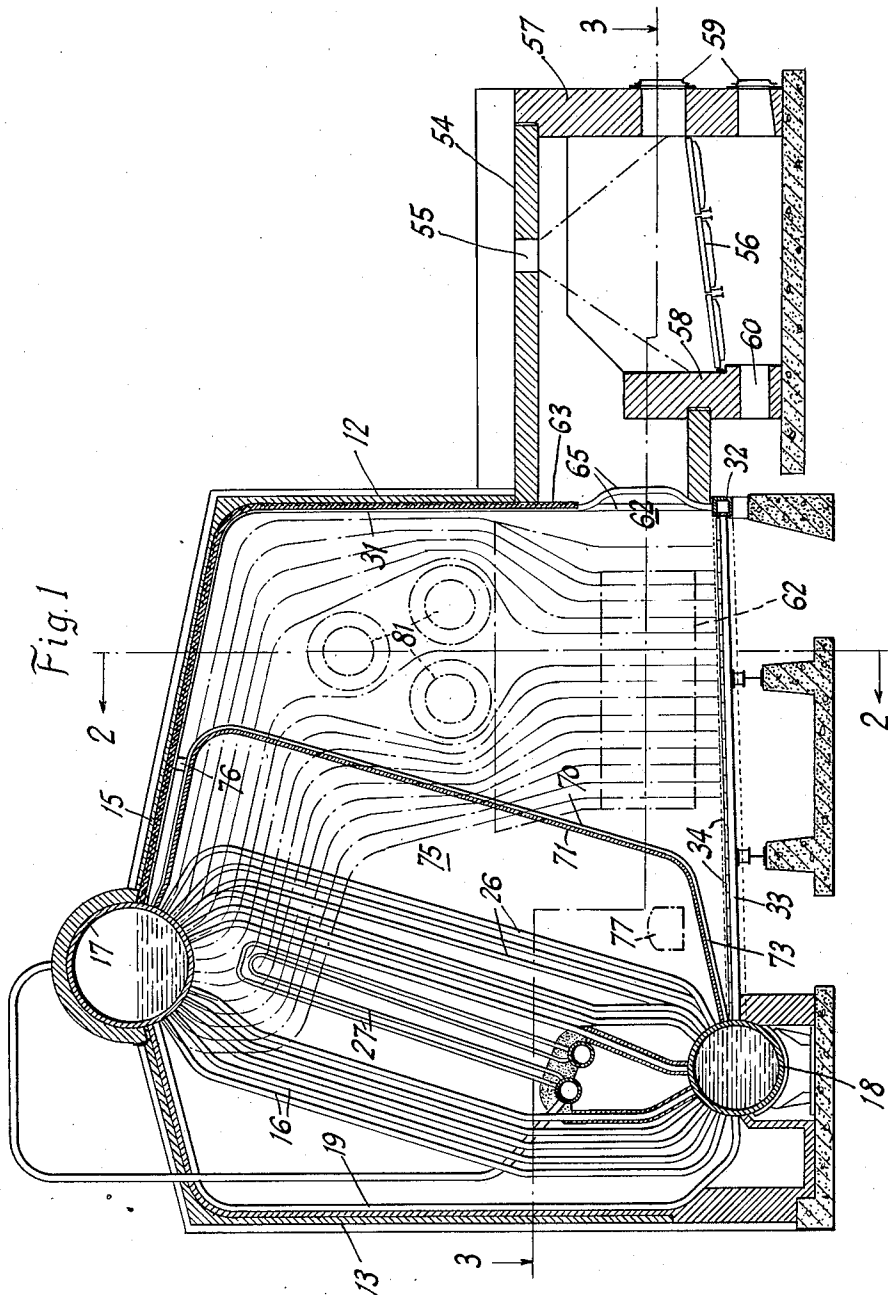
E. H. VICARY

2,296,656

STEAM GENERATING UNIT

Filed Sept. 6, 1940

5 Sheets-Sheet 1



