

Sept. 2, 1941.

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2,254,455

CONTINUOUSLY OPERATING CENTRIFUGE

Filed Feb. 4, 1939

2 Sheets-Sheet 1

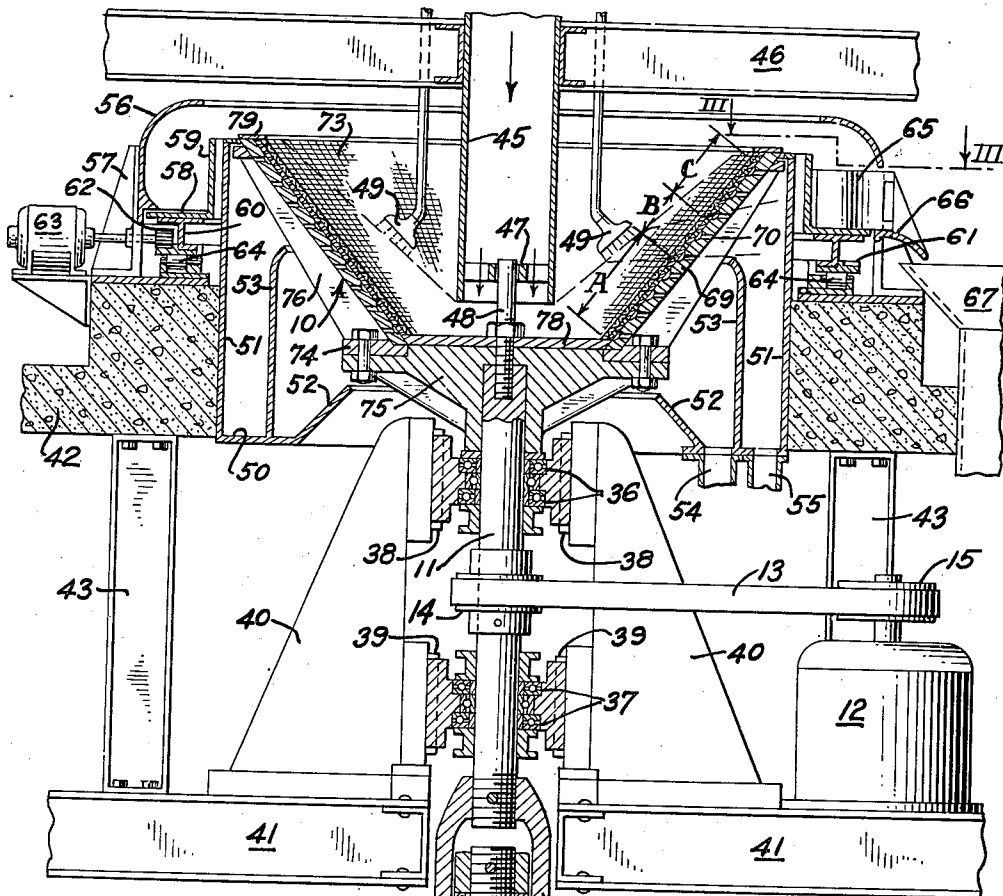
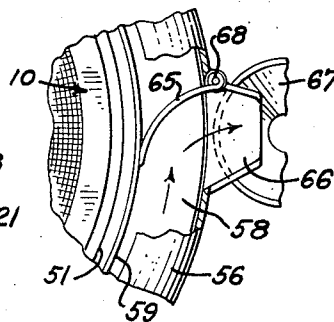
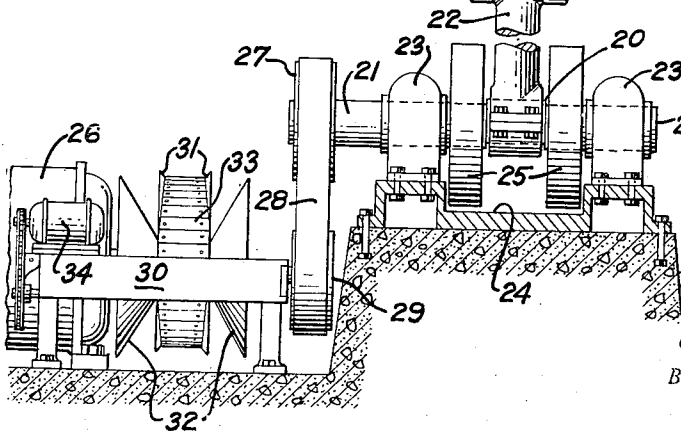


Fig. 1.

