

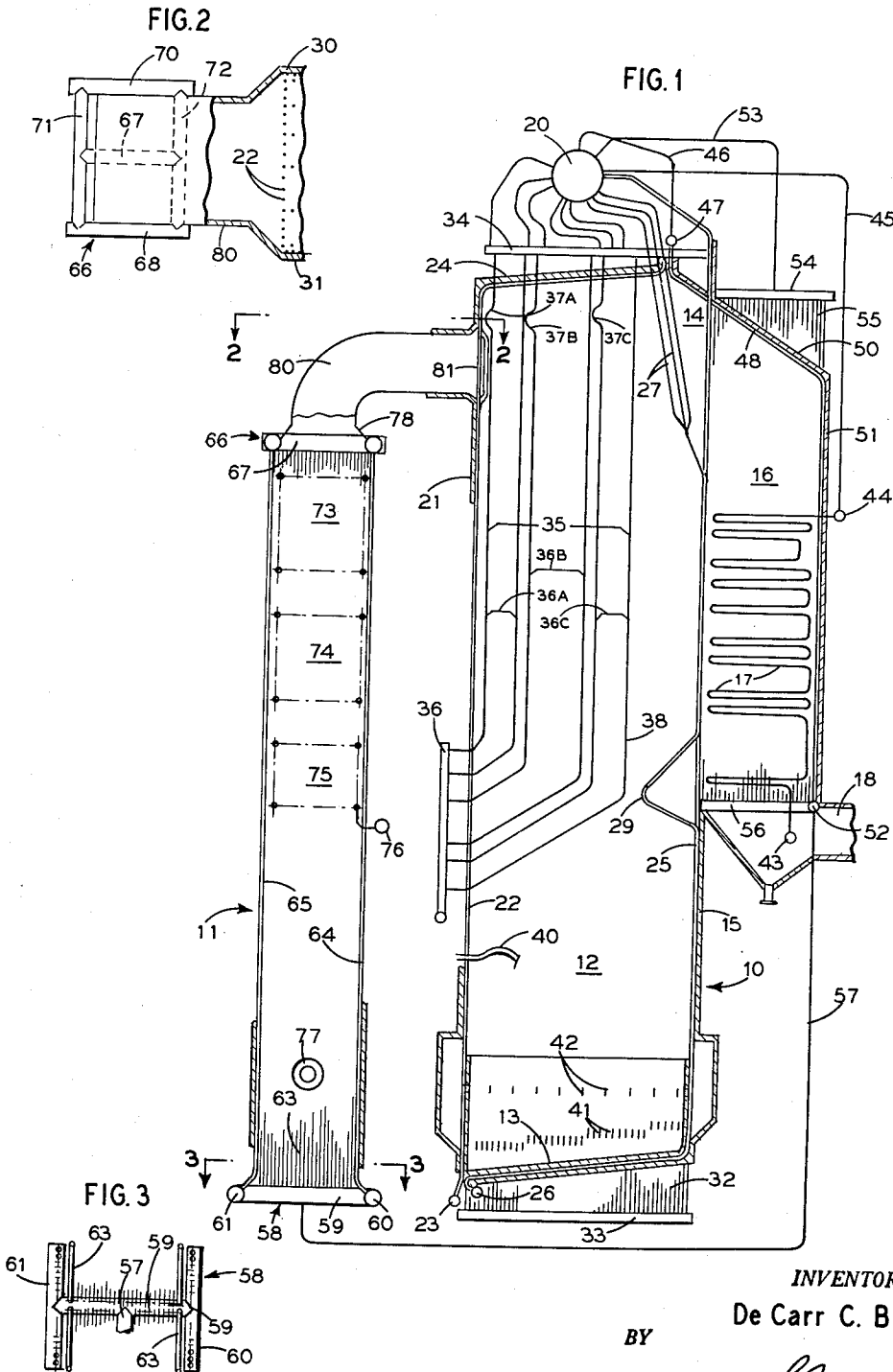
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APPARATUS FOR SUPERHEATING VAPOR

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APPARATUS FOR SUPERHEATING VAPOR

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The present invention relates to vapor generating and heating apparatus, and more particularly to a chemical recovery unit wherein residual pulp liquors are incinerated with the inorganic chemicals recovered in the form of a molten smelt and the organic chemical matter burned to produce hot gases to generate vapor. The vapor is superheated to a desired value in a separately fired superheater.

