

July 24, 1951

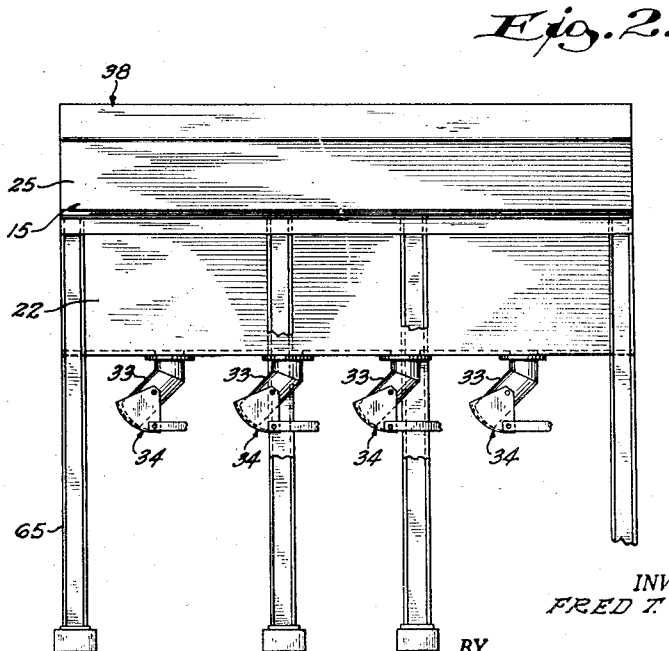
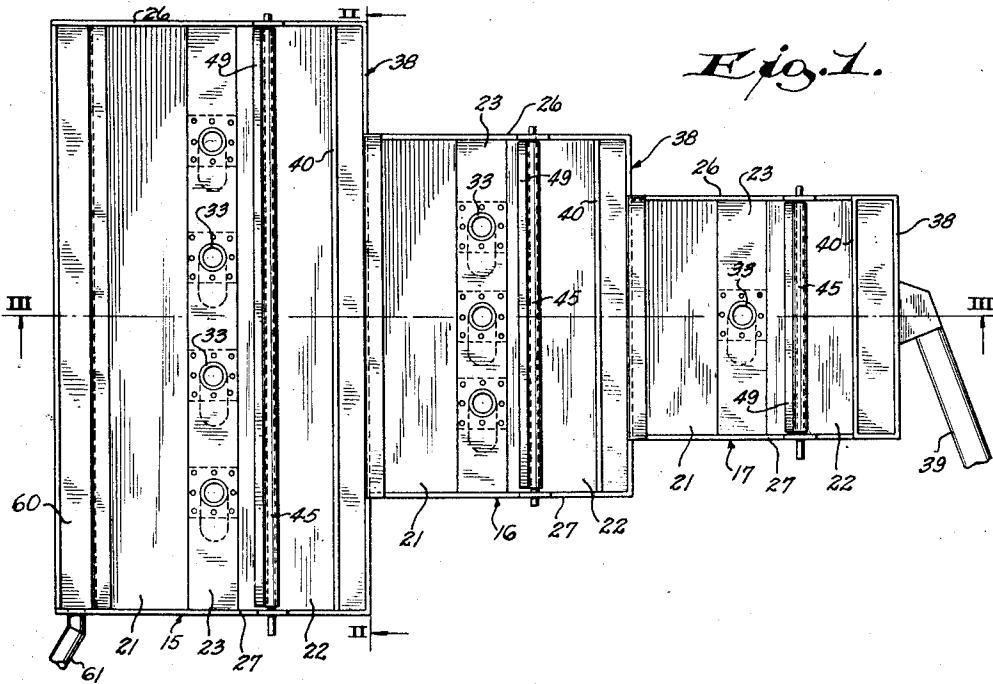
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2,561,665

CONTINUOUS CLASSIFIER FOR SOLIDS

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3 Sheets-Sheet 1



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Fig. 3.

