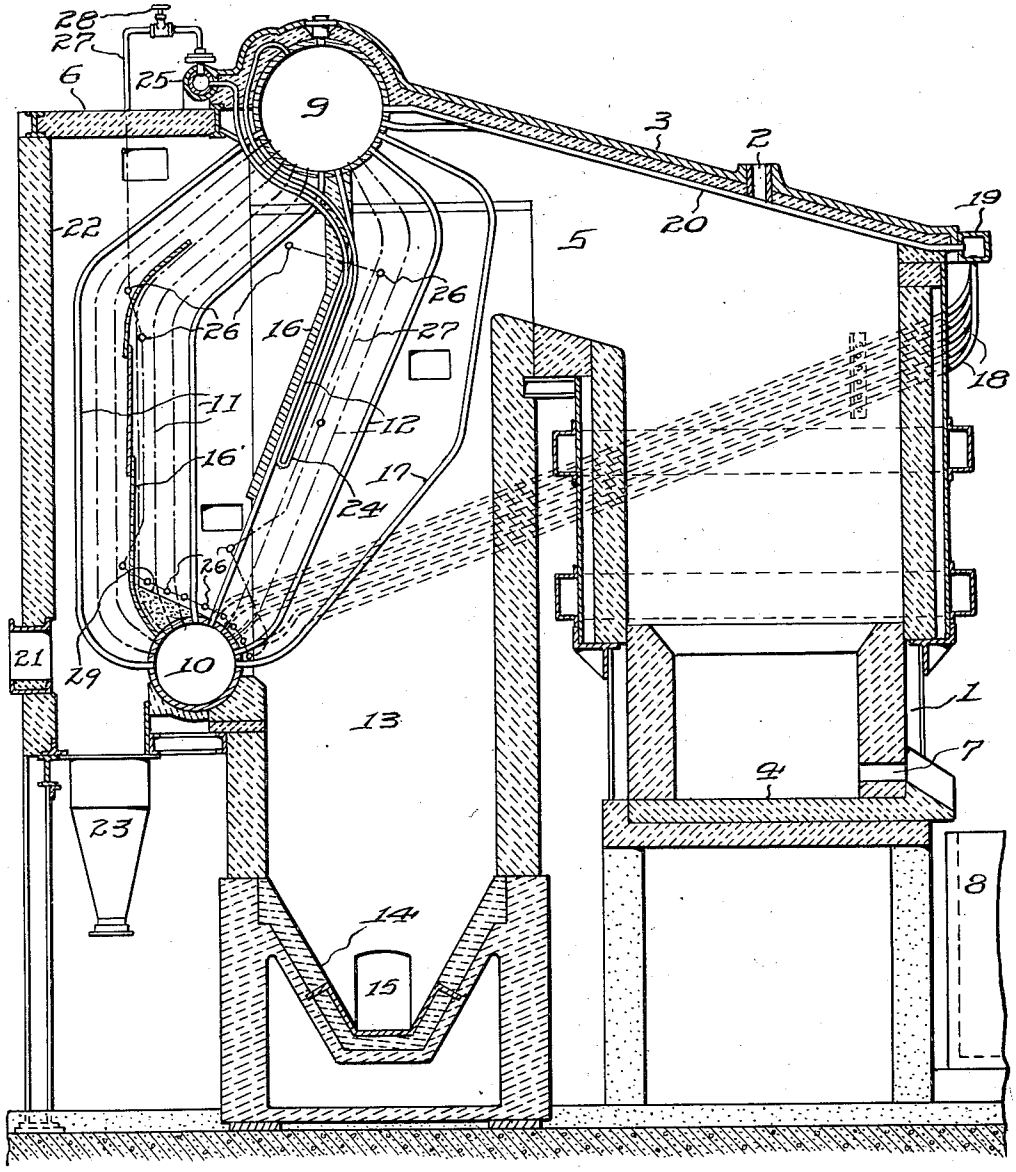
Dec. 3, 1935. J. H. ROHRER 2,023,031

BOILER FOR PULP MILLS AND THE LIKE

Filed June 22, 1931 3 Sheets-Sheet 1

Fig. 1.