In the combustion of some fuels, the resultant gaseous products are contaminated by vapors, liquids or solids which may deposit on heat exchange surfaces to the detriment of heat exchange. These deposits may lead to corrosion of metallic surfaces. The deposition problem occurs during the combustion of many fuels, and is particularly prevalent during the incineration of pulp residual liquor obtained from the digestion of wood chips in sulphate cooking liquors. The seriousness of the deposition on tubular heat exchange surfaces increases with the temperatures of the heating gases in contact with the tubes and the temperatures of the fluid being heated within the tubes. For example, in chemical recovery units wherein the residual liquor from the sodium sulphate digestion process is burned, the contaminants in the combustion gases will include sodium carbonate and sodium sulphate. Such materials will be sticky in the gas temperature range of 1200° F., and will tend to deposit on surfaces they contact in passing through the vapor generating and heating unit associated with the liquor incinerating furnace. The nature of the deposit will vary with the temperature of the surfaces contacted, with the deposits being harder and more difficult to remove at the higher surface temperatures. Although units have been constructed and successfully operated with superheated steam temperatures in the 800 to 825° F. range, such operation necessitates careful regulation to avoid serious deposition problems particularly on the tubular elements of the superheater. Advantageously, a separately fired superheater can be used in many installations either to attain higher superheat temperatures than can be attained by the incineration of residual liquor, or to reduce cleaning and corrosion problems when desired superheat temperatures are in excess of 750° F.

In accordance with the present invention, a separately fired superheater is combined with a residual liquor fired vapor generating unit so as to obtain the desired high superheat temperatures, while at the same time providing a close regulation of superheat temperatures throughout the capacity range of the vapor generating unit. The separately fired superheater may be arranged to receive saturated steam from the associated vapor or steam generator, or it may be supplied with partially superheated steam, with the initial superheating being attained within the associated vapor generating unit.

In the inventive combination, the heating gases produced in a separately fired superheater are cooled to a value of, for example, 1000° F. in heating the steam, and the gases are thereafter combined with the gases from the chemical recovery process so as to have a tempering effect thereon and to thereby reduce the tendency for solids in the combined gases to deposit on the tubular surface during passage over the relatively low temperature convection heating surfaces of the unit. In the combination of the present invention, the separately fired superheater will advantageously be supplied with a fuel of low ash content so that the chemical recovery of the vapor

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generating unit will not be adversely influenced by contamination from this auxiliary fuel.

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 a preferred embodiment of the invention.

Of the drawings:

FIG. 1 is a sectional elevation of a vapor generating unit and separately fired superheater constructed and arranged according to the invention; and

FIGS. 2 and 3 are plan views, partly in section, of a portion of the apparatus as taken on lines 2-2 and 3-3, respectively, of FIG. 1.

The invention is illustrated as applied to a chemical recovery unit of the general type disclosed and claimed in copending Coulter et al. application, Serial No. 664,780, filed June 10, 1957, now Patent No. 2,946,669. As shown in FIG. 1, and as hereinafter described, the vapor generating unit 10 is provided with some steam superheating surfaces so that the steam delivered to the separately fired superheater 11 will have some amount of superheat added thereto. It will be understood that other types of vapor generating equipment may be used in the combination of this invention and that it is not necessary to provide superheated vapor for delivery to the separately fired superheater.

