June 6, 1950 S. L. BAKER ET AL 2,510,057

EVAPORATOR

Filed April 24, 1944

Fig. 1.

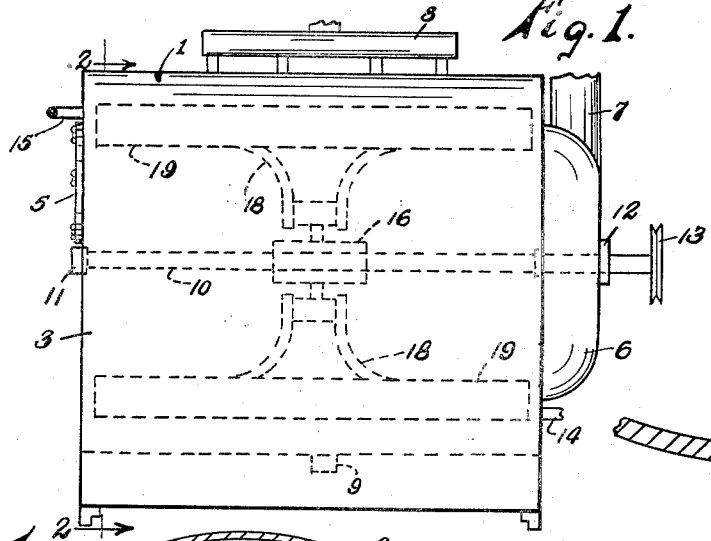


Fig. 4.

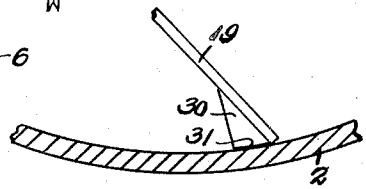
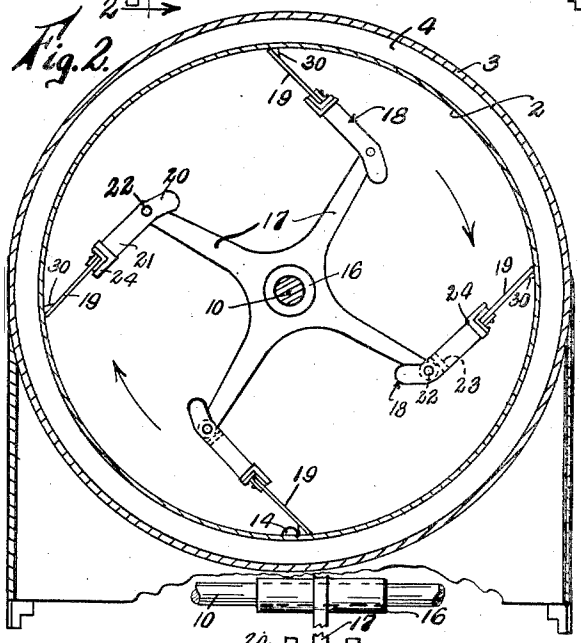


Fig. 2.



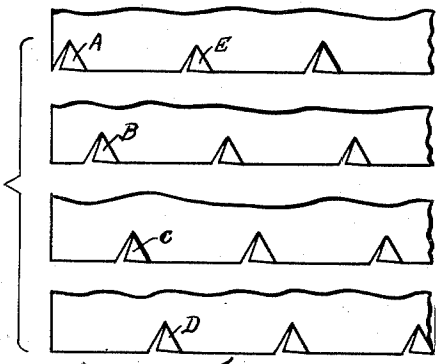
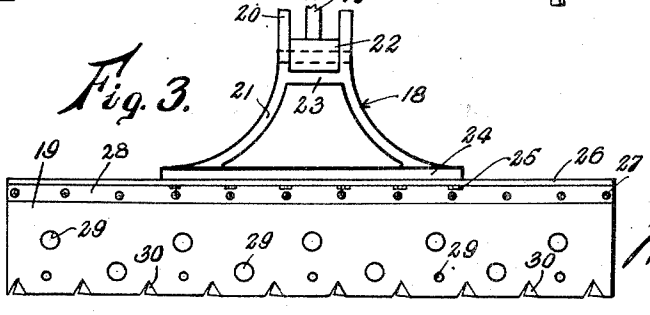


Fig. 5.

Fig. 3.



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EVAPORATOR

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Application April 24, 1944, Serial No. 532,554

5 Claims. (Cl. 159—12)

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This invention relates to an evaporator for semi-liquid or plastic materials, or liquids with suspended solids.

