Dec. 10, 1968 C. W. WEILAND 3,415,446

HYDRAULICALLY ACTUATED VALVE PLATE FOR A CENTRIFUGE

Filed April 11, 1967 2 Sheets-Sheet 1

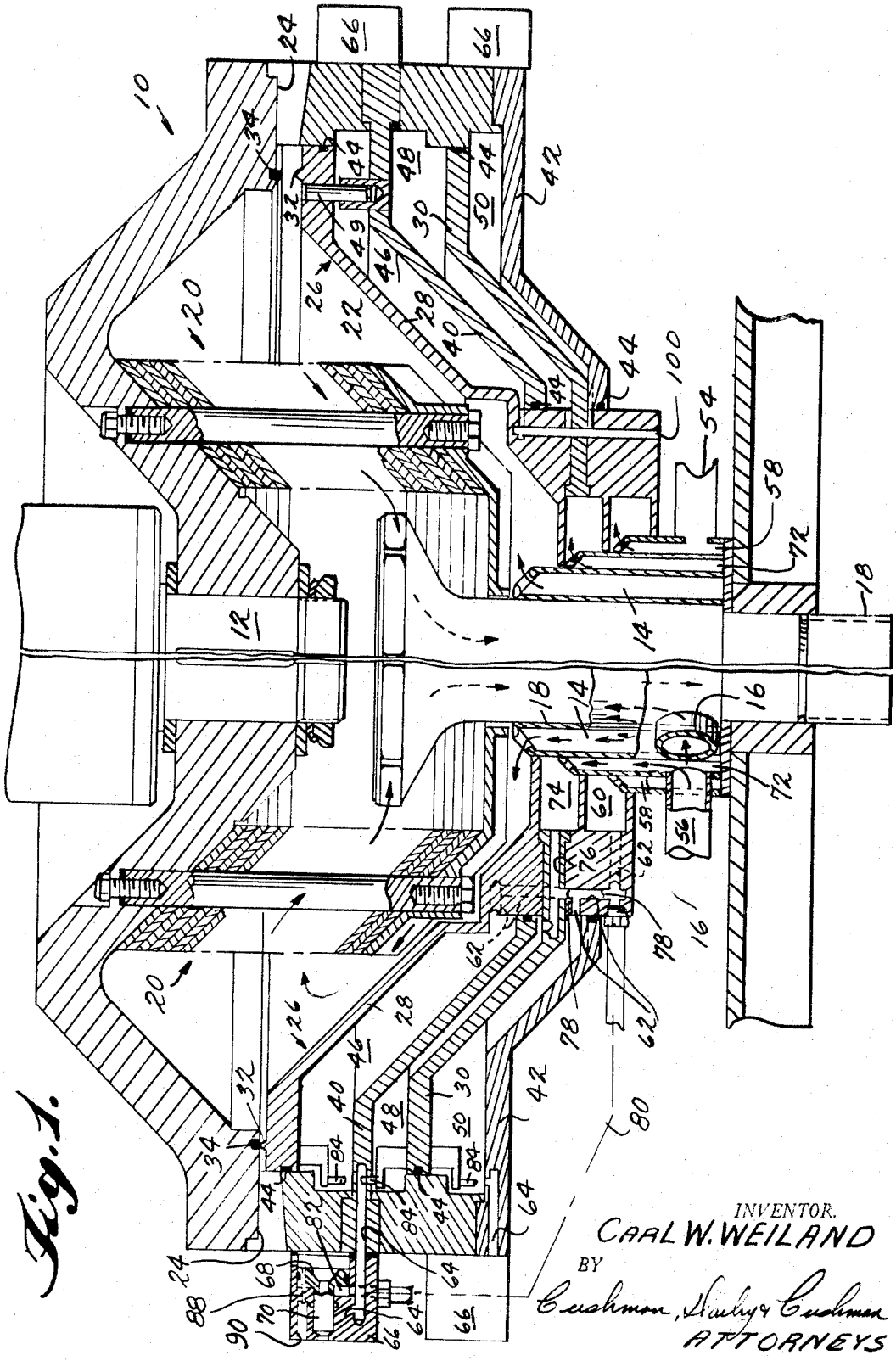


Fig. 1.

