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947. J. B. MCKAY
APPARATUS FOR AUTOMATICALLY CONTROLLING DISCHARGE
OF SETTLED PARTICLES IN A HYDRAULIC CLASSIFIER
1945 3 Sheet

Filed March 31, 1945

3 Sheets-Sheet 1

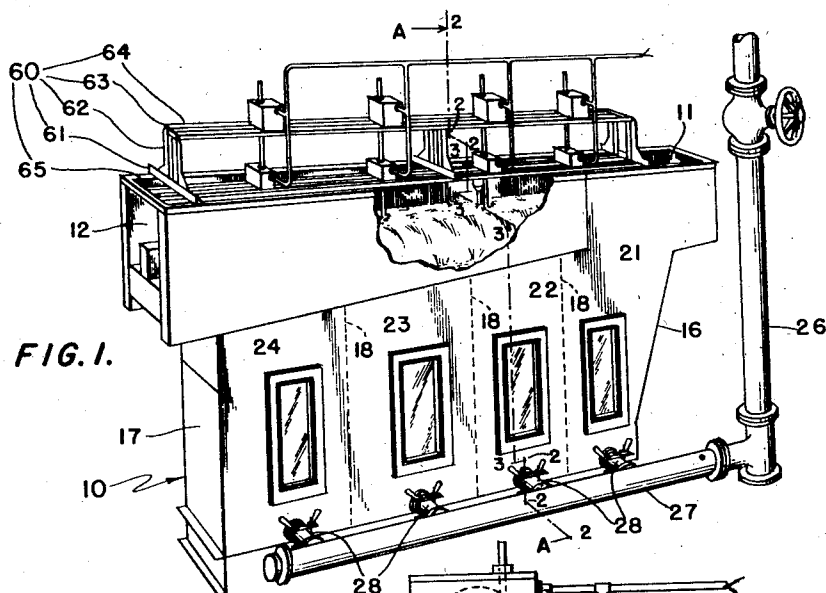


FIG. 1.

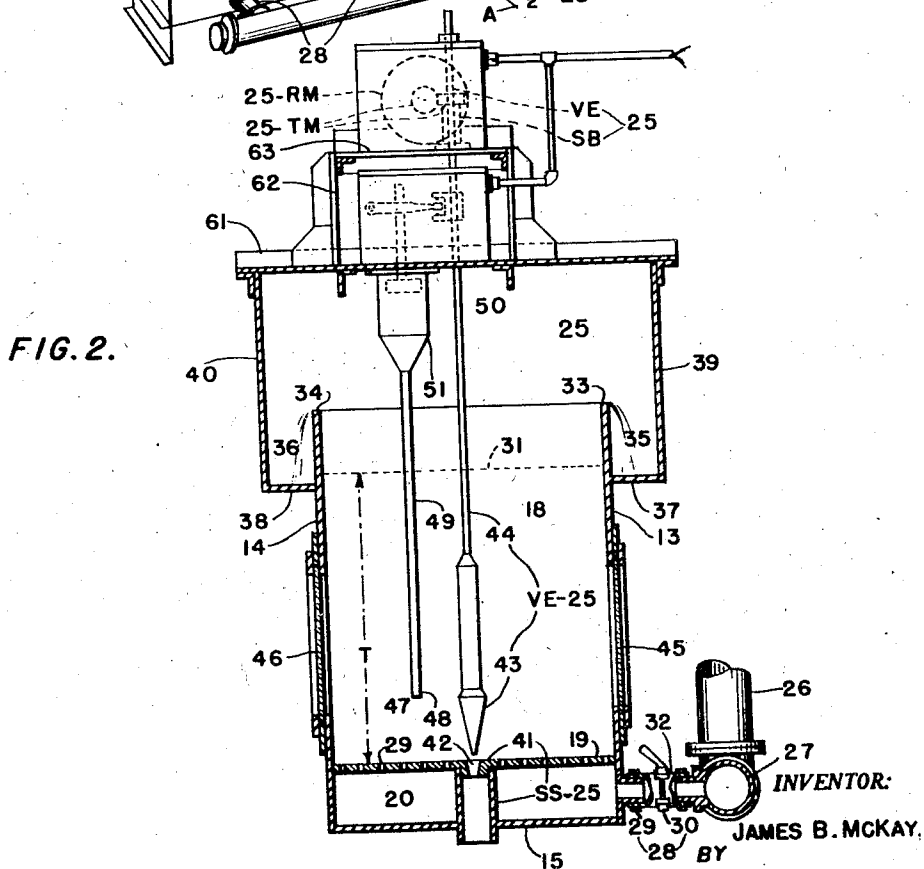


FIG. 2.

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3 Sheets-Sheet 2

FIG. 3.

