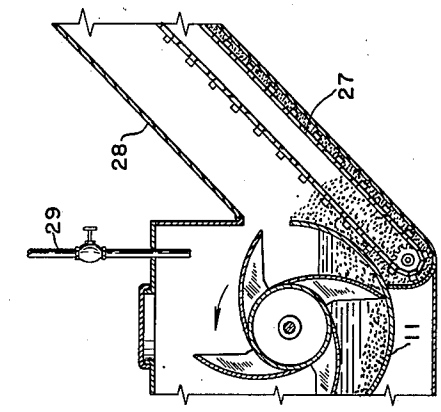
Sept. 11, 1951 G. R. FITTS ET AL 2,567,474

COUNTER CURRENT SOLVENT EXTRACTOR

Filed July 2, 1947



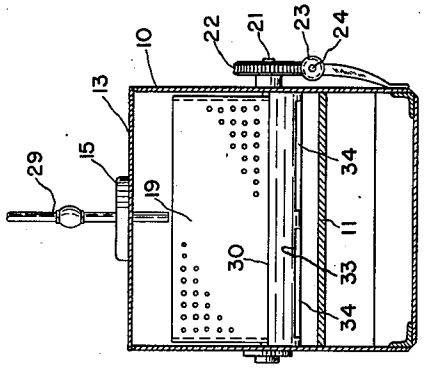


FIG. 2

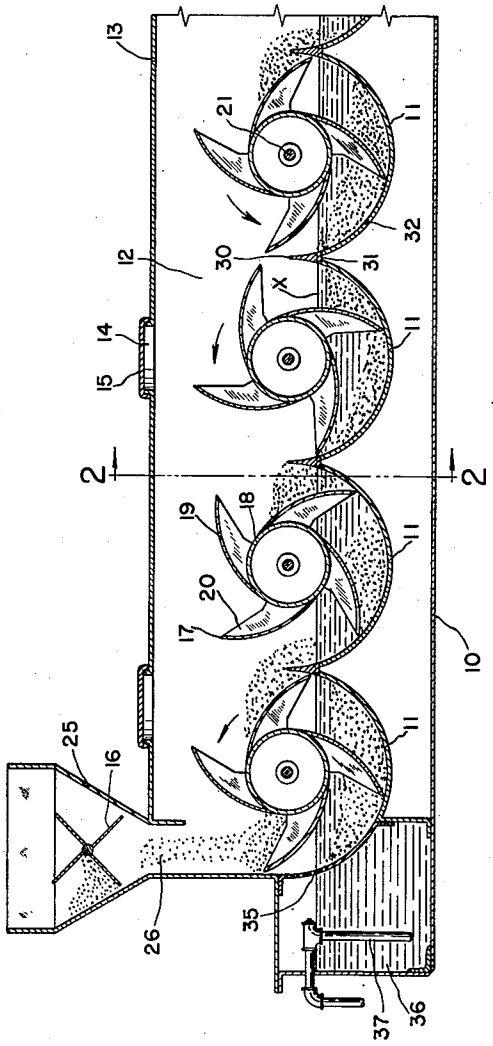


FIG. 1

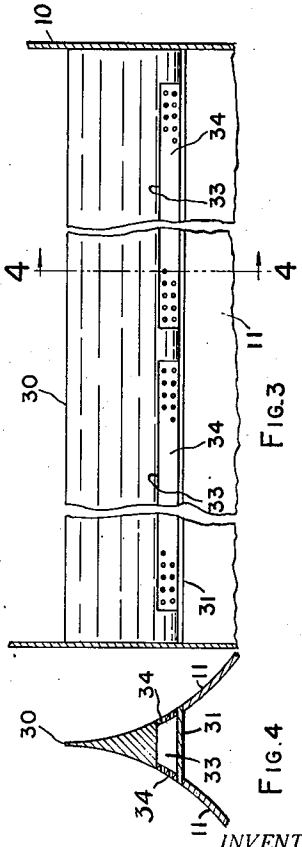


FIG. 3

FIG. 4

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Patented Sept. 11, 1951 2,567,474

UNITED STATES PATENT OFFICE

2,567,474

COUNTERCURRENT SOLVENT EXTRACTOR

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Application July 2, 1947, Serial No. 758,520

5 Claims. (Cl. 23—270)

1

This invention relates to a method and apparatus for continuous counter-current solvent extraction of solid materials.

It is an object of the present invention to provide a novel procedure and apparatus of greater efficiency than those disclosed in the prior art for extracting soluble matter from solid materials containing such matter.

