J. AVRUTIK.

METHOD OF AND APPARATUS FOR SEPARATING LIQUIDS AND SOLIDS.

APPLICATION FILED JULY 2, 1919.

1,360,708.

Patented Nov. 30, 1920.

2 SHEETS—SHEET 1.

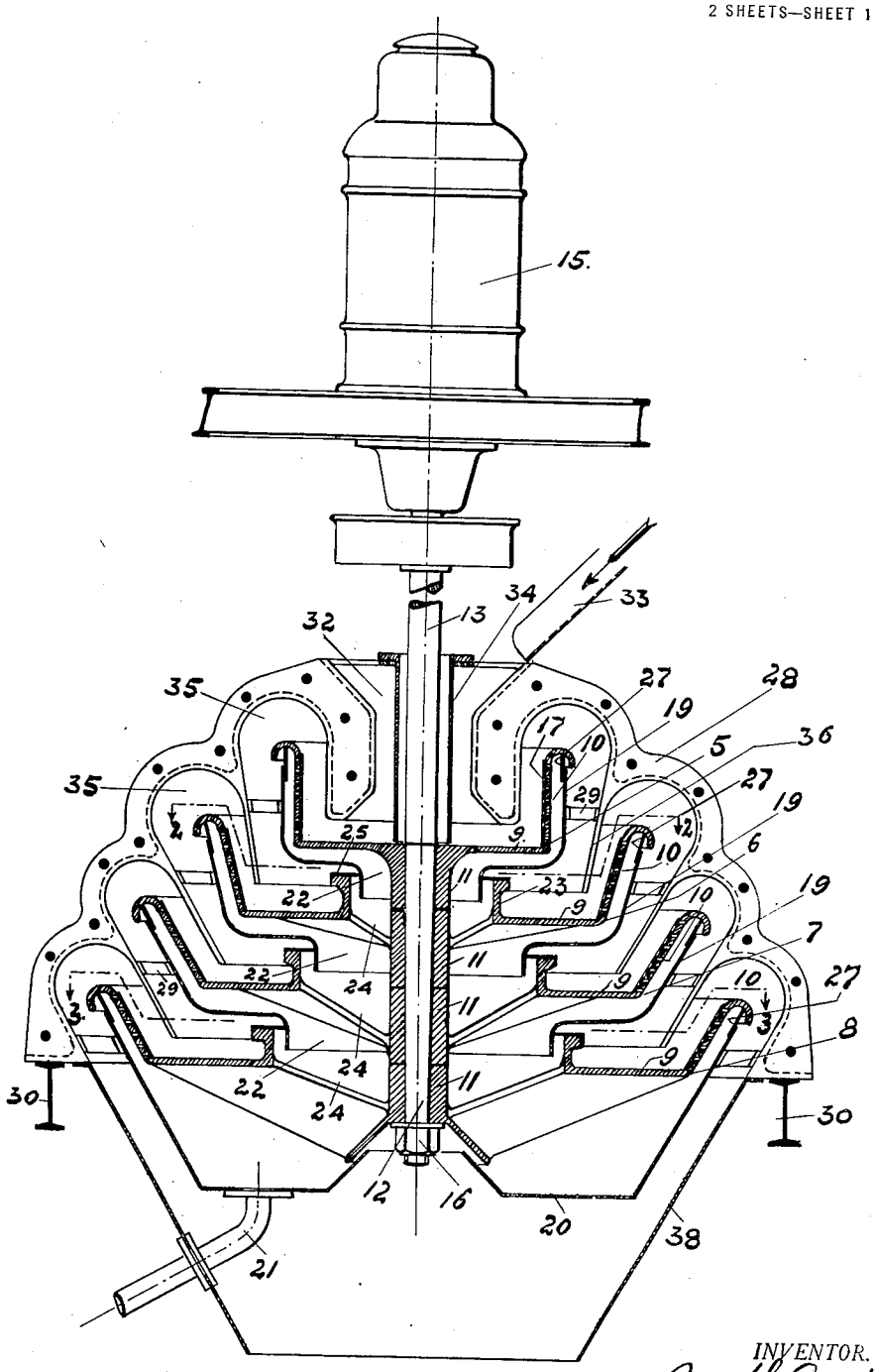


FIG. 1

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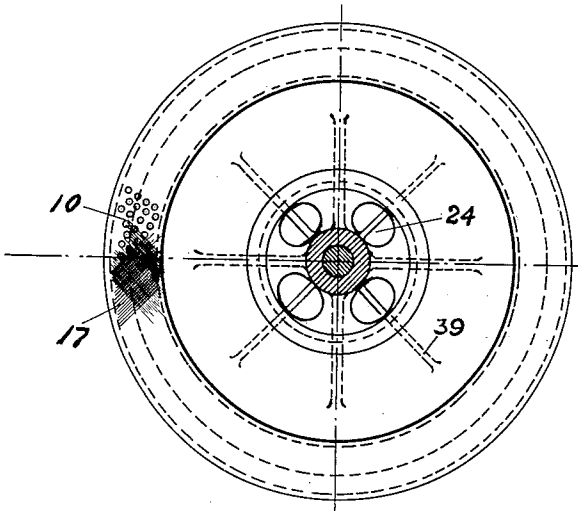


FIG. 2.

TYPICAL PLAN VIEW 2-2
OUTER CASING REMOVED

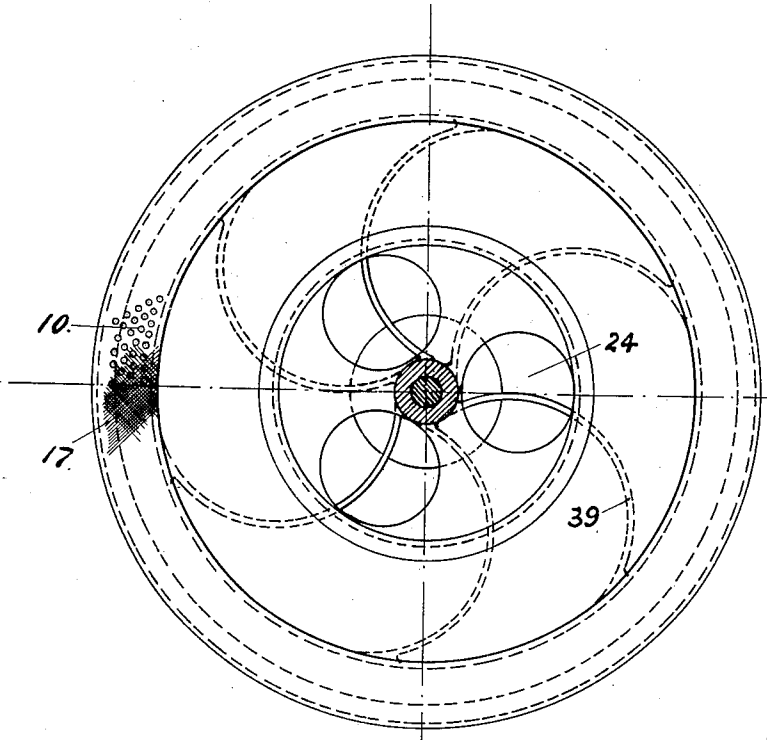


FIG. 3.

PLAN VIEW 3-3
OUTER CASING REMOVED

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UNITED STATES PATENT OFFICE.

JOSEPH AVRUTIK, OF YONKERS, NEW YORK.

METHOD OF AND APPARATUS FOR SEPARATING LIQUIDS AND SOLIDS.

1,360,708. Specification of Letters Patent. Patented Nov. 30, 1920.

Application filed July 2, 1919. Serial No. 308,227.

To all whom it may concern:

Be it known that I, JOSEPH AVRUTIK, a citizen of the United States, residing in Yonkers, in the county of Westchester, in the State of New York, have invented certain new and useful Improvements in Methods of and Apparatus for Separating Liquids and Solids, of which the following is a specification.

The present invention relates to an improvement in methods of and apparatus for separating liquids and solids.

