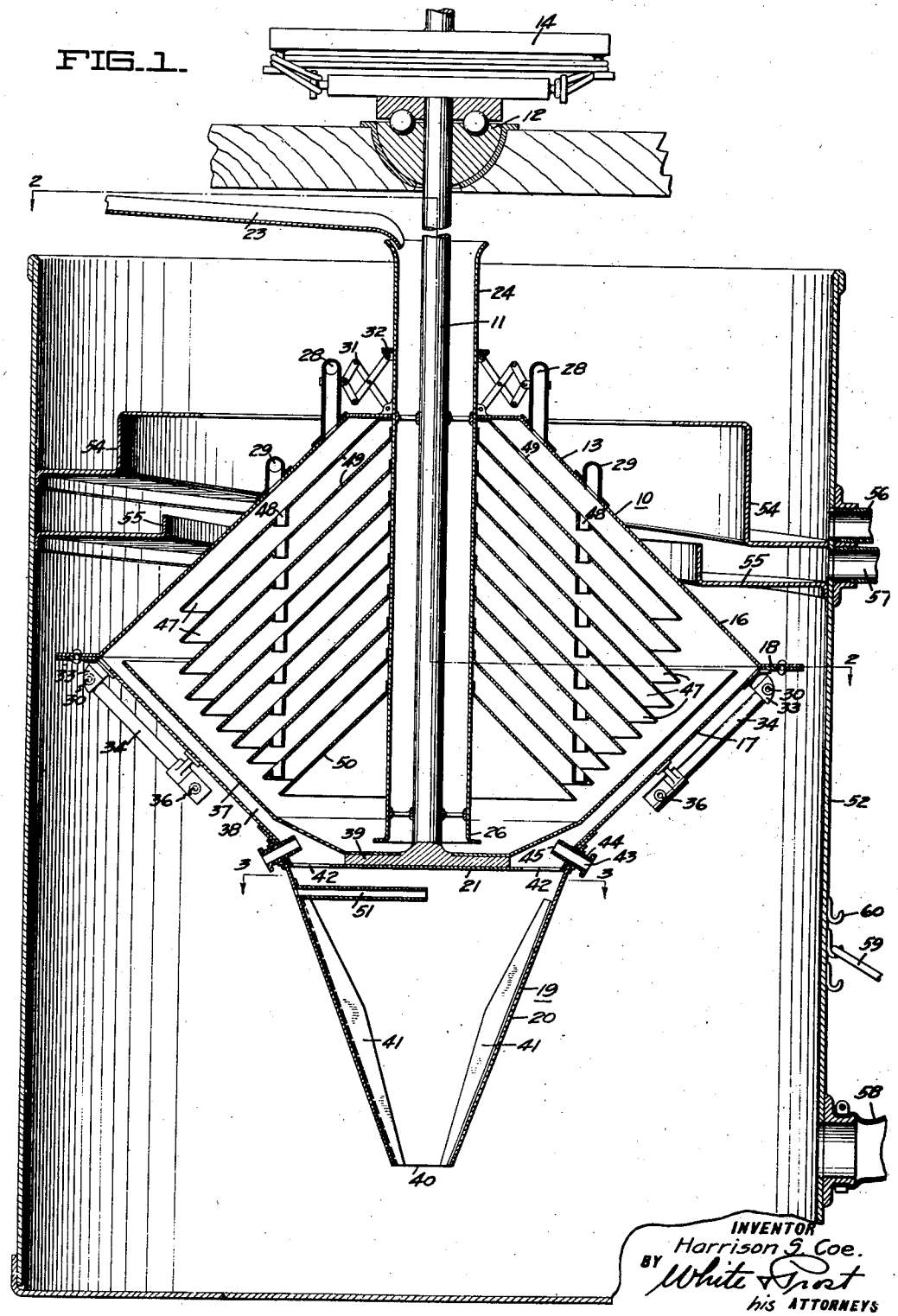
Sept. 26, 1933. H. S. COE 1,927,822

CENTRIFUGE APPARATUS

Filed Feb. 16, 1926 3 Sheets-Sheet 1

FIG. 1.



