

March 16, 1937.

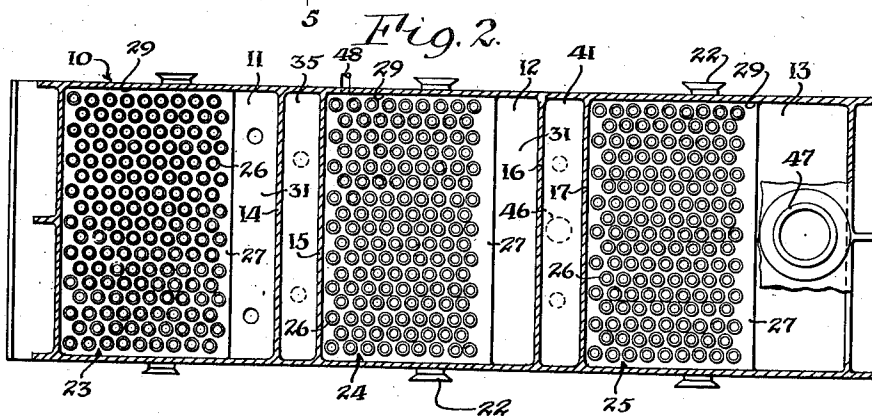
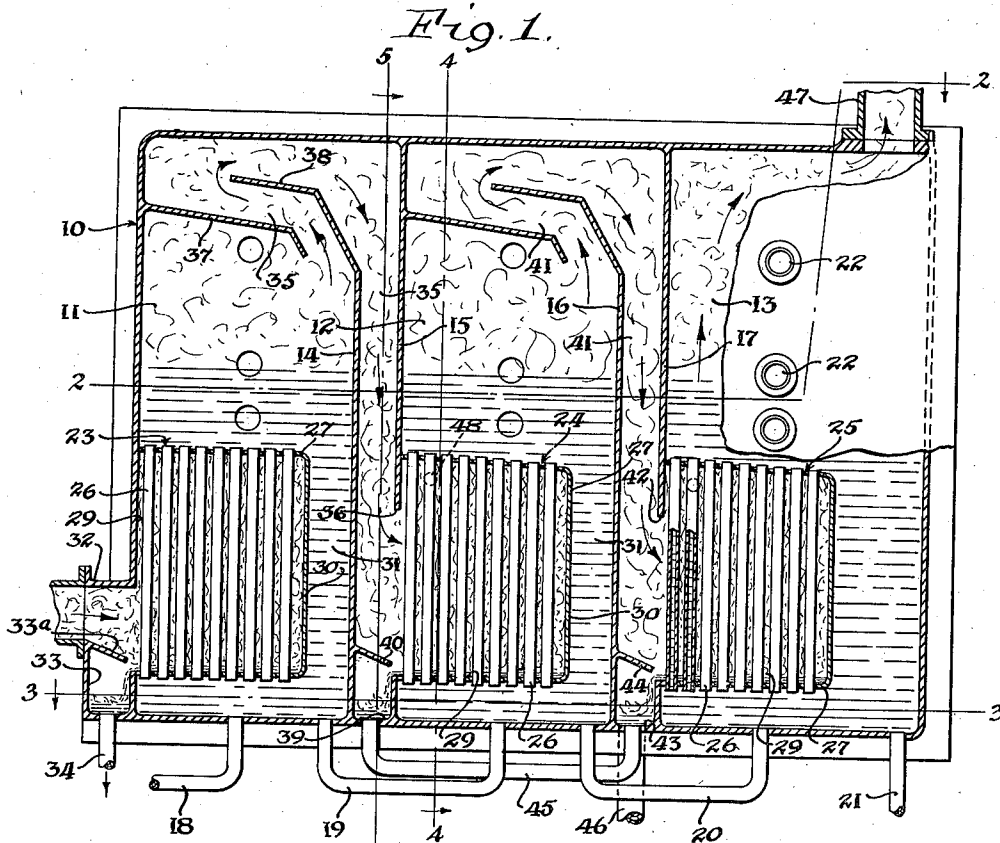
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2,073,738

EVAPORATING APPARATUS

Filed Nov. 8, 1935

2 Sheets-Sheet 1



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Fig. 3.