Although the method and apparatus of the present invention are adapted for the separation of the liquid from the solid content of materials or substances of all kinds, whether organic or inorganic, the invention will be described in connection with the separation of the molasses residuum from the crystallized sugar in the manufacture of sugar. It will be understood that the selection of the step in the sugar making industry of separating the molasses from the crystallized sugar to illustrate the principles and features of the invention is made only for the sake of convenience of description, and that the invention is not to be limited to this purpose, inasmuch as it is equally applicable to the separation of all kinds of liquid from solid matters.

In the manufacture of sugar, the juice which has been extracted from the fruit, the beet-root, or the cane, is boiled until the sugar content is in a crystallizable stage. The syrup obtained by the boiling consists of two elements,—sugar and molasses. The molasses residuum is next separated from the sugar crystals. This is commonly effected by the action of centrifugal force. As this method of separating the liquid and solid content of the sugar syrup is commonly practised at present, the syrup is introduced into a rapidly revolving cylindrical drum or basket having a solid bottom and perforated sides. Under the action of the centrifugal force, the liquid molasses is forced through the perforations and the sugar crystals arrange themselves in an annular ring or hollow cylinder within the inner periphery of the drum. Inasmuch as the centrifugal force is strongest at the outermost layer of sugar crystals, that is to say, those piled against the perforated sides of the drum, the molasses is more quickly separated from the outermost layer than from the inner layer of crystals. This permits the crystals of the outermost layer or layers to pack together closely, thereby materially retarding the passage of the molasses being separated from the inner layers. The fact that the inner layers of the crystals are subjected to a much weaker centrifugal force than the outer layers, and the fact that the solidifying of the outer layers of the crystals (the longer the operation the greater the solidification) results in an incomplete and only partial separation of the molasses from the inner layers of sugar crystals. This is shown by the fact that when the contents of the drum are removed, the inner layers of crystals are quite moist and easily removed, whereas the outer layers of crystals are quite dry and immovable. The inefficiency of the present method of separating the molasses from the sugar crystals seems to lie in the fact that when the syrup is forced against the side walls of the drum, the sugar crystals arrange themselves in layers or rings and having once assumed these positions maintain them without relative movement or change of position. Hence the crystals farthest from the center of the drum are subjected to a greater centrifugal force than the crystals nearer the center of the drum. Consequently, a thicker film of molasses is permitted to remain on the crystals nearer the center of the drum. Another disadvantage in the present method of separating the molasses from the sugar crystals is the fact that the operation is intermittent and consumes an unnecessary amount of time and labor, due to the fact that the attention of an operator is required to introduce the syrup into the drums and to remove the dried sugar crystals therefrom.

One object of the present invention is to produce a method of and apparatus for separating liquids and solids such that the separation of the liquid and solid contents of any material or substance, organic or inorganic, will be completely, thoroughly and quickly effected. In accomplishing this object, one feature of the invention consists in subjecting all parts of the substance equally to the liquid separating action. Another feature of the invention consists in subjecting the substance to a successive and increasingly stronger and more vigorous application of the force separating the liquid from the solid content of the substance until the solid content is completely divested of the liquid. If the substance operated upon

is the syrup obtained by boiling sugar-containing juice, the relatively fluid syrup is first subjected to a moderate liquid separating force sufficient to remove the greater part of the molasses from the sugar crystals. The sugar crystals, coated more or less thickly with the molasses, are then rearranged in position and subjected to a greater liquid removing force, the latter being availed of to rearrange the positions of the sugar crystals. The sugar crystals which are now only covered with a very thin film of molasses are again rearranged in position by the liquid separating force and subjected to a still greater liquid separating force. If the successive actions or operations to which the syrup and afterward the sugar crystals have been subjected have not proved sufficient for the purpose of thoroughly and completely divesting each sugar crystal of its film of molasses, the successive operations of rearranging the sugar crystals and subjecting them to increasingly greater liquid removing force are continued until the sugar crystals are thoroughly dry. In the meantime, the molasses separated out from the sugar crystals is conducted into a separate receptacle.