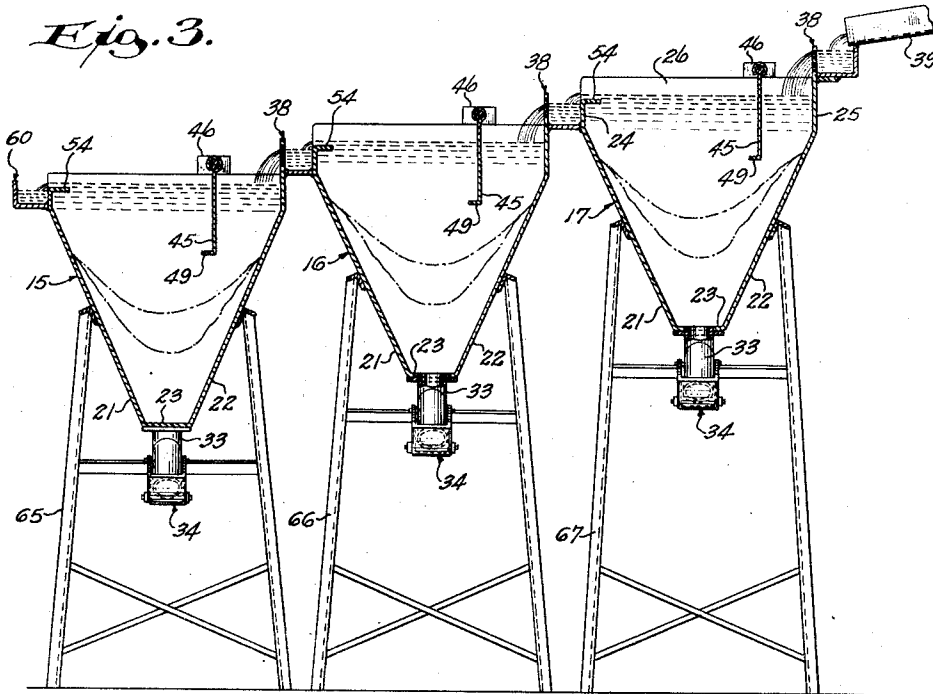
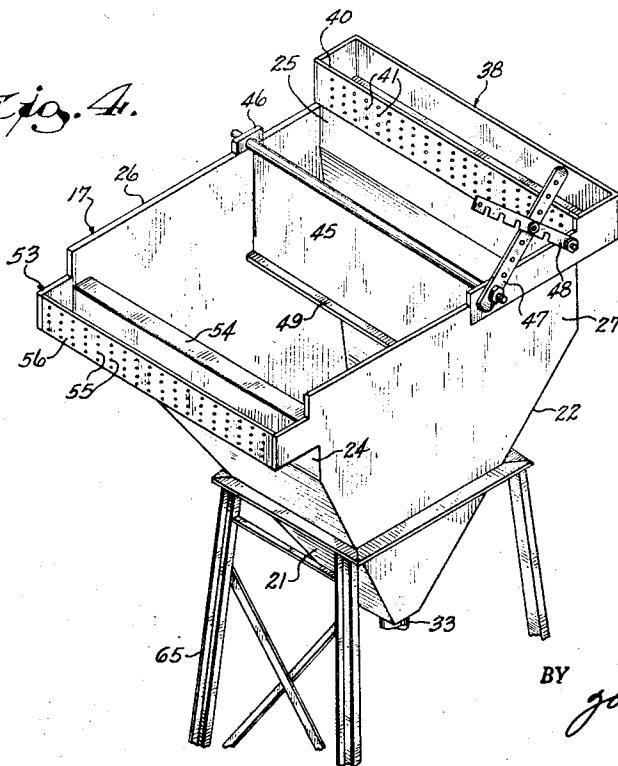


Fig. 4.