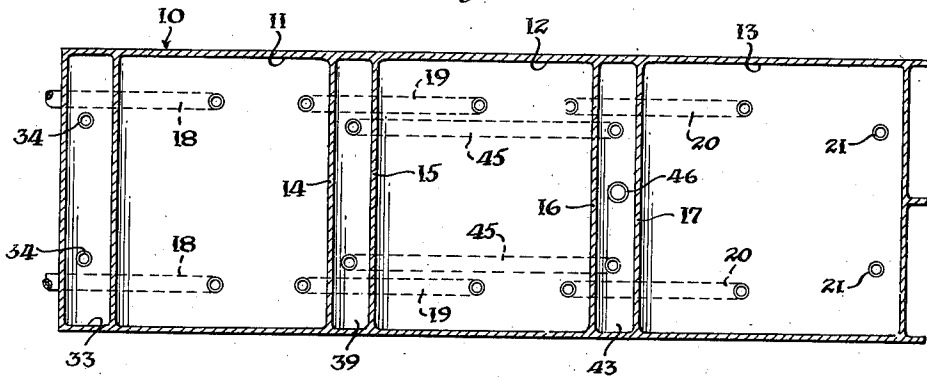


Fig. 4.

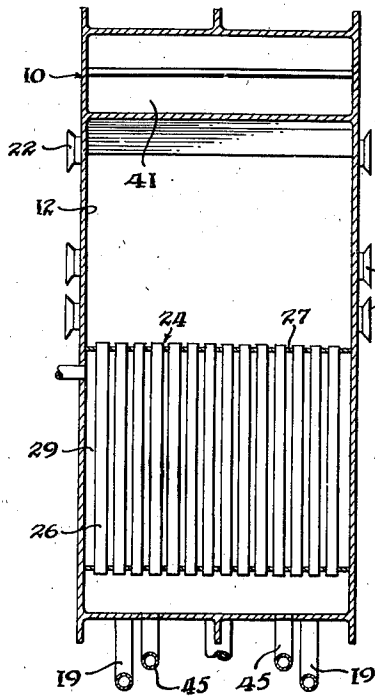
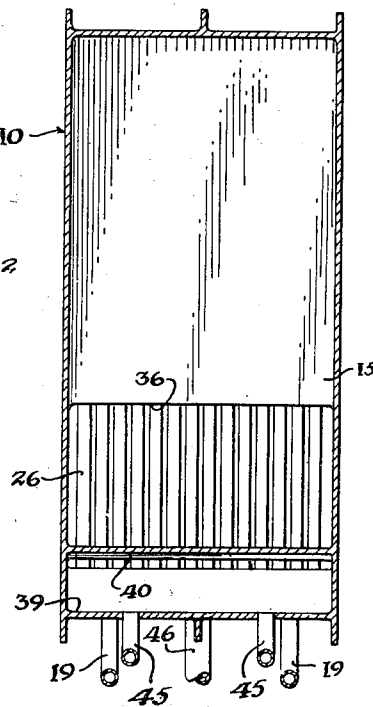


Fig. 5.



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UNITED STATES PATENT OFFICE

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EVAPORATING APPARATUS

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6 Claims. (Cl. 159—17)

This invention relates to improvements in evaporating apparatus of the kind in which the liquor to be condensed or concentrated is caused to flow through a plurality of serially connected chambers, the liquor being partially vaporized in each of the said chambers to effect the separation of the excess liquid in stages and more particularly the invention is concerned with apparatus wherein the vapor which is generated in each of the evaporating chambers in the series is utilized as the heating medium for the liquor in the succeeding chambers, the evaporation of the liquor being initiated by introducing steam into a heating element which is immersed in the liquor in the first evaporating chamber of the series and the evaporation of the liquor in the remaining chambers being effected by the vapors which are generated in the preceding chambers.