Fig. 3.



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2 Sheets-Sheet 2

Fig. 2.

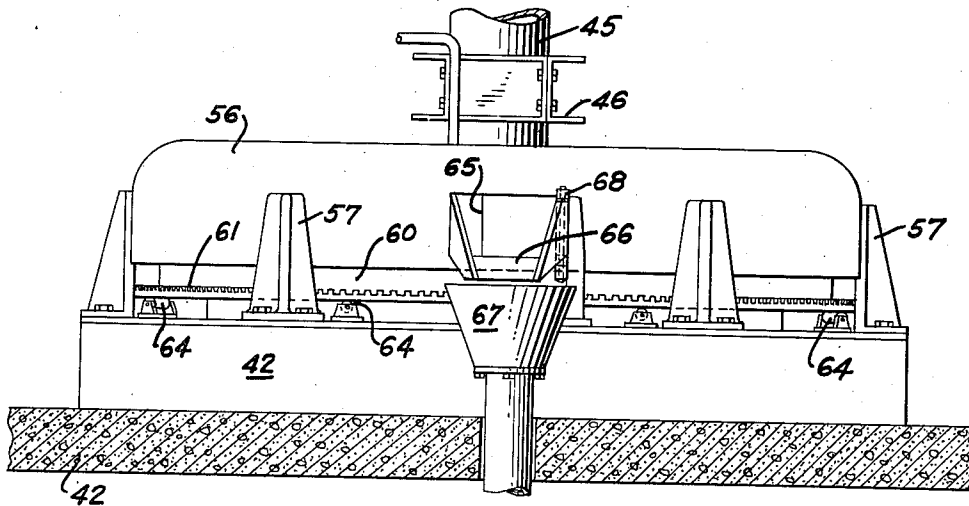


Fig. 4.

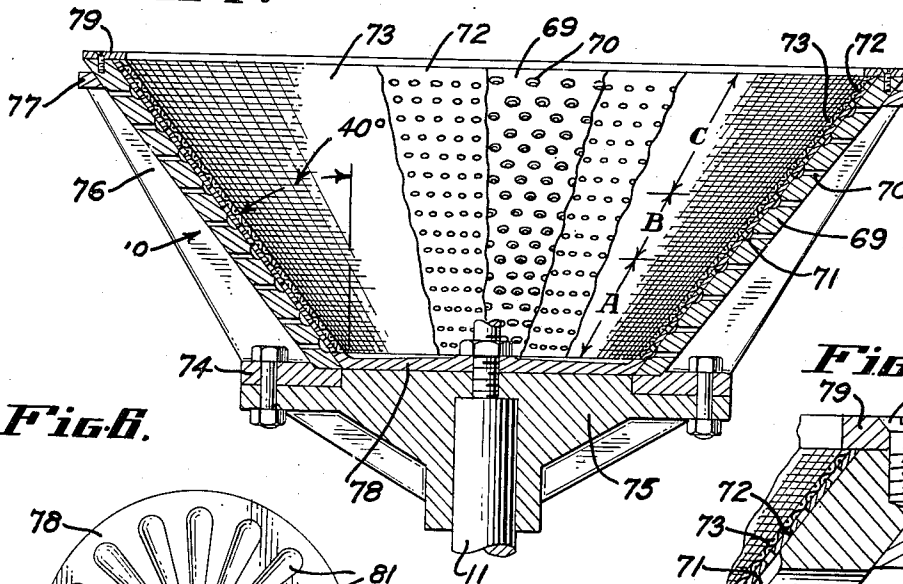


Fig. 6.

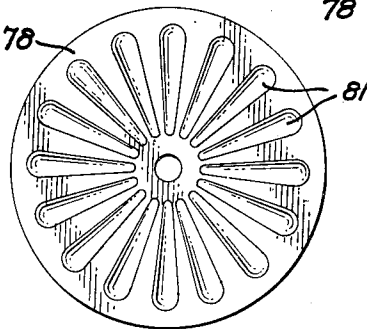
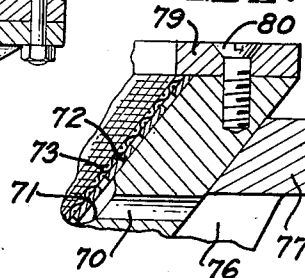


Fig. 5.