An object of the invention is to provide an evaporator of the "flash" type adapted to reduce the moisture content of such materials in a minimum of time.

Another object is to provide such a device in which, during the evaporation period, the material is simultaneously moved from a point of introduction to a point of withdrawal.

Another object is to provide an evaporator of this kind in which the material is alternately spread and actuated or worked on a drying surface.

Another object is the provision of a novel form of blade for such an evaporator.

Another object is to provide an evaporator of the kind described which is simple and efficient in construction and in use.

The concentration by evaporation of various fluid materials containing suspended solids, such as brewer's slurry, is attended by serious practical difficulties which are aggravated as the material approaches a semi-liquid state of concentration. For rapid and effective evaporation it is desirable to spread the material in a relatively thin film on a heated evaporating surface. However, if the solids in such a film are allowed to remain stationary in contact with the hot surface they will stick to and harden upon it within a matter of seconds and an accumulation of adherent material will build up. The efficiency of the apparatus then progressively decreases as the evaporation process goes on, and it is necessary to stop the operation and clean the evaporating surface at frequent intervals. Also the adherent material tends to scorch or burn, increasing the difficulty of cleaning and deleteriously affecting the finished product into which some of the scorched material finds its way. On the other hand, the adherent material removed during cleaning represents a substantial loss in yield of the process. Hence it is necessary to maintain the film in continuous and rapid movement and to keep the evaporating surface scraped or wiped clean of adherent material, while at the same time the speed of travel of the film through the evaporating apparatus must be slow enough to permit the desired evaporating effect to be obtained. Various forms of apparatus have been proposed for such purposes but without solving the above problems satisfactorily.

According to the present invention, a blade is moved over the hot evaporating surface in a direction transverse to its length, the lower edge of the blade being interrupted at spaced points to provide a series of straight edges which advance the material in the direction of movement of the blade and scrape the heating surface clear of adherent material in their paths. At one end of each straight blade section, a plow-like projection extends forwardly and outwardly away from the blade section with a forward working face inclined transversely to the direction of blade movement and preferably inclined also to the vertical after the manner of a plow and its moldboard. These plow projections substantially span the gaps between the adjacent straight sections of the interrupted blade edge and not only scrape the material from the surface in the paths of these gaps but also lift and turn it over in front of the adjoining blade sections. The material is thus caused to move transversely across each advancing blade section to the other end where it passes behind the plow of the next section and hence through the intervening gap or opening between the sections, tending to spread out again on the evaporating surface behind the blade. A plurality of such blades follow one another in succession over the evaporating surface with their plows and intervening blade sections arranged as hereinafter described so that the entire surface is scraped and the material is kept in rapid and continuous movement and also is overturned and agitated while it is advanced both in the direction of movement of the blades and transversely thereto.

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By way of example an embodiment of the invention is described herein and illustrated in the accompanying drawings, in which:

Fig. 1 is a side elevational view of the evaporator.

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

Fig. 3 is a plan view of one of the arms and blades of the evaporator.

Fig. 4 is a detail view of the edge portion of one of the blades and the adjacent part of the heating chamber wall.

Fig. 5 is a schematic view illustrating the relative positions of the edge projections on successive blades.

In greater detail, and with reference to the drawings, the evaporator preferably comprises a cylindrical chamber having a heated internal working surface which may be provided by a housing 1 made up of an inner cylindrical wall 2 and an outer jacket 3 spaced therefrom and forming a steam jacket or chamber 4. The housing 1 is suitably closed at the ends, one end being provided with an access door 5 and the other end being formed or flared outwardly at 6 and provided with a flue 7 for vapors evolved during the evaporation process. The outer wall or jacket 3 at the top may have a steam injection manifold 8 associated therewith and at the bottom a condensate outlet 9.

In the case of a cylindrical evaporator, the blades mentioned above form a sort of paddle

wheel or the like which may be rotated in any suitable manner. In the form shown, the wheel is carried by a drive shaft 10 extending centrally through the heating chamber 2 and rotatably mounted at the ends in bearings 11 and 12. On the latter end of the shaft, exteriorly of the housing, a suitable drive pulley 13 or similar means may be provided.

At the bottom of the heating chamber 2 at one end is an inlet 14 for the material to be operated upon. A tangential outlet 15 for the material is provided at the opposite end of the chamber, preferably at the top.

