April 5, 1949. W. V. MORTON 2,466,259

CONTINUOUS DIFFUSION UNIT

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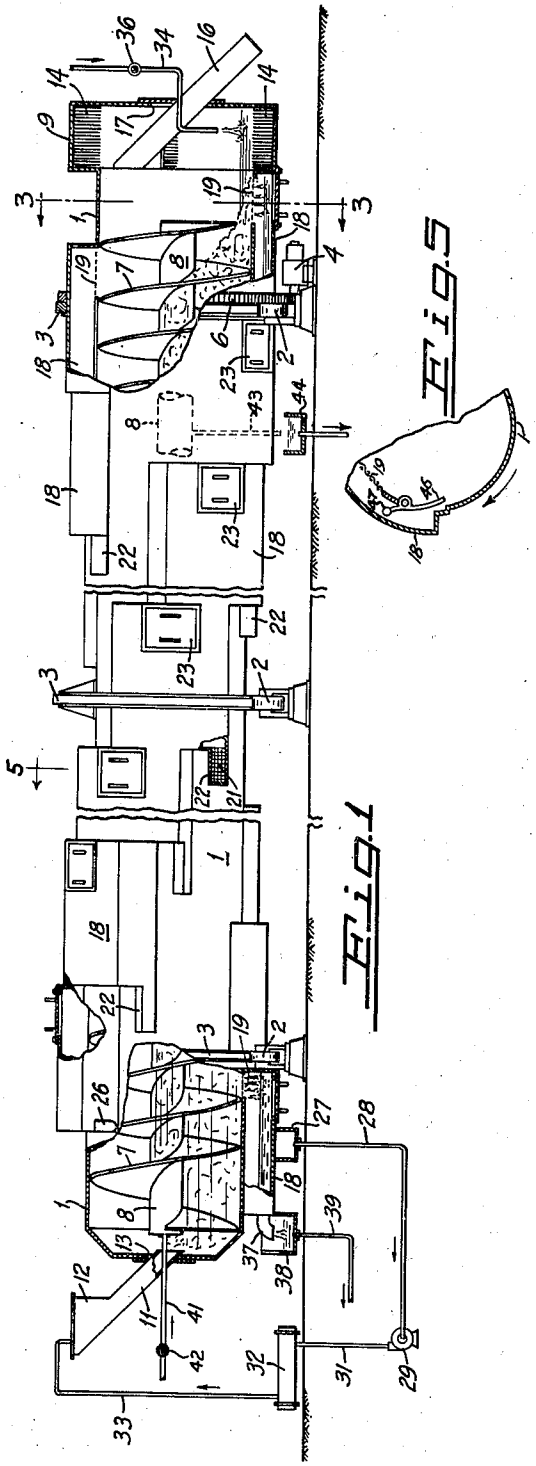


Fig. 1

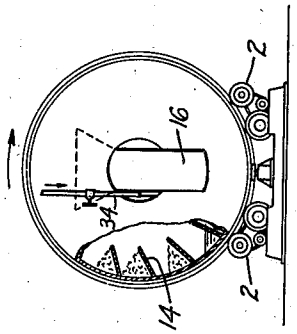


Fig. 4

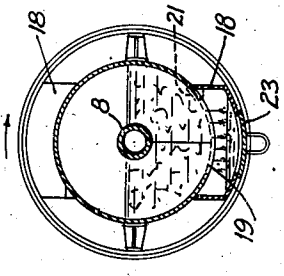


Fig. 3

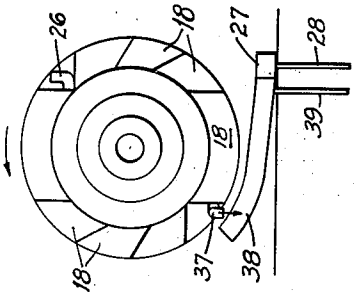


Fig. 2

Fig. 5

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CONTINUOUS DIFFUSION UNIT

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13 Claims. (Cl. 127—7)

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My invention relates to diffusion units for the lixiviation of solid materials such as cossettes.