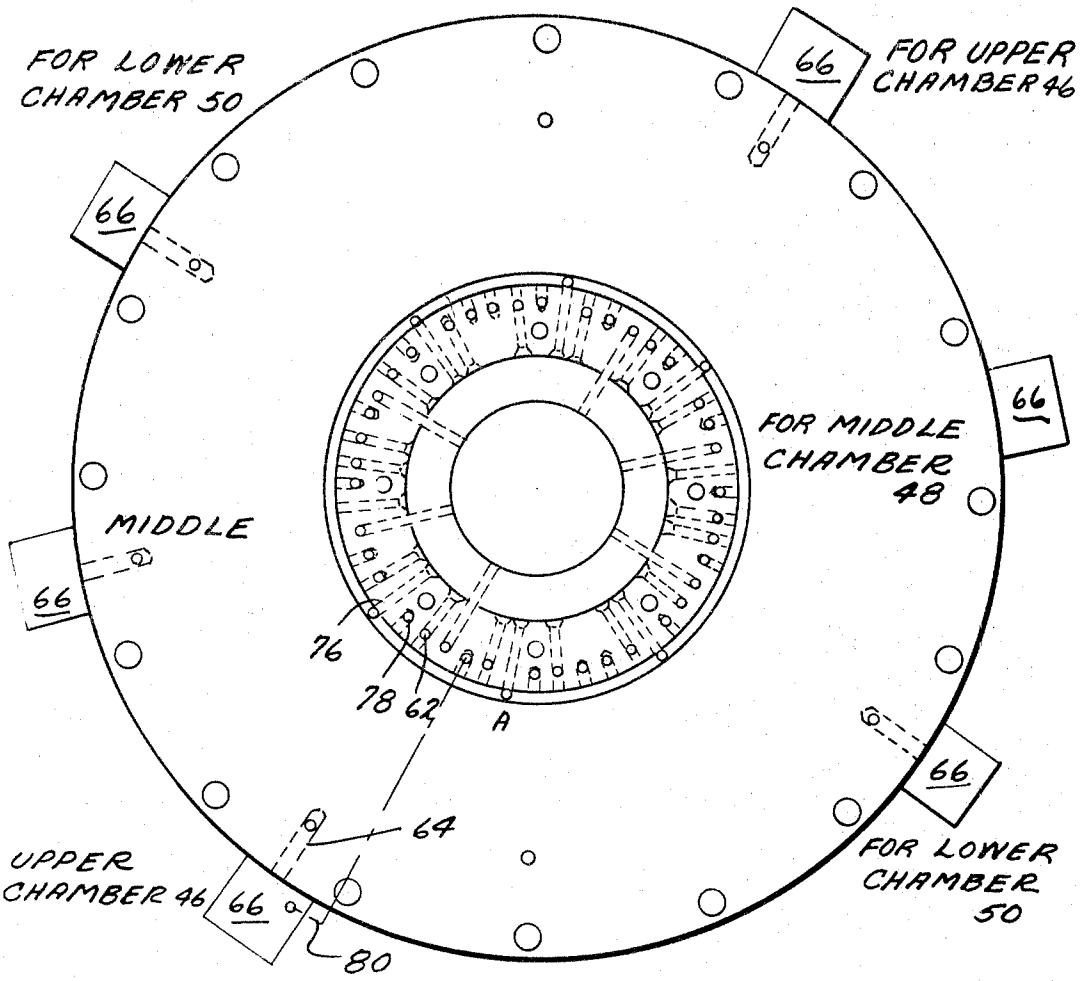
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Filed April 11, 1967 2 Sheets-Sheet 2

Fig. 2.



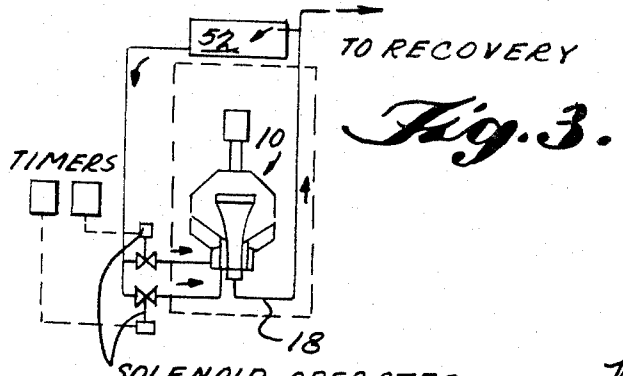


Fig. 3.