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BOILER FOR PULP MILLS AND THE LIKE

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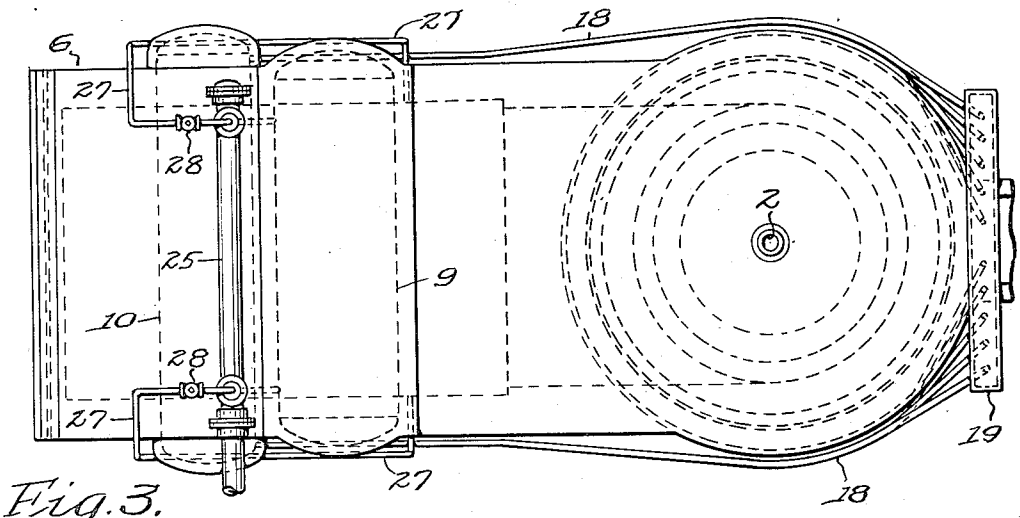
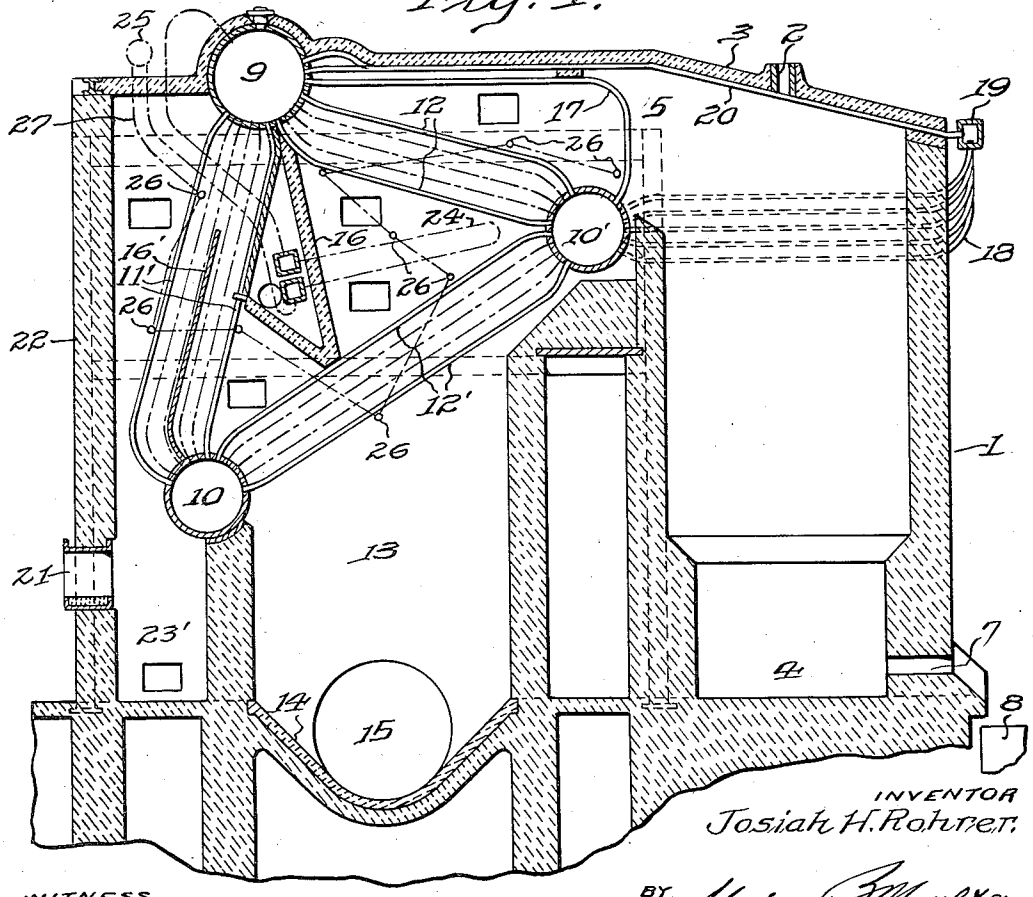


Fig. 3.

