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CHEMICAL RECOVERY UNIT

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Fig. 2.

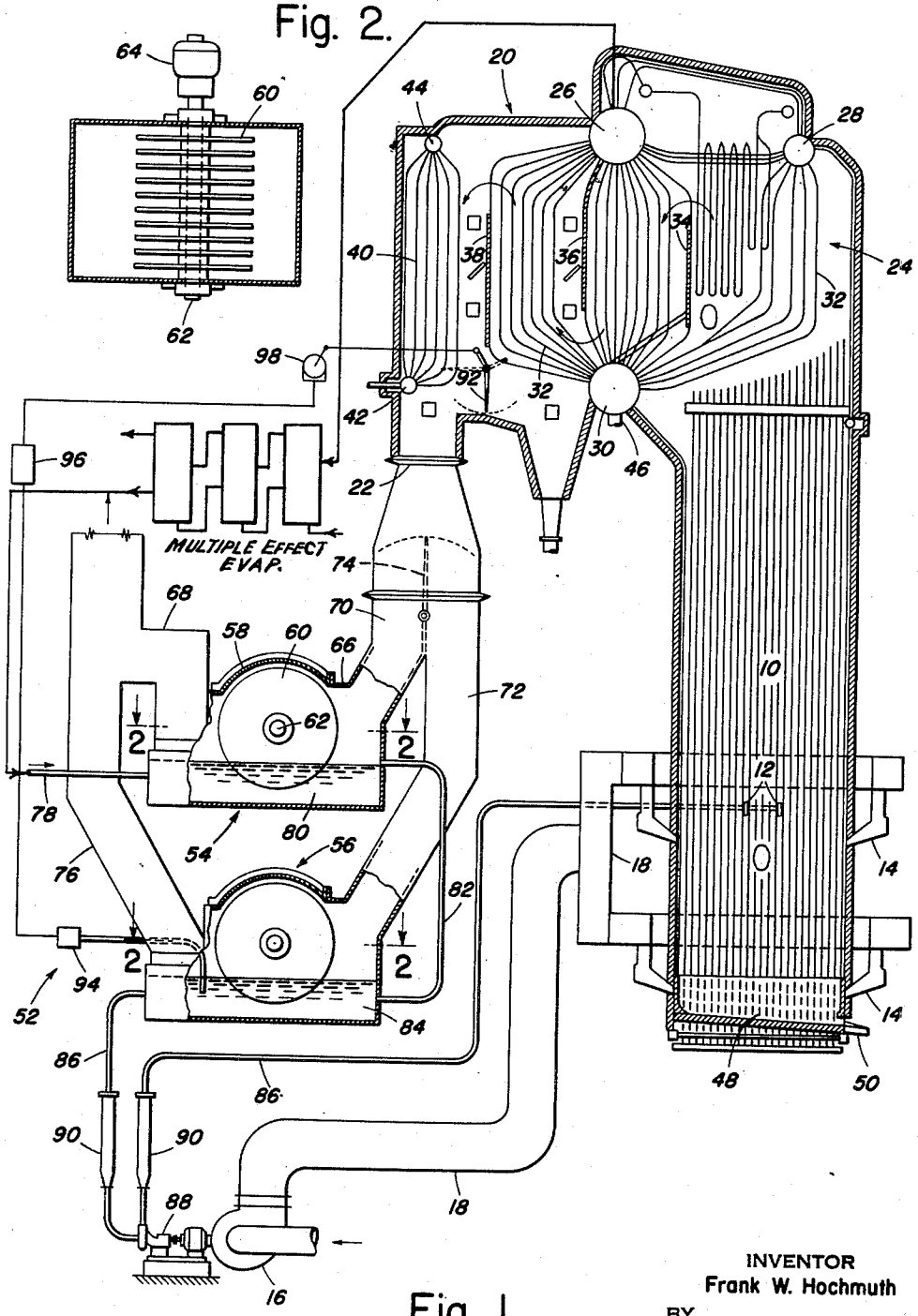


Fig. 1.

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CHEMICAL RECOVERY UNIT

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This invention relates to chemical recovery units of the type employed for the residual liquor obtained from the manufacture of pulp and in which units the liquor is concentrated and burned with the chemicals being recovered by smelting and with the heat evolved being used for the generation of steam.

