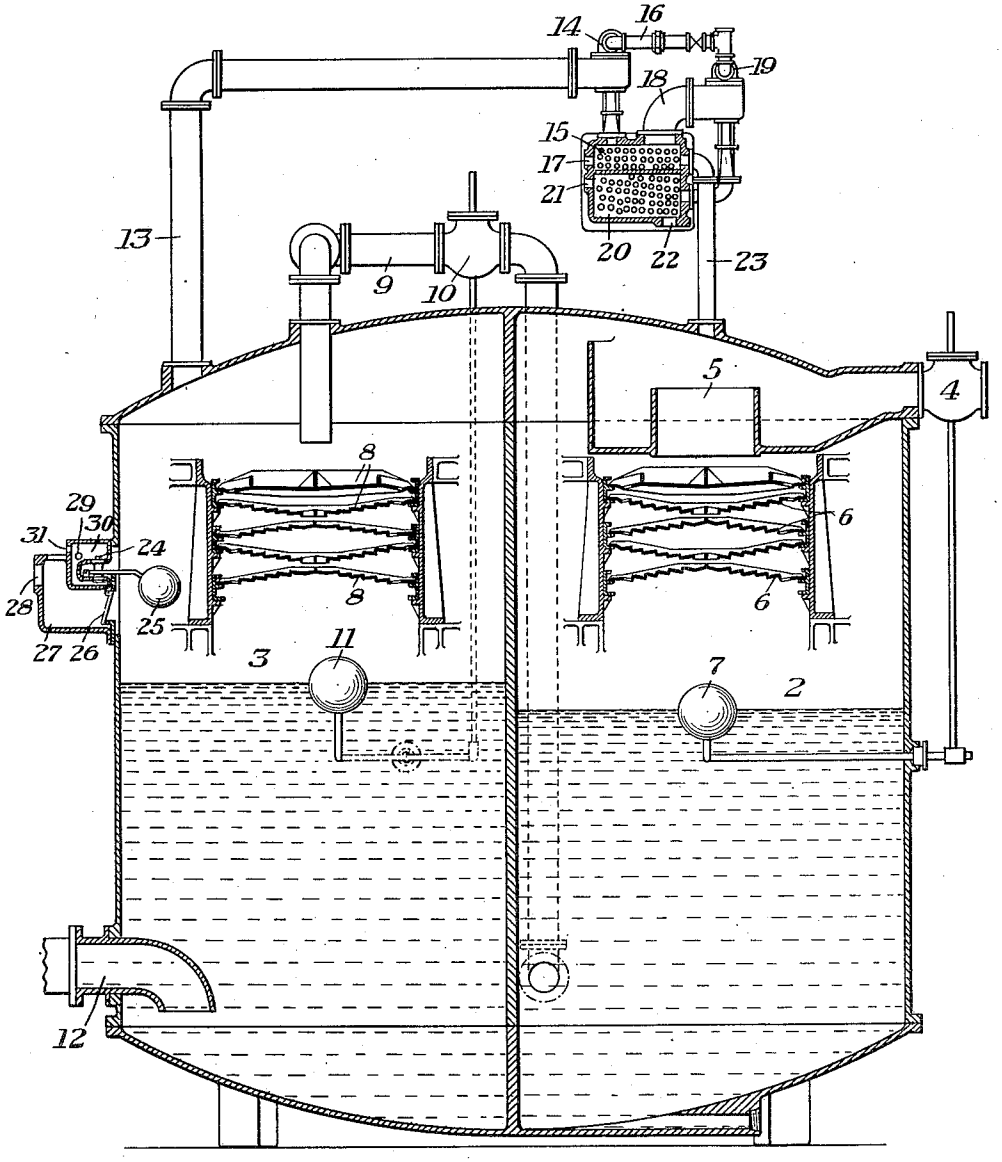
June 9, 1931. W. S. ELLIOTT 1,809,441

METHOD AND APPARATUS FOR THE TREATMENT OF LIQUIDS

Filed Aug. 6, 1925 2 Sheets-Sheet 1

Fig. 1.



