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VACUUM CRYSTALLIZER AND METHOD OF CRYSTALLIZING

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Fig. 1

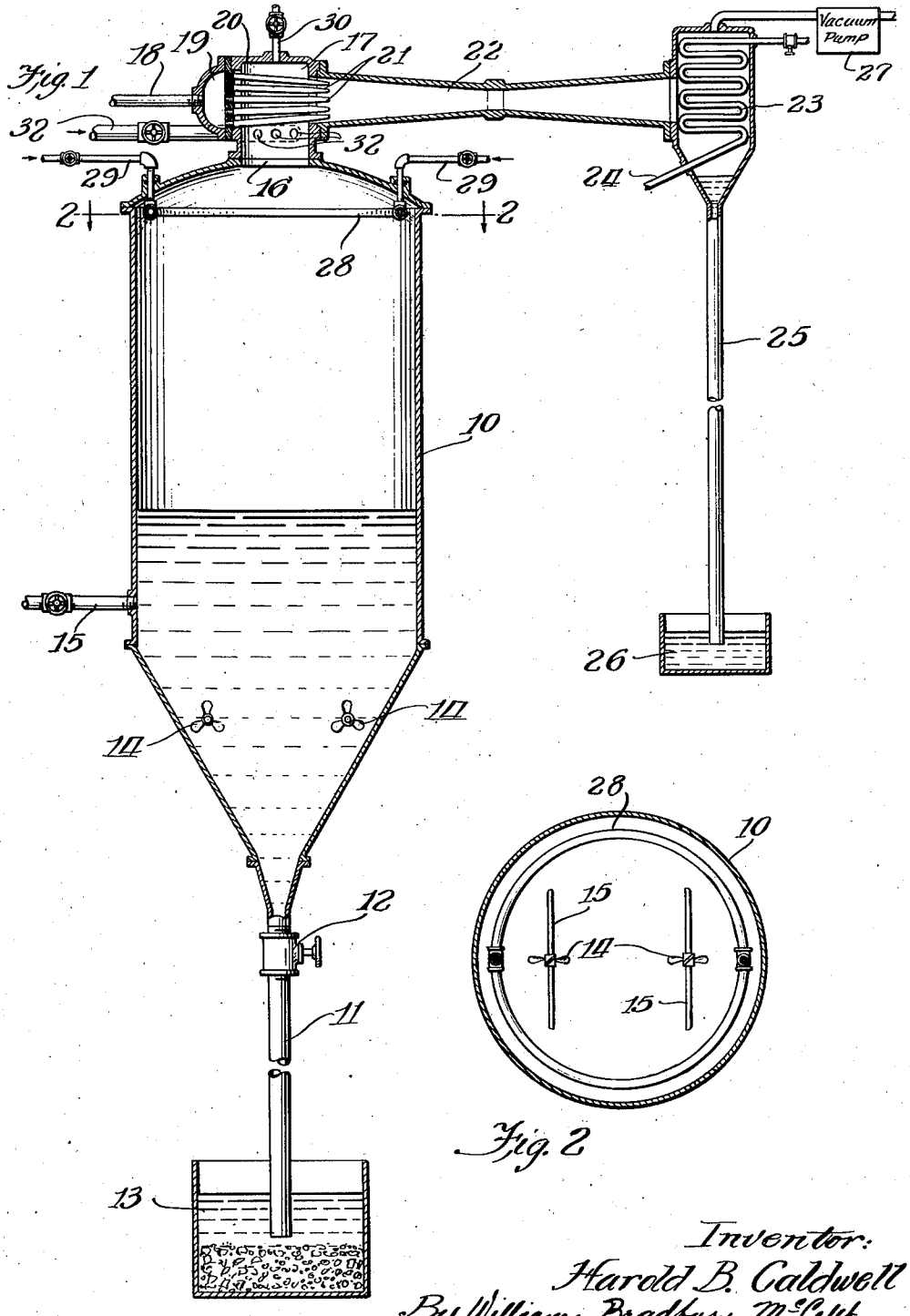

Fig. 2

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VACUUM CRYSTALLIZER AND METHOD OF CRYSTALLIZING

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11 Claims. (Cl. 159—45)

