W. KIRKWOOD.

EVAPORATOR.

APPLICATION FILED MAY 6, 1907.

899,738. Patented Sept. 29, 1908.

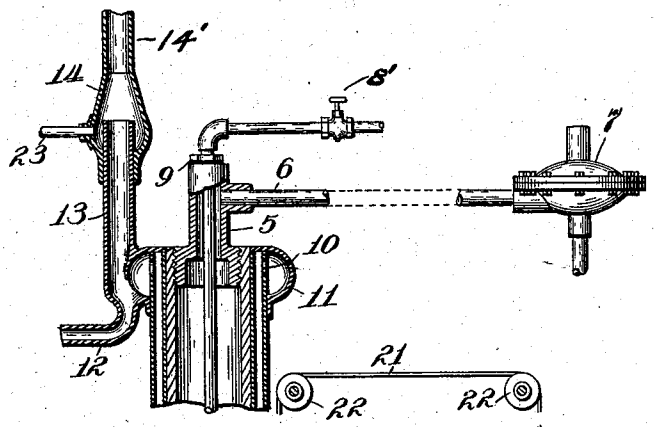

Fig. 1.

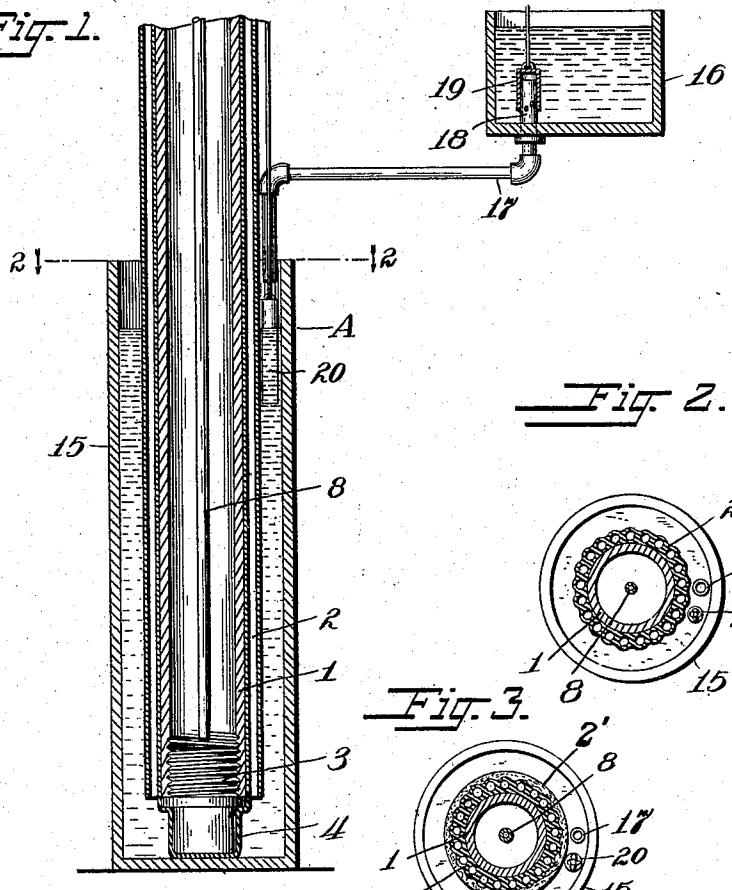

Fig. 2.

Fig. 3.

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EVAPORATOR.

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To all whom it may concern:

Be it known that I, WILLIAM KIRKWOOD, a subject of the King of Great Britain, and a resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Evaporators, of which the following is a specification.

My invention relates to evaporators for concentrating liquids, such as acids and the like, and it has for its object improvements in such devices.

In the device of the present application the evaporation and concentration of the liquid is effected in comparatively small upright tubes wherein it is subjected to heat, the effect of which is to cause steam bubbles in the body of the liquid, which bubbles in their upward course entrain and cause the liquid to flow upward to a point of discharge at or near the upper end of each tube and a considerable distance above the hydrostatic head maintained at the inlet side of the evaporator. During operation the liquid is fed regularly into the supply side of the apparatus to maintain a substantially uniform hydrostatic head, and continuously enters the lower end of each tube, so that there is within each tube a continuous supply of liquid to be evaporated. The liquid discharged from the upper ends of the tubes is collected in a suitable chamber and conducted thence to a storage receptacle while the vapor escaping with the liquid passes to waste.

