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VERTICAL HEATING AND CIRCULATING TUBE STILL

Filed Dec. 15, 1944

2 Sheets-Sheet 1

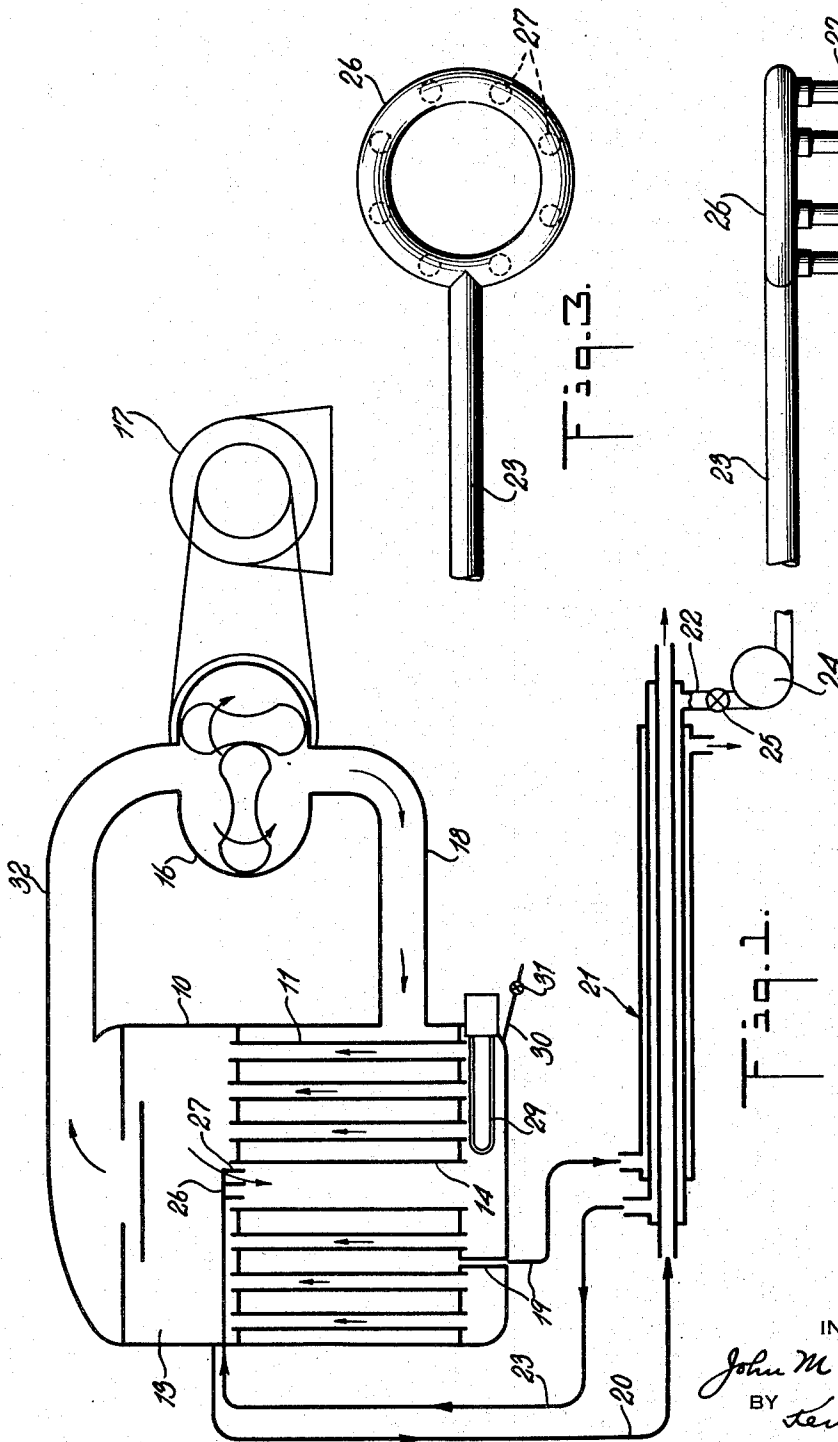
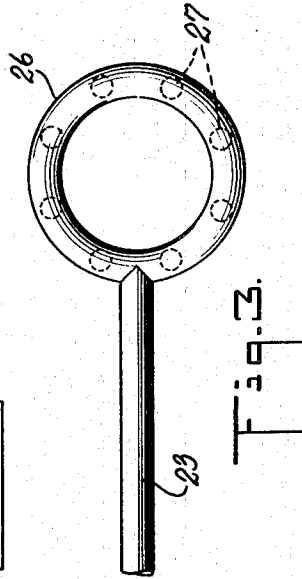
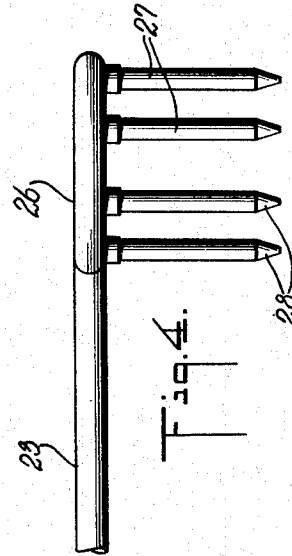


