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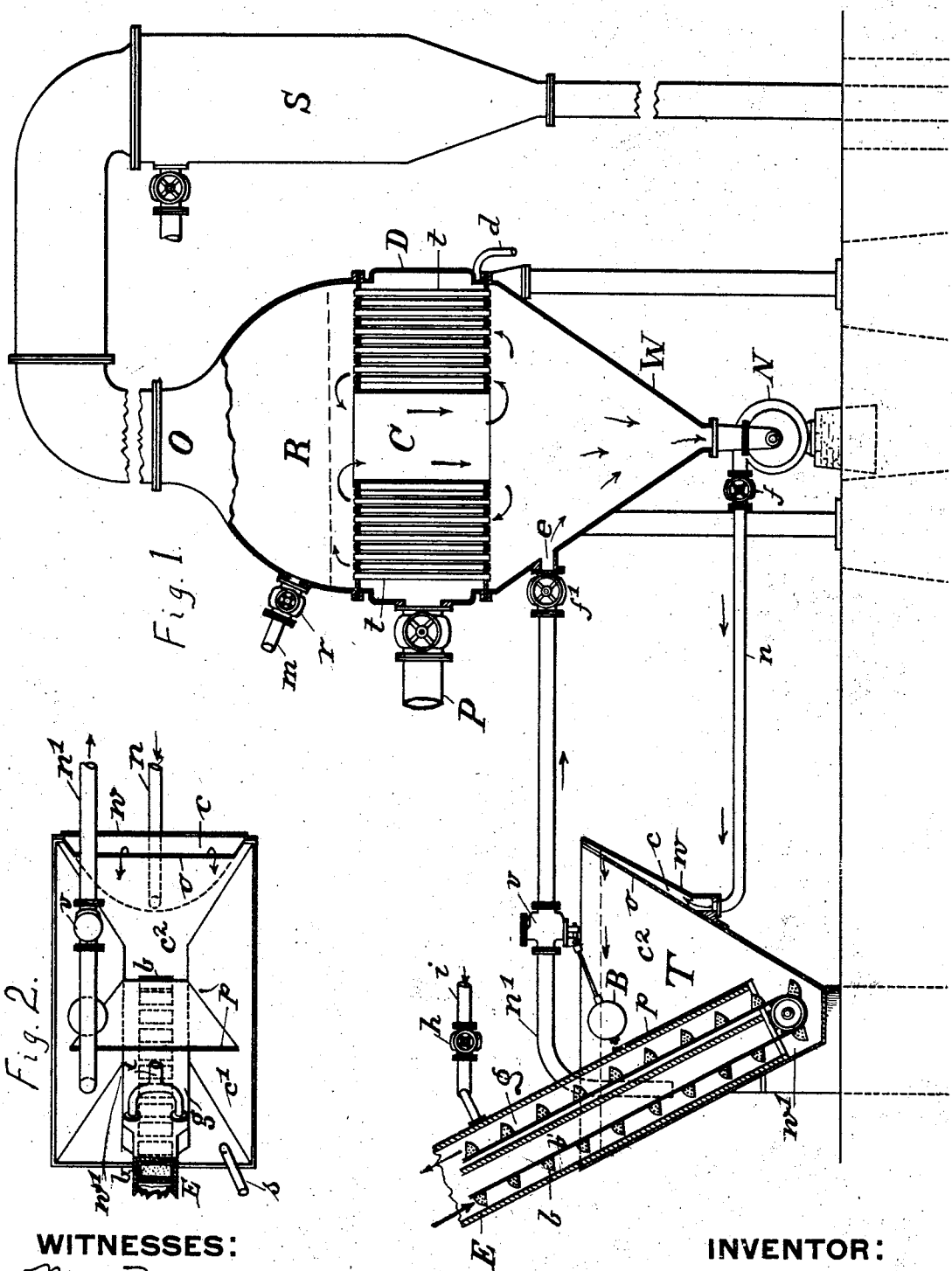
METHOD OF REMOVING SALT FROM EVAPORATORS.

APPLICATION FILED DEC. 11, 1909.

1,036,127. Patented Aug. 20, 1912.



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METHOD OF REMOVING SALT FROM EVAPORATORS.

1,036,127. Specification of Letters Patent. Patented Aug. 20, 1912.

Application filed December 11, 1909. Serial No. 532,696.

To all whom it may concern:

Be it known that I, SAMUEL MORRIS LILLIE, a citizen of the United States, and a resident of the city and county of Philadelphia, State of Pennsylvania, have invented an Improvement in Methods of Removing Salt from Evaporators, of which the following is a specification.