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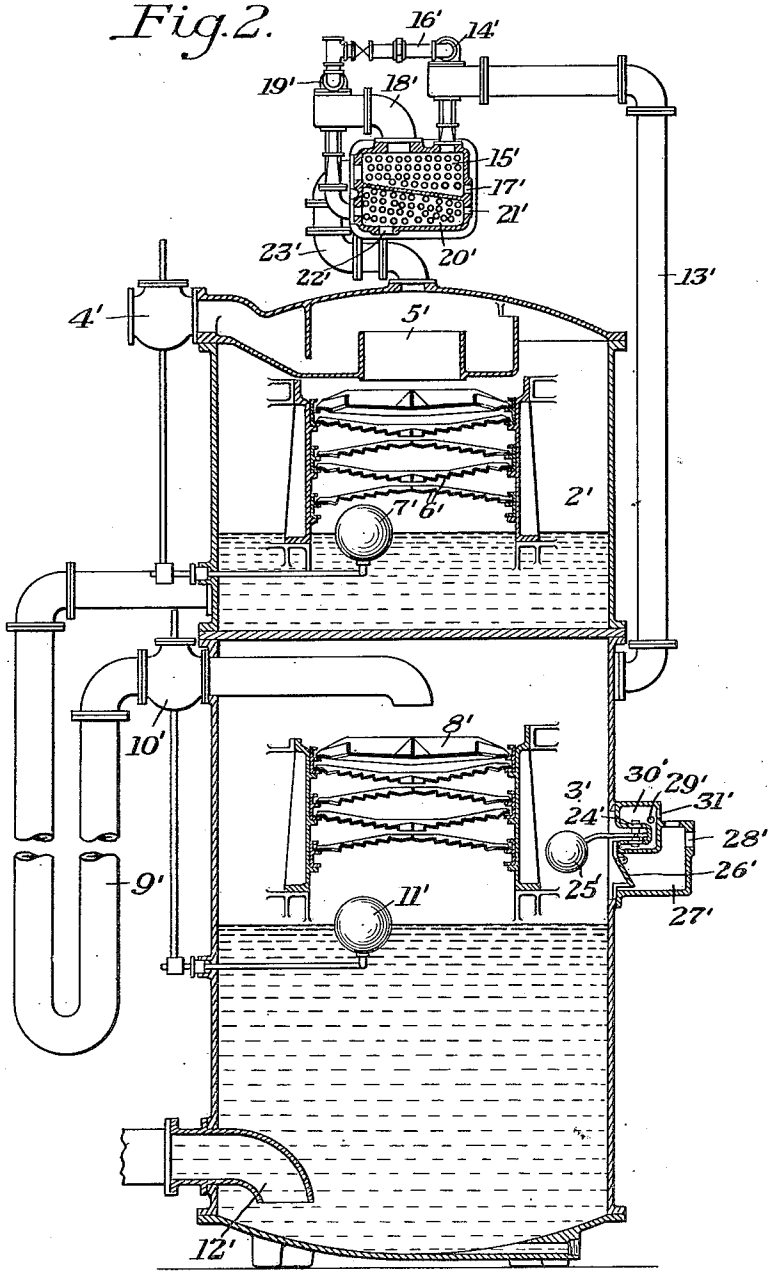
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METHOD AND APPARATUS FOR THE TREATMENT OF LIQUIDS

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Fig. 2.



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Patented June 9, 1931 1,809,441

UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR THE TREATMENT OF LIQUIDS

Application filed August 6, 1925. Serial No. 48,543.

The present invention relates broadly to a method and apparatus for treating liquids, and more particularly to a method and apparatus adapted for the deaeration or degasification of water.

It is recognized that corrosion is occasioned, to a very large extent at least, by the presence of air in water, and different methods and forms of apparatus have been constructed for its substantial elimination. Such apparatus, however, has ordinarily been designed to operate under conditions requiring the supply of a predetermined amount of heat, the quantity of heat being capable of producing a predetermined percentage of evaporation or change of phase in the liquid undergoing treatment.

It has also been proposed to effect the deaeration of water by subjecting it in suitable apparatus to certain conditions of vacuum, it having been generally understood in the art that as the pressure on the liquid is decreased the air tends to separate therefrom. In all such apparatus with which I am familiar the treatment has taken place in what may be termed a single stage, either with or without recirculation.

I have found that very desirable results can be accomplished for certain purposes without the utilization of any heat, and that the cost and effectiveness of the so-called cold or low temperature methods of water deaeration can be, respectively, decreased and increased by dividing the work between a plurality of stages, and maintaining in at least one of said stages such an absolute pressure ratio of the partial pressures that air is effectively released. This constitutes one of the important objects of the present invention.