It is among the objects of my invention to provide a method of and apparatus for continuously lixiviating solid materials, such as cossettes, wherein solid material is moved continuously in one direction through the apparatus and solvent is moved step by step through the apparatus in the opposite direction, for removing soluble material from the solid material.

Another object is to provide a method and apparatus wherein separate unitary volumes of solids, such as cossettes, are subjected to the action of a succession of unitary volumes of solvent, the identity of the unitary volumes of solids and solvent being preserved during successive steps of the treatment.

A further object is to effect a substantially complete removal of soluble material from bulk solid material, and to obtain a relatively high concentration of the soluble material in a solvent for expediting the recovery and refiining of the soluble material.

It is also an object of my invention to facilitate the continuous supply, mixing, and subsequent separation of solids and solvent in a lixiviation process.

My invention possesses other objects and features of value, some of which with the foregoing will be set forth in the following description of the invention. It is to be understood that I do not limit myself to the showing made by the said description and the drawings as I may adopt variant forms of the invention within the scope of the appended claims.

In the drawings:

Figure 1 is a side elevation of a diffusion unit embodying my invention, parts being broken away, and parts being shown in longitudinal, vertical section.

Figure 2 is a front end elevation of the drum shown in Figure 1.

Figure 3 is a transverse sectional view taken upon the line 3—3 of Figure 1 in the direction indicated; and

Figure 4 is a rear end elevation of the drum, parts being broken away and shown in section.

Figure 5 is a fragmental sectional detail of a portion of the drum and a transfer chamber illustrating the mounting of a pivoted gate for returning pulp to the drum.

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In terms of broad inclusion the diffusion unit and method of my invention comprises a drum provided with means for moving a continuous succession of unitary volumes of solid materials, such as cossettes, separately through the drum in one direction. The unit is also provided with means for directing unitary volumes of water, or other solvent liquid, successively through the units of solid material, the units of liquid being moved step by step along the drum in the direction opposite the direction of movement of the solids, for effecting continuous lixiviation of the solid material as it is advanced through the drum. My invention also contemplates the provision of means for separating the spent solids from incoming liquid; and for heating and directing liquid from the drum onto fresh incoming solids for increasing the concentration of soluble solids in the liquid.

In terms of greater detail, the apparatus of my invention comprises a drum designated in general by the numeral 1. The drum is supported in substantially horizontal position upon rollers 2 engaging riding rings 3 upon the outer surface of the drum. The drum is rotated about its longitudinal axis by suitable driving means, as for example a motor 4 geared to a ring gear 6 carried by the drum.

A spiral baffle 7 extends from substantially one end of the drum to the other, and forms a plurality of compartments therealong. The outer edge of the baffle is secured in sealing engagement with the inner surface of the drum, and the inner edge of the baffle is secured to a tubular shaft 8 coaxially disposed within the drum. The flights of the spiral baffle are preferably uniformly spaced in helical form, except the first which is preferably elongated to give increased volume to the compartment at the head or supply end of the drum. At its outlet or delivery end, the drum 1 is provided with an enlarged portion 9 spaced from the adjacent end of the baffle 7, and forming an enlarged chamber at the end of the drum.

A supply chute 11 extends from a hopper 12 into the supply end of the drum 1 through an opening 13 for supplying solid materials, such as cossettes, into the drum for lixiviation. Unitary volumes of the solid material are separately ad-

vanced through the drum by the successive flights of the baffle which operate as an Archimedes screw for feeding the material through the drum. The identity of each unitary volume of solid material is preserved during movement along the drum, and the particles of one unitary volume are not mixed with the particles of the volumes which precede or succeed it.

A plurality of combs 14 are mounted in inwardly extending circumferentially spaced relation within the enlarged portion 9 of the drum. The combs preferably extend longitudinally across the width of the enlarged portion 9, and are preferably radially disposed. A chute 16 is mounted within the enlarged portion 9 of the drum, and extends outwardly therefrom through an opening 17 for delivering solid material from the drum.