Inside the heating chamber, the spreader-carrier wheel or paddle is fixedly mounted on the shaft 10 (Figs. 2 and 3). This wheel, in the form illustrated, comprises a hub 16 fixed on the shaft 10 and provided with four equi-distant spoke members 17 each of which carries a bifurcated support 18 for a blade 19. Each support 18 comprises an upper section 20 and a lower section 21 disposed at an angle thereto. At substantially the apex of this angle, the support 18 is pivotally mounted at 22 on the spoke member 17. Just beyond this pivotal mounting a cross bar 23 extends between the arms of the bifurcated support 18 and limits inward pivotal movement of the paddle arm as a whole relative to its associated spoke member 17, in the manner seen in Fig. 2.

At the outer end of the supporting frame 18, an angle bracket 24 has secured thereto at 25 a longer angle strip 26 to which the plate 19 is secured at 27. A brace strip 28 may be utilized along the top edge of the blade for further securing the latter in position.

The blades 19 may be formed of relatively flexible metal or other material, the flexibility of which may be increased by perforating the same as indicated at 29 at suitable intervals. The outer edge of each blade 19 has a series of spaced projections 30 extending ahead of the blade in the direction of blade movement and also at an angle to said direction. These projections may be made integral with or attached to the blade in any desired manner. They are conveniently formed by cutting the edge portion of the blade at an angle and bending out small triangular sections of the blade edge as shown in Figs. 4 and 5. The lower edges 31 of these projections extend transversely across the direction of blade movement and substantially span the gaps in the interrupted lower edge of the blade 19. The forward working faces of the projections are inclined both transversely to the direction of movement and to the vertical in the manner of a plow and its moldboard. Preferably the lower edges 31 of the projections, as seen in Fig. 4, are formed or cut arcuately to conform to the arc or curvature of the heated surface 2.

Preferably and as shown in Fig. 5, all of the plows are arranged to turn the material over to the same side, i. e., toward the side of the outlet 39. Also the spacing between each two adjacent projections, i. e., the length of each straight blade section, is the same along all the blade edges and is several times as great as the gaps between the sections, but the series of projections on the second blade is off-set to the right relative to the series of projections of the first blade and so on. Thus the material streaming back through a gap of one blade spreads out in front of a straight blade section of the succeeding blade. Moreover, the amount of the off-set is such that the parallel tracks of each two successive projections such as A and B are practically contiguous, and the same relationship exists between projections D and E, etc., so that when considered collectively the projections alone scrape over substantially the entire area of the heated evaporating surface. This is desirable because of the plowing, overturning and lateral feeding action of the plow projections as distinguished from the straight wiping or scraping action of the intervening blade sections. In a cylindrical evaporator such as described above, the successive plow projections form a continuous spiral or helix around the periphery of the paddle wheel.

In operation, power is suitably applied to the drive pulley 13 for rotating the wheel or paddle in a clockwise direction as indicated by the arrows in Fig. 2. Centrifugal force causes the arm and blade assemblies to swing outwardly around their pivots 22 and maintains the blades in contact with the evaporating surface, the pressure of the blades against the heating surface being, however, reduced by the counterbalancing effect of the arms 20. The semi-liquid material to be operated upon is introduced through the inlet 14 and is spread over the heated surface of the cylindrical chamber 2 where it is kept in continuous and rapid movement and at the same time advanced both circumferentially and axially by the blades. More specifically, the action is as follows: Projection A (Fig. 5) scrapes up the material in its path and turns it over to the right in front of the adjacent section of the first blade. The material in this "furrow" being fluid, it tends to flatten and spread out further to the right, and this tendency is supplemented positively by the advancing blade section which immediately wipes out the "furrow" and causes the fluid material to spread out and flow to the right. Should the material pile up in front of the advancing blade section, it can also pass through the openings 29. Both lateral and circumferential displacement of the material take place in the above action.

As the material reaches the right hand end of the blade section, it passes behind the plow E and thus into and through the gap or opening between the blade sections and then spreads out again behind the first blade. Plow B of the second blade, which is offset to the right relative to plow A, then turns the material over to the right again in front of the adjacent advancing blade section with further spreading and circumferential and lateral displacement as described above. The same actions take place with projections C and D of the third and fourth blades, then with projection E of the first blade, and so on. Thus the material is carried through the chamber in a generally spiral path until it is removed at the outlet 15. In this way the material is spread in a thin layer on the heated surface for efficiently evaporating moisture therefrom, but is kept in rapid and continuous movement and by virtue of the projections 30 is not permitted to remain spread in one position for a period of time sufficient to harden or otherwise injuriously affect the material or the equipment, the material being constantly plowed up and turned over during its passage through the chamber.