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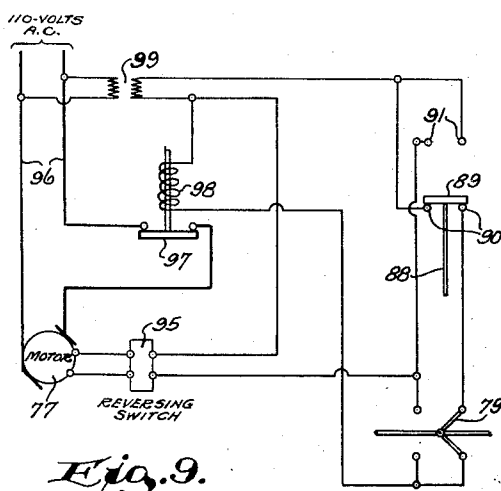
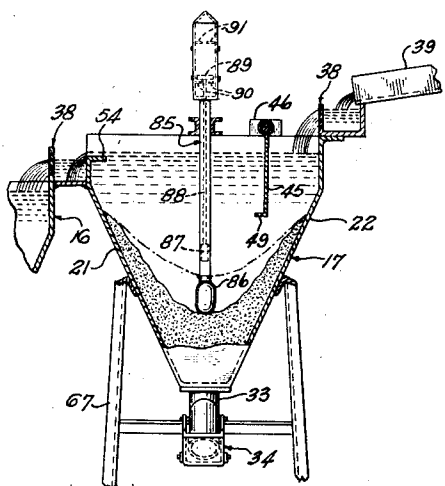
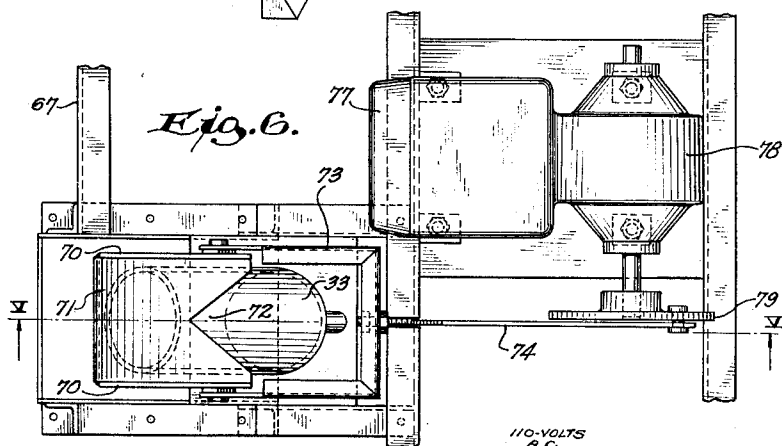
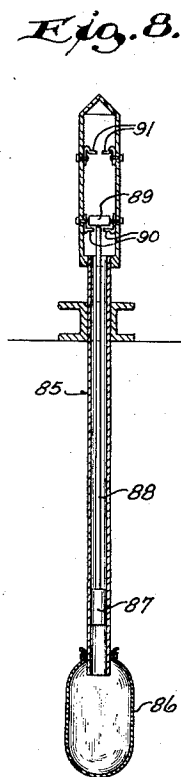
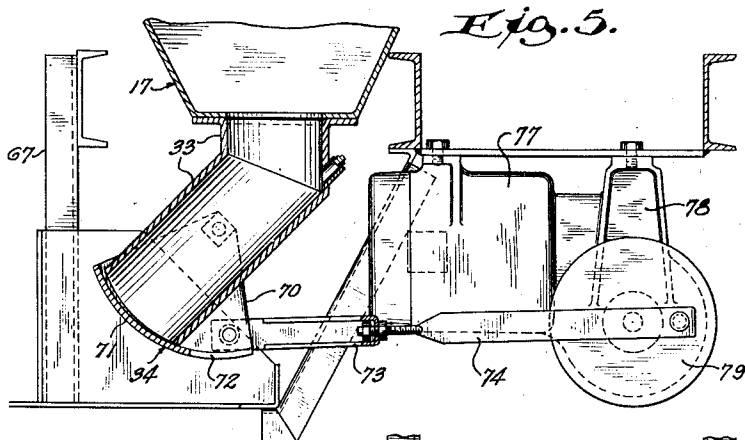
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CONTINUOUS CLASSIFIER FOR SOLIDS

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3 Claims. (Cl. 209—210)

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This invention relates to improvements in devices for classifying and separating solids, liquid in suspension, and depositing or settling therefrom.

In devices of this type, the minimizing of turbulence and control of the flow of the suspension as to both direction and velocity, is highly important and has been accomplished in the past, if at all, only by expensive and complicated apparatus not adapted to rigid and severe operating conditions and not suited for use with a large variety of solids of different size and physical characteristics.

It is an object of this invention, therefore, to provide a device to accurately and adjustably direct and control the flow of a liquid suspension of solids to achieve desired deposition or settling of solids, which device is of simple, rugged and comparatively economical construction.

A further object of the invention is to provide a device which in addition to controlling the flow of a liquid suspension to obtain deposition or settling will also automatically discharge accumulated solids, in such manner as to minimize disturbance of the suspension flow and to avoid discharge of any of the suspension.

A still further object of the invention is to provide a positive and efficient control device for the discharge of accumulated solids, which is automatically responsive to the rise above a given maximum or dropping below a given minimum of the accumulated solids.