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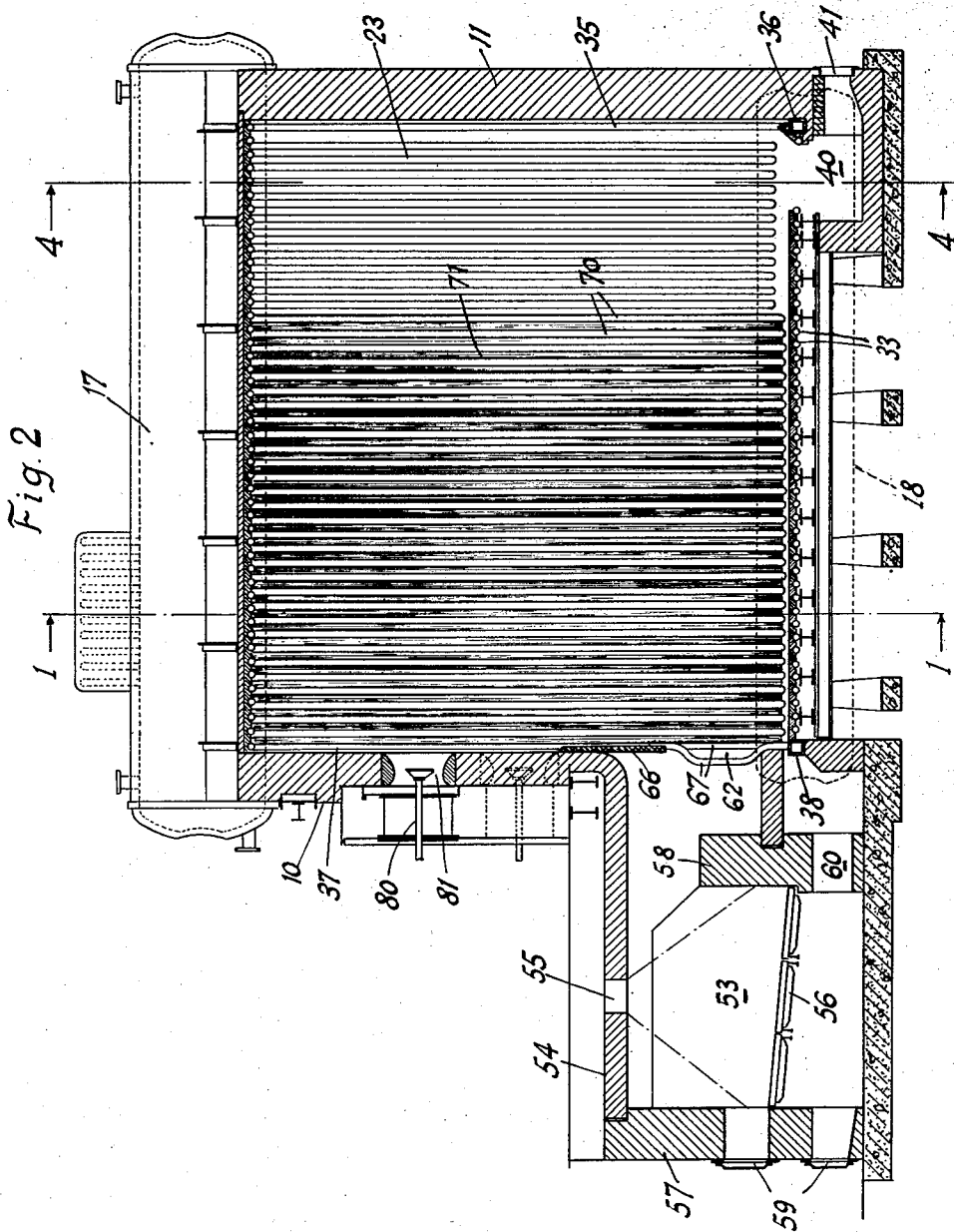
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5 Sheets-Sheet 2



