Sept. 19, 1950 C. W. SMITH 2,522,905

EVAPORATOR

Filed Aug. 17, 1945

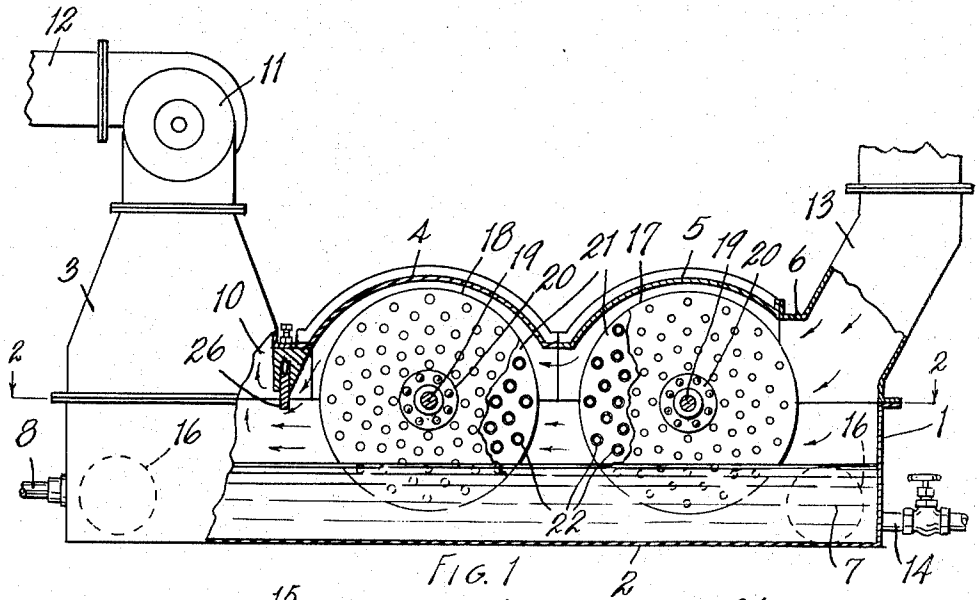


FIG. 1

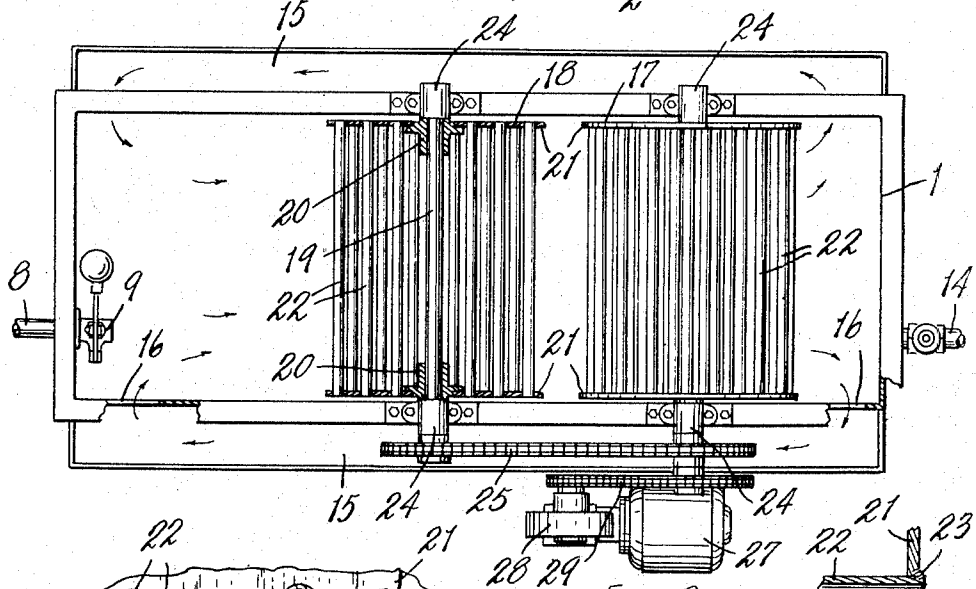


FIG. 2

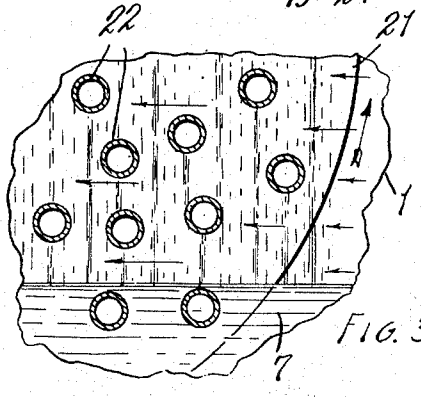


FIG. 3

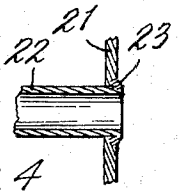


FIG. 4

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EVAPORATOR

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5 Claims. (Cl. 159—10)

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The main objects of this invention are:

First, to provide an evaporator for recovering soda ash and other chemicals from black liquor which is highly efficient in the matter of quantity of material handled and the recovery of the chemicals.

Second, to provide an evaporator of this type which is simple and compact in structure and automatic in operation, requiring very little attention.

Third, to provide an evaporator which is not likely to become clogged or fouled and require cleaning with shut-downs for that purpose.

Fourth, to provide an apparatus having these advantages which is very economical in its parts.

Objects relating to details and economies of the invention will appear from the description to follow. The invention is defined in the claims.

A structure which embodies the features of the invention is clearly illustrated in the accompanying drawing, in which:

Fig. 1 is a fragmentary side elevation of a structure embodying my invention partially in vertical longitudinal section.

Fig. 2 is a horizontal view on a line corresponding to line 2—2 of Fig. 1, certain parts being sectioned below that line.

Fig. 3 is an enlarged vertical transverse section through one of the evaporator wheels, the dripping of the liquid from the pick-up bars being conventionally illustrated.

Fig. 4 is an enlarged fragmentary view showing the manner of securing the pick-up bars to the end plates of the evaporator wheel.

The embodiment of the invention illustrated is an adaptation to an evaporator especially designed for recovering soda ash and other chemicals from black liquor. It should be understood, however, that certain features of my invention are capable of a wide adaptation to evaporators for recovering solids from solutions, particularly where it is necessary to handle relatively thick liquids and where large capacity and continuous performance are required.

