

June 3, 1930.

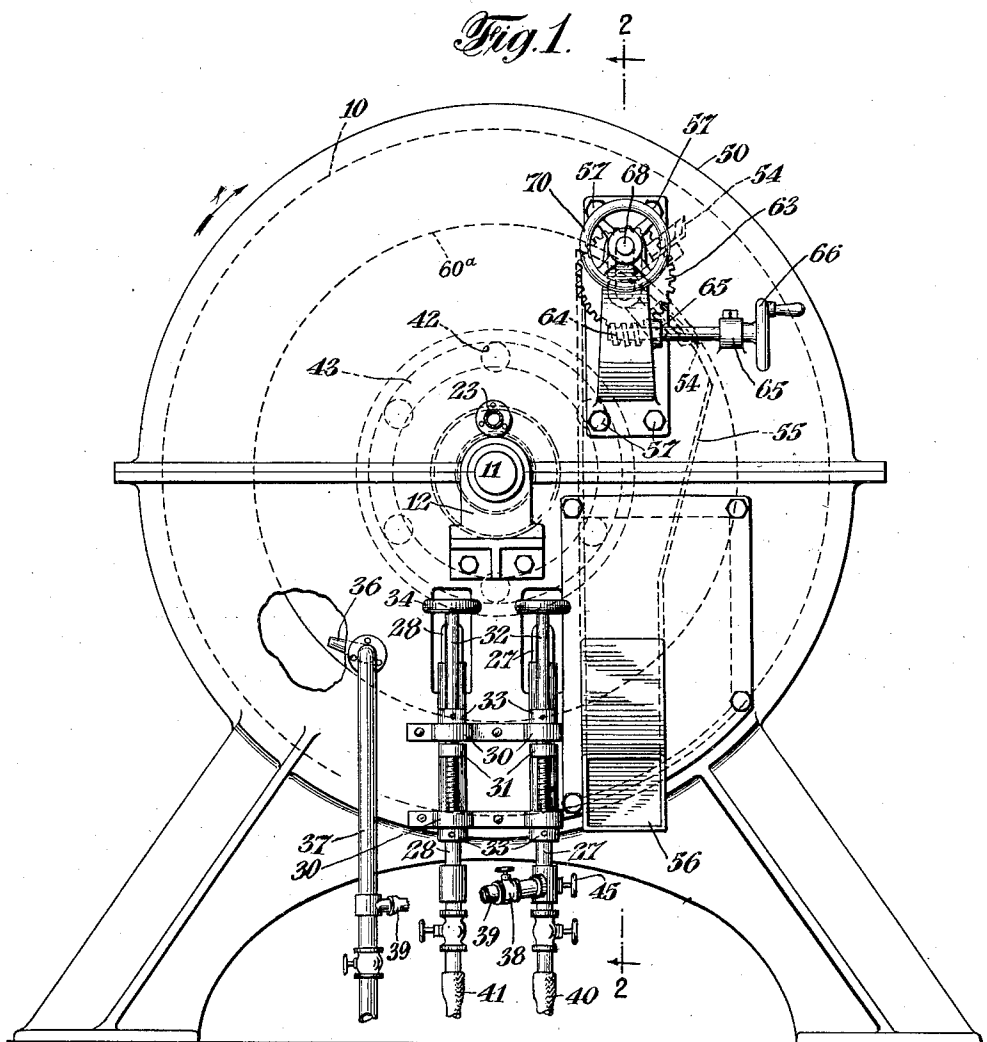
L. P. SHARPLES

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CENTRIFUGAL TREATMENT OF SUBSTANCES

