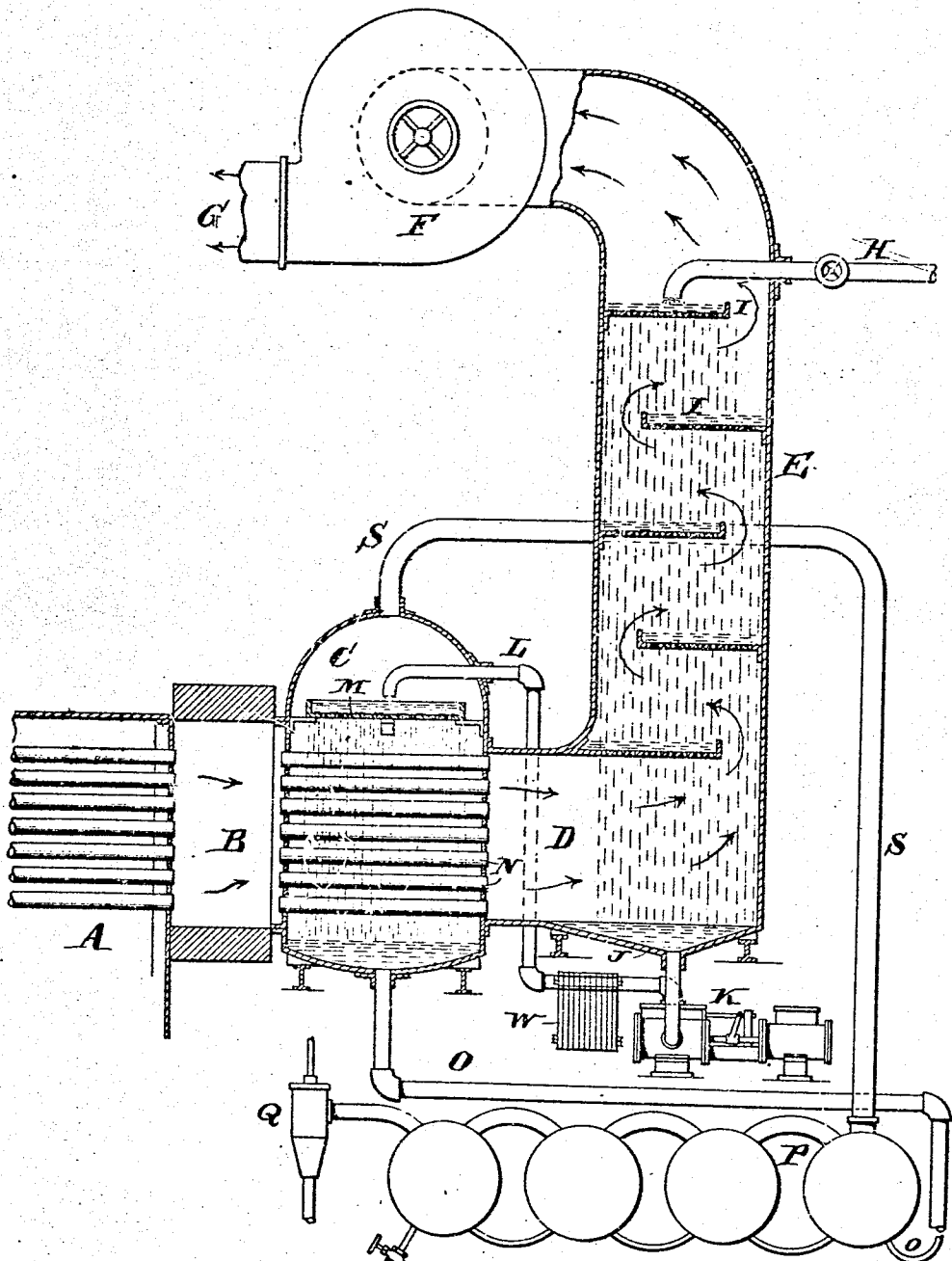


S. M. LILLIE.
METHOD OF EVAPORATING SOLUTIONS.
APPLICATION FILED APR. 20, 1907.

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Patented Feb. 21, 1



Witnesses

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METHOD OF EVAPORATING SOLUTIONS.