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2,254,455

CONTINUOUSLY OPERATING CENTRIFUGE

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Application February 4, 1939, Serial No. 254,627

7 Claims. (Cl. 210—68)

My present invention relates to centrifugal filtering and/or separating devices and more particularly to a new and improved form of centrifugal machine in which the filtering and/or separating operation is carried out in a continuous manner.

An object of the invention is to provide a new, novel and practical centrifugal device for filtering or separating solid matter, insoluble or soluble, from fluids or liquids of different specific gravity and one which is particularly adapted for use in separating molasses or syrup from massecuite or concentrated granular sugar solutions.

Another object of the invention is to provide a continuously operating centrifugal machine in which a centrifugally operating receptacle in addition to being operated at a high rotating speed is also reciprocated axially in a new and novel manner to advance the solids or semi-solids therethrough.

Another object of the invention is to provide in combination with a centrifugally operating receptacle, means for reciprocating said receptacle while in rotation and which can be adjusted to reciprocate the receptacle at any predetermined frequency independently of its rotative speed.

Another object of the invention is to provide a continuously operating centrifugal separating machine in which there is provided a filtering zone, a purging zone and a drying zone through which the material under treatment will progress in a continuous manner and one in which the filtrate will be collected and separated from the purging fluid.

Another object of the invention is to provide in combination with a continuously operating centrifugal machine of the character described, in which the solids are discharged at the rim of a centrifugally operating receptacle, means for collecting the solids and directing them into a desired receptacle or channel.

At the present time the most successfully operating centrifugals in use for separating molasses from sugar solutions and/or purging concentrated granular sugar solutions consists of a centrifugally operating receptacle having a perforate cylindrical side wall against which the material to be filtered is thrown by centrifugal force and there held while the more liquid portion filters out through the perforations of said side wall. With this type of centrifuge when molasses and/or syrup is being separated from concentrated sugar massecuite, the solids build up on the inside surface of the receptacle where after a predetermined period of spinning, to discharge the syrup,

the solids are subjected to a spray of wash water for a predetermined period and then allowed to spin for an additional predetermined time for the purpose of discharging the wash water and partially drying the crystallized solids. After this operation the centrifugal receptacle is slowed down and a stationary plow is swung into position against the side wall of the receptacle to dislodge the accumulated solids which are then discharged through an opening at the bottom of the receptacle. With this type of apparatus it will be readily seen that the operation thereof consumes considerable time due to the necessity for a periodic charging and discharging of the receptacle. It is, therefore, a further object of the invention to provide a centrifugally operating machine which will overcome this difficulty and which when once put into operation can be operated in a continuous manner.

Other objects and advantages will be in part evident to those skilled in the art and in part pointed out in the following description, taken in connection with the accompanying drawings, wherein there is shown by way of illustration and not of limitation a preferred embodiment of the invention.

In the drawings, wherein like numerals refer to like parts throughout the several views;

Figure 1 is a vertical sectional view through a device constructed in accordance with the invention,

Figure 2 is a side elevation of a portion of the apparatus illustrated in Figure 1 of the drawings,

Figure 3 is a fragmentary plan view partially in section taken along line III—III of Figure 1 looking in direction of arrows,

Figure 4 is a fragmentary sectional view showing the details of the centrifugally operating receptacle,

Figure 5 is an enlarged sectional view of a detail of the receptacle as illustrated in Figure 4, and

Figure 6 is a plan view of a further detail of the receptacle illustrated in Figure 4.

Before proceeding with a detailed description of the apparatus chosen for illustration it may be said that the present invention contemplates a centrifugal machine having a receptacle with a perforate outwardly flaring or frusto-conical side wall over which the material subject to separation is advanced in a continuous manner through what may be termed three zones of treatment; namely, a zone A, near the bottom of the receptacle where the thick syrup and/or raw filtrate is separated from the material undergo-

ing treatment; a zone B, where wash water is applied to the rotating mass for purging the solids after filtration; and a zone C, where the material is subjected to a centrifugal drying operation after which the solids are discharged from the centrifugally operating receptacle.