To accomplish these objects, there is provided a plurality of tanks associated in series and increasing in the cross sectional area of flow path from the inflow tank to the outflow tank. In each tank the flow of the liquid suspension is directed in a downward and upward path in order to increase the depositing or settling of the heavier solids and collection thereof at the bottom of each tank. Because each subsequent tank is of larger cross sectional area of flow path, the velocity of the flow decreases thus permitting the lighter solids not settled or deposited in previous tanks to settle or deposit in the subsequent tank. An adjustable baffle is placed in the upper portion of each tank and controls the depth of the downward path, the cross sectional area of the path of flow and to some degree the direction of flow thus also controlling the velocity of flow within each tank. The outflow from each tank is spread by means of a launder across the larger edge of the next tank thereby providing a quiet inflow which does not unnecessarily disrupt the depositing or settling of solids. Thus by the use of simple and rugged tanks with an adjustable baffle the flow of liquid suspension can be adjusted and directed to obtain desired deposition of solids to a higher degree of accuracy than heretofore obtained.

Each tank is provided with a settling area and a discharge gate, the latter being controlled by a variable volume chamber responsive to the pressure of accumulated solids within the tank. When the settling solids have accumulated to a

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predetermined upper level, the gate will open and a part of the accumulated solids will be discharged until the lever thereof reaches a predetermined lower level. The gate is then closed before the level or solids is too greatly changed to materially disturb the flow path of the liquid suspension or permitting a material portion of the suspension to escape.

Objects and advantages other than those above set forth will be apparent from the above description when read in connection with the attached drawings, in which:

Fig. 1 is a top plan view of a tank arrangement forming one feature of the present invention;

Fig. 2 is a cross section taken on the plane II—II of Fig. 1;

Fig. 3 is a section taken on the plane III—III of Fig. 1;

Fig. 4 is a perspective view of one of the tanks of Fig. 1;

Fig. 5 is a view, partially in section and partially in elevation, of a gate and gate operating means for discharging material from a tank;

Fig. 6 is a bottom plan view of Fig. 5;

Fig. 7 is a partially sectional and partially elevational and somewhat diagrammatic view of a portion of means controlling gate operation;

Fig. 8 is an enlarged view of a portion of Fig. 7;

and Fig. 9 is a diagram of the electric connections controlling the gate operating motor.

Referring particularly to the drawings, reference numerals 15, 16 and 17 generally designate any desired number of open-topped tanks of different sizes and connected in series. The tanks are progressively larger in total cross section area from the inflow end of the tank series at tank 17 to the outflow end of the series at tank 15, the tanks being severally wider, that is, larger in the dimension transverse to the direction of flow of the material through the tanks, but substantially the same dimension in the direction of flow through the tanks, which dimension is herein considered the length of the tanks.

The several tanks are generally similar in construction and only tank 17 will be described in detail. Tank 17 comprises a hopper type bottom in which two side walls have portions 21, 22 sloping toward each other to a bottom 23 and parallel portions 24, 25. The other two or end walls 26, 27 are parallel and extending in a single plane at right angles from the bottom 23. One or more discharge spouts 33 extend from the bottom and severally have a gate 34 mounted thereon as will be described hereinafter.

An inflow quieting means or distributor 38 generally in the form of an open top box or launder extends across the entire width of and is mounted on the tank for receiving a suspension of solids in a liquid, from a suitable source by way of a conduit 39. The wall 40 of the inflow distributor, toward the inside of tank, is formed with apertures 41 dividing the flow into a number of separate streams of small volume

and uniformly distributed over the width of the tank. The apertures may be slots uniformly spaced in wall 40 or may be rows of circular perforations as shown. If slots are used, a stream of relatively large size is obtained from each slot whereas rows of perforations permit further division of the streams so that the suspension is homogenized in passing through the perforations and the turbulence caused by flow into the tank is minimized.

A baffle 45 extending across the tank (see Fig. 4 particularly) is pivoted in bearings 46 on the tank walls 26, 27. By swinging on its pivots, its depth may be regulated and its angle of flow direction altered to regulate the velocity and direction of flow through the tank. The baffle may be held in any desired position by adjustably connecting an arm 47, which is fixed on the baffle pivot, with an arm 48 pivoted on a tank wall. The lower edge 49 of the baffle is turned in the direction of flow through the tank and the baffle as a whole provides means for obtaining a uniform flow across the entire flow area in a tank and produces a non-turbulent rising current moving toward the outflow side of the tank.