As shown particularly in FIG. 1, the vapor generating and chemical recovery unit 10 includes an upwardly elongated furnace 12 having a hearth 13 at the bottom thereof and provided with a heating gas outlet 14 in the upper portion of the rear wall 15 of the unit. The heating gases discharged from the gas outlet 14 of the furnace flow downwardly through a convection gas pass 16 in contact with a plurality of transversely positioned heat exchange tubes or economizer section 17 where the relatively low temperature heating gases leaving the furnace gas outlet 14 are further cooled by indirect heat exchange before the discharge of the gases from the convection gas pass outlet 18. Thereafter, the gases may be passed through direct contact heat exchangers such as cascade evaporators, cyclone evaporators or the like (not shown) before the gases are discharged to the atmosphere.

The upwardly elongated furnace 12 is provided with walls containing vapor generating tubes which extend upwardly from lower headers to a steam and water drum 20 located above the roof of the furnace. The front wall 21 of the furnace is provided with a row of tubes 22 extending upwardly from a lower header 23 and are shaped to define a major portion of the furnace roof 24 before the tubes are again bent to enter the steam and water drum 20. The rear wall 15 of the furnace is provided with a row of tubes 25 which extend in a horizontally inclined direction from a header 26 to form a portion of the hearth 13 at the furnace bottom. The tubes 25 are thereafter extended in an upward direction, with certain of the tubes displaced inwardly and then again outwardly to define a nose baffle 29 positioned intermediate the height of the furnace. Some of the tubes 25 remain in wall alignment behind the nose baffle, with all of the tubes extending upwardly in co-planar relationship above the baffle to a position downwardly adjacent the gas outlet 14 from the furnace. From this position a portion of the tubes of the tube row 25 are inclined forwardly and upwardly and are spaced so as to define an inclined slag screen 27 interposed between the furnace and the gas outlet 14. These tubes are thereafter extended to open into the steam and water drum 20. Others of the tubes in the tube row 25 are extended substantially vertically

through the roof of the unit and enter the steam-water drum 20.

The opposite side walls 30 and 31 of the furnace 12 (see FIG. 2) are each provided with a row of vapor generating wall tubes 32 (only one wall shown in FIG. 1) with each row receiving fluid from a lower header 33, thereafter extending upwardly in co-planar relationship to an upper header 34 positioned above the roof 24 of the furnace.

As disclosed in said copending application, Serial No. 664,780, the furnace 12 is provided with a plurality of upright vapor generating tube platens 35 each of which is supplied with water from an upright header 36 positioned exteriorly of the front wall 21 of the furnace. The tubes of each platen extend through the wall and between displaced tubes of the front wall tube row 22. The tubes are inclined upwardly in platen formation toward the nose baffle 29 and thereafter are extended substantially vertically through the upper portion of the furnace to discharge into upper headers which are connected in flow relationship with the steam and water drum 20. Each platen 35 in the furnace is divided into laterally spaced groups 36A, 36B and 36C with the group spacing maintained by offset portions 37A, 37B and 37C, respectively, of the tube in the forward portion of each group. The offset tube portions 37B and 37C engage an adjacent tube of a forwardly adjacent group, while the tube portion 37A engages the front wall 21 so as to maintain the required spacing of the groups in each platen. The spacing between groups provides access for cleaning deposits from the platens and also serves to equalize the gas pressure in each of the parallel flow paths defined by the platens.

The rearmost tube 38 of the rearmost groups 36C of each platen is closely adjacent the forward edge of the nose baffle 29, and upper end of the tube 38 is positioned adjacent the upper end of the slag screen 27, as these tubes are passed through the furnace roof 24.

With the construction described, any accumulation of solids collected on the slag screen 27 which may shed as the accumulations increase falls upon the upper surface of the nose baffle 29 and thereafter onto the hearth 13 of the furnace.