In these chemical recovery units the liquor is sprayed into a furnace where it is burned with the combustion gases thus generated being passed over heat exchange surface which takes the form of a steam generator. The chemicals in the liquor fall to the bottom of the furnace where they are smelted and are withdrawn in a molten state. In order for the liquor to be self sustaining in the combustion in the furnace a large portion of the moisture in the liquor, as it comes from the digester employed in the pulping processes, must be removed. For this reason it has been the practice to employ a direct contact evaporator for evaporating a portion of this moisture with this evaporator utilizing the combustion gases generated in the furnace as the evaporating medium with these gases, after being passed over the steam generating heat exchange surface, being directed through this evaporator. These evaporators have almost universally taken the form of a housing into which weak liquor is delivered and from which this liquor, after having its concentration raised to a desired value, is conveyed. The liquor is maintained at a predetermined depth in the housing and a rotatable member or members are provided with these members being rotated about a generally horizontal axis and being only partially submerged in the liquor so that as they rotate wetted surfaces are continuously raised above the level of the liquor with the hot combustion gases that are passed through the housing contacting these surfaces and evaporating the moisture in the liquor thereon. In these evaporators the body of liquor contacted in the housing is at a concentration corresponding to that at which it is desired to withdraw the liquor or in other words is at a high concentration relative to that of the liquor delivered to the evaporator. This results in a relatively high power consumption for rotating the rotatable members of the evaporator as well as producing appreciable carbonation of the liquor by the flue gases and the formation of precipitates from the liquor.

In accordance with the present invention these undesirable effects are reduced by organizing the direct contact evaporator into a plurality of separate parts or stages through which the liquor is serially conveyed. Each of the stages is comprised of a separate compartment or housing in the lower portion of which is contained a body or pool of the liquor with each of these pools being separate and independent of one another except that the liquor is conveyed serially from one pool to the next. The concentration of the liquor in each successive pool will of course increase with that of the last or final pool being the concentration that is desired. With this stage type direct contact evaporator the power consumption will be substantially less than that heretofore obtained

and the possibility of lignin precipitation from carbonation of the liquor as well as the tendency of other solids to precipitate from the liquor, is minimized.

It is an object of this invention to provide an improved chemical recovery unit for the residual liquor obtained in the manufacture of pulp.

It is a further object of this invention to provide an improved method of evaporating liquor delivered to such a chemical recovery unit.

Other and further objects of the invention will become apparent to those skilled in the art as the description proceeds.

With the aforementioned objects in view, the invention comprises an arrangement, construction and combination of the elements of the inventive organization in such a manner as to attain the results desired as hereinafter more particularly set forth in the following detailed description of an illustrative embodiment, said embodiment being shown by the accompanying drawing wherein:

Fig. 1 is a vertical section of a chemical recovery unit for the residual liquor obtained in pulp manufacture and shows a two stage direct contact evaporator.

Fig. 2 is a plan view of the uppermost evaporator stage taken along line 2—2 of Fig. 1.

Referring now to the drawing, wherein like reference characters are used throughout to designate like elements, the illustrative and preferred embodiment of the invention depicted therein comprises a furnace 10 into which liquor of predetermined concentration is sprayed through suitable nozzles 12. Air for supporting combustion of this liquor is introduced into the furnace through the two sets of nozzles 14 with this air being supplied from forced draft fan 16 through ducts 18. The liquor is burned in furnace 10 and the hot combustion gases thus generated pass up through the furnace and through the horizontal offtake 20 at the upper end of the furnace with these gases leaving the offtake through the outlet 22 in its lower portion. At the upper end of furnace 10 and in offtake 20 there is provided a boiler designated generally 24 and which includes the laterally spaced upper drums 26 and 28 and the lower drum 30. These drums are interconnected by steam generating tubes 32 in a conventional manner and in order that the gases will traverse the several banks of tubes in a tortuous path to insure maximum contact and transfer of heat from the gases to the tubes, baffles 34, 36 and 38 are provided as shown. In the passageway formed in the rear of baffle 38 there is provided the economizer 40 of the boiler with feed water being supplied to inlet header 42 and delivered from outlet header 44 to drum 26. The inner surfaces of the walls of furnace 10 are lined with side by side, vertically extending steam generating tubes which are supplied from drum 30 through downcomer 46 and which communicate at their upper ends with drum 26 or 28.

The liquor that is burned in furnace 10 contains substantial amounts of chemicals which it is desired to recover and in the burning operation these chemicals are smelted forming a molten pool or layer 48 in the bottom of the furnace which is periodically or continuously tapped through discharge spout 50.

In order that the liquor delivered to furnace 10 through nozzles 12 will have a sufficiently high solid content so that it will be capable of self sustaining combustion in the furnace the moisture in the liquor must be maintained at a predetermined low value and must be greatly reduced from that which it contains as it is discharged from the digester. As thus discharged it generally contains about 15% solids or 85% water and the minimum solid concentration that is generally introduced into furnace 10 is about 50% with 68% being average.

In order to raise the concentration of the liquor to a value suitable for introduction into the furnace there is employed a direct contact evaporator organization designated generally 52 and which employs as the evaporating medium the combustion gases passing through outlet 22. The liquor that is delivered to this direct contact evaporator organization may have a minimum concentration of 15% solids or in some instances may have as high a concentration as 60% solids with this latter being obtained by means of multiple effect evaporators which are now conventional in chemical recovery organizations and employ steam as the heating medium with the vapor produced in one effect being the heating medium for the next subsequent effect and with the pressure in the several effects progressively decreasing. In present day practice the concentration of the liquor delivered to the direct contact evaporator averages about 50%.

