

[54] SELF CLEANING CENTRIFUGE DRUM WITH STEPWISE VARIABLE CLOSING PRESSURE

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[58] Field of Search..... 233/19 R, 19 A, 20 R, 233/20 A, 46, 47 R

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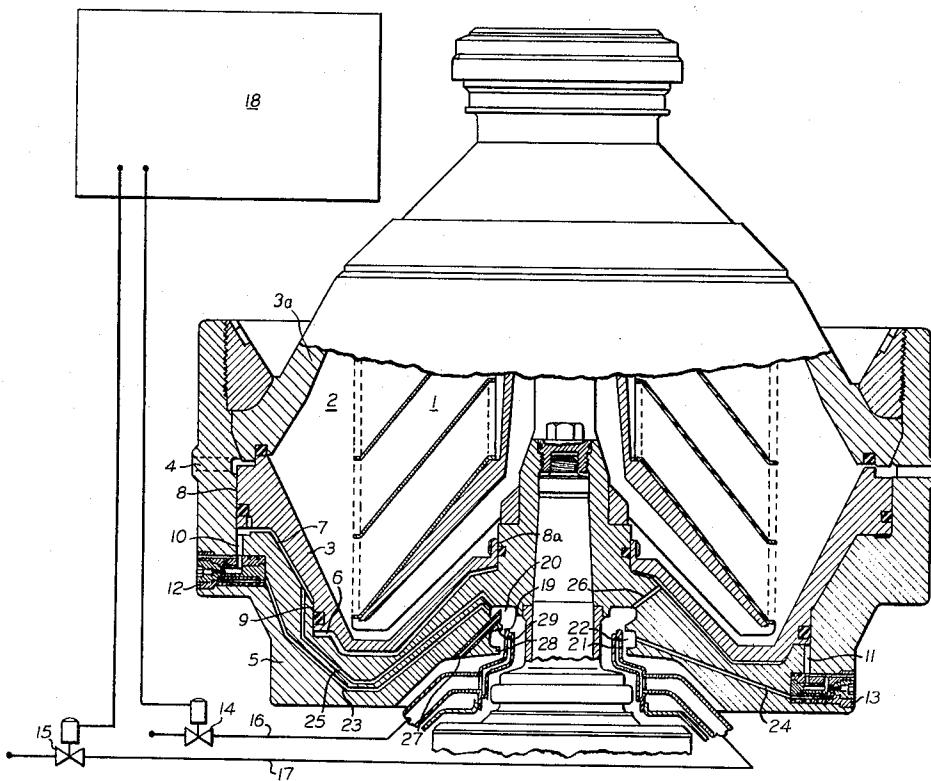
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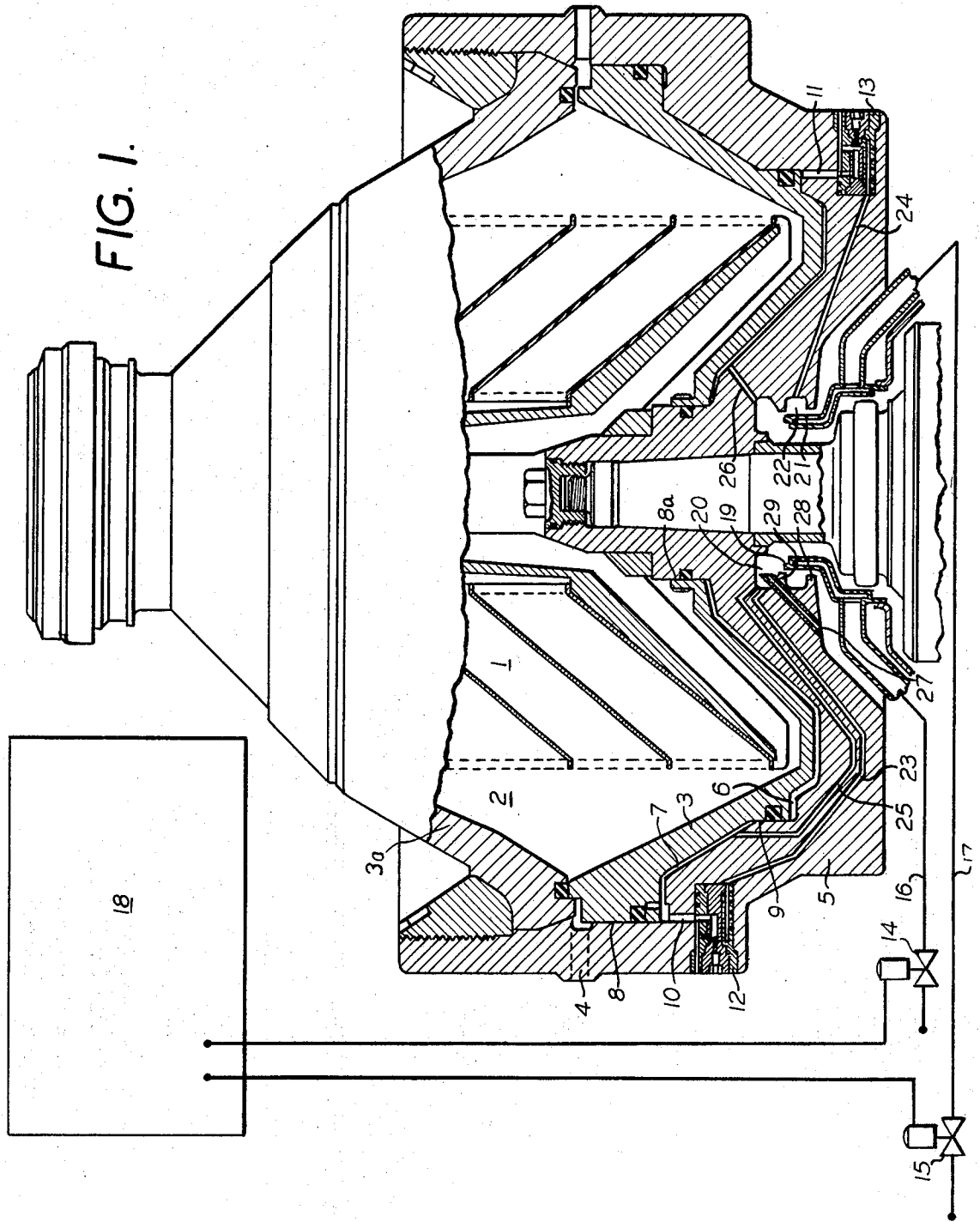
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[57] ABSTRACT