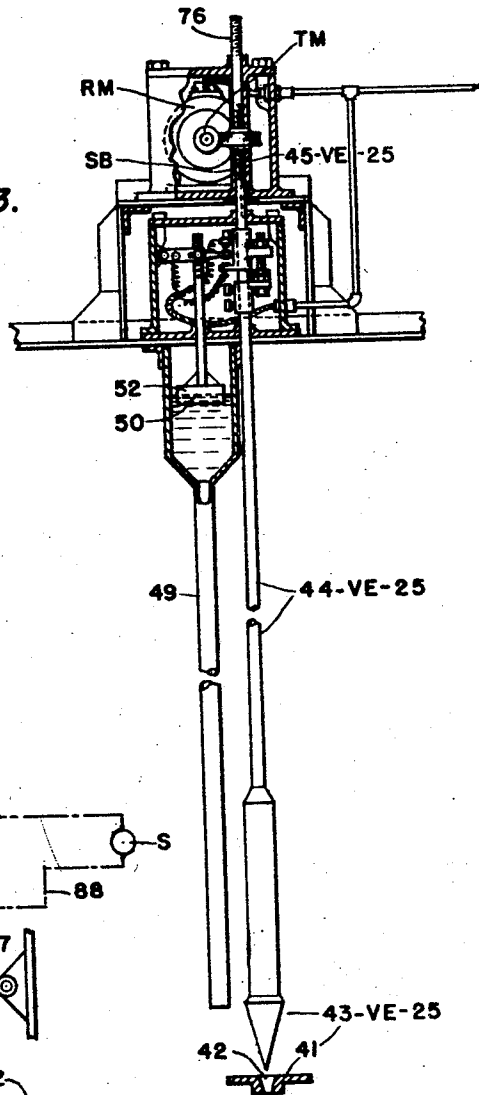
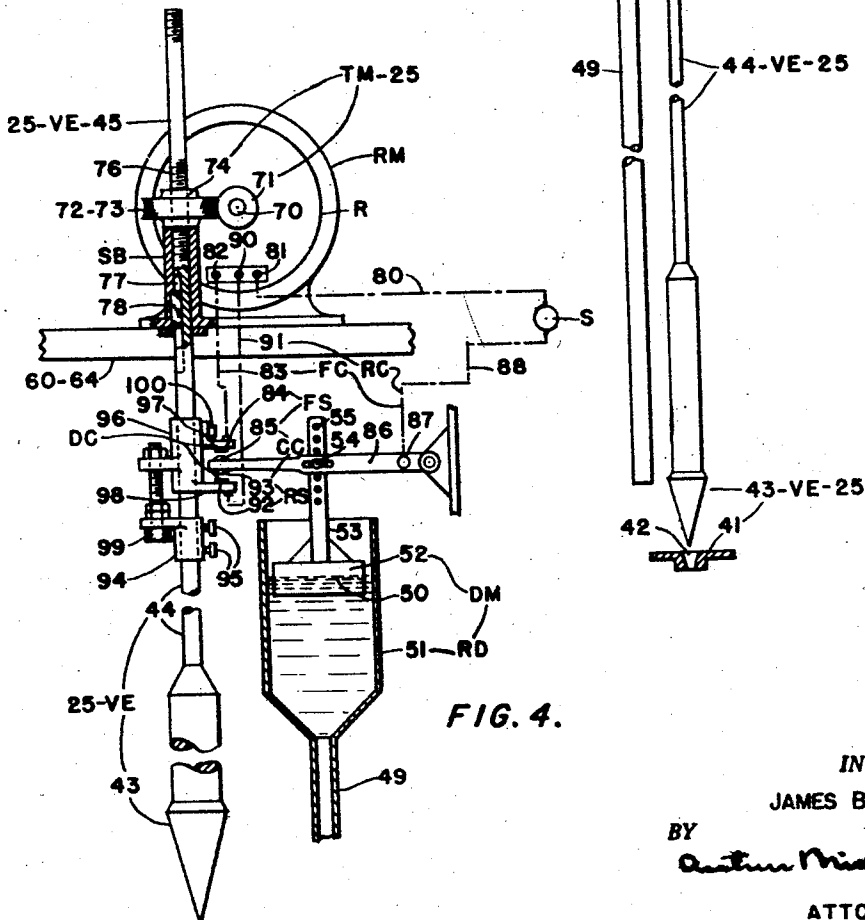


FIG. 4.



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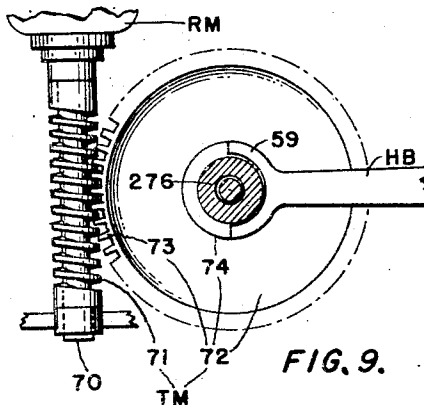
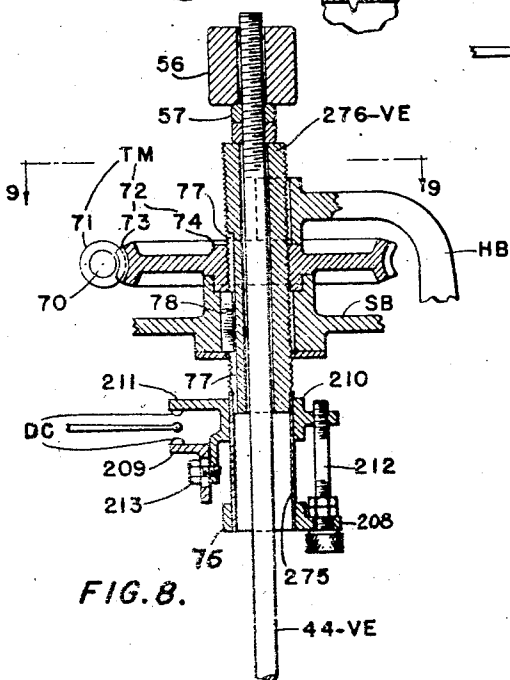
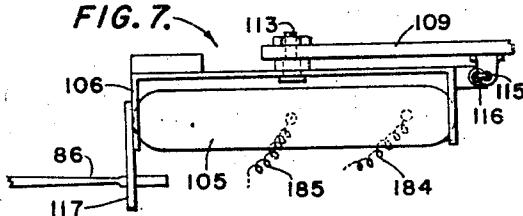
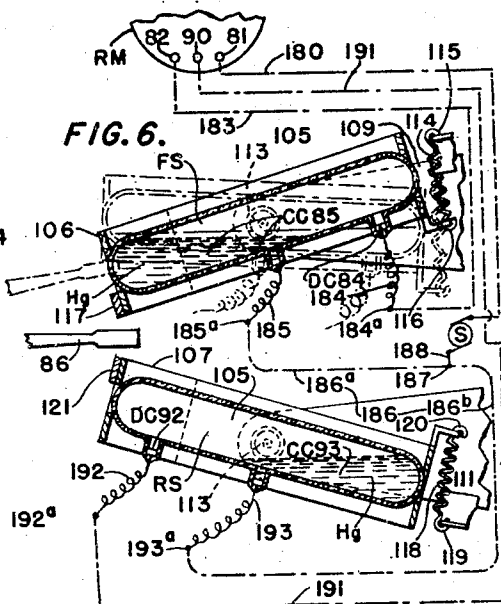
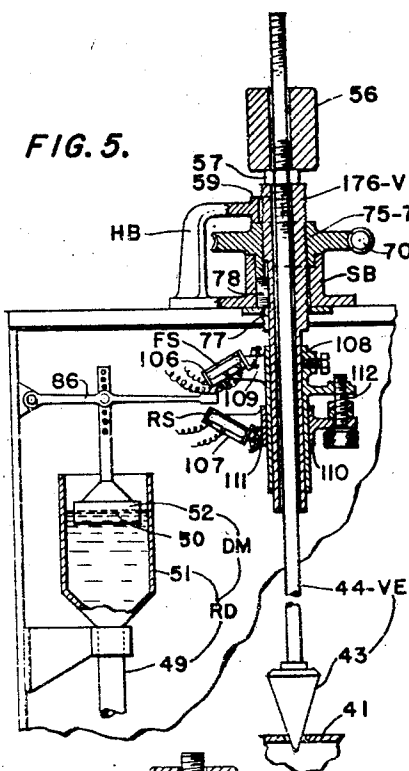
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2,425,551