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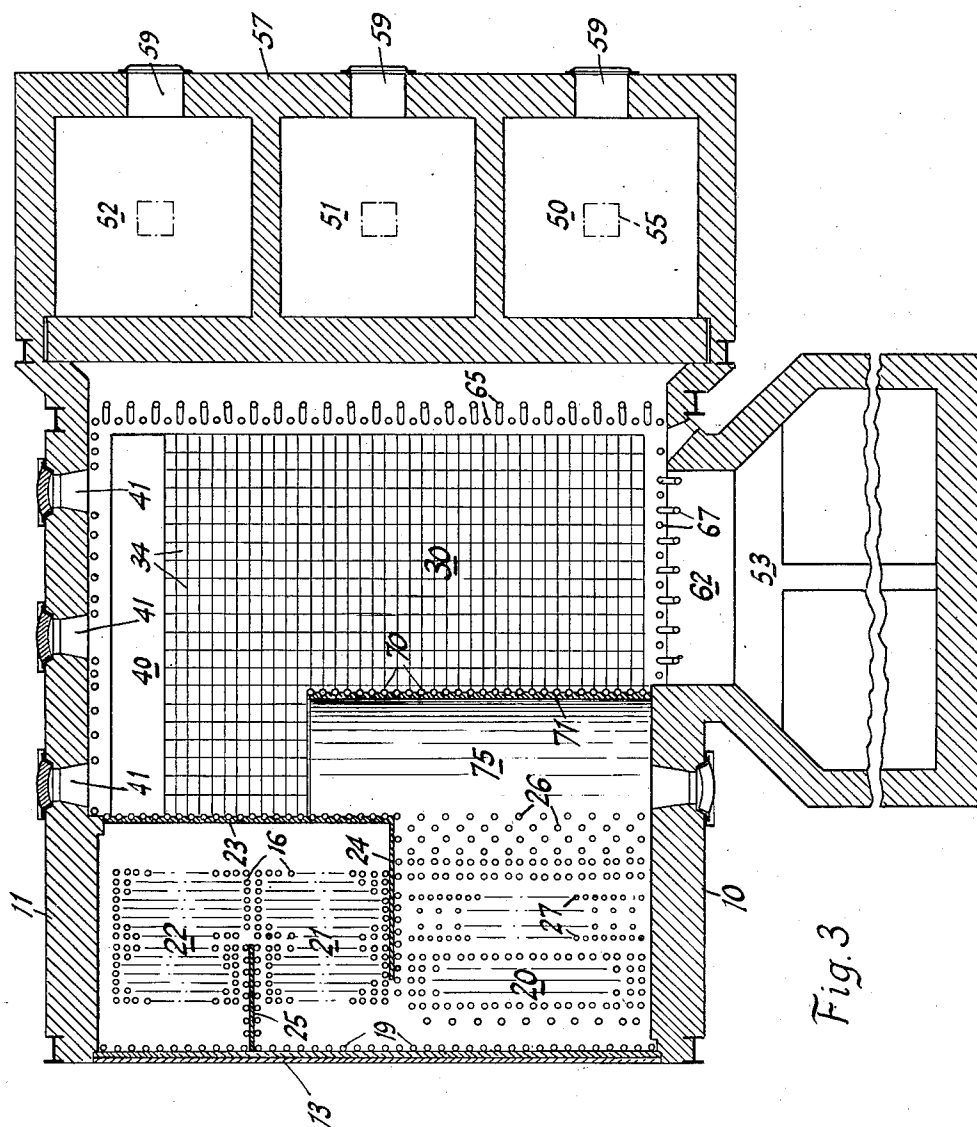


