March 12, 1963 P. STEINACKER 3,081,028

PERIODIC SLUDGE DISCHARGING CENTRIFUGAL DRUM SEPARATORS

Filed June 16, 1959 4 Sheets-Sheet 1

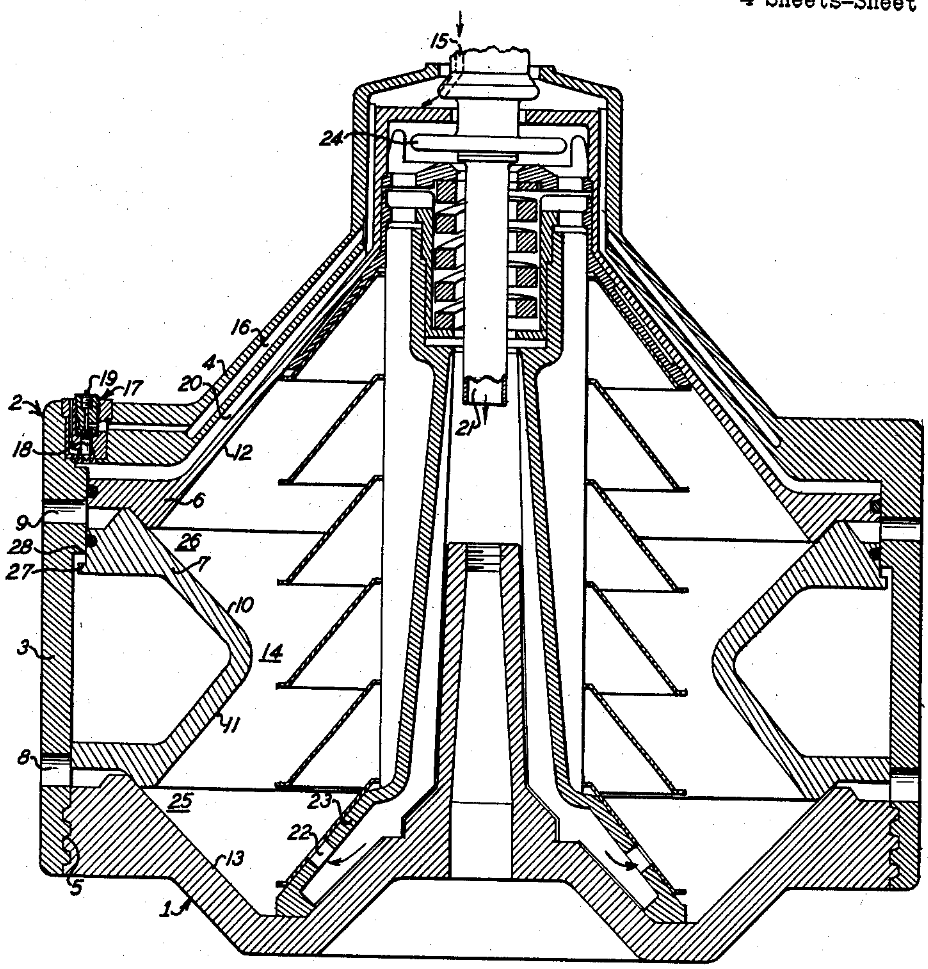

Fig. 1

INVENTOR.
PETER STEINACKER
BY
Burgess, Dinklage & Sprung
ATTORNEY

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Filed June 16, 1959 4 Sheets-Sheet 2