APPARATUS FOR AUTOMATICALLY CONTROLLING DISCHARGE OF SETTLED PARTICLES IN A HYDRAULIC CLASSIFIER

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Application March 31, 1945, Serial No. 585,959

4 Claims. (Cl. 209-496)

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This invention relates to hydraulic classifiers or sizers of the hindered settling type wherein solids suspended in liquid are supplied to the sizer and the suspended solids are classified according to effective particle size so that one fraction issues from the sizer containing larger solids or sands while another fraction issues from the sizer containing smaller sized solids, called fines.

More particularly the invention relates to apparatus for sizing suspended solids of the kind comprising means for establishing and maintaining a pool of suspended solids to be classified by hindered settling, means for continually feeding suspended solids thereto, means for continually discharging fractionated larger solids or sands from the bottom of the pool, means for continually overflowing from the upper section of the pool another fraction of smaller solids or fines, means for continually supplying liquid under hydraulic pressure to mobilize solids in such pool, means for establishing and maintaining a column of clean liquid balanced by the density of the pool to a super-elevation above the top of the pool which super-elevation varies with the density of the pool, an adjustable valve controlling the rate of discharge of the solids fraction through a valve seat in the bottom of the pool, and automatic means for establishing the density of the pool at or near a predetermined normal to ensure accurate size classification of solids therein.

The bath of liquid with its suspended solids is maintained in teeter, namely, thoroughly mobilized or in motion. This type of hydraulic classification is often referred to as "hindered settling."

The hydraulic liquid supplied to the pool or bath is usually water but may be a liquid of greater density, including a solution of salt, calcium chloride and so on. The head under which the hydraulic water is supplied effects the teeter or the mobilizing of the suspended solids of the bath, which is an important condition of operation. The density of the bath, however, affects the size separating qualities of the machine, so the automatic control of this invention operates to control the density of the solids classifying or sizing bath.

The invention is particularly directed to improved means for automatically operating the adjustable valve to close or to open it for controlling the density of the bath to be more or less, as the case may be.

Since the pool or bath contains suspended solids and the balancing column contains clear liquid, the liquid in the pool or bath will be of

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greater density than the clean liquid and the balancing column of clean liquid will rise to an elevation higher than that of the surface of the bath. The difference in height between the liquid level of the bath and liquid level of the clean water in the column is called "super-elevation." This super-elevation is an important factor in determining the proper density of the bath.

Thus any change in density of the bath containing the mobilized suspended solids that are in teeter and are in the process of being classified as to size, is indicated by a corresponding change in the liquid level of the clean liquid column that is balanced by the denser bath.

Heretofore it has been customary to associate a diaphragm with the teeter bath to indicate variations in the density thereof so that the diaphragm would move in one direction if the density of the bath became too great, and thus would open the valve plug to let out some of the larger solids or sands from the bath, and thus lessen the density of the bath. Conversely, if the density of the bath was too light, the diaphragm would move the other way, the valve plug would close and remain closed until the continuing feed of suspended solids to the bath would raise the density and thus open the valve plug to go on with normal operation.

The principle of the size classifying operation of a machine of this type, known to the trade as the Fahrenwald sizer, is well known and described in British Patent 268,663, filing date October 4, 1926.

An object of this invention is to provide a sensitive and dependable automatic sands discharge and density control apparatus embodying a reversible electrical motor for moving a valve plug either up or down according to density conditions within a lower portion of the pool increased or decreased above or below a selected normal density therefor, the starting of which motor is under the control of a density-positioned member or float while the stopping of the motor is under the control of a valve element carrying the plug when the valve element has moved a predetermined distance in a predetermined motor-actuated direction.

In order that the invention may be clearly understood, reference is made to the accompanying drawings which illustrate by way of example certain embodiments of the invention.

In said drawings—

Fig. 1 is a perspective view, partially broken away, of a multiple pocket hindered settling classifier embodying the invention hereof;

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Fig. 2 is a vertical cross-sectional view taken as on planes indicated by the broken line 2-2-2, 3-3-3, and 2-2-2-2 looking in the direction of the arrows A;

Fig. 3 is a vertical view, partially shown in section, of an automatic sand discharge and density control apparatus for realizing the invention hereof;

Fig. 4 is a vertical view, partially in section, showing at somewhat larger scale certain parts of the apparatus of Fig. 3;

Fig. 5 is a vertical view, partially in section, of a modified form of automatic apparatus for realizing the invention hereof;

Fig. 6 is illustrative of associated Mercoid switches and a portion of a density controlled member for moving either of the Mercoid switches to circuit closing position according to an increased or decreased density condition experienced within a bath served by the automatic apparatus of Fig. 5;

Fig. 7 is a plan view of the upper switch of Fig. 6 when moved into horizontal circuit closing position incident to the upper movement of a density controlled member underlying the switch;

Fig. 8 is a detail of a form of a valve positioning mechanism which may be used in any of the forms of automatic apparatus illustrated;

Fig. 9 is a partial plan view taken as on the line indicated by line 9-9 of Fig. 8 looking downwardly in the direction of the arrows.

Reference is now made to the drawings in detail:

The hindered settling type of hydraulic classifier herein shown to illustrate the invention or the employment thereof comprises a tank 10 resembling a deep trough having a narrow feed inlet end 11 and a wider liquid outlet or overflow end 12. The tank 10 comprises side walls 13 and 14 diverging from the inlet towards the overflow and a horizontal bottom 15, a narrow end wall 16 and a wider end wall 17. The tank is subdivided into a series of pockets by transverse overflow partitions 18. The pockets of the series mentioned are designated as 21, 22, 23 and 24. Each is equipped with an automatic sands discharge and density controlled device or apparatus collectively designated 25 embodying the invention hereof. A description of an automatic sands discharge device or density controlled apparatus adapted for any one of these pockets is sufficient for imparting information as to the invention hereof.