As shown in FIG. 1, and as disclosed in the said copending patent application, the described furnace is constructed and arranged for the spray incineration of pulp residual liquor. Liquor is admitted to the furnace through an oscillating spray nozzle 40 which extends through the front wall 21 of the furnace and is vertically spaced between the platens 35 and the furnace hearth 13. The residual liquor discharged from the spray nozzle is partially dehydrated in its flight across the furnace and deposits the entrained solids upon the rear and side walls of the furnace. Thereafter, as the residual liquor is further dehydrated by contact with heating gases rising from the hearth 13, chunks of char will tear away from the walls 15, 30 and 31, and fall to the furnace hearth. While on the hearth, the char is burned under reducing conditions by the admission of primary combustion air through a row of primary air ports 41 positioned upwardly adjacent the hearth in the side and rear walls of the furnace. The action of the primary air jets on the char bed reduces the inorganic chemicals in the bed so that they may be recovered from the char in the form of a molten smelt. The smelt is discharged through a spout (not shown) at the lower end of the furnace hearth into a dissolving tank (not shown) for subsequent treatment in recycling the chemicals in the recovery process.

The gaseous combustion products rising from the char bed at the bottom of the furnace 12 are impacted by streams of secondary air admitted through ports 42 located in all of the walls which complete the combustion of the combustibles in the gas. The gases are cooled in their upward passage through the furnace by radiation to and contact with the furnace wall tubes and the platens. Upon reaching the upper portion of the furnace, the gases

will be at a temperature of approximately 1200° F., when the unit is operated at its maximum capacity.

As hereinafter described, the gases of combustion resulting from the incineration of the residual liquor are tempered by a stream of cooler gases discharged from the separately fired superheater 11. Thus, the combined gases passing through the slag screen 27 and the gas outlet 14 into the convection gas pass 16 are at a lower temperature than would be the case if the tempering effect was not present.

Upon entering the upper portion of the convection gas pass 16, the gases move in a downward direction in indirect heat transfer relationship over a plurality of economizer sections 17 which are supplied with feed water. The economizer sections receive incoming feed water in lower header 43, and which, after passing through the economizer 17, is collected in a discharge header 44 positioned exterior to the convection gas pass. Thereafter, the heated feed water is delivered to the steam and water drum 20 through tubes 45.

As shown in FIG. 1, the front wall of the convection gas pass is formed by a portion of the rear wall 15 of the furnace. The two sides and rear wall of the convection gas pass are lined with rows of tubes which are supplied with saturated steam received from the steam and water drum 20. The saturated steam passes through a row of tubes 46 to a header 47 positioned above the roof 24 of the furnace 12. From the header 47, a row of tubes 48 lines the roof 50 of the convection gas pass 16 and extends in a substantially vertical direction downwardly along the rear wall 51 of the convection gas pass to an outlet header 52 located substantially at the level of the upper edge of the convection gas pass outlet 18. A row of tubes 53 from the steam and water drum 20 discharges saturated steam to upper sidewall headers 54 positioned on opposite sides of the gas pass 16, each of which supplies saturated steam to the row of tubes 55 lining each of the side walls of the convection gas pass. The sidewall tubes 55 open to lower headers 56 which are interconnected with the rear wall header 52.

The saturated steam, in flowing through the walls of the convection pass, absorb heat from the gases and thus becomes partially superheated, and is collected in headers 52 and 56 from whence it is passed through a conduit 57 to the lower header 58 of the separately fired superheater. The lower header is formed as a letter H (see FIG. 3) with the cross bar 59 of the H receiving the incoming partially superheated steam through the conduit 57 and supplying the steam to rows of tubes 63 in each of the sidewalls of the separately fired superheater. The opposite arms 60 and 61 of the H-shaped lower header 58 supply steam to the lower ends of the front and rear wall tube rows 64 and 65, respectively. The wall tubes 63, 64 and 65 of the superheater are upright and open at their upper ends into a box-like header 66 having an intermediate connecting header arm 67, as shown in FIG. 2. The side wall tubes 63 discharge into the header portions 68 and 70 while the front and rear wall tubes 64 and 65 discharge into elongated header portions 72 and 71, respectively, which are interconnected by the intermediate header portion 67. The steam in passing upwardly through the wall tubes 63, 64 and 65 is heated and combined to discharge through the intermediate connecting header arm 67 into serially connected banks 73, 74 and 75 of transversely arranged superheater tubes extending across the upper portion of the superheater 11. The flow of steam is downward sequentially through the transversely arranged banks 73, 74 and 75 with the steam discharging from the tubes of bank 75 to an exteriorly positioned outlet header 76 for eventual delivery to a point of use.

