METHODS AND APPARATUS FOR MAINTAINING A LIQUID HEAD IN A CENTRIFUGE


Filed Sept. 15, 1965, Ser. No. 487,368
13 Claims. (Cl. 233—2)

ABSTRACT OF THE DISCLOSURE

Method and apparatus for controlling a liquid head in a centrifuge by controlling the drain rate from the centrifuge and wherein the perforate basket member which includes a circumferential collecting chamber carries a drain with a valve therein which is mounted for adjustment from one position in which liquid is enabled to pass through the drain to another position in which liquid is at least partially disabled from passing through the drain, and wherein means is provided for controlling movement of the valve and thereby maintaining the desired liquid head in the basket.

This invention relates to centrifuges of the kind wherein, a slurry containing a mixture of liquid and solid components is subjected to centrifugal force so as to cause the liquid to be thrown off and the solids to be retained as a cake within the centrifuge. More specifically, the invention pertains to apparatus and methods for controlling the rate of drainage from a each type centrifuge so as to maintain a head of liquid within the centrifuge and thereby enable the deposition of a substantially uniform thickness cake of solids in the centrifuge.

In the use of a centrifuge to obtain the deposit of a cake of solids on a rotating screen or drum, it is important that the thickness of the deposited solids be as uniform as possible so as to avoid subjecting the centrifuge apparatus to forces resulting from the unequal distribution of weight about the axis of rotation. Not all slurries subjected to centrifuge treatment can be processed in exactly the same manner since some solids will enable liquid to be drained therethrough at a greater or lesser rate than can be achieved with other solids. Consequently, it has been the practice heretofore to provide two different centrifuge designs, one of which is adapted for use with slurries wherein the drain rate may exceed the rate at which the centrifuge is charged with the slurry, and the other of which is adapted for use in those instances where the charge rate may exceed the drain rate. In the former, uneven depositions of solids are prevented by a rake which scrapes the radially inner surface of the cake of solids, and in the latter apparatus the inner peripheral portions of the solids are maintained in a quasistatic state by the head of liquid so as to enable the solids to flow over one another and form a cake of substantially uniform thickness. Generally speaking, the liquid head method of levelling is a preferred system for most products. The necessity of having to utilize two different types of centrifuge apparatus can be expensive for a customer, not only from the standpoint of cost of the centrifuges, but also from the standpoint of the utilization of floor space. In those instances where a single centrifuge may be added for conversion from one kind of operation to the other, the conversion can be an arduous and expensive undertaking.

An object of the invention is to provide a liquid head type centrifuging apparatus which is universal in the sense that it can be used for both fast and slow draining materials, without requiring any appreciable modification.

Another object of the invention is to provide a centrifuge having a perforate member through which liquid may be drained, and wherein the rate of drainage of the liquid may be regulated so as to achieve the optimum drainage rate.

A further object of the invention is to provide a centrifuge of the character described in which the drainage rate may be adjusted during operation of the centrifuge.

A further object of the invention is to provide an improved method of depositing a uniform thickness cake of fast draining solids in a centrifuge.

Another object of the invention is to provide a method of regulating the rate of drainage of liquid from a slurry in a centrifuge.

Other objects and advantages of the invention will be pointed out specifically and will become apparent from the following description when it is considered in conjunction with the appended claims and the accompanying drawings, in which:

FIGURE 1 is a fragmentary vertical sectional view of apparatus constructed in accordance with the invention, the section being taken along the line 1—1 of FIGURE 2;

FIGURE 2 is a fragmentary transverse sectional view taken on the line 2—2 of FIGURE 1;

FIGURE 3 is a fragmentary, sectional view of a modification of the apparatus;

FIGURE 4 is a view similar to FIGURE 3, but illustrating another modification;

FIGURE 5 is a view similar to FIGURE 4, but illustrating a further modification; and

FIGURE 6 is a view similar to FIGURE 5 but illustrating a still further embodiment of the invention.

Apparatus constructed in accordance with the embodiment of the invention disclosed in FIGURES 1 and 2 comprises a main frame or base 1 on which is fixed an annular wet housing 2. The housing 2 comprises a cylindrical rim 3 having a radial flange 4 at one side that is secured by screws 5 or the like to the frame member 1. At the outer side of the rim 3 is another radial flange 6 to which may be screwed a cover plate 7.