Filed March 12, 1927

3 Sheets-Sheet 1



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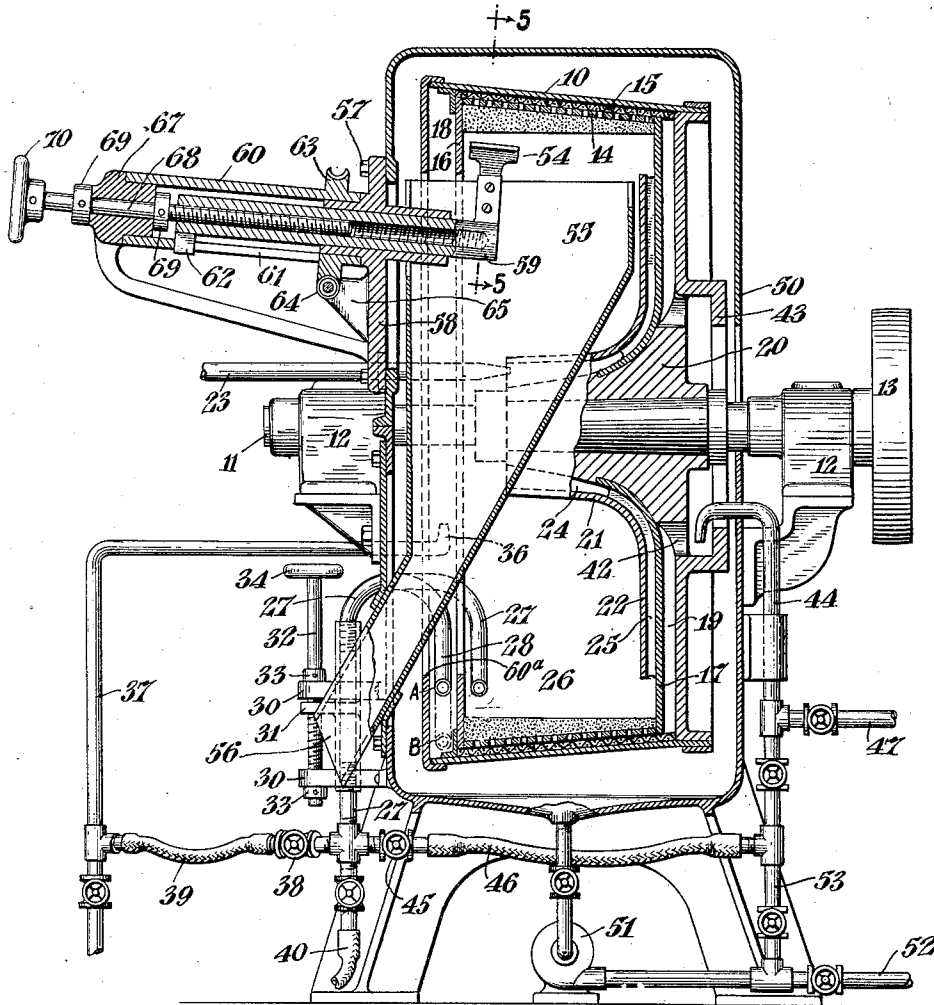
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CENTRIFUGAL TREATMENT OF SUBSTANCES

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3 Sheets-Sheet 2

Fig. 2.



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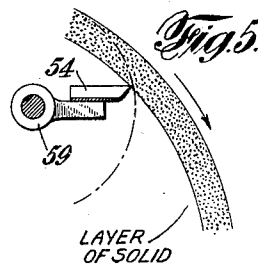
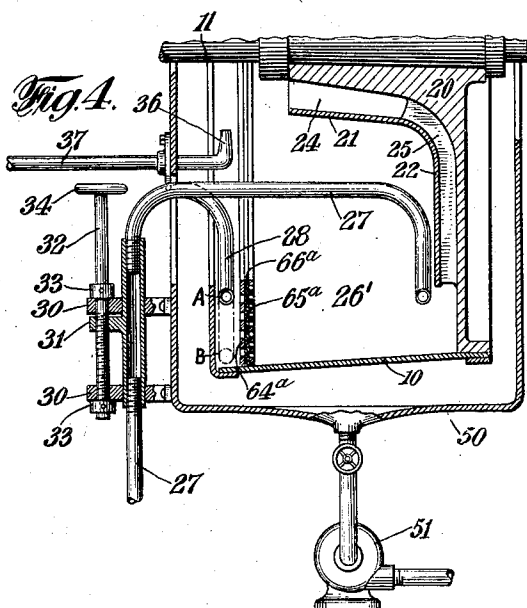
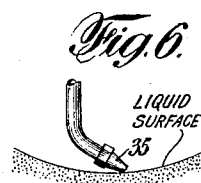
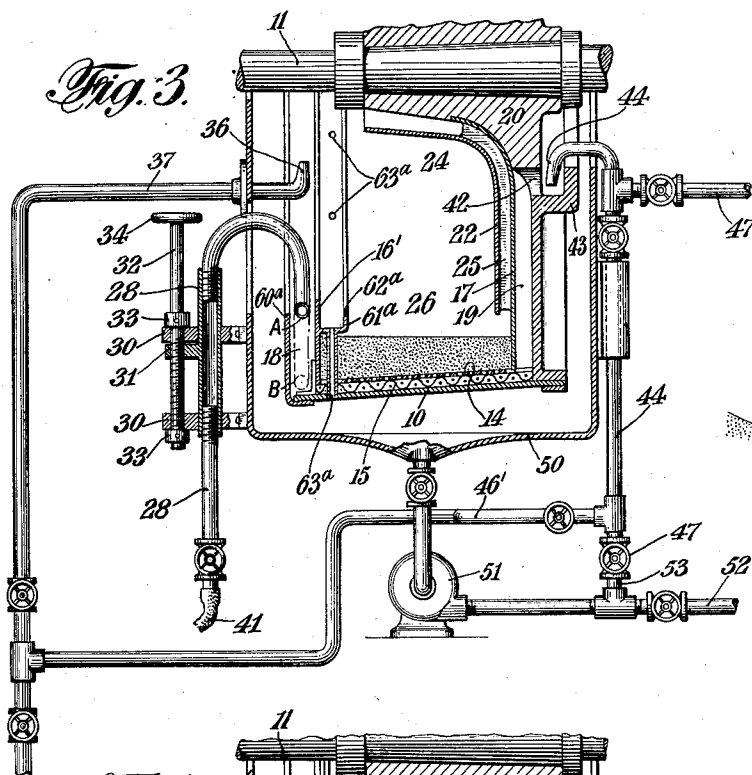
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CENTRIFUGAL TREATMENT OF SUBSTANCES

Filed March 12, 1927

3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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CENTRIFUGAL TREATMENT OF SUBSTANCES

Application filed March 12, 1927. Serial No. 174,975.