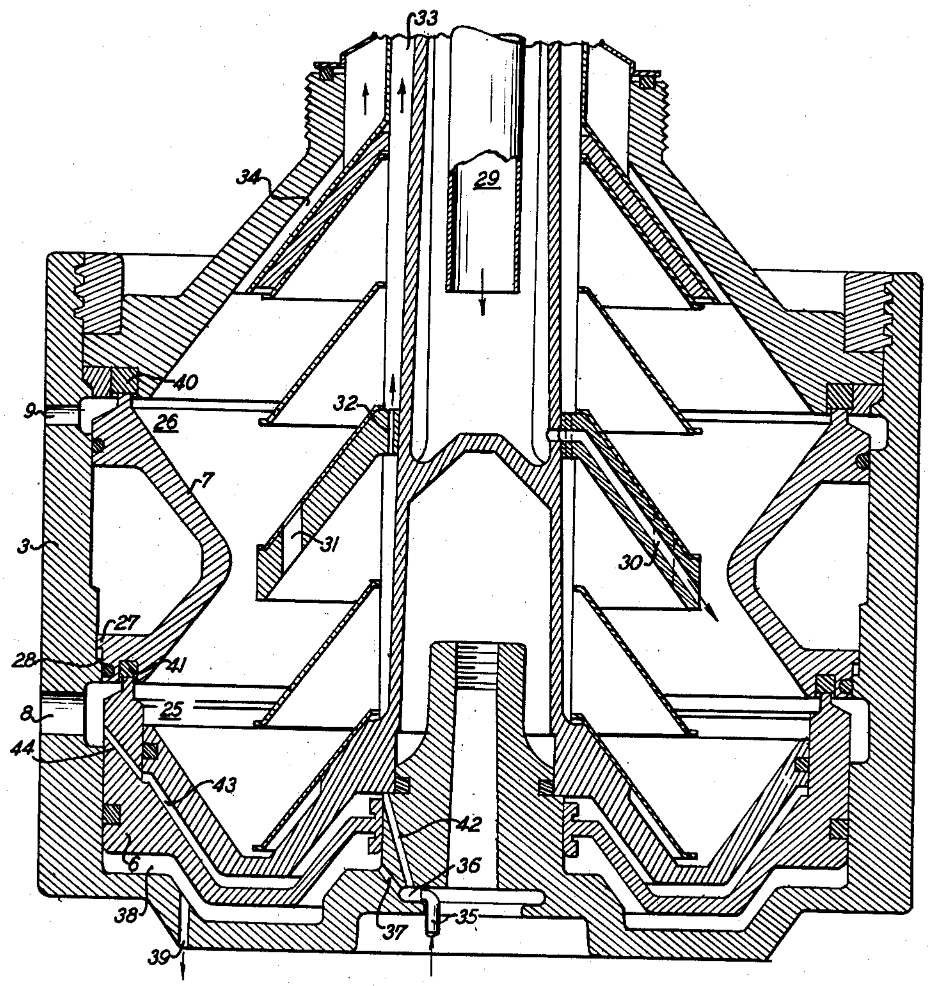

Fig. 2

INVENTOR.
PETER STEINACKER
BY
Burgess Dinklage & Sprung
ATTORNEYS

March 12, 1963 P. STEINACKER 3,081,028

PERIODIC SLUDGE DISCHARGING CENTRIFUGAL DRUM SEPARATORS

Filed June 16, 1959 4 Sheets-Sheet 3

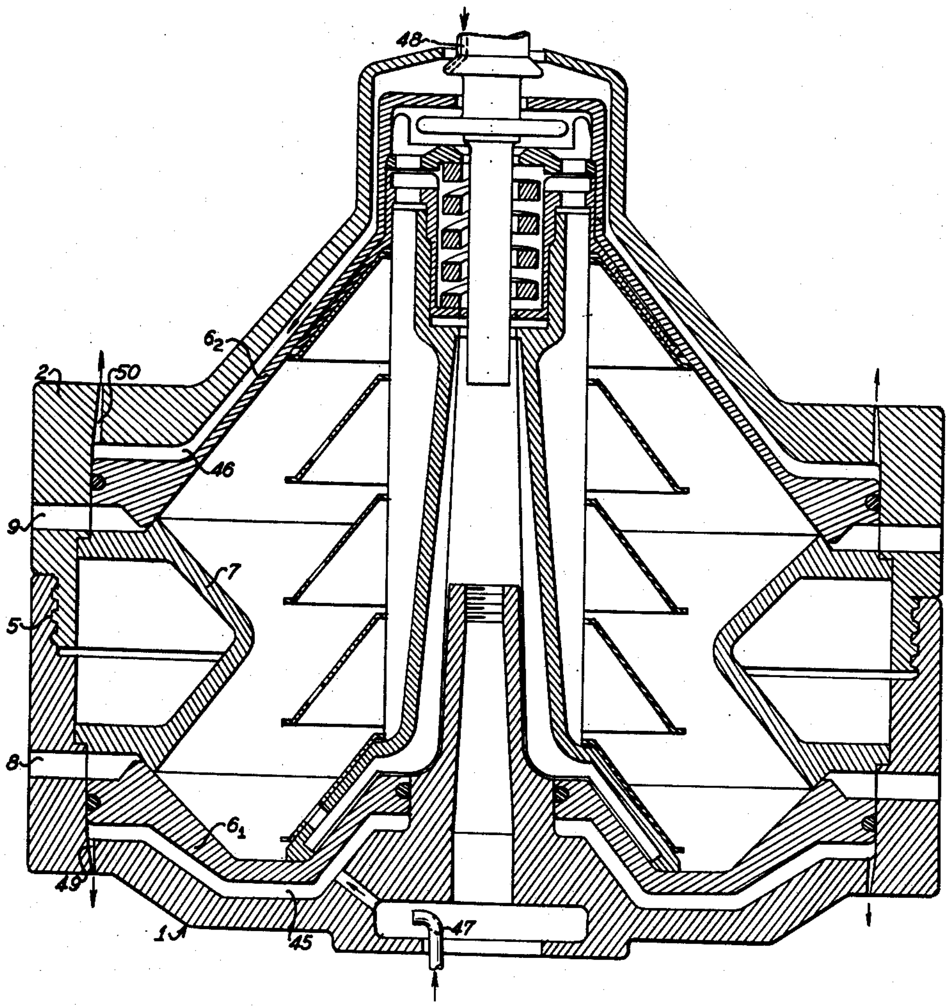

Fig. 3

INVENTOR.
PETER STEINACKER
BY
Burgess Dinklage & Sprung
ATTORNEYS

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PERIODIC SLUDGE DISCHARGING CENTRIFUGAL DRUM SEPARATORS

Filed June 16, 1959 4 Sheets-Sheet 4

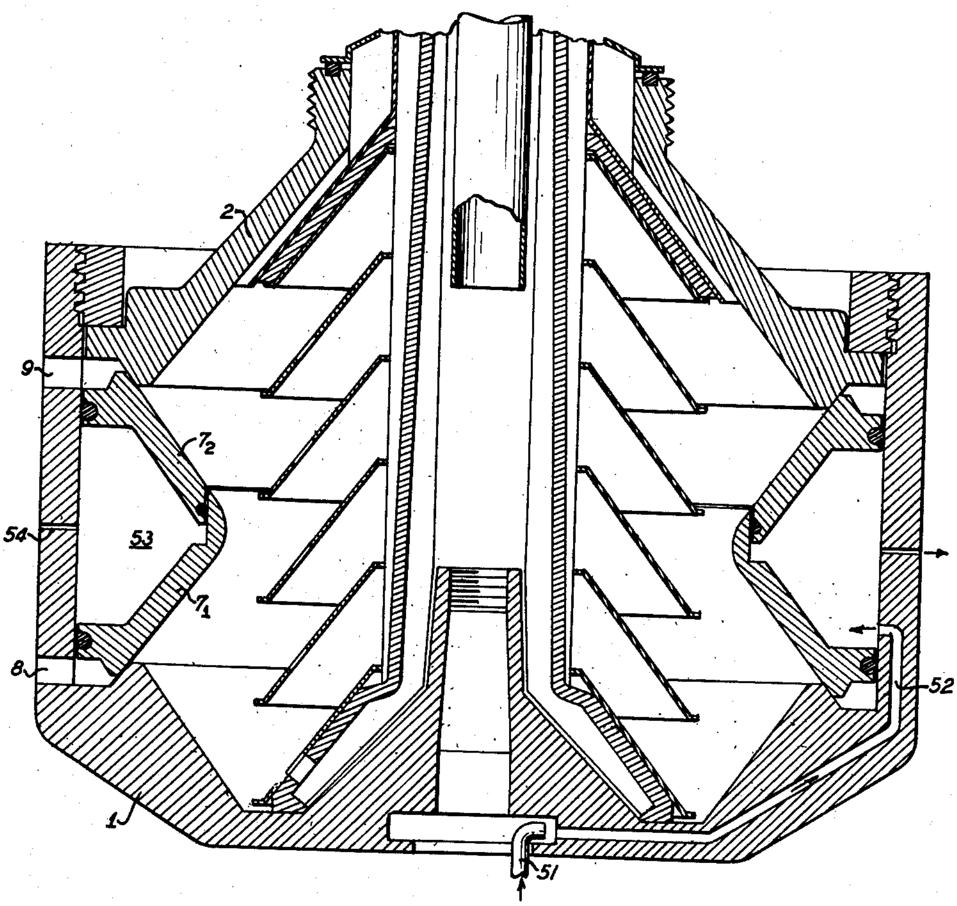

Fig 4

INVENTOR.
PETER STEINACKER
BY
Burgess Dinklage & Sprung
ATTORNEYS

United States Patent Office

3,081,028

Patented Mar. 12, 1963

3,081,028

PERIODIC SLUDGE DISCHARGING CENTRIFUGAL DRUM SEPARATORS

Peter Steinacker, Oelde, Westphalia, Germany, assignor to Westfalia Separator A.G., Oelde, Westphalia, Germany, a corporation of Germany

Filed June 16, 1959, Ser. No. 820,735
Claims priority, application Germany June 16, 1958
11 Claims. (Cl. 233—20)

This invention relates to improvements in periodic sludge discharging centrifugal separators for treatment of liquid-solid mixtures, and more particularly to such separators wherein the separated solids collected in the separating chamber are periodically discharged therefrom through outlet ports provided in the drum periphery.

Centrifugal separators which have bowls from which accumulated sludge may be periodically discharged are known. These separators may have a centrifugal bowl with peripheral sludge discharge openings which may be opened or closed by an axially moveable sleeve valve. The sleeve valve may be hydraulically operated in one or both directions.

In conventional centrifugal separators, to obtain a greater degree of separation of the solids from the liquids with which they are admixed, the drum separating chamber is usually provided with one or more axially positioned conical disc inserts. Since the separating capacity of the drum is approximately directly proportional to the quantity output of the entire disc surface area at any given number of revolutions per unit of time, by increasing the number of disc inserts a corresponding increase in separating capacity may be obtained. Nevertheless, this proportional relation is limited somewhat depending on the type and size of the solid particles in the mixture to be separated. To overcome this limitation, changes in drum construction must be made.

Thus, the separating capacity and/or the quantity output of the disc surface area may be accordingly increased by simply enlarging the axial height of the drum interior and providing a correspondingly greater number of disc inserts. In general, the number of revolutions need remain unchanged despite this axial increase.