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To all whom it may concern:

Be it known that I, SAMUEL MORRIS LILLIE, of the city and county of Philadelphia and State of Pennsylvania, have invented an Improvement in Methods of Evaporating Solutions, of which the following is a specification.

My invention has reference to a method for evaporating solutions and consists of certain improvements which are fully set forth in the following specification and shown in the accompanying drawings which form a part thereof.

The object of my invention is to utilize the hot waste gases or products of combustion from furnaces of boilers and other apparatus for producing a preliminary heating of the fluid to be evaporated prior to its final treatment in a multiple effect or other evaporating or concentrating apparatus, whereby the caloric of said waste gases or products of combustion or matters held in suspension or in gaseous form may be extracted and absorbed into the solution to be evaporated or concentrated.

My invention comprehends a method of treating the liquor in which it is caused to shower or spray through hot gases or products of combustion from the furnace of a boiler or other apparatus and become heated by direct contact with them, and subsequently treating the said heated liquor to evaporation by indirect heating.

My method further makes use of the said hot gases or products of combustion to further heat the aforesaid directly heated liquor by indirect heating as in the first stage in the subsequent evaporation or concentration.

My invention further consists of the utilization of the sprayed liquor upon hot gases charged with matters in suspension or in gaseous form to extract the said matters and also the heat, and subsequently subjecting the charged solution so produced to further heating or to concentration in a multiple effect evaporating apparatus.

My invention may be employed in an apparatus comprising a vertical flue through which the hot gases or products of combustion are caused to pass upwardly, combined with means for causing a downwardly traveling spray of fluid (through the said flue) while evaporated, and an evaporating apparatus for subjecting the directly heated liquor to an indirect further heating or

evaporation by the same hot gases or products of combustion.

My invention also comprehends specific operations which, together with the features above set forth, will be better understood by reference to the drawings, in which is shown apparatus, more or less diagrammatically, partly in section and partly in elevation, adapted for carrying out the method embodying my invention.

A represents an apparatus, such as a steam boiler, from which hot gases and products of combustion are secured, said gases and products passing through flue B, thence through the evaporating tubes N of an evaporator C, then into a chamber D and from which they pass upwardly through the flue E to the atmosphere. If desired a forced draft may be maintained by an exhaust fan F at the upper end of the flue E, which fan may discharge into the atmosphere. The boiler or other apparatus A is provided with any of the usual furnaces or means for producing hot waste products of combustion or gases of any description. The evaporator C consists of a chamber having a series of evaporating tubes N over which the liquor to be evaporated is caused to pass in spray or streams. Said liquors may be supplied by a feed pipe L to a perforated pan M within the chamber and above the tube N. The hot vapors pass off at the top of the chamber by pipe S and the liquor may be drawn off from the bottom by a pipe O. The chamber D has a well J at its bottom to collect the descending liquor from the vertical flue E; and from this well the liquor is delivered by a pump K to the evaporator C by the pipe L, through a filter W, if desired. The vertical flue E may be made in any suitable manner, of sheet metal or otherwise, and is provided with a series of baffle plates I, preferably made in the form of perforated trays and extending from opposite walls alternately and projecting part way across the flue. In this way a circuitous passage is provided for the upward passage of the hot gases and products of combustion as indicated by the arrows, and the liquor to be evaporated or condensed is caused to flow downward in a dense shower as indicated by the dotted lines. Such liquor as is not vaporized passes into the well J at bottom of the flue E and is subsequently subjected to further treatment. The exhauster F may be of any suitable construction. By its use the spray of liquor in

the flue E may be very dense and a rapid circulation of hot gases and products of combustion be maintained through it. If a tall chimney is available it is possible to dispense with the exhauster, but I prefer it in most cases. The cooled gases pass from the exhauster at G.

In addition to evaporating the liquor by the evaporator C, further evaporation may be carried on by the evaporating apparatus P which may be a single or multiple effect apparatus as preferred. In the illustration I have shown diagrammatically a quadruple effect, to which the hot liquor from the evaporator C is supplied by pipe O to the first effect of the series and after concentration, is delivered by pipe R from the last effect. The vapors pass from effect to effect in the usual manner and the vapors from the last effect of the series are condensed by the condenser Q.