My invention has reference to methods of removing salt from evaporators, 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 enable the separation and removal of salt from evaporators as a continuous process, and also for purifying the separated salt before being delivered to the driers or receiving receptacles.

My improved process is adapted to be practised in connection with that class of evaporators in which the salt crystallized out of the brine is collected in outside pockets and from which it is preferably removed in a continuous manner or without interrupting the flow of the brine.

It has heretofore been proposed to collect salt from an evaporator by circulating the concentrated brine alternately through two separate strainer tanks to strain out the salt, the strained brine being returned to the evaporator; the strainers being alternately opened and the salt removed by hand.

My improved process consists in drawing the brine from the evaporator, and causing it to pass to an outside place with a current speed sufficient to prevent the deposition of the salt crystals held in suspension, then reducing the speed of the current whereby the salt crystals are permitted to deposit by gravity, and returning the brine liquor to the evaporator, and removing the deposited salt continuously or without interrupting the flow of the brine; further in the above stated process the removed salt is conveyed to a distance, and during the said removal and conveyance of the salt, cleansing the same of impurities by washing it by fresh brine liquor.

My invention will be better understood by the description hereinafter given in connection with the apparatus illustrated in the drawings, in which:

Figure 1 is a sectional elevation of a salt evaporating and separating apparatus in which to practice my invention; and Fig. 2 is a plan view of the salt separating and cleansing devices.

The evaporator is in general, of the well known vertical tube construction having a drum D of vertical evaporating tubes *t* surrounded with steam, a dome R above the tubes with a main outlet O for the escape of the vapor produced in the evaporator to the condenser S, and a well or pocket W below the drum. The center of the drum is provided with a large circulating downtake C forming a communication between the dome R above the tubes and the well or pocket W below the tubes. Steam to produce evaporation may be introduced in the drum space around the tubes through a pipe P, and the water of condensation from the drum may pass off by a drip pipe *d*. A pipe *m* provided with a valve *r* may be employed for charging or feeding the evaporator with brine as an initial operation, or at any other time when additional brine may be required.

Attached to the bottom of the well or pocket W is a pump N, preferably of the centrifugal type, said pump having its suction port opening into the well or pocket at its bottom, which connection may, if desired, be made in the manner shown in my U. S. Letters Patent No. 789,159 dated May 9, 1905. A discharge pipe *n* leads from the pump N and may be provided with a controlling valve *f* of any suitable character. The pipe *n* leads to a convenient distance from the evaporator and delivers into a compartment *c* on one of the side walls *w* of truncated pyramidally-shaped tank T, which tank serves as the sump for an elevator referred to hereinafter. This compartment *c* covers a considerable portion of the surface of the side wall *w* of the tank T and is closed on all sides except the top, at which place the top edge of its inner wall *o* is parallel to the top edge of the wall *w* of the tank but at a lower level so as to provide a dam over which the brine is caused to flow. The space *c* between the walls *o* and *w* is narrow, but the width of this space *c* increases from its point of connection with the pipe *n* up to its open end, at which latter place it is of substantially the full width of the tank, as clearly shown in Fig. 2. In the tank T opposite to the

compartment c and its wall w is a transverse partition p, the upper edge of which is somewhat below the top of the tank, and the bottom edge of which is somewhat above the bottom of the tank. The partition p divides the tank into two compartments c' and c^2, and from the compartment c' a return pipe n' leads back into the evaporator well at e. This pipe n' may have a hand valve f', and also a regulating valve v which may be of a balanced valve type and provided with a float operated lever B which opens and closes the valve according to the level of the brine liquor in the tank T. The elevation and location of the float is such, that it will rest on the surface of the brine while the apparatus is in operation and will close the valve v before the surface of the brine is lowered below the lower and open end of the return pipe n' is reached, and will open the valve wide before the surface of the brine rises to the top of the tank T. As the brine is forced toward the tank T by the pump N and is drawn from the tank T by the vacuum in the evaporator, it is evident that the circulation of the brine will take place through the pipes n and n' in a practically continuous manner and maintain the level of the brine in the tank T substantially constant.

E is a bucket elevator of any suitable construction and extends down into the bottom of the tank T through the compartment c'. The bucket elevator may consist of an endless apron or chain b' provided with a series of buckets b having perforations. The buckets of the elevator travel close to the bottom of the tank T so as to pick up the salt collected therein and elevate it to suitable draining bins or other device for draining the brine from the salt. A pipe s, Fig. 2, may lead down from the drainage bins or other device for discharging the drainage brine water back again into compartment c' and by which it may be returned to the evaporator. The elevator moves its buckets in the direction indicated by the arrows and during the earlier portion of their travel upward, the buckets move through an alley-way or passage g closed on all sides save at the top and bottom, which alley-way extends above the top of the tank T and down as near to the foot of the elevator as practicable and so as to leave just about enough room for the elevator buckets to travel close to the bottom of the tank T.