Fig. 3

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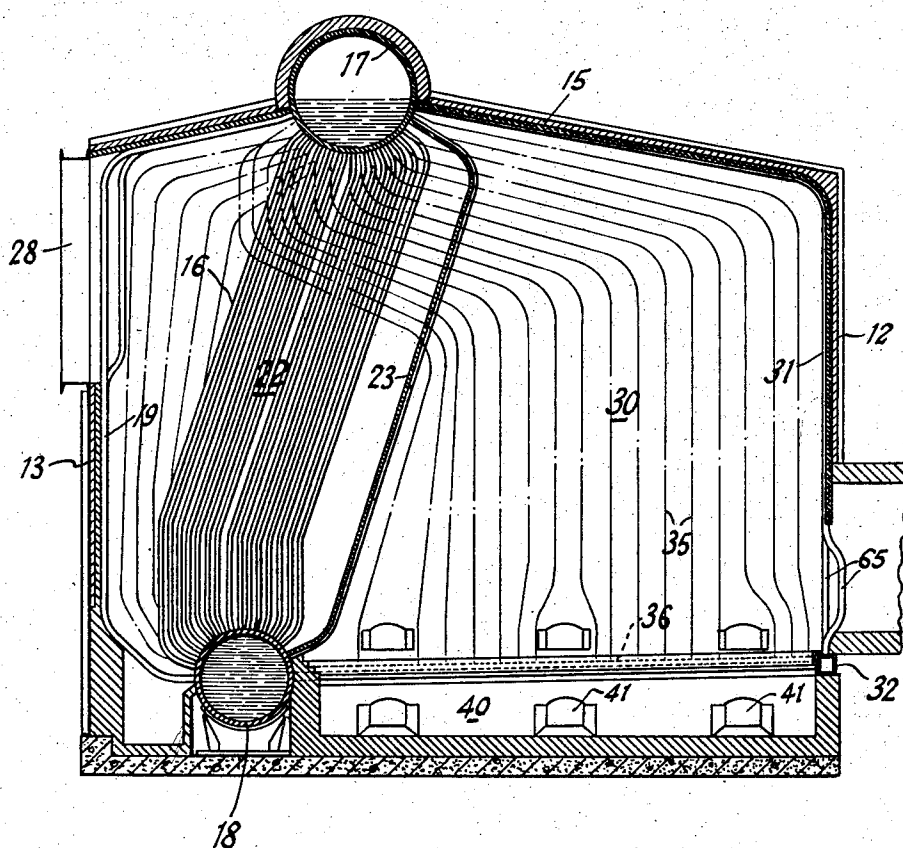
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Fig. 4



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Fig. 5

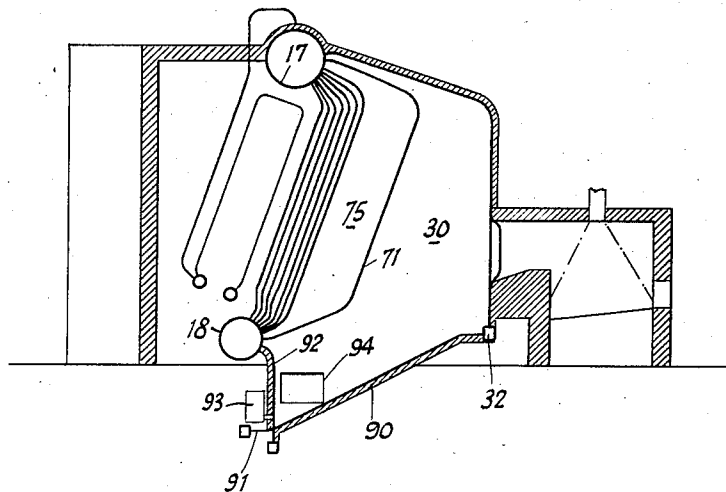
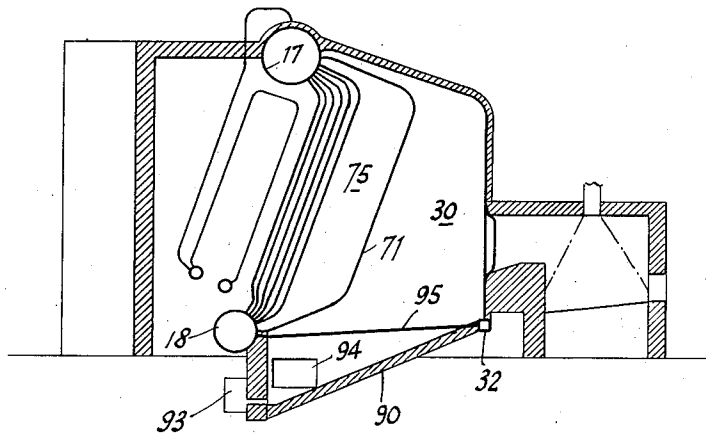