A centrifugal separator constructed for performing full desludgings as well as partial desludgings during separation. One end member of the separating chamber is a piston valve movable axially to open and close sludge discharge openings disposed at the outer periphery of the drum. The axially outward disposed side of the piston valve is in sliding sealing engagement with confronting drum portion at radially spaced intervals so that a radial succession of divisions of the closing chamber is provided which can be filled up in a known manner with control fluid and selectively emptied for reducing the force acting on the piston valve and thereby performing a full desludging or a partial desludging.

3 Claims, 3 Drawing Figures





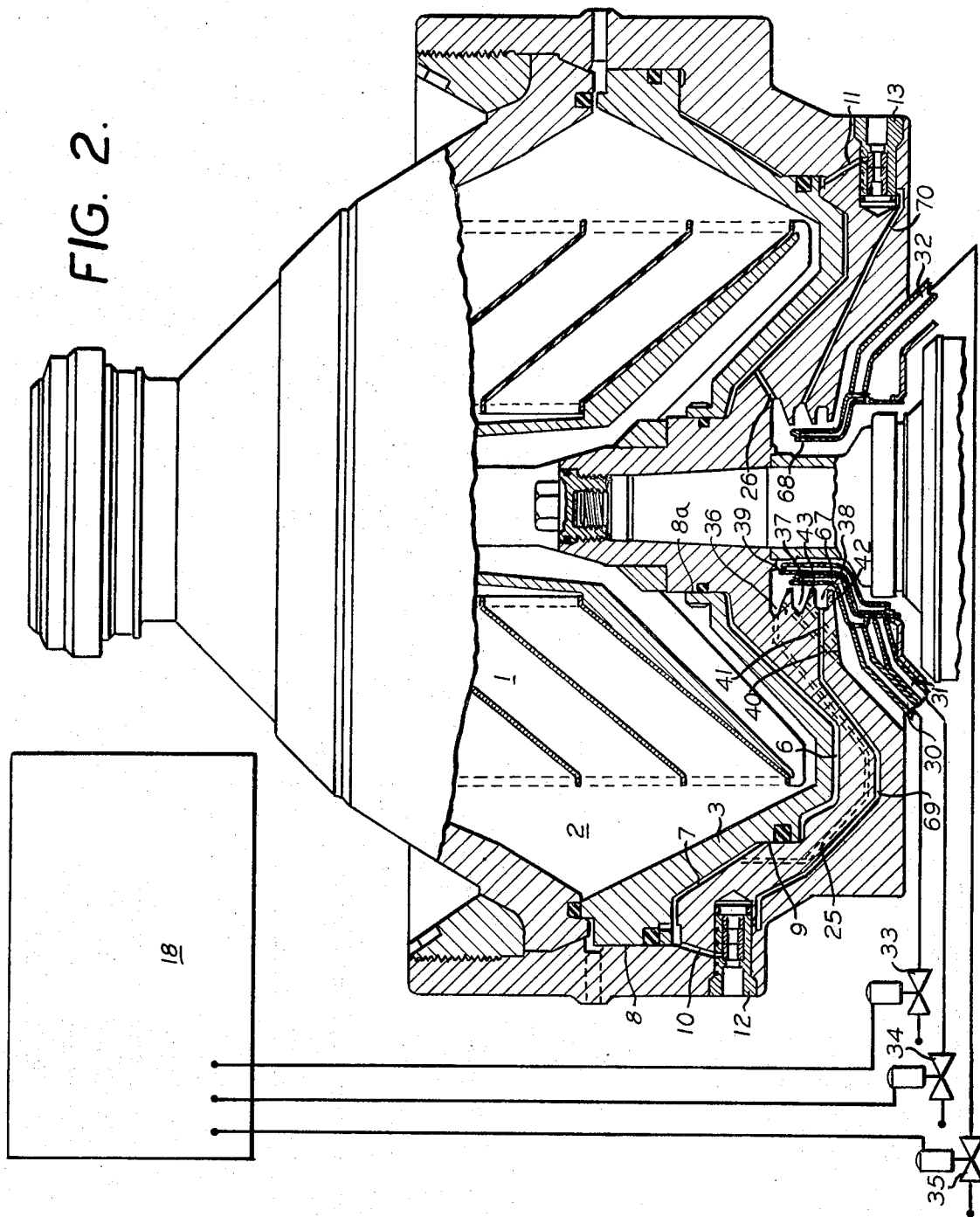
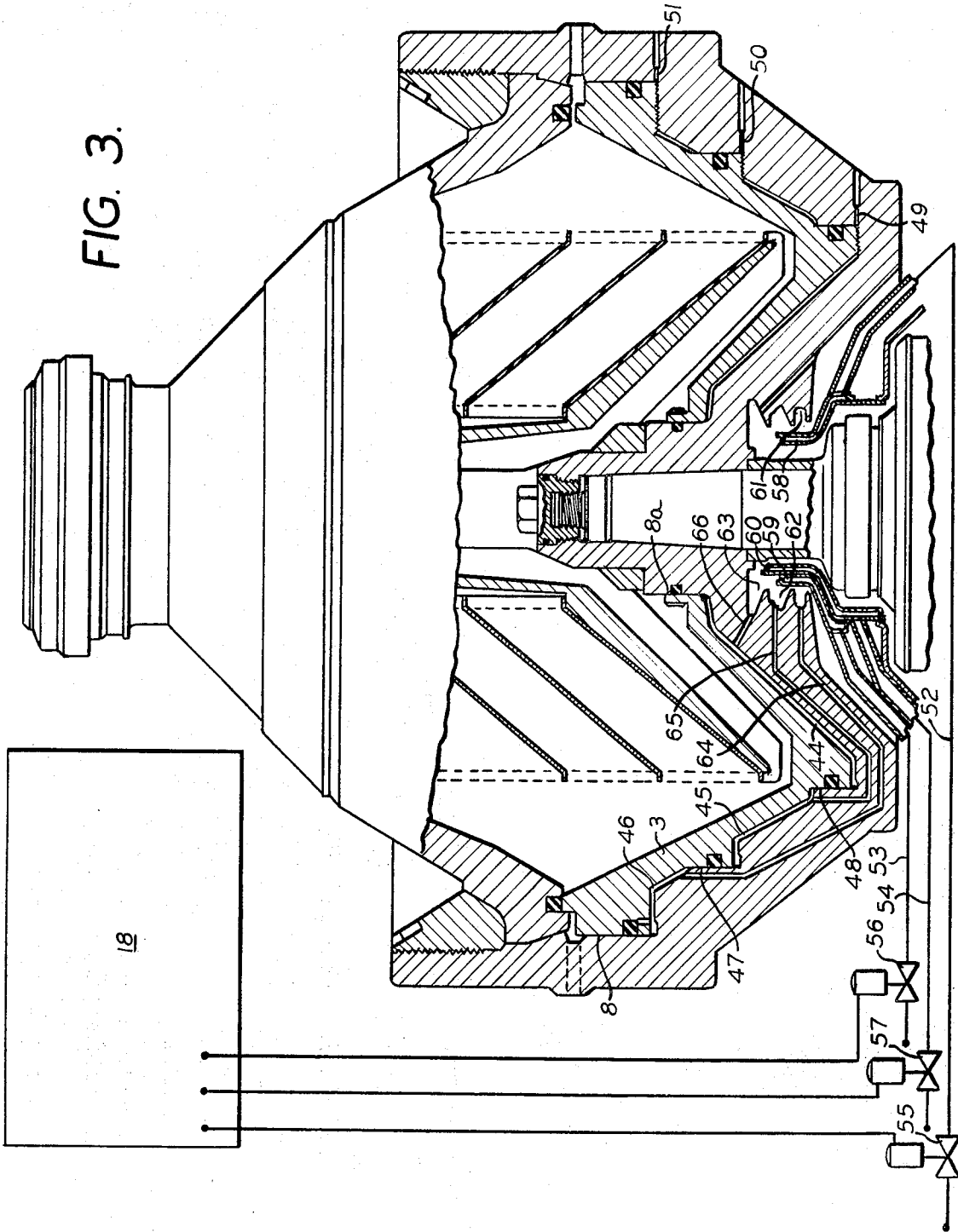