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CENTRIFUGE APPARATUS

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FIG. 2.

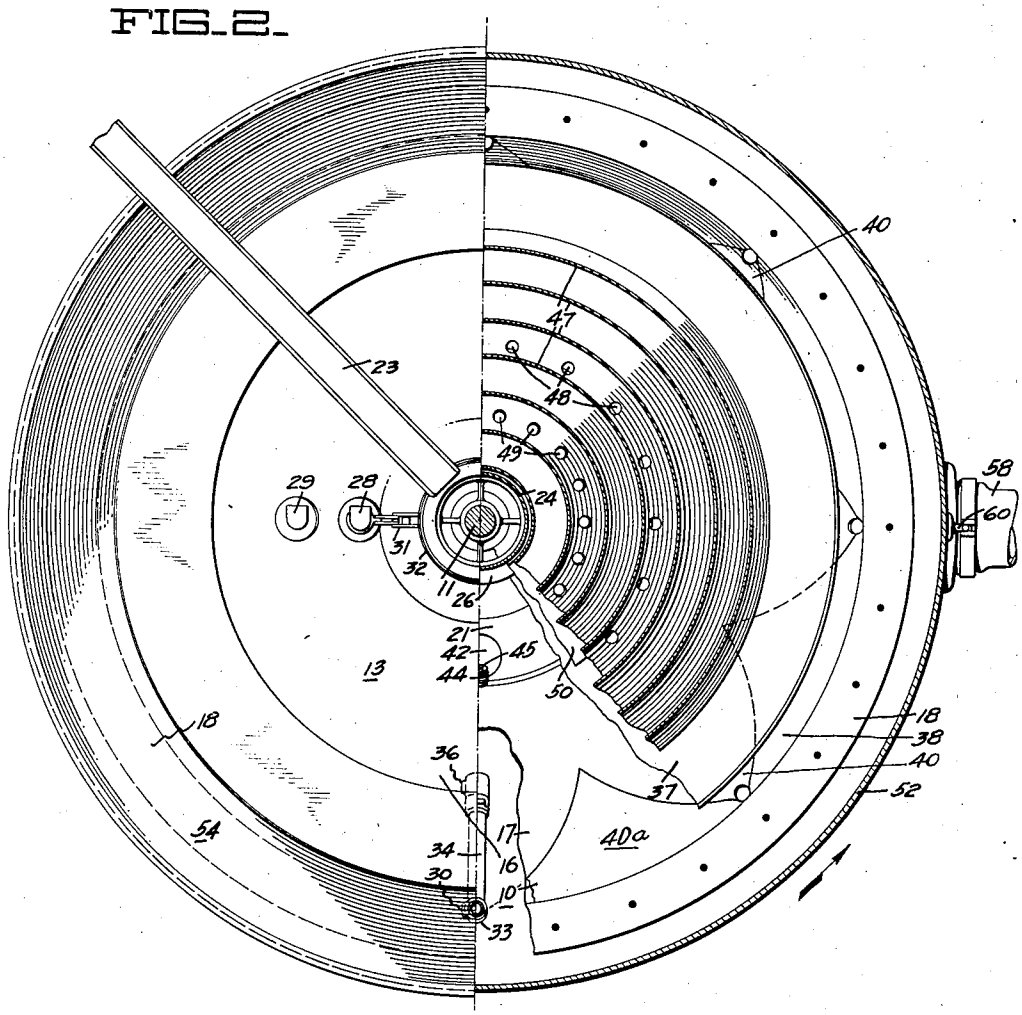
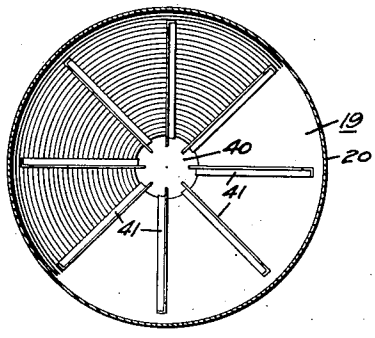


FIG. 3.