Fig. 4.



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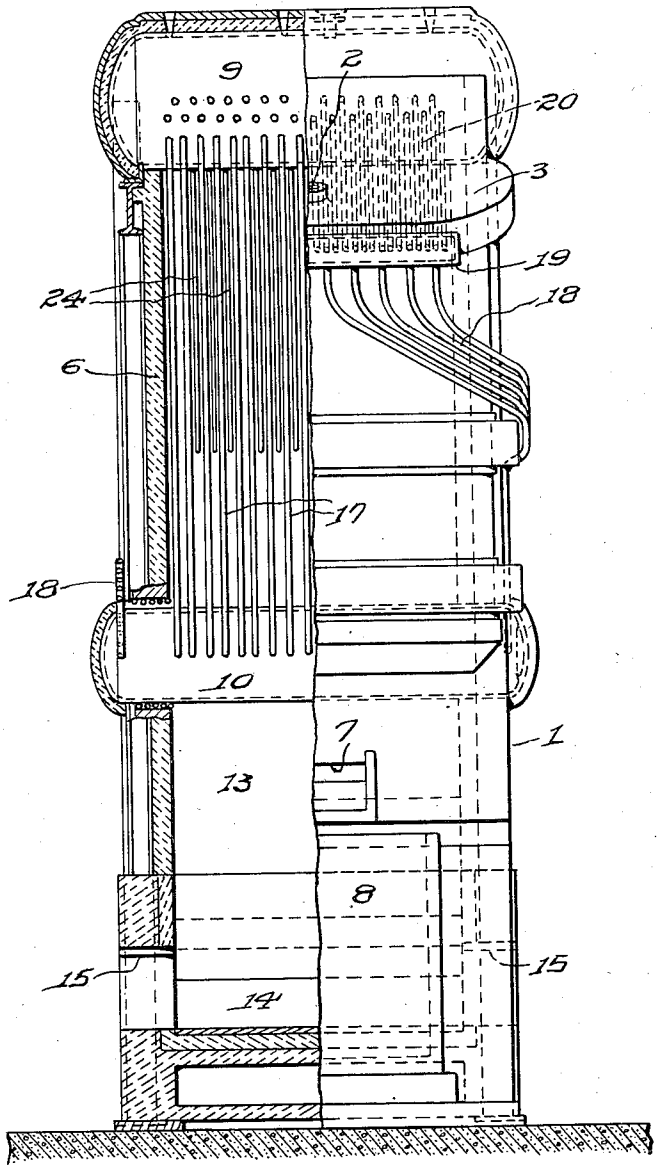
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BOILER FOR PULP MILLS AND THE LIKE

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Fig. 2.



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2,023,031

UNITED STATES PATENT OFFICE

2,023,031

BOILER FOR PULP MILLS AND THE LIKE

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Application June 22, 1931, Serial No. 546,020

2 Claims. (Cl. 23—277)

My invention relates to boilers particularly adapted for use in paper mills, pulp mills and similar plants, wherein the heat, incident to the reduction and recovery of the alkali in pulp liquors, is utilized for the generation of steam.

The recovery of the alkali from pulp liquors coming from the digesters of paper making plants is now effectively practised by burning the pulp liquor in a special furnace of the reduction type, the caustic soda and/or sulphite collecting at the bottom of the reduction furnace in a molten condition whence it is drawn off either regularly or intermittently into a suitable receptacle.

The temperature of such a furnace is high, generally speaking, about 2000°. This temperature is, generally speaking, below the volatilization point of the caustic soda and sulphite, but the sulphides and sulphates, developed during the process of combustion, are volatile and pass with the hot waste gases out of the furnace. Where the hot gases of combustion from such a reduction furnace are utilized for the development of power in a steam boiler, these valuable products carried in the gases leaving the furnace, are precipitated or sublimated out of the hot gases upon reaching the lower temperature around the steam-generating tubes of the boiler and fall to the bottom of the boiler. The sublimates of these solids out of the gases of combustion fall as a white dust out of the gases of combustion during their travel around the boiler tubes and collect on the floor of the boiler.