This invention relates to a centrifugal process and apparatus and particularly to a process and apparatus wherein solid particles are centrifugally separated from mixtures thereof with liquids.

In the practice of my invention solid particles are centrifugally separated from liquids by sedimentation under the action of centrifugal force with the consequent formation of a cake or layer of solid particles and the liquids are drained from that cake or layer by centrifugal force. Also, in the practice of my invention, a cake or layer of solid particles that has been so produced by sedimentation under the influence of centrifugal force, and which has or has not been previously so drained of liquid by centrifugal force, may be centrifugally washed or otherwise centrifugally treated with liquid while under the influence of centrifugal force. And, in accordance with my invention, a cake or layer of solids produced by sedimentation under the action of centrifugal force may be removed from centrifugal mechanism that is capable of so forming it and that is capable of draining liquids from it centrifugally and that may be capable of subjecting such cake to washing or other treatment by liquids under centrifugal force, by an auxiliary tool, preferably without change of speed of rotation of the centrifugal mechanism.

In accordance with my invention mixtures of liquids and solids, which mixtures are of a wide range of characteristics and proportions but particularly mixtures in which the solid constituent of the mixture is in fine particles and constitutes a small percentage of the mixture, are introduced into an imperforate centrifugal bowl and subjected to the action of centrifugal force to separate the solids from the liquids by sedimentation and to form a layer or cake of solids in the bowl. During the building up of such a cake or layer, the liquid may be removed from the bowl by being centrifugally discharged therefrom over a weir or by being skimmed out. In accordance with my invention the bowl in which the cake is so formed is provided with means whereby a liquid may be centrifugally drained from the cake. Thus, as one

embodiment of my invention the cake may be so formed in a compartment of the centrifugal bowl, which compartment is separated from the remainder of the bowl by a perforated partition, and the liquid is removed, as by skimming, from that remaining portion of the bowl in effecting such centrifugal draining of the cake so produced. Such a bowl, therefore, effects centrifugal separation by sedimentation and then centrifugal draining or straining; and this operation is carried out in accordance with my invention regardless of whether the cake floats upon, or sinks into, the liquid under the action of centrifugal force during the formation of the cake. Also, in accordance with my invention a cake that has been so formed may, with or without preliminary employment of the draining or straining step above described, be subjected to centrifugal washing or other centrifugal treatment with liquid, while under the action of centrifugal force, in various ways. For example, liquid may be withdrawn from the compartment in which the cake is formed and reintroduced into the other compartment of the bowl, or vice versa or a liquid of any desired characteristics may be introduced into the compartment of the bowl in which the cake is not formed and removed from the other compartment of the bowl or vice versa; and other variations of the liquid-washing or liquid-treating operation are described herein or will be apparent to those using my invention. Such variations include passing the liquid through the cake in a radially inward or a radially outward direction or in the general direction of the axis of rotation. In other words the liquid may be introduced to the cake at any point and withdrawn therefrom at a point operatively remote from the point of introduction. As a matter of economy or to improve a process in which my invention is applied, a newly formed cake may be washed with liquid that has been used for a second washing of a previously formed cake.

An important advantage of my invention resides in the fact that the effectiveness of a washing or treating of the cake with liquid is

greatly increased because the residual liquid of the cake is reduced to a relative low proportion of the cake in the centrifugal straining or draining operation as compared with the proportion of water remaining in a body of the same solids after mere gravity draining or common mechanical squeezing. By so thoroughly removing from the cake the liquid of an earlier washing as little as half as much liquid is necessary to attain the same effect in a subsequent washing, as compared with the amount of liquid necessary for a subsequent washing of a cake or mass from which the liquid of a previous washing has been removed merely by gravity draining or squeezing, or even for a washing of a cake formed by centrifugal force within a body of liquid and not thereafter centrifugally drained.

In accordance with my invention a cake of solid material that has been so produced and so treated is removed from a centrifugal bowl by an auxiliary tool and apparatus embodying my invention comprises a centrifugal bowl and associated mechanism whereby a cake may be so produced and so treated and it embodies means whereby such a cake may be removed from such bowl.

Other objects and advantages of my invention will appear from the following description wherein the construction and operation of one form of apparatus embodying my invention is set forth for the purpose of aiding in the understanding of my invention but with the understanding that my invention is not limited to the illustrative embodiment described.

In the drawings which accompany the specification and in which like reference characters indicate similar parts,

Fig. 1 is an elevation of apparatus embodying my invention and whereby my process may be practised.

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

Fig. 3 is a sectional view, with parts broken away, of a modification.

Fig. 4 is a sectional view, with parts broken away, of a modification.

Fig. 5 is a partial sectional view on the line 5—5; and

Fig. 6 is a detail view.