A further object of the invention is to provide solvent extraction apparatus of the type described embodying the counter-current flow of solvent and solvent material, that is so improved in structure and mode of operation as to be capable of more rapid and efficient extraction than prior devices.

It has been previously proposed to employ a tank having a series of adjacent extracting sections in the form of trough-shaped tubs, with a paddle wheel in each for moving the material to be extracted through its respective section and over the common edge of a pair of adjacent sections into the next succeeding section, and causing solvent to flow from one section to the next succeeding section in a direction counter-current with respect to the direction of movement of the material being extracted. In this previous method and apparatus, the level of the solvent has been maintained a substantial distance above the common or spill edge of a pair of adjacent sections to assure a continuous flow of solvent. It is apparent that in such method and apparatus a substantial portion of the material to be extracted is carried over from one extracting section or tub to the next succeeding one while still immersed in the solvent, resulting in the carrying back of solvent having a greater concentration of dissolved matter into and mixing it with the solvent having a lesser concentration of dissolved matter. Since this occurs continually in each extracting section, the cumulative effect is to materially prolong the extracting time.

It is, therefore, a more specific object of the invention to provide a novel procedure and apparatus in which carry back of solvent having a greater concentration of dissolved matter and mixing of it with solvent having a lesser concentration of dissolved matter is very materially reduced by raising the material to be extracted entirely out of contact with the solvent for substantially completely draining it before it is moved into the next succeeding extraction section.

In apparatus employing successive extraction sections it has been previously proposed to form a dam of material being extracted on or near the common spill edge of a pair of adjacent extracting sections tending to prevent "reverse infusion" of the solvent, however, since the major portion of the dam was beneath the level of the

2

solvent, it not only carried back a substantial part of the solvent but also interferred with the free flow of solvent from one extracting section to the next. An important object of the present invention, therefore, is to provide a novel procedure and apparatus wherein not only is "reverse infusion" of solvent minimized but damming of the flow of solvent is eliminated permitting free flow of solvent from one extracting section to the next.

These and other objects, including improving generally on the procedures and structures previously employed in similar solvent extraction operations, will appear more fully from the following description and the accompanying drawing illustrating a preferred embodiment of the invention. In the drawing

Figure 1 is a central vertical longitudinal sectional view of the improved apparatus;

Figure 2 is a sectional view of the invention taken on the line 2—2 of Figure 1;

Figure 3 is an enlarged view of the baffle and portions of the adjacent extracting sections of the improved apparatus; and

Figure 4 is a sectional view taken on the line 4—4 of Figure 3.

The preferred embodiment of the invention, as shown in the drawing, comprises a tank 10 provided with a plurality of adjacent trough-shaped tubs or extracting sections 11 which extend across the entire width of the tank 10 and are arranged parallel one with respect to the other. The adjacent upper ends of each pair of adjacent tubs are formed with a common spill edge over which material to be extracted is passed from one tub 11 to the next, the series of tubs 11 forming the bottom wall of an extraction chamber 12.

The tank 10 is provided with a top wall 13 which also forms the top wall of the extraction chamber 12. The top wall 13 is preferably provided with a plurality of inspection openings 14 normally closed by the covers 15.

Mounted in each of the tubs 11 is a paddle wheel 17, extending the full width of the extraction chamber 12 and comprising a hub 18 which may be in the form of a drum of any suitable shape in cross section, but preferably round as shown in the drawings, and a plurality of preferably, though not necessarily, curved perforated blades 19. The blades 19 extend the full width of the extraction chamber 12 and are spaced at equal distances about the hub 18 to which they are secured in any suitable manner. Strengthening ribs 20 either formed with or suitably secured to the blades 19 extend a distance circumferentially of the hub 18.

The hubs 18 are secured to and arranged to rotate with shafts 21 which extend through and are journaled in the sides of the tank 10. On the extensions of the shafts 21 at one side of the tank 10 are mounted worm wheels 22 meshing with worms 23 on the main driving shaft 24 which is operated from a suitable source of power (not shown).

The material from which soluble matter is to be extracted is introduced into an end tub 11 of the extraction chamber 12 in any suitable manner. As shown in the drawings, the material passes from the spout 25, which preferably extends the width of the tub 11, through a rotary metering device 16 and then through an opening 26 in the top wall 13 of chamber 12. It is, of course, desirable to arrange the spout or spouts 25 in such manner as to obtain an even distribution of the material across the width of tub 11. The blades 19, which rotate in the direction of the arrows as shown in Figure 1, advance the material in segregated masses from one tub 11 to the next succeeding tub, finally delivering the residue onto the lower end of an endless conveyor 27 mounted in the conveyor housing 28 which communicates with the end of the extraction chamber 12 opposite that end into which the material is introduced.