In the accompanying drawings there are shown, for purposes of illustration only, and in more or less diagrammatic form, two embodiments of the present invention, it being understood that the drawings do not define the limits of the invention as changes in the construction and operation disclosed therein may be made without departing either from the spirit of the invention or the scope of my broader claims.

In the drawings:

Figure 1 is a vertical sectional view through one form of apparatus embodying the present invention, and

Figure 2 is a view similar to Figure 1 illustrating another embodiment of the invention.

So-called low temperature or cold water deaeration has heretofore been carried out either by recirculation of the water in a single tank or stage, or by the treatment in such single tank or stage without any recirculation. It may be assumed, for example, that the water being treated, and the amount thereof, are such that one hundred pounds of air must be extracted per hour. With modern forms of apparatus, this might be accomplished by air ejectors employing steam at a pressure of approximately one hundred and twenty-five pounds, under which conditions the steam consumption to accomplish the air removal would be in the neighborhood of eight hundred pounds per hour. If the work is divided so that the total amount of air which must be removed under the high vacuum conditions is decreased, the effectiveness of the apparatus can be very materially increased, and the steam consumption correspondingly reduced. For example, if the water is treated in two stages under such conditions that approximately eighty percent of the air is removed in the first stage, and twenty percent is removed in the second stage, with apparatus of the character and the efficiency before referred to for the purpose of effecting air removal, the total steam consumption would be in the neighborhood of only five hundred pounds per hour. The present invention incorporates the advantages of a multi-stage treatment of cold or relatively low temperature water. It will be understood that the terms cold and relatively low temperature are used in their generic sense as definitive of a system or method which is self-contained with respect to heat, the water being treated at substantially the temperature at which it is supplied to the treating apparatus.

Referring more particularly to Figure 1 of the drawings, there is illustrated a liquid treating apparatus comprising a chamber 2

constituting the first stage of the apparatus, and a chamber 3 constituting the second stage. These chambers may obviously be compartments of a common apparatus, or may comprise structurally independent units without affecting the spirit or operation of the invention. The first stage is a low vacuum stage, which, for purposes of illustration, may be considered as operating under a vacuum of twenty-five inches of mercury, while the second stage is a high vacuum stage operating under a vacuum of say twenty-nine inches of mercury.

The first stage is provided with a water inlet 4 leading to a distributing or overflow box 5 which, in turn, supplies agitating or distributing trays 6. These trays insure the passage of the water through the vapor zone of the apparatus in finely broken up condition whereby each particle is effectively subjected to the vacuum conditions obtaining within the first stage. The supply of water may be auomatically controlled, if desired, as by the provision of a float 7 constructed to operate as understood in the art.

The second stage may be similarly provided with agitating or distributing trays 8 adapted to receive water from the first stage through an inter-stage connection 9. This inner-stage connection may, in turn, be provided with a controlling valve 10 operated in accordance with demands on the apparatus by a float 11. The second stage may also be provided with a water off-take 12 leading to the point of use and constituting the demand on the apparatus.

It has been pointed out that a higher vacuum is maintained in the second stage than in the first stage. These vacuum conditions may be maintained by providing an air off-take 13 communicating with a first -stage air ejector 14 discharging into an inter-condenser 15, the steam for the first-stage ejector being supplied through a steam connection 16. Within the inter-condenser the steam will be condensed and the condensate may be withdrawn through a suitable drain 17. The air and other non-condensible gases, on the other hand, will be withdrawn through the connection 18 by a second-stage air ejector 19 which may have a common steam supply with the first-stage air ejector, the relative amounts of steam being manually controlled as understood in the art. The second stage air ejector may in turn discharge at substantially atmospheric pressure into an after condenser 20 having an air and gas vent 21 directly to the atmosphere. The after condenser may also be provided with a condensate outlet 22. Under the example given, the combined action of the first and second stage ejectors will be sufficient to maintain a vacuum of twenty-nine inches of mercury in the second stage of the apparatus.

The desired vacuum in the first stage of the apparatus may be maintained by providing an air off-take 23 leading into the inter-condenser, the apparatus being designed for maintaining such conditions within the inter-condenser that the desired vacuum of twenty-five inches of mercury is obtained, as per example, within the first stage of the apparatus. It will also be obvious to those skilled in the art that instead of withdrawing condensate through the opening 17, the condensate may be passed directly from the inter-condenser to the first stage of the apparatus through the off-take 23.