The tank is also provided with a box-like extension generally designated 53 and receiving the suspension flow from the tank over wall 21 which has a flange 54 extending into the tank to form a weir allowing discharge of only the relatively quiescent upper strata of suspension across substantially the entire upward flow path at the outflow end of the tank. From such receiver 53, the suspension discharges through rows of perforations 55 in the receiver wall 56 and into the next tank. It will be understood that the suspension discharging from a tank into its receiver 53 has had removed therefrom a portion of the solids as will be explained hereinafter.

Tanks 16 and 15 are generally similar to tank 17 except for provision of a plurality of individual discharge spouts and gates for such spouts. It is desirable to keep the weight of accumulated solids and of suspension on any one gate below a given value. The tank 16 accordingly is provided with three separate spouts while tank 15 has four separate spouts. However, the number of spouts may be varied dependent on size of accumulated particles and other factors. Tank 15 also has an offtake receiver 60 for the suspension residue after passage of suspension through all tanks and the bottom of receiver 60 is inclined so that all the residue may flow into a waste conduit 61.

Although only three tanks have been shown in the series, any number of tanks may be used depending on the number of kinds or sizes of material to be separated from the suspension. Reference to Fig. 3 will show that the tanks are supported on similar frames 65, 66 and 67 and at different levels to cause flow of the suspension from tank to tank by gravity. It will be understood that the two or more spouts discharging from any tank may be at any desired level and may discharge into the same or different conveying means.

Each of the discharge spouts is preferably circular with an arcuate end with which a gate 34 is associated. The gate is substantially U-shaped with the legs 70 of the "U" pivotally mounted on the spout and with the bend 71 of the U shaped to conform with the end of the spout and provided with a notch 72 which is

substantially an isosceles triangle in shape. The gate opening is so placed that the apex of the notch moves into registry with the spout opening as the gate is opened. A yoke 73 is pivoted on the legs of the gate and has a rod 74 adjustably connected therewith to permit some lost motion of the rod relative to the yoke.

One end of rod 74 is connected with gate operating means herein shown as a reversible electric motor 77 driving a speed reducer 78 having a double shaft with a crank disk 79 mounted on one shaft end. The gate oscillates only short distances and the degree of overrun at the end of each gate movement is to be minimized. One end of the speed reducer shaft accordingly drives a limit switch to interrupt the motor circuit at desired times. Such switch is one of the well known types of circuit breakers and makers and is only diagrammatically indicated at 89 in Fig. 9.

The gates of any tank are preferably operated by a single drive and the gates of any tank are dependent upon the solids level in such tank and each gate motor is controlled responsive to the pressure of the solids bed at a given location or locations in the tank. Where a tank has a plurality of gates, a pressure responsive means is associated with each gate and the means are so interconnected as to join in controlling the motor of such gates. The pressure responsive means may be a variable volume chamber within the tank itself together with means for transmitting volume variations to the outside of the tank, the wall of the chamber being flexibly responsive to the pressure of the accumulated solids bed thereon. The variable volume or flexing means actuates switch means in a controlling circuit for the gate operating motor. One form of variable volume means is shown in Figs. 7 and 8 in which a chamber 85 with a flexible portion 86 is mounted to extend into a tank above the gate to the minimum height at which the solids bed is to be maintained. The chamber contains a liquid and a float 87 from which a rod 88 extends beyond the end of the chamber for movement of a member 89 for bridging either contacts 90 or 91 when the float is in the low and high positions respectively. The above pressure responsive means is only one example of structure suitable for the purpose.

In the electrical diagram shown in Fig. 9, motor 77 is provided with a reversing switch 95, the form of which is dependent on the type of motor used. The motor is supplied with electrical current from a power line 96 under control of a magnetically operated switch 97 and limit switch 80 dependent upon energization of the coil 98 for operating switch 97. A transformer 99 is connected with the power line 96 and with the member 89 and contacts 90 and 91 controlling energization of the switch coil 97.