To produce the above result, the angle of the outwardly flaring wall of the centrifugal receptacle is so proportioned with respect to the axis of rotation and the consistency of the material being treated that the solids and/or semi-solids will be retained in the receptacle against discharge therefrom by centrifugal force. In order to provide for a continuous flow of the material undergoing filtration through the machine, the invention, therefore, in addition to the centrifugal separation of the liquids and solids, also contemplates a reciprocation of the centrifugal receptacle at a frequency which will create and maintain a jogging movement of the material undergoing treatment along the filter forming perforate outwardly flaring wall of the receptacle. The frequency of the reciprocation and the magnitude thereof is so chosen with respect to the particular material under treatment that the movement of the material through the machine will be properly timed to effect the desired filtration thereof.

In addition to the novel construction and operation of the machine, as broadly set forth above, the invention also contemplates an association with the centrifugally operating receptacle of a plurality of separating conduits by means of which the filtrate, the wash water or diluted filtrate, and the recovered solids are each directed into separate channels for future treatments.

Reference is now made to the drawings for a detailed description of apparatus embodying the present invention. As illustrated in Figure 1, the centrifugal receptacle, designated generally by the numeral 10, is mounted upon the upper end of a vertically disposed shaft 11 that is adapted to be driven at a high rotative speed by means of a motor 12. As here shown, the motor 12 is connected in driving relation with the shaft 11 by means of a belt 13 which passes over pulleys 14 and 15 carried respectively by the shaft 11 and the motor 12. In addition to its rotary movement, the shaft 11 together with the centrifugal receptacle 10 is also adapted to be driven with a reciprocating movement and for this purpose the lower end of the shaft 11 carries a yoke-like member 16 in which there is journaled a short co-axially arranged stub shaft 17 upon the lower end of which there is a clevis-like member 18. The clevis-like member 18 has a short horizontal shaft 19 and connected between this horizontal shaft 19 and an offset or crank forming portion 20 of a horizontally disposed shaft 21 there is a pitman or connecting rod 22. The shaft 21 is journaled in a horizontal position upon bearings 23 that are carried by a foundation plate 24 arranged therebeneath. In order to counterbalance the weight of the vertically moving parts associated with the shaft 11, when in operation the shaft 21 also carries two counterbalancing fly wheels 25, one of which is located at each side of the crank forming portion 20 thereof. The shaft 21 with its crank forming portion 20 and the counterbalancing fly wheels 25 is adapted to be driven by a second motor 26. For this purpose the shaft 21 is provided with a pulley 27 over which a belt 28 passes. The belt 28 connects with a pulley 29 which is driven at a vari-

able speed through a speed reducing device 30 of the type commonly referred to in the trade as a Reeves variable transmission. For the purpose of this description it will be sufficient to state that this Reeves transmission comprises two sets of adjustably mounted and opposed cone pulley surfaces 31 and 32 over which a power transmitting belt 33 passes. With this type of transmission it is possible to vary the relative speeds of the driving and driven shafts to produce any desired ratio of reduction by simultaneously enlarging the belt contacting diameter of the driving shaft while reducing the belt contacting diameter of the driven shaft or vice versa, depending upon whether an increase or a decrease in the speed of the driven shaft is desired. These drives are made for both manual and automatic adjustments. The device illustrated in the drawings is of the automatic type and for controlling the adjustments thereof there is shown a small motor 34. At this point it should be noted that the stub shaft 17 is journaled in the yoke-like member 16 by means of roller bearings 35 which provide what might be termed a reciprocating step bearing at the lower end of the shaft 11. Surrounding the shaft 11 and mounted in axially spaced relation there are two bearings 36 and 37 that are slidably mounted between guides 38 and 39 which are carried by oppositely arranged stationary pedestals 40. As shown, the pedestals 40 and the driving motor 12 are mounted upon a structural iron support 41 which is suspended beneath a floor 42 of a building by means of struts 43 and the horizontally disposed shaft 21 is shown as mounted upon a foundation 44 which may be the next lower floor of a refinery building. With this arrangement it will be seen that the centrifugal receptacle 10 will be located with respect to the floor 42 so that an attendant can observe and take care of the operation of the machine in a convenient manner. For this purpose the invention contemplates that when installed each machine will have arranged adjacent thereto a suitable control board which will carry suitable speed indicating devices and switches by means of which the motors 12, 26 and 34 may be controlled from this point.