Fig. 1.

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2 Sheets-Sheet 2

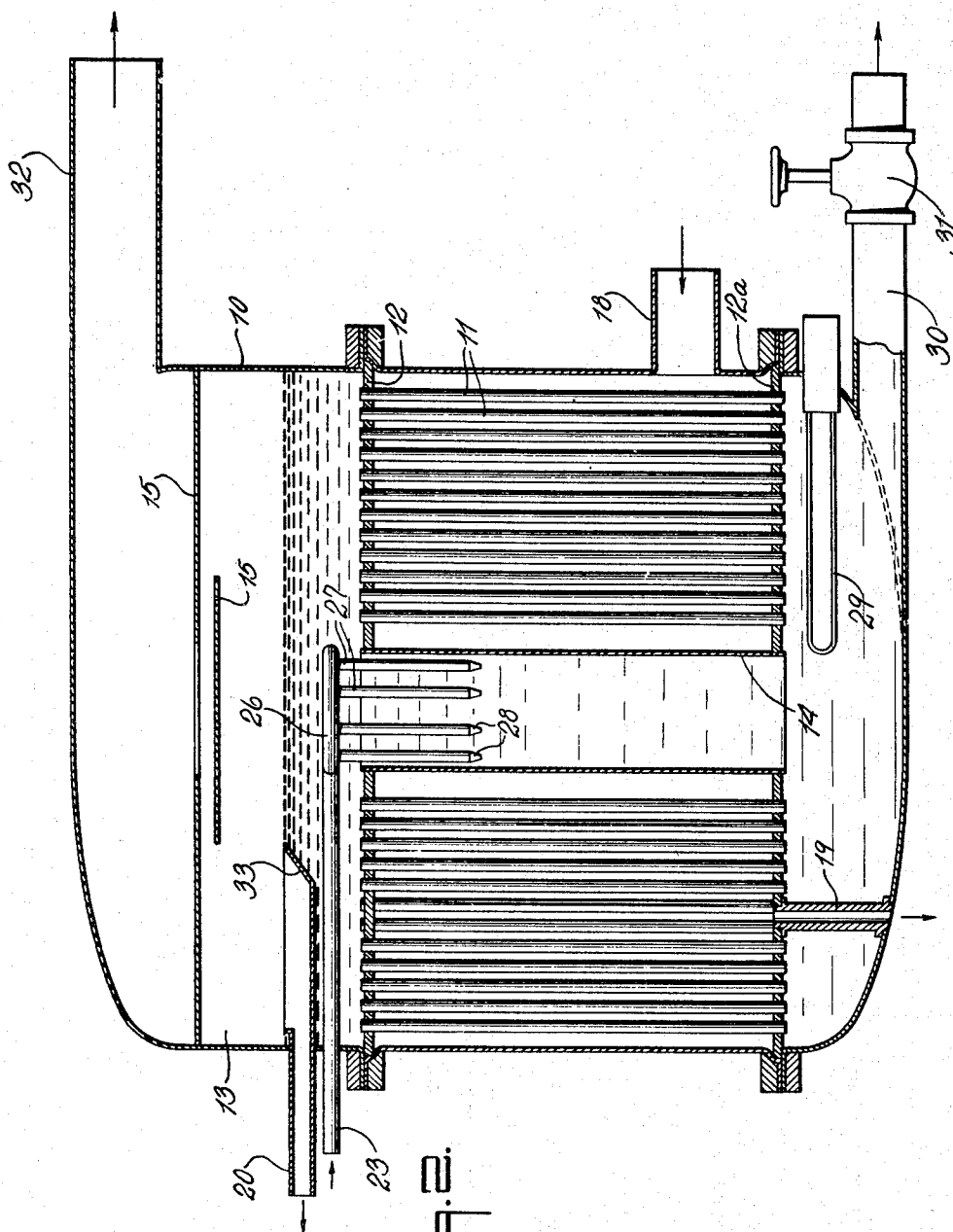


Fig. 2.