A brine feed pipe i is arranged to discharge fresh brine liquor to be evaporated into the alley-way g near the top of the brine in the same and by which the salt being elevated is washed approximately clear of impurities that may be associated with it. This washing process is made very effective by the fact that as the buckets of the elevator rise, after leaving the brine, the fresh brine drains from the salt in the buckets, escaping through the perforations therein. The supply of this fresh brine liquor may be controlled by a hand valve h.

My improved process will now be understood, and may be described as follows: The evaporator is charged with brine through pipe m to a level above the upper ends of the tubes t and approximately to the level indicated by the dotted lines. All the valves in the other pipes connecting the evaporator are closed during this operation. The tank T is also filled with brine through the pipe i until it reaches the level indicated by the horizontal dotted line. Steam is then turned into the drum D to heat the tubes t for evaporating the brine, the circulation of the brine taking place upward through the tubes t and downward through the large central down-take C, as indicated by the arrows. In the evaporation which thus takes place, the brine will be concentrated in the upper part of the evaporator, the circulation therein bringing new portions of the brine into contact with the evaporating pipes, and the salt crystals which are suspended in the circulating brine together with the brine in which they are suspended, are led or caused to pass, in the course of the circulation, through the body of brine at the lower part or well of the evaporator in which there is a sufficiently quiescent brine to insure the depositing of the salt therein by gravity. The centrifugal pump N is then started, and the hand valves f and f' are opened so that the well W of the evaporator is in communication with the tank T by the pipes n and n'. The valve f is adjusted to the extent needed to give the desired volume of movement of the brine from the evaporator to the tank T and back through the pipe n' into the evaporator to insure the proper working of the process. In this manner, the salt deposited in the evaporator is transferred in a current of brine from the body of quiescent brine in the evaporator and deposited in a second body of sufficiently quiescent brine separate from the evaporator and its circulating brine to insure the depositing of the salt entirely outside of the evaporator. It is to be assumed that the conditions are such, due to the vacuum in the evaporator, that the brine will flow back into the evaporator from the tank T through the return pipes n' when the valve f' therein is opened. It is also evident that if the tank T is elevated at the proper level, the flow of the brine back into the evaporator would take place by gravity, with or without the assistance of the partial vacuum. It is immaterial whether the brine returns by gravity, or by the partial vacuum, or by both. The vapors from the brine are drawn off from the evaporator through the outlet

O into the condensers S, and after the evaporation has continued for a more or less long time the brine will become concentrated to the crystallizing condition. As soon as the brine reaches this point of saturation, salt crystals which are hereinafter termed "salt" commence and continue to separate from the brine as long as the evaporation from it continues. This salt moving with the circulating brine, being heavier than the brine, will, on leaving the bottom of the down-take C, settle through the brine to the bottom of the well W, from which it passes with the brine which, by the centrifugal pump N, is forced through the pipe n into the compartment c on the tank T, the said travel of the brine and salt through the pipe n having a speed which is regulated by the hand valve f, the said speed being sufficient to keep the salt in circulation with the brine. This brine, moving with the regulated speed sufficient to carry with it the salt, enters the compartment c, rises through the same, and overflows at the top into the compartment c^2 of the tank T, and flows across the surface of the body of the brine in the tank T until it reaches the other side of the partition p, and enters the compartment c', and thence through the return pipe n' back into the evaporator, at e. As the moving brine, after leaving the pipe n, gradually reduces its speed of flow and travels across the compartment c^2 at a comparatively slow speed, the salt which it bears, or the bulk of it, falls by gravity and settles through the comparatively stagnant or quiescent brine between the partitions o and p, which prevent horizontal motion in the compartment c^2 to the bottom or pocket of the tank, indicated at w', whence it is removed by the buckets of the elevator E. It is subsequently delivered into the draining bin or draining device previously referred to (but not shown), and which devices are well known. The brine which goes up the elevator with the salt drains more or less perfectly from the salt and passes back into the tank T by the pipe s.