From an examination of the arrangement of the parts of the apparatus as a whole it is evident that the evaporating apparatus C may be considered as the first effect of the entire evaporating apparatus though the heating is not done by condensation of steam as in the ordinary multiple effect apparatus.

It will be observed that the first heating and evaporation of the liquor in the flue E is by direct contact with the heating medium, and subsequent heating and concentration by indirect heating, first by flues heated by hot non-condensable gases and products of combustion and finally by indirect heating by hot condensable vapors such as steam.

The ordinary utilization of my invention in heating and evaporating water and for concentrating solutions will be apparent from the foregoing explanations. I will, however, state a specific use of my invention in which not only heating and evaporation with concentration takes place but also removal of objectionable substances held in suspension, said removal involving chemical reaction and subsequent filtration. In the production of beet sugar my apparatus may be used as follows: The alkaline or lime treated beet juices are sprayed downward through the flue E and are therein simultaneously heated and subjected to the action of the carbonic acid of the gases. Carbonate of lime is so produced and is carried down with the juices and held in suspension in the liquor. The lime is in this way placed in a condition by which it may be removed by filtration. The liquor is then pumped by pump K through the filter W and delivered by pipe L to the evaporator and subsequently passes by pipe O to the multiple effect evaporating apparatus P in which it is concentrated. The liquor is free from suspended matters after pass-

ing through the filter so that not only is the liquor in fine condition for concentration but scale producing substances are kept out of the evaporating apparatus. This example of the use of my invention shows that not only may it be employed for evaporation and also concentration, but also for elimination of suspended matters and matters in gaseous form, the latter being through the chemical affinity between the gases in the liquor and the gases in the heating medium. Various other uses for my invention in the industrial arts will be apparent to those skilled in such arts.

Primarily, my invention has utility in economy in that waste heat is utilized as the means for raising the liquor to be concentrated to a high degree of temperature before the final concentration in steam heated single or multiple effect apparatus; further, by this apparatus I am enabled to dispense entirely with the necessity of an external source of steam. Secondly, my apparatus may be employed for washing hot gases of products held in suspension or in gaseous form and subsequently concentrating the said washing solution for obtaining the matter so extracted. There are many uses for my improved apparatus and hence I do not restrict myself to any special application of my invention, the application being merely a secondary matter.

It is evident that, if desired, the liquor in the evaporator or heater C may be maintained above the level of the tubes so as to be in direct contact therewith instead of allowing it to flow over the tubes as hereinbefore described.

The apparatus shown is only intended as an illustration of the combination of elements making up a structure adapted for the proper carrying out of my improved method of heating and evaporating, and for utilizing the products of combustion from boilers and the like for heating and treating a liquid, and for concentrating the same by evaporation, and I do not confine or restrict myself to the details thereof.

I do not claim the apparatus herein described in this application specifically, as the same forms subject matter of a divisional application, Serial No. 595,790, of 1907.

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

1. The method of heating and evaporating a liquid which consists of first spraying the liquid in a downwardly descending stream, heating the descending liquid by an upward current of hot gases of combustion with which the liquid is brought into direct contact, collecting the heated sprayed liquid, transferring the heated liquid to a separate receptacle, and then evaporating the

liquid under partial vacuum by subjecting it to the action of a multiple effect evaporating apparatus.

2. The method of heating and evaporating a liquid which consists in causing the liquid to fall in spray form, heating the sprayed liquid to a high degree by direct contact with hot gases from a suitable source passing upward through the sprayed liquid, collecting the heated liquid and transferring it to a separate vessel and subjecting it in the said vessel to indirect heating by the gases from the same source of the hot gases.

3. The method of transferring heat to a liquid for evaporating it which consists in spraying the liquid in a downward shower, passing hot crude products of combustion upward through the shower of sprayed liquid and heating it by direct contact therewith, collecting the sprayed and heated liquor, transforming the collected heated liquor into spray for a second time, and receiving the sprayed liquor thus provided upon tubes which are heated by the products of combustion preliminary to their passing upward through the first mentioned shower of sprayed liquor, whereby the liquor is first directly heated by the current of products of combustion and then indirectly heated by the same current of products of combustion.