FIG. 3.



## SELF CLEANING CENTRIFUGE DRUM WITH STEPWISE VARIABLE CLOSING PRESSURE

### BACKGROUND

The invention relates to self-cleaning centrifuge drums in which the separating chamber and the sludge chamber are defined at one end by the piston valve controlling the sludge discharge outlet apertures. Drums of this type of construction are provided with a closing chamber located between the piston valve and the adjacent portion of the drum, which is filled with a control fluid before the centrifuging to impose pressure on the piston valve to move the piston valve and thereby close the sludge discharge openings. The closing chamber has a greater radial expanse than the sludge chamber, so that when the closing chamber is completely filled with fluid exerting closing pressure acting to close the piston valve, the closing force on the piston valve is always greater than the force of the drum charge acting on the other side urging the piston valve open. For the ejection of solids, control fluid is let out of the closing chamber with the drum running at full speed, and thus the closing pressure is diminished. Under the pressure of the drum charge the piston valve then moves to the position in which the sludge discharge outlet apertures are uncovered.

Depending on the nature and consistency of the separated solids, it may be advantageous to perform so-called partial desludgings at brief intervals of time, with occasional full desludging operations at longer time intervals.

When partial desludging is performed, the sludge discharge outlet apertures are opened only slightly and/or for a brief period, so that only a portion of the accumulated solids in the sludge chamber is ejected, while the rest remains as a safety ring within the drum. This prevents any great amount of product fluid from being ejected with the solids and going to waste.

When full desludging is performed, the drum is opened wide and the entire contents of the drum is ejected. To achieve a thorough cleaning, full desludging is often followed by a rinsing operation in which the drum is filled with fresh water and spun to empty it again.

To limit the length of time and the degree to which a self-cleaning drum is opened for partial discharge purposes, the drum can be so constructed that a portion of the closing fluid (the fluid in the closing chamber urging the piston valve toward the closed position) remains in the closing chamber. After the ejection of solids commences, as soon as the fluid level in the separating chamber has receded to such an extent that the opening pressure is lower than the closing pressure of the closing fluid remaining in the closing chamber, the piston valve immediately moves back to the closed position. The greater the closing pressure of the control fluid retained in the closing chamber is, the more rapidly the drum recloses and the less solid matter is ejected in each opening operation.

A drum of different construction, having a closing chamber that does not have to be emptied, is shown for example in German Pat. No. 1, 055,451. With this prior-art drum both partial and full desludging can be performed, depending on how long an opening chamber is kept filled with control fluid. This time-dependent control, however, is quite critical in the performance of partial desludging, because the time it takes to fill the

opening chamber of that device is dependent upon the water pressure, and is a portion of the time that has to be preset in a control apparatus.

But even in the case of a drum having a piston valve which defines one side or end of the separating chamber, it is a known procedure to retain a portion of the closing fluid in the closing chamber. German Auslegeschrift Pat. No. 1,432,760 discloses a plurality of design possibilities for achieving this.

According to one of these proposals, a conical plate is inserted into the closing chamber to divide the outer portion of the chamber into two axially opposite chambers. The outlet passage, which is controlled by a valve, extends from the periphery of the lower chamber. When this valve is opened for the ejection of solid matter, the closing fluid in the upper chamber of the outer portion of the closing chamber always remains, and causes the piston valve to move to its closed position whenever the fluid level in the separating chamber recedes and the pressure on the top side of the piston valve has become lower than the pressure of the retained closing fluid acting on its bottom side. With this drum, however, only partial desludging can be performed.

According to another proposal set forth in German Auslegeschrift Pat. No. 1,432,760, the lower portion of the drum is provided at various distances from the axis of rotation with outlet bores for closing fluid, which extend from the closing chamber. The closing chamber extends over the entire radial expanse of the piston valve. These bores can be selectively stopped with plugs, so that the level of the retained closing fluid can be adjusted to different distances from the axis of rotation. The orifice of these bores on the outside of the drum are uncovered by an axially movable valve at predetermined intervals of time for the purpose of the ejection of solid matter. With this drum it is possible to adjust the draining of the closing fluid such that either full desludging can be performed, or partial desludging operations adapted to the specific weight of the mixture being centrifuged.

If the outlet bores on the periphery of the closing chamber are uncovered, the chamber is completely emptied upon the opening of the valve and thus a full desludging is performed. The closer the open outlet bores are to the axis of rotation, the more closing fluid is left in the closing chamber, and only partial desludging can be performed.

In order to change over from full desludging to partial desludging, and to adapt the level of the retained closing fluid to the specific weight of a different mixture, the drum has to be stopped and at least partially disassembled.

### THE INVENTION

The invention is first addressed to the problem of creating a centrifuge drum which selectively permits the performance of partial and full desludging operations without shutting down the separator.

In further development of this main idea, it will be possible in a step-wise manner to vary the closing pressure of the retained closing fluid during operation.

The invention is characterized by the fact that the piston valve, in addition to its customary guidance, is additionally guided sealingly on the adjacent drum portion at different distances from the axis of rotation and thereby divides the closing chamber into a plurality of

radially successive divisions which can be fed with control fluid in a known manner and can be selectively emptied through passages which lead outwardly from the peripheral portions of the individual divisions. In the case of simultaneous emptying of all divisions, the closing pressure is completely eliminated, so that full desludging operations can be performed.