Referring to the drawings in which are shown illustrative embodiments of my invention, which are subject to modification within the spirit of my invention, an imperforate centrifugal bowl 10 is mounted for rotation upon a shaft 11 that is supported in bearings 12 and is provided with a pulley 13 or similar driving element.

Within the bowl 10 and co-axial therewith is a perforate or pervious partition or screen 14 that is spaced from the inner wall of bowl 10 and is held in spaced relation therefrom by a spacing member 15, a convenient

form of which is a woven wire screen or fabric, that will permit free flow of liquid between screen 14 and bowl 10. Screen 14 may be of any suitable form so long as it holds back solid particles to a desired degree. Within bowl 10 and spaced from one end thereof is a disk 16 that extends radially inward from partition 14 and forms with the end of bowl 10 a compartment that is usually a liquid compartment 18 and which forms with the space between screen 14 and the inner wall of the bowl, an auxiliary compartment. Within the bowl and spaced from the other end thereof is a partition 17 that extends radially inward from screen 14 and forms with said other end of the bowl a compartment 19.

Within the bowl and surrounding the hub 20 thereof is a plate having a conical portion 21 and a disk-like portion 22. This plate extends in spaced relation with the hub 20 and the plate 19 to provide a supply passage 24 into which substances are introduced through pipe 23. Extending radially within supply passage 24 are wings 25 which ensure that substances introduced into supply passage 24 will attain substantially the speed of the bowl by the time they pass from supply passage 24 into the bowl proper. Supply passage 24 leads into the main separating compartment 26 of the bowl, which lies between partitions 16 and 17 and radially inward of screen 14.

The bowl being imperforate a mixture of solid particles with liquid, when introduced through supply 23, is separated by sedimentation or subsidence into a layer of solid particles and a layer of liquid, as compared with the separation which occurs in a perforate centrifugal shell in which the solid is retained in such perforate shell and the liquid is thrown out through the perforations in a straining or draining operation. While the mixture is being supplied to bowl 10, the bowl will fill up until the inner surface of the liquid, when the solid is heavier than the liquid, lies at or radially outward of the inner edge of partition 16 and a layer or zone of solid particles will form on screen 14. Then clear liquid may be skimmed from the surface of the liquid in the main compartment 26 by a skimmer 27; and this operation proceeds until a suitable body of solid particles has been collected in the bowl by centrifugal subsidence. Or, since partition 17 does not engage the inner wall of the bowl 10 and liquid will assume the same level in the compartment 18 that it assumes in compartment 26, liquid may be skimmed from compartment 18 by skimmer 28; but usually clearer liquid is obtainable from the inner surface of liquid in the main compartment.

After a body of solid particles is separated out and collected in compartment 26 by centrifugal sedimentation and the supply of mixture to the bowl is stopped, skimmer 28 may

be moved successively to radially outer positions thereby withdrawing more and more liquid from the bowl with the result that a body of solid particles is subjected to a centrifugal draining or straining without interruption of the influence of centrifugal force. By making bowl 10 frusto-conical in form skimmer 28 will skim liquid from a point radially outward of any part of the body of solids. Other bowl formations may be employed to accomplish the same purpose.

Adjustability of the radial distance of skimmers 27 and 28 from the bowl axis is obtained by mounting the skimmers slidably in brackets 30 and providing them with lugs 31 through which is threaded a shaft 32 that is mounted for rotation in brackets 30 and held against longitudinal motion therein by collars 33. By turning shaft 32 by means of hand wheel 34, lug 31 is moved longitudinally of the shaft 32 and the skimmer to which lug 31 is attached is adjusted at desired radial distance from the axis. The skimmers may have any suitable construction and may be provided with nozzles 35, it being understood that the bowl rotates in the direction of the arrow in Figures 1, 5 and 6.

After a cake or layer of solid particles has been produced by a centrifugal sedimentation, and, if desired, after such a cake has been centrifugally drained, the cake may be treated with liquid of suitable characteristics or washed while still under the action of centrifugal force and that liquid may be caused to pass through the solid particles by centrifugal sedimentation. For this purpose liquid may be supplied by pipe 37 and discharged through nozzle 36 into compartment 18. And, liquid withdrawn by skimmer 27 may, subject to control by valve 38 be passed through pipe 29 into pipe 37. Liquid withdrawn from compartment 26 by skimmer 27 may be passed to storage through flexible pipe 40 and liquid withdrawn through skimmer 28 may be passed to storage through flexible pipe 41. Moreover, the end of the bowl is provided with openings 42 that lead into compartment 19 and on the end of the bowl surrounding openings 42 is an annular trough 43 and into that annular trough liquid may be introduced by pipe 44 whereupon it will pass into compartment 19 and into the space between screen 14 and the inner wall of the bowl. By skimming liquid out of the main compartment 26, by means of skimmer 27, liquid introduced either into compartment 18 or compartment 19 is caused to pass radially inward through the body of solid particles by centrifugal subsidence and is skimmed off by means of skimmer 27. Under control of valve 45 liquid skimmed from main compartment 26 by skimmer 27 may be passed through flexible pipe 46 to the pipe 44 so that it enters the bowl and again passes by centrifugal sedimentation through the body

of solid particles therein for the purpose of washing or treating the solid particles. Pipe 47 is provided for supplying other liquids through pipe 44 to the centrifugal bowl. Liquids centrifugally discharged from the bowl as by passing over edge 60 may be collected in a casing 50 that surrounds the bowl and passed by means of pump 51 to storage through pipe 52 or by pipe 53 to pipe 44.