The solvent employed in the extraction process is introduced through a pipe or pipes 29 into the end tub 11 opposite the point of introduction of the material to be extracted, however, it will be apparent that if desired the solvent may be introduced into the conveyor housing 28, from which it will flow over the edge of and into the adjacent tub 11.

The common spill edge of adjacent tubs 11 is preferably though not necessarily formed as a separable member or baffle 30 seated on a sealing strip or plate 31 connecting the adjacent upper ends of the arcuate shaped wall portions 32 of adjacent tubs 11. Considered in cross section, the arcuate shaped wall portions 32 are in the form of a minor arc described about the axis of the paddle wheels 17 so that during rotation of the paddle wheels, the ends of the blades 19 will fit closely against the inner surface of the arcuate shaped wall portions 32.

In cross section, the baffles 30 are preferably triangular in shape, the side faces of which are preferably formed on the same radius as the wall portions 32, so that they form continuations of the arcuate surfaces of the wall portions 32. It is obvious that the baffles 30 may be other than triangular in cross section and the side faces need not necessarily be arcuate, since the ends of the blades 19 may be provided with flexible flaps that will maintain a close fit with the side faces of the baffles 30, or if the space between the ends of the blades 19 and the side faces of the baffles is not so great as to permit an appreciable amount of material to pass therebetween, such flaps are not necessary. Each of the baffles 30 is provided in its base with recesses 33 and perforated metal strips 34 are secured in any suitable manner, as by welding, in the recesses 33, and are preferably curved to follow the contour of the wall portions 32 and the side faces of the baffles 30. The recesses 33 and perforated strips 34 are disposed at a level substantially below the level of the axes of the paddle wheels 17 but not below the level of the lowermost portion of the drums 18, while the crest or spill edge of the baffles 30 are arranged at approximately the same level as the level of the axes of the paddle wheels 17. The recesses 33 provide passages for the

flow of solvent from one trough shaped tub to the next, and the sealing strips 31 which as previously explained connect the upper ends of adjacent tubs, form a bottom wall for the passages, as best shown in Figures 3 and 4, preventing solvent from flowing from the extraction chamber 12 into the bottom of tank 10.

The solvent introduced through pipe 29, thus flows through the perforated strips 34 from one tub to the next maintaining the level of the solvent, indicated at X in Figure 1, at substantially the level of the perforations in the strips 34. The crests or spill edges of the baffles 30 being substantially above the level X of the solvent, it is apparent that the solid material is carried upwardly by the paddle wheel blades 19 out of contact with the solvent and drops over the spill edge of the baffles 30 into the next succeeding tub, the direction of movement of the solid material through the extraction chamber 12 being countercurrent with respect to the direction of flow of the solvent. Since the perforated metal strips 34 are at an elevation at least as high as the bottom portion of the drums 18, it is evident that the level of the solvent will be maintained at least as high as the bottom portion of the drums 18, thereby preventing light particles of material from floating on the surface of the solvent into the next section and assuring positive submersion of all the material in the solvent in each of the series of tubs 11.

The end tub 11 opposite the solvent inlet pipe 29 is provided with a strainer or screen 35 which permits passage of the micella or solvent with its dissolved matter into the micella receiving chamber 36, formed by an extended portion of the tank 10. The micella or solvent with its dissolved matter is withdrawn from the chamber 36 through pipe 37 and may then be delivered to a suitable recovery plant where the soluble matter and solvent may be separated and collected in known manner.

The blades 19 curve back from the drums 18 of the paddle wheels 17 in a generally tangential direction so that the material falls away from the blades, as they ascend from the confines of the tubs 11, and drops into the next succeeding tub.

In operation the material to be extracted drops from the rotary valve 16 into the space between two successive blades 19 of the paddle wheel 17. The trailing blade pushes the material down into the solvent around the bottom of the tub 11, then elevates the segregated mass of material through the solvent and finally raises the entire segregated mass of material out of contact with the solvent, whereupon this segregated mass of material is substantially completely drained. The solvent that is drained from the material passes through the perforations of the trailing blade 19 back into the same tub 11, while the thoroughly drained material drops from the trailing blade 19 over the spill edge of the baffle 30 into the next succeeding tub 11. This positive submersion of the material and substantially complete drainage is repeated in each of the series of tubs 11, the drained material finally passing onto the conveyor 27.

Since the segregated masses of material are substantially completely drained of solvent before being delivered from one tub to the next succeeding tub, carrying back of solvent having a higher concentration of dissolved matter into solvent having a lower concentration of dissolved

matter is very materially reduced as compared to prior apparatus.