In addition to the above described elements and for the purpose of continuously feeding the material to be treated to the centrifugally operating receptacle 10, the invention also contemplates the provision of a centrally disposed feeding conduit 45 through which the massed material is introduced into the receptacle 10. This feeding conduit 45 may be of any suitable size. In practice it is contemplated that it will connect with a hopper (not shown) from which the material will flow by gravity. The feeding conduit 45 is supported upon a structural iron frame 46 and at its lower end it carries an internal spider 47 having a central opening through which a centering stud 48 carried by the shaft 11 extends. This provides for an exact centering of the feeding conduit 45 with respect to the centrifugal receptacle 10 during its operation. Arranged around the feeding conduit 45 and extending into the receptacle 10 to a point intermediate the top and bottom thereof there is one or more wash water dispensing spray nozzles 49. As illustrated, the spray nozzles are located substantially midway between the top and bottom of the receptacle 10 so that when in operation the perforate side wall of the receptacle 10 will be divided into the three distinct zones referred to hereinabove. As indicated in this figure of

the drawings, zone A, which comprises the filtering zone extends from the bottom of the receptacle 10 to a point along the wall thereof where the wash water leaves the same. The zone B covers that portion of the perforate wall of the receptacle 10 through which the major portion of the wash water is discharged therefrom, while the zone C comprises the remaining portion of the perforate wall of the receptacle 10. In connection with the washing aspect of this invention it should be stated that while I have shown two spray nozzles 49 arranged one on each side of the material feeding conduit 45, it is contemplated that even a larger number of these spray nozzles 49 may be used. It is also conceivable that the washing operation may be carried out in accordance with the present invention by providing a single annular or ring type of nozzle which will extend entirely around the axis of the receptacle 10 so as to discharge a substantially annular sheet of water at high pressure against the surface of the material as it flows outwardly along the perforate side wall of the receptacle 10.

For the purpose of collecting the filtrate and wash water discharged by centrifugal force from the centrifugally operating receptacle 10 there is an annular housing 50 having an outer cylindrical wall 51 that extends upwardly to a point adjacent the upper end of the receptacle 10. This housing 50 also has a conical inner wall 52 that extends inwardly toward the bottom of the receptacle 10. Extending upwardly between the side walls 51 and 52 there is an inner annular partition 53 which divides the housing 50 into two annular compartments. The partition 53 extends upwardly to a point substantially midway along the perforate side of the receptacle 10 where it will intercept the molasses and/or other filtrate thrown out by centrifugal force from the receptacle 10 and at the same time permit the wash water and/or diluted filtrate to escape over the top thereof. With this arrangement it will be seen that the annular partition 53 divides the housing 50 into what may properly be termed two annular receptacles, the inner one of which is adapted to collect the raw filtrate and the outer one of which is adapted to collect the wash water and/or diluted filtrate. Attached to the bottom of the housing 50 and leading from the inner annular chamber, there is a conduit 54 by means of which the filtrate may be conducted to a subsequent station for a future treatment, and leading from the outer annular chamber there is a similar conduit 55 by means of which the wash water and/or diluted filtrate may be conducted to any suitable point.

For the purpose of collecting the filtered solids discharged over the rim of the centrifugally operating receptacle 10, as is also more clearly shown in Figure 2, there is an outwardly disposed stationary overhanging shroud-like enclosure means 56. This shroud 56 is shown as supported upon the foundation floor 42 by means of brackets or pedestals 57 that are arranged in spaced relation therearound. Rotatably mounted within the shroud 56 there is an annular platform 58 upon which the filtered solids are adapted to be deposited by the shroud 56 as they are discharged by centrifugal force from the receptacle 10. The annular platform 58 has an inner vertically extending wall 59 which extends upwardly to a point corresponding to the inside wall 51 of the annular chamber 50. The annular platform 58 is shown as carried by a supporting ring 60 to which there is attached a large an-

nular gear rack 61 with which a pinion 62 driven by a motor 63 is adapted to mesh. The ring gear 61 is supported upon roller bearings 64 arranged in spaced relation in a circle; therebelow so that when the motor 63 is energized it will operate to drive the platform 58 at a suitable speed around the axis of the receptacle 10. As the platform 58 is thus rotated it will collect the discharged solids and carry them around to a point along its path of travel where a stationary plow or scoop-like member 65 will divert the solids from the platform 58 and outwardly through a discharge outlet 66 and into a suitable hopper or other form of receptacle 67.