As embodied, evaporator 52 comprises a first evaporating stage 54 and a second evaporating stage 56 with the liquor passing serially through these two evaporating stages and with the combustion gases passing in parallel relation therethrough with this latter being merely for the purpose of economy in duct work and convenience in positioning of the apparatus within available space and if desired the combustion gases may be passed serially through the two stages.

The evaporating apparatus at each of the stages 54 and 56 is similar and comprises a housing 58 into which liquor is delivered with a pool of liquor of predetermined depth being maintained in the bottom of the housing. There is mounted in housing 58 a rotatable member 60 which may take a variety of well known forms with spaced discs being shown in the drawing. Member 60 is continuously rotated about its horizontal axis 62 through motor 64 with the member being disposed so that the lower portion is immersed in the body or pool of liquor while the upper portion extends adjacent to the upper end of the housing 58 which generally conforms to the periphery of the member. Combustion gases are supplied to housing 58 through inlet 66, passed through the housing in contact with member 60 and leave the housing through outlet duct 68. In passing over member 60, the surface of which is wetted because of its partial immersion in the liquor and its continuous rotation, moisture is absorbed from the liquor disposed on the relatively large surface area of this rotatable member with a rather high rate of evaporation thereby being obtained.

In the illustrative organization evaporating stage 54 is positioned above stage 56 for reasons of economy of construction and conservation of space as well as to permit gravity flow from the upper to the lower evaporator stage. Combustion gases leaving outlet 22 are supplied to these respective stages through ducts 70 and 72, respectively, with adjustable splitter damper 74 being provided to adjust the proportion of the total gas flow which is directed to each of these stages. The combustion gases upon leaving the evaporating stages 54 and 56 are received by duct 76 through which they are conveyed to a suitable stack or other desired point.

The liquor is conveyed to the housing of the upper evaporating stage 54 through supply conduit 78 with the pool of liquor 80 formed therein overflowing into conduit 82 with this overflow maintaining the depth of pool 80 at a constant level. The liquor conveyed through conduit 82 is delivered into the housing of the lower evaporating stage 56 where a pool of liquor 84 of predetermined depth is maintained. Liquor is withdrawn from this pool through conduit 86 by means of a pump 88 and is delivered to nozzles 12 with the liquor being passed through heaters 90 to raise it to its desired temperature. The liquor is delivered to nozzles 12 at a pressure of approximately 15 to 35 p.s.i. and a temperature of between 220–240° F.

The evaporating capacity of direct contact evaporating organization 52 is controlled, within limits, by controlling the temperature of the gases passing through outlet 22 and entering evaporator organization. This is accomplished by providing damper 92 at the lower end of baffle 38 by means of which regulated amounts of combustion gases may short circuit the heat exchange surface located in the passageways formed at each side of the baffle 38. As damper 92 is progressively moved from its solid to its dotted line position shown in the drawing a progressively greater portion of the gases will be short circuited or bypassed resulting in progressively increasing the gas temperature exiting through outlet 22 and entering the evaporator organization. The adjustment of damper 92 is preferably automatically regulated to maintain a desired concentration of the liquor in pool 82 with this being obtained through a concentration responsive device 94 which operates a control apparatus 96 which in turn positions motor 98 as required with these control components being of conventional construction and accordingly only diagrammatically shown.

In operation, liquor of a certain concentration is delivered to first evaporator stage 54. In this evaporating stage the liquor is evaporated a predetermined amount through contact with hot combustion gases with the pool of liquor 80 thereby having a predetermined higher concentration. This liquor of increased concentration is delivered from pool 80 through conduit 82 into the second stage 56 where further evaporation takes place with the pool of liquor 84 in this second stage having a predetermined higher concentration result from the evaporation effected therein. Liquor from pool 84, which is then at its desired concentration for supply to the furnace, is withdrawn from the second stage of the evaporator and introduced into the furnace as previously described. The concentration responsive device 94 detects any change of concentration of liquor in pool 84 from the desired value and, through the control mechanism, damper 92 is automatically adjusted so as to vary the temperature of the gases passing through each of the evaporator stages which changes the evaporating capacity so as to bring the concentration of liquor in pool 84 back to its desired value. The relative evaporating action of each of the stages 54 and 56 is varied as desired through the adjustable damper 74.