Heating gases are produced in the separately fired superheater by the combustion of a fuel such as fuel oil. The fuel oil and combustion air are discharged into the lower portion of the superheater through oppositely ar-

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ranged burner and air register assemblies 77 positioned in the opposite sidewalls containing the tubes 63.

The combustion gases produced by burning the fuel oil move upwardly through the separately fired superheater, through a hood 78 and a connecting duct 80, and discharge through an inlet 81 in the front wall 21 of the vapor generating furnace 12. The gases of combustion discharged through the inlet 81 are cooled to a temperature of approximately 1000 F. when the superheater is operated at its normal rating. These gases have a cooling effect when mixed with the gases produced by the residual liquor combustion process, which are moving upwardly through the furnace 12. As shown in FIGS. 1 and 2, some of the front wall tubes 22 of the furnace are displaced in the vicinity of the gas inlet 81 from the duct 80 so as to distribute the gases substantially across the full width of the front wall 21 of the furnace. As shown, the gas inlet opening 81 is located downwardly adjacent the roof 24 of the furnace and immediately below the offset tubes 37A of the platen group 36A in the furnace.

In a unit of the type described, the vapor generating portion including the furnace 12 and the convection gas pass produced 305,000 pounds of steam per hour at 1350 p.s.i.a. (pounds per square inch absolute). The saturated steam discharging from the drum 20 was superheated to a total temperature of 603 F. in the wall tubes 48 and 55, with the gases of combustion leaving the outlet 18 cooled to a temperature of approximately 550-600 F., which is a temperature effective for concentrating the black liquor in direct contact evaporators for use in the spray nozzle 40. The partially superheated steam delivered to the superheater 11 was heated during its upward movement through the tubes 63, 64 and 65 and the desired total steam temperature of 950 F. at the header 76 was obtained following sequential downflow through the tube banks 73, 74 and 75. The steam pressure at the header 76 was 1280 p.s.i.a.

The gases leaving the superheater 11 through the duct 80 and entering the furnace 12 through the inlet 81 were at a temperature of approximately 1000 F. under the above conditions and effectively moderated the gases passing upwardly through the furnace. Due to the transversely distributed flow of gases from the superheater 11 into the furnace, and the effective mixing of the combined gases entering the convection gas pass 16, the temperatures therein are safely below the fusion and sticky phase of the solids in the gas stream of gases from the incineration furnace. Thus, the problem of maintaining the heat exchange surfaces within the convection pass of the recovery unit in a clean condition is greatly reduced in comparison with the usual operational problems encountered under similar conditions without a separately fired superheater.

While in accordance with the provisions of the statutes I have illustrated and described herein the best form and mode of operation 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.