From the foregoing it will be apparent that with the apparatus so far described a mixture of liquid with solid particles can be introduced into an imperforate centrifugal bowl and liquid can be discharged centrifugally through skimmers withdrawing liquid from either the main compartment or an auxiliary compartment while a layer of solid particles is formed by sedimentation. And, it will be apparent that the layer formed by sedimentation may be centrifugally drained. It will also be apparent that the layer or cake of solids, before or after centrifugal draining, may be treated with liquid under the action of centrifugal force by introducing such liquid through the main supply passage 24 or into either compartment 18 or 19 while withdrawing the liquid from compartment 26. Or liquid may be withdrawn from compartment 18. And, liquid withdrawn from one compartment may be reintroduced into another compartment to effect continuous washing or treatment under the influence of centrifugal force by the same body of liquid. Moreover, if there are no wings in compartment 19, liquid introduced therein will tend to lag behind the rotating bowl and in passing through the space between screen 14 and the inner wall of the bowl, will flush out that space. Discontinuance of supply to the bowl and draining thereof may be carried out at any time during cake forming or washing operations.

To remove a cake or layer of solid particles from the bowl without stopping it an auxiliary tool 54 is so constructed and mounted as to dislodge the solid particles and to cause them to drop into a hopper 55 positioned within casing 50 and extending into bowl 10, the solid particles discharging through spout 56. In the construction shown a tool support 58 extends through an opening in casing 50 and is held in place therein by bolts 57. The tool support 58 comprises a bearing supporting an internally threaded bar 59 on which is mounted tool 54. Surrounding an outward extension of support 58 is a cylindrical member 60 provided with a groove 61 in which slides a lug 62 carried by bar 59, whereby cylindrical member 60 and bar 59 are caused to rotate together and bar 59 is permitted to move longitudinally in member 60. Cylindrical member 60 carries a worm gear 63 that is engaged by a worm 64 mounted in brackets 65 and operated by hand wheel 66. Thus rotation of member 60 will, as shown in Fig. 5,

cause tool 54 to swing about the axis of rod 59 and toward and from screen 14 and into engagement with a cake carried thereby. Fitting into the outer end of cylindrical member 60 is a bracket member 67 that is supported from the casing 50, and passing through bracket member 67 is a threaded shaft 68 that is held against axial movement by collars 69 fixed thereto. Shaft 68 is threaded into bar 59 and when rotated by hand wheel 70 tool 54 is caused to move back and forth along the face of the cake in bowl 10. Thus, while solid particles are still under the influence of centrifugal force they may be withdrawn from a bowl that is so constructed as to form a cake by sedimentation and to drain the cake and to permit of its washing or other treatment with liquid.

In the construction shown in Figure 3 the withdrawal of liquid from the main compartment 26 of bowl 10 is effected by passing the liquid over a weir and discharging it from the bowl 10. The annular partition 16', which divides the main compartment 26 from compartment 18 extends from the screen 14 to a point radially inward of the edge 60^a of the adjacent end of bowl 10 so that liquid would pass around the outside of partition 16' and over the edge 60^a but it could not pass over the inner edge of partition 16' and over the top of the liquid in compartment 18 and then over the edge 60^a as is possible in the construction shown in Figure 2. An annular member 61^a of angular cross-section is carried by partition 16' and forms with it a trough, the edge 62^a of which constitutes a weir that fixes the radial position of the surface of liquid in compartment 26. Liquid flowing over weir 62^a is centrifugally discharged from the bowl through tubes 63^a that pass through the shell of bowl 10. During the separation of solid particles from a liquid by sedimentation, liquid will pass over weir 62 and through pipe 63^a into casing 50 and may be withdrawn therefrom by pump 51 and passed through pipe 52. Centrifugal draining of the body of solid particles may be effected by skimming liquid from compartment 18 by advancing the end of skimmer 28 from position A to position B at which latter position it skims liquid from substantially the radially outermost point of the interior of the bowl. Washing of the cake may be effected by passing liquid supplied by pipe 37 either into compartment 18 through nozzle 36 or into compartment 19 through pipes 46' and 44. Washing may be effected by passing liquid collected in casing 50 through pipes 46' and 37 and nozzle 36 into compartment 18 or by pipe 44 into compartment 19. In washing operations liquid may be supplied through nozzle 36 and pipe 44 at the same time. Washing liquid may also be introduced through supply nozzle 23. Furthermore skimmer 28 could be used for removing liquid during the building up of the

cake by sedimentation or for removing, washing, or treating liquid. If washing or treating liquid is introduced into compartment 18 or compartment 19 or into both of those compartments and passed out over weir 62^a the washing liquid passes radially inward by sedimentation through the layer of solid particles. If washing liquid is introduced through supply nozzle 23 and withdrawn from compartment 18 it passes radially outward by sedimentation through the layer of solid particles in the bowl. Obviously weir 62^a must lie radially outward from edge 60^a of the end of the bowl.

