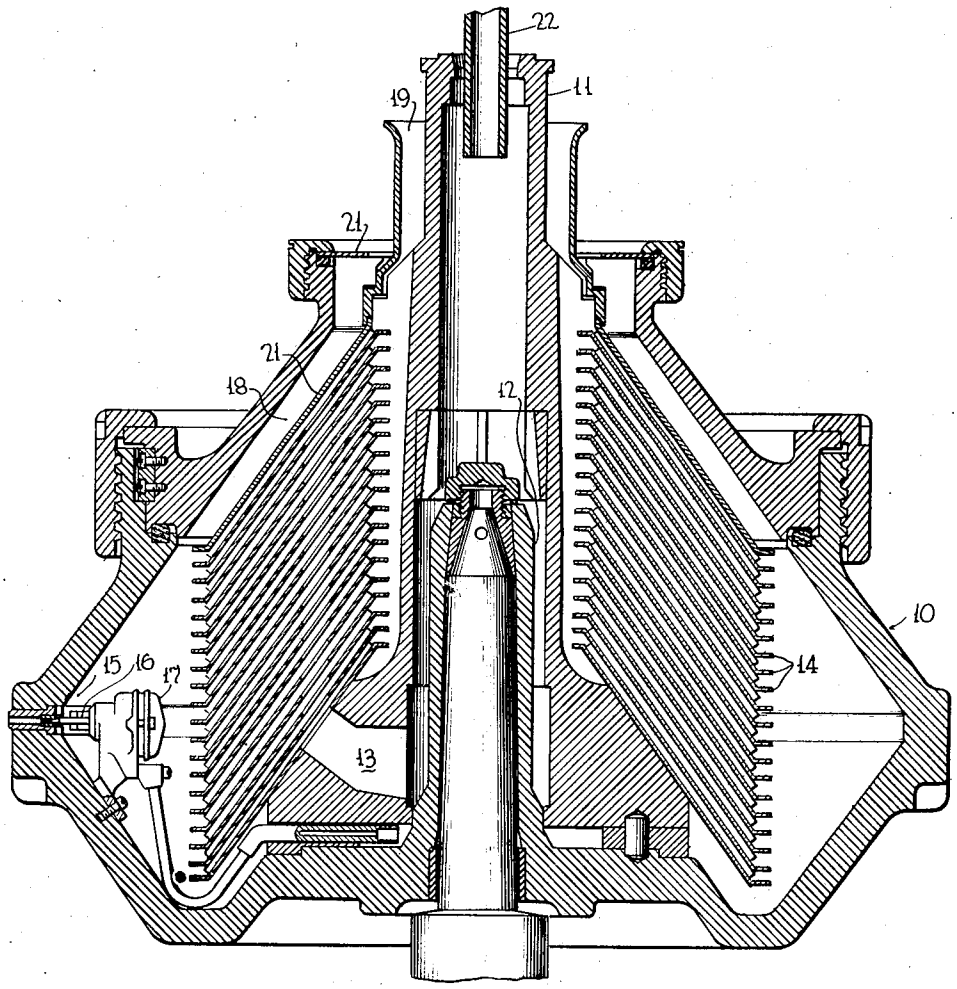
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CENTRIFUGAL SEPARATING METHOD AND APPARATUS

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FIG. 1



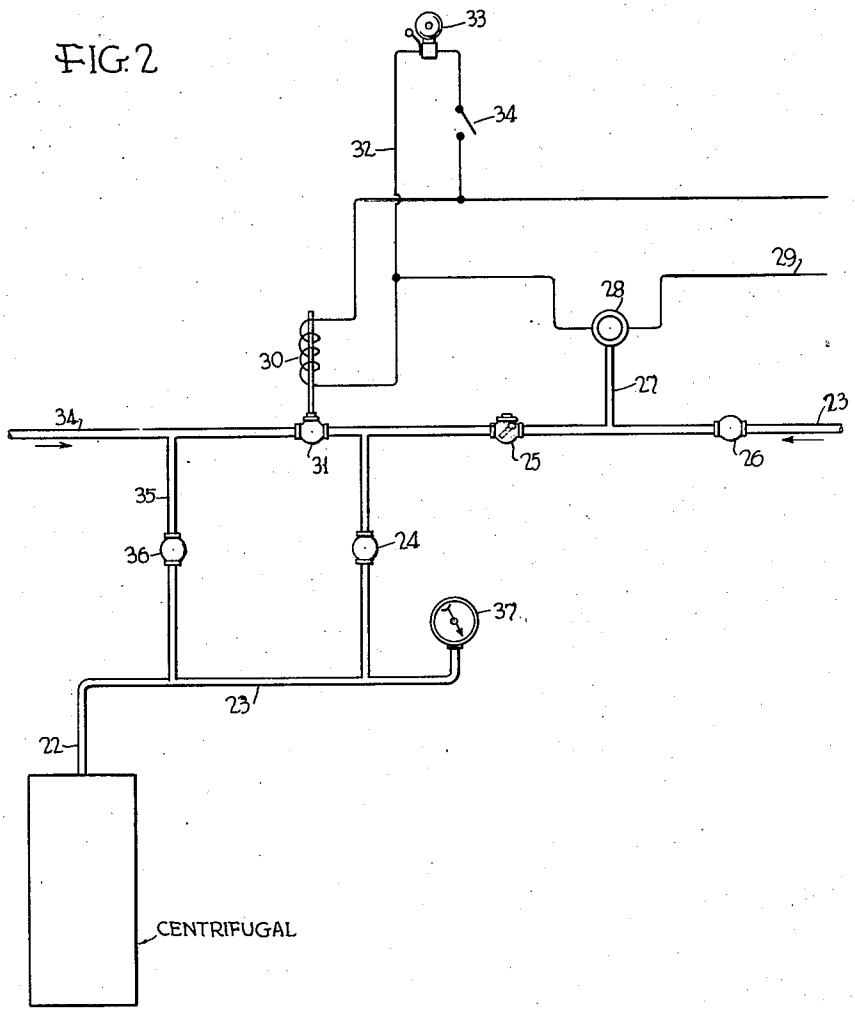
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CENTRIFUGAL SEPARATING METHOD AND APPARATUS

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FIG. 2



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UNITED STATES PATENT OFFICE

2,321,918

CENTRIFUGAL SEPARATING METHOD AND APPARATUS

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Application December 31, 1941, Serial No. 425,050

10 Claims. (Cl. 233—21)

The present invention pertains to the art of centrifugal separators of the so-called desludging type, designed to separate solid or semi-solid impurities from one or more liquids and discharge the separated solids during the rotation of the rotor in which sedimentation of such solids is accomplished.

As is well known to those skilled in this art, desludging centrifugals may effect periodic discharge of the sludge by control of valves, or the sludge may be continuously discharged through restricted passages communicating with an outer portion of the separating space of the centrifugal rotor. In either case, an attempt is made to operate the machine in such a manner that the solid impurities are separated from the liquid or mixture of liquids passed to the rotor, and discharge the solids separately from the rotor, usually together with a minor part of the liquid under treatment.

In the operation of desludging centrifugals, it frequently occurs that the centrifugal becomes unbalanced by accumulation of solids irregularly about the periphery of the separating space of the rotor. This may occur because of failure of one or more of the valves controlling discharge of sludge from the peripheral separating space to open, or because of cloggage of one or more of the discharge outlets through which sludge is removed from the centrifugal. Such irregular deposition of solids within the rotor does not ordinarily have any very detrimental effect during normal operation of the machine so long as the rotor is full of liquid by reason of continued feed of the material under treatment to the rotor, but when such feed is discontinued, the condition of unbalance is aggravated by the decrease in weight of the rotor contents other than the accumulated sludge, with the result that objectionable vibration occurs. As long as the rotor is full of liquid, the unbalance caused by irregular deposition of solids is proportional to the difference in specific gravity between solids and liquid, but when liquid is drained from the rotor it becomes proportional to the absolute specific gravity of the solids.

The feed of liquid to the rotor is ordinarily discontinued when the operator desires to stop the machine, and objectionable vibration may occur after the feed is stopped during the period between such cessation of feed and the time when the rotor comes to a stop. Objectionable vibration may also occur by reason of accidental failure of the normal feed to the rotor, due to cloggage of strainers through which the material is fed to the centrifugal, failure of the pump for feeding the material to the centrifugal or failure of the source of supply from which the material is fed to the centrifugal. Regardless of the cause of cessation of feed to the centrifugal, objectionable vibration may be caused in any case in which the liquid contents of the rotor are diminished during continued rotation at high speed by failure to feed liquid at a rate at least as great as the rate of discharge of such liquid from the centrifugal.

A feature of the present invention consists of provision of a method and apparatus by which liquid is fed to the rotor at such rate as to maintain it full of liquid up to the normal depth of liquid in the rotor in case cessation of the normal feed of liquid due to any one of the above causes occurs during rotation at high speed. In order to accomplish this object, automatic means are provided for passing an auxiliary liquid into the separating space of the rotor in case of failure of the normal feed for any reason whatever.

Further features of the invention and the details of the method and apparatus constituting the invention will be evident from a reading of the following detailed description in the light of the attached drawings, in which,

Figure 1 illustrates a centrifugal separator of the so-called valve bowl type to which the invention may be applied, and

Figure 2 is a diagrammatic illustration of apparatus for accomplishing treatment in accordance with the invention.

The process and apparatus of the invention may be usefully employed either in separation of solids from a single liquid by a desludging centrifugal of the so-called clarifier type, or in the separation of solids from two immiscible liquids at the same time that the liquids are separated from each other, in a centrifugal of the so-called separator type. Both types will hereinafter be referred to by the generic name "centrifugal separator."

Figure 1 of the drawings illustrates a desludging centrifugal of the separator type which may be used in practice of the invention. This separator includes a centrifugal rotor 10 provided with a central feed tube 11 which receives liquid through a conduit 22. The rotor is provided with an upstanding hollow boss 12 which receives the rotor driving shaft. Liquid is passed from the lower end of the feed tube 11 through a plurality of radial channels 13 into the space between successive pairs of discs 14, as will be well understood by those skilled in the art. Heavy impuri-

ties pass outwardly through the disc stack into zones 15 of accumulation of solids, and the solids are periodically discharged from these zones 15 by actuation of valves 16 under the power of individual hydraulic motors 17 secured to the respective valves. These valves, and their actuating mechanisms, are disposed symmetrically about the largest part of the circumference of the rotor. Stratification of the immiscible liquids from each other occurs in the rotor at the same time that the solids are discharged outwardly into the zones 15, the heavier liquid being discharged from the rotor through the passages 18 between the dividing cone 20 and the upper portion of the rotor wall and over the ring dam 21, while the lighter liquid is discharged inwardly from the disc stack and over the extension 19 of the dividing cone 20.

The centrifugal separator described above forms no part of my present invention, since it is the subject matter of the co-pending application of Harold C. Fitzsimmons, Serial No. 318,672, filed February 13, 1940. In operation, when the rotor is first brought up to speed, the valve 16 is forced against its seat in the rotor wall under the influence of centrifugal force. As the rotor fills with liquid, and this liquid reaches the radial portion of the separating space occupied by the motor 17, this liquid will act upon the motor to move the valve to open position. As the body of liquid in the rotor becomes deeper, these valves remain in open position until the liquid has reached substantially its maximum depth. The valves are then closed until accumulation of the sludge adjacent the valves occurs to a sufficient extent to cause actuation of the motors to move them again to open position. Each individual valve motor is controlled by accumulation of sludge adjacent thereto in such manner that the individual valves are independently and automatically opened intermittently in response to accumulation of sludge in order to discharge that sludge, and are again closed after discharge of excess accumulation of sludge adjacent the valve motor. The opening of the valves is caused by accumulation of the sludge and the closing of the valves by the hydrostatic head due to application of centrifugal force to the depth of liquid maintained in the rotor during normal operation.

When the hydrostatic head in the centrifugal rotor is diminished by failure to feed liquid to the rotor, the valves are automatically moved to open position, permitting sludge to discharge through the valve-controlled outlets and also permitting liquid from the main body of the rotor to be discharged through these outlets. In case diminution of this hydrostatic head is caused by failure to feed liquid to the rotor, the valves will be retained in open position until most of the liquid in the rotor has been discharged through these valves. In case one or more of the valve-controlled outlets has become plugged, or in case irregularity of the body of solids in the rotor due to other causes exists during the period of discharge of liquid from the rotor through valve-controlled outlets, very objectionable vibration may occur due to the unbalanced condition of the rotor during continued rotation at high speed. Such vibration is minimized or avoided in accordance with the features of the present invention by feeding an auxiliary liquid to the rotor at times in the cycle of operations when the normal feed is cut off.

The features of the present invention by which objectionable vibration is avoided in cases in which normal feed is discontinued or diminished are illustrated in Figure 2 of the drawings. As there illustrated, the normal feed of material to be treated in the rotor passes to the feed pipe 22 through a system of piping 23 controlled by manually operated valves 24 and 26 and a check valve 25. A conduit 27 connects the piping 23, at a point between the manually operated valve 26 and the check valve 25, with a pressure-controlled electric switch 28 in a circuit 29. A solenoid 30 is also provided in the circuit 29, and this solenoid controls operation of a valve 31. The solenoid 30 may be wired in parallel with a branch electrical circuit 32 containing a warning signal apparatus, such as an alarm bell 33, and a switch 34 for controlling this branch circuit.

During normal operation of the machine, the valves 24 and 26 are maintained open, and as long as normal feed continues, the pressure in the piping 23, acting through the conduit 27, will maintain the pressure switch 28 in open position, and the solenoid-controlled valve 31 will remain closed. If, for any reason, total or partial failure of feed occurs, resulting in substantial diminution of pressure in the portion of piping 23 connecting valves 26 and 25, the pressure in the conduit 27 will diminish to such point as to cause actuation of the pressure switch 28 to closed position. Current will then be passed from power line 29 through solenoid 30, causing the valve 31 to be opened, to admit water or other auxiliary liquid from conduit 34 through valve 31 and valve 24 into the centrifugal, thereby avoiding depletion of the liquid content of the centrifugal with the objectionable vibration which such depletion would entail. The check valve 25 prevents auxiliary liquid introduced through conduit 34 from passing to the right through conduit 23 and actuating switch 28 to open position. If normal flow of liquid should be resumed during passage of auxiliary liquid to the rotor, pressure in conduit 27 will cause actuation of switch 28 to open position, with resultant closing of valve 31, and discontinuance of the supplemental liquid feed.

When the switch 28 is closed by failure of feed, current will be passed through branch circuit 32 and warning signal 33 to warn the operator. Upon being warned in this manner, the operator can shut off the centrifugal, and during the period while the centrifugal is being brought to rest, the feed of auxiliary liquid will maintain the rotor full of liquid up to its normal operating depth until the rotor has been slowed down to such a point that objectionable vibration will be avoided.

While the invention has been discussed above in connection with an automatic control of the auxiliary liquid, it is not restricted to such operation, since this control can be effected manually without resort to the automation discussed above. Thus, the operator may be warned concerning failure of feed of the main liquid by reduction of pressure in the feed line as indicated by the pressure gauge 37, and he may thereupon open valve 36 in by-pass line 35, thereby permitting auxiliary liquid to pass to the rotor from conduit 34. In any case, such control may be effected in case of failure of the automatic connection including the pressure switch 28 and solenoid 30 to operate properly. Such manual control may also be effected in response to an alarm signal controlled by connections such as those discussed above with respect to the signal 33.

Various modifications are possible within the scope of the invention, and I do not therefore

wish to be limited except by the scope of the following claims.

1. In a desludging centrifugal, the combination comprising a centrifugal rotor bowl having sludge discharge outlets, said bowl having the characteristic of vibrating when operating at high speed and upon failure of feed of material thereto, means for feeding to the separating space of said rotor bowl a mixture to be subjected to centrifugation, and means controlled by the feed of said mixture to be treated in said bowl for feeding an auxiliary liquid to said bowl upon failure of the feed of said mixture to be treated, said auxiliary feed being at a rate in excess of the discharge capacity of said outlets for maintaining sufficient liquid in said bowl during continued rotation thereof to avoid vibration of said bowl.

2. In a desludging centrifugal, the combination comprising a centrifugal rotor bowl provided with sludge discharge outlets, said bowl having the characteristic of vibrating when operating at high speed and upon failure of feed of material thereto, means for feeding under pressure to the separating space of said rotor bowl a mixture to be subjected to centrifugation, means for feeding an auxiliary liquid to the separating space of said rotor bowl, and means controlled by the pressure under which said mixture to be treated is fed to said rotor bowl for causing said auxiliary liquid to be passed to said rotor bowl upon predetermined diminution of said pressure, said auxiliary liquid feed being at a rate in excess of the discharge capacity of said outlets for maintaining sufficient liquid in said bowl during continued rotation thereof to avoid vibration of said bowl.

3. In a desludging centrifugal, the combination comprising a centrifugal rotor bowl provided with sludge discharge outlets, said bowl having the characteristic of vibrating when operating at high speed and upon failure of feed of material thereto, means for feeding to the separating space of said rotor bowl a mixture to be subjected to centrifugation, means for feeding an auxiliary liquid to the separating space of said rotor bowl, a solenoid-controlled valve for controlling the operation of said last-named means, and means controlled by the feed of said mixture to be treated in said rotor bowl for causing actuation of said solenoid-controlled valve upon failure of the feed of said mixture to be treated and causing feed of said auxiliary liquid upon occurrence of said failure, said auxiliary liquid feed being at a rate in excess of the discharge capacity of said outlets for maintaining sufficient liquid in said bowl during continued rotation thereof to avoid vibration of said bowl.

4. In a desludging centrifugal, the combination comprising a centrifugal rotor bowl provided with sludge discharge outlets, said bowl having the characteristic of vibrating when operating at high speed and upon failure of feed of material thereto, means for feeding to the separating space of said rotor bowl a mixture to be subjected to centrifugation, means for feeding an auxiliary liquid to the separating space of said rotor bowl, a pressure-actuated switch controlled by the feed of material to be treated in said rotor bowl adapted to be actuated by failure of said feed to control an electric circuit including a solenoid, and a valve controlled by said solenoid for controlling feed of said auxiliary liquid to said rotor bowl and for introducing said auxiliary liquid into said rotor bowl upon failure of the feed of said mixture to be treated, said auxiliary liquid feed being at a rate in excess of the discharge capacity of said outlets for maintaining sufficient liquid in said bowl during continued rotation thereof to avoid vibration of said bowl.

5. In a desludging centrifugal, the combination comprising a centrifugal rotor bowl provided with a plurality of peripherally spaced valve-controlled outlets, said bowl having the characteristic of vibrating when operating at high speed and upon failure of feed of material thereto, means for feeding to the separating space of said rotor bowl a mixture to be subjected to centrifugation, means for feeding an auxiliary liquid to the separating space of said rotor bowl, and means controlled by the feed of material to be treated in said rotor bowl for causing said auxiliary liquid to be passed to said rotor bowl upon failure of the feed of said mixture to be treated, said auxiliary liquid feed being at a rate in excess of the discharge capacity of said outlets for maintaining sufficient liquid in said bowl during continued rotation thereof to avoid vibration of said bowl.