A plurality of transfer chambers 18 are mounted in longitudinally and circumferentially spaced relation along the drum. Each chamber 18 communicates with the compartment between two adjacent flights of the baffle 7 through a screened opening 19, and with the compartment between another two flights of the baffle 7 nearer the head or supply end of the drum 1 through another screened opening 21. The openings 19 and 21 of each transfer chamber 18 are spaced longitudinally of the drum to conduct liquid drained through the opening past two or more flights of the baffle 7 before the liquid is returned into the drum through the opening 21. The openings 21 are preferably positioned within extensions 22 formed on each chamber 18, and are spaced circumferentially from the openings 21 sufficiently to permit the drainage to flow along an extension 22 and into the drum after the companion opening 19 has moved to a point above the then prevailing level of liquid in the drained compartment. Preferably the openings 19 are relatively wide so that a substantial area is provided through which the solvent may drain, and to permit drainage for a substantial portion of each rotation of the drum. The openings 21 may be relatively small. In the preferred structure illustrated in the drawings, the opening 21 is centered upon a radius about 45° behind the radius on which the opening 19 is centered, with the leading edge of the opening 21 spaced slightly behind the trailing edge of the opening 19, so that substantially all the liquid may be drained and transferred from the various spaces or compartments between the flights of the spiral baffle.

The transfer chambers 18 are spaced longitudinally and circumferentially along the drum to cause liquid delivered into the various compartments to be retained and mixed with the solids therein for a suitable period before the liquid is drained away and transferred to a succeeding compartment. For example, the transfer chambers may advantageously be arranged in two rows spirally disposed along the drum. The chambers 18 of each row are positioned end to end along the length of the drum, and are circumferentially spaced progressively about 30° apart.

The chambers 18 of the second row are spaced circumferentially about 180° from the corresponding chambers of the first row; and are spaced longitudinally therefrom a distance substantially equal to the pitch of the baffle 7. As illustrated, the length of the chambers is sufficient to span three compartments between adjacent flights of the baffle; and the extension 22 extends over and opens into the next succeeding compartment in the space afforded by the 30° offset of the adjacent chamber.

Openings are formed in the outer walls of the chambers 18 opposite the screened openings 19, and are covered by manhole covers 23 normally secured in sealing position over the openings. The covers 23 are removable to give access to the screens mounted in connection with the openings 19 to facilitate cleaning, repair, and replacement of the screens.

One of the transfer chambers 18 nearest the supply end of the drum 1, differs from the other transfer chambers 18 in its row in that it is provided with a liquid delivery spout 26 instead of a screened opening 21 for returning liquid to the drum. The spout 26 is aligned with a trough 27 into which liquid from the last transfer chamber is delivered as the spout is carried through the trough by rotation of the drum.

The trough 27 is provided with an outlet connection 28 connected to a pump 29, which is operated to force the liquid through a connection 31 to a heater 32 and thence through a connection 33 into the hopper 12. The heated liquid is mixed with an appropriate amount of fresh solid material supplied into the hopper 12, and the liquid and solid materials are delivered together into the supply end of the drum through the chute 11. The first two flights of the spiral baffle 7 are spaced substantially farther apart than the succeeding flights so that the water level may be kept below the level of the opening 13. Between subsequent flights of the baffle 7 the same volume will be compressed laterally to maintain a higher working level.

Fresh water, or other solvent, is supplied at the delivery end of the drum 1 through a conduit 34. A valve 36 is provided for regulating the supply of solvent to the drum through the conduit 34.

The diffusion unit of my invention is especially useful for the lixiviation of cossettes, for extracting the sugar content therefrom. In that connection, the operation is as follows:

A continuous supply of the fresh cossette material is fed into the supply end of the drum at a rate such as to cause unitary volumes of cossettes of appropriate size to be picked up and advanced through the drum 1 between adjacent flights of the baffle 7 as the drum is rotated. At the same time, water is supplied through the connection 34 at a rate regulated to maintain a substantially constant working level within the drum. Unitary volumes of water are moved step by step along the drum by means of the transfer chambers 18. In normal operations, the unitary volumes of cossettes advanced along the drum in one direction are subjected successively to lixiviation by successive volumes of water moved along the drum in the opposite direction.