The embodiment illustrated comprises an elongated evaporator chamber designated generally by the numeral 1 consisting of a bottom section or portion 2 and removable top members 3, 4, 5 and 6, the top and bottom parts being flanged to receive connecting bolts or the like, not illustrated. The bottom portion of the evaporator chamber constitutes a liquid tank, the liquid being designated by the numeral 7. The liquid is supplied through the inlet 8 controlled by the float valve 9.

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The evaporator chamber is provided with a precipitating or separator chamber 10 of substantial height. The discharge blower shown conventionally at 11 is connected to the top thereof and delivers through the conduit 12. The heated gases are supplied through the conduit 13 connected to the top section 6. The discharge for the condensed liquor is conventionally shown at 14. This in practice leads to the combustion furnace, the gases from the combustion furnace being supplied to the evaporator through the conduit 13.

The tank is provided with circulating channels 15 at each side thereof opening to the front and rear of the tank at 16. The evaporating wheels set up a circulation through these channels.

The embodiment of the invention illustrated comprises a pair of evaporator wheels designated generally by the numerals 17 and 18, these embodying the same structure but designated by different numerals for convenience in description. Each evaporator wheel comprises a shaft 19 having flanged hubs 20 to which the disk-like end members 21 are secured. These end members constitute supports for a plurality of dip bars 22 which may be desirably formed of sections of pipe arranged through the end members 21 and welded thereto at 23. The wheel shafts are supported in suitable bearings 24 and are provided with sprockets at one end connected by the chain 25. The sprockets for said wheels are of different diameters to provide for different relative speeds of said wheels. The speed may be substantially varied for different condensations but it should be such that the liquid is picked up by the pick-up bars and drips therefrom in streams commonly tending to a sheet form.

It will be understood that in the accompanying drawing I have not attempted to illustrate the parts in proportion, but I have obtained highly satisfactory results in a structure in which the wheels are approximately eight and one-half feet in diameter and in which the front wheel is driven at 18 R. P. M. and rear wheel at 12 R. P. M.