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CENTRIFUGE APPARATUS

Filed Feb. 16, 1926 3 Sheets-Sheet 3

FIG. 5.

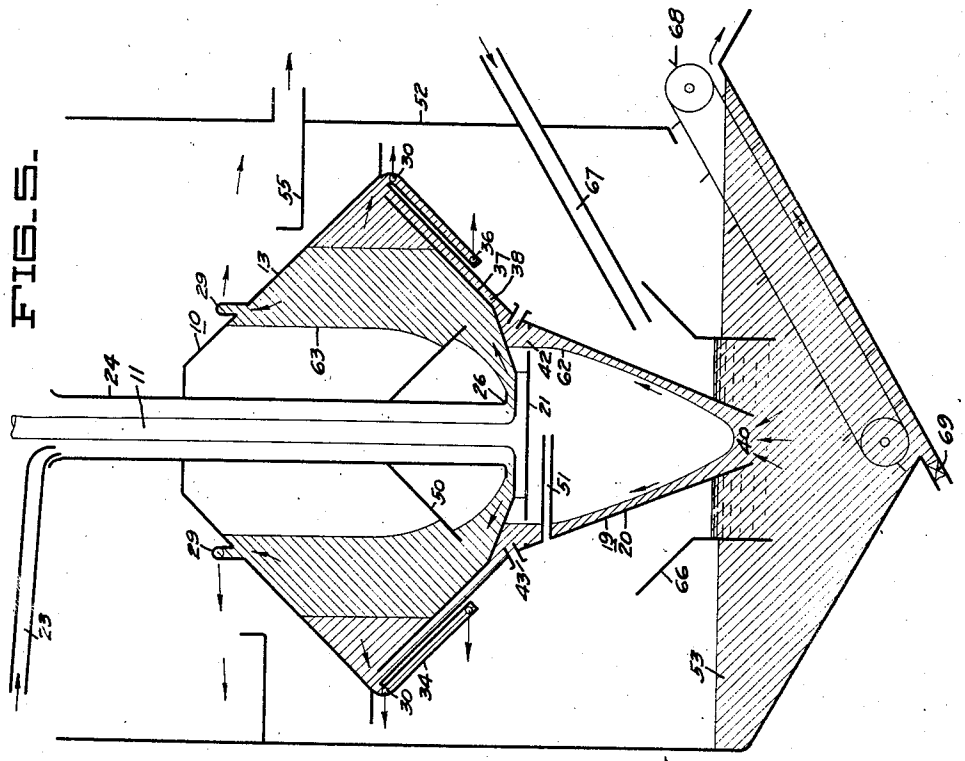
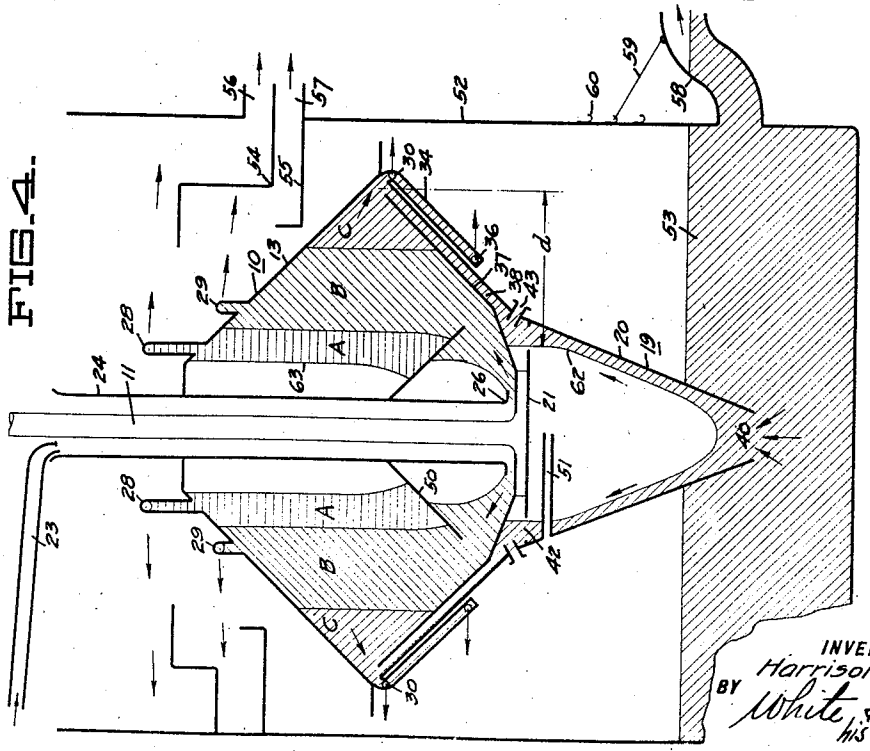