As each unitary volume of cossettes reaches the delivery end of the drum 1 it is flooded with fresh incoming water from the connection 34 and is mixed therewith during about one full revolution of the drum. The fresh water dissolves substantially all sugar then remaining undissolved in the cossettes; and the pulp is washed into the enlarged portion 9. The pulp is picked up by the combs 14 and delivered thereby into the chute 16 through which it passes out of the drum.

As the opening 19 of the transfer chamber 18 nearest the delivery end of the drum approaches its lowermost position, as shown in Figure 1, water is drained off from the cossettes into the chamber 18. As the rotation of the drum 1 con-

tinues, the water flows through the extension 22 and the screened opening 21 into the compartment third from the delivery end of the drum, and is mixed with the unitary volume of cossettes contained therein. The cossettes are subjected to the action of the water during about one and one-half revolutions of the drum. The opening 19 of the next transfer chamber then reaches a position for draining the water off from the cossettes and delivering it into another compartment, at least three flights nearer the supply end of the drum, and from which liquid has just previously been drained through a chamber of the opposite row to a compartment still nearer the head end of the drum. In this manner, liquid is moved alternately two steps toward the head end of the drum and one step back toward the delivery end for lixiviating the cossettes in the compartments through which the water is successively passed while the cossettes are being moved continuously toward the delivery end of the drum.

At each step, the amount of sugar carried by the cossettes is reduced, and the concentration of dissolved sugar carried by the water is increased. The length of the drum and the number of unitary volumes of water through which the unitary volumes of cossettes are passed is sufficient to effect a substantially complete removal of the sugar from the cossettes as they reach the delivery end of the drum 1, and to effect complete diffusion of the extracted sugar in the water.

In order to increase the concentration of sugar in the solution, the liquid from the last transfer chamber 18 of one of the rows of transfer chambers, is delivered into the trough 27; and then is pumped through the heater 32 and into the hopper 12. The heated solution is mixed with the incoming cossettes in the head end of the drum during two full revolutions of the drum, and is then drained into the last transfer chamber of the other row, as indicated at the left-hand end of Figure 1. The solution then flows through a spout 37 into a trough 38 from which it is conducted by a conduit 39 to a desired point for storage or further treatment for recovering the sugar.

Preferably steam is introduced into the tubular shaft 8 by means of a supply line 41 having a control valve 42. The steam maintains the cossettes and water in a heated condition, and aids in effecting extraction of the sugar from the cossettes. Condensation from the steam is drained away through a pipe 43 emptying into a trough 44 at a point near the delivery end of the drum.

In order to prevent an accumulation of fine particles of pulp in the transfer chambers 18, such as may wash through the screen covering the openings 19, a gate 46 is pivoted adjacent the trailing edge of the screen to cover a portion of each opening 19. The gate 46 is pivoted at a point such that it is moved by gravity to a closed position, as its transfer chamber is moved downwardly to a position in which the water will drain through the screened opening 19 into the transfer chamber; and to swing open as the chamber is moved upwardly at the opposite side of the drum. The bulk of the water with its dissolved sugar flows through the extension 22 and is returned to the drum through opening 21. However, enough water remains trapped in the transfer chamber to wash collected pulp back into the drum past the gate 46 as the gate swings

open. Preferably a counterbalance 47 is carried by the gate to aid the free swinging movement of the gate between its open and closed positions. The gate 46 may be applied to the screened opening 21 instead of the screened opening 19, if desired.

While the method and apparatus has been described primarily as applied to the lixiviation of cossettes for removing the sugar content, both are equally useful for removing any soluble material from bulk solids by an appropriate solvent.

I claim:

1. A diffusion unit comprising a rotatable drum, means for moving solid material through the drum in one direction, and transfer chambers upon the outer surface of the drum having inlets and outlets spaced axially and circumferentially of the drum, the inlets and outlets of each chamber communicating with spaced sections within the drum for moving liquid step by step through successive sections of the drum in the opposite direction for lixiviating the solid material.