In actual operation, assuming the conditions referred to, water will enter the first stage of the apparatus, wherein under the conditions existing approximately eighty per cent of its total air content may be removed. Thereafter it will pass through the inter-stage connection 9 into the second stage of the apparatus entirely by reason of the differential pressure conditions in the two stages of the apparatus. This permits a given body of liquid to be subjected to a greater tray surface exactly as would be obtained by recirculation without, however, employing any mechanical means, such as a pump, for the specific purpose of accomplishing such recirculation. In the second stage of the apparatus, wherein an extremely high vacuum is maintained, it will be obvious that due to the relatively low partial air pressure, substantially the entire remaining portion of the contained air will be removed. This remaining portion, which may comprise about twenty percent of the original content, may be effectively handled by withdrawing means with a much lower steam consumption than could possibly be the case with the removal of a greater quantity of air. This is due to the reason that the steam required per unit of air removal above a predetermined amount with a predetermined vacuum increases extremely rapidly. By reason of the treatment in successive stages, the apparatus is relieved of the duty of withdrawing such a large quantity of air from a chamber in which a high vacuum must be maintained, the work being effectively distributed.

As a safety factor, the second stage of the apparatus may be provided with a vacuum breaker comprising an air admission valve 24 controlled by a float 25 whereby when the liquid level rises too high within the second stage the float will be operated to open the valve 24 and permit air to enter the second stage and thereby destroy the vacuum conditions and, consequently, the delivery of further water thereto. As an additional safety feature, there may be provided an outwardly opening valve 26 normally held seated by the pressure differential within and without the second stage, but adapted to be opened when the vacuum is destroyed within the second stage to permit the water to flow into the

overflow chamber 27 and through the overflow outlet 28. The valve 24 and the valve 26 may both be water sealed at all times by providing a liquid inlet 29 adapted to fill the valve chamber 30 and overflow therefrom through the port 31 into the overflow chamber 27. In this manner air infiltration can be effectively prevented.

In Figure 2 there is disclosed a modified form of apparatus in which parts corresponding to parts already described are designated by the same reference characters having a prime affixed thereto. In this embodiment the first and second stages for the liquid treatment are arranged in superimposed relationship, the inter-stage connection 9′ being shaped to provide a water leg or water seal by means of which the pressure differential between the two stages may be maintained. With this construction, the operation is identical to that already described with the exception that circulation or passage of the liquid from one stage to the other occurs by reason of the head of liquid existing in the first stage. The valve 10′ therefore constitutes only a safety means insuring an inter-stage liquid flow exactly as in the first form of the apparatus proportional to demands for treated liquid.

The advantages of the present invention arise from the provision of a multi-stage method and apparatus for the low temperature deaeration of liquids.

Further advantages of the invention arise from the provision of a method and apparatus by means of which the necessity of providing mechanical recirculating means is obviated.

Further advantages arise from the provision of an effective apparatus for maintaining the desired absolute pressure ratios of the partial pressures due, respectively, to freed gas and the vapor of the liquid, whereby air separation is effectively obtained without the necessity of an extraneous source of heat, and with a minimum power consumption for effecting the mechanical withdrawal of the released air.

I claim:

1. Liquid-treating apparatus, comprising a plurality of chambers connected in series, a multistage air ejector for withdrawing air and vapors from the last chamber of said series, an inter-condenser and an after-condenser for said multistage ejector, a connection between said inter-condenser and another chamber of said apparatus, and means other than the liquid being treated for operating said air-withdrawing means.

2. Deaerating apparatus comprising a plurality of interconnected chambers, means for maintaining a vacuum in at least two of said chambers with a pressure differential therebetween, means for supplying the liquid to be deaerated, and means effective for automatically destroying the vacuum in the chamber having the highest vacuum therein upon a predetermined increase in the liquid level in such chamber.

3. Deaerating apparatus comprising a treating chamber, means for supplying liquid thereto, means connected to said chamber for maintaining a vacuum therein effective upon the water at its supplied temperature, and a vacuum breaker for said chamber.

4. Deaerating apparatus comprising a treating chamber, means for supplying liquid thereto, means connected to said chamber for maintaining a vacuum therein effective upon the water at its supplied temperature, a vacuum breaker for said chamber, and means for sealing the operating parts of said vacuum breaker against air infiltration.

5. Deaerating apparatus comprising a treating chamber, means for supplying liquid thereto, means connected to said chamber for maintaining a vacuum therein effective upon the water at its supplied temperature, a vacuum breaker for said chamber, and a normally sealed liquid overflow connection for said chamber.