It is one object of the present invention to bring the hot gases of combustion leaving the reduction furnace and prior to their entry into the first tube bank of the boiler, into close contact or association with relatively cool surfaces such as water tubes extending across the inlet from the furnace into the boiler and which are operative to reduce the temperature of the gases of combustion quickly to about 1500° F. or below, at which temperatures the sulphates and other valuable alkali salts in gaseous form in the waste gases are at once sublimated out of the gases.

In this way the greater portion of such contents of the gases of combustion are separated therefrom and fall to the bottom of the boiler before the gases reach the main banks of steam-generating tubes of the boiler, or at least are so cooled that they will not adhere to the boiler tubes, thereby greatly reducing the amount of such solids as would otherwise collect in the boiler, on the tubes and lower drum of the boiler.

A further object of my invention is to provide a construction wherein the tubes which precipitate the alkaline solids from the gases of combustion leaving an alkaline recovering furnace are arranged vertically, in the main, so that the solids precipitated or sublimated out of the gases of combustion may freely fall and collect in a chamber or compartment whence they may be easily removed from time to time.

A further object of my invention is to provide the roof or upper wall of the furnace for the reduction of alkali from pulp liquors with means to water cool the same, the water cooling of the roof cooperating with the first row of tubes of the boiler to precipitate or sublimate the alkaline content of the gases of combustion for the most part, immediately upon their entry into the boiler and before they reach the main banks of tubes of the boiler.

Other objects of my invention will appear in the specification and claims below.

Since the furnace for the reduction and recovery of the alkali from pulp liquors may be, in the main, of any standard construction, I have shown a typical furnace except that I have provided the roof thereof with a water-cooling system which, in addition to preserving the roof from the destructive effects of the hot gases leaving the furnace cooperates with a row of cooling tubes connected with the boiler system to quickly cool the gases leaving the furnace to a temperature at which the alkali carried by the waste gases is sublimated out therefrom.

In the drawings forming a part of this specification and in which the same reference characters are employed throughout the various views to designate the same parts,

Fig. 1 is a vertical longitudinal section through a furnace for burning alkaline pulp liquor and through a boiler combined therewith and provided with means to quickly reduce the temperature of the gases of combustion immediately upon their passage into the boiler or steam-generator.

Fig. 2 is a front view of the device shown in Fig. 1, the left half of the figure being broken away to show the interior of the front of the boiler section and the row of tubes for reducing the temperature of the gases of combustion entering the boiler section.

Fig. 3 is a plan view of the apparatus shown in Figs. 1 and 2; and

Fig. 4 is a modified construction showing the application of my invention to a three drum water-tube boiler.

Referring first to the form of my invention il-

lustrated in Figs. 1 to 3 inclusive, the reduction furnace 1 is of standard and approved type. The furnace is first heated to a high temperature as by burning wood or gas therein in any approved way, and then pulp liquor is introduced as a spray through a suitable nozzle (not shown) entering the furnace through the opening 2 in the roof 3 thereof and burned therein. As a result of the combustion the caustic soda or sulphite contained in the caustic liquor is fused and collects on the bottom 4 of the furnace, the admission of air into the furnace being so controlled that the lower part of the furnace acts as a reduction chamber while the upper part of the furnace is supplied with a sufficient amount of air to insure rapid and high combustion of the combustibles contained in the caustic liquor. The water contained in the liquor passes off as steam, the combustible content of the liquor is burned in the upper part of the furnace and a great deal of the alkaline content of the liquor collects on the bottom 4 of the furnace as caustic soda or sulphite. The hot waste gases of combustion pass outwardly from the furnace 1 through the substantially horizontal passage or flue 5 to the boiler 6 as will be more fully described below.

The reduction furnace is preferably provided with any suitable gate 7 through which the molten alkali recovered in the furnace may flow into a suitable receptacle 8. The boiler shown in Figs. 1 to 3 is of a two drum type, the upper steam-and-water drum 9 being connected to the lower water drum 10 by a bank of downcomer water-tubes 11 at the rear of the furnace and by a bank of riser or upcomer tubes 12 at the front of the furnace, these two banks being arranged, so far as possible, vertically and being generally spaced somewhat farther apart from each other than they usually are in a standard water-tube boiler using other types of fuels. Each tube bank comprises a plurality of closely spaced rows of water tubes.

