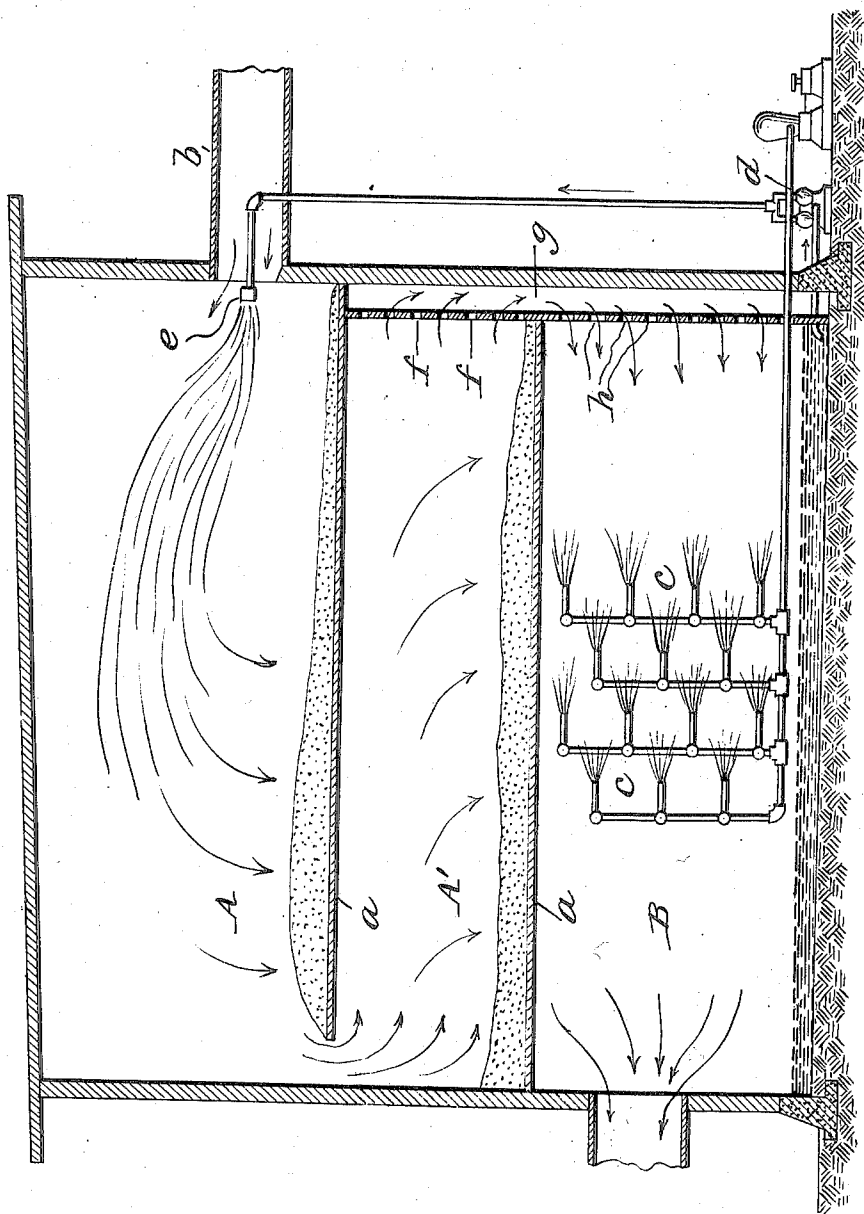


O. CARR.
 METHOD OF AND APPARATUS FOR EVAPORATING LIQUIDS.
 APPLICATION FILED SEPT. 24, 1917.

1,312,019.

Patented Aug. 5, 1919.



Inventor
Oma Carr

By *Davis & Davis*

Attorneys

UNITED STATES PATENT OFFICE.

OMA CARR, OF NEW YORK, N. Y., ASSIGNOR OF ONE-HALF TO EUGENE W. DEMING, OF NEW ORLEANS, LOUISIANA.

METHOD OF AND APPARATUS FOR EVAPORATING LIQUIDS.

1,312,019.

Specification of Letters Patent.

Patented Aug. 5, 1919.

Substitute for application Serial No. 850,413, filed July 11, 1914. This application filed September 24, 1917. Serial No. 192,936.

To all whom it may concern:

Be it known that I, OMA CARR, a citizen of the United States of America, and a resident of New York, county of New York, State of New York, have invented certain new and useful Improvements in Methods of and Apparatus for Evaporating Liquids, of which the following is a full and clear specification.

This application is a substitute for my former application Serial No. 850,413, filed July 11, 1914.