FIG. 4.



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UNITED STATES PATENT OFFICE

1,927,822

CENTRIFUGE APPARATUS

Harrison S. Coe, Milwaukie, Oreg., assignor to Merco Centrifugal Separator Co., Ltd., San Francisco, Calif., a corporation of California

Application February 16, 1926. Serial No. 88,530

4 Claims. (Cl. 233—28)

This invention relates generally to machines for effecting separation by the use of centrifugal force and methods of operating the same. It is especially applicable to those methods of separation known as thickening, classifying, and hydraulic concentration. By thickening is meant the separating of a given liquid into parts differing in density. Classifying refers to the separation of coarser material, from finer material and colloidal matter suspended in the same medium. Hydraulic concentration is a term applied to the separation of material having different specific densities by utilizing the difference in their rates of settlement in a liquid. In the past such machines have been expensive to construct and operate, the methods by which they have been operated did not give proper control over the products separated, and the discharge ports and interior of the machine frequently became clogged, necessitating expensive shut-downs and repairs.

It is an object of this invention to devise a machine in which clogging of the discharge ports is prevented. It is proposed to make these ports relatively large and then pass an additional material through the same to prevent the escape of too large a quantity of treated material.

It is a further object of this invention to devise a centrifuge in which wear on the discharge orifices or ports is compensated for by introducing an additional fluid into the rotary chamber of the machine and then controlling the rate of introduction to offset enlargement of the orifices. It is also proposed to make the control of the additional fluid automatic so as to make automatic compensation for wear.

It is a further object of this invention to maintain a zone of treated material in the chamber of a centrifuge to prevent the discharge of untreated material.

It is a further object of this invention to prevent undue accumulation of packed material in the treatment zones by introducing a fluid into the treatment chamber near the periphery thereof.

It is a further object of this invention to introduce a fluid into the chamber of a centrifuge in addition to the feed in such a manner as to produce a substantially constant pressure head at the point of introduction. Thus a set of equilibrium conditions is established for the material being treated, thereby making it possible to adjust the machine for any separation desired. In order to form a zone of treated material it is preferable to return the material discharged back into the chamber, although an extraneous fluid may be employed.

It is a further object of this invention to devise a centrifuge having means for introducing a discharged or extraneous fluid into the machine and to provide for controlling the rate of introduction of the same whereby the character of the separated products may be controlled.

It is a further object of this invention to devise a centrifuge in which the lower portion of the rotary shell is in the form of a pump which is adapted to lift the fluid into the upper treatment chamber. It is proposed to rotatably support the shell within a tank with the lower end of the pump portion immersed in fluid. Means is provided to control the amount of fluid pumped by adjusting the level of the fluid in the tank.

Another object of this invention is to devise a novel method of operating a centrifuge to attain the objects set forth above.

Further objects of the invention will appear from the following detailed description in which I have set forth the preferred embodiments of my invention. It is to be understood that the scope of the invention is not to be limited by the structures shown but only as defined by the appended claims.

Referring to the drawings:

Figure 1 is a vertical cross sectional view of a centrifuge constructed in accordance with the teachings of this invention.

Fig. 2 is a cross sectional view taken along the line 2—2 of Fig. 1.

Fig. 3 is a cross sectional view taken along the line 3—3 of Fig. 1.

Fig. 4 is a diagrammatic view showing one method of operating a centrifuge.

Fig. 5 is a diagrammatic view of a modified form of a centrifuge showing another method of operating the same.