Each of the pockets has a perforated false bottom or perforated flow constriction plate 19 forming between it and the tank bottom 15, a pressure chamber 20 to receive liquid under hydraulic pressure herein, also called teeter liquid for the purpose to be further explained. The constriction plate 19 also defines the floor of the classifying pocket in which during operation there is established a hindered settling classifying zone or teeter bed of depth T as hydraulic liquid from the pressure chamber 20 is forced upwardly through the openings 29 of the constriction plate whereby the sands or solids in the slurry or solids feed passing through the tank are graded or sized as the apparatus functions. The means for passing hydraulic water or water under pressure into each of the compartments 20 embodies a vertically extending pipe 26 delivering the hydraulic water into a horizontally extending distributing main or pipe 27 and a series of valve controlled laterals or pipes 28 each leading from the distrib-

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uting main into a pressure chamber 20 corresponding thereto. As shown each of the laterals embodies a flexible tubular connection, such as is provided by a rubber pipe 32 and an adjustable clamping means 30 whereby there is thus provided a valve construction for each lateral pipe.

The solids in a classifying zone or pool within a pocket may be viewed as a bath containing solids, many of which are in a state of mobilized suspension because of the several jets of upflowing water provided by hydraulic water upwardly delivered through and from the apertures 29 of the constriction plate 19 from the body of pressure water underlying the plate. The solids to be classified into fractions are continually supplied at the feed-receiving end of the classifier or hindered settling apparatus with the result that a teeter bed for each pocket is normally maintained up to the depth T, to wit, up to the top or upper edge 31 of the transverse partition 18 or member analogous thereto. Solids which would otherwise accumulate at elevation higher than that of said upper edge 31 progressively pass thereover as solids submergedly overflowing from the upper region of the teeter bed into the succeeding pocket. A teeter bed is thus maintained in and for each pocket whereby the surface of the teeter bed is up to but not substantially higher than that of the upper or solids overflow edge 31. From each teeter bed there is also a progressive release, as will hereinafter appear, of certain of the larger solids from the bed.

Along the upper portion of each side wall of the tank there are provided two launders 35 and 36 for receiving liquid overflowing therein from a body of supernatant liquid overlying the several teeter beds and maintained because of upflowing liquid passing from said beds. The upper edge 33 of side wall 13 and the upper edge 34 of side wall 14 collectively provide overflow edges for the supernatant passing the same. Each of the overflow edges 33 and 34 is at elevation higher than that of the solids-overflow edge 31 of the transverse partition 18 with the result that the solids edge 31 may be referred to as providing, as has been previously indicated, for the submerged passing of solids from one pocket past the overflow edge 31 into a succeeding pocket. The side launders 35 and 36 extend along the upper outer portion of the side walls. These launders 35 and 36 are formed or completed by longitudinally sloping bottom members 37 and 38 extending outwardly from the side walls and outwardly disposed side members 39 and 40 rising from the bottom members 37 and 38.

The arrangement of the apparatus is such that solids passing from the lower or bottom portion of any one pocket is delivered through a valve seat 41 apertured at 42. The effective flow area through or past said apertured seat is controlled by a positionable cooperatively disposed valve element such as is provided by a valve plug 43. This valve seat 41 can well be considered as part of the automatic control apparatus collectively designated 25.

From what has preceded one will readily understand that there is a bath or pool within each pocket maintained as to upper normal surface liquid level up to an elevation determined by the supernatant liquid overflow edges 33 and 34, and it will be appreciated that there cannot take place a submerged passage of solids undergoing classification from one pocket to another except when the solids of the teeter bed within the pool reach

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to and extend above the elevation of submerged edge 31 of the partial partition. As this juncture it is in order to point out that there rise with and continue in the liquid constituting the supernatant liquid of the bath or pool fine or light solids having characteristics such that they cannot and will not settle counter to the rising liquid and such fine or light solids pass from the apparatus with the liquid overflowing the edges 33 and 34 into the side launders mentioned. It has been pointed out that solids from the lower portion of the pool pass therefrom according to the effective flow area through the opening 42 as determined by the position of the valve element or valve plug 43 thereof that is operatively associated with the apertured valve seat 41. For each pocket there are inspection windows 45 and 46 of glass or other transparent material whereby an operator may observe the operations taking place in any particular pocket.

The foregoing specific description is indicative of the type of apparatus and of the general features of an apparatus to which the invention hereof is applicable.

The main features of the present invention revolve about and relate to a novel type of automatic sand discharge and density controlled apparatus having as functioning characteristics thereof the positioning of the valve plug 43 relative to its seat 41 according to density conditions currently obtaining at a lower portion of the bath, to wit, according to density conditions at a locality as 47, or as otherwise expressed, at the lower end 48 of a vertically extending tubular member 49 for maintaining a column of relatively static clear liquid balanced by the density of the liquid-solids bed constituting the lower portion of the pool and rising to a super-elevation as 50 above substantially that of the operative level of the supernatant liquid at the top of the pool, to wit, the surface level as determined by the overflow edges 33 and 34. This tubular member 49 has an enlarged hollow upper end section 51 into which the clear liquid extends and which liquid in the enlarged section is relied upon or availed of for positioning a float 52 serving as a density controlled or density positioned member. This float or density controlled member 52 responds as to its position to density changes, for example, to density increased or density decreased with respect to what may be termed a mean or selected normal density condition for and at a lower portion of the teeter bed. This density controlled responsive member is employed to control automatically the closing at one time of a forward operating circuit of a reversible motor, to wit, when an increased density condition above normal has developed, and to control automatically the closing of another or reverse circuit of the motor, to wit, when decreased density condition below normal has developed, for example, an increased density condition above normal will cause an automatic closing of a forward operating circuit of the reversible motor which through a positive driving mechanism extending from the rotor of the motor to a stem carrying the valve plug can cause a moving of the valve further from its seat whereby there will follow a greater rate of discharge of solids from the lower portion of the particular bed and which operation will be followed by a decrease in density condition within the lower portion of the bed, to wit, towards the selected normal or mean density. A decreased density condition below the normal will cause an automatic closing of a reverse operating circuit

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of the motor which through the positive driving mechanism extending from the rotor of the motor to the stem carrying the valve plug will cause a moving of the valve plug toward its seat whereby there will follow a lesser discharge of the solids from the lower portion of the particular bed, which operation will be followed by an increase in density condition within the lower portion of the bed.