In centrifugal drums having conically shaped sludge chamber walls and sludge outlet openings at the level of the greatest inside drum diameter, an elongation of the drum in axial direction must also lead to an enlargement of the drum diameter, if the angle of inclination of the walls defining the sludge chamber is to remain the same. With equal constructional materials and equal thickness of the various drum parts, however, such drum diameter enlargement also makes necessary a reduction in the number of revolutions per unit of time, in order not to exceed the permissible load and stress on the working parts. Unfortunately, upon decreasing the number of revolutions, a diminution of the centrifugal separation force also necessarily takes place which counteracts the intended capacity increase and in fact nullifies the same.

Thus, attempting to increase the capacity by increasing the drum diameter is not practical, since this would require a reduction in the number of revolutions, thereby decreasing the efficiency of the separation operations. By constructing the drum from comparatively higher grade materials and by increasing the thickness of the various drum parts, it is possible to offset the higher liquid pressures created, although these measures are not practical either, since a considerable increase in initial cost is involved. Moreover, with a heavier construction, operational costs are much higher due to the higher operating energy requirement.

It is an object of the invention to overcome the foregoing drawbacks and to provide a centrifugal drum having

an increased separator capacity which is simple and durable in construction and inexpensive to operate.

Other and further objects of the invention will become apparent from a study of the within specification and accompanying drawing in which,

FIG. 1 is a partial schematic view in section of a centrifugal drum separator in accordance with one embodiment of the invention which has a slide piston top wall member and an angular slide piston side wall member for periodically opening and closing the peripheral outlet ports;

FIG. 2 is a similar view to that of FIG. 1 of another embodiment of the invention which has a slide piston bottom wall insert member and an angular slide piston side wall member for periodically opening and closing the peripheral outlet ports;

FIG. 3 is another similar view to that of FIG. 1 of a further embodiment of the invention which has a slide piston top wall member and a slide piston bottom wall insert member for periodically opening and closing the peripheral outlet ports; and

FIG. 4 is another similar view to that of FIG. 1 of a still further embodiment of the invention which has a bipartite angular slide piston side wall member for periodically opening and closing the peripheral outlet ports.

In accordance with the invention, it has been found that an increase in separation capacity of the centrifugal drum may be effected by increasing the axial height of the drum separating chamber without increasing the inside diameter thereof, while instead increasing the side wall working area.

The construction of the drum is such that by means of an angular sludge chamber side wall member, an increase in collection space for solids is obtained as well as an increase in the separating capacity and quantity output of the entire disc surface area without a corresponding increase in the diameter of the drum.

The separating chamber interior has one or more hollow double frusto-conical side wall portions with the bottom surfaces of the conical portions facing one another. The outlet openings for the solids are situated in the peripheral portion of the drum wall at the points of greatest inside drum diameter between said conical side wall portions and top and bottom wall portions wherein they collect. The angle of inclination which the frusto-conical wall portions form with the drum axis are in each case greater than the natural angle of slope needed for removal of the separated solids so that these solids upon opening of the outlet ports will efficiently slide along the conical wall portions and pass outside the separation chamber through said ports.

In accordance with a preferred embodiment of the invention, the top and bottom wall members of the drum separation chamber are conical in configuration and an angular side wall member is disposed therebetween. Thus, two angular collection spaces for separated solids are provided, one being bounded by the top wall conical portion and the upper portion of the angular side wall member and the other being bounded by the bottom wall conical portion and the lower portion of the angular side wall member. Located at the periphery of the drum, between the top wall conical portion and the upper portion of the angular side wall member, are one or more outlet ports through which the solids may be passed out of the chamber. Similarly, one or more outlet ports are located at the periphery of the drum between the bottom wall conical portion and the lower portion of the angular side wall member.

These ports are normally closed during centrifugal operation, but may be periodically opened to discharge collected solids. For this purpose, at least one of the defining wall members of each collection space is constructed as a slidable valve member moving in axial direction whereby the closed ports will be opened.

Thus, in accordance with one embodiment of the invention, wherein two collection spaces are provided as aforesaid, at least the peripheral portion of the bottom wall of the chamber is upwardly and outwardly directed, for example as defined by an inverted hollow frusto-conical bottom wall member. The top wall, on the other hand, is downwardly and outwardly directed and is axially displaceable, for example as defined by an upright hollow frusto-conical or conical top wall slidable piston member which is movable in axial direction. The angular side wall member disposed between said bottom and top wall members in this case will also be slidable in axial direction so that upon upward actuation of the top wall slidable piston member, the angular side wall member will also be upwardly moved due to the centrifugal forces created which urge the collected solids thereagainst during continued rotation of the drum.

By means of a suitably dimensioned stop means, the angular member will only travel upwardly a part of the distance which the top wall member travels, thereby leaving a gap between the outermost edge of the top wall member and the outermost edge of the upper portion of said angular member. Inasmuch as the angular member has been upwardly displaced a certain distance, a gap is also formed between the outermost edge of the bottom wall member and the outermost edge of the lower portion of said angular member so displaced. Solids collected in the two defined collection spaces will therefore pass out the peripheral ports positioned adjacent the open gaps due to the created centrifugal force.