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HYDRAULICALLY ACTUATED VALVE PLATE FOR A CENTRIFUGE

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ABSTRACT OF THE DISCLOSURE

A centrifuge construction is provided with sludge discharge openings about the bowl of the centrifuge, and a hydraulically operated valve plate means is utilized for opening and closing the openings. Control means are provided for admitting fluid into various portions of the centrifuge device to operate the valve plate to empty the centrifuge bowl when sludge has accumulated around an inner perimeter of the bowl. A frusto-conical shaped valve plate having spaced pressure receiving members is positioned in the lower portion of a centrifuge bowl, and the valve plate is moved to separate positions which open and close discharge openings spaced around the centrifuge bowl. An application of fluid pressure on the spaced pressure receiving members of the plate determines the actuated position of the plate. The invention also provides for valve control devices which contain piston means for controlling and directing the flow of fluid through the valve plate actuating system.

The foregoing abstract is not intended to define the scope of the invention and is only provided to permit a cursory review of the gist of the invention.

Background of invention

This invention relates to centrifuge devices and is particularly concerned with an improved sludge discharge system for centrifuges.

Various types of valving devices for discharging sludge from centrifuges are well known in the art, and also it is known to provide various means for operating and actuating such valve devices. Quite often some form of counterbalance system is incorporated into a discharge mechanism for a centrifuge, and such an arrangement has been described in my copending application Ser. No. 510,566 filed Nov. 30, 1965, now Patent No. 3,369,742. However, it has been found that various types of sludge discharge mechanisms are more or less suitable for particular centrifuging operations and materials being centrifuged, and the present invention is concerned with an improved hydraulic system for reliably actuating a sludge discharge mechanism for a centrifuge which is especially adapted for separating abrasive particles from a liquid. Such a centrifuging operation is required where sludge is being removed from liquids used with grinding machines. Hydraulically operated discharge mechanisms are also known in the art, as illustrated by Steinacker Patent 3,167,509 and Simon Patent 3,255,958, but such mechanisms have been unreliable for separating abrasive particles from a liquid for long periods of use. In contrast, the system of this invention incorporates a novel valve plate assembly which can be reliably moved into a closed or open position for blocking or releasing sludge material from the centrifuge bowl and provision is made for automatically controlling the displacement of the valve plate into and out of a closed position so that material may be periodically discharged through valve openings which are normally blocked by the plate. It has been found that valve plate mechanisms of this type are not always reliable in operation unless there is some positive means of maintaining the desired position of the plate. Conceivably, complex linkage mechanisms could be used to move the plate into its closed or open positions, but prior mechanical arrangements have been costly to manufacture and difficult to maintain in good working order in the usual centrifuge system. Also, attempts have been made to apply a fluid pressure to opposed surfaces of a single valve plate member but such arrangements have required a relative movement between the valve plate member and a bottom portion of the centrifuge bowl, thus creating problems of sealing the centrifuge bowl at its critical maximum diameter base portion. In accordance with the present invention, an improved valve plate means is provided in the form of an assembly which includes a first plate member for sealing the botttom of a centrifuge bowl and for opening and closing sludge discharge openings formed through a maximum diameter portion of the bowl. The assembly also includes a second plate member which functions to receive fluid pressure on its opposed surfaces so as to effect rapid and reliable movements of the first valve plate member. By providing two plate members in the valve plate assembly, it is possible to apply nearly double the pressure which would otherwise be available for closing a single valve plate while a centrifuge is running. The valve plate means of this invention is also positioned at an end of the centrifuge bowl which is opposite to the driven end of the bowl, and this means that the driven end of the bowl can be reinforced and constructed so as to provide a stronger centrifuge capable of smoother operations. The sludge discharge openings which are formed in the centrifuge bowl are relatively large to permit an easy discharge of grinding sludge (abrasive particles resulting from grinding operations), and the valve plate assembly is constructed to be actuated for a relatively long stroke which opens and closes the large discharge openings. The provision of two plate members assures a positive and rapid movement of the valve plate means, and the entire system operates reliably and with little maintenance.