10 The switch contacts of the motor circuits are so connected or embodied in the circuit whereby upon a required movement of the valve plug relative to the seat, there is effected a disrupting of the circuit last closed by causing a separating of the switch contacts that previously engaged each other and thereby completed or closed circuit and such opening of that switch will take place without permitting or effecting a simultaneous closing of the pair of contacts of the switch for the other circuit.

20 The hindered settling apparatus has means providing a stationary framework upon which the reversing motor is supported and from which other elements of the automatic control apparatus are suitably carried. The supporting means or framework is generally designated 60 and embodies such members as cross-supports 61, uprights as 62, upper cross members as 63, upper longitudinals as 64 and lower longitudinals 65, all of which are connected to provide a relatively rigid structure which is stationarily mounted upon and carried from the tank structure 10.

30 The automatic sands discharge and density controlled apparatus generally designated as 25 may be viewed as deriving support from a stationary structure, to wit, from the tank 10 and framework 60 carried by the tank. The automatic apparatus may also be considered as comprising:

40 1. A sands discharge spigot SS leading from the bottom of a classifying pocket wherein a bed of solids is maintained in teetering condition due to upflowing water supplied to and distributively delivered into the lower portion of the bed. The sands spigot shown has the apertured valve seat 41 through which certain classified sands or solids pass on their way from the lower portion of the bed to a locality outside of the tank.

50 2. Positionable closure means for controlling the effective sands discharge area of the spigot. In the construction shown the positionable means is provided by movable valve element VE embodying a vertically extending valve stem carrying at the lower end thereof a valve plug operatively disposed with respect to said seat. The valve element is provided with an externally threaded portion at the upper end of the stem or with a sleeve member from which the stem is supported and constituting part of means for positioning the valve stem and valve plug thereupon either up or down, as the case may be.

60 3. Means providing a supporting bearing SB by which the valve element is guided and with respect to which the valve element is movable.

65 4. A suitably supported reversible motor RM having a forward operating circuit FC which when closed by a control switch FS therefor causes the rotor of the motor to turn in a forward direction and a reversible circuit RC which when closed by a circuit switch RS therefor causes the rotor of the motor to turn in a reverse direction.

70 5. Speed reducing and power transmission mechanism TM by which, when an operating circuit of the motor is closed, the turning rotor thereof imparts through said mechanism move-

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ment to the valve element whereby the positionable valve element moves in either a valve opening direction or in a valve closing direction as the case may be dependent upon whether the forward operating circuit or the reverse operating circuit is closed.

6. A density responsive device RD functionally disposed with respect to the lower portion of the bed. This device includes a density controlled or density positioned member DM movable (a) outwardly or upwardly incident to a density condition within the bed increased above normal or (b) inwardly or downwardly due to the density conditions within the bed decreased below normal. For connection with the foregoing it will be noted the density responsive device shown embodies the vertically extending tubular member 49 having the enlarged end section 51 and the density controlled member DM thereof is provided by the float 52 in the enlarged upper end section. It will also be noted that a lever connected to the float constitutes a part of this particular device and of which the free end of the lever serves as a means carrying a pair of circuit closing contacts CC, which lever (a) when moved upwardly or outwardly a sufficient distance effects a closing of switch FS for the forward circuit FC; or (b) when moved downwardly or inwardly a sufficient distance effects a closing of the switch RS of the reverse operating circuit RC.

7. The pair of circuit closing contacts CC, to wit, two contacts 85 and 93, at the free end of the lever and which are movable therewith, namely, upwardly to effect closing of the forward operating circuit FS or downwardly to effect closing of the reverse operating circuit RS; and

8. A pair of spacedly disposed circuit disrupting contact members DC, to wit, provided by contacts 84 and 92 which are carried by and movable with the valve element and of which (a) the upper contact 83 is disposed for causing or effecting an opening of the switch FS controlling the forward operating circuit RC and (b) a lower contact 92 is disposed for causing or effecting an opening of the switch RS controlling the reverse operating circuit RC.

In short, the arrangement of the circuit controlling switches with respect to the density controlled or density positioned member for closing one or the other of said switches according to increased or decreased density conditions, as the case may be, is such that when forward control circuit switch FS is closed consequent to increased density conditions there follows a completion or closing of the forward operating circuit FC and a tuning of the rotor of the motor in its forward direction and thereby providing for an impelled movement of the valve element VE in direction to position the valve plug further from its seat. Manifestly such moving of the valve plug in a direction from its valve seat is for the purpose of lowering or bringing down density conditions at the lower portion of the teeter bed to the selected normal therefor. Conversely a closing of the reverse control circuit switch RS consequent to decreased density conditions causes to be realized a moving of the valve plug in a direction towards its seat is for the purpose of raising or bringing up the density conditions thereat to the selected normal.

The reversible motor heretofore referred to is designated RM and the rotor thereof R has a shaft 70 carrying a worm gear 71 which may be referred to as a gear element turnable with and

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directly driven by the rotor shaft 70. This motor is fixedly supported on and carried from the upper longitudinals 64 of the stationary supporting frame structure 60.

5 This motor has two operating circuits diagrammatically illustrated in Fig. 4.

One of the circuits arbitrarily referred to as forward operating circuit FC comprises a source S of electrical energy supply, wire 88, lever 86, to which wire 88 is connected at 87, circuit closing contact 85 of switch FS when moved into engagement with circuit disrupting contact 84 of switch FS, said circuit disrupting contact 84, wire 83, field terminal 82 for forward rotation, common field terminal 81 and wire 80 extending from the common field terminal 81 to source S.

The other of the circuits and arbitrarily referred to as the reverse operating circuit RC comprises said source S, wire 88, lever 86, circuit closing contact 93 of switch RS when moved into engagement with circuit disrupting contact 92 of switch RS, wire 91, field terminal 90 for rearward rotation, common field terminal 81 and wire 80 extending from the common field terminal 81 to source S.