Journalled on the frame 1 by suitable bearings 8 is a rotatable shaft 9 one end of which may be connected in any suitable manner to a driving motor (not shown). Fixed to the other end of the shaft 9 is a centrifuge 10 comprising spaced side plates or discs 11 and 12 between which may be secured either an imperforate conical member or, as shown, a cylindrical member 13. On the inner surface of the member 13 is secured a plurality of spacer members 14 which engage and support a perforate screen 15. The screen is spaced radially inwardly of the member 13 so as to provide an annular chamber 16 between the members 13 and 15.

At diametrically opposed points about the periphery of the side plate 11 are mounted a plurality of valve assemblies 17 each of which comprises a tubular housing 18 in which is accommodated a thimble 19 that is provided with a bore 20 extending radially of the axis of the shaft 9. Communicating with each bore 20 is a transverse passage 21 that also communicates with the annular chamber 16. Mounted in each bore 20 for radial reciprocating movements is a valve 22 having a tubular stem 23 which communicates with the passage 21 through ports 24. On the radially inner end of each stem 23 is provided an enlarged head 25 in the underside of which is an annular recess 26. A bleed port 27 may be provided in each head 25 or, if desired, sufficient clearance may be provided between the head 25 and the housing 18 to permit leakage of fluid.

The construction and arrangement of the valve assemblies 17 are such that, upon rotation of the centrifuge 10, the valves 22 are urged by centrifugal force to a radially outer position as shown in FIGURE 1 in which the ports 24 provide communication between the annular chamber 16 and the bores 20. In these positions of the
valves 22 the heads 25 bear against the thimbles 19 to limit radially outward movement of the valves 22. A mounting plate 29 is fixed to the main frame 1 by bolts or the like, one of which is shown at 30 in FIG-URE 1. The plate 29 is joined to an annular support 31 that is accommodated in an opening 32 formed in the main frame 1 and through which the shaft 902 rotates. A suitable packing 33 surrounds the shaft 9 and is retained by a retaining ring 34. A fixing to the mounting plate 29 by bolts 35 or the like is a trough member 36 having a mounting flange 37 on which the bolts 35 are accommodated, and a radially inwardly extending flange 38 which, together with the inner surface of the mounting plate 31, forms an annular, station- ary trough 39. In communication with the trough 39 is a passage 40 in the plate 31 and in which is accommo- dated a fitting 41 fixed at the end of a tube 42, by means of which fluid may be introduced from a source (not shown) to the trough 39. A suitable valve 43 is provided in the tube 42 so as to regulate the flow of fluid from the source to the trough 39.

Interconnecting each valve assembly 17 and the trough 39 is a tubular conduit or scoop tube 45 that is welded or otherwise fixed to the centrifuge 10 in any suitable way so as to rotate with the latter. The radially inner end of each tube 45 is open and extends between the mounting plate 31 and the flange 38 so as to project into the trough 39. The opposite or radially outer end of each tube 45 also is open and extends into a block member 46 that is mounted adjacent the associated valve housing 18 and in communication with a transverse bore 47 which communicates at one end with the recess 26 in the valve head 25. The opposite end of the passage 47 is closed by a plug 48.

In communication with the trough 39 is a drain tube 50, one end of which is connected to a fitting 51 that extends through an opening in the mounting plate 31 in a manner similar to the fitting 41. A valve 52 may be included in the tube 50 so as selectively to open and close the latter.

Mounted within the centrifuge 10 is a knife box assembly 53 which may be of the type disclosed in United States Patent No. 3,092,575, issued June 4, 1963, and which may be used to scrape solids from the centrifuge. In communication with the knife box 53 is a discharge chute 54 which extends through the opening provided by the annular flange 12 and through an opening 55 formed in the cover plate 7 of the wet housing 2.

Also extending through the opening 55 is a slurry de- livery pipe 56, the terminal end of which is bent to extend axially of the centrifuge 10 and on which is mounted a slurry distributing member 57 of conventional construction.

In the operation of the apparatus, a slurry containing liquid and solid particles may be introduced to the interior of the rotating centrifuge. The slurry will be acted upon by centrifugal force so as to cause the liquid to pass through the screen, the solid particles being retained by the screen and forming a cake on the inner periphery of the screen. Liquid passed through the screen will be received in the chamber 16. As long as the valves 22 are in the radially outer positions, as shown in FIGURE 1, liquid may pass from the chamber 16 through the pas-sages 21 and the ports 24 into the bore of the valve stem 23 so as to be discharged from the centrifuge into the wet housing 2. Liquid received in the wet housing may be discharged therefrom through one or more drain openings 58.