Inasmuch as the arms or frame members 18 are pivotally mounted, the blades are maintained in contact with the heated surface of the chamber by centrifugal action. The construction likewise precludes undue frictional contact between the blades and the heated surface. At the same

time it makes possible the evaporation of the material in very thin layers about one-sixteenth ($\frac{1}{16}$) of an inch thick during the operating period when material is being fed into the evaporator. When operation is stopped, the final rotations of the paddle serve to thoroughly clean the surface over which the blades pass. The speed of rotation of the paddle may be varied in accordance with the character of the material being operated upon.

Variations will suggest themselves upon consideration of the means herein described, but these are within the spirit and scope of the invention and reference should be had to the appended claims for a definition of the invention.

What is claimed is:

1. In an evaporator of the type wherein the material to be evaporated is spread in a film and moved over a heated surface, the combination therewith of means for spreading and moving the material comprising a blade movable over said surface in a direction transverse to its length and having gaps in its lower edge forming a plurality of spaced blade portions projections extending forwardly from the blade between said blade portions, the working faces of said projections being inclined transversely to the direction of movement and the lower edges thereof together with the lower edges of said portions engaging the material on said surface, the forward working faces of the projections substantially spanning the gaps between adjacent blade portions so that the combined forward faces of said projections and portions are substantially continuous from end to end of the blade while said material can move transversely into the spaces behind the projections and through said gaps.

2. In an evaporator of the type wherein the material to be evaporated is spread in a film and moved over a heated surface, the combination therewith of means for spreading and moving the material comprising a blade movable over said surface in a direction transverse to its length, longitudinally spaced sections of the lower edge of said blade being bent forwardly from its plane on inclined bend lines to provide plow-like forward working faces that are inclined to the vertical and also extend transversely relative to the direction of movement and across the gaps between the blade portions to which they are joined at said bend lines and the adjacent portions of the blade, the lower edges of each projection and its adjoining blade portion forming a continuous working edge engaging the material on said surface.

3. In an evaporator of the type wherein the material to be evaporated is spread in a film and moved over a heated surface, the combination therewith of means for spreading and moving the material comprising a plurality of blades movable one after another over said surface in a direction transverse to their lengths and each having gaps in its lower edge forming a plurality of spaced blade portions, a projection extending forwardly from one end of each blade portion and transversely across the adjacent gap, the forward working faces of said projections being all inclined in the same direction transverse to the direction of movement and the lower edges of each working face and its adjacent blade portion being substantially continuous, whereby material scraped from the surface by said projections is turned over plow-like to the same side in front of the adjacent blade portions, the projections of each blade being off-set toward said same side relative to the projections of the preceding blade and the combined working edges of said projections scraping substantially the entire heated surface.

4. In an evaporator of the type wherein the material to be evaporated is spread in a film and moved over a heated substantially cylindrical surface, the combination therewith of means for spreading and moving the material comprising a blade extending in a direction parallel to the cylinder axis and movable circumferentially over the surface with its lower edge parallel thereto and engaging said material thereon, said lower edge having longitudinally spaced gaps therein, and projections extending forwardly from the blade at an angle transverse to its direction of movement, one such projection extending forwardly from one side of each gap in the interrupted blade edge and substantially spanning the gap, the lower edges of said projections being curved to conform to said surface and engaging and scraping said surface whereby material thereon is turned over in front of the advancing sections of the lower blade edge.

5. In an evaporator of the type wherein the material to be evaporated is spread in a film and moved over the heated surface of a cylindrical chamber in a direction parallel to the axis thereof, the combination therewith of a carrier mounted coaxially within the chamber for rotation, longitudinally extending blades for the carrier and each having a working edge cooperating with said surface and formed by a number of longitudinally spaced, spreader portions having edges parallel to said surface and plow-shaped members formed between adjacent portions and projecting ahead of the blade at an angle transverse to the direction of rotation, the working edges of said member being curved to conform to the cylindrical surface of the working chamber, said members being each adapted to turn over and mix the material and also advancing said mixed material into the path of an adjacent spreader portion, the members of each blade being offset in the same longitudinal direction with respect to the members of the preceding blade and the combined working edges of said members traversing substantially the entire cylindrical surface of the chamber as said carrier rotates.

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