It will be appreciated that each circuit switch referred to is closed only by the circuit closing contact 85 or 93 thereof being raised or lowered by movement of the float or density positioned member 52 consequent to substantially changed density conditions either increased or decreased, as the case may be, relative to a selected normal density for the lower portions of the teeter bed.

It will also be noted that each circuit switch mentioned is opened only by the circuit disrupting contact 84 or 92 thereof being raised or lowered by movement of the motor actuated or motor positioned valve element VE. The float 52 which is determined as to its elevation or position by the super-elevation of the clear liquid, to wit, by the elevation of the surface level of the liquid at 50, functions through the medium of an intermediate member or upright 53 having a pivotal connection at 54 to the central portion of the lever 86. This upright 53 or intermediate means extending from the float 52 to the lever has a series of pin-receiving openings 55 whereby the position of the density positioned float relative to the lever 86 which is actuated thereby or therefrom can be changed according to operative requirements. The closing contacts 85 and 93 which are both electrically connected to the lever 86 carrying the same may be viewed as two different contacts or as a single contact member providing two different contact engaging faces. In any event these two members 85 and 93 while moving as a single mechanical element function as two different electrical elements.

As to the movable valve element VE, this includes the valve plug 43 and is carried from the lower end of a vertically extending valve stem 44 the upper end 45 of which is exteriorly screw threaded at 76 and is operatively engaged by an interiorly threaded portion 75 of hub 74 of a worm gear 72 the external teeth 73 of which have operative engagement with the external screw threads of the worm gear 71. The worm gear 71, the worm wheel driven therefrom, internally threaded portion 75 of the hub of the worm gear, and the exteriorly threaded upper portion 76 of the valve stem 44 constitute a positive speed reducing and power transmission mechanism extending from the rotor of the motor to the exteriorly threaded portion 76 at the upper end of the valve stem 44 of the valve element VE of

Fig. 4, or to the externally threaded sleeve member 176 shown in the modified form of valve element as illustrated by Figs. 5 and 8, whereby according to a forward turning movement of the rotor there is caused an upward movement to the valve plug in direction from the valve seat, or whereby consequent to a reverse turning movement of the rotor of the motor there is imparted a lowering movement of the valve plug in direction towards the valve seat. In this connection with the construction of Fig. 4, it will be noted that the worm gear rests upon a stationary bearing member SB carried on the frame and there is provided in this bearing member a vertically extending key 78 which enters a vertically extending keyway 77 provided in the valve stem for retaining the valve stem from turning but which permits vertical movement of the valve stem within the bearing SB whereby the turning movement of the threaded hub about the threaded stem will cause the lowering or rising of the stem as the case may be as the rotor turns. The circuit closing contacts or members 85 and 93 are collectively designated as CC and are positioned by or from the float or density controlled means DM or float 52 thereof. The circuit disrupting contacts or members 84 and 92 are collectively designated as DC and they are positioned by or from the valve element VE and more specifically from the exteriorly threaded portion or sleeve member thereof.

While the construction in Fig. 3 is shown at smaller scale than in Fig. 4 nevertheless the former figures in certain respects bring out more clearly the general arrangement and relationship of the parts constituting the automatic sands discharge and control apparatus 25. The description thus far made in respect to Fig. 4 applies to Fig. 3. The valve stem 44, or as otherwise expressed, the screw-threaded portion 76 thereof carries and moves therewith a holding bracket 94 adjustably secured in place by the screw or bolts 95 vertically spaced above the holding bracket. There is an upper vertically adjustable bracket 96 having vertically spaced upper and lower laterals 97 and 98 of which the upper lateral 97 carries the circuit disrupting contacts 84 and while the lower lateral carries the circuit disrupting contact 92. This upper bracket can be positioned through the medium of an adjusting screw 99 carried from the lower bracket and having operative threaded engagement with the upper bracket whereby to raise or lower the upper bracket and consequently to raise or lower the circuit disrupting contacts 84 and 92 as a set namely, to a desired adjustable positioning thereof. Said contacts 84 and 92 are also vertically positionable relative to each other because of the upper lateral 97 being adjustably secured by bolt 100 to a body portion of the upper bracket 96.

In Fig. 5 there is shown an arrangement of parts wherein two "Mercoïd" or equivalent type of switches are substituted for the circuit control switches FS and RS the arrangement of parts shown in Fig. 4. These Mercoïd switches and their associated relationships are shown in larger scale in Fig. 6.

In Figs. 5 and 6 the upper Mercoïd switch is designated as FS and corresponds in function to a circuit control switch FS of Fig. 4. The lower Mercoïd switch is designated RS and corresponds in function to the switch RS of Fig. 4. In the instance of the Mercoïd switches liquid mercury indicated by Hg constitutes an essential element of each switch and it is located within a tube

105 closed at each end. The tube of the upper switch is located in and carried by a frame or casing member 106 and the lower switch is located within and carried by a frame or casing 107. An adjustable bracket 108 (see Fig. 5) is carried by or from the valve element VE and embodies an upper lateral member 109 extending therefrom. The adjustable bracket member 108 also has slidably mounted thereupon a positionable bracket member 110 having a lower lateral member 111. An adjusting screw 112 is employed for positioning the bracket member 110 along the bracket member 108 and thereby the lower lateral 111 relative to the upper lateral 109.

In Fig. 6 it will be seen that the end portions of the laterals 109 and 111 have pivotal means or trunnions 113 by which the upper frame or casing 106 carrying "Mercoïd" switch FS is pivotally supported from the upper lateral 109 and by which the lower frame or casing 107 carrying "Mercoïd" switch RS is pivotally supported from the lower lateral 111. A tension spring 114 is provided for the upper "Mercoïd" switch FS the upper end of which spring is connected at 115 to the upper lateral 109 while the lower end of the spring is connected at 116 to a projecting portion extending from the lower right hand end section of the frame 106 whereby the upper "Mercoïd" switch FS is normally supported in the inclined open position therefor as shown unless moved from that position by the free end of the lever 86 when that lever is moved upwardly by float 52 (see Fig. 5) rising incident to increased density conditions within the lower portion of the bed or pool, to wit, due to the free end of the lever engaging a member 117 extending outwardly from the frame and over the path of movement of the free end of the lever. As to the lower "Mercoïd" switch RS this has a tension spring 118 the lower end of which is connected at 119 to lower lateral 111 and the upper end of which is connected at 120 to a projecting portion extending from the upper right hand end section of the member 107 with the result that the lower switch RS is normally supported in the inclined open position therefor as shown unless moved from that position by the downward movement of the free end of lever 86 engaging a member 121 extending outwardly from the lower frame into the path of downward movement of the lever.