This invention relates to vacuum crystallizers and method of crystallizing. The invention has particular relation to the method of and apparatus for crystallizing disclosed in my prior Patent 1,865,614 issued July 5, 1932, according to which crystallization is effected by subjecting the solution to a vacuum whereby the solution is cooled to the temperature at which crystals deposit. The vacuum is produced by a suitable compressing device and the vapors are condensed by a suitable cooling fluid, which may be at a temperature substantially higher than the temperature of the solution from which the crystals are being deposited.

One of the principal objects of the invention is to provide an improved method of and apparatus for crystallization.

A further object of the invention is to provide an improved method of and apparatus for crystallization, which is substantially continuous and can be continued for prolonged periods of time without ceasing operations.

Other objects, advantages and capabilities of the invention will appear from the following description of a preferred embodiment thereof, taken in conjunction with the accompanying drawing, in which—

Figure 1 is a diagrammatic view of a crystallizer embodying my invention, and

Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1.

Referring to the drawing, the reference numeral 10 designates an evaporating shell, the upper part of which is substantially cylindrical in form, the lower part being hopper shaped and communicating with a barometric leg 11 which may be provided with a valve 12. The barometric leg 11 extends downwardly and terminates in a trough 13 which is adapted to make a liquid seal at the bottom of the leg 11. It will be understood that the leg 11 is of sufficient height so that when the shell is evacuated to a substantial degree, for example, about 29 inches of mercury, the surface of the liquid in the shell 10 is at a relatively low point on the cylindrical portion thereof, so that ample vapor space is provided above the surface for the ebullition which takes place.

Suitable stirring means are provided for agitating the liquid within the shell 10. These means may suitably consist of propellers 14 mounted on shafts 15 which are driven by suitable means (not shown) so as to agitate the liquid thoroughly. The solution from which salts are to be crystallized is supplied by a valved pipe 15.

The upper end of the shell 10 is provided with an opening 16 which communicates with a suitable device 17 for creating a vacuum within the shell 10 and compressing the vapors removed from the shell. This evacuating means may be any of the pumps or ejectors known in this art. In the specific embodiment illustrated the evacuating means 17 is a booster ejector which is supplied with high pressure steam through a pipe 18. This steam is supplied to a steam chest 19 from which it passes through a chamber 20 through nozzles 21. The chamber 20 communicates with the opening 16. The nozzles 21 terminate in the converging portion of a venturi 22, which venturi delivers into a condenser 23. The condenser 23 is shown by way of example as comprising a chamber through which passes a coil 24 through which suitable cooling fluid is passed. Said chamber communicates with the barometric leg 25 sealed by a trough 26. The chamber is also connected to a vacuum pump 27 which exhausts air introduced into the system with the liquid supplied or introduced by leakage.

With an efficient evacuating means 17 of the type shown and an efficient condenser 23 the apparatus thus far described is a very effective means for cooling liquid introduced into the shell 10. For example, it is quite feasible to freeze water in the shell 10, notwithstanding the fact that the cooling water available for use in the coil 23 is at ordinary summer temperatures.

In crystallizing salts from solutions containing them the solution is introduced by the pipe 15 and the booster ejector 17 is put into operation, likewise the vacuum pump 27. As a result of the high vacuum produced in the shell 10, for example a vacuum of 29 inches of mercury when the atmospheric pressure stands at 30 inches, a certain amount of ebullition occurs within the shell 10 and the resulting evaporation cools the liquid to a point where crystals deposit to a desired extent.