2. A diffusion unit comprising a rotatable drum, a spiral baffle within the drum for moving solid material through the drum in one direction, and transfer chambers upon the outer surface of the drum communicating with spaced sections within the drum having inlets and outlets spaced axially and circumferentially of the drum, the inlets and outlets of each chamber for moving liquid step by step through successive sections of the drum in the opposite direction for lixiviating the solid material.

3. A diffusion unit for lixiviating solid materials comprising a drum, means for rotating the drum about its longitudinal axis, a spiral baffle extending substantially from end to end of the drum for dividing the drum into compartments and for moving separate unitary volumes of solid materials through the drum from the supply end to the delivery end thereof in unmixed condition as the drum is rotated, and transfer chambers longitudinally and circumferentially spaced upon the outer surface of the drum, each chamber having inlet and outlet openings spaced axially and circumferentially of the drum and communicating with the interior of the drum at spaced points for directing liquid drawn from one compartment of the drum into another compartment of the drum at a point nearer the supply end thereof whereby the liquid is moved step by step through the drum in the direction opposite the pitch of the baffle.

4. A diffusion unit comprising a rotatable drum provided with a spiral baffle for dividing the drum into compartments and for moving solid materials through the drum in one direction from a supply end to a delivery end thereof as the drum is rotated, transfer chambers carried upon the drum and provided with axially and circumferentially spaced inlets and outlets in communication with spaced compartments within the interior of the drum for moving unitary amounts of liquid step by step between spaced compartments along the drum in a direction opposite the pitch of the baffle, successive unitary volumes of solid materials contained between adjacent flights of the baffle being successively mixed with units of liquid from successive transfer chambers, and means for separating outgoing solids from incoming liquid at the delivery end of the drum.

5. A diffusion unit comprising a rotatable drum provided with a spiral baffle for dividing the drum into compartments and for moving solid materials through the drum in one direction from a

supply end to a delivery end thereof as the drum is rotated, transfer chambers carried upon the drum and provided with axially and circumferentially spaced inlets and outlets in communication with spaced compartments within the interior of the drum for moving unitary amounts of liquid step by step between spaced compartments along the drum in a direction opposite the pitch of the baffle, successive unitary volumes of solid materials contained between adjacent flights of the baffle being successively mixed with units of liquid from successive transfer chambers, a plurality of circumferentially spaced combs inwardly projecting adjacent the delivery end of the drum for separating outgoing solids from incoming liquid, and a chute for receiving solids from the combs.

6. A diffusion unit for lixiviating solid materials comprising a drum substantially horizontally disposed, means for rotating the drum about its longitudinal axis, a spiral baffle dividing the drum into a plurality of interconnecting compartments and operating to move solid materials through the drum in separate unitary volumes as the drum is rotated, transfer chambers upon the outside of the drum each having an inlet communicating with one compartment and an outlet spaced axially from the inlet to communicate with another compartment in advance of the first mentioned compartment, said outlet also being spaced circumferentially with respect to the inlet in trailing relation thereto, means for supplying solid materials into the drum adjacent one end for movement therethrough as the drum is rotated, and means for supplying liquid into the drum adjacent the opposite end for step by step movement through the transfer chambers in the direction opposite the direction of movement of the solids whereby the liquid is drained successively through the solids contained in successive compartments.

7. A diffusion unit for lixiviating cossettes comprising a substantially horizontally disposed drum mounted for rotation about its longitudinal axis, means for rotating the drum, a spiral baffle extending substantially from end to end of the drum for moving separate unitary volumes of solids from a supply end to a delivery end of the drum, a plurality of transfer chambers longitudinally and circumferentially spaced upon the outer surface of the drum for moving unitary volumes of water step by step along the drum in the direction opposite the pitch of the baffle, each chamber comprising a body portion and a reduced delivery extension communicating with the interior of the drum at circumferentially spaced points between spaced turns of the baffle for passing unitary volumes of water successively through unitary volumes of cossettes moved along the drum as the drum is rotated, means for separating outgoing cossettes from incoming water at the delivery end of the drum, and means for directing water from a transfer chamber adjacent the supply end of the drum onto the cossettes as they are delivered into the drum.