By reverse actuation the top wall member is downwardly displaced to its closed position and in turn urges the angular wall member downwardly against the outermost edge of the bottom wall member. The gaps are thereby closed and communication with the peripheral ports is cut off.

In this embodiment, a closable chamber is defined by the upper surface of the slidable piston top wall member and the lower surface of the outside top wall drum cover. A further fixed volume chamber is disposed above the closable chamber and is defined within said top wall drum cover. A main inlet conduit for control liquid located in the vicinity of the axis of the drum communicates with both of said chambers. A closable valve means is situated between said chambers, preferably at the periphery of the drum, which permits communication therebetween and the drum exterior.

A suitable control liquid, such as water, is continuously passed at a given rate from a source into said main conduit from which it flows to both said chambers. The liquid passing to the closable chamber fills the same normally urging the slidable piston top wall member downwardly against the slidable angular side wall. The liquid passing to the fixed volume chamber passes out an exit through said valve means at the same time urging said valve means against outflow therethrough of liquid from said closable chamber.

To open the ports, the flow of control liquid is interrupted so that all the liquid in the fixed volume chamber flows out through the valve exit. The valve is thereby no longer urged against outflow therethrough of liquid in said closable chamber, and consequently said closable chamber empties.

With no control liquid downwardly urging the slidable piston top wall member, the same is displaced upwardly closing said chamber by the centrifugal force acting on the collected sludge thereat. In turn, the angular side wall member is displaced upwardly in the same way, but its travel is limited to a given extent so that the ports at either outward end of the angular side wall member will be in communication with the exterior. Therefore, the collected sludge may be readily discharged and the separation instituted once more as soon as control liquid is again passed to the aforesaid chambers.

In accordance with another embodiment of the invention, instead of having a slidable piston top wall member downwardly urge the angular side wall member in order to close the discharge ports, the top wall is stationary and the bottom wall is constructed as a slidable piston member upwardly urging the angular side wall so as to close said ports. A control liquid in this case also is used to actuate the bottom wall slidable piston member for opening and closing said ports.

In accordance with a further embodiment of the invention, the top wall member and bottom wall member are both constructed as slidable pistons abutting at either end a stationary angular side wall member. Upon actuation to open the discharge ports, top wall piston member moves upwardly while bottom wall piston member moves downwardly, while, upon actuation to close said ports, the reverse movement is carried out.

In accordance with a still further embodiment, in accordance with the invention, both top wall and bottom wall members are stationary while the angular side wall member is bipartite constructed, having a movable top angular element cooperating with a movable bottom angular element. These elements are upwardly and downwardly urged, respectively, so as to close the discharge ports by the pressure of the control liquid. By stopping the flow of liquid, the top and bottom elements may draw toward one another leaving the ports open to the drum separator exterior.

Referring to the drawing, in FIG. 1 a centrifugal drum is shown having a bottom portion **1** and an upper portion **2**. Upper portion **2** includes cylindrical drum casing **3** and conical drum lid **4**. Bottom portion **1** and upper portion **2** are connected at threaded portion **5**. Below drum lid **4** is situated the conically-shaped piston member **6** which effects, in joint action with angular side wall slidable member **7**, the opening and closing of the plurality of discharge ports **8** and **9** defined in drum casing **3** which communicate with the exterior. Frusto-conical walls **10** and **11** of angular side wall member **7** which have a common edge along their smaller radial ends are provided with the same angle of inclination as top wall **12** and bottom wall **13**, which, together, limit the extent of the sludge chamber **14**.

Before initiating the centrifuging operation, control liquid is continuously passed through channel **15** into the drum. The liquid passes into the radially outer channel **16** to valve **17** where its constant flow pressure causes valve body **18** to be downwardly urged against its valve seat. The control liquid exits from valve **17** through opening **19**. Since more control liquid is passed into channel **15** than flows out opening **19**, channel **16** will fill up and a certain portion of the liquid will overflow into closable chamber **20**. Since valve body **18** is closed to outflow from chamber **20**, the liquid entering chamber **20** causes the downward actuation of slidable piston top wall member **6**. This, in turn, causes the downward movement of slidable angular member **7** against bottom wall **13** so that both discharge ports **8** and **9** remain closed.

The material to be centrifugally separated enters by way of feed pipe **21**, then passes through bore holes **22** defined in distributor **23** into the drum and against the disc insert surfaces. The clear liquid flows toward the drum axis and is conducted out of the drum by means of peeling disc or stripping disc **24** which is constructed with a plurality of radial spiral paths which impel collected clear liquid upwardly and out of the drum. The solids, on the other hand, are urged outwardly and collect in the sludge pockets **25** and **26**.

Periodically, when the sludge pockets **25** and **26** have become filled with solids, the feed of control liquid to channel **15** is interrupted. As a consequence, the liquid in channel **16** empties through opening **19** in valve **17** and valve body 18, thereby becomes unseated due to the pressure of the control liquid in chamber 20 which, in turn, also passes out valve 17 through opening 19.