A further object of the invention is to produce a method of and apparatus for separating liquids and solids such that the operation of separating the liquids and solids may be performed continuously and automatically without requiring the attendance of an operator to introduce the syrup into the receptacle where the operation of separating the liquid from the solids is performed, and such that when the operation is completed, the services of an operator in removing the dried solids from the receptacle before a fresh supply of material is introduced are dispensed with. This object is accomplished by arranging the receptacle or receptacles, in which the operation of separating the liquid from the solid is performed, in such manner that when the liquid is partially separated from the solid, the solid content is then removed to another receptacle, its position during the removal being completely changed automatically by the action of the liquid separating force. This mode of operation is continued automatically until the liquid is completely and thoroughly separated from the solid, the separating force serving not only to automatically feed the solid content of the substance being operated upon from one receptacle to another, so that it may be subjected to an increasingly stronger liquid separating force, but also serving to conduct the liquid content into a separate receptacle. The receptacles in which the liquid separating operation takes place are so arranged that the feed or flow of the substance operated upon through them is continuous. The partially treated substance in the first receptacle, as soon as it is discharged therefrom into the second, is replaced by fresh material; and, in like manner, as the substance being treated in any given receptacle is discharged therefrom, its place is taken by a fresh supply from the preceding receptacle. Thus, the feed of the substance through the apparatus is automatic and continuous, it being only necessary to keep a constant supply of material passing into the first receptacle.

In the accompanying drawings is illustrated a form of apparatus suitable for practising the method of the invention. Figure 1 is a vertical section through the apparatus; Fig. 2 is a section taken on the line 2—2 of Fig. 1; and Fig. 3 is a section taken on the line 3—3 of Fig. 1.

The apparatus illustrated in the drawings for practising the method of the invention comprises a set of drums or baskets concentrically arranged. For the sake of the convenience of mechanical construction, the drums are superposed one above the other, although they can also be arranged to occupy the same plane. The number of drums or baskets employed will depend upon the number of successive operations required to thoroughly separate the liquid and solid content of any given substance. In the apparatus illustrated, there are four of these concentric and superposed drums, indicated generally at 5, 6, 7, and 8. The topmost basket is cylindrical in form and the others generally conical, and each basket comprises a solid bottom portion 9 and perforated side walls 10. The bottom of each drum is provided with a hub 11 mounted on the slightly tapered lower end 12 of a vertically arranged shaft 13, depending from an electric motor 15. The shaft 13 is so connected with the motor, as by a flexible coupling, that the drums are self-balancing. The centrifugal action on the drums having a tendency to lift them, the shaft is provided with the tapered portion so that the drums will not shift. The drums are secured in position by a nut 16. On the inner periphery of the perforated walls of each drum is provided a fine wire gauze 17. Below each drum is arranged a syrup or liquid receiving pan 19 The bottom pan 20 serves as a receptacle to receive the liquid from the pans arranged above it, and is provided with a discharge pipe 21, which conveys the liquid from the apparatus. The bottoms of the three upper pans are provided with an open central portion 22. This open portion 22 is formed by a central downwardly projecting flange, which is received within a corresponding upwardly projecting flange 23 rising from the bottoms of the drums 6, 7, and 8. In order that the liquid may pass from one pan to another through the bottoms of the drums, the central portions of the drums 6, 7, and

8, are provided with holes 24. A cylindrical rubber gasket 25 placed on the top of each flange 23 surrounds the downwardly projecting flanges of the liquid receiving pans 19. The rim of each liquid receiving pan 19 is provided with a rubber gasket 27, which projects in a groove formed by the curved rims of the drums, so as to prevent the liquid thrown out from one drum from passing into a lower drum. The drums, being splined to the shaft 13, rotate rapidly, whereas the liquid receiving pans 19 are stationary, being fastened to the casing 28 of the apparatus by brackets 29. The casing of the apparatus is supported from two I-beams 30. The substance whose liquid and solid content are to be separated is introduced into the hopper part 32 of the casing by a chute 33. The hopper 32 is formed by a portion of the casing which projects downwardly into the upper drum 5. In order that the substance may fall freely into the drum 5, a cylindrical pipe 34 surrounds the upper portion of the shaft 13.