In the embodiment illustrated the bars are arranged in a plurality of concentric series, the bars of adjacent series being in staggered relation. The bars are of relatively small section but are arranged quite close together, thereby increasing the pickup capacity of the wheel and providing a substantial total area of the bars exposed to the gases. A desirable feature is that with the bars thus arranged the dripping liquid is brought into intimate contact with the heated

gases and serves to wash the solids, which may be carried from the evaporating or sintering furnace, out of the gases.

The top members 4 and 5 have curvature concentric with the wheels and are arranged close to the wheels. The ends of the wheels are close to the side walls of the chamber so that the gases are compelled to travel through the wheels. The separating chamber is of substantial size and the gases are directed downwardly into the separating chamber by the baffle 26 which is preferable adjustable. This change of direction of the gases and the retarding of the speed incident to the gases passing into the separator chamber results in a very large proportion of solids carried thereby being precipitated into the liquid, the liquid tank extending below the separator chamber.

The evaporator wheels are driven by the motor 27 and transmission gearing disposed in gear box 28 mounted at the side of the chamber and having a speed control take-off designated generally by the numeral 29, this take-off being connected by the sprocket 29 to a suitable sprocket on the forward evaporator wheel.

As stated, I have not attempted to show the parts in proportion. The liquid depth may be maintained at a level which is found satisfactory for the evaporator wheels, at a level of ten to 13 inches for the diameter of wheel stated. The over-all length of the structure with wheels of the diameter stated may desirably be about 30 feet, the separator chamber being about eight and one-half feet from front to rear or a width corresponding to the diameter of the wheels. I mention these dimensions, not in a limiting sense, but in order to furnish information as to an effectice commercial embodiment adapted primarily for the recovery of chemicals from black or digester liquor. The dip bars do not objectionably cut down the speed of the gas flowing through the evaporator but they do pick up the liquor, which falls therefrom in a curtain-like spray, through which the hot gas must pass. The pickup bars are preferably of cylindrical shape or substantially circular cross section. These bars, as shown in Fig. 1 are of relatively small section and closely spaced so that the liquor picked up drips therefrom in a large number of streams of more or less sheet-like character, thus insuring very intimate contact of the heated gases with the liquid. The bars 22 being of cylindrical shape or circular cross section facilitate a stream-like flow of the heated gases substantially entirely around the bars, that is, the heated gases contact the bars with a stream-like flow, not only at the front of the same but also over substantially all of the rear surface of the bars. This brings the heated gases into contacting relation with relatively large areas of the liquid to facilitate rapid evaporation of the same; and the bars being of circular cross section, this stream-like flow of the gases around each of the bars takes place regardless of the particular position of the bar in its cycle of bodily rotation above the liquid in the tank. The bars being of circular cross section greatly reduce friction losses due to the flow of the heated gases through the evaporator, the friction losses being as much as 30% less than that of the bars of relatively thin flat plate cross section. Such circular bars also prevent what is known in the art as "plugging" when black liquors of relatively high percentage of solids are handled in the evaporator. Also, such bars presenting a relatively wide front liquor-engaging surface when dipping through the liquor, and thereby a better cascading effect, facilitate better scrubbing of the gases.

I have not attempted to illustrate or describe various modifications or adaptations of my invention which I contemplate as it is believed this disclosure will enable those skilled in the art to embody or adapt the invention as may be desired.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. An evaporator for recovering soda ash and other chemicals from black liquor and the like comprising an elongated closed evaporating chamber comprising a top and side walls and provided with an inlet for heated gases at its front end and a separating chamber provided with an outlet for gases at its rear end, a liquid tank at the bottom of said evaporating chamber extending below said separating chamber, the liquid tank being substantially coextensive with the evaporating and separator chambers, a plurality of evaporator wheels each comprising end plates and a plurality of bars of relatively small cross section extending between the end plates, said bars being arranged in staggered relation, said wheels being arranged in tandem within said evaporator chamber and disposed transversely thereof, the top and side walls of the evaporator chamber being closely associated with the wheels so that gas passing through the evaporator chamber is directed transversely through the wheels, the wheels being unobstructed between the bars to facilitate such passage, a plurality of the bars being submerged in the liquid in the tank as the wheels rotate and acting to lift liquid from the tank, the liquid dripping from the bars in exposed relation to the evaporating gases passing longitudinally through the evaporating chamber and transversely of the bars, there being a downwardly directed baffle at the rear of the last evaporator wheel to deflect a substantial portion of the gases entering the separator chamber downwardly, said bars being of substantially circular cross section to facilitate the flow of heated gases against both the front and rear surfaces of each bar regardless of its position in the cycle of translation above the liquid in the tank.