In the art of evaporating, or evaporating and drying, by means of atomized liquid floated in an atmosphere of air or other gas (whereby the moisture is dissolved in the air or other gas), it is necessary in order to obtain the highest efficiency in conjunction with maximum yield of product, that the liquid shall be atomized with a minimum expenditure of energy, and the mixture of air and spray be so controlled that all heat of the air or other gas be used without loss of material by entrainment.

In my invention I reduce to a minimum the energy for atomizing by using atomizers which function through the pressure of the liquid—not, as in most processes of this nature, by compressed air; atomizing by means of compressed air requires approximately 300 cubic feet of free air per minute compressed to 60 pounds pressure per square inch per ton of liquid atomized per hour, or about 1 pound coal for 20 pounds liquid atomized, while by the use of pressure atomizers a result of 1 pound coal to 250 pounds liquid may be obtained. I use, however, atomizers for two distinct purposes to be hereafter considered.

In converting the solids contained in a solution into a powder by flotation in air or other gas, much difficulty is found in entrainment, or escape of dried particles in the effluent air or other gas. I overcome this defect in my invention, and at the same time provide for complete saturation, by moisture, of the air or gas; these two features—prevention of entrainment and complete saturation of air or gas—being linked together and constituting the essence of the invention.

For example, I have a solution containing 5 per cent. of solids, to be brought to powder.

I construct two or more chambers, cross-section and length to be determined by ca-

capacity desired. Into one of these chambers—called drying chambers—I pass heated air or gas, and into such air or gas I atomize a preliminarily concentrated solution of the solids (prepared in the wet chamber hereafter described), proportioning the air and spray to provide the requisite heat, so that when the evaporation in the drying chamber has been completed the drying air or gas still contains heat capacity and absorption capacity. The procedure will be: Into the wet chamber the initial solution will be sprayed, moisture being withdrawn from the liquid and its concentration brought to, say, 50 per cent. solids; the concentrate is withdrawn from the wet chamber and sprayed into the drying chamber. The heating air or gas follows the reverse direction—it is blown first into the drying chamber, in sufficient excess to insure instantaneous drying of the liquid concentrate being atomized therein; the mixture of air and floating powder is passed through the settling chamber, properly diffused to secure low velocity, where the powder particles settle; the air effluent from the settling chamber enters the wet chamber, where it meets the spray of initial liquid and is saturated with moisture before becoming effluent, any fine powder particles entraining into the wet chamber being scrubbed out and retained in the concentrated liquid.

It will be observed that, for 100 pounds of the initial liquid, a total of 95 pounds water must be evaporated; of this 5 pounds is done in the drying chamber and 90 pounds in the wet chamber—whereby it becomes possible to use in the drying chamber (90÷5) 18 times the poundage of air or gas actually necessary to evaporate the moisture atomized into drying chamber. The important result following this condition is that a much larger liquid particle may be sprayed into the drying chamber (owing to the large excess of drying capacity there), a much larger dry particle secured, and therefore practically no entrainment of powder out of the settling chamber—the larger and heavier the dry particle, the more perfect its subsidence in the air velocity employed. The powder particles made in my drying plants (which I am building to do as much as 100 tons of powder in 24 hours) are often $\frac{3}{2}$ of an inch in diameter, and readily settle out of air velocity equal to 10 feet per second.

A conventional arrangement for carrying out my method is shown in the accompanying diagram. It shows a rectangular building with a ground floor, two additional floors, *a a* and a roof. The upper chamber A so made (often 20 feet high, 40 feet wide and 100 feet long) is the drying chamber; the next chamber below is the settling chamber A', of proper height to secure desirable air velocity through it; the lower chamber B is the wet chamber, also of suitable height for the air velocity wanted. For some purposes it is sufficient to use two chambers only, combining the drying and settling chambers into one chamber, since the settling chamber is virtually a part or continuation of the drying chamber.

The drying air passes into the drying chamber through a supply conduit *b*, thence through the settling chamber into the wet chamber. The initial liquid is sprayed into the wet chamber through a series of nozzles *c*, the concentrate collected on the floor thereof and pumped thence by a pump *d* through the atomizer *e* into the dry chamber. The powder is suitably collected mainly on the floor of the compartment A' as it settles from the air and is withdrawn by suitable conveyers or otherwise. The partly saturated air exits from the settling chamber A' through perforations *f* in the rear wall thereof, thence down the conduit *g* and into the wet chamber B through the perforations *h* in the front wall thereof.

It is thus seen that the drying air is twice used—once in the drying chamber, then in the wet chamber; the wet chamber is kept filled with spray of the initial liquid, and the air effluent therefrom is, in practice, fully saturated and its entire drying capacity utilized. At the same time, the presence in the drying chamber of a large excess of drying air permits the use of a large spray particle, the production of a large dry particle and perfect collection of the powder from the air currents; while the passage of the air effluent from the settling chamber into the wet chamber insures the recovery, by the wet chamber sprays, of any powder entrained by the currents out of the settling chamber.