The passage way or aperture existing between the lower end of the hopper 32 and the bottom of the uppermost receptacle or drum 10 constitutes means by which the quantity of substance passing into the apparatus at any one time to be subjected to the liquid separating force is regulated or controlled.

If the substance whose liquid and solid content is to be separated is sugar syrup, the syrup is introduced in a continuous stream into the uppermost drum or basket 5. As the syrup strikes the bottom of the drum, the centrifugal action, superinduced by the rotation of the drum, causes the syrup to be forced against the side walls of the drum. The centrifugal action on the syrup causes the syrup to travel upwardly on the sides of the drum; and, inasmuch as there is nothing to impede its progress, the syrup overflows the rim of the drum and falls down into the next lower drum. The centrifugal action on the substance will force the substance out of the drums and against the casing 28. In order that the syrup may fall to the bottoms of the next succeeding lower drums, the casing is provided with a series of annular grooves 35 opposite the rims of the drums, and between each two adjacent grooves is a downwardly projecting flange or partition wall 36. Each partition wall acts as a deflecting plate and projects sufficiently toward the bottom of its respective drum to insure that the material will strike the bottom of the drum before it reaches the sides thereof. While the syrup is being subjected to the centrifugal action in the uppermost drum. a considerable amount of its liquid content passes out through the perforated walls of the drum and into the liquid receiving pan 19, placed immediately below the drum 5. Inasmuch as the syrup is in a liquid condition owing to the molasses it contains when it enters drum 5, the walls of this drum are vertically arranged.

As the partially treated syrup passes from the uppermost drum 5 into the next lower drum 6, the position of the constituents of the syrup is rearranged. This necessarily follows from the fact that the syrup drops to the bottom of drum 6, where it is again subjected to centrifugal action. It will be observed that drum 6 is somewhat larger in diameter than drum 5 and, consequently, the centrifugal action, that is to say, the liquid separating action of drum 6 is somewhat greater than that of drum 5. A portion of the liquid content of the syrup having been removed while the syrup was passing through drum 5, the upward climbing tendency of the syrup has been greatly reduced. Consequently, in order that the passage of the syrup, which may now be designated the sugar crystals more or less thickly coated with molasses, in passing from drum 6 into the next lowest drum may be facilitated, the side walls of drum 6 flare outwardly at an angle. While the sugar crystals are mounting up the walls of drum 6, they are divested of the greater portion of the molasses film covering them by reason of the centrifugal force to which they are subjected; and this molasses is caught by the liquid receiving pan placed immediately under the drum 6.

The sugar crystals, which by this time have been divested of the greater portion of their molasses covering, fall from the drum 6 to the bottom of drum 7 and, being there subjected to centrifugal action, are thrown against the walls of drum 7. Drum 7 being greater in diameter than drum 6, the centrifugal force to which the sugar crystals are now subjected is greater than that to which they were subjected in drum 6; and, moreover, because they are now much drier than they were in passing through drum 6, the side walls of drum 7 flare outwardly at a greater angle than do the side walls of drum 6, in order to facilitate the passage of the crystals into the next lower drum.

By the time the sugar crystals have passed through drum 7, they are quite thoroughly divested of their coating or film of molasses and, in some cases, it is not necessary to subject them to still further centrifugal action. In the apparatus illustrated, however, there is provided a fourth drum of still greater diameter than drum 7, so that in case there is a thin film of molasses still adhering to the sugar crystals when they leave drum 7, this film of molasses will be removed or separated from the crystals by the greater centrifugal force to which the crystals are subjected in drum 8. When the sugar crystals are thrown out of drum 8 by the centrifugal action of the

rotating drum, they pass down into a discharge hopper 38, secured to the bottom of the casing 28. As the now dry sugar crystals fall from the discharge hopper 38, they are conveyed to the point of the next operation.