Upon referring to Figure 3, it will be noted that the plow or scoop-like member 65 is pivotally mounted at its outer end upon a hinge-like support 68 arranged at one side of the discharge outlet 66 of the shroud 56. This plow or scoop-like member 65 may be straight or curved as shown and when installed its inner free end will be pressed tightly against the inner wall 59 of the platform 58 so as to dislodge all solids carried around by the platform 58 to this point.

Before continuing with the description of the invention as illustrated in the remaining figures of the drawings, it should be here pointed out that while the shaft 11 which carries the centrifugal receptacle 10 is shown as mounted upon bearings 36 and 37 that move therewith and as having a pulley 14 also movable therewith, it is to be understood that this shaft 11 may be mounted so as to move axially within stationary bearings and that the pulley 14 may also be mounted and held against axial movement by providing a splined connection between it and the shaft 11 which will permit the shaft 11 to move axially therethrough as it is rotated by the motor 12.

Upon referring to Figure 4, it will be noted that the perforate outwardly flaring side wall of the centrifugal receptacle 10, except for its outwardly flaring characteristic, is not unlike prior art receptacles of the so-called cylindrical type. In other words, the receptacle 10 comprises an outer portion 69 of relatively heavy construction in which there is provided closely spaced and staggered apertures 70 through which the filtrate may pass, the apertures 70 being provided with an enlarged or counter-sunk inlet 71. The portion 69 is shown as frusto-conical and as covered upon its inside surface with a metal screen 72 which may be of wire mesh or in the form of a finely perforated relatively thin sheet of metal. As a further filtering medium, where a relatively fine mesh surface is desired, the screen 72 may be covered with bolting cloth 73. These superimposed filtering media will provide any degree of fineness in the filter surface that may be desired. The outer frusto-conical wall 69 provides for strength and the inner screen and bolting cloth provide the fineness of mesh. As a mounting for the perforate side wall 69 of the centrifugal receptacle 10, the invention is shown as contemplating a spider-like member having an inner annular portion 74 that is adapted to be firmly secured upon a flange or supporting member 75 secured to the upper end of the vertical shaft 11. The inner annular portion 74 of the spider-like member carries a plurality of radially spaced outwardly flaring arms 76 that are connected together at their upper ends by means of a ring 77. As a means for securing the frusto-conical side wall 69 of the receptacle 10 upon the spider-like member

there is a central clamping plate 78 which when clamped upon the supporting member 75 will firmly hold the frusto-conical side wall 69 thereupon. At the outer rim of the receptacle 10 there is also provided an annular ring 79 over which the solids must pass when discharged from the receptacle 10.

As shown in Figure 5 of the drawings, the annular ring 79 is firmly secured to the frusto-conical portion 69 by means of screws 80. The inner annular surface of this ring 79 is preferably positioned so that it will form a substantially cylindrical extension at the outer end of the frusto-conical filtering surface formed as above described. An important aspect of this ring, as contemplated by the invention, is that its axial dimension should preferably be substantially equal to the magnitude of the reciprocating movement imparted to the centrifugal receptacle 10 when in operation.

As shown in Figure 6 of the drawings and in order to expedite the impartation of rotary motion to the material to be treated, as it is introduced through the feed conduit 45, the clamping plate 78 is provided with radially arranged depressions or flutings 81.