4. The method of heating liquid which consists in spraying the liquid, passing hot gases through the sprayed liquid to heat it by direct contact, maintaining a circulation of the hot gases by a forced draft, collecting the heated liquid and then passing the heated liquid in a subdivided condition over metal surfaces maintained at a high temperature by the hot gases before they pass to the sprayed liquid.

5. The method of heating and evaporating liquid which consists in spraying the liquid, passing hot gases through the sprayed liquid to heat it by direct contact, and then passing the heated liquid over metal surfaces maintained at a high temperature by the hot gases before they pass to the sprayed liquid, utilizing the hot vapors so produced to supply heat to a multiple effect evaporating apparatus, and treating the liquid in its heated condition to further evaporation in the multiple effect apparatus.

6. The method of treating gases for extraction of matters contained therein which consists in passing hot gases containing matters in suspension through a descending spray of liquid, transferring to the liquid the suspended matter from the gases, collecting the liquid sprayed and matters contained therein, and indirectly heating the collected liquid by the hot gases before being subjected to the liquid spray.

7. The method of treating gases for extraction of matter contained therein which consists in passing the gases in a hot condi-

tion through a spray of liquid to cool the gases and extract matter contained therein, and finally evaporating the charged liquid by subjecting it to successive evaporators in a multiple effect apparatus receiving its heat from the hot gases.

8. The method of treating liquids with gases which consists in passing hot gases of combustion in their natural state containing matters in suspension through a spray of liquid and thereby simultaneously heating the liquid and transferring the suspended matter to the liquid, collecting the liquid spray, and passing the collected liquid through a filtering device for filtering out the matters held in suspension by the liquid.

9. The method of treating liquids with gases which consists in passing hot gases containing matters in suspension through a spray of liquid and thereby simultaneously heating the liquid and transferring the suspended matter to the liquid, collecting the liquid spray, passing the collected liquid through a filtering device for filtering out the matters held in suspension by the liquid, and subsequently evaporating and concentrating the liquid by the heat from the hot gases employed for heating the spray of liquid before said gases reach the spray.

10. The method of heating and evaporating a liquid which consists in causing the liquid to fall in spray form, heating the sprayed liquid to a high degree by direct contact with current of hot gases passing upward through the sprayed liquid, collecting the heated liquid and transferring it to a separate vessel and subjecting it in the said vessel in sprayed form to indirect heating by the same current of hot gases.

11. The herein described method of treating liquids which consists in spraying a liquid in a downward direction, passing hot products of combustion upwardly through the sprayed liquor and thereby transferring the heat of the products of combustion to the liquor, collecting the sprayed liquor in its heated condition, heating an evaporator by the hot products of combustion before they act upon the sprayed liquor, supplying the collected liquor to the evaporating apparatus whereby it may be further heated to provide a hot vapor, and transferring the hot vapor so produced to a multiple effect evaporating apparatus and employing said hot vapor as the heating medium therein.

12. The herein described method of treating liquids which consists in spraying a liquid in a downward direction, passing hot products of combustion upwardly through the sprayed liquor and thereby transferring the heat of the products of combustion to the liquor, collecting the sprayed liquor in its heated condition, heating an evaporator by the hot products of combustion before they act upon the sprayed liquor, supplying the

collected liquor to the evaporating apparatus whereby it may be further heated to provide a hot vapor, transferring the hot vapor so produced to a multiple effect evaporating apparatus and employing said hot vapor as the heating medium therein, and also simultaneously circulating the unvaporized liquor to the multiple effect evaporating apparatus whereby it may be evaporated and concentrated.

13. The herein described method for treating liquids which consists in heating the liquid by hot products of combustion and producing thereby both a hot vapor and a hot

liquid, supplying the hot liquid to a multiple effect evaporating apparatus in which it is concentrated, and simultaneously therewith supplying the hot vapors to the multiple effect apparatus as the heating medium thereof, whereby the concentration of the liquid is performed by its own hot vapors.

In testimony of which invention, I have hereunto set my hand.

S. MORRIS LILLIE.

Witnesses:

R. M. HUNTER,

R. M. KELLY.