Aside from the above described process for separating and removing the salt, the process of cleansing it during its removal is accomplished by feeding the fresh brine for use in the system through the pipe i into the alley-way g, and which in descending, washes the salt being carried upward by the buckets b. The brine which flows through the pipe i, being confined in the alley-way g of the elevator, finds access into the tank T near the bottom by passing down through said alley-way in the reverse direction to upward travel of the salt, and from the bottom of the tank rises slowly through the same against the settling salt and joins the current of the impure evaporator brine moving across the surface of the liquid contents of the tank. Both the alley-way g and the lower portion of the tank T are thus kept filled with the fresh brine, and the salt which settles from the upper current of the brine, is washed by the incoming fresh brine first in the tank T and then in the alley-way g, and in its course meets with brine of increasing conditions of purity.

During the operation of the apparatus, the float B operates the balanced valve v in such a manner as to maintain a substantially constant level of brine in the tank T, but as this level can be constantly changed by the addition of fresh brine through the pipe i, it is evident that the level of the brine in the evaporator may be controlled by the hand valve h in the brine pipe i. As contrasted with feeding the fresh brine into the body of the evaporator (as by means of the pipe m and valve r) the feeding of the fresh brine into the passage for the outgoing salt and operating in such manner that the salt as it leaves the system is caused to pass through and washed by the incoming fresh brine, possesses the advantage of yielding a somewhat purer salt, for the reason that salt as it leaves the evaporator is mixed with and is wetted by brine in which impurities, matters other than "salt," have been more or less concentrated by evaporation from the brine, and which, were it not for the washing by the incoming fresh brine, would remain with the salt being elevated and would pass into the bins. This salt moistened with impure brine and then dried would be contaminated. When, however, it is washed by the incoming fresh brine in which the impurities have not been concentrated by evaporation, the salt goes into the bins moistened by this purer brine and consequently it is, to that extent, a purer salt. My improved method of feeding fresh brine to the system also results in an economy of heat, if the fresh brine be of a temperature lower than that of the brine in the pan, or evaporator, because the salt goes away at the temperature of the former instead of at the temperature of the latter. Brine often goes to evaporators at about 60 degrees Fh., while the temperatures in the evaporators vary from, say 110 to 190 degrees Fh., depending upon the extent of vacuum carried in the evaporators.

From the foregoing it is assumed that the relative pressures in the evaporator and in the tank T are such that the brine will, unassisted, flow back through the pipe n' into the evaporator and that assistance such as the pump N is required only to deliver the brine into the tank T. Should the relative conditions be such, however, that the brine would not thus flow back unassisted through the pipe n', then any suitable means, such as the pump, may be employed to assist the return flow to the evaporator.

The tank T and its adjuncts serve as a means for separating the salt from the brine circulating from the evaporator back into itself, and while I have shown means which are excellently adapted for the purpose, any other suitable means for securing the same results may be employed in lieu thereof without departing from the spirit of the invention. It is also apparent that the salt separating device, of which the tank T and elevator E are parts may be located at any distance from the evaporator or in any suitable position as to elevation, so long as there is sufficient motive power provided to deliver the brine through the tank of the separator device, and to insure the return of the brine from the separating device to the evaporator. It is also to be understood that the particular form of the evaporator which I have shown, by way of explanation of my improved process, may be substituted by any other well known form of evaporator.

In this application I do not claim the apparatus shown, as the same is reserved for a separate application.

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

1. The herein described process of manufacturing salt from brine which consists in concentrating in an evaporator a brine circulating in the same and thereby forming salt crystals suspended in the circulating brine and leading the brine in the course of its circulation through a body of sufficiently quiescent brine to insure depositing the salt therein by gravity, then in transferring this deposited salt in a current of brine from the body of quiescent brine in the evaporator to and depositing it in a second body of sufficiently quiescent brine separate from the evaporator and its circulating brine, in returning brine to the evaporator from the second body of quiescent brine, and in removing the deposited salt from the latter continuously as it is deposited.

2. The herein described process of manufacturing salt from brine which consists in concentrating in an evaporator a brine circulating in the same and thereby forming salt crystals suspended in the circulating brine and leading the brine in the course of its circulation through a body of sufficiently quiescent brine to insure depositing the salt therein by gravity, then in transferring this deposited salt in a current of brine from the body of quiescent brine in the evaporator to and depositing it in a second body of sufficiently quiescent brine separate from the evaporator and its circulating brine, in returning brine to the evaporator from the second body of quiescent brine, in removing the deposited salt from the latter, and in passing fresh brine into the brine being returned to the evaporator and at the same time washing the salt during its removal by causing it to pass through the said fresh brine on its way to the evaporator.