It is believed that the operation of the present invention will be evident from the above description of the apparatus and, therefore, it should only be necessary to add that the material to be filtered will be introduced through the conduit 45 at a steady and regulated rate of flow. This can be accomplished by any suitable means; for example, a float and/or pressure responsive controlling means may be disposed in the conduit 45 so as to maintain a predetermined head or flow of the more or less fluid material. As the material thus introduced through the conduit 45 enters the centrifugal receptacle 10, it will flow outwardly and into contact with the flaring perforate side wall thereof where the syrup and/or other liquid will be thrown outwardly through the filtering elements 70, 72 and 73. At the same time the solids will move along the filter surface and be subsequently washed by the purging water introduced through the spray nozzle 49. After being washed the solids or semi-solids will be subjected to a drying as they move outwardly through the zone C, after which they will be discharged from the centrifugal receptacle 10 and collected upon the rotating platform 58 from which the solids will be finally directed into the hopper 67 by means of the plow 65.

As illustrated, it will be noted that the angle of outward flaring provided in the perforate side wall of the receptacle 10 is shown as approximately 40° from a true cylinder. This angle of flaring has been found to be particularly well suited to the filtration of concentrated sugar massecuite. At this point, however, it should be stated that the angle of flaring from a true cylinder may vary to form 10° to 45°. Experiments indicate that the angle of flaring should not exceed 45° where a high rotative speed is used. In other words, the angle of flaring is dependent upon the rotative speed to be maintained in the receptacle 10. For example, where the rotative speed is of a high order, the angle of flaring may be somewhat reduced. Another consideration which necessarily influences the angle of outward flaring in the perforate side wall of the receptacle 10 is in the frequency and magnitude of the vertical reciprocation of the receptacle 10. For example, as the magnitude of the

reciprocation increases, the angle of outward flaring from the cylindrical may be decreased, whereas with a relatively small magnitude of reciprocating movement, the angle of outward flaring may be increased. In experiments so far made in connection with continuous filtration of sugar massecuite, it has been found that the rotative speed of the centrifugal receptacle 10 may range from 900 to 1750 R. P. M. It has been also found that the angle of flaring may vary approximately from 20° to 45°, while the magnitude of axial movement imparted to the centrifugal receptacle 10 may vary from $\frac{1}{8}$ of an inch to one inch with a frequency varying from 100 to 4000 reciprocations per minute. In this latter connection it appears that with an increase in the frequency of reciprocation of the receptacle 10, the angle of flaring of its perforate side wall may be decreased.

While I have in the above attempted to briefly set forth some of the principal operating characteristics of the apparatus, it is to be understood that the values given are in no way to be considered as controlling, for with different materials the nature thereof will determine largely at what speed the receptacle 10 should be rotated and with what magnitude and frequency it should be reciprocated. Therefore, while I have, for the sake of clearness and in order to disclose my invention so that the same can be readily understood, described and illustrated a specific device and arrangement, I desire to have it understood that this invention is not limited to the specific means disclosed, but may be embodied in other ways that will suggest themselves to persons skilled in the art. It is believed that this invention is new and it is desired to claim it so that all such changes as come within the scope of the appended claims are to be considered as part of this invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a continuously operating centrifugal machine of the character described, the combination of a centrifugally operating receptacle having a conical outwardly flaring perforate side wall through which a filtrate may pass, means disposed centrally of said receptacle for introducing a solution containing solids for separation, a driving means for rotating said receptacle at an operative speed about a vertical axis, the degree of flaring in the side wall of said receptacle being so proportioned that the introduced solids of said solution will not slide thereover under the influence of centrifugal force alone, a second driving means operating independently of said first driving means for imparting a positive up and down movement of uniform magnitude to said receptacle in a direction parallel to its axis and irrespective of its speed of rotation, whereby the solids introduced into said receptacle will be discharged therefrom at a uniform rate with a jogging movement while said receptacle is in rotation.

2. In a continuously operating centrifugal machine of the character described, the combination of a centrifugally operating receptacle having a conical outwardly flaring perforate side wall through which a filtrate may pass, means disposed centrally of said receptacle for introducing a solution containing solids for separation, a driving means for rotating said receptacle about a vertical axis, the degree of flaring in the side wall of said receptacle being so proportioned that the introduced solids of said solution will not

slide thereover under the influence of centrifugal force alone, a second driving means operating independently of said first driving means for imparting a positive up and down movement of uniform magnitude to said receptacle in a direction parallel to its axis irrespective of its speed of rotation, whereby the solids introduced into said receptacle will be jogged outwardly along the wall of said receptacle and be discharged therefrom while said receptacle is in rotation, a mechanical speed changing power transmission device between said second driving means and said receptacle for changing the frequency of the up and down movements of said receptacle while it is in rotation to thus control the rate of discharge of the solids therefrom, and means associated with said receptacle adapted to collect the filtrate discharged through the perforate side wall of said receptacle and also the solids discharged over the rim thereof.