The liquid content of the sugar syrup, that is to say, the molasses residuum, does not pass by the action of gravity alone into the lowest liquid receiving receptacle 20, but its passage from the uppermost liquid receiving pan 19 down to the receptacle 20 is aided by centrifugal action. For this purpose, the central portions of the drums 6, 7 and 8, in which are located the holes 24, are conically formed with the apex pointing downwardly. This is clearly shown in Fig. 1. As the liquid drips from the liquid receiving pans onto the central portions of the drums, the centrifugal action upon the liquid will tend to throw out the liquid on a horizontal plane. Consequently, the liquid will be forced through the holes before it has a tendency to climb up the inner peripheries of the flanges 23. Inasmuch as the volume of molasses increases by increments received by each pan in its passage down to the receptacle 20, the holes in the central portion of the bottoms of the drums are progressively larger.

For the purpose of strengthening the central portions of the drums, they are provided on their under surfaces with ribs 39. The ribs on the drums 6 and 7 project outwardly in straight lines, as shown in Fig. 2, and the ribs on the lowermost drum are curved as shown in Fig. 3. When the liquid or molasses passes through the holes 24 in drum 8, it is caught and thrown by the ribs 39 on the bottom of the drum 8 outwardly against the sides of the receptacle 20.

It will be understood from the above described description of the construction and mode of operation of the apparatus illustrated that it is adapted for carrying out the purposes of the invention, and that the method of the invention may be practised by its use. The substance in the uppermost basket 5 is subjected only to a moderate liquid separating or removing force. The substance having been divested of a portion of its liquid content, its constituents or ingredients are then rearranged and it is subjected to a greater liquid removing force. These two modes of operation, namely, the rearrangement of the constituents of the substance and its subjection to a progressively greater liquid removing force, are continued until no liquid remains in the substance. By this method of removing the liquid content from the substance, all the solid particles of the content of the substance are equally subjected to the liquid removing force. The action while the substance is in a relatively liquid condition is that of separating the liquid from the solids. When this has been accomplished, the further action is that of divesting or removing what liquid still remains covering the solid particles now constituting the body of the substance. It is thus seen that a progressively greater liquid separating or removing force is required as more and more liquid is separated out from the substance.

It will be observed upon consideration of the method practised by the apparatus illustrated that the operation of separating the solid and liquid content of the substance operated upon is continuous and automatic, neither requiring the services of an operator to feed the substance to the apparatus or to remove either the liquid or the solid content therefrom. The stream of substance passing into the first drum is steady and constant and of a requisite volume; and so, likewise, the stream of partially treated substance passing from the first drum to the second is steady and constant; and the same is true of the stream of substance which passes through the lower drums. As the substance is acted upon by the centrifugal force during any stage of the operation and then passes on, its place is immediately taken by a portion of the substance not yet subjected to that stage of the operation. It will be seen that only a relatively small quantity of the substance is acted upon at any one stage in the liquid separating or removing operation. When the apparatus has been in operation long enough for the first of the substance to reach the lowermost drum, every stage of the liquid separating or removing operation is then practised simultaneously from the topmost to the lowermost drums. The present method of and apparatus for separating liquids and solids are not only more efficient than the methods and apparatus heretofore employed for this purpose, but effect also a great saving in time and labor.

It will be understood that the apparatus shown in the drawings to illustrate the practice of the method is only one form, and that preferred, of apparatus suitable for the practice of the method, the scope of the invention being determined by the following claims.

Having thus described the invention, what I claim is:—

1. The method of separating the liquid and solid content of substances which comprises, introducing the substance into a receptacle and subjecting it to a liquid separating force, utilizing the liquid separating force to introduce the substance into a second receptacle and at the same time rearrange the constituents of the substance, subjecting the substance in the second receptacle to a greater liquid separating force and

utilizing the greater liquid separating force to introduce the substance into a third receptacle and at the same time rearrange the constituents of the substance, subjecting the substance to a greater liquid separating force in the third receptacle, and repeating these steps until the liquid and solid content of the substance are separated.

2. The method of separating the liquid and solid content of substances which comprises, introducing a continuous stream of the substance into and through a series of receptacles, subjecting the substance to a progressively greater liquid separating force in each successive receptacle and utilizing the liquid separating force to feed the substance from one receptacle into the next.