3. The herein described process of manufacturing salt from brine which consists in concentrating in an evaporator a brine circulating in the same and thereby forming salt crystals suspended in the circulating brine and leading the brine in the course of its circulation through a body of sufficiently quiescent brine to insure depositing the salt therein by gravity, then in transferring this deposited salt in a current of brine from the body of quiescent brine in the evaporator to and depositing it in a second body of sufficiently quiescent brine separate from the evaporator and its circulating brine, in returning brine to the evaporator from the second body of quiescent brine, in removing the deposited salt from the latter, washing the salt during its removal by causing it to pass directly through a body of fresh brine, and in causing said fresh brine to be subsequently delivered into the evaporator after it has been utilized to wash the salt.

4. The herein described process for the manufacture of salt which consists in concentrating a brine solution in an evaporator, transferring the concentrated brine solution with its suspended salt under a rapid flow into a vessel outside of the evaporator in which a large body of brine is provided and maintained through which the salt is deposited and introducing the concentrated brine into the upper portion of the body of the brine in such manner that the speed of flow of the incoming brine is reduced relatively to its speed of flow in the vessel, returning the brine solution to the evaporator, automatically regulating the discharge of the brine from the vessel in which the salt is deposited to the evaporator under control of the level of the brine in the vessel, and removing the deposited salt from the brine liquor in the vessel at the place of deposit.

5. The herein described process of manufacturing salt from brine which consists in concentrating in an evaporator a brine circulating in the same and thereby forming salt crystals suspended in the circulating brine and leading the brine in the course of its circulation through a body of sufficiently quiescent brine to insure depositing the salt therein by gravity, then in transferring this deposited salt in a current of brine from the body of quiescent brine in the evaporator to and depositing it in a second body of sufficiently quiescent brine separate from the evaporator and its circulating brine, and in removing the deposited salt from the latter continuously as it is deposited.

6. The herein described process for the manufacture of salt which consists in causing the salt from a concentrated brine solution to settle in an evaporator itself, remov-

ing the salt from the evaporator, passing the salt thus removed from the evaporator through fresh brine to wash it of precipitated impurities, and subsequently delivering the fresh brine so employed to the brine circulating in the evaporator.

7. The herein described process for the manufacture of salt which consists in causing brine to be concentrated and the salt crystallized therein to settle in the lower part of the evaporator itself, positively removing the salt associated with concentrated brine from the evaporator in a continuous manner and transferring it to a place entirely outside of the evaporator and there causing a second settling of the salt from the concentrated brine, removing the deposited salt from the brine at the place outside of the evaporator and washing the said separated salt with fresh brine solution, and subsequently conveying said washing brine solution into the evaporator.

8. The herein described process of manufacturing salt from brine which consists in concentrating in an evaporator at a pressure below atmospheric pressure a brine circulating in the same and thereby forming salt crystals suspended in the circulating brine and leading the brine in the course of its circulation through a body of sufficiently quiescent brine to insure depositing the salt therein by gravity, then in transferring this deposited salt in a current of brine from the body of quiescent brine in the evaporator to and depositing it in a second body of sufficiently quiescent brine and existing under atmospheric pressure and separate from the evaporator and its circulating brine, and in removing the deposited salt from the latter.

9. The herein described method of manufacturing salt, which consists in concentrating in an evaporator a brine circulating in the same and thereby forming salt crystals suspended in the circulating brine and leading the brine in the course of its circulation through a body of sufficiently quiescent brine to insure depositing the salt therein by gravity, then transferring this deposited salt in a current of brine from the quiescent brine of the evaporator to a place wholly outside of the evaporator and the zone of evaporation and into a second body of sufficiently quiescent brine separate from the evaporator and its circulating brine and at said second body of quiescent brine causing the circulation therethrough of the suspended salt at a speed greatly reduced over that existing during the transference of the said salt and brine to said second body of quiescent brine to cause the salt to be deposited, and removing the deposited salt from said second body of quiescent brine continuously as it is deposited.

10. The herein described process for the manufacture of salt which consists in concentrating a hot brine solution in an evaporator and causing the salt to settle to its lower part, positively transferring the concentrated brine solution with its suspended salt to a cooler place wholly outside of the evaporator and thereby causing the suspended salt to be deposited by gravity through a quiescent body of brine, returning the brine solution separated from the deposited salt again to the evaporator, mechanically removing the deposited salt from the brine liquor at the place of deposit outside of the evaporator during the circulation of said brine liquor, and supplying additional fresh brine to the circulating brine through the salt being deposited to compensate for that which is eliminated by the evaporation of the water and crystallization of the salt and for washing the salt before its removal.

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

S. MORRIS LILLIE.

Witnesses:
R. M. HUNTER,
R. M. KELLY.