3. In a continuously operating centrifugal machine of the character described, the combination of a centrifugally operating receptacle having an outwardly flaring perforate side wall through which a filtrate may pass, means disposed centrally of said receptacle for introducing a solution containing solids for separation, a driving means for rotating said receptacle at a uniform speed about a vertical axis, means for spraying said solution and solids with water during rotation of said receptacle, a second driving means operating independently of said first driving means for imparting a positive up and down reciprocating movement of uniform magnitude to said receptacle in a direction parallel to its axis of rotation, whereby the solids introduced into said receptacle will be caused to move outwardly along the wall of said receptacle with a jogging movement and be discharged over the rim of said receptacle as it rotates, means associated with said second driving means for varying the frequency of the up and down movements of said receptacle to thus control the rate of movement of the solids along the wall thereof, separating means adapted to collect the filtrate and wash water discharged at different points along the perforate side wall of said receptacle as the solids move outwardly therealong, and means disposed outwardly at the rim of said receptacle adapted to collect the solids discharged from said receptacle.

4. In a continuously operating centrifuge of the character described in which a centrifugally operating receptacle is reciprocated axially to cause a jogging movement of the material to be filtered over a perforate wall of the receptacle, the combination of a receptacle forming member having an upwardly and outwardly flaring perforate filter surface, a driving means for rotating said receptacle at a centrifugally operative speed, a second driving means operating independently of said first driving means for imparting an axial reciprocating motion of uniform magnitude to said receptacle independently of its speed of rotation, whereby the solids introduced into said receptacle will be discharged therefrom with a jogging movement while said receptacle is in rotation, and a lip forming member carried by said receptacle providing a cylindrical continuation of the inner surface of said

receptacle over which the solids are jogged by the up and down movements of said receptacle, the cylindrical continuation provided by said lip forming member having an axial dimension substantially equal to the magnitude of the reciprocating movement, whereby the solids will be discharged from said receptacle in a uniform manner.

5. In a continuously operating centrifugal machine of the character described, the combination of a centrifugally operating receptacle having a frusto-conical outwardly flaring perforate side wall through which a filtrate may pass, means disposed centrally of said receptacle for introducing a solution containing solids for separation, means for rotating said receptacle about a vertical axis, the degree of flaring in the side wall of said receptacle being so proportioned that the introduced material will not slide thereover under the influence of centrifugal force, means for imparting a positive reciprocating movement to said shaft and receptacle in a direction parallel to the axis of rotation, whereby the solids of the material introduced into said receptacle will be jogged outwardly along the wall of said receptacle and be discharged therefrom while in rotation, and means for controlling said last means whereby the frequency of reciprocation of said shaft and receptacle may be varied while in rotation.

6. In a continuously operating centrifuge, the combination of a vertical shaft mounted for both axial and rotary movement, means for driving said shaft about its axis at a high rotative speed, a receptacle secured upon the upper end of said shaft and having a perforate filter forming side wall through which the liquid of a solids containing solution will pass under the influence of centrifugal force, means at the lower end of said shaft adapted to impart a positive reciprocating axial movement thereto while in rotation, and means for varying the frequency of said reciprocating axial movement during the operation and independently of the speed of the centrifuge.

7. In a continuously operating centrifugal machine of the character described, the combination of a vertically disposed shaft mounted for both axial and rotary movement, means for driving said shaft about its axis at a high rotative speed, a centrifugally operating separator receptacle carried by the upper end of said shaft adapted to receive a fluid mass having solids for separation, said receptacle having an outwardly flaring perforate filter forming side wall through which the fluids of said mass may pass under the influence of centrifugal force, a transversely disposed shaft having a crank forming portion disposed centrally below said vertical shaft, a pitman connected between the crank forming portion of said latter shaft and said vertical shaft, driving means for rotating said transversely disposed shaft, and means for changing the speed of rotation of said transversely disposed shaft, whereby the frequency of reciprocation of said vertically disposed shaft and centrifugally operating separator receptacle may be changed during the operation thereof.

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