If the rate of drainage of liquid from the centrifuge is greater than that which will maintain a liquid head governing the deposition of a uniform thickness cake, the valve 43 in the fluid delivery tube 42 is opened at the same time that the valve 60 in the slurry supply pipe is opened so as to admit fluid to the trough 39. When a charge has been delivered to the centrifuge and the valve 60 is closed the valve 43 is also closed. The fluid so admitted through line 42 may be a separate control liquid such as water or may be mother liquor. Upon the intro- duction of liquid to the stationary trough 39, continued rotation of the centrifuge 10 will cause the radially inner ends of the conduits 45 to pass through liquid in the trough so as to scoop liquid therefrom. Liquid thus intro- duced to the conduits 45 will be acted on by centrifugal force so as to move radially outwardly for delivery to the valve assemblies 17 via the passages 47. From the control liquid will be introduced to the recesses 26 between the valve heads 25 and the thimbles 19. The introduction of liquid to the valve assemblies under a pressure generated by centrifugal force will exert a force on the valves 22 in direct proportion to the speed of rotation of the centrifuge and in such direction to move them radially inwardly so as to restrict or close the passages 21, and either retard or disable altogether the drainage of liquid from the chamber 16. The control fluid, therefore, utilizes the centrifugal force generated by rotation of the centrifuge to overcome the centrifugal force acting on the valves 22 so as to adjust the latter between positions in which the drainage of liquid from the centrifuge is enabled and disabled and the desired cake leveling liquid head is maintained in the centrifuge.

Control fluid introduced to the valve assembly 17 eventually will escape therewith via the bleed ports 27 in the valve head 25, unless the flow of fluid to the trough 39 is maintained. By maintaining valve 43 open during centrifuging while valve 60 is closed and adjusting the rate of flow of fluid to the trough 39, a condition of balance may be maintained so as to enable the valves 22 to remain in any selected position of adjustment.

When it is desired to drain the trough 39, the valve 43 may be closed and the valve 52 may be opened, whereupon fluid in the trough will be drained through the drain tube 50.

By regulating the positions of the valves 22, the rate of drainage of fluid from the centrifuge may be controlled so as to enable deposition of a cake on the rotating screen in such manner as to permit the leveling of various centrifugally deposited materials by the liquid head process.

The embodiment shown in FIGURE 3 is generally similar to the previously described embodiment but dif- fers from the latter in that a trough 39a is formed by a cup-shaped member 31a that is fixed to the plate 11 to rotate with the latter. At diametrically opposed inter- vals are radially inner ends 45a, the latter which communicate with the trough, and the radially outer ends of which communicate with the valve assemblies 17 as previously described. The member 31a has a central opening therein through which a control fluid delivery tube 42a extends so as to introduce fluid to the trough 39a. A valve 43a controls the flow of fluid through the tube 42a. The operation of the apparatus shown in FIG-URE 3 is the same as has earlier been described.

The embodiment of the invention disclosed in FIG-URE 4 relies upon centrifugal force to urge the valve assembly 17 to its closed position, and utilizes pressure fluid, either air or liquid, to shift the valve assembly to its open position. In the modified construction, a fluid delivery line 65 communicates at one end with the valve housing 18 in substantially the same manner described earlier. The other end of the line 65 communicates with a bore 66 formed in the shaft 9, the bore 66 also commu- nicating through a rotary joint 67 with a fluid delivery tube 65 connected to a source (not shown) of pres- sure fluid. A valve 69 may be operated to control the flow of pressure fluid.

In operation, opening of the valve 69 will permit pressure fluid to enter the valve housing 18 and act on the valve head 25 to exert a force on the valve in pos- sition to the centrifugal force generated by rotation of the centrifuge, whereupon the valve may be shifted.
radially inward to such position as to enable liquid to be drained from the chamber 16. The embodiment of the invention disclosed in FIG. 5 relies upon electrical actuating means for controlling the flow of liquid from the centrifuge. In this embodiment, the centrifuge wall 11 is provided with a peripheral flange 70 which is secured to the annular wall 13, both the flange and the wall having aligned openings 71 and 72, respectively, therein through which one end of a valve rod 73 may extend. The rod 73 also extends through an opening formed in a guide flange 74 fixed to the wall 11, and has its upper end recessed to accommodate a slot 75 in the hub 76 of the wall 11. The rod 73 preferably includes an enlargement 77 between which and the flange 74 is a spring 78 which may counterbalance the centrifugal force exerted on the rod by rotation of the centrifuge or, if desired, bias the rod radially inwardly when the centrifuge is at rest. The arrangement is such that, when the radially outer end of the valve rod 73 occupies the opening 72, liquid from the chamber 16 is disabled from draining out of the centrifuge. When the valve rod is shifted radially inwardly, however, it clears the opening 72 and enables drainage of the centrifuge.