3. The method of separating the liquid and solid content of substances which comprises, feeding the substance into a receptacle in which it is subjected to centrifugal force, utilizing the centrifugal force to feed the substance into the second receptacle in which it is subjected to a greater centrifugal force and repeating the operations of introducing the substance into succeeding receptacles in each of which the substance is subjected to a progressively greater centrifugal force until the liquid and solid content of the substance are separated.

4. The method of separating the liquid and solid content of substances which comprises, feeding the substance to a series of receptacles in each succeeding one of which the substance is subjected to a progressively increasing liquid separating force, utilizing the liquid separating force to feed the substance from one receptacle to another and at the same time rearrange the relative positions of the constituents of the substance.

5. The method of separating the liquid and solid content of substances which comprises, introducing the substance into a receptacle and subjecting it to a liquid separating force by which a portion of the liquid is removed from the substance, utilizing the liquid separating force to feed the substance into a second receptacle, subjecting the substance in the second receptacle to a greater liquid separating force by which a portion of the liquid still remaining in the substance is separated from it, utilizing the liquid separating force to which the substance is subjected in the second receptacle to introduce the substance into a third receptacle, subjecting the substance in the third receptacle to a still greater liquid separating force by which a portion of the liquid still remaining in the substance is separated from it and repeating the steps of introducing the substance into successive receptacles and subjecting it to successively greater liquid separating forces until the liquid content is entirely removed from the substance.

6. The method of separating the liquid and solid content of substances which comprises, introducing the substance into a receptacle, subjecting the substance while in the receptacle to a liquid separating force, thereby partially removing the liquid from the substance, utilizing the liquid separating force to introduce the substance into a second receptacle and at the same time rearrange the constituents of the substance, subjecting the substance in the second receptacle to greater liquid separating force by which a portion of the liquid still remaining in the substance is removed from it and repeating the steps of utilizing the liquid separating force to which the substance is subjected in one receptacle to introduce it into another receptacle and at the same time rearrange the constituents of the substance and subjecting the substance in each successive receptacle to a progressively greater liquid separating force until the liquid content of the substance is removed from it.

7. The method of separating the liquid and solid content of substances which comprises, feeding a continuous stream of the substance to and through a series of receptacles, subjecting the substance as it passes from one receptacle into the next to a progressively greater liquid separating force, maintaining the receptacles in constant operation as the stream of substance passes through them and utilizing the liquid separating force to feed the substance from one receptacle to the next.

8. The method of separating the liquid and solid content of substances which comprises, feeding a continuous stream of the substance to and through a series of receptacles, maintaining each receptacle in constant operation as the stream of substance passes through them, subjecting the substance in each successive receptacle to a progressively greater liquid separating force and utilizing the liquid separating force to feed the substance from one receptacle into the next.

9. The method of separating the liquid and solid content of substances, which consists in feeding a continuous stream of the substance to and through a series of receptacles in which the substance is subjected to a liquid separating force, and using the liquid separating force to feed the substance from one receptacle to another and thereby rearrange the position of the constituents of the substance before it is subjected to each succeeding liquid separating operation.

10. The method of separating the liquid and solid content of substances, which consists in feeding a continuous stream of the substance to a series of receptacles in each of which the substance is subjected to a liquid removing force, the liquid removing force

being availed of to feed the substance from one receptacle to another and, at the same time, rearrange the position of the constituents of the substance as it passes from one receptacle to another.

11. The method of separating the liquid and solid content of substances which comprises introducing the substance into a receptacle in which it is subjected to centrifugal force, utilizing the centrifugal force to discharge the substance from the receptacle, then introducing it into another receptacle into which it is subjected to a greater centrifugal force and utilizing this centrifugal force to discharge the substance from this receptacle and repeating these steps until all the particles of the substance are equally subjected to centrifugal force so that the liquid and solid content of the substance are separated.

12. An apparatus for separating the liquid and solid content of substances, comprising a series of superposed, concentric drums having perforated side walls, the side walls of the uppermost drum being vertically arranged and the side walls of the lowermost drums being arranged at an angle, and means for rotating the drums.