The pressure of the collected solids forces slidable piston top wall member 6 upwardly so as to open discharge ports 9. The solids in pocket 26 may then slide outwardly along the conically and angularly shaped walls 10 and 12 to be ejected through ports 9. This causes a decrease in pressure on wall 10 of angular member 7 as opposed to the pressure of the solids collected in pocket 25 acting upon wall 11. Hence, angular member 7 is caused to travel upwardly until projection 27 abuts seat 28. Angular member 7 is constructed so that upon completing its upward travel, limited by projection 27 and seat 28, both ports 8 and 9 will be opened to the drum exterior.

By reinstituting liquid flow through channel 15, channel 16 and chamber 20 are filled with liquid so that slidable piston top wall member 6 is again downwardly urged, in turn forcing angular member 7 downwardly until both ports 8 and ports 9 are closed. Centrifugal separation operations may now begin once more.

In the drum embodiment shown in FIG. 2, the slidable piston is constructed in the bottom wall rather than in the top wall of the centrifugal drum. This type of centrifugal drum is capable of separating from one another, two liquid components admixed with a solid component.

The material to be centrifuged enters from feed pipe 29 into the drum via channels 30 and disc openings 31. The lighter liquid component is urged axially, the portion in the lower half of the drum passing to the upper half via radially arranged bore holes 32. The lighter liquid component leaves the drum through channel 33.

On the other hand, the heavier liquid component flows outwardly past the conical disc inserts to the draining channel 34 from whence it leaves the drum.

The solids collect in the same way in pockets 25 and 26, angular slidable member 7 being upwardly urged by bottom wall slidable piston member 6 to keep ports 8 and 9 closed.

Prior to the start of the centrifuging operation, control liquid is fed through inlet pipe 35 into annular recess 36 from whence it passes into closable chamber 38 through conduits 37. The liquid in closable chamber 38, upon filling to overflow exits 39, urges slidable piston bottom wall member upwardly against angular slidable side wall member 7 at packing 41 and said angular member 7 in turn against packing 40, whereby ports 8 and 9 are kept closed.

After solids have collected in pockets 25 and 26 as a result of centrifugal operation, their discharge is initiated by increasing the supply of control liquid to such an extent that the feeding rate through inlet pipe 35 exceeds the rate at which channels 37 may carry liquid to chamber 38 and out exit 39. The inlet feed is thereby caused to spill over into conduits 42 and from these into opening chamber 43.

As the liquid builds up in chamber 43, due to the fact that the inlet rate through conduits 42 exceed the outlet rate through bore hole exits 44, bottom wall slidable piston member 6 is downwardly urged. Since the surface area of bottom member 6 against which the liquid in chamber 43 acts is greater than that against which the liquid in closable chamber 38 acts because of limiting exit 39, bottom wall slidable piston member 6 travels downwardly opening port 8.

The solids collected in pocket 25, due to centrifugal force, are ejected from ports 8, relieving the upward pressure against angular member 7. Because of the downward pressure of collected solids in pocket 26 acting against angular member 7, said angular member 7 is urged downwardly to the extent limited by projection 27 which abuts seat 28 of drum casing 3. In this way, outlet ports 9 as well as outlet ports 8 are opened and the solids collected in pocket 26 are ejected through ports 9.

By decreasing the rate of control liquid fed through inlet pipe 35, spilling over of liquid, from annular recess 36 into bore holes 42 to chamber 43, no longer occurs. The liquid occupying chamber 43 is consequently completely emptied through conduits 44. As the inlet feed of control liquid to bore holes 37 is still sufficient to maintain a body of liquid to the level of exit openings 39, the force of this liquid pressure again urges bottom wall slidable piston member 6 upwardly against packing 41 of angular member 7 in closed position. In turn, angular member 7 is urged against packing 40. Thus, the centrifugal drum ports 8 and 9 are once more closed and centrifugal separation operations may be reinstituted.

With respect to FIG. 3, angular member 7 is constructed for rigid mounting on the drum, half onto lower part 1 and half onto upper part 2, parts 1 and 2 being secured to one another by threaded means 5. Top wall member 6_2 and bottom wall member 6_1 are both constructed as slidable pistons which may be actuated by control liquid so as to open and close discharge ports 9 and 8 respectively.

For closing actuation of top wall member 6_2, liquid is passed through inlet pipe 48 to chamber 46 at a rate which exceeds the exit rate through outlets 50. Thus, the pressure of said liquid which builds up in the chamber 46, forces top wall slidable piston member 6_2 to abut angular member 7 so as to close ports 9. Similarly, for closing actuation of bottom wall member 6_1, liquid is passed through inlet pipe 47 to chamber 45, through bore holes (not shown) which are constructed analogously to bore holes 37 of FIG. 2, at a rate which exceeds the exit rate through outlets 49. Thus, the pressure of said liquid which builds up in chamber 45 forces bottom wall slidable piston member 6_1 to abut angular member 7 so as to close ports 8.