Fig. 6



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UNITED STATES PATENT OFFICE

2,296,656

STEAM GENERATING UNIT

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Application September 6, 1940, Serial No. 355,555

6 Claims. (Cl. 122—336)

This invention relates in general to the construction and operation of steam generating units, and more particularly, to steam generating units designed for burning fibrous fuels, either alone or in combination with other fuels.

Fibrous fuels vary in chemical and physical properties according to the vegetable growth from which they are derived, the processing operations performed before reaching the point of consumption, and the physical and chemical changes taking place in the fuel during its handling and storage. The last factor is particularly important in the design and construction of steam generating units burning hogged fuel and bark refuse from paper mills on the Pacific Coast. In that area it is the general practice to transport and store the logs in water, resulting in a higher moisture content in the wood than when dry transportation and storage is used. Furthermore, if salt water is used for transportation and storage, considerable marine life accumulates on the logs, and the shells and other residue left by such accumulations acts as a flux on the wood ash when the wood is burned and materially reduces its fusion temperature, sometimes to a fusing temperature as low as 1050° F. This not only causes a destructive reaction with refractory parts of the setting, but also causes troublesome slag conditions on the heat absorbing surface of the unit. Because of this situation, it is necessary that the temperature of the gases entering the superheater section of the unit be reduced, if possible, to a point below that at which the slag is in a sticky condition, in order to reduce the tendency of the slag to block the heating gas passages through the superheater.

In steam generating units burning a fibrous fuel, such as hogged bark or wood, grain hulls, or bagasse, there is usually a substantial carryover of ash and incompletely burned solid particles by the heating gases into the convection heated section of the unit. The disadvantages of such carryover are substantially increased when the ash has a low fusion temperature and/or one or more auxiliary fuel burners are simultaneously employed.

The general object of my invention is the provision of an improved construction of a steam generating unit for burning fibrous fuels which is particularly characterized by a high combustion efficiency, a low carryover of ash and unburned combustibles into the convection section, and a relatively low temperature of the heating gases and ash particles suspended therein as the

gases enter the convection section of the unit.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described several embodiments of my invention.

Of the drawings:

Fig. 1 is a sectional elevation of a steam generating unit embodying the invention and taken on the line 1—1 of Fig. 2;

Fig. 2 is a longitudinal section taken on the line 2—2 of Fig. 1;

Fig. 3 is a horizontal section taken on the line 3—3 of Fig. 1;

Fig. 4 is a partial vertical section taken on the line 4—4 of Fig. 2; and

Figs. 5 and 6 are somewhat diagrammatic views similar to Fig. 1 of modified constructions.

The steam generating unit illustrated in Figs. 1-4, is particularly designed for burning a fibrous fuel of the character described and producing steam at relatively high temperatures and pressures and at relatively high efficiencies. The unit has a setting substantially rectangular in horizontal and vertical cross-section and defined by a front wall 10, rear wall 11, side walls 12 and 13, and a roof 15. The setting space alongside the side wall 13 is occupied by a major portion of the steam generating surface consisting of a bank of vertically disposed tubes 16 extending between horizontal upper and lower drums 17 and 18, respectively.

The tube bank space is divided into three serially connected transverse gas passes 20, 21, 22 by a partition 23 formed of partly studded tubes and refractory and transverse baffles 24 and 25, with groups of screen tubes 26 and inverted U-shaped superheater tubes 27 located in the first gas pass 20, all constructed substantially as described in U. S. Patent 1,999,984. A row of downcomer tubes 19 extends between the drums along the roof 15 and side wall 13, the upper portions of alternate tubes 19 in the pass 22 being bent out of alignment across the gas outlet 28 from the unit.