Each of the "Mercoïd" switches shown has a leading-in wire extending to and entering the interior of the tube near the central portion thereof, that is to say, at a locality intermediate the ends of the tube. The terminal of the leading-in wire mentioned is always in electrical contact with the mercury within the tube. This leading-in wire for the upper switch is designated 185 and the leading-in wire for the lower switch is designated 193. Another leading-in wire is provided for each switch and extends into the lower interior portion of the high end of the mercury containing tube of the "Mercoïd" switch to which it corresponds, such wire is designated as 184 for the upper switch and as 192 for the lower switch. That portion of the wire 184 entering the upper tube is referred to as a circuit disrupting contact DC 84. Likewise that portion of wire 192 entering the lower tube is referred to as circuit disrupting contact DC 92. The mercury in each switch constantly electrically engages the end of the leading-in wire 185 or the end of the leading-in wire 193 of the switch in which the mercury is located. The mercury is viewed for the pur-

pose herein described as providing the circuit closing contact for each of the "Mercoïd" upper switches. The mercury of the upper switch is designated as closing contact CC 85. The mercury at the lower switch is designated as closing contact CC 93. The mercury Hg accomplishes the closing of the forward motor operating circuit FC when the lower end of Mercoïd switch FS is bodily lifted by upward movement of the free end of lever 86 whereby the mercury flows into circuit completing engagement with the disrupting contact DC 84. Likewise, the mercury is caused to flow into circuit completing engagement with circuit disrupting contact DC 92 of the lower switch when downward movement of lever 86 causes the upper end of lower "Mercoïd" switch RS to be lowered. Both of these "Mercoïd" switches are carried by and movable according to the upward or downward movement of the valve element VE. An upward movement of the valve element causes the upper switch FS to move towards or return to its inclined position shown when not otherwise displaced by the lever 86. This upward movement of the switch FS causes the disrupting contact DC 84 to move whereby the mercury cannot longer engage it and it is for this reason that contact DC 84 is referred to as the circuit-disrupting contact. Likewise, when the lower switch RS moves toward or returns to its inclined position shown the disrupting contact DC 92 gradually assumes the position where-at the mercury no longer engages it.

Respecting the circuits controlled by these "Mercoïd" switches:

When "Mercoïd" circuit switch FS is closed the circuit completed thereby includes the following:

S indicates the source of electrical energy and wire 188 extends therefrom to connecting point 187 and another wire 186, namely, portion 186^a thereof extending from the connecting point 187 to lead-in wire 185 to which it is connected at 185^a. The mercury constituting closing contact CC 85 always contacts the end of leading-in wire 185 and when the low end of circuit switch FS is raised the mercury extends to and engages the circuit disrupting contact DC 84 provided by the inner end of wire 184. The wire 184 extends to point 184^a from which there extends wire 183 to field terminal 82 of the motor. From common field terminal 81 wire 180 extends to source S.

The circuit completed when "Mercoïd" switch RS is closed is as follows:

Source of power is S, wire 188 extending to connecting point 187, wire 186—namely, portion 186^b thereof—extending from the connecting point 187 to leading-in wire 193 to which it is connected at 193^a. The mercury constituting closing contact CC 93 always contacts the end of leading-in wire 193 and when the upper end of circuit switch RS is lowered the mercury extends to and engages the circuit disrupting contact DC 92 provided by the inner end of lead-in wire 192. A wire 191 is connected at 192^a to wire 192 and extends to field terminal 90 of the motor. Wire 180 extends from the common field terminal 81 to the source of power S.

The mechanical construction of the forms shown in Figs. 5 and 8 are quite similar to the forms shown in Figs. 3 and 4 with the exception that in 5 and 8 there are changes as to certain details thereof.

In the form shown in Figs. 3 and 4 the externally threaded portion 76 constitutes the upper part of the valve rod 44 and the valve body or plug in its upward or downward movement has

imparted thereto the same movement as that imparted to the threaded portion 76. However, there may be abnormal instances where an obstruction may become interposed between the valve body and its seat. Provision is therefore made according to the constructions shown in Figs. 5 and 8 to avoid detrimental effects from such obstruction. In the figures last referred to an externally threaded sleeve is employed to position the valve stem and valve plug carried thereby. This sleeve is designated as 176 in Fig. 5 and as 276 in Fig. 8. The valve stem 44 extends through the sleeve and is carried thereby in a manner to permit yielding of the valve stem relative to the sleeve as the latter is positively positioned downwardly should the valve plug 43 at the lower end of the stem encounter an underlying obstruction. The operating mechanism for positioning such sleeve comprises the suitably supported reversible motor RM, the speed reducing and power transmission mechanism TM embodying the worm or worm screw 71, worm gear wheel 72 having teeth 73 engaging the threads of the worm screw and also having a hub 74 with terminal screw threads thereon fitting and having screw engagement with the externally threaded portion of the sleeve 176 or 276 as the case may be. The worm gear 72 is turnably mounted in a seated portion on stationary bearing SB and is held in operative position relative to its seat and against any lifting movement such as might be imposed upon it by an obstruction below the valve body by means of a stationary holding down bracket HB having a forked end 59 spanning the externally threaded sleeve and overlying the upper end of the hub 74 as shown in Fig. 9. The valve stem 44 is normally pressed downwardly against the top of the sleeve 176 or 276 as the case may be by a counterweight 56 which can be adjustably positioned along the valve stem through the medium of a screw nut 57 carried at the upper threaded end portion of the valve stem 44.

In the instance of each of the forms shown in Figs. 5 and 8, there is a keyway or key-receiving portion 77 provided in the externally threaded sleeve as 176 or 276 for receiving therein key 78 carried in the supporting frame SB. This key prevents turning of the sleeve as 176 or 276, but permits upward and downward movement of the sleeve according to the movement effected or obtained by the turning of the internally threaded worm wheel 72 about the sleeve.