In the construction shown in Figure 4 the imperforate centrifugal bowl 10, which in all modifications shown is of the type wherein separation is effected by sedimentation, is provided with a perforate or pervious partition 16^a extending radially inward from the inner wall thereof and forming with the end of the bowl a compartment 18' leaving the remainder of the bowl as a main compartment 26'. Partition 16^a preferably consists of plate 64^a having relatively large perforations and a screen 65^a having perforations or porosity of desired magnitude and an intermediate spacing member 66^a which may conveniently consist of a sheet of woven wire screen that will permit circulation of liquid between plate 64^a and screen 65^a. Within the spirit of my invention skimmer 27 may act upon the surface of liquid in the bowl at different points, and in the construction shown in Figure 4 skimmer 27 is shown as acting upon the liquid at the opposite end of the bowl from the point at which skimmer 28 is located. The operation whereby a cake is formed by sedimentation in the construction shown in Figure 4 will be obvious from the foregoing description of the operation of my invention, and in the washing of such a cake fresh liquid or previously used wash liquid may be introduced by nozzle 36 into compartment 18' and withdrawn by skimmer 27. Washing liquid may be introduced through supply nozzle 23 and withdrawn by skimmer 28. Draining of the cake can be effected by adjusting skimmer 28 from position A to position B. Other operations of the construction shown in Figure 4 will be apparent from the foregoing description.

While several modes of operation have been set out in detail whereby separation of solids from liquids by centrifugal sedimentation is effected with consequent formation of a layer of solid particles and whereby centrifugal draining is effected and whereby washing is effected under the influence of centrifugal force, other modes of procedure, particularly in connection with the introduction and withdrawal of substances and especially introduction and withdrawal of wash liquid, will be apparent. For example, the solid particles may be lighter than the liquid and the cake

formed will float upon the surface of the liquid and will recede to the screen 14 or to the inner wall of the bowl 10 in the centrifugal draining operation; and in the washing of such a floating cake the wash liquid will preferably be supplied to the surface thereof and be withdrawn from a radially outward point thereof.

My invention is capable of general application and is well adapted to the extracting of water soluble substances from malt and to the recovery of the yeast from its mixture with solid particles.

While I have described my invention in details it is to be understood that it is not limited to the details set forth but includes such modifications and variations as fall within the hereunto appended claims. In this connection it is pointed out that while I have referred to mixtures of liquids with solid particles, the liquids of such mixtures may be solutions having various compositions and differing in viscosity and the solid particles may be of varying character including semi-solid substances.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In the centrifugal treatment of substances, the process comprising subjecting a mixture of liquid with solid particles to the action of centrifugal force and thereby separating the liquid from the solid particles by sedimentation and retaining the solid particles under the influence of centrifugal force and thereby forming a cake of solid particles, then withdrawing liquid from a radially outward point of the material under the influence of centrifugal force and thereby draining the cake, and treating the solid particles with liquid while the solid particles are still under the influence of centrifugal force.

2. In the centrifugal treatment of substances, the process comprising subjecting a mixture of liquid with solid particles to the action of centrifugal force and thereby separating the liquid from the solid particles by sedimentation and centrifugally discharging the liquid while retaining the solid particles under the influence of centrifugal force and thereby forming a cake of solid particles, supplying treating liquid to one point of the solid particles and withdrawing it from the solid particles at a point remote from said first named point while the solid particles are under the influence of centrifugal force.

3. In the centrifugal treatment of substances, the process comprising subjecting a mixture of liquid with solid particles to the action of centrifugal force and by centrifugal sedimentation separating the liquid from the solid particles while preventing discharge of liquid from a radially outward point of the material under the influence of centrifugal force, and thereafter centrifugally draining the liquid from the solid particles.

4. In the centrifugal treatment of substances, the process comprising subjecting a mixture of liquid with solid particles to the action of centrifugal force and by centrifugal sedimentation separating the liquid from the solid particles, thereafter centrifugally draining the liquid from the solid particles, and treating the drained solid particles with liquid while the solid particles are still under the influence of centrifugal force.

5. In the centrifugal treatment of substances, the process comprising subjecting a mixture of liquid with solid particles to the action of centrifugal force and by centrifugal sedimentation separating the solid particles from the liquid and thereby forming a cake stationary in the direction of the axis of rotation, and while the solid particles are still under the influence of centrifugal force introducing treating liquid to the solid particles at one point thereof, withdrawing the liquid from the solid particles at a point remote from said first named point, and reintroducing the treating liquid to the solid particles at substantially said point of introduction.