One object of the invention is to provide apparatus which is economical from a standpoint of steam consumption, this object contemplating a construction which will enable the evolving vapors to flow freely and without substantial reduction in volume to the various vaporizing elements.

A further object is to provide for the uniform distribution of the generated vapors over the heat transferring surfaces of the vaporizing elements.

A still further object is evaporating apparatus in which provision is made for utilizing a part of the heat from the vapor condensate.

A still further object is to provide for facility in removing fixed or non-condensable gases from the apparatus.

A still further object is a novel arrangement of the parts of the apparatus, whereby simplicity and economy in construction are obtained.

The invention is illustrated in the accompanying drawings, in which:

Figure 1 is a vertical longitudinal section through evaporating apparatus embodying the features of the invention.

Figure 2 is a horizontal section taken along line 2—2 of Figure 1.

Figure 3 is a similar section taken along line 3—3 of Fig. 1.

Figures 4 and 5 are vertical sections taken along lines 4—4 and 5—5, respectively, of Figure 1.

The apparatus, as illustrated, includes a casing 10 which is formed to provide evaporating chambers 11, 12 and 13, the chamber 11 being separated from the chamber 12 by vertical substantially co-extensive partitions 14 and 15 and the chambers 12 and 13 being separated by similar partitions 16 and 17. The casing may be evacuated in any suitable manner if, as preferred,

the evaporation is carried out at a sub-atmospheric pressure. The liquor to be concentrated is caused to flow successively through the chambers 11, 12 and 13, being introduced into the chamber 11 through pipes 18, (Figure 3) being conducted from the chamber 11 to the chamber 12 by pipes 19 and passing from the chamber 12 to the chamber 13 through pipes 20. From the last mentioned chamber the concentrated liquor is withdrawn through pipes 21, there being suitable windows 22 in the casing 10 through which an attendant may look in order to ascertain the level and state of the liquor in the evaporating chambers. It is understood, of course, that the liquor may, if desired, be caused to flow through the evaporating chambers in a direction counter to that described, the liquor in such case being introduced initially into the chamber 13. On the other hand the liquor may, if it is preferred, be introduced directly into each of the evaporating chambers.

Vaporizing elements 23, 24 and 25 are located in the chambers 11, 12 and 13, respectively. Each of the said elements comprises a bank of vertically arranged tubes 26 which are carried by a tube sheet 27, the said sheets supporting the tubes a short distance above the bottom walls of their respective chambers so that the liquor to be concentrated will enter them. The tube sheets 27 extend the full width of the evaporating chambers and they co-operate with the walls thereof to provide vapor compartments 29 through which the tubes 26 extend, the front walls 30 of the said compartments being spaced from the adjacent end walls of the chambers to provide passages 31.

Steam from a suitable source is introduced into the vaporizing element in the evaporating chamber 11 through an inlet connection 32, the said steam entering the vapor compartment of the element and filling the passages between the tubes 26, thereby to heat the liquor in the evaporating chamber and cause a portion of the surplus liquid to vaporize. The steam condensate drains into a well 33 from which it is withdrawn through suitable pipes 34, the said well extending the full width of the chamber to facilitate drainage of the condensate from the heating element. A baffle 33a which is located above the well 33 serves to direct the steam across the latter into the vapor compartment of the heating element.

The evolving vapors enter a tortuous passage 35 which communicates with the vapor compartment of the vaporizing element 24 through

an opening 36 which is formed in the partition 15, the inlet to the said passage being provided by an inclined baffle 37 and a laterally projecting portion 38 of the partition 14 while the main portion of the said passage is provided by the partitions 14 and 15. Any liquor particles which are entrained by the vapors collect upon the baffle 37 and laterally extending portion of the partition 14 and drain back into the chamber 11. It will be noted that the passage 35 throughout its length extends across the entire width of the casing. The evolving vapors, therefore, are permitted to flow freely and without a substantial reduction in volume to the heat transferring surfaces of the element 24 whereby to aid in the vaporization of the liquid in the chamber 12. The vapor condensate from the element 24 drains into a well 39, a baffle 40 which is located above said well serving to direct the vapors from the chamber 11 into the vapor compartment of the said element.