Means for shifting the valve rod 73 radially inwardly in opposition to the centrifugal force exerted thereon comprises a wedge-shaped flinger 79 that is accommodated in an elongate slot formed in the valve rod 73. The flinger is fixed to a shaftable operating ring 80 that rotates with but is axially slideable on the hub 76 of the member 11. Adjacent the hub the shaft 9 is provided with an ear 81 on which is pivoted, as at 82, a lever 83, one end of which extends through a slot in the ring 80 and the other end of which extends into a transverse bore 84 formed in the shaft. The parts described thus far are duplicated on opposite sides of the ring 80. The shaft also is provided with an axial bore 85 in communication with the bore 84 and in which is accommodated an actuating solenoid 86 having an axially displaceable armature 87 to which the levers 83 are connected. Current conducting wires 88 and 89 extend from the solenoid to insulated slip rings 90 and 91 which rotate with the shaft 9, and collector leads 92 and 93 connect the slip rings to a source of electrical energy.

In the operation of the apparatus, energization of the solenoid 86 causes the armature 87 to be displaced to the left from the position shown in FIGURE 5, thereby rocking the levers 83 counterclockwise and moving the ring 80 in the direction of the fingers 79 to the right, whereupon the inclined surface of the fingers 79 engages the edges of the associated slots in the valve rods 73 and moves the latter radially inwardly to positions in which the drain openings 72 are open. Deenergization of the solenoid causes opposite rocking of the levers 83 and opposite movement of the ring 80 and the fingers 79 so as to effect radially outward movement of the valve rods 73 to positions in which the drain openings 72 are closed. The embodiment shown in FIGURE 6 is similar to that just described, but in the modified embodiment, adjustment of the valve rods 73 is effected manually. In this instance each rod 73 is provided with a roller 94 which rides against an inclined surface 95 formed on an operating ring 96 which surrounds the hub 76 and is capable of being shifted axially of the shaft 9. The actuating means for the ring 96 comprises a righthand lever 97 pivoted as at 98 on a fixed support 99. At one of its ends the lever has a lateral extension 100 that is accommodated in a slot 101 formed in the ring. The arrangement is such that rocking of the lever 97 in one direction shifts the ring axially of the shaft 9 to effect radially inward movement of the associated valve rods 73 to open the drain 72, and movement of the ring in the opposite direction effects radially outward movement of the valve rods to close the opening 72.
11. Centrifuging apparatus as set forth in claim 9 wherein said actuating means comprises a manually operable lever.

12. Centrifuging apparatus as set forth in claim 1 wherein said controlling means comprises a source of fluid under pressure and means controlling its supply to said valve means.

13. A method of controlling a liquid head on the radially inner solids screening surface of a rotating perforate basket centrifuge to which a fast draining slurry comprising liquid and solid components is fed comprising: feeding said slurry to the interior of the rotating basket; rotating the basket at centrifuging speeds; separating the liquid and solid components by centrifugal force such that the liquid passes through the basket and solid components collect on the radially inner face of the basket, collecting the liquid components exteriorly around the basket in an open restricted space revolving with said basket; and at least partially restricting the discharge of liquid components from the space during rotation of the basket at centrifuging speeds and, while effecting said separation, maintaining a liquid head on the radially inner face of the basket.

References Cited

UNITED STATES PATENTS

9,72,030 10/1910 Smith 23-20 X
1,119,350 12/1914 Hamill 23-20
2,106,986 2/1938 Pearce 23-20
2,467,742 4/1949 Hanno 23-20
2,820,589 1/1958 Fitzsimmons 23-20
349,106 9/1886 Koelkebeck 23-20
489,090 1/1893 Peck 23-20
648,711 5/1900 De Raasloff 23-20
722,522 3/1903 Lucas 23-20
1,132,814 3/1915 Weston et al. 23-20
2,488,746 11/1949 Strezynski 23-20

FOREIGN PATENTS

623,143 5/1949 Great Britain.

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