The remaining portion of the setting is occupied by a fluid cooled furnace chamber 30 arranged alongside the tube bank space and communicating therewith as hereinafter described. The furnace chamber is fluid cooled by a row

of tubes 31 extending along the side wall 12 and roof 15 between the drum 17 and a side wall header 32, a row of floor tubes 33 extending between the header 32 and drum 18 and covered by metallic blocks 34, a row of tubes 35 extending along the rear wall 11 between a bottom header 36 and the drum 17, and a row of tubes 37 extending along the front wall 10 between a bottom header 38 and the drum 17. The ends of the headers 36 and 38 are connected to the drum 18 and side wall header 32. The floor tubes 33 and blocks 34 terminate short of the rear wall 11, leaving a space therebetween which forms an entrance to a subadjacent ash pit 40 into which the ash depositing on the furnace floor is raked or blown and subsequently removed through doors 41.

At two sides of the setting is arranged a series of fibrous fuel burning cells, three of such cells, 50, 51, and 52 being arranged side-by-side along the side wall 12, and a double cell 53 along the front wall 10 adjacent the side wall 12. Each of these cells consists of a refractory walled structure having a flat roof 54 in which is located a fuel feed port 55 through which fuel is dropped onto an inclined water cooled grate 56 extending between the vertical side walls 57 of the cell and a bridge wall 58. Doors 59 are located in an exposed wall 57 above and below the grate, while air inlet passages 60 are provided in the bridge wall below the grate for supplying combustion air to the cell. In operation, hogged fuel, for example, is supplied to the cells, forming a conical pile on the grates 56. Most of the combustion taking place in the cells is on the surface of the fuel pile, and the heating gases generated flow over the bridge wall and through a rectangular opening 62 into the furnace chamber 30. The side wall tubes 31 extend downwardly across the discharge openings 62 of the cells 50, 51, and 52. The tubes 31 are studded and covered with refractory on their outer sides for a short distance below the roof 54, forming a fluid cooled drop nose arch 63, and the remaining portions of alternate tubes 31 are bent out of alignment to form a tube screen 65 across the outlet 62. A similar construction of the front wall tubes 37 is used for the double cell 53 to form a drop nose arch 66 and screen 67.

With the cell construction and arrangement described a considerable fibrous fuel burning capacity is attained. The heating gases generated carrying a large quantity of ash in suspension in a dry or a fused condition pass through the screened outlets 62 into the furnace chamber 30. The tube screens 65 and 67 effect a substantial mixing of the gases and any unconsumed air therewith so that considerable secondary combustion will take place in the furnace chamber 30.

With the arrangement of the cells along the front and side wall described, the heating gases would tend to enter the adjacent gas pass 20 at a relatively high temperature and with some of the ash in a molten or a sticky condition. In accordance with my invention, the path of travel of the heating gases in the furnace chamber 30 is considerably lengthened, the temperature of the heating gases and suspended ash particles reduced, and much of the suspended ash separated before the heating gases enter the gas pass 20 of the main tube bank space.

The foregoing results are mainly due to the provision of an additional row of substantially U-shaped water tubes 70 having their opposite

ends directly connected to the upper and lower drums of the boiler beyond the tube connections of the laterally spaced tube row in the partition 23. The tubes 70 are partly studded throughout their lengths on their sides adjacent the tube bank space, with the studs covered and intertube spaces closed by initially plastic refractory to form a correspondingly shaped partition 71 extending from the front wall 10 rearwardly to a point overlapping the forward end of the partition 23. As shown in Fig. 1, the partition 71 extends outwardly and upwardly from the drum 18 into the furnace chamber to form an inclined floor 73 for the space 75 enclosed by the partition which thus forms an unobstructed gas passage connecting the rear portion of the furnace chamber to the entrance end of the gas pass 20. The main portion of the partition 71 and tubes 70 extends parallel to the corresponding part of the tubes 23, so that the gas pass 75 is of substantially the same width throughout its height. The tubes 70 are partly supported by small plates 76 welded between the upper legs of those tubes and the adjacent roof portions of the tubes 31. A door 77 is positioned in the front wall 10 adjacent the partition floor 73 to permit the removal of deposited ash.