The vapors generated in the chamber 12 pass through a tortuous passage 41 which is similar to the passage 35 and enter the element 25 through an opening 42 which is formed in the partition 17, whereby to effect vaporization of the remaining excess liquid. The condensate from the vapors which enters the element 25 drains into a well 43, the vapors from the chamber 12 being directed across the said well by a baffle 44. Preferably the condensate from the well 39 is conducted by pipes 45 to the well 43 whereby, owing to the lower pressure prevailing in the chamber 13, a portion of said condensate will vaporize and enter the vaporizing element to commingle with the vapors from the chamber 12. Likewise, if desired, the condensate which accumulates in the well 33 may be conducted to the well 39 in order that a part of its heat may also be utilized. The condensate may be withdrawn from the well 43 through a suitable pipe 46 while the vapors which are generated in the chamber 13 may be utilized or they may be permitted to escape through an outlet connection 47 which may, if preferred, be connected to a suitable condenser.

From the foregoing it will be apparent that as the passages through which the vapor is conducted from the evaporating chambers to the vaporizing elements extend across the entire width of the casing flow of the evolving vapors is facilitated. The construction described, therefore, has the advantage that the building up of substantial back pressures in the evaporating chambers, with the attendant reduction in the rate of vaporization, is prevented. At the same time substantial condensation of the vapors in the passages which connect the evaporating chambers and the vaporizing elements is avoided as the pressure of the vapor in the passages is substantially the same as the pressure prevailing in the evaporating chambers. It will be noted also that the openings 36 and 42 through which the vapors enter the vaporizing elements extend the full length of the banks of tubes and are of a height slightly less than the height of the said tubes. Hence the vapors will be uniformly distributed over the heat transferring surfaces of the vaporizing elements. The construction described, therefore, not only enables the maintenance of relatively low pressures in the evaporating chambers but also insures the maximum transfer of heat from the vapors which are generated in the evaporating chambers. Hence steam consumption is maintained at a

minimum and the cost of operation is correspondingly low.

Referring to Figure 1 it will be noted that the openings in the partitions 15 and 17 are so formed that shallow pockets are provided at the upper parts of the tube banks. The fixed or non-condensable vapors which enter the vaporizing elements accumulate in the said pockets and may be withdrawn through suitable pipes 48 (Figures 1 and 2), whereby to maintain a relatively low pressure in the vaporizing elements and facilitate entry of the vapors into them.

The apparatus illustrated includes three evaporating chambers. It is understood, of course, that this is by way of example only and that any desired number of evaporating chambers may be employed.

I claim as my invention:

1. Apparatus of the character described including a casing, said casing having top and bottom walls, a partition which divides said casing into a plurality of evaporating chambers through which the liquor to be concentrated is caused to flow, the lower end of said partition abutting said bottom wall while its upper end terminates in spaced relation with respect to said top wall, means for heating the liquor in one of said chambers to convert a portion of the excess liquid into vapor, an element in a second of said evaporating chambers for vaporizing a portion of the remaining excess liquid, said element having a vapor compartment and a second partition which co-operates with said first mentioned partition to provide a passage which is located between said chambers and through which the vapors generated in said first mentioned chamber pass to said vapor compartment, said partitions co-operating to provide a passage which extends substantially the full length of said element whereby to permit free flow of the vapors into it.

2. Apparatus of the character described including a casing, said casing having top and bottom walls, a partition which divides said casing into a plurality of evaporating chambers through which the liquor to be concentrated is caused to flow, the lower end of said partition abutting said bottom wall while its upper end terminates in spaced relation with respect to said top wall, means for heating the liquor in one of said chambers to convert a portion of the excess liquid into vapor, an element in a second of said evaporating chambers for vaporizing a portion of the remaining excess liquid, said element having a vapor compartment and a second partition which extends substantially the full width of said casing, said partition having an opening which communicates directly with said vapor compartment and co-operating with said first mentioned partition to provide a passage through which the vapors generated in said first mentioned chamber pass to said vapor compartment, said partitions providing a passage which is located between said chambers and which extends substantially the full width of the casing, whereby to permit free flow of the vapors to said element.