In using the present structure, a suspension of solids in liquid is supplied to the inflow distributor 38 of tank 17 and is discharged into the tank. After the tank is filled to the level of the weir 54, continued discharge into the tank creates only a slight turbulence in the suspension for a short distance below the surface thereof. The suspension accordingly flows beneath the baffle 45 and over the weir 54 into the outflow distributor 53 at a velocity which is substantially uniform as regulated, over the entire cross section area and for the full flow length of the tank. In such flow through the relatively small width of tank 17, the velocity of the stream is such as to deposit or

settle solid particles of a particular kind and size. Flow through tanks 16 and 15 in series, is similar to that above described for tank 17 except that the velocity is successively decreased in tanks 16 and 15, both relative to each other and to tank 17. Hence, the solid particles depositing or settling in tanks 16 and 15 are progressively smaller than those in tank 17. Hence materials of one specific gravity, such as clay, may be separated from a material of a different specific gravity, such as sand, or other aggregate. One type of material such as sand may also be separated into three sizes.

As solids accumulate in a tank bottom, the solids bed eventually rises around and above the flexible portion 86 of chamber 85 and presses on such portion to tend to collapse the same. The liquid level and the float 87 in the chamber are accordingly raised and raise rod 88 with its electrically conductive member 89 to bridge contacts 91 after the solids bed reaches a given level. The circuit of the switch coil 98 is closed and switch 97 closes the circuit of motor 77 which swings the gate 70, 71 clockwise to bring the apex of gate notch 72 into registry with the opening of spout 33 until the spout is completely open for discharging solids from the tank. Gate movement continues until motor operation is interrupted by the limit switch 80 which may be adjusted as desired.

Discharge of the solids continues until the lowered pressure of the solids about the flexible tube portion 86 is overbalanced by the weight of displaced liquid float 87, etc., and the flexible portion is re-expanded to its original size. This occurs before the level of the accumulated solids decreases an appreciable amount below flexible tube portion. Member 89 then moves away from contacts 91 to open the circuit for coil 98 which allows switch 97 to open. Toward the end of the motor movement, limit switch 80 is opened and reversed and reversing switch 95 is operated to change the motor connections for operation in clockwise direction. As soon as float 87 and member 89 drop sufficiently to bridge contacts 90, coil 97 is re-energized to close switch 97 and the motor circuit is re-closed to swing gate 70, 71 counterclockwise for closing. Gate closing continues until limit switch 80 reopens, whereupon the circuit is placed in its original condition.

It will thus be seen that the present invention provides a tank arrangement into which suspended solids are delivered uniformly across the entire width of each tank and in such manner as to minimize disturbance of the flow in the tank. The path of flow of the suspension through the tank is controlled to secure regulated and uniform flow in the entire cross-sectional area of the flow and without forming non-flowing areas or "dead-pockets." The discharge from the tank is uniform and is taken from across the entire area at the end of the flow path in the tank. The lost motion in the gate drive insures gate movement and the gate opening varies in size proportionally to the gate movement. The gate is power operated in both directions of its movement and is controlled by the pressure of the accumulated solids bed to keep the bed between given minimum and maximum limits for respectively preventing "blow by" of the suspension and interference with the flow through the tank. The present structure accordingly better meets the required conditions for a continuous classifier than is done by any structure now in use.

Although but one embodiment of the present invention has been illustrated and described, it

will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

I claim:

1. In a classifier tank for solids suspended in a liquid, a tank for the accumulation of solids in the lower portion thereof, a discharge spout in said lower portion, an electric motor controlled gate associated with said spout for controlling the discharge therefrom, and pressure-responsive means for controlling said electric motor-operated gate comprising a chamber having a lower flexible portion mounted in said tank above said spout, and a float in said chamber operatively connected with said electrical control means, said chamber containing a liquid on the surface of which said float is operable.

2. In a classifier tank having an electrically operated discharge gate for controlling the discharge of solids from said tank, the provision of means responsive to the pressure of accumulated solids in said tank comprising an elongated chamber extending from above the normal level of liquid in said tank into said tank and positioned above said gate, a flexible member sealing the bottom end of said chamber, a liquid in said chamber and said flexible member, a float movable in response to the change of level of the liquid in said chamber, and means connecting said float to the electrical control apparatus for controlling said gate.

3. In a classifier tank having an electrically operated discharge gate for controlling the discharge of solids from said tank, the provision of means responsive to the pressure of accumulated solids in said tank comprising an elongated chamber extending from above the normal level of liquid in said tank into said tank and positioned above said gate, a flexible member sealing the bottom end of said chamber, a liquid in said chamber and said flexible member, a float movable in response to the change of level of the liquid in said chamber, said chamber being vertically adjustable to position said flexible member at the desired minimum height at which solids collected in said tank are to be maintained, and means connecting said float to the electrical control apparatus for controlling said gate.

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