As an example of this operation, liquor with a concentration of 50% solid may be delivered to stage 54 through conduit 78. In this stage 54 the liquor may be dried to a concentration of 57% solids with this then being the concentration of the liquor in pool 80 and with this 57% solid liquor being delivered to stage 56 where it is further dried to a concentration of about 65% solids which is suitable for introduction into furnace 10 and with this process of course being continuous. In this organization the total power required to drive the rotating members is substantially less than that of previously known organizations. Since the evaporating stage 54 has a thinner liquor than stage 56 the driving power needed to drive member 60 in stage 54 is relatively less. The power required for this member 60 in stage 54 will be only about 50% of what it would be if the same rotating member were mounted in a unitary evaporator organization running in a liquor concentration of 65% solids as would be the case heretofore. This means that would this evaporator organization the power will be approximately 25% less than that previously required. Furthermore, since the hot combustion gases will be in contact with the high concentration of liquor that is delivered to the furnace for a less period of time in the multi-stage evaporator of this invention the possibility of lignin precipitation which results from the carbonation of the liquor by the flue gases is minimized and the tendency for other solids to precipitate from the liquor is reduced. With the illustrative two stage direct contact evaporation the time reduction during which the high concentration liquor delivered to the furnace is retained in the evaporator is in the order of 50%.

The particular design of each of the separate evaporating stages 54 and 56 may of course vary as desired with there being one or more rotating members and with the stages being either in parallel or series flow with respect to the combustion gases. If both of these stages are of the same size and the gases are distributed, when parallel flow is had, substantially evenly between them, about 50% of the evaporating action of the evaporating unit 52 will take place in stage 54 and the remaining 50% in stage 56. However, the relative proportion of evaporation taking place in each stage may be varied as desired by manipulation of damper 74.

While I have illustrated and described a preferred embodiment of my invention it is to be understood that such is merely illustrative and not restrictive and that variations and modifications may be made therein without departing from the spirit and scope of the invention. I therefore do not wish to be limited to the precise details set forth but desire to avail myself of such changes as fall within the purview of my invention.

What I claim is:

1. A chemical recovery unit comprising in combination a furnace into which the residual liquor obtained in the manufacture of pulp is introduced and burned, a boiler having heat exchange surface in a number of passageways and disposed to have the hot gases generated in the furnace pass through the passageways and over this surface to absorb heat from the gases to generate steam, means for supplying liquor of a predetermined concentration to said furnace, said means including multiple effect evaporators operative to raise the concentration to an intermediate desired value and a direct contact evaporation facility for evaporating the liquor to its final concentration and located adjacent the combustion gas outlet of the boiler to receive the combustion gases exiting therefrom as the evaporation medium, said facility including a pair of separate evaporator means disposed one above the other with each including means to form a pool of said residual liquor and with the pools being separate, an evaporator wheel means mounted in each of these means about a generally horizontal axis so the lower portion is immersed in said liquor and the upper portion extends above said liquor, means for rotating the wheel means, means for delivering partially concentrated liquor from the multiple effect evaporators to the upper of said evaporator means, an overflow for said upper evaporator means operative to convey liquor by gravity from the upper to the lower evaporator means, means for conveying liquor from the lower evaporator means and introducing it into the furnace, separate duct means extending from the outlet of the boiler to each of said evaporator means for conveying combustion gases thereto, adjustable means operative

to controllably proportion the gas flow to each evaporator means, adjustable damper means in said boiler effective to control the flow of combustion gases so as to controllably bypass a portion of the heat exchange surface of the boiler and accordingly control within limits the gas temperature leaving the boiler, and sensing means operative to sense changes in concentration of the liquor delivered to the furnace and control means regulated by the sensing means and operative to adjust said damper means so as to maintain said concentration at a desired value.

2. The method of operating a chemical recovery unit of the type described and wherein the chemicals in the residual liquor obtained in the manufacture of pulp are removed and the B.t.u. value of the liquor utilized comprising concentrating the raw liquor to at least a predetermined value by means of multiple effect evaporation, thereafter concentrating the liquor to its final value in steps by passing it in direct contact with hot combustion gases in a plurality of separate but successive stages, contacting the liquor with the combustion gases in each stage by forming a separate pool of the liquor for each stage, forming a pair of parallel flow streams of combustion gases, passing a different one of said streams over the surface of each of the pools of liquor and continuously wetting a surface with the liquor in each pool and passing it through said stream of gases thereabove, adjustably proportioning the flow in each gas stream to control the evaporation in each of the stages, passing the liquor successively from one of the separate pools to the next pool, introducing the concentrated liquor from the final stage into a furnace and burning the same therein, passing the gases evolved by such burning through a boiler and thence through the several evaporation stages as the evaporating medium, continuously detecting the concentration of the liquor delivered to the furnace, controllably regulating the heat transfer in the boiler in response to the concentration of the liquor delivered to the furnace to vary the temperature of the combustion gases and accordingly regulate the evaporation effect so that the concentration of the liquor delivered to the furnace remains substantially constant.

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