When only one or several of the divisions are emptied, a portion of the closing fluid is retained, so that partial desludging can be performed.

The radial dimensions of the individual divisions can be such that different partial pressures result, which individually or in combination permit extensive adaptation of the residual closing pressure to the specific weight of the mixture being centrifuged and of the solids being separated.

Thus, in summary, the invention is concerned with a centrifugal separator constructed for intermittent discharge of sludge, comprising a rotatably mounted separator drum having a separating chamber defined by an upper end member and a lower end member, and at least one sludge discharge passageway disposed at the radially outward periphery of the drum. One of said end members of the separating chamber is a piston valve movable axially to open and close the sludge discharge passageway for desludging. Fluid operated piston valve control means are provided for alternately forcing the piston valve to the closed position by a fluid pressure created in a closing chamber by feeding a control fluid thereto and permitting the piston valve to move to an opened position by draining off the control fluid therefrom. Further included are control fluid routing means for controlling the position of the valve. The invention provides the improvement which comprises the piston valve control means including a plurality of divisions of the closing chamber disposed in radial succession from the axis, provided by concentric slide seals between the axially outwardly disposed surface of the piston valve and the confronting drum portion. The control fluid routing means includes means for connecting the different divisions of the closing chamber with the infeed of the control fluid and means for selectively depressurizing of the different divisions of the closing chamber permitting selection of the force imposed on the piston valve.

A number of embodiments of the invention are represented in the drawing.

FIG. 1 shows a centrifuge drum in which the closing chamber is divided into two divisions which can be emptied selectively through valves which are held in closing position by feeding a liquid thereto and brought to the open position by shutting off the infeed. (In each of the figures, the piston valve is shown in the closed position (sludge discharge passageways closed) on the left of the figure, and in the open position on the right side. Also, like reference characters refer to corresponding parts.)

FIG. 2 shows the same drum, in which the valves are normally in closed position and brought to the open position by the infeed of fluid, and

FIG. 3 shows a centrifuge drum in which the closing chamber is divided into three divisions from whose peripheral portions calibrated bores lead outward.

With reference to FIG. 1, a separating and sludge chamber is provided by separating section 1 and sludge section 2. The chamber is defined by upper end member 3a and lower end member 3, which is a piston valve

which is axially movable. Axial movement of piston valve 3 opens and closes the sludge discharge apertures 4 for the ejection of solids. Between the piston valve 3 and the lower drum wall 5 is located the closing chamber which in the present embodiment is divided so as to provide two chambers or two divisions 6 and 7, which are sealed from one another and are at different radial distances from the axis so that they are disposed in radial succession from the axis, the piston or slide valve 3 being not only sealingly guided in the conventional manner at 8 and 8a, but being also sealingly guided at 9 on the adjacent drum part 5.

The separator includes control fluid routing means for pressurizing and depressurizing of control fluid for controlling the position of the piston valve. Outlet passages 10 and 11 run from the radially external end of divisions 7 and 6, respectively, and are controlled, respectively by fluid controlled valves 12 and 13. These valves are held in the closed position by the constant infeed of fluid and are brought into the open position by shutting off the feed of fluid. Their manner of operation is described in detail in the copending German Pat. application P 20 22 197.0 of the assignee hereof; U.S. Ser. No. 139,078 filed Apr. 30, 1971, also of the assignee hereof.

Prior to the opening of the inlet (not shown) for the liquid that is to be separated, control valves 14 and 15 in control fluid infeed conduits or lines 16 and 17 are opened, this being brought about in the present embodiment by the control apparatus 18. The control fluid passes from feed line 16 through bore 19 into the receiving groove 20 and from feed line 17 through bore 21 into the receiving groove 22. From the receiving groove 20 the control fluid flows first through the passage 23 which runs out radially and brings the valve 12 into the closed position. The receiving groove 22 communicates with valve 13 through a passage 24, so that this valve, too, shifts to the closed position.