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VERTICAL HEATING AND CIRCULATING TUBE STILL

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Merely for illustration, the supply of heated fluid used to maintain the distillation in the

vaporization chamber is shown as a supply of compressed vapor, the compressed vapor being the vapor, after compression, that is evolved in the vaporization chamber 10, this type of system being representative of distillation of the vapor compression type. The vapor that is evolved in the vaporization chamber escapes into the vapor region 13, and, in order to eliminate entrained droplets of solution, can be passed through any suitable type of liquid-vapor separator, which, for purposes of illustration, is shown in the drawing as comprising the baffles 15. The vapor then passes through the low pressure vapor line 32 to the compressor 16 which may be of any suitable type and which may be driven by any suitable source of power such as the motor 17. The vapor compressed by the compressor 16 is directed by the compressed vapor line 18 to the region surrounding the tubes 11. The vapor compressed by the compressor is compressed to a pressure such that its condensing temperature is above the boiling point of the solution within the tubes 11. Such being the case the compressed vapor will be condensed and give up its latent heat of vaporization as well as any sensible heat carried thereby to the boiling solution with which it is in out-of-contact heat exchange relation. The condensate is taken off through the line 19.

The concentrated solution that results from the boiling of solution in the vaporization chamber, after the separation of vapor therefrom, is directed from the vaporization chamber by the line 20, which is provided with a receiving mouth 33 which determines the normal liquid level of solution in the vaporization chamber 10.

At the bottom of the vaporization chamber there is shown an electrical heating element 29 which can be employed to assist in starting the vapor-compression distillation, or to compensate for heat losses during operation, as may be desirable. If desired, the distillation unit can be surrounded by suitable thermal heat insulating material (not shown).

In the system shown, the hot concentrated solution withdrawn from the vaporization chamber through line 20, and the hot condensate withdrawn through the line 19, are directed in out-of-contact and counter-flow heat exchange relation in preheater heat exchanger 21 with incoming feed of fresh solution which enters the system through line 22 and is directed from the heat exchanger 21 to the vaporization chamber 10 by the line 23. The feed is preferably forced into the system as by the pump 24 although a gravity force feed can be employed if desired. The pump 24 may be of a fixed displacement type so that the amount of feed entering the system can be controlled by regulation of the speed of the pump. Alternatively a constant pressure type of pump may be employed, or a constant pressure gravity feed may be employed, together with a valve 25, or other flow regulating device, to control the rate at which the feed is introduced into the system. The employment of a preheater such as the preheater 21 is not essential to the practice of this invention, but is especially desirable in a distillation system of the vapor compression type. A drain 30, controlled by valve 31, is also provided.

Features of this invention relate to the manner of introducing the feed of incoming fresh solution into the body of solution in the vaporization chamber. In the embodiment shown, the feed is directed to the header 26 by the feed line 23. The header 26 has a plurality of lines 27 projecting

downwardly therefrom which terminate in nozzles 28.

It is to be noted that the feed is injected into the system in the down-comer passage 14 of the distillation unit. This has the effect of increasing the rate of circulation of solution in the vaporization chamber. This increase in rate of circulation is due to the fact that the feed of fresh solution at a lower temperature is of a greater density as compared with the balance of the solution in the vaporization chamber. There is, therefore, a greater density differential between the solution in the down-comer 14 and the solution in tubes 11, which fact promotes convection circulation. This in itself is one feature and advantage of the invention. However, it is preferable, as shown, to further promote the circulation of the solution by the ejector action of the feed of fresh solution in being discharged into the solution in the down-comer 14 in the direction of normal liquid flow in the down-comer. The incoming feed is ejected as a jet which affords a positive propulsion of the liquid in the down-comer in the desired direction.