Under the bank of riser tubes 12 I provide a chamber 13, the bottom 14 of which is trough-shaped so that the solids collecting therein may be easily removed therefrom through the opening or door 15. To the rear of the bank of riser tubes 12, I provide a baffle 16 depending from the steam-drum 9 downwardly in the rear of the bank of risers 12, and within the bank of downcomer water-tubes 11 I provide a baffle 16' extending upwardly from the water-drum 10.

Well separated from and forward of the bank 12 of riser tubes I provide a supplemental row of riser tubes 17 extending forwardly and upwardly from the water drum 10 and in a substantially vertical plane straight across the flue 5. Between the tubes of this row 17 the gases of combustion from the flue 5 must first pass before they travel down longitudinally over the bank of riser tubes 12.

At the opposite ends of the water drum 10, I provide groups of tubes 18 extending outside of the furnace boiler proper and outside of the reduction furnace 1 and which bend around the front of the reduction furnace 1 and communicate with the under side of a horizontal header 19 located at the front edge of the roof 3. From this header 19 a row of water-tubes 20 line the interior surface of the roof 3 and the upper wall of the passage 5 and extend from the header 19 rearwardly to the steam-drum 9 with which they communicate.

The circulation of water in the steam-generating section will, of course, be at once apparent. From the steam-and-water drum 9, the water first flows downwardly through the bank of downcomers 11 to the water-drum 10 and then rises through the bank of risers 12 back to the steam-and-water drum 9. The water also rises in the supplemental row of tubes 17 from the lower water-drum 10 upwardly to the steam-and-water drum 9. Similarly, the water of the roof wall cooling system rises from the water-drum 10 through the tubes 18 on the sides of the apparatus into the horizontal header 19 whence it flows through the roof tubes 20 back to the steam-and-water drum 9 absorbing heat from the gases of combustion, since the row 20 is exposed to the radiant heat of the furnace and to the waste gases of combustion leaving the furnace 1.

The course of the gases of combustion leaving the furnace 1 will also be readily understood as passing from the flue 5 between the tubes of the supplemental row 17 and then downwardly under the baffle 16 traversing the length of the bank 12 and then upwardly between the baffles 16 and 16' traversing the front half of the bank 11 of downcomer tubes and then across the said tubes 11 around the upper end of the baffle 16' and down parallel to the rear half of the bank 11 to the exhaust flue 21.

From the flue 21 the gases are usually conducted to a scrubber by means of which any solids remaining in the gases of combustion may be removed and reclaimed. At the bottom of the passageway for the gases of combustion between the rear baffle 16' and the rear wall 22 of the boiler, I may also provide a bin or trough 23 in which the solids precipitated or sublimated out of the gases of combustion during their last passage over the tubes 11 of the boiler or carried over by the draft of waste gases may be collected.

I preferably provide the boiler with superheater tubes 24 connected at one end with the steam-and-water drum 9 and at the other end with the superheater drum 25 preferably located outside of the setting. The superheater tubes 24 are preferably positioned between and are substantially parallel to the riser tubes 12 constituting the first pass or bank of boiler tubes. They may be between every pair of riser tubes, or between every other pair of tubes, or between every set of three or more tubes. It will be readily understood that the temperature of the steam in the superheater tubes is lower than the temperature of the gases entering therebetween from the reduction furnace 1 and by the boiler tubes 11 and 12 and the superheater tubes 24 substantially all of the alkaline contents of the gases remaining therein after their passage through or between the tubes 17 is sublimated out of the gases and collects in the spaces between the tubes and on the bottom 14, floor 29 and trough 23 of the steam-generating section of the boiler.

This also makes plain how the powdered alkali falling from the gases of combustion or carried by the draft of waste gases and collecting within the boiler, may be removed by soot cleaners 26 positioned at suitable places in and between the tubes of the banks 11 and 12 of the boiler. From the superheater drum 25 is a tube or pipe 27 controlled by a valve 28 and to which the soot cleaners 26 are connected. By opening the valve 28 dry superheated steam is delivered to the said cleaners 26 which are operative to blow the powdered solids collecting in and among the tubes out therefrom so that they may fall and collect on the bottom 14 of the chamber 13 and in the bin or trough 23.

I have shown these soot cleaners 26 as arranged

in series in their attachment to the pipe 27 so that the opening of the valve 28 delivers steam to all the soot cleaners 26, but, of course, it is understood that this arrangement is merely diagrammatic and that any system of supplying steam or air to the soot cleaners 26 may be employed for the removal of the collection of solids in and between the banks of tubes of the boilers.