What is claimed is:

1. In combination, walls defining a chemical recovery furnace having a hearth in the lower portion and a combustion gas outlet in an upper side wall portion thereof, said furnace walls each including a row of steam generating tubes, means for incinerating residual liquor in the lower portion of said furnace with the discharge of inorganic chemicals in smelt form from said hearth and the discharge of hot gaseous combustion products through said furnace toward said combustion gas outlet, a convection gas-pass adjoining said furnace and having a gas inlet opening to said combustion gas outlet, convection

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heat exchange tubes in said convection gas-pass, wall means forming a separate furnace having a combustion gas outlet adjacent one end and with an upright row of tubes in the walls and a plurality of rows of tubes transversely disposed across the gas outlet end portion thereof, means for burning a fuel in the opposite end of said separate furnace and passing the resulting gases through said separate furnace and over said transversely disposed tubes, means for directing steam generated in the wall tubes of said chemical recovery furnace to the tubes in the walls of said separate furnace for flow of steam through the separate furnace wall tubes and thereafter through the transversely disposed tubes to superheat said steam, means defining a gas inlet positioned in a side wall of said chemical recovery furnace substantially at the level of and directly opposite said chemical recovery furnace gas outlet, and means for discharging the gases from said separate furnace through said gas inlet and transversely across said chemical recovery furnace whereby the gases from said separate furnace blend with the hot gaseous combustion products from said chemical recovery furnace for combined flow through said convection gas-pass.

2. In combination, walls defining a chemical recovery furnace having a hearth in the lower portion and a combustion gas outlet in an upper side wall portion thereof, said furnace walls each including a row of steam generating tubes, means for incinerating residual liquor in the lower portion of said furnace with the discharge of inorganic chemicals in smelt form from said hearth and the discharge of hot gaseous combustion products through said furnace toward said combustion gas outlet, a convection gas-pass adjoining said furnace and having a gas inlet opening to said combustion gas outlet, convection heat exchange tubes in said convection gas-pass, wall means forming a separate furnace having a combustion gas outlet adjacent its upper end and with an upright row of tubes in the walls and a plurality of rows of tubes transversely disposed across the upper portion thereof, means for burning a fuel in the lower end of said separate furnace and passing the resulting gases upwardly through said separate furnace and over said transversely disposed tubes, means for directing steam generated in the wall tubes of said chemical recovery furnace to the tubes in the walls of said separate furnace for flow of steam through the separate furnace wall tubes and thereafter through the transversely disposed tubes to superheat said steam, means defining a gas inlet positioned in and extending across a side wall of said chemical recovery furnace substantially at the level of and directly opposite said chemical recovery furnace gas outlet, and means for discharging the gaseous combustion products from said separate furnace through said gas inlet and transversely across said chemical recovery furnace whereby the gases from said separate furnace blend with and cool the hot gaseous combustion products from said chemical recovery furnace for combined flow through said convection gas-pass.

3. In combination, walls defining a chemical recovery furnace having a hearth in the lower portion and a combustion gas outlet in an upper side wall portion thereof, said furnace walls each including a row of steam generating tubes, a plurality of platens of steam generating tubes in the upper portion of said furnace, a steam and water drum positioned above said furnace and arranged to receive a steam and water mixture discharged from said steam generating tubes, means for incinerating residual liquor in the lower portion of said furnace with the discharge of inorganic chemicals in smelt form from said hearth and the discharge of hot gaseous combustion products through said furnace toward said combustion gas outlet, a convection gas-pass adjoining said furnace and having a gas inlet opening to said combustion gas outlet, convection heat exchange tubes in said convection gas-pass, wall means forming a separate furnace having a combustion gas outlet adjacent its upper end and with an

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upright row of tubes in the walls and a plurality of rows of tubes transversely disposed across the upper portion thereof, means for burning a fuel in the lower end of said separate furnace and passing the resulting gases upwardly through said separate furnace and over said transversely disposed tubes, means for directing steam from said steam and water drum to the tubes in the walls of said separate furnace for flow of steam through the separate furnace wall tubes and thereafter through the transversely disposed tubes to superheat said steam, means 5
10 defining a gas inlet positioned in and extending across a side wall of said chemical recovery furnace substantially at the level of and directly opposite said chem-

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ical recovery furnace gas outlet, whereby the gases from said separate furnace blend with and cool the hot gaseous combustion products from said chemical recovery furnace for combined flow through said convection gas-pass.

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