6. In a liquid handling apparatus, a vacuum chamber, and a combined vacuum breaker and overflow connection for said chamber.

7. In a liquid handling apparatus, a vacuum chamber, and a combined water sealed vacuum breaker and overflow connection for said chamber.

8. In a liquid handling apparatus, a vacuum chamber, a vacuum breaker therefor, and an overflow connection controlled by said vacuum breaker.

9. In a liquid handling apparatus, a vacuum chamber, a vacuum breaker therefor, an overflow connection controlled by said vacuum breaker, and a water seal for said vacuum breaker.

10. In a liquid handling apparatus, a vacuum chamber, a vacuum breaker therefor, an overflow connection controlled by said vacuum breaker, and means for water-sealing both said vacuum breaker and said overflow connection.

11. In the method of deaerating and delivering low temperature water, the steps comprising treating the water at substantially its initially supplied temperature in all of a plurality of stages, maintaining at all times a difference in pressure between at least some of said stages by means other than the water being treated, and delivering said water at substantially its initially supplied temperature.

12. In the method of deaerating water, the steps comprising treating the water at substantially its supplied temperature in all of a plurality of stages, and continuously maintaining at all times a substantially constant difference in pressure between at least

some of said stages when no water is being supplied.

13. In the method of deaerating water, the steps comprising treating the water at substantially its supplied temperature in all of a plurality of stages, continuously withdrawing air from said stages to maintain a substantially constant difference in pressure between at least some of said stages, and utilizing means other than the water being deaerated for effecting such air withdrawal.

14. In the method of deaerating and delivering low temperature water, the steps comprising treating the water under a vacuum the temperature corresponding to which is above the temperature of the supplied water, and then subjecting the water so treated to a vacuum the temperature corresponding to which is not materially below the temperature of the water being treated.

15. In the method of deaerating and delivering low temperature water, the steps comprising treating the water under a vacuum the temperature corresponding to which is above the temperature of the supplied water, then subjecting the treated water to a vacuum the temperature corresponding to which is approximately that of the water being treated.

16. In the method of deaerating and delivering low temperature water, the steps comprising treating the water under a vacuum the temperature corresponding to which is above the temperature of the supplied water, then subjecting the water so treated to a vacuum the temperature corresponding to which is not materially below the temperature of the water being treated, and maintaining the vacuum differential irrespective of the amount of water being treated.

17. In the method of deaerating and delivering low temperature water, the steps comprising treating the water under a vacuum the temperature corresponding to which is above the temperature of the supplied water, then subjecting the treated water to a vacuum the temperature corresponding to which is approximately that of the water being treated, and maintaining the vacuum differential irrespective of the amount of water being treated.

18. In the method of deaerating and delivering low temperature water, the steps comprising treating the water at its supplied temperature in all of a plurality of stages, maintaining in said stages a vacuum the temperature corresponding to which is not materially below the temperature of the water being treated, and maintaining a difference in pressure between at least some of said stages.

19. In the method of deaerating water, the steps comprising treating the water in a preliminary stage under a vacuum the temperature corresponding to which is above the temperature of the water to effect the removal of at least a portion of its contained air in the absence of supplied heat, subsequently effecting the removal of substantially all of the remaining air in the absence of heat in a final stage having pressure conditions different from those in the first stage and under a vacuum the temperature corresponding to which is not materially below the temperature of the water being treated.

20. In the method of deaerating water, the steps comprising treating the water in a preliminary stage under a vacuum the temperature corresponding to which is above the temperature of the water to effect the removal of at least a portion of its contained air in the absence of supplied heat, subsequently effecting the removal of substantially all of the remaining air in absence of heat in a final stage having pressure conditions different from those in the first stage and under a vacuum the temperature corresponding to which is not materially below the temperature of the water being treated, and withdrawing the deaerated water from the final stage at substantially its original temperature.

21. In the method of deaerating and delivering low temperature water, the steps comprising passing water at substantially the temperature of the water at its source into a stage of water treatment, subjecting the water therein to a vacuum the temperature corresponding to which is materially above the temperature of the supplied water, passing the treated water into a second vacuum treatment stage, maintaining in said second stage a vacuum the temperature corresponding to which is not materially below the temperature of the water as originally supplied to the first stage, and withdrawing the treated water at substantially its original temperature.

In testimony whereof I have hereunto set my hand.

WILLIAM S. ELLIOTT.