It may also be noted that the incoming feed is commingled with the solution in the vaporization chamber so that the outlet for concentrated solution from the vaporization chamber is intermediate between the upper ends of the tubes 11 and the point of introduction of the feed. In this manner the incoming feed is caused to become thoroughly commingled with the solution in the vaporization chamber and to pass through the tubes 11 before any of the incoming feed is taken from the vaporization chamber. This is of considerable advantage since premature discharge of insufficiently concentrated solution is prevented and the complementary undesirable building up of solution of excessive concentration is prevented. Difficulties of this character have been incident to other types of apparatus due to disproportionate amount of feed passing prematurely out of the overflow line.

More uniform distribution of the boiling solution among the tubes 11 is also afforded in the practice of this invention. Apparatus and method of the character aforesaid can advantageously be used, for example, in a distillation system designed to recover pure water from sea water. In such an operation the feed can, for example, be fed into the system at the rate of 130 gallons per hour and introduced into the vaporization chamber after having been preheated to about 200° F. in the preheater heat exchanger 21. Using the method and apparatus of this invention the circulation of solution through the down-comer 14 can be at the rate of about 12,000 gallons per hour in a system of the capacity aforesaid.

It is apparent that the foregoing embodiment of the invention is merely illustrative and that the method and apparatus can be varied considerably without departing from the scope of this invention. Thus it is apparent that the location of the down-comer is largely optional and may, if desired, be disposed on the exterior of the vaporization chamber. The down-comer passage may be vertical as shown, or may be inclined. When the down-comer is inclined it is to be regarded as vertically extending (as distinguished from absolutely vertical) provided the upper end is above the lower end. The down-comer may have appropriate connections, elbows, etc., as may be required to connect it in operative relation for returning the solution from the upper to the lower ends of the tubes 11.

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The feed introducing means may be varied. Thus, if desired, a single feed line may introduce the feed into the down-comer, instead of the plurality of lines 27. Moreover, the nozzles 28 or the equivalent, may be dispensed with, but the use of the nozzles 28, or equivalent jet producing means, is to be preferred in order to obtain the ejector impulsion action. In this connection it may be noted that the pump or other pressure supply means for the feed cooperates with the nozzles 28 or the equivalent to positively impel the solution in the down-comer. The point of introduction of the feed solution into the down-comer is ordinarily adjacent the upper end, as shown, but may be at any other location in the down-comer. Preferably, the feed is introduced into the down-comer at a point substantially above the lower ends of the tubes 11.

The tubes 11 may be as shown or may be in the form of any other suitable passages. They may be vertical, as shown, or in any other vertically extending position, within the meaning of the term "vertically extending" that has been mentioned above.

The vapors which are introduced for condensation in out-of-contact heat exchange with solutions in the tubes 11 may, of course, be derived from other sources than the compressor 16. Thus the vapor may be supplied from an independent boiler and may be other than the vapor which is evolved in the vaporization chamber. Moreover, hot combustion gases or other heated fluid may be used.

While this invention has been described in connection with a typical example of the practice thereof, it is to be understood that this has been done for illustrative purposes only and that the practice of this invention may be varied within the scope thereof as defined by the language of the following claims.

I claim:

1. Distillation apparatus for the separation of vapor from a solution which comprises a vertically disposed vaporization chamber, a heat exchanger within said vaporization chamber in the form of a heating chest which is disposed between the upper and lower portions of said vaporization chamber and which consists of upper and lower walls, a plurality of vertically extending conduit passages extending through said heating chest and said walls in open communication with solution within said vaporization chamber above and

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below said heating chest, and a single vertically extending down-comer passage centrally located in said chest and of substantially larger flow capacity than the individual conduit passages of said plurality of conduit passages for returning solution from the portion of said vaporization chamber above said heating chest to the portion of said vaporization chamber below said heating chest, said heating chest separating the said upper and lower portions of said vaporization chamber from each other except for said conduit passages and said down-comer passage, means for introducing a fluid at a temperature above the boiling point of solution within said vaporization chamber into said heating chest to heat and boil solution within said conduit passages by out-of-contact heat exchange through the walls of said conduit passages, means for removing vapor from the upper portion of said vaporization chamber, outlet means for withdrawing residual concentrated solution from the said vaporization chamber, and feed means for supplying fresh solution into said vaporization chamber, said feed means being arranged to forcibly discharge a stream of incoming fresh feed downwardly into said down-comer passage in the normal downward direction of flow of solution within and through said down-comer passage.

2. Distillation apparatus according to claim 1 wherein said means for supplying fresh solution into said vaporization chamber includes jet means located adjacent the upper end of said down-comer passage for forcibly ejecting a jet of incoming feed downwardly into said down-comer passage.

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