2. An evaporator for recovering soda ash and other chemicals from black liquor and the like comprising an elongated closed evaporating chamber comprising a top and side walls and provided with an inlet for heated gases at its front end and a separating chamber provided with an outlet at its rear end, a liquid tank at the bottom of said evaporating chamber extending below said separating chamber, the liquid tank being substantially coextensive with the evaporating and separator chambers, an evaporator wheel comprising end plates and a plurality of bars of relatively small cross section extending between the end plates, said wheel being arranged transversely within said evaporator, the top and side walls of the evaporator chamber being closely associated with the wheel so that the gas passing through the evaporator chamber is directed transversely through the wheel, a plurality of the bars being submerged in the liquid in the tank as the wheel rotates and acting to lift liquid from the tank, the liquid dripping from the bars in exposed relation to the evaporating gases passing longitudinally through the evaporating chamber and transversely of the bars, said bars being of substantially circular cross section to facilitate the flow of heated gases against both

the front and rear surfaces of each bar regardless of its position in the cycle of translation above the liquid in the tank.

3. An evaporator of the class described comprising an evaporating chamber having a top and side walls and provided with a liquid tank at the bottom thereof and with an inlet for heated gases at one end and a gas discharge at the other end located above the liquid of the tank, and an evaporator wheel arranged in said evaporating chamber between said gas inlet and outlet and with its axis transversely of the chamber and comprising end members and a plurality of rod-like members extending between and secured to said end members, said rod-like members being arranged in a plurality of concentric annular series with the members of adjacent series in staggered relation, the walls of the chamber coacting with the wheel to compel gases passing through the chamber to pass transversely through the wheel above the liquid in the tank, the level of the liquid in the tank being such that a substantial part of the rod-like members are alternately passed through and submerged within the liquid in the tank and exposed to the heated gases passing through the evaporating chamber, said rod-like members being of substantially circular cross section to facilitate the flow of the heated gases against both the front and rear surfaces of each rod-like member regardless of its position in the cycle of translation above the liquid in the tank.

4. An evaporator of the class described comprising an evaporating chamber having a top and side walls and provided with a liquid tank at the bottom thereof and with an inlet for heated gases at one end and a gas discharge at the other end located above the liquid of the tank, and an evaporator wheel arranged in said evaporating chamber between said gas inlet and outlet and with its axis transversely of the chamber and comprising end members and a plurality of rod-like members extending between and secured to said end members, said rod-like members being arranged in staggered relation, the walls of the chamber coacting with the wheel to compel gases passing through the chamber to pass transversely through the wheel above the liquid in the tank, the level of the liquid in the tank being such that a substantial part of the rod-like members are alternately passed through and submerged within the liquid in the tank and exposed to the heated gases passing through the evaporating chamber,

said rod-like members being of substantially circular cross section to facilitate the flow of the heated gases against both the front and rear surfaces of each rod-like member regardless of its position in the cycle of translation above the liquid in the tank.

5. An evaporator for recovering soda ash and other chemicals from black liquor and the like comprising an elongated evaporating chamber having top and side walls and a liquid tank at the bottom thereof, said evaporating chamber being provided with an inlet for heated gases at its front end and a gas discharge at its rear end, and evaporator wheels disposed transversely within said evaporator chamber and each comprising a shaft, disk-like end plates on the shaft, and a plurality of bars of relatively small round section secured to said end plates, said bars being in a plurality of concentric annular series with the bars of adjacent series in staggered relation, the liquid level of the tank and the positioning of the wheels in the chamber being such that only the lower portions of the wheels are submerged and pass through the liquid as the wheels are rotated, the portions of the wheels above the liquid being exposed to the gas passing through the chamber, the walls of the chamber and the wheels being so associated that the gas passing through the evaporator chamber is directed transversely through the wheels.

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