By interrupting the liquid feed from pipes 48 and 47, the liquid remaining in chambers 46 and 45, respectively, is soon emptied through outlets 49 and 50, respectively. The collected solids, therefore, urge the top and bottom members 6_2 and 6_1 respectively, upwardly and downwardly so as to open both ports 8 and ports 9. By reinstituting liquid flow to chambers 45 and 46, ports 8 and 9 are again closed and centrifugal separation operations may proceed once more.

It will be appreciated that the feed from pipes 48 and 47 may be separately regulated so that ports 8 and 9 may be alternately opened and closed as well as opened and closed in unison.

In the centrifugal drum, according to FIG. 4, both top wall member 2 and bottom wall member 1, are rigidly constructed. The angular side wall member, however, is constructed as a hydraulically actuatable doubly slidable bi-partite angular member, including upper element 7_2 and lower element 7_1 mutually displaceable against one another. A constant supply of control liquid is fed from inlet pipe 51 through conduits 52 to angular member chamber 53 defined by the drum side wall and mutually displaceable bi-partite elements 7_2 and 7_1. A portion of said liquid passes out exit ports 54, the remainder exerting pressure against elements 7_2 and 7_1, thereby causing the same to abut top wall 2 and bottom wall 1, respectively, so as to keep ports 9 and 8 closed.

Upon interrupting the flow of control liquid from pipe 51, the remaining liquid occupying chamber 53 passes out exit ports 54. The pressure of the collected solids in turn causes downward displacement of element 7_2 and upward displacement of element 7_1, thereby causing the opening of ports 9 and ports 8 and the ejection of said solids from the drum. By reinstituting liquid feeding through conduits 52 from pipe 51, the elements 7_2 and 7_1 are again outwardly urged against the top and bottom walls of the drum by the pressure of the liquid which collects once more in chamber 53.

It will be appreciated that while the foregoing description has indicated preferred constructions containing only one angular side wall member, whether integral or bipartite, more than one such angular side wall member may be included, one above the other along the drum side wall, which operate to open and close the drum peripheral discharge ports as aforesaid in connection with slidable piston means and hydraulically actuating means.

What is claimed is:

1. In a centrifugal separator having a rotatably mounted centrifugal bowl including wall means defining a separating chamber, an inlet into the separating chamber for material to be separated, outlets through the periphery of the separating chamber for separated specifically heavy components, and a discharge exit from the interior portion of the bowl adjacent the axis of rotation of the bowl for the separation of separated specifically light components, the improvement which comprises means defining the interior of said separating chamber including means defining an angular side wall, including two angular side wall portions each having a radially inner edge and a radially outer edge, the radially inner edges being adjacently disposed means defining a downwardly and outwardly directed top wall portion having its outer edge adjacent the outer edge of one of said side wall portions and means defining an upwardly and outwardly directed bottom wall portion having its outer edge adjacent the outer edge of the other of said side wall portions, said chamber having peripheral outlets for heavy components located between at least one said angular side wall portion and the corresponding adjacent other wall portion, said one angular side wall portion and said corresponding other wall portion together normally closing said outlets, and axially slidable piston means defined by at least one of said last named portions adjacent said peripheral outlets and including actuation means for axial actuation of said piston means for opening and closing said outlets, said outlets when open communicating directly with the exterior of the centrifugal bowl, said one of said side wall portions forming an angle with the drum axis substantially equal to the angle formed with the axis by said bottom wall portion and said other of said side wall portions forming an angle with the drum axis substantially equal to the angle formed with the axis by said top wall portion, said angles being greater than the natural angle of slope required for removal of separated, specifically heavier components from the separating chamber.

2. Improvement, according to claim 1, wherein said actuation means provided for opening and closing said outlets are hydraulic actuation means.

3. Improvement, according to claim 1, wherein the actuation in axial direction is limited by stop means provided in said bowl.

4. Improvement, according to claim 1, wherein said angular side wall is bi-partite and said angular side wall portions together define said axially slidable piston means, said angular side wall portions being axially slidable with respect to one another a limited degree for opening and closing the outlets, said outlets being axially positioned correspondingly adjacent the outer edges of said angular side wall portions.

5. Improvement, acording to claim 4, wherein said actuation means are hydraulic means and said side wall portions are capable of hydraulic actuation thereby in axial direction, said sidewall portions forming with the adjacent wall means defining the separating chamber, a closed hollow working chamber having hydraulic liquid-restricted flow outlet means remote from the interior of the separating chamber and hydraulic liquid flow inlet means remote from said interior, said hydraulic actuation means including means for supplying hydraulic control liquid to said working chamber through said flow inlet means for exerting pressure on said wall portions thereat for opening and closing said peripheral outlets in dependence upon the control liquid supply.

6. Improvement, according to claim 1, wherein said angular side wall is axially immovable and said top wall portion and said bottom wall portion together define said axially slidable piston means, said top and bottom wall portions each being axially movable with respect to said angular side wall portion adjacent thereto for opening and closing the outlets, said outlets being axially positioned correspondingly adjacent the outer edges of said angular side wall portions.