13. An apparatus for separating the liquid and solid content of substances, comprising a series of concentric, superposed drums having perforated side walls, a liquid receiving pan surrounding each drum, partition walls between the drums so that the contents passing over the rim of one drum will fall to the bottom of the next lower drum, holes in the central portion of the pans and the lowermost drums to convey away the liquid separated from the substance and means for rotating the drums.

14. An apparatus for separating the liquid and solid content of substances, comprising a series of rotating drums having perforated side walls, a pan adjoining each drum to receive the liquid forced through the perforations, the drums being so constructed that the centrifugal action on the substance being treated forces the substance up the side walls of the drums and over the rims thereof, and means for directing the substance as it passes from one drum to another so that it will fall to the bottom of the drums before reaching the sides thereof.

15. An apparatus for separating the liquid and solid content of substances, comprising a series of concentric, superposed drums having perforated sides, each drum below the uppermost having openings at its central portion, a pan arranged adjacent each drum to receive the liquid passing through the perforations, each pan except the bottom one having an open center arranged to register with the holes in the drums so that the liquid from all the drums will pass into the lowermost pan, and means connected with each drum for facilitating the downward passage of the liquid.

16. An apparatus for separating the liquid and solid content of substances, comprising a series of rotating drums having perforated sides, means for feeding a continuous stream of the substance to the drums, the drums having open tops so that the substance as it is subjected to centrifugal action in each drum passes out over the rim of the drum, each succeeding drum being arranged to receive the substance ejected from the preceding drum and means for directing the substance passing from one drum to the bottom of the next succeeding drum.

17. An apparatus for separating the liquid and solid content of substances, comprising a series of rotating drums, means for feeding a continuous stream of substance to the drums, the drums having open tops so that the centrifugal action upon the substance causes the substance to pass over the rims of the drums, each succeeding drum being arranged to receive the substance passing from the preceding drum, each succeeding drum being of greater diameter than the preceding drum and having its side walls arranged to facilitate the passage of the substance therefrom and means for directing the substance passing from one drum into the next succeeding drum.

18. An apparatus for separating the liquid and solid content of substances, comprising means for subjecting a continuous stream of the substance to a progressively increasing liquid separating force, and means utilizing the liquid separating force for rearranging the constituents of the substance between each application of the liquid separating forces so that each particle of the substance will be equally subjected to the liquid separating forces.

19. An apparatus for separating the liquid and solid content of substances, comprising a series of concentric, superposed drums having perforated sides, each succeeding drum of the series being larger than the preceding one, the sides of the uppermost drum being vertically arranged, and the sides of the other drums being arranged at an angle.

20. An apparatus for separating the liquid and solid content of substances, comprising a series of rotating drums having perforated walls in which the substance is subjected to centrifugal force, the drums having open tops so that as the drums rotate the substance passes over the rims thereof, each succeeding drum being arranged to receive the substance from the preceding drum and means for directing the substance as it passes from one drum to the next so that the constituents of the substance are rearranged before it is subjected to centrifugal force in the next drum.

21. An apparatus for separating the liquid

and solid content of substances, comprising a series of rotating drums having perforated walls, means for feeding a continuous stream of the substance to the first drum, the drums having open tops so that the rotation of the drums causes the substance to be ejected from them, a casing for inclosing the drums and means connected with the inner surface of the casing for causing the substance ejected from one drum to pass into the next succeeding drum.

22. An apparatus for separating the liquid and solid content of substances which comprises a series of drums having perforated side walls, means for feeding the substance to the drums, means for rotating the drums and means interposed between the drums for catching the liquid separated from the solid content of the substance in any one drum and preventing it from passing into the next succeeding drum.

23. An apparatus for separating the liquid and solid content of substances comprising a series of rotating drums in which the substance is subjected to centrifugal force, means for feeding a continuous stream of the substance to the first drum, means for utilizing the centrifugal force to feed the substance from one drum into the next succeeding drum, and means for regulating the quantity of the substance permitted to be subjected to the centrifugal force in the first drum.

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