With the described construction and arrangement of the partition 71, the tubes in the first gas pass 20 will be substantially completely shielded from direct radiation from the furnace chamber 30. The partition is also effective in substantially increasing the length of travel of the heating gases in the main furnace chamber 30, and in view of the large amount of exposed tube surface in the boundary walls of this chamber, this increase in the flow path will cause a sufficient reduction in the temperature of the heating gases and suspended ash so that the superheater tubes will not be heated above a safe metal-temperature and the ash contacting with the tubes in the main generating bank will be in a dry condition, facilitating the periodic cleaning thereof. A further advantage of the described arrangement is the increased separation of ash from the heating gases in the main furnace chamber 30, due to the sharp turn in the path of gas travel around the end of the partition 71 and the further turn from the open pass 75 into the gas pass 20.

The operating advantages of the construction are particularly noticeable when the steam generating load may require the simultaneous use of an auxiliary fuel, such as pulverized coal, gas, or oil, with a consequent increase in the temperature conditions in the unit. The steam generating unit described is of this type and includes a group of auxiliary oil burners 80 positioned in burner ports 81 formed in the front wall 10 above the fibrous fuel burning cell 53. The heating gases generated by the fuel burners 80 when in use will follow a flow path similar to the gases from the subadjacent cell 53 and have their temperature substantially reduced while traveling through the fluid cooled path described before entering the main tube bank space.

In Figs. 5 and 6 are conventionally illustrated modified constructions of the bottom of the main furnace chamber 30. In Fig. 5 the furnace chamber bottom is formed by an inclined hopper bottom 90 having a row of inclined water tubes 91 extending along the same to the side wall header 32, and an additional row of vertical water tubes 92 along the opposite wall of the hopper. An air duct 93 is connected to a series of air inlets open-

ing between the tubes 92 for supplying combustion air to the material accumulating in the hopper, and thereby burning out any unburned combustibles therein. A clean-out door 94 provides access to the accumulated material.

The modified construction of Fig. 6 differs from that of Fig. 5 in that the hopper bottom 90 is entirely refractory with a row of tubes 95 extending horizontally from the side wall header 32 directly to the lower drum 18 to provide a water cooled screen above the hopper through which the separated ash falls and is cooled to a dry condition.

While in accordance with the provisions of the statutes I have illustrated and described herein the best forms of the invention now known to me, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by my claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features.

I claim:

1. A steam generator comprising walls forming a setting, a vertically disposed bank of steam generating tubes extending along one side of said setting, a vertically disposed partition separating the space containing said tube bank from a laterally adjoining furnace chamber except at one end of said tube bank, a fibrous fuel burning cell having a heating gas outlet into one side of said furnace chamber adjacent the communicating end of said tube bank, and a second vertically disposed partition in said furnace chamber extending in spaced relation across the communicating end of said tube bank to a point overlapping said first partition and defining a gas pass extending in the same direction as said tube bank space and forming a gas flow connection between said tube bank space and the remaining portion of said furnace chamber.

2. A steam generator comprising walls forming a setting, a vertically disposed bank of steam generating tubes extending along one side of said setting, upper and lower horizontally arranged drums connected to said tube bank, a vertically disposed partition separating the space containing said tube bank from a laterally adjoining furnace chamber occupying the remaining portion of said setting except at one end of said tube bank, a fibrous fuel burning cell having a heating gas outlet into said furnace chamber adjacent the communicating end of said tube bank, and a second vertically disposed partition in said furnace chamber extending in spaced relation across the communicating end of said tube bank to a point overlapping said first partition and defining a gas pass extending in the same direction as said tube bank space and forming a gas flow connection between said tube bank space and the remaining portion of said furnace chamber, said second partition comprising a row of U-shaped water tubes having their ends connected to said upper and lower drums.