The controller 18 can actuate the various valves such as 14 and 15 to control desludging in dependence on operation of the separator, e.g., based on a time interval or operation, e.g., properties of product.

After passage 23 is filled up, the control fluid passes in known manner from the receiving groove 20 to the closing chamber, passing in the present embodiment through one or more passages 25 into the outer division 7 of the closing chamber, and through one or more passages 26 into the inner division 6 of the closing chamber. In both instances, control fluid overflows from groove 20 in the respective bores leading to the respective chamber divisions. The sum of the closing forces produced in divisions 6 and 7 is equal to the closing force which the control fluid would produce in an undivided closing chamber. The filling up of divisions 6 and 7 brings the piston valve 3 into the closed position (left side of FIG. 1).

After a certain quantity of solid matter has collected in the sludge chamber 2, the outlet valve 12 is opened by the closing of valve 14 in the control fluid infeed line 16 and the outer division 7 is thereby emptied, while the closing fluid is retained in the inner division 6.

Starting with both valves 14 and 15 open, by the closing of valve 15 in the control fluid infeed line 17, the outlet valve 13 is opened and the pressure in the inner division is thereby relieved since the fluid can then run freely through the inner division, while the closing fluid is retained in the outer division 7. In both cases partial

desludging is performed. The individual closing pressures in divisions 6 and 7 can be different. The piston valve 3 moves to the open position (right side of FIG. 1) and immediately moves back to the closed position whenever the opening pressure has become lower than the closing pressure of the retained closing fluid as a result of the receding liquid level in separating chamber 1.

The closing of both valves 14 and 15 brings both outlet valves 12 and 13 into the open position and both divisions 6 and 7 are emptied so that the drum is completely emptied.

To avoid the trouble that would develop if excess control fluid were to pass over from receiving groove 20 into receiving groove 22, receiving groove 20 is provided with an overflow pipe 27 to limit the fluid level to prevent overflow from groove 22 into groove 20, the diameter of the overflow lip 28 is made larger than that of the annular flange 29 which separates grooves 20 and 22.

In the embodiment in FIG. 2, the outlet valves 12 and 13 are closed in the fluid-free state and are brought into the open position by the infeed of control fluid. The manner of operation of such valves is also described in detail in copending German Pat. application P 20 22 197.0, U.S. application Ser. No. 139,078 filed Apr. 30, 1971, both assigned to the assignee hereof. This embodiment is advantageous wherever there is a shortage of fresh water and its consumption must be kept down.

The drum shown in FIG. 2 requires three infeed lines 30, 31 and 32 for control fluid with valves 33, 34 and 35, respectively, and three separate receiving grooves 36, 37 and 38. When valves 33 and 35 are closed, the outlet valves 12 and 13 are also closed. when valve 34 opens, control fluid flows in a known manner through the aperture 39 into the receiving groove 36 and thence through passages 25 and 26 to the inner and outer divisions 6 and 7 of the closing chamber. After both divisions have been filled up, the piston valve 3 is in the closed position and the fluid infeed can be shut off.

After a certain amount of solid matter has built up in the sludge chamber 2, the outlet valve 12 or 13 can be put into the open position by a selective, momentary opening of valve 33 or 35, these outlet valves being fed with control fluid from bores 67 and 68 through receiving grooves 38 and 37, respectively, and passage 69 and 70, respectively. In this manner the inner division 6 or the outer division 7 of the closing chamber is emptied and a partial desludging is performed. By the simultaneous opening of both valves 33 and 35 both divisions 6 and 7 are emptied and full desludging is performed. To prevent the overflow of control fluid from one receiving groove into another, overflow bores 40 and 41 are provided for the two upper grooves 36 and 37, respectively, while overflow lip 42 of the bottom groove 38 has a larger diameter than the annular flange 43.