3. Apparatus of the character described including a casing which in the direction of its length is of a generally rectangular cross-section, a partition which divides said casing into a plurality of evaporating chambers through which the liquor to be concentrated is caused to flow, means for heating the liquor in one of said chambers to convert a portion of the ex-

cess liquid into vapor, an element in a second of said evaporating chambers for vaporizing a portion of the remaining excess liquid, a second partition which extends across said second chamber and which co-operates with said first mentioned partition to provide a passage through which the vapors generated in said first mentioned chamber pass to said element, said element including a bank of tubes which extends substantially the full width of said second chamber and a shell which co-operates with said second partition and the side walls of said casing to provide a vapor compartment, said tubes extending through said compartment and communicating with said second chamber whereby to permit the liquor in said chamber to enter them, said second partition having an opening which extends substantially the full length of said bank of tubes and through which the vapors enter said vapor compartment, said partitions providing a passage which is located between said chambers and which throughout its entire length is of a width at least equal to the length of said opening.

4. Apparatus of the character described including a casing, a partition which divides said casing into a plurality of evaporating chambers through which the liquid to be concentrated is caused to flow, means for heating the liquor in one of said chambers to convert a portion of the excess liquid into vapor, an element in a second of said evaporating chambers for vaporizing a portion of the remaining excess liquid, a second partition which extends across said second chamber and which co-operates with said first mentioned partition to provide a passage through which the vapors generated in said first mentioned chamber pass to said element, said element including a bank of tubes which extends substantially the full width of said second chamber, a shell which co-operates with said second partition and the side walls of said casing to provide a vapor compartment, said second partition having an opening which extends substantially the full length of said bank of tubes and through which the vapors enter said vapor compartment, said partitions providing a passage which throughout its entire length is of a width at least equal to the length of said opening, the opening in said second partition being so located that a portion of the latter extends a short distance below the top wall of said shell, whereby to provide a pocket in the upper part of said tube bank in which the fixed or non-condensable

vapors may accumulate and a conduit communicating with said pocket and through which said vapors may be withdrawn.

5. Apparatus of the character described including a casing, a partition which divides said casing into a plurality of evaporating chambers through which the liquor to be concentrated is caused to flow, means for heating the liquor in one of said chambers to convert a portion of the excess liquid into vapor, an element in a second of said evaporating chambers for converting a portion of the remaining excess liquid into vapor, said element having a vapor compartment and a second partition which extends substantially the full width of said casing, said partition having an opening which communicates directly with said vapor compartment and co-operating with said first mentioned partition to provide a passage which is located between said chambers and through which the vapors generated in said first mentioned chamber pass to said vapor compartment, said partitions providing a passage which extends substantially the full width of said casing so as to permit free flow of the vapors to said element and providing a well at their bottom portions into which the condensate drains from said element.

6. Apparatus of the character described including a casing, a partition which divides said casing into a plurality of evaporating chambers through which the liquor to be concentrated is caused to flow, means for heating the liquor in one of said chambers to convert a portion of the excess liquid into vapor, an element in a second of said evaporating chambers for converting a portion of the remaining excess liquid into vapor, said element having a vapor compartment, a second partition which extends substantially the full width of said casing, said partition having an opening which communicates directly with said vapor compartment and co-operating with said first mentioned partition to provide a passage which is located between said chambers and through which the vapors generated in said first mentioned chamber pass to said vapor compartment, said partitions providing a passage which extends substantially the full width of said casing so as to permit free flow of the vapors to said element and providing a well at their bottom portions into which the condensate drains from said element and a deflector in said passage for directing the vapors across said well and into said element.

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