Also, an improved arrangement is provided for controlling the displacement of the valve plate means, and this is accomplished with a hydraulic system which utilizes fluid pressure and various valving devices to operate and maintain the valve plate means in selected positions.

These and other advantages of this invention will become apparent in the more detailed discussion which follows and in that discussion reference will be made to the accompanying drawings in which:

FIGURE 1 is a vertical elevational cross section of a sludge discharge system in accordance with this invention, illustrating a control system for hydraulically operating a novel valve plate means;

FIGURE 2 is a top plan view of the first embodiment of FIGURE 1; and

FIGURE 3 is a schematic view of a hydraulic flow system for the centrifuge and control system of this invention.

Detailed description of invention

FIGURES 1 and 2 illustrate portions of a typical centrifuge bowl of a well known type. Such general centrifuge constructions are shown in my Patent No. 2,788,937 granted Apr. 16, 1957, but, in the present instance, the centrifuge is preferably mounted with a vertical axis of rotation. In the figures any well known construction for a rotor or bowl **10** is provided wherein the bowl can be rotated by a motor means (not shown) through a bearing and drive shaft assembly indicated at **12**. The drive shaft is illustrated as being mounted on a vertical axis of rotation, and thus any liquids which are introduced into the bowl **10** are centrifuged outwardly from the vertical

axis of the main drive shaft. The centrifuge bowl may be of the type which is suspended into the liquid which is to be centrifuged as described in my copending application Ser. No. 510,566, now Patent No. 3,369,742, or liquid may be separately introduced into the centrifuge from a reservoir or source of supply. Preferably the liquid is contained in a separate reservoir so that it may be introduced by controlled amounts into a central annular passageway **14** by way of a main conduit **16**. It can be seen by the arrows in the drawings that introduced liquid rises upwardly about an outlet pipe **18**, and from there, it travels laterally outwardly to the maximum diameter portion of the bowl assembly **10**. Then, the liquid is centrifuged, and one portion of the liquid passes back through a conventional strainer **20** which is in the form of a straining drum having a nest of frusto-conical discs or rings **22**. Any solid particles or sludge which are being removed from the liquid remain in the maximum diameter portion of the bowl assembly, and the centrifuged liquid passes downwardly through the outlet pipe **18** after it has passed through the straining drum **20**. Thus, there is provided a very typical arrangement for continuously centrifuging a liquid stream which is being introduced into the centrifuge device and which is continuously emptied therefrom after the centrifuging action. Because sludge is caused to build up in the maximum diameter portion of the centrifuge bowl **10**, it is necessary to periodically remove the sludge from the bowl. For this purpose, sludge discharge slots or openings **24** are provided in spaced positions about the perimeter of the bowl, and through its maximum diameter portion, so that sludge may be expelled outwardly from the maximum diameter portion of the bowl when a cleaning action is desired. The sludge discharge openings **24** are normally closed by a valve plate means **26** which is made up of two spaced plate members **28** and **30**. For ease of illustration, the right hand side of FIGURE 1 shows the valve plate means **26** in an open position and the left hand side of FIGURE 1 illustrates a closed position, but it is to be understood that the entire valve plate about the entire bowl assembly **10** would be only in one position or the other. In its closed position, the valve plate means **26** blocks the sludge discharge openings **24**, and in order to assure a good sealing of the discharge openings, a projecting ring member **32** is provided on the upper plate member **28** of the valve plate to press into a ring gasket **34** contained within a portion of the upper bowl assembly. Accordingly, when the valve plate **26** is in a fully closed position, no sludge or other material can escape from the centrifuge bowl past the projecting ring **32** and its mating sealing gasket **34**.