In the embodiment represented in FIG. 3 the closing chamber is divided into three divisions 44, 45 and 46 of successively greater radius by the fact that the piston valve 3 is sealingly guided at 47 and 48 in addition to the conventional guidance it has at 8 and 8a. Instead of outlet valves such as 12 and 13 in FIG. 1 for controlling flow from the chamber divisions calibrated bores are used, the bores permitting a small bleed stream to be discharged continuously from the chamber divisions when the divisions hold fluid under pressure. If infeed to a division is shut off, the division empties as cali-

brated bores 49, 50 and 51 lead outward from the peripheral portion of divisions 44, 45 and 46.

The control fluid is fed in through separate lines 52, 53 and 54, into which valves 55, 56 and 57, respectively, are installed. It passes in known manner through bores 58, 59 and 60 into receiving grooves 61, 62 and 63, and thence through passages 64, 65 and 66 to divisions 46, 45 and 44, respectively of the closing chamber. This drum, like the one in FIG. 1, requires a constant infeed of control fluid.

If all three valves 55, 56 and 57 are simultaneously closed the control fluid is dumped by centrifugal force from the three divisions 44, 45 and 46 through the calibrated bores 49, 50 and 51.

Upon the selective closing of the individual valves or of two valves in combination, partial desludging takes place. The closing force of the retained fluid can be varied step-wise over a wide range.

#### EXAMPLE

Let us say that the radial dimensions of the individual divisions 44, 45 and 46 are such that the fluid in the inner division produces three twelfths, the fluid in the middle division produces four twelfths and the fluid in the outer division produces five twelfths of the total closing pressure. The following closing pressure settings are then possible.

I Inner chamber only	3/12 of the total closing pressure
II Middle chamber only	4/12 of the total closing pressure
III Outer chamber only	5/12 of the total closing pressure
IV Inner + middle chamber	7/12 of the total closing pressure
V Inner + outer chamber	8/12 of the total closing pressure
VI Middle + outer chamber	9/12 of the total closing pressure
VII Inner + middle + outer chamber	12/12 of the total closing pressure

Any other desired division can, of course, be chosen.

The closing chamber may also be divided into four or more divisions, thereby appreciably increasing the number of possible combinations.

Also, it is possible to provide the drum in FIG. 1 with calibrated outlet bores instead of outlet valves, or the drum in FIG. 3 can be equipped with valves as in FIGS. 1 or 2 instead of calibrated bores as in FIG. 3. The control fluid infeed passages must then be arranged in accordance with the construction of the drum. With the drums of the invention it is possible selectively to perform full or partial desludging without any conversion, and, in the performance of partial desludging, to adapt the closing pressure of the retained fluid to the specific weight of the liquid being centrifuged and to the solid matter being separated.

What is claimed is:

1. In a centrifugal separator constructed for intermittent discharge of sludge, comprising:
  - a. a rotatably mounted separator drum having an upper end member and a lower end member defining a separating and sludge chamber, at least one sludge discharge passageway disposed at the radially outward periphery of the drum,
  - b. one of said end members including a piston valve movable axially within said chamber to open and

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close the sludge discharge passageway for desludging,

- d. a fluid operated piston valve control means for alternatively forcing the piston valve to the closed position by the pressure of a control fluid and permitting the piston valve to move to an open position by relieving the pressure of the control fluid,
- d. control fluid routing means for pressurizing and depressurizing of control fluid for controlling the position of the piston valve,

the improvement which comprises:

- e. said piston valve having an axially outwardly disposed surface, and said drum having a surface confronting said surface of the piston valve, said piston valve control means comprising a plurality of closing chambers disposed in radial succession from the axis, concentric slide seals between the axially outwardly disposed surface of the piston valve and

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said confronting drum surface, providing said plurality of closing chambers,

- f. said control fluid routing means comprising means for selectively pressurizing and depressurizing of the closing chambers permitting selection of the force imposed on the piston valve.

2. Separator according to claim 1, said control routing means comprising fluid controlled valves for closing and opening of the control chambers for, respectively, pressurization and depressurization of control fluid therein.

3. Separator according to claim 1, said control fluid routing means comprising conduits outfitted with control valves for controlled routing of the control fluid and a controller for controlling operation of the control valves in dependence on operation of the separator.

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