6. In the centrifugal treatment of substances, the process comprising subjecting a mixture of liquid with solid particles to the action of centrifugal force and by centrifugal subsidence separating the liquid from the solid particles while preventing discharge of liquid from a radially outward point of the material under the influence of centrifugal force, thereafter centrifugally draining the solid particles while still under the influence of centrifugal force, and thereafter withdrawing the solid particles from the influence of centrifugal force by an auxiliary tool.

7. In the centrifugal treatment of mixtures of liquid with solid particles, the process comprising introducing the mixture into the influence of centrifugal force and separating the liquid from the solid particles by centrifugal subsidence while preventing discharge of liquid from a radially outward point of the material under the influence of centrifugal force, and thereafter withdrawing liquid from a radially outer point of the material under the influence of centrifugal force and thereby centrifugally draining the solid particles.

8. In the centrifugal treatment of a mixture of liquid with solid particles, the process comprising introducing the mixture into the influence of centrifugal force and thereby separating the liquid from the solid particles by centrifugal subsidence, and so supplying treating liquid to and withdrawing it from the material under the influence of centrifugal force as to centrifugally pass such treating liquid through the solid particles stationary in the direction of the axis of rotation that are under the influence of centrifugal force.

9. In the centrifugal treatment of a mixture of liquid with solid particles, the process comprising introducing the mixture into the influence of centrifugal force and thereby separating the liquid from the solid particles by centrifugal subsidence while preventing discharge of liquid from a radially outward point of the material under the influence of centrifugal force, thereafter centrifugally draining the solid particles in the centrifugal bowl, and thereafter removing the drained solid particles from the rotating bowl.

10. In the centrifugal treatment of substances, the process comprising maintaining solid particles under the influence of centrifugal force and stationary in the direction of the axis of rotation, and while the solid particles are still under the influence of centrifugal force introducing a treating liquid to one point thereof and removing the treating liquid from the solid particles at another point thereof.

11. In the centrifugal treatment of a mixture of liquid with solid particles, the process comprising continuously introducing the mixture into the influence of centrifugal force and separating the liquid from the solid particles by centrifugal subsidence while centrifugally discharging liquid from only a radially inward point of the material under the influence of centrifugal force until a desired quantity of solid particles has been collected, and thereafter centrifugally draining the solid particles.

12. In the centrifugal treatment of a mixture of liquid with solid particles, the process comprising continuously introducing the mixture into the influence of centrifugal force and separating the liquid from the solid particles by centrifugal subsidence while centrifugally discharging liquid from the material under the influence of centrifugal force until a desired quantity of solid particles has been collected in the rotating bowl, and then withdrawing liquid from a radially outer point of the rotating material and thereby centrifugally draining the solid particles.

13. In the centrifugal treatment of substances the process comprising introducing a mixture of liquids and solids into the influence of centrifugal force and by sedimentation producing a cake of the solids, and passing a treating liquid by centrifugal sedimentation through the cake of solid particles and withdrawing the treating liquid from the influence of centrifugal force while maintaining said solids under the influence of centrifugal force.

14. In the centrifugal treatment of substances the process comprising passing a treating liquid by centrifugal sedimentation through a body of solid particles under the influence of centrifugal force, and then cen-

trifugally draining the body of solid particles while it is still under the influence of centrifugal force.

15. In the centrifugal treatment of substances the process comprising introducing a mixture of liquids and solids into the influence of centrifugal force and by sedimentation producing a cake of the solids, and passing a treating liquid by centrifugal sedimentation radially through the cake of solid particles and withdrawing the treating liquid from the influence of centrifugal force while maintaining said solids under the influence of centrifugal force.

16. In the centrifugal treatment of substances the process comprising maintaining a body of solid particles under the influence of centrifugal force and substantially stationary in the direction of the axis of rotation, and while said particles are still under the influence of centrifugal force passing a treating liquid by centrifugal sedimentation radially inward through the body of solid particles by introducing a treating liquid to one point of said body and removing the treating liquid from a radially inward point thereof.

17. In a centrifugal machine, an imperforate bowl mounted for rotation, a pervious partition within the bowl and dividing it into a main compartment and an auxiliary compartment, means for introducing into said main compartment a substance to be centrifugally treated, and means for withdrawing liquid from said auxiliary compartment at radially different distances from the axis of rotation to the bowl.

18. In a centrifugal machine, an imperforate bowl mounted for rotation, a pervious partition within the bowl and dividing it into a main compartment and an auxiliary compartment, means for introducing into said main compartment a substance to be centrifugally treated, means for withdrawing liquid from a radially inward point of said main compartment, and means for withdrawing liquid from a radially outer point of said auxiliary compartment.

19. In a centrifugal machine, an imperforate bowl mounted for rotation, a pervious partition within the bowl and dividing it into a main compartment and an auxiliary compartment, means for introducing a substance into said main compartment, means for withdrawing liquid from a radially inward point of said main compartment, and means for introducing liquid into said auxiliary compartment.

20. In a centrifugal machine, an imperforate bowl mounted for rotation, a pervious partition within the bowl and dividing it into a main compartment and an auxiliary compartment, means for introducing a substance into said main compartment, and means for withdrawing liquid from a radially

inward point of said main compartment and introducing it into said auxiliary compartment.