The device comprises generally a shell 10 which is suitably mounted upon a vertical rotatable shaft 11, which shaft is supported from a universal thrust bearing 12 and is driven thru the flexible coupling 14. The upper portion 13 of the shell constitutes a treatment chamber and is formed by joining together the bases of two truncated conical sections 16 and 17 as by means of a flange joint 18. The lower or pump portion 19 of the shell is formed of an inverted truncated conical section 20 secured to the lower end of the section 17. The shaft 11 is suitably secured to the shell as by means of a transverse plate 21 secured to the shell and to the lower end of the shaft. For feeding material into the treatment chamber

from the launder 23 there is provided a vertical pipe or well arranged concentric with the shaft 11 and having its lower open end 26 terminating near the bottom of the treatment chamber.

The treatment chamber 13 is provided with a plurality of sets of overflow ports or orifices 28, 29, and discharge ports 30, arranged at progressively increasing radii from the axis of the shaft 11. The ports 28 are preferably adjustable as by a suitable mechanism such as a lazy-tong connection 31 actuated by a slidable ring 32 whereby upon movement of the ring 32 the radial distance between the ports 28 and the shaft center may be increased or decreased as desired. The ports 30 are arranged near the outer edge of the periphery and are adapted to handle the material which is separated from the fluid being treated. The pipe sections 33 in which the ports 30 are formed also communicate with inturned pipes 34 having discharge ports or orifices 36 adjacent their inner ends. Adjacent the bottom of the mixing chamber there is arranged a truncated conical-shaped member 37 which is disposed in spaced relationship with the section 17 of the treatment chamber so as to define a passageway 38 between the pump section 19 and the interior of the treatment chamber. This member 37 is suitably secured in position as by means of a flange 39 which is secured to the bottom end of the shaft 11.

It is obvious that when the apparatus is in operation, the flow of material within the treatment chamber toward the peripheral portion of the same from whence it is discharged thru ports 30 and 36, will form pockets within the chamber, the apex of each pocket terminating at a port 30. Such pockets represent the path of direct flow of material. In Fig. 2, the flow pockets 35 formed below member 37 are shown as permanently defined by filling in the intervening portions 40 with cement or other suitable material.

The lower pump section 20 has an open lower end 46 and is provided on its inner periphery with a plurality of longitudinal vanes 41. Plate 21 is provided with apertures 42 so that fluid raised by the pump is permitted to pass through the passageway 38 into the treatment chamber. Arranged adjacent the entrance to the passageway 38 are a plurality of escape ports 43 which are preferably in the form of short pipe sections 44 adjustably mounted in the shell 10 as by means of a screw fitting so that the distance between their inner ends 45 and the center of the shaft 11 may be varied as desired. To increase the separating action the treatment chamber 13 may also be provided with a plurality of spaced conical baffles 47 provided with a plurality of sets of alined apertures 48 and 49 and being suitably secured to the vertical pipe 24. A lower conical hood 50 is also provided to form a guide and flocculation chamber for the feed as it enters the treatment chamber 13. In order to insure atmospheric pressure within the lower pump portion a vent pipe 51 is provided which has its inner end terminating adjacent the axis of rotation. All of the discharge nozzles are arranged to discharge tangentially so as to utilize as much as possible of the energy imparted to the material being treated.

The entire shell is disposed with a tank 52 which is normally partially filled with a fluid 53 to immerse the lower end of the pump 19. The inner periphery of this tank is provided with launders 54 and 55 adapted to receive fluid discharged by the ports 28 and 29 respectively. Pipes 56 and 57 communicate with the launders 54 and 55 and serve to carry away the fluid discharged. For controlling the level of the liquid within this tank the outlet 58 is made adjustable in height as by means of a bail 59 which may be engaged with any one of a plurality of hooks 60.