One of the special objects of my invention is to make an apparatus of this kind which is capable of use for concentrating acids or other corrosive liquids which necessitate the use of soft metals not susceptible to such corrosion and not strong enough to withstand high pressure without collapsing. For example, in the apparatus as embodied for concentrating sulfuric acid the evaporating pipes or tubes are of lead, and in order to secure proper efficiency the walls of these pipes must not be unduly thick yet they must be suitably supported and of considerable length. I secure this result by using a central tube of some stronger material, preferably brass, and arrange around this tube of brass a series of lead pipes, which pipes are soldered or sweated to the brass tube. Thus arranged the central tube and the series of brass tubes form an integral structure of metal through which heat may easily pass from the central brass tube to the liquid within the lead tubes and the said tubes are so arranged that the material being evaporated does not reach and cannot chemically attack the material of the central tube.

My invention is illustrated in the accompanying drawings in which

Figure 1 is a vertical, longitudinal section of the apparatus and Fig. 2 is a transverse section on line 2—2 of Fig. 1. Fig. 3 is a view similar to Fig. 2 showing a modified construction.

In the said drawings 1 is a metallic tube which may be of brass or iron but is preferably of brass because of the ease with which the tubes may be connected to it by soldering or the sweating process. Around the tube 1 are a series of small tubes 2 which small tubes are preferably of lead, are comparatively thin and are united by a metallic bond by soldering or sweating to the tube 1. The tubes 1 and 2 are substantially the same length.

The lower end of the tube 1 is closed by a plug 3 which plug is covered by a lead cap 4 so that the liquid coming in contact with the lower portion of this part of the apparatus will not attack the plug or the inner tube. The upper end of the tube 1 is provided with a plug 5 which has a steam inlet pipe 6 in which inlet pipe there is a steam regulator 7 for the purpose of regulating the flow of steam through the pipe 6 and plug 5 into the tube 1. Extending through the top of the plug 5 is a smaller pipe 8 the lower end of which is closely adjacent to the inner end of the plug 3. A bushing 9 at the top end of the plug 5 serves as a means for preventing steam from escaping around the outer portion of the pipe 8.

The lower ends of the tubes 2 are open but the top ends are closed and have small lateral openings 10 close to the top ends. Surrounding the upper ends of the tubes 2 and inclosing the openings 10 is a discharge chamber 11 which is soldered or sweated to the tubes 2 so as to make a tight joint. Extending downward from the discharge chamber 11 is a discharge outlet 12 for liquid and extending outward from the same chamber is a discharge outlet 13 for vapor. The upper end of the outlet 13 enters a smaller chamber 14 which is provided with a discharge pipe 23; the lower part of said chamber 14 forming a collecting chamber for the

weak liquid condensed from the vapor passing through chamber 14 and the waste pipe 14′ connected therewith.

The lower end of the apparatus I have described is inserted within a cylindrical receptacle 15 which contains the liquid to be evaporated or at least partially evaporated by the apparatus. Located at a convenient place somewhat higher than the receptacle 15 is a reservoir or tank 16 from which the liquid is supplied to the receptacle 15. A pipe 17 serves to convey the liquid from reservoir 16 to receptacle 15. The inner end of the pipe 17 within the reservoir 16 is provided with a series of smaller holes 18 and over the end of the pipe 17 which contains these holes 18 is a cap 19 which is vertically movable so as to open or close a greater or less number of the holes 18 and thus regulate the flow of liquid from the reservoir 16 to the receptacle 15. The level within the receptacle is regulated by a float 20 which connects with a cord 21 running over the guide sheaves 22 to the cap 19. If the liquid within the receptacle 15 falls to a point below the line A the float 20 will descend and raise the cap 19 thus permitting a greater flow of liquid through the pipe 17 into the receptacle 15. If the level of the liquid within the receptacle 15 rises above the normal level, then the ascent of the float will lower the cap 19 and thus shut off more of the holes 18 and so restrict the flow of liquid.