21. In a centrifugal machine, an imperforate bowl mounted for rotation, means for introducing liquid to solid material in the rotating bowl at one point, and means for withdrawing said liquid from the solid material at a point remote from said first named point, one of said points being radially outward of said solid material.

22. In a centrifugal machine, an imperforate bowl mounted for rotation, a partition within the bowl and in part pervious and dividing the bowl into a main compartment and an auxiliary compartment having a part surrounding said main compartment and a part at one end of said main compartment, means for introducing into said main compartment a substance to be treated, and means for withdrawing liquid from said auxiliary compartment at different radial distances from the axis of rotation.

23. In a centrifugal machine, an imperforate bowl mounted for rotation, a partition within the bowl and in part pervious and dividing the bowl into a main compartment and an auxiliary compartment having a part surrounding said main compartment and a part at one end of said main compartment, means for introducing into said main compartment a substance to be treated, means for withdrawing liquid from a radially inward point of said main compartment, and means for introducing liquid into said auxiliary compartment.

24. In a centrifugal machine, an imperforate bowl mounted for rotation, a pervious partition within the bowl and coaxial therewith and spaced from the wall thereof, a solid disk extending radially inward from said partition and spaced from the end of said bowl, means for introducing a substance into said bowl within said pervious partition and on one side of said disk, and means for withdrawing liquid from said bowl on the other side of said disk.

25. In a centrifugal machine, an imperforate bowl mounted for rotation, a pervious partition within the bowl and coaxial therewith and spaced from the wall thereof, a solid disk extending radially inward from said partition and spaced from the end of said bowl, means for introducing a substance into said bowl within said pervious partition and on one side of said disk, and means for withdrawing liquid from said bowl on the other side of said disk at different radial distances from the axis of the bowl.

26. In a centrifugal machine, an imperforate bowl mounted for rotation, a pervious partition within the bowl and coaxial therewith and spaced from the wall thereof, a solid disk extending radially inward from said partition and spaced from the end of

said bowl, means for introducing a substance into said bowl within said pervious partition and on one side of said disk, means for withdrawing liquid from said bowl at a radially inward point on the same side of said disk, and means for introducing liquid to said bowl on the other side of said disk.

27. In a centrifugal machine, an imperforate bowl mounted for rotation, a pervious partition within the bowl and coaxial therewith and spaced from the wall thereof, and means for flushing the space between said pervious partition and the wall of the bowl.

28. In a centrifugal machine, an imperforate bowl mounted for rotation, a pervious partition within the bowl and coaxial therewith and spaced from the wall thereof, means for introducing a substance into said bowl and within said partition, and means for withdrawing liquid from the space between said partition and said bowl.

29. In a centrifugal machine, an imperforate bowl mounted for rotation, a pervious partition within the bowl and coaxial therewith and spaced from the wall thereof, means for introducing a substance into said bowl and within said partition, means for withdrawing liquid from said bowl at a point radially inward of said partition, and means for supplying liquid to said bowl between said partition and the wall thereof.

30. In the centrifugal treatment of mixtures of liquid with solid particles, the process comprising subjecting the mixture to the influence of centrifugal force in an imperforate sedimentation rotor and thereby separating the solid particles from the liquid by centrifugal sedimentation while preventing discharge of liquid from a radially outward point of the material under the influence of centrifugal force, and then centrifugally draining liquid from the solid particles in said rotor while said rotor remains imperforate.

31. In the centrifugal treatment of mixtures of liquid with solid particles, the process comprising subjecting the mixture to the influence of centrifugal force in an imperforate sedimentation rotor and thereby separating the solid particles from the liquid by centrifugal sedimentation while preventing discharge of liquid from a radially outward point of the material under the influence of centrifugal force, and then withdrawing liquid from the rotor at substantially the radially outermost point of its interior and thereby draining said solid particles while said rotor remains imperforate.

32. In the centrifugal treatment of substances, the process comprising continuously introducing a mixture of liquid with solid particles into the influence of centrifugal force and separating the liquid from solid particles by centrifugal subsidence while centrifugally discharging liquid from the in-

fluence of centrifugal force from only a radially inward point of the material under the influence of centrifugal force until a desired quantity of solid particles has been collected, discontinuing the supply of mixture, and then withdrawing liquid from a radially outward point of the collected solids while they are still under the influence of centrifugal force and thereby centrifugally draining the solid particles.

33. In the centrifugal treatment of substances, the process comprising continuously introducing a mixture of liquid with solid particles into the influence of centrifugal force and separating the liquid from solid particles by centrifugal subsidence while centrifugally discharging liquid from the influence of centrifugal force until a desired quantity of solid particles has been collected, discontinuing the supply of mixture, then withdrawing liquid from a radially outward point of the collected solids while they are still under the influence of centrifugal force and thereby centrifugally draining the solid particles, and then passing a treating liquid through the body of solid particles by centrifugal sedimentation without substantial cessation of the influence of centrifugal force.

In testimony whereof, I have signed my name to this specification.

LAURENCE P. SHARPLES.

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