One method of operating the centrifuge described for thickening fluid material is illustrated diagrammatically in Fig. 4. The shell is rotated at a given speed and fluid to be treated is introduced into the bottom of the treatment chamber 13 by way of the launder 23 and well 24. The material will fill the treatment chamber until the rate at which it is discharged from the various discharge nozzles is equal to the rate with which it is introduced into the chamber through the well 24. Assuming that the treatment chamber is filled as shown in Fig. 4, the fluid by virtue of the centrifugal force will divide itself into a plurality of zones corresponding to varying stages in the treatment. For example, three zones have been shown marked A, B and C, A being a zone of liquid from which substantially all of the suspended material has been separated, B being a blend between the liquid and the feed entering the chamber, and C being a zone of thickened material of the kind discharged. In order to prevent clogging of the ports 30 and 36 and at the same time to prevent untreated material from discharging from these ports, ports 30 and 36 are made relatively large and are made to pass an additional fluid material introduced into the treatment chamber through the passage 38. The large amount of material caused to pass through the ports 30 and 36 reduces the possibility of their becoming clogged or bridged over by the treated material in the zone C. Passage 38 also has its outlet adjacent the ports 30 to agitate the material in the zone C and further tend to reduce clogging.

The additional fluid introduced through the passage 38 may be from an extraneous source but is preferably a portion of the material discharged from the ports 30 and 36. Therefore the fluid discharged from these ports is allowed to collect in the bottom of the tank 52 and flows upward along the inner side of the pump section 19 through the ports 42 and into the passageway 38. If no treated fluid is removed from the tank 52 thru the outlet 58 the fluid 53 will gradually become thicker as the separated liquid is being removed from the system thru ports 28 or 29. When the desired consistency is reached, the outlet 58 is adjusted to remove the product but to maintain the level corresponding to this consistency. The outlet 58 therefore provides a means for controlling the consistency of the treated material.

In many centrifugal machines the zone C of treated material is not maintained with the result that variations in the product will result from variations in the rate of feed of the material to be treated. For example, if the rate of feed be too slow untreated material may be discharged from the ports, while if the rate be too great the separation will not be complete. These difficulties have been overcome with this invention by constantly maintaining the zone C of treated material. This is also accomplished by the introduction of additional fluid thru the passageway 38. The pressure with which a fluid of given density is discharged from the passageway 38 into the treatment chamber is a function of the radial distance *d*, which is indicated on Fig. 4. Since this distance *d* is substantially independent of variations in the rate of feed

a constant pressure head will be maintained adjacent the periphery of the treatment chamber 13. This constant pressure head causes a condition of equilibrium to be established within the treatment chamber whereby the products may be readily controlled by varying the value of the pressure column *d*. The condition of equilibrium is readily understood when it is considered that with an increase in the rate of feed the pressure within the zone C will increase to overbalance the pressure of the additional fluid coming from the passageway 38, with the result that the rate of discharge from zone C will increase while the extent of the zone itself will decrease and zone B will increase. If the machine is being operated with ports 29 closed and ports 28 open, clear liquid will continue to be discharged from ports 28 until the rate of feed is increased to such a point that the capacity of the machine is exceeded, after which the liquid coming from the ports 28 will become turbid. In case the rate of feed is decreased below normal the amount of material passing through passageway 38 will increase, zone C will increase, and zone B will decrease. If the feeding is entirely stopped zone C will still be maintained continuously although zone B will disappear.

The adjustable ports 43 serve both to maintain the pressure column *d* substantially constant and also provide a control means for varying this head. The amount of excess fluid returned through this port to the tank 52 is determined by the depth of the fluid covering the open entrance 45 to this port, and by the radial distance of this end from the center of the shaft 11. Thus, for a given amount of fluid being raised by the pump 19 the perpendicular distance between the surface line 62 and the entrance 45 of the port 43 will tend to remain constant. However, by adjusting the position of the end 45 farther within the shell the pressure of the fluid tending to escape from this port will be correspondingly decreased with the result that the surface line 62 will shift closer to the center of the shaft 11 and cause a corresponding increase in the pressure column *d*. Another manner of controlling the pressure column *d* is by varying the level of the fluid 53 and therefore varying the rate with which the additional fluid is introduced into the passageway 38. This is accomplished by adjusting the level of the flexible outlet 58.