The operation of the apparatus constructed and arranged as described is substantially as follows: Steam being supplied from any suitable source, enters the lower side of the reducing valve or regulator 7, and flows thence through the pipe 6 to the interior of the tube 1. The heat of the steam is transmitted to the walls of the tube and imparted to the liquid contained in the surrounding smaller tubes 2; the water of condensation due to the cooling of the steam descending to the bottom of the main tube. As soon as sufficient water of condensation collects to seal the lower end of the discharge tube 8, the pressure of the steam will thereafter force the further accumulation of condensed liquid out through said pipe. The heat of the steam soon brings the temperature of the liquid in the tubes 2 high enough to generate steam within the latter, and the bubbles of vapor thus generated not only concentrate the liquor but in their upward passage entrain upwardly the unevaporated liquor and finally cause it to overflow out through the lateral openings 10 in the tubes and into the surrounding collecting or discharging chamber 11. The rate of supply of liquid to be evaporated to the tank 15, the pressure of the steam entering through the controlling valve 7, and the actual vertical height of the pipes 2 above the normal level in the supply tank, are all so adjusted relatively to each other as to bring about a substantially uniform upward flow through, and discharge from, the evaporating tubes, with the result that each portion of the liquid will consume an approximately equal period of time in passing through the apparatus, and the liquid which escapes will be concentrated with approximate uniformity. The vapor or steam generated in the evaporating tubes escapes upwardly through the waste pipe or chamber 13 and superposed chamber 14, and whatever water of condensation or weak liquor accumulates in the lower part of the chamber 14 is conveyed away through the pipe 23 and saved for further condensation. The eduction pipe 8 which carries away the water of condensation from the steam is provided with a controlling valve 8′ which will be so adjusted as to restrict the flow therethrough and prevent the waste of steam.

In Fig. 3 is shown in cross sectional view similar to Fig. 2, a modification. This modification comprises the outer tank 15, the evaporating tubes 2, pipe 8, supply pipe 17, float 20 and the inner tube 1 as heretofore described. However in this modification the ends of the evaporating tubes 2 are covered with a wrapping or covering of insulating material 2′ which prevents the transmission of heat from the evaporating tubes to the liquid contained in the surrounding tank 15. This wrapping is preferably arranged to extend from the bottom ends of the tubes upwardly to a point as high as the upper end of the tank, and is composed of an inner layer of asbestos and a protecting covering of lead; the latter being burned or soldered to the tubes proper at its lower end and rising as high as the upper end of the insulating material so as to completely seal the latter against access of liquid. The purpose of this insulating jacket is two-fold, viz: to prevent the transmission to and waste of heat through the liquid contained in the tank, and to prevent the heating of such liquid to such extent as to cause it to overflow. Moreover, the lower ends of the tubes being thus protected against cooling, the liquid as soon as it enters the evaporating tube is subjected to the full heating effect.

I claim as my invention:

1. In an evaporator, a centrally disposed closed metallic tubular heating chamber arranged in upright position, a series of evaporating tubes metallically united with the exterior of said heating chamber and extending throughout substantially the full length of the latter, a steam pipe communicating with the upper end of said heating chamber, an eduction pipe communicating with the lower end of said heating chamber and leading to an elevated point of discharge, a receptacle within which the lower end of said heating chamber and associated evaporating tubes are submerged, the lower ends of said

evaporating tubes being in communication with the interior of said tank, a collecting chamber surrounding the upper end portion of the group of evaporating tubes and in communication with each of the latter, said collecting chamber being provided with a vapor outlet, and a drawing-off pipe communicating with said collecting chamber.

2. In an evaporator, a steam chamber consisting of a tube having its lower end closed, a plug closing the upper end of the tube and providing an inlet passageway for steam, a discharge tube for condensation, said discharge tube passing through said plug and having its inlet end near the lower closed end of the steam chamber, a series of evaporating tubes surrounding the steam chamber and arranged to receive heat therefrom, said tubes having their lower ends open and their upper ends communicating with a discharge chamber, a discharge chamber surrounding the upper ends of said tubes, and a receptacle for liquid within which the lower ends of said tubes and steam chamber are immersed.

3. In an evaporator, the combination of a receptacle for liquid to be evaporated, a steam fed tube rising in and beyond said receptacle and having a closed lower end with a discharge tube for condensation extending through its upper end, a plurality of relatively narrow evaporating tubes extending lengthwise of said tube and about the exterior of the same and metallically united with the outer wall surface thereof and with each other, the inner ends of said tubes being open within said receptacle, and a receiving chamber for the products of condensation, communicating with the discharge ends of said evaporating tubes.

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