The atomizers in the wet chamber may be operated at low pressure (20 pounds per square inch being ample), forming a coarse mist filling the chamber, the power for operating these atomizers being small. The atomizers in the drying chamber operate at a higher pressure (500 to 2000 pounds per square inch, depending upon liquid and product desired), but the weight of concentrate to be pumped is much less than the total weight of initial liquid, and the power account is small.

The chambers may be of any desired form, and may be disposed as desired, so long

as the succession of conditions is obtained. The drying air or other gas may be obtained from any source.

It must be understood that I do not employ whirling or rotating air currents for separation of the dried particles as in many apparatuses, for similar purposes, which involve so-called centrifugal separators. On the contrary, I specially avoid such currents. I employ at the ends of the chambers checker-walls, or perforated partitions, the function of which (by graduation of the perforations) is to diffuse the air uniformly over the cross-section of the chamber and thus secure a velocity at which the dried particles will settle to the floor. I am able, by this means, and by the concurrent use of a strong excess of drying air or other gas in the drying chamber to insure the production of a large particle and also to collect practically the entire poundage of solids in the solution being dried. For the immense air volumes required when drying a large daily tonnage, I have found the centrifugal separator wholly inadmissible, as its magnitude becomes prohibitive. This also applies to conditions in the wet chamber B, where, in order to obtain full evaporative use of the air, the latter must be diffused into low velocity and thoroughly scrubbed by the liquid—to efficiently scrub the immense volume of air issuing from the effluent duct of a centrifugal separator, at very high velocity, requires enormous pumpage of the scrubbing liquid. It is, therefore, a specific feature of my invention that the drying air or other gas shall, after the reaction between air and pray in the drying chamber, be diffused to a uniform velocity suitable for separation of the particles; and in the wet chamber a similar diffusion to permit thorough scrubbing of the air entering the wet chamber.

I claim—

1. A method of drying which comprises continuously removing moisture from sprayed liquid concentrate carrying the solids to be recovered by a current of gas much greater in volume than is sufficient to remove the moisture contained in said concentrate and which current moves at a low velocity uniformly over the cross-section of the drying chamber, settling the dry particles from the current of gas so controlled, thereafter causing the partly saturated gas to pass at low velocity uniformly over the cross-section of another wet chamber in which a more dilute solution of the substance to be dried is sprayed to fully saturate said gas, to thereby not only collect the entrained dry particles carried into said wet chamber by said gas but also to utilize the surplus moisture-absorbing capacity of the gas to preliminarily concentrate said more dilute solution, the

proportions of gas and liquid being such that the greater part of the water is removed in said wet chamber.

2. The method herein described of evaporating liquid substances consisting (1) in continuously passing drying-gas through a drying chamber and a wet chamber in succession, (2) preliminarily spraying said liquid in the wet chamber in proportions that will remove the greater part of its contained water and (3) continuously withdrawing the concentrate thus produced from said wet chamber and continuously subjecting it to a final evaporation by spraying in the drying chamber, (4) the proportions of drying air and concentrate in the drying chamber being such that there shall always be a great excess of drying air in said first chamber, for the purpose set forth.

3. In an apparatus of the class set forth, a lower wet chamber into which extends a spraying apparatus and which has its front wall perforated, an upper drying chamber divided horizontally into an upper commingling chamber and a lower settling chamber, the front wall of the latter being perforated and a flue being provided at the front end of the apparatus for conveying the partly-saturated gas from the settling chamber into the wet chamber, and means for atomizing the concentrate formed in the wet chamber in the commingling compartment and for simultaneously introducing heated gas into said commingling compartment.

4. In an apparatus of the class set forth, a lower wet chamber into which extends a spraying apparatus and which has its front wall perforated, an upper drying chamber divided horizontally into an upper commingling chamber and a lower settling chamber, the front wall of the latter being perforated and a flue being provided at the front end of the apparatus for conveying the partly-saturated gas from the settling chamber into the wet chamber, and means for atomizing the concentrate formed in the wet chamber in the commingling compartment and for simultaneously introducing heated gas into said commingling compartment, said commingling compartment being provided at its exit end with a perforated wall to insure uniform flow.

5. In an apparatus of the class set forth, a wet chamber and means for spraying the liquid to be evaporated therein, said wet chamber being provided with a perforated wall opposite its exit end, a drying chamber provided with a perforated wall at its exit end, a flue connecting the chambers behind said perforated walls so as to direct the partly-saturated gas from the drying chamber into the wet chamber, means for spraying the concentrate from the wet chamber into the drying chamber, and means for introducing a continuous stream of hot gas into the drying chamber.

In testimony whereof I hereunto affix my signature.

OMA CARR.