The valve plate means **26** is preferably constructed in the manner shown for FIGURE 1 wherein two plate members **28** and **30** are associated with the valve plate for forming a plurality of chambers which function to receive liquids for controlling the position of the valve plate **26**. By providing two plate members for the valve plate means, there is provided a substantially increased surface area against which fluid pressures may be applied to actuate the valve plate means and to overcome internal pressures in the centrifuge. In the assembly illustrated in FIGURE 1, the valve plate means **26** includes a base ring portion **36** to which the lower plate member **30** is secured, and the entire assembly moves up and down and rotates with respect to the bowl **10**. Associated with the lower bowl portion of the centrifuge are two additional plates **40** and **42** which are arranged to alternate with the plate members **28** and **30** of the valve plate means, as shown. Since the plates **40** and **42** are associated with the lower bowl assembly and rigidly secured thereto, it can be seen that whenever the valve plate means **26** is moved up or down, there is a movement relative to the fixed positions of the plates **40** and **42** as well as to the remainder of the bowl assembly. Suitable sealing ring gaskets are provided between all surfaces of the assembly which must move relative to one another so that a liquid seal is provided between all such surfaces. Sealing rings **44** are shown in the drawings, and any other sealing arrangement may be used to provide a liquid seal between the moving surfaces. All of the plate members **28**, **30**, **40** and **42** are generally of a frusto-conical shape, and the plate member **28** forms an interior bottom portion for the bowl **10**, while the plate **42** forms an exterior bottom housing for the bowl. It should be noted that the improved arrangement of this invention provides for an interior bottom portion of a centrifuge bowl which is uninterrupted right up to the point of sealing between the projecting ring **32** of the plate member **28** and the gasket **34**. Prior attempts to provide a valve plate which is positively actuated by hydraulic means have required an interior bottom portion of a centrifuge bowl which is interrupted and separate from the plate means which opens and closes sludge discharge openings. Thus, the present invention eliminates a requirement for precision sealing devices for the interior bottom portion of a centrifuge bowl in an important area of the bowl. Also, the arrangement shown in FIGURE 1 provides for a stronger bowl assembly since the valve plate means is mounted in a lower end of the bowl and separate from structure associated with the driving means for the bowl. The valve plate mechanism of this invention also moves with a longer stroke than prior arrangements, and this is important where abrasive particles are being centrifuged out of a liquid, since such particles require larger discharge openings for their removal because of their tendency to "bridge" smaller openings. Guide pin means **49** are provided to guide the up and down movements of the valve plate means.

With the arrangement which has been just discussed, it can be seen that three separate chambers **46**, **48** and **50** are formed within the centrifuge bowl, and these chambers function to receive a fluid for applying a fluid pressure and a movement to the valve plate means **26**. The chambers **46** and **50** function to move the valve plate means upwardly to a closing position when they are filled with a fluid, and the intermediate chamber **48** functions to positively move the valve plate means downwardly to an open position when chamber **48** is filled with a fluid. As will be discussed below, means are provided for filling and emptying the separate chambers, and also, a control system is provided for automatically correlating the filling and emptying of the separate chambers.

Any suitable fluid may be introduced into the centrifuge for actuating the valve plate means **26**, and typically, some of the same liquid which has been centrifuged may be used as an actuating fluid. As shown in FIGURE 3, a source for the actuating liquid may be in the form of a reservoir **52**, and this reservoir may receive liquid from the centrifuge after a centrifuging action for use in actuating the valve plate mechanism. For example, the main conduit **16** may supply liquid directly into the central annular channel **14** which communicates with the main conduit **16** and with the interior of the bowl **10**. As shown by the arrows in FIGURE 1, liquid which is introduced into the channel **14** flows upwardly and outwardly toward the maximum diameter portion of the centrifuge bowl, and there a centrifuging action takes place when the bowl is rotating about its vertical axis. After the centrifuging action has taken place, the liquid passes back through the strainer drum **20** and downwardly through the outlet pipe **18**, from where it is retrieved for ultimate storage or use.

Additional conduits **54** and **56** may lead from the reservoir **52** for the purpose of supplying liquid to the valve plate actuating system of the centrifuge. Conduit **54** is illustrated as communicating with an outer annular channel **58** which supplies liquid to both of the chambers **46** and **50** for closing the valve plate means **26** and for maintaining the closed position for as long as desired. From the annular channel **58**, liquid flows outwardly through