The vapors from the shell 10 together with the steam introduced by pipe 18 are commingled in the venturi 22 and are finally condensed in the condenser 23. In practicing crystallization in this manner I have found that a considerable amount of salt is deposited on the walls of the shell 10 above the liquid level, this deposit resulting from the splashing of the chilled solution upon these walls. Here the film of liquid is subjected to the full effect of the vacuum and the water evaporates therefrom rapidly so that the deposit grows as the crystallization is continued. I have also found that the overhead carries with it a certain amount of entrainment which builds

up on the nozzles 21, which nozzles are at high temperature owing to the passage of steam therethrough. The entrainment hitting these nozzles is immediately deprived of its water content so that the salts build up thereon.

In order to render the operation continuous I provide within the shell 10, preferably at a position as high as possible therein, a spray pipe 28 which is preferably annular in form and provided with spray openings adapted to distribute liquid around the whole surface of the cylindrical wall of the shell. This liquid is adapted to flow downwardly over this surface and remove any salts deposited thereon or prevent the deposition of any salts thereon. The pipe 28 communicates with one or more valved pipes 29 so that a controlling supply of liquid can be supplied to pipe 28 continuously or at intervals. The nature of the liquid supplied to the pipe 28 will depend upon the nature of the precipitate on the walls, or the salt or substance which is being crystallized. The solvent in the solution being evaporated is always suitable. In many cases where the solution being evaporated is relatively dilute, a certain portion of the feed supplied to the shell 10 may be introduced by the pipe 28. In order to remove the deposit of salts or the like upon the nozzles 21 I provide a valved pipe 30 adapted to deliver water or other suitable liquid upon these nozzles. In the embodiment of the invention illustrated I have shown the pipe 30 delivering into the top wall of the chamber 20. In addition to the supply of liquid by means of the pipe 30, I prefer to provide in opposite walls of the chamber 20, openings 31 for the supply of further quantities of liquid. The openings 31 are preferably located near the level of the lowest nozzles 21 so that the overhead carries the spray with it over the outer surfaces of the nozzles whereby the deposit of solute is effectively prevented or removed. The openings 31 are supplied with said liquid by means of valved pipes 32. It is to be understood that it is not intended to limit the invention to this disposition of the means for supplying liquid to the ejector, since such means may be located in any position whereby they are effectively adapted to remove or prevent deposit of the solute on the nozzles 21.

While the liquid supplied to the ejector may suitably be a solvent for the solute, this is not necessary since the removal of the deposit is at least partially mechanical due to great changes of temperature fracturing the deposit. I find that after running for one hour, that by turning on the liquid supply for three minutes and then turning on the steam the deposit is substantially fractured and falls from the nozzles.

In the preferred manner of operating, I prefer to supply a small amount of liquid continuously by the pipes 28, that is, an amount of liquid which will keep any entrainment striking the walls from depositing crystals thereon or which will cause crystals on the walls to remain slushy and become washed down by the stream of liquid.

As stated above, it is preferred to supply liquid by pipes 30 and 32 for short periods at comparatively long intervals, for example, periods of about three minutes at intervals of about one hour.

Although the invention has been described in connection with the specific details of a preferred embodiment thereof, it is not intended that such details should be considered limitative of the invention except so far as set forth in the accompanying claims.

Having thus described my invention I declare that what I claim is:

1. A vacuum crystallizer comprising a chamber adapted to contain solution and provide a vapor space thereabove, means for withdrawing vapors to create a vacuum in the chamber and compress the withdrawn vapors, cooling means for condensing said compressed vapors, and means for injecting liquid upon surfaces within the vapor space of said chamber in order to prevent accumulation of solute thereon.

2. A vacuum crystallizer comprising a chamber adapted to contain solution and provide a vapor space thereabove, means for withdrawing vapors to create a vacuum in the chamber and compress the withdrawn vapors, cooling means for condensing said compressed vapors, and means for injecting liquid upon the internal surfaces of the vapor withdrawing means in order to prevent accumulation of solute thereon.