It is, of course, apparent that the material being extracted still retains a certain amount of the solvent-solute mixture when it passes over the baffles 38 from one tub to the next. In the description and claims it will be understood that by substantially complete drainage is meant that no substantial further amount of solvent-solute mixture will freely drip from the material being extracted. In other words, the solvent-solute mixture is not expressed from the material but is permitted to substantially completely drain by gravity from each entire segregated mass of material before being introduced into the next succeeding extraction section.

The solvent-solute mixture retained by the material being extracted is diluted in the next succeeding extraction section with solvent containing a lower percentage of solute, the extraction process is repeated and again the material is drained before being passed on to the next extraction section. This process is repeated through the necessary number of extraction sections until the solvent-solute content of the material being extracted reaches the minimum of residual solute.

Our improved method and novel apparatus for extracting soluble matter from solid materials containing the same are capable of more rapid and efficient extraction than previously known methods and apparatus.

We claim:

1. In a countercurrent solvent extraction apparatus, a series of troughs arranged side by side and forming the bottom of an extraction chamber, each pair of adjacent troughs having their adjacent walls meeting in a common top edge portion, said adjacent walls having passageways formed in said common top edge portion and above the bottom of said troughs providing for the flow of solvent therethrough from one trough to the next to maintain the solvent at the level of said passageways and conveying means rotating in said troughs above and below the level of said passageways for moving the material through said troughs counter to the direction of flow of the solvent and above said passageways for depositing it over said common top edge portions into the next succeeding trough.

2. In a countercurrent solvent extraction apparatus, a series of troughs arranged side by side and forming the bottom of an extraction chamber, said troughs being of arcuate configuration in cross section, each pair of adjacent troughs having their adjacent walls meeting in a common top edge portion, said adjacent walls having passageways formed in said common top edge portion and above the bottom of said troughs providing for the flow of solvent therethrough from one trough to the next to maintain the solvent at the level of said passageways, means for moving material through said extraction chamber in a direction opposed to the direction of flow of said solvent, said means including a rotatable hub extending the full length of each trough with the lowermost peripheral portion of each of said hubs being below said passageways and the uppermost peripheral portion of each of said hubs being above said common top edge portion, perforated blades extending outwardly from said hubs and having their free ends move in a path in juxtaposition to the arcuate interior surface of said troughs, said blades on rotation submerging the material below the level of the solvent, moving it through said troughs, raising it above said passageways and depositing it over said common top edge portions into the next succeeding trough.

3. In countercurrent solvent extraction apparatus in which material to be treated is introduced adjacent one end of the apparatus and solvent adjacent the other, a series of adjacent extracting troughs comprising walls of arcuate configuration in cross section, a plate connecting the adjacent upper edges of said arcuate walls, a baffle seated on each of said plates and provided with passageways for the flow of solvent therethrough from one trough to the next adjacent trough and conveying means rotating in said troughs for first moving the material through the solvent in said troughs and then out of contact with the solvent and over said baffles into the next succeeding trough.

4. In countercurrent solvent extraction apparatus in which material to be treated is introduced adjacent one end of the apparatus and solvent adjacent the other, a series of adjacent extracting troughs comprising walls of arcuate configuration in cross section, a plate connecting the adjacent upper edges of said arcuate walls, a baffle seated on each of said plates, the side walls of said baffles being formed on the same radius of curvature as the radius of curvature of said arcuate walls to form continuations thereof, said baffles having passageways formed in the base portion thereof adjacent said plates for the flow of solvent therethrough from one trough to the next adjacent trough and conveying means rotating in said troughs above and below the level of said passageways for moving the material through said troughs counter to the direction of flow of the solvent and above said passageways for depositing it over said baffles into the next succeeding trough.

5. In countercurrent solvent extraction apparatus in which material to be treated is introduced adjacent one end of the apparatus and solvent adjacent the other, a series of adjacent extracting troughs comprising walls of arcuate configuration in cross section, a plate connecting the adjacent upper edges of said arcuate walls, a baffle seated on each of said plates, said baffles having recesses provided in the bases thereof penetrating said baffles, perforated strips mounted in the recesses of said baffles and providing for the flow of solvent therethrough from one trough to the next adjacent trough, said baffles and perforated strips being formed on the same radius of curvature as the radius of curvature of said arcuate walls and rotating paddle wheels in said troughs for moving said material through said solvent counter to the direction of flow of the solvent and above said perforated strips for depositing it over said baffles into the next succeeding trough.

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