7. Improvement, according to claim 1, wherein said angular side wall and said top wall portion together define said axially slidable piston means, said angular side wall and said top wall portion being axially slidable, peripheral outlets are disposed on the bowl wall means both at a first level corresponding to the adjacent edges of said top wall portion and the correspondingly adjacent angular side wall portion and at a second level corresponding to the adjacent edges of said bottom wall portion and the correspondingly adjacent angular side wall portion, said top wall portion is capable of periodic axial movement from a position normally closing the corresponding first level of outlets to a position opening said outlets, and said angular side wall is capable of periodic limited axial movement from a position normally closing the corresponding second level of outlets to a position opening said outlets, said limited axial movement being less than the axial movement of said top wall portion.

8. Improvement, according to claim 1, wherein said angular side wall and said bottom wall portion together define said axially slidable piston means, said angular side wall and said bottom wall portion being axially slidable, peripheral outlets are disposed on the bowl wall means both at a first level corresponding to the adjacent edges of said top wall portion and the correspondingly adjacent angular side wall portion and at a second level corresponding to the adjacent edges of said bottom wall portion and the correspondingly adjacent angular side wall portion, said bottom wall portion is capable of periodic axial movement from a position normally closing the corresponding second level of outlets to a position opening said outlets, and said angular side wall is capable of periodic limited axial movement from a position normally closing the corresponding first level of outlets to a position opening said outlets, said limited axial movement being less than the axial movement of said bottom wall portion.

9. Improvement, according to claim 1, wherein said top wall portion and said bottom wall portion together define said axially slidable piston means, said top and bottom wall portions being axially slidable; peripheral outlets are disposed on the bowl wall means both at a first level corresponding to the adjacent edges of said top wall portion and the correspondingly adjacent angular side wall portion and at a second level corresponding to the adjacent edges of said bottom wall portion and the correspondingly adjacent angular side wall portion, said top wall portion is capable of periodic axial movement from a position normally closing the corresponding first level of outlets to a position opening said outlets, and said bottom wall portion is capable of periodic axial movement from a position normally closing the corresponding second level of outlets to a position opening said outlets, said angular side wall portions being axially immovable.

10. Improvement, according to claim 1, wherein said angular side wall is bi-partite and said angular side wall portions together define said axially slidable piston means, said angular side wall portions being axially slidable with respect to one another, peripheral outlets are disposed on the bowl wall means both at a first level corresponding to the adjacent edges of said top wall portion and the

correspondingly adjacent angular side wall portion and at a second level corresponding to the adjacent edges of said bottom wall portion and the correspondingly adjacent angular side wall portion, and said angular side wall portions are capable of periodic axial movement from a position normally closing the corresponding levels of outlets to a position opening said outlets.

11. In a centrifugal separator having a rotatably mounted centrifugal bowl defining a separating chamber, said chamber having a side wall, top wall and bottom wall, an inlet into the separating chamber for material to be separated, disc inserts for separating said material, outlets through the periphery of the separating chamber for separated specifically heavy components, and a discharge exit from the interior portion of the bowl adjacent the axis of rotation of the bowl for the separation of separated specifically light components, the improvement which comprises means defining an upright conical top wall member for the separating chamber, means defining an inverted frusto-conical peripheral portion bottom wall member at the peripheral portion of the bottom wall of said separating chamber, a top level of outlets through the periphery of the bowl adjacent said upright conical top wall member and a bottom level of outlets through the periphery of the bowl adjacent said inverted frusto-conical bottom wall member, means defining an intermediate inverted frusto-conical peripheral member at the peripheral portion of said chamber, the outer portion of said inverted frusto-conical peripheral member being adjacent the peripheral portion of said upright conical top wall member and said top outlets and together with said top wall member normally closing said top outlets, an intermediate upright frusto-conical peripheral member at the peripheral portion of said chamber, the outer

portion of said upright frusto-conical peripheral member being adjacent the peripheral portion of said inverted frusto-conical peripheral bottom wall member and said bottom outlets and together with said bottom wall member normally closing said bottom outlets, the inner portion of said inverted frusto-conical peripheral member and the inner portion of said upright frusto-conical peripheral member being adjacent whereby to form a common edge portion, and slide piston means slidable in axial direction defined entirely within the bowl by two of said members each adjacent a corresponding level of outlets and including hydraulic actuation means for axial actuation of said piston means for opening and closing and outlets, said outlets when open communicating directly with the exterior of the centrifugal bowl, said upright conical top wall member and said upright frusto-conical member each forming substantially the same angle with respect to the bowl axis and the inverted frusto-conical member and inverted frusto-conical peripheral portion bottom wall member each forming substantially the same angle with respect to the bowl axis, said angles being greater than the natural angle of slope required for removal of separated, specifically heavier components from the separating chamber.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,081,028

March 12, 1963

Peter Steinacker

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, lines 70 and 71, for "foreging" read -- foregoing --; column 5, line 56, for "these" read -- there --; line 59, for "exceed" read -- exceeds --; column 7, line 67, after "hydraulic" insert -- actuation --.

Signed and sealed this 24th day of September 1963.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents