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A. E. ZIMMERMAN
CENTRIFUGE CONSTRUCTION

2,616,620

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3 Sheets-Sheet 2

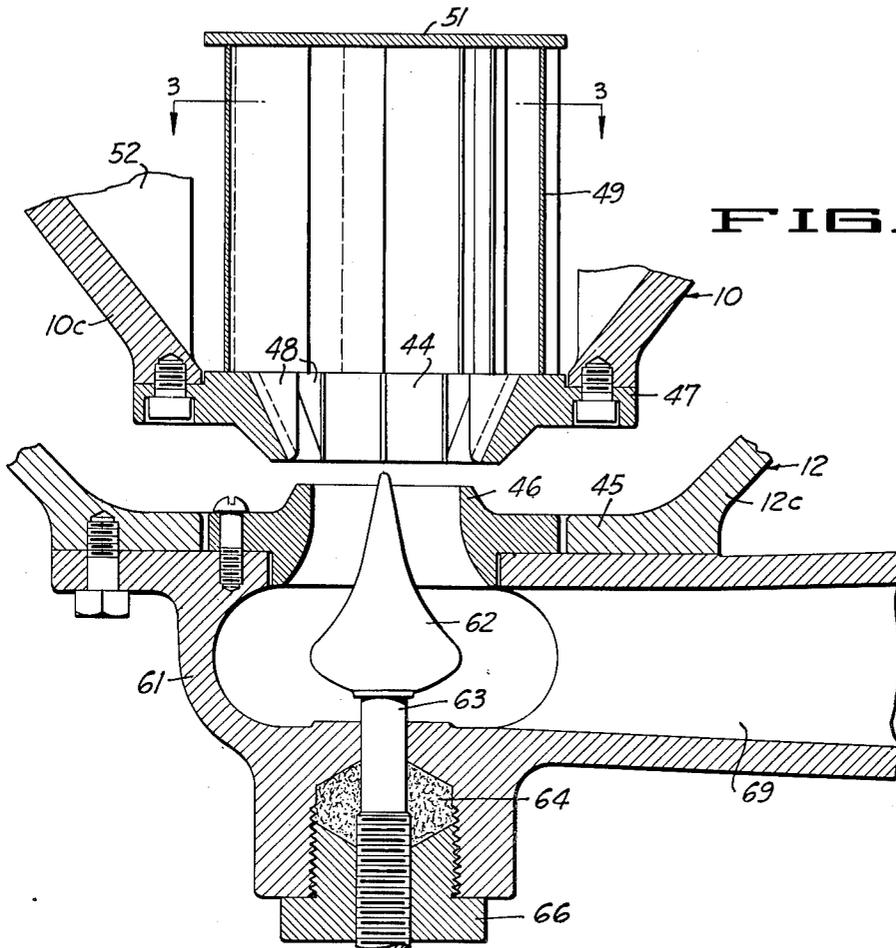


FIG. 2.

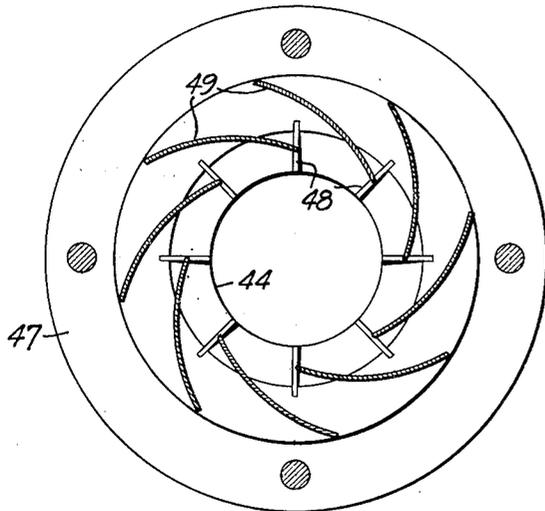


FIG. 3.

INVENTOR
A. E. Zimmerman
BY *Flehm & Swain*

ATTORNEYS

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3 Sheets-Sheet 3

FIG. 5

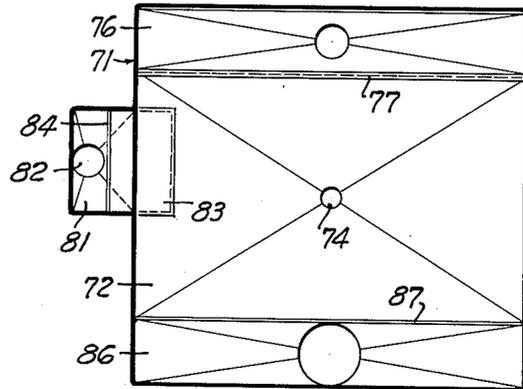
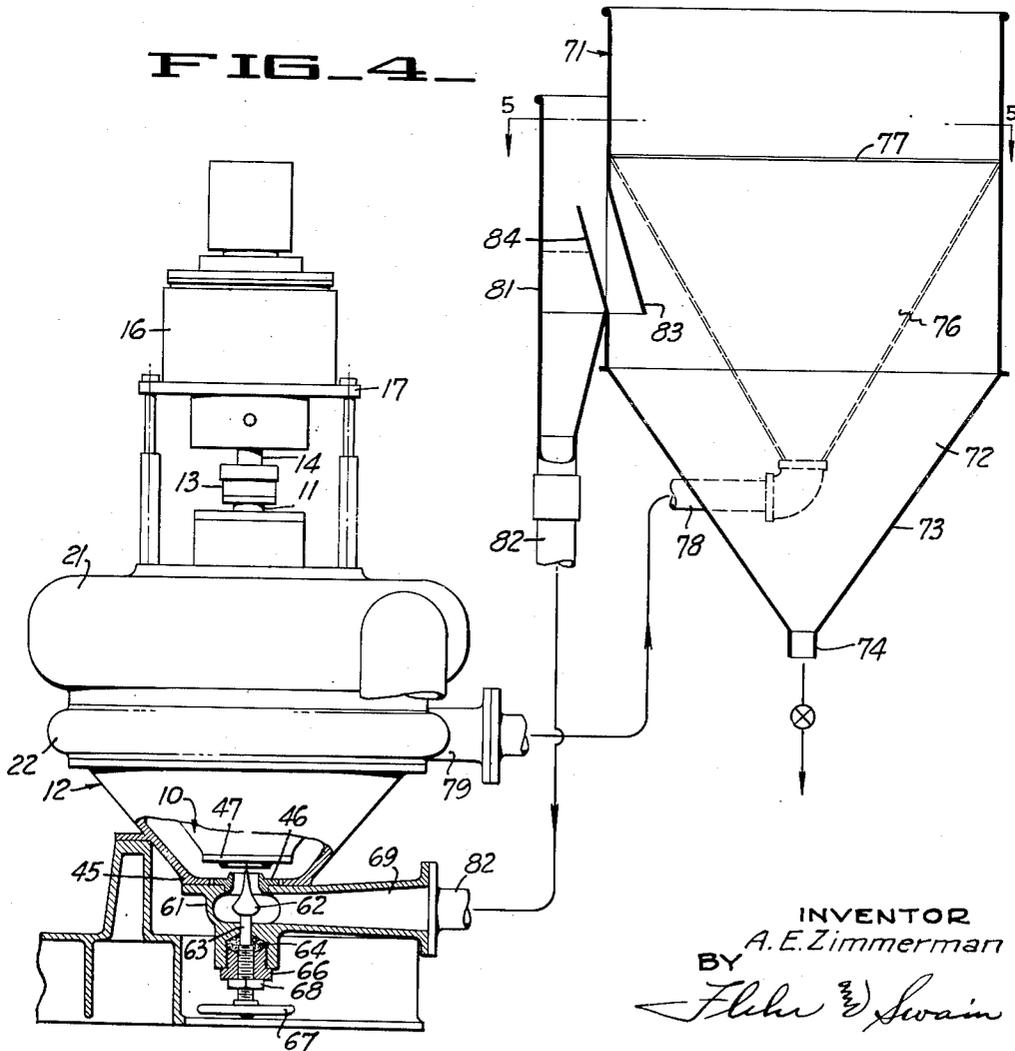


FIG. 4



INVENTOR
A. E. Zimmerman
BY
Fluhr & Swain
ATTORNEYS

UNITED STATES PATENT OFFICE

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CENTRIFUGE CONSTRUCTION

Albert E. Zimmerman, Tiburon, Calif., assignor
to Merco Centrifugal Co., San Francisco, Calif.,
a corporation of California

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4 Claims. (Cl. 233—19)

1

This invention relates generally to centrifuges of the type adapted particularly for the continuous separation and discharge of solid components from a feed material containing suspended solids, and to methods making use of such centrifuges.

Continuous centrifuges of the type disclosed in Letters Patents 1,847,751, 1,923,454 and 2,060,239 utilize so-called return circuits, by means of which a large part of the centrifugally separated underflow is continuously returned into the centrifuge rotor. A commercial machine of this character makes use of a volute which surrounds the rotor, and which receives the centrifugally separated underflow. The rotor is provided with a lower conical shaped impeller portion which has an axially disposed opening faced downwardly, and which is adapted to receive the returned underflow material. A return circuit connects from the volute to a nozzle disposed below the lower end of the rotor, whereby underflow material is delivered upwardly into the impeller of the rotor. The impeller is constructed in such a manner as to deliver the returned material into an annular chamber forming a part of or communicating with the separating chamber of the rotor.

It is frequently desirable to introduce a so-called vent box in the return circuit, whereby the returned underflow material is introduced into a relatively quiescent body of the same, before its reintroduction into the rotor. As disclosed and claimed in Patent No. 2,039,605, the vent box may be in the form of a flotation cell and may serve the purpose of floating off a readily floatable component. With such a vent box in the return circuit it has been found difficult to maintain a proper return of the underflow material into the impeller or pump portion of the rotor, without excessive and objectionable spill of material into the centrifuge housing.

It is an object of the present invention to generally improve upon centrifuge apparatus of the type described above, particularly with respect to securing return of the heavier separated material into the pump portion of the rotor without excessive spill.

Another object of the invention is to provide an improved centrifuge apparatus of the above character which will facilitate operation of the apparatus at optimum capacity, with a proper rate of return and a minimum amount of manual supervision and control.

Further objects of the invention will appear from the following description in which the pre-

2

ferred embodiment has been shown in detail in conjunction with the accompanying drawing.

Referring to the drawing—

Figure 1 is a side elevational view partly in section showing a centrifuge incorporating the present invention.

Figure 2 is an enlarged cross-sectional detail showing the needle valve means and the lower portion of the centrifuge rotor.

Figure 3 is a cross-sectional detail taken along the line 3—3 of Figure 2.

Figure 4 is a diagrammatic side elevational view partly in section showing the centrifuge of Figure 1 operatively connected to an exterior vent box.

Figure 5 is a plan view of the vent box shown in Figure 4.

Referring first to Figure 1 of the drawing the centrifuge illustrated consists of a rotor 10 carried by the vertical shaft 11, and disposed within the stationary housing 12. This rotor is provided with various passages, including a passage for the inflow of fluid feed material, a passage for discharge of lighter centrifugally separated overflow, and a passage for a supplemental fluid liquid which is preferably made up of the heavier centrifugally separated discharge material or underflow. The rotor shaft 11 is connected by coupling 13 to the vertical shaft 14 of a suitable bearing assembly 16. The springs 19 which act against the ring 17 of assembly 16 exert downward force against separable parts of the housing.

The housing 12 can be conveniently formed of a plurality of separable sections 12a, 12b and 12c. Section 12a forms the volute chamber 21 for receiving centrifugally separated overflow, and section 12b is formed to provide the volute chamber 22 which receives underflow or heavier separated material.

The body of the rotor 10 can likewise be formed of a number of separable annular parts, including in this instance the main part 10a, and the upper and lower conical shaped parts 10b and 10c. Part 10c has an inner structure 23 which is attached to the lower end of the rotor shaft 11. Parts 10a and 10b are retained together by suitable means such as the expansible clamping ring 24. Within the separating chamber 25 there is a group of spaced separating discs 27 such as are commonly used in centrifuges. Mounted within the outer peripheral wall 28 of the main body part 10a are the symmetrically spaced nozzles 29, each of which is provided with a discharge orifice directed backwardly with

respect to the direction of rotation. The annular periphery 28 of the rotor part 10a is accommodated within a diverging portion 31, or throat ring of the volute chamber 22.

The lower portion 10c of the rotor forms an impeller for the return of heavier centrifugally separated underflow material back into the rotor. Thus the lower end of the rotor part 10c is provided with an axially and downwardly faced opening 44. This opening is directly above a nozzle 46 carried by the lower wall 45 of the centrifuge housing, and which as will be presently explained serves to direct a solid stream of the returned underflow material upwardly into the impeller, and through the opening 44. Opening 44 is formed in a ring 47 which is removably clamped to the lower part of the body part 10c. Opening 44 is divergent upwardly and the ring is provided with a plurality of circumferentially spaced vanes 48. These vanes have inner vertical edges, and their outer edges can be fitted within grooves provided in ring 47 as illustrated. The vanes extend in planes radial with respect to the axis of rotation.

Ring 47 also serves to mount a vane assembly which extends into the impeller, and which aids in securing the desired pumping action. This assembly consists of a plurality of circumferentially spaced and vertically extending vanes 49, which have their lower ends attached to the ring 47, and their upper ends attached to the disc 51. Vanes 49 are inclined to the direction of rotation as indicated in Figure 3, and preferably they are slightly curved whereby their convex faces are towards the direction of rotation.

Surrounding the vanes 49 are the radially extending vertical webs or vanes 52 which serve to act upon and impart rotor velocity to the material. The material passing through the spaces between the vanes 52 passes upwardly through passages 53 to the outer annular space 54, which forms a part of or communicates with the main separating chamber 26, and which also communicates with the discharge nozzles 29. The inner walls of passages 53 are defined by the conical shaped member 56, which is upwardly divergent, and which is attached to the structure 23.

In conjunction with the nozzle 46 there is a needle-like valve member 62. This member is disposed axially of the nozzle and rotor, and may be adjusted vertically for the purpose of controlling the flow of material through the nozzle. Various mechanical expedients can be used for mounting the valve member 62 and for arranging to adjust the same longitudinally of the rotor axis. Thus the valve member is shown carried by a stem 63, which extends through the packing 64 and has threaded engagement with the gland fitting 66. The stem can be turned by the hand wheel 67, to position the valve member as desired. A suitable lock nut 68 can be provided to retain a desired adjustment.

Underflow material is supplied to the nozzle 46 through the conduit 69, which is connected in the return circuit of the machine as will be presently explained.

Figures 4 and 5 illustrate the vent box 71 which is incorporated in the return circuit. In this instance the box consists of a main container or tank 72, having a lower convergent portion 73, and a bottom draw-off outlet 74. At one end of the container 72 there is a feed compartment 76, from which material may flow into the container 72 over the horizontal weir 77. Conduit 78 serves to connect the compartment 76 with

the tangential discharge passage 79 of the centrifuge volute.

One side of the container 72 is provided with a compartment 81, the lower end of which is connected by conduit 82 with the passage 69. Material from the main container 72 may flow into the compartment 81 underneath the deflecting apron or baffle 83 and over the horizontal weir 84.

It is also desirable for the vent box to include means for the removal of foam or froth. Thus upon that end of the box opposite the compartment 76, there is another compartment 86, into which foam may flow over the horizontal weir 87.

Operation of the apparatus described above and the carrying out of the present invention, can be described as follows: The vent box 71 is mounted at an elevation with respect to the centrifuge, so that a liquid column of substantial height can be maintained in the conduit 82 and in the compartment 81. A continuous feed is supplied to the machine, and an underflow is established from the peripheral nozzles 29 into the volute 22. The centrifugally separated overflow is continuously discharged over lip 43 and received in chamber 21.

Pressure developed in the volute 22 causes flow under pressure through passage 79 and pipe 78 into the feed compartment 76 of the vent box, from which it flows over the horizontal weir 77 into the main vent box container 72. In the container 72 a substantial volume of underflow material is maintained in substantially quiescent condition. Foam arising to the surface of this body of liquid is discharged over the weir 87 into the foam compartment 86. From the main container 72 of the vent box underflow material passes beneath the baffle 83 and over the weir 84 into the compartment 81. From this compartment the material flows downwardly through the conduit 82 and passage 69, to be delivered upwardly through the nozzle 46 into the lower pump or impeller portion of the centrifuge rotor.

Assuming that the feed to the machine is constant, the needle valve 62 is adjusted so that a solid stream of the underflow material is discharged upwardly from the nozzle 46 into the impeller portion of the rotor, to strike and be deflected laterally by the disc 51. In this connection the needle valve 62 should be adjusted so that an optimum liquid column is maintained in conduit 82 and compartment 81, and which is adequate to maintain a pressure head sufficient to discharge the material with optimum velocity from nozzle 46. If the valve member 62 is moved too far towards open position, then the column of fluid material in conduit 82 falls to such a low level that an insufficient pressure head is available for causing discharge of a solid or compact stream from the nozzle 46 to strike the disc 51. In place of such a solid stream, the material discharging from the nozzle 46 will be delivered only in part to the impeller, and a considerable amount will spill out of the impeller and into the centrifuge housing. In addition to this disadvantage the cascading of material from the weir 84 for a substantial vertical distance, before it strikes the upper level of the column of material in conduit 82, may cause substantial aeration and foaming of the material, thereby impairing proper operation of the centrifuge. Should the valve member 62 be moved too far into the nozzle the effective cross-sectional flow area of nozzle 46 will be restricted to such an extent that although a substantial pressure head will be maintained by the column

5

6

of material in conduit 32 and compartment 31, the rate of flow into the impeller of the rotor will be lower than that required for proper centrifuge operation. In actual practice therefore the valve member 62 is moved upwardly to a position in which the column of material in conduit 32 and compartment 31 is maintained so that its top level is relatively close to the weir 34, while at the same time an ample rate of return is established to the rotor. Under such conditions a compact stream of material will be discharged upwardly from the nozzle 46, to be received by the impeller of the rotor with negligible spill.

I claim:

1. In a centrifuge apparatus, a centrifuge rotor having provision for receiving a fluid feed and also having provision for discharge of heavier separated material, the lower end of said rotor having a free downwardly faced opening concentric with the axis of rotation and adapted to receive a jetting stream of fluid material for introduction into the rotor in addition to the feed, an upwardly faced nozzle disposed below and aligned with said opening, said nozzle being adapted to deliver an upwardly directed jet of material into said opening, adjustable means serving to control the effective cross-sectional flow area of said nozzle, and means serving to continuously deliver a portion of the discharged heavier separated material to said nozzle at a substantially constant gravity pressure head.

2. In a centrifuge apparatus, a centrifuge rotor having provision for receiving a fluid feed and also having provision for discharge of heavier separated material, the lower end of said rotor having a free downwardly faced opening concentric with the axis of rotation and adapted to receive a jetting stream of fluid material for introduction into the rotor in addition to the feed, an upwardly faced nozzle disposed below and aligned with said opening, said nozzle being adapted to deliver an upwardly directed jet of material into said opening, adjustable means serving to control the effective cross-sectional flow area of said nozzle, and means serving to continuously deliver a portion of the discharged heavier separated material to said nozzle at a substantially constant gravity pressure head, said means including an upright stand pipe having its lower end connected to supply material to said nozzle and having its upper end extending to an elevation above the nozzle and adapted to receive a portion of the discharged heavier separated material.

3. In a centrifuge apparatus, a centrifuge rotor having provision for receiving a fluid feed and also having provision for discharge of heavier separated material, the lower end of said rotor forming a pump portion and having a free downwardly faced unsubmerged opening concentric with the axis of rotation and adapted to receive

a jetting stream of fluid material for introduction into the rotor in addition to the feed, an upwardly faced nozzle disposed below and aligned with said opening, said nozzle being adapted to deliver an upwardly directed jet of material into said opening, means disposed within said pump portion of the rotor serving to laterally deflect the jetting stream of fluid material discharged upwardly from said nozzle and also for urging fluid material into the separating chamber of the rotor, a vertically adjustable needle-like valve member disposed concentric with the nozzle and serving to control the effective cross-sectional flow area of the nozzle, and means serving to continuously deliver a portion of the discharged heavier separated material to said nozzle at a substantially constant gravity pressure head.

4. In a centrifuge apparatus, a centrifuge rotor having provision for receiving a fluid feed and also having provision for discharge of heavier separated material, the lower end of said rotor forming a pump portion and having a free downwardly faced unsubmerged opening concentric with the axis of rotation and adapted to receive a jetting stream of fluid material for introduction into the rotor in addition to the feed, an upwardly faced nozzle disposed below and aligned with said opening, said nozzle being adapted to deliver an upwardly directed jet of material into said opening, means disposed within said pump portion of the rotor serving to laterally deflect the jetting stream of fluid material discharged upwardly from said nozzle and also for urging fluid material into the separating chamber of the rotor, a vertically adjustable needle-like valve member disposed concentric with the nozzle and serving to control the effective cross-sectional flow area of the nozzle, and means serving to continuously deliver a portion of the discharged heavier separated material to said nozzle at a substantially constant gravity pressure head, said means including an upright stand pipe having its lower end connected to supply material to said nozzle and having its upper end extending to an elevation above the nozzle and adapted to receive a portion of the discharged heavier separated material.

ALBERT E. ZIMMERMAN.

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