a chamber **60** and into a passageway **62** (shown in dotted lines and offset from a separate conduit shown in solid lines) which is drilled or formed into the base ring **36** so as to provide separate branches communicating with the separate chambers **46** and **50**. Thus, when liquid is caused to flow through the conduit **54**, there is a flow of liquid into the chamber **60** and from there through the branched conduit **62** and then into chambers **46** and **50**. When liquid flows into the chambers **46** and **50**, the valve plate means is forced upwardly to its maximum position by an action of pressure against the lower surfaces of the two plate members **28** and **30**. Since the interposed plates **40** and **42** cannot move downwardly, the valve plate means must move upwardly into its maximum upward position which closes the discharge slots **24**. Once liquid has entered the chambers **46** and **50**, it can be released only through the separate passageways **64** (see left-hand side of FIGURE 1) provided for each of the separate chambers. However, each of the passageways **64** is controlled by a control valve mechanism **66** which prevents the release of liquid through the passageway **64** until certain conditions are met within the system. As seen in the detailed cross section of the control valve **66** in FIGURE 1, a piston member **68**, having a valve stub **70**, can be moved inwardly and outwardly toward the central axis of the centrifuge in response to fluid pressure on one face of the piston. In the position shown in FIGURE 1, the piston is shown in a position which causes the stub **70** to block the release of any liquid through the passageway **64** leading out of the chamber **46**. A similar arrangement is provided for the chambers **48** and **50**, and thus, there can be no release of fluid pressure from within the separate chambers **46**, **48** and **50** until pistons within the control valve **66** have moved radially inwardly to permit the release of fluid from the chambers.

The control valves **66**, as used in the system of this invention, provide for an automatic releasing of fluid from the chambers **46** and **50** when fluid is being introduced into the intermediate chamber **48**. Such an automatic releasing of fluid is required so that the valve plate means **26** can be caused to positively move downwardly to an open position and to maintain that position until again moved upwardly. Intermediate chamber **48** is filled by introducing liquid through the conduit **56** into the intermediate annular channel **72**. The channel **72** is in communication with a small chamber **74** from which a passageway **76** conducts fluid directly into the intermediate chamber **48**. However, the passageway **76** includes a branch conduit **78** (shown in full lines and in circumferential alignment with the vertical portion of passageway **62**) leading to a conduit **80**, and the conduit **80** introduces liquid into a chamber **82** adjacent the outer surface of each piston **68** contained within the separate control valves **66**. Therefore, when liquid is introduced into the intermediate chamber **48**, there is a simultaneous introduction of liquid against the control valve pistons **68**, and the pistons **68** are moved radially inwardly so as to open the passageways **64** leading out of the separate chambers **46** and **50**. In this way, the chambers **46** and **50** are relieved of fluid pressure at the same time that fluid is being introduced into the intermediate chamber **48**, and this causes the entire valve plate assembly **26** to move downwardly into a position which opens the sludge discharge slots **24**. Any suitable mechanism may be utilized for causing liquid to flow through the conduits **54** and **56**, and a timing mechanism may be included within the system to control a cycle of operation wherein the valve plate means is maintained in a closed position for a requisite period of time and then periodically opened to release sludge from the operating centrifuge. A typical system is shown in FIGURE 3 wherein the timers operate solenoid valves associated with each of the conduits **54** and **56**.

The embodiment of FIGURE 1 also provides for a novel construction wherein orifice cleaning mechanisms automatically operate to keep certain passageways clean and unobstructed, and the mechanisms operate with the normal opening and closing movements of the valve plate means **26**. As shown in FIGURE 1, orifice cleaning mechanisms **84** are rigidly secured to the plate members **28** and **30** to move up and down with the normal opening and closing movements of the entire valve plate assembly. The orifice cleaning mechanisms are constructed to insert projecting members into and out of passageways associated with the outlets from chambers **46**, **48**, and **50**. The action of the orifice cleaning mechanisms can be clearly seen in the left-hand view of FIGURE 1 wherein all upwardly directed mechanisms are inserted into associated passageways. Also, a cleaning mechanism **88** is in its uppermost position. Likewise, when the valve plate assembly is moved downwardly, all downwardly directed orifice cleaning mechanisms are inserted into their associated passageways. Also, a cleaning mechanisms **88** is associated with the piston means **68** of each control valve, and this mechanism functions to keep an outlet passage **90** clean. The outlet passage **90** permits escape of liquid from the piston chamber **82** when the piston **68** is being moved radially outwardly to block the passage **64** with the stub **70**. The piston **68** is moved radially outwardly by the centrifugal action of the bowl, and normally remains in its outermost position until actuated inwardly by the introduction of liquid into the chamber **82**. The provision of orifice cleaning mechanisms in a centrifuge system of this type is very important since small passageways in centrifuges normally become clogged periodically, and this requires loss of time and maintenance costs in cleaning such passageways. With the devices of the present invention, a centrifuge hydraulic control system is maintained essentially trouble free over a long period of time of operation for the centrifuge. The valve plate means of this invention is operated during normal operation of the centrifuge, and the entire plate assembly rotates with the rotation of the centrifuge bowl.