When the hot gases of combustion reach the tubes of the supplemental row 17, the temperature of the gases has been somewhat reduced by the absorption of the heat therefrom by the roof cooling tubes 20 so that upon striking the row 17 of relatively cool tubes the temperature is quickly reduced to 1500° or lower, for the temperature of the water in the row 17 is greatly below the temperature of the gases as they leave the flue 5, with the result that the alkaline salts carried by the gases of combustion are sublimated out of the gases of combustion and the greater portion of them fall out of the gases of combustion before the gases pass below the lower end of the baffle 16 and collect at the bottom 14 of the chamber 13.

Of course, some of these light floating particles of alkaline sublimate may float under the lower end of the baffle 16 and be carried upwardly, but in the main, such particles as are carried beyond the lower end of the baffle 16 will collect on the floor 29 of refractory material provided above the water drum 10. The lightest of the particles of solid matter floating in the gases of combustion may be carried over the upper end of the baffle 16, but when the gases turn to make their passage out of the boiler through the flue 21, much of that fine solid matter will be thrown to the bottom of the chamber and will be collected in the bin or trough 23.

It is hardly to be expected that all of the alkaline content of the gases will be instantly sublimated or precipitated out of the gases at the instant when they contact with and pass between the tubes 17 but substantially all of what remains therein will be subsequently sublimated or thrown down as the gases travel around and contact with the boiler tubes 12, the superheater tubes 24 and the boiler tubes 11. The temperature of the water and steam in said tubes is substantially below that at which the alkaline content is volatile and the process of sublimation goes on continuously as the gases travel through the boiler and by the time the gases leave by the flue 21 practically all of the salts will have collected on the bottom 14, the floor 29 and in the bin or trough 23.

In Fig. 4 is illustrated a slightly different arrangement wherein the boiler is of the three-drum type and the tubes 17 for cooling the gases as they enter the boiler are connected to the upper water-drum 10' and to the upper steam-and-water drum 9 and are spaced from the first bank 12 of tubes of the steam-generating section of the boiler to cool the gases before they reach the first bank of tubes 12. The upper water-drum 10' is connected to the lower water-drum 10 by risers 12' and the water for cooling the roof 3 is, in this instance, supplied to the header 19 by tubes 18 connected to the opposite ends of the water-drum 10'.

After passing the row of cooling tubes 17 the gases of combustion travel through the bank 12 and then downwardly in front of the baffle 16 and through the bank 12' in the chamber 13 under the baffle to enter between the tubes of the forward half of the rear bank of downcomers 11' and passing upwardly, travel through or across the tubes 11' near the upper ends thereof around the upper end of the baffle 16' and thence downwardly to the flue 21. In this instance, the fine powder which may be carried with the gases of combustion over the baffle 16' is collected in the chamber 23' below the flue 21. Although of slightly different shape, the chamber 13 is provided with a bottom 14 of sloping sides and access thereto is obtained by opening the closure or circular door 15.

Having thus described my invention, what I claim and desire to protect by Letters Patent of the United States, is:

1. The combination with a boiler having a transverse horizontal upper drum, a transverse horizontal lower drum, and a bank of tubes connecting the drums, of walls forming a furnace in front of the boiler, a row of tubes extending forwardly and downwardly from the upper drum and lining the roof of the furnace, a transverse horizontal header connected to the front ends of the forwardly extending tubes, and groups of tubes extending from the end portions of the lower drum directly to the header, the tubes of said group being located entirely outside the furnace and connected to the header at points spaced along the length thereof.

2. Apparatus for treating waste wood-pulp liquor comprising in combination a vertical furnace having substantially vertical walls, means for introducing waste liquor into the upper part of said furnace for combustion of its organic constituents and recovery of its inorganic constituents, means for supplying air for combustion to said furnace, a tap hole at the bottom of said furnace for the removal of molten inorganic constituents of the waste liquor, a row of inclined cooling fluid tubes defining the roof of said furnace, a heating gas outlet from said furnace adjacent said roof, a steam boiler arranged to receive heating gases from said furnace and comprising a bank of steam generating tubes extending across said heating gas outlet and arranged to absorb heat by radiation from said furnace, the front rows of tubes in said bank being more widely spaced apart than the rear tube rows of said bank to form a slag screen for said rear tube rows, a collecting hopper below said bank of tubes, means arranged to provide a flow of heating gases over the tubes of said bank, and conduit means connecting said roof tubes into the boiler circulating system.

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