3. A steam generator comprising walls forming a setting, a vertically disposed bank of steam generating tubes extending along one side of said setting, upper and lower horizontally arranged drums connected to said tube bank, a vertically disposed partition separating the space containing said tube bank from a laterally adjoining fluid cooled furnace chamber occupying the remaining portion of said setting except at one end of said

tube bank, a fibrous fuel burning cell having a heating gas outlet into said furnace chamber adjacent the communicating end of said tube bank, a fluid cooled floor in said furnace chamber below the level of said gas outlet, and a second vertically disposed partition in said furnace chamber extending in spaced relation across the communicating end of said tube bank to a point overlapping said first partition and defining an unobstructed gas pass extending in the same direction as said tube bank space and forming the only gas flow connection between said tube bank space and the remaining portion of said furnace chamber, said second partition comprising a row of U-shaped water tubes having their ends directly connected to said upper and lower drums.

4. A steam generator comprising walls forming a setting, a vertically disposed bank of steam generating tubes extending along one side of said setting, upper and lower horizontally arranged drums connected to said tube bank, a vertically disposed partition separating the space containing said tube bank from a laterally adjoining furnace chamber occupying the remaining portion of said setting except at one end of said tube bank, a fibrous fuel burning cell having a heating gas outlet into said furnace chamber adjacent the communicating end of said tube bank, a fluid cooled floor in said furnace chamber below the level of said gas outlet, a second vertically disposed partition in said furnace chamber extending across the communicating end of said tube bank in spaced relation with said first partition and defining an unobstructed gas pass extending in the same direction as said tube bank space and forming a gas flow connection between said tube bank space and the remaining portion of said furnace chamber, said second partition comprising a row of U-shaped water tubes having their ends directly connected to said upper and lower drums, and a transversely extending ash pit at the end of said furnace floor beyond the gas entrance end of said unobstructed gas pass.

5. A steam generator comprising walls forming a setting, a vertically disposed bank of steam generating tubes extending along one side of said setting, upper and lower horizontally arranged drums connected to said tube bank, a vertically disposed partition separating the space containing said tube bank from a fluid cooled furnace chamber occupying the remaining portion of said setting except at one end of said tube bank, a fibrous fuel burning cell having a heating gas outlet into said furnace chamber adjacent the communicating end of said tube bank, a fluid cooled floor in said furnace chamber below the level of said gas outlet, a second vertically disposed partition in said furnace chamber extending across the communicating end of said tube bank to a point overlapping said first partition and defining an unobstructed gas pass extending in the same direction as said tube bank space and forming a gas flow connection between said tube bank space and the remaining portion of said furnace chamber, and an auxiliary fuel burner positioned in a wall of said furnace chamber above said fibrous fuel burning cell.

6. A steam generator comprising walls forming a setting, a vertically disposed bank of steam generating tubes extending along one side of said setting, upper and lower horizontally arranged drums connected to said tube bank, a vertically disposed partition separating the space containing said tube bank from a laterally adjoining fluid cooled furnace chamber occupying the remaining

portion of said setting except at one end of said tube bank, a fibrous fuel burning cell having a heating gas outlet into said furnace chamber adjacent the communicating end of said tube bank, a fluid cooled floor in said furnace chamber below the level of said gas outlet, a second vertically disposed partition in said furnace chamber extending in spaced relation across the communicating end of said tube bank to a point overlapping said first partition and defining an unobstructed gas pass extending in the same direction as said tube bank space and forming the only

gas flow connection between said tube bank space and the remaining portion of said furnace chamber, said second partition comprising a row of U-shaped water tubes having their ends directly connected to said upper and lower drums, a transversely extending ash pit at the end of said furnace floor beyond the gas entrance end of said unobstructed gas pass, and an auxiliary fuel burner positioned in the wall of said furnace chamber above said fibrous fuel burning cell.

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