FIGURE 1 also illustrates air vents **100** which are formed in the valve plate assembly to permit the escape of air from the chambers **46**, **48**, and **50** when any of the chambers are being filled with a liquid. The vent **100** communicates with all three of the named chambers, and thus, air can be drawn into the respective chambers when they are being emptied of liquid, and forced out of the chambers when they are being filled with liquid. In practice, it has been found that the chambers do not have to be completely filled with liquid to operate the valve plate means, and thus, there is no need for continuously overfilling a given chamber in order to effect a valve plate movement.

Having described a representative embodiment of this invention, it can be seen that sludge discharge means is more reliably actuated, and a mechanism has been provided which is essentially maintenance-free for a period of years. All obvious variations of this invention are intended to be included within the scope of my patent claims.

What is claimed is:

1. A sludge discharge system for a centrifuge bowl comprising:

a valve plate means for opening and closing sludge discharge ports formed through a portion of the centrifuge bowl, said valve plate means being hydraulically actuated and formed to include two separate pressure responsive plate members, a first plate member for opening and closing said sludge discharge ports and a second plate member for assisting the action of said first plate member,

a dividing plate means between said first and second plate members for forming first and second chambers between the first plate member and the second plate member, said valve plate means being movable relative to said dividing means, and said dividing

plate means being stationary with respect to the centrifuge bowl assembly.

hydraulic means for separately filling said first and second chambers with fluid for positively actuating said valve plate means in opposed directions in accordance with one chamber or the other being filled.

2. The system of claim **1** and including means for automatically releasing fluid from one of said chambers when the other of said chambers is being filled with fluid.

3. The system of claim **1** and including:

an additional plate means for forming a third chamber adjacent to said second plate so that fluid can be received into said first and third chambers for forcing said valve plate means into a position which closes said sludge discharge ports.

4. The system of claim **3** and including separate conduits for admitting fluid alternatively into said second chamber or into both of said first and third chambers.

5. The system of claim **3** and including separate means for releasing fluid from each of said three chambers.

6. The system of claim **5** wherein each of said means for releasing fluid from said chambers comprises a control valve means for opening and closing a fluid discharge passageway in communication with an associated chamber, said control valve means including a piston member which can be hydraulically actuated in a first direction for opening the fluid discharge passageway.

7. The system of claim **6** wherein said piston member of said valve control means is moved in a second direction for closing said fluid discharge passageway by centrifugal forces of the centrifuge acting upon the mass of the piston member, whereby said valve control means requires hydraulic actuation for one direction of movement only.

8. The system of claim **6** wherein the separate valve control means are each in communication with only one of said three chambers for releasing fluid from the respective chambers, but wherein said means for hydraulically actuating each said piston member for each said valve control means is responsive to fluid pressure conditions in at least one adjoining chamber relative to the chamber associated with a particular valve control means, whereby the filling of a particular chamber for actuating said valve plate means automatically releases fluid from at least one adjoining chamber.

9. The system of claim **6** wherein each piston member further includes an orifice cleaning element for cleaning an orifice which permits release of hydraulic actuating fluid away from the piston member when the piston member is moved in said second direction.

10. In a sludge discharge system of the type having a valve plate means for opening and closing sludge discharge ports formed through a bowl of said centrifuge, wherein said valve plate means is moved to open and closed positions by the application of fluid pressure to opposed surfaces of a pressure responsive plate member associated therewith, and wherein a fluid discharge passageway is associated with a fluid releasing system for said pressure responsive plate member, the improvement comprising:

an orifice cleaning element connected to said pressure responsive plate member for movement therewith, said orifice cleaning element being positioned to be inserted into and out of said fluid discharge passageway with the opening and closing movements of said valve plate means, whereby said passageway is maintained in a clean and open condition by the normal operation of the sludge discharge system.

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