6. A process of separating solids from liquid which comprises, feeding a mixture of solids and liquid to a centrifugal rotor, discharging the solids peripherally from the rotor in the form of a sludge while separately discharging the liquid from the rotor, discontinuing said feeding of said mixture and the driving of said rotor, and immediately feeding an auxiliary and different liquid into the separating space of the rotor at a rate in excess of the discharge capacity of the sludge discharge outlets after discontinuance of feed of the material to be treated to the rotor to maintain a sufficient depth of liquid in said rotor during continued rotation thereof after discontinuance of feed of material to be treated to said rotor and until said rotor has substantially reached a state of rest to avoid vibration of said rotor.

7. In a centrifugal separator, the combination comprising a centrifugal rotor bowl provided with outlets for discharging sludge and a discharge weir for controlling discharge of liquid continuously from the rotor bowl, said bowl having the characteristic of vibrating when operating at high speed and upon failure of feed of material thereto, means for feeding to the separating space of said rotor bowl a mixture to be subjected to centrifugation, means for feeding an auxiliary liquid to the separating space of said rotor bowl, and means controlled by the feed of said mixture to be treated in said rotor bowl for causing said auxiliary liquid to be passed to said rotor bowl upon failure of the feed of said mixture to be treated, said auxiliary liquid feed being at a rate in excess of the discharge capacity of said outlets for maintaining sufficient liquid in said bowl during continued rotation thereof to avoid vibration of said bowl.

8. A process of separating solids from liquid which comprises, feeding a mixture of solids and liquid to a centrifugal rotor, discharging the solids peripherally from the rotor in the form of a sludge while separately discharging the liquid from the rotor, discontinuing said feeding of said mixture and the driving of said rotor, and immediately feeding an auxiliary liquid from a separate source under pressure into the separating space of the rotor at a rate in excess of the discharge capacity of the sludge discharge outlets upon discontinuance of feed of the material to be treated to the rotor to maintain a sufficient depth of liquid in said rotor during continued rotation thereof after discontinuance of feed of said mixture to be treated to said rotor and until

said rotor has substantially reached a state of rest to avoid vibration of said rotor.

9. In a desludging centrifugal, the combination comprising a centrifugal rotor bowl provided with outlets for discharging sludge and a discharge weir for controlling discharge of liquid continuously from the rotor bowl, said bowl having the characteristic of vibrating when operating at high speed and upon failure of feed of material thereto, means for feeding to the separating space of said rotor bowl a mixture to be subjected to centrifugation, means for feeding an auxiliary liquid from a separate source under pressure to the separating space of said rotor bowl, and means controlled by the feed of said mixture to be treated in said rotor bowl for causing said auxiliary liquid to be passed to said rotor bowl upon failure of the feed of said mixture to be treated, said auxiliary liquid feed being at a rate in excess of the discharge capacity of said outlets for maintaining sufficient liquid in said bowl during continued rotation thereof to avoid vibration of said bowl.

10. A process of separating solids from liquid which comprises, feeding a mixture of solids and liquid to a centrifugal rotor, discharging the solids peripherally from the rotor in the form of a sludge while separately discharging the liquid from the rotor, discontinuing said feeding of said mixture and immediately feeding an auxiliary and different liquid into the separating space of the rotor at a rate in excess of the discharge capacity of the sludge discharge outlets after discontinuance of feed of the material to be treated to the rotor, and discontinuing the driving of said rotor during feed of said auxiliary liquid thereto, to maintain a sufficient depth of liquid in said rotor during continued rotation thereof after discontinuance of feed of material to be treated to said rotor and until said rotor has substantially reached a state of rest to avoid vibration of said rotor.

LEO D. JONES.