In ordinary centrifuge machines enlargement of the discharge ports thru wear results in inefficient separation of the products. However, with the applicant's arrangement any enlargement of the discharge ports 30 or 36 will be accompanied by an increase in the amount of fluid introduced through the passageway 38 so as to automatically compensate for such enlargement. Furthermore, since the applicant's discharge ports are relatively large in diameter a given amount of wear will cause a comparatively small percentage increase in cross sectional area compared to an orifice or port of small diameter. The positioning of the discharge ports 30 and 36 upon the pipe section 34 at different radial distances from the center of the shaft 11 introduces an automatic control tending to vary the amount of thickened material discharged in accordance with the amount of material in the treatment chamber. That is, since the ports 36 are relatively closer to the fluid surface 63 in the treatment chamber, the rate of discharge from these ports will vary more in accordance with variations in the amount of material in the treatment chamber. The ports 30 insure continued discharge of material while starting and stopping the machine before the ports 36 have come into operation. An additional advantage in having the discharge orifices 36 located inwardly of the periphery is that the discharge velocity of material is thereby reduced, thus permitting the use of relatively large orifices which will not be subject to as much wear as smaller orifices having the same discharge rate but located near the periphery.

Fig. 5 shows a mode of operating a modification of the machine for hydraulic concentration and classification. In order to free the separated material from colloidal material it is preferable, although not necessary, to introduce water with the material introduced through the pump 19. Therefore, the intake 40 is surrounded by an open ended chamber 66 adapted to receive water through the launder 67. A conveyor rake 68 may also be employed for removing semi-solid material settling to the bottom of the tank. For the same purpose a valve 69 may be arranged in the bottom of the tank. In this case only one set 29 of the overflow orifices need be employed.

As previously explained, the rate of introduction of the additional material may be controlled between certain limits by varying the level of the water in the tank 52. By making the rate sufficiently rapid a counterflow effect will be produced within the treatment chamber; that is, a flow of liquid will occur from the periphery towards the central portion of the chamber which aids in the separation of material moving outwardly towards the periphery by virtue of the centrifugal force. The conical sections 16 and 17 forming the treatment chamber are preferably so proportioned that the respective areas intersected by a series of imaginary cylindrical surfaces concentric with the shaft 11 would increase as the radii of the cylinders decreased. Therefore the rate of movement of a counterflow within the chamber will decrease as it progresses inwardly, thus aiding in the formation of zones of separated material. In classification work when water is not available, the thickening of colloids in sandy discharge material may be prevented by introducing sufficient additional fluid to cause the above mentioned counterflow effect, for example by introducing feed material thru the launder 67 of Fig. 5.

I claim:

1. A machine of the class described, comprising a rotary chamber, means for feeding material to be treated into said chamber, passageways communicating with said chamber near its outer periphery, a plurality of sets of discharge ports in each of said passageways, said sets of ports being located at different radial distances from the axis of rotation of the chamber.

2. A machine of the class described, comprising a rotary chamber, means for feeding material to be treated into said chamber, at least one pipe extending laterally of the axis of rotation of the chamber and having its outer end in communication with said chamber, said pipe having a plurality of discharge ports located at different radial distances from the axis of rotation.

3. A machine of the class described, comprising a rotary chamber having discharge ports, means for feeding material to be treated into said chamber, means for introducing an additional fluid into said chamber, said means comprising a passageway extending laterally of the axis of rotation of the chamber and communi-

cating at its outer end with the outer periphery of the chamber, means for introducing said fluid into the passageway to establish a pressure head in the passageway tending to oppose the pressure of treated material within the chamber, and means including a port located near the inner end of the passageway for automatically maintaining said pressure head.

4. A machine comprising a rotary shell having an upper treatment chamber and a lower pump portion, said chamber having discharge ports adjacent its outer periphery, means for feeding material to be treated into the chamber, means for immersing a portion of the pump portion in discharged material, a passageway communicating between the pump portion and the outer periphery of the treatment chamber whereby discharged material lifted by the pump portion is introduced into the treatment chamber thru said passageway, and means including a port adjacent the entrance to said passageway for maintaining substantially a constant pressure column of returned fluid within the passageway.

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