8. A diffusion unit for lixiviating cossettes comprising a substantially horizontally disposed drum mounted for rotation about its longitudinal axis, means for rotating the drum, a spiral baffle extending substantially from end to end of the drum for moving separate unitary volumes of solids from a supply end to a delivery end of the drum, a plurality of transfer chambers longitudinally and circumferentially spaced upon the outer surface of the drum for moving unitary volumes of water step by step along the drum in the direction opposite the pitch of the baffle, each chamber comprising a body portion and a reduced delivery extension communicating with the interior of the drum at circumferentially spaced points between spaced turns of the baffle for passing unitary volumes of water successively through unitary volumes of cossettes moved along the drum as the drum is rotated, means for separating outgoing cossettes from incoming water at the delivery end of the drum, means for directing water from a transfer chamber adjacent the supply end of the drum onto the cossettes as they are delivered into the drum, and means for heating the water passing from said transfer chamber to the point of delivery onto the incoming cossettes.

9. In a diffusion unit, a drum having a spiral baffle dividing the interior into a plurality of compartments for separately containing unitary volumes of cossettes and moving the same along the drum as the drum is rotated, and a plurality of transfer chambers carried upon the outer surface of the drum for rotation therewith, each chamber having a pair of axially and circumferentially spaced screened openings communicating with spaced compartments of the drum for directing unitary volumes of water successively through the unitary volumes of cossettes.

10. In a diffusion unit, a drum having a spiral baffle dividing the interior into a plurality of compartments for separately containing unitary volumes of cossettes and moving the same along the drum as the drum is rotated, a plurality of transfer chambers carried upon the outer surface of the drum for rotation therewith, each chamber having a pair of axially and circumferentially spaced screened openings communicating with spaced compartments of the drum for directing unitary volumes of water successively through the unitary volumes of cossettes, a delivery chamber upon the delivery end of the drum, a plurality of circumferentially spaced inwardly extending combs in the delivery chamber for separating cossettes from incoming water, and a chute for receiving cossettes from the combs.

11. In a diffusion unit, a drum having a spiral baffle dividing the interior into a plurality of compartments for separately containing unitary volumes of cossettes and moving the same along the drum as the drum is rotated, a plurality of transfer chambers carried upon the outer surface of the drum for rotation therewith, each chamber having a pair of axially and circumferentially spaced screened openings communicating with spaced compartments of the drum for directing unitary volumes of water successively through the unitary volumes of cossettes, a delivery chamber upon the delivery end of the drum, means for delivering water into the delivery chamber, and means for separating the cossettes from the water in the delivery section.

12. In a diffusion unit, a drum having a spiral baffle dividing the interior into a plurality of compartments for separately containing unitary volumes of cossettes and moving the same along the drum as the drum is rotated, a plurality of transfer chambers carried upon the outer surface of the drum for rotation therewith, each chamber having a pair of axially and circumferentially spaced screened openings communicating with spaced compartments of the drum for directing unitary volumes of water successively through the unitary volumes of cossettes, a water heater, means for directing water from the last transfer

chamber to the heater, and means for directing the water from the heater onto cossettes adjacent the point of supply thereof into the drum.

13. A diffusion unit for lixiviating solid materials comprising a drum, means for rotating the drum about its longitudinal axis, a spiral baffle extending substantially from end to end of the drum and dividing the drum into compartments separated by successive turns of the baffle, and a plurality of transfer chambers longitudinally and circumferentially spaced along the drum, each chamber having an inlet communicating with one compartment for delivering liquid from the compartment to the chamber during a portion of each revolution of the drum, and each chamber also having an outlet communicating with another compartment in advance of the first mentioned compartment, said outlet being axially and circumferentially spaced from the inlet of the chamber for delivering liquid from the chamber to the second mentioned compartment during another portion of each rotation of the drum.

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