3. A vacuum crystallizer comprising a shell adapted to contain solution and provide a vapor space thereabove, means for withdrawing vapors to create a vacuum in the chamber, and means for injecting liquid upon the internal surfaces of the vapor withdrawing means in order to prevent accumulation of solute thereon.

4. The method of crystallizing solute from solutions which consists in supplying said solution to a closed chamber, maintaining a vapor space above said solution in said chamber, withdrawing vapors from said space and maintaining a substantial vacuum therein thereby causing a fall of temperature below that necessary for the precipitation of crystals, injecting liquid upon surfaces within said vapor space to prevent accumulation of solute thereon and withdrawing said crystals from said chamber.

5. The method of crystallizing solute from solutions which consists in supplying said solution to a closed chamber provided with an ejector communicating with the upper portion of said chamber, withdrawing vapors from said space by said ejector and maintaining a substantial vacuum therein thereby causing a fall of temperature below that necessary for the precipitation of crystals, injecting liquid into said ejector to prevent accumulation of solute therein, and withdrawing said crystals from said chamber.

6. A vacuum crystallizer comprising a chamber adapted to contain solution and provide a vapor space thereabove, means for withdrawing vapors to create a vacuum in the chamber and compress the withdrawn vapors, said means including ejector tubes adapted to convey steam at high temperature, cooling means for condensing said compressed vapors and steam, and means for injecting liquid upon the outer surfaces of said ejector tubes for the purpose of removing accumulated solute therefrom.

7. A vacuum crystallizer comprising a shell adapted to contain solution and provide a vapor space thereabove, means for withdrawing vapors to create a vacuum in the chamber, said means comprising ejector tubes adapted to convey steam at high temperature, and means for injecting liquid upon the exterior surfaces of said ejector tubes, for the purpose of removing accumulated solute therefrom.

8. The continuous method of crystallizing solute from solutions which consists in supplying said solution continuously to a closed chamber so as to pass over unsubmerged portions of the wall thereof so as to prevent deposition of solute thereon, maintaining a vapor space above said

solution in said chamber, continuously withdrawing vapors from said space and maintaining a substantial vacuum therein, thereby causing a fall of temperature below that necessary for the precipitation of crystals, and continuously withdrawing said crystals from said chamber.

9. The continuous method of crystallizing solute from solutions which consists in supplying said solution to a closed chamber, maintaining a vapor space above said solution in said chamber, continuously withdrawing vapors from said space and maintaining a substantial vacuum therein, thereby causing a fall of temperature below that necessary for the precipitation of crystals, continuously injecting liquid upon surfaces within said vapor space to prevent accumulation of solute thereon, and continuously withdrawing said crystals from said chamber.

10. The continuous method of crystallizing solute from solutions which consists in continuously supplying said solution to a closed chamber provided with an ejector communicating with the upper portion of said chamber, said ejector comprising an ejector tube conveying steam at high temperature, continuously withdrawing vapors from said space by said ejector and maintaining a substantial vacuum therein, thereby causing a fall of temperature below that necessary for the precipitation of crystals, intermittently injecting liquid upon said ejector tubes to remove solute deposited thereon, and continuously withdrawing said crystals from said chamber.

11. A continuous method of crystallizing solute from solutions which consists in continuously supplying said solution to a closed chamber provided with an ejector communicating with the upper portion of said chamber, said ejector comprising an ejector tube adapted to convey steam at high temperature, continuously withdrawing vapors from said space by said ejector and maintaining a substantial vacuum therein, thereby causing a fall of temperature below that necessary for the precipitation of crystals, injecting liquid into said chamber so as to cause the injected liquid to flow down the unsubmerged walls thereof and prevent accumulation of solute thereon, intermittently injecting liquid upon the exterior of the ejector tubes for the purpose of removing solute deposited thereon, and continuously removing said crystals from said chamber.

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