In the arrangement of Fig. 5, an adjustable bracket member 108 is carried on a lower tubular portion provided by an integral downwardly extending portion 175 of the sleeve 176. The adjustable bracket 108 is secured in adjusted position on the integral extension 175 by a screw or bolt 195. A positionable bracket 110 is slidably mounted on 108 and is positionably adjusted along the latter and held in adjusted position relating thereto by adjusting screw 112. The adjustable bracket 108 has lateral extension 109 upon which the frame 106 of upper "Mercoïd" switch FS is carried. The positionable bracket has lateral 111 upon which the frame 107 of the lower "Mercoïd" switch RS is carried.

In Fig. 8 a sleeve-like extension 275 is secured to the lower end of the externally threaded sleeve member 276. A fixed or adjustable bracket 208 is secured to the lower end of the sleeve extension 275. A positionable bracket 210 is slidably mounted on sleeve extension 275 and is vertically positionable along the sleeve extension 275 in re-

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lation to the bracket 208 through the medium of adjusting screw 212 carried by the bracket 76. The positionable bracket 210 has vertically spaced laterals extending therefrom. The upper lateral designated 211 is an integral part of the positionable bracket 210, while the lower lateral designated 209 is adjustably held in place upon the positionable bracket through the medium of bolt 213 whereby it is positionable relative to the upper lateral 211. Each of these laterals carry a circuit disrupting contact whereby there is realized a set of vertically spaced circuit-disrupting contact CC movable vertically as a set according to an up or down movement of the exteriorly threaded valve stem member 276.

From that which has preceded, it is believed the operation of the assembly of parts constituting the invention hereof will be readily understood and appreciated. However, a terse statement as to the operation of said sands discharge and density controlled apparatus may advantageously be inserted at this place and in this connection one should bear in mind that for any one pocket a selected or target density condition is aimed at or sought as a basic or normal density condition for and at the lower portion of a teeter bed in the pocket.

For density conditions increased substantially above the target or selected normal there is an upward or outward positioned movement of a density controlled member DM, namely, float 52 which operating through the medium of lever 86 moves a circuit closing contact CC, as 85 or CC-85 to switch closing position, thereby completing a forward operating motor circuit FC whereby such resulting forward turning of the rotor of the motor RM effects through the speed reducing and power transmission mechanism TM a lifting of the valve element VE and a corresponding moving of a valve plug 43 in the direction from the apertured valve seat 41 corresponding thereto. The upward movement of the valve element VE brings it to a position at which a circuit disrupting contact DC, as 84, or DC 84, is moved from its companion circuit-completing contact thereby opening the forward circuit switch embodying the contacts mentioned and consequently disrupting the forward operating motor circuit FC.

Similarly, upon a density condition substantially decreased below normal being reached, there is caused a lowering or inward movement of the density positioned member DM, or float 52, a consequent closing of circuit switch RS with the resulting completion of the reverse motor operating circuit RC, the moving through the speed reducing and power transmission mechanism TM of the valve element VE in a downward direction whereby the valve plug 43 is moved towards its apertured valve seat 41. The downward movement of the valve element VE causes it to reach a position whereat the circuit disrupting contact as 92 or DC 92 has disengaged its companion circuit closing contact as 93 or CC 93, thereby opening the reverse circuit switch RS and consequently disrupting the reverse motor operating circuit RC.

I claim:

1. Automatic control apparatus of the class described for association with an ever-changing pool of suspended solids classified by hindered settling to which solids are continually fed and from which one classified fraction of solids is continually discharged along one path leading

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from a lower portion of the pool downwardly through a closure-controlled spigot opening leading from a lower portion of the pool while another fraction of such solids in suspension passes along another path leading from an upper portion of the pool, and into the lower portion of which pool hydraulic water under pressure is upwardly delivered to sustain hindered settling conditions within the pool; said automatic control apparatus comprising in operative combination an apertured valve seat providing the spigot opening, a valve element having a vertically extending stem member and a valve plug providing a vertically positionable spigot closure element for regulating the rate of flow through the spigot opening, a density-responsive device functionally disposed with respect to a lower portion of the bed having a density controlled member movable in an outward direction as density conditions increase beyond a selected normal and movable in an inward direction as density conditions decrease therebelow, a reversible electric motor having a forward-operating circuit with a control switch therefor closable by outward movement of said density controlled member and a reverse-operating circuit with a control switch therefor closable by inward movement of said density controlled member, power transmission means actuated from said motor for moving the valve element in direction from valve seating position when the forward-operating circuit is closed and in an opposite direction when the reverse-operating circuit is closed, and a stationary structure affording support for the motor and transmission means; each switch including a movable circuit-completing contact positionable for switch closing from the density responsive member and a movable circuit disrupting contact positionable for switch-opening from the valve stem; said switches being structurally separated and disposed so that there is a time lag between the opening of any one switch and the closing of the other switch; said apparatus being characterized in that said circuit disrupting contacts are positionably supported from the valve stem through the medium of means comprising a bracket member connected to the valve stem, a slidable member vertically movable along and with respect to the valve stem and from which said circuit disrupting contacts are supported so as to be vertically spaced with respect to each other, and a turnable adjusting screw operatively associated with the bracket member and the slidable member whereby to adjustably position the slidable member relative to the valve stem.

2. An automatic control apparatus according to claim 1, in which the circuit disrupting contacts are supported from the slidable member so that the circuit disrupting contact of at least one of the circuit switches is vertically positionable with respect to the circuit disrupting contact of the other circuit switch whereby the effective vertical spacing between said circuit disrupting contacts can be changed according to operating requirements.

3. Automatic control apparatus of the class described for association with an ever-changing pool of suspended solids to be classified by hindered settling to which solids are continually fed, from which a classified fraction of solids is continually discharged along one path leading from a lower portion of the pool through an apertured valve seat located in the bottom of the pool while

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other solids in suspension pass along another path leading from an upper portion of the pool, and into the lower portion of which pool hydraulic water under pressure is upwardly delivered to sustain hindered settling conditions within the pool; which automatic control apparatus includes in combination the aforementioned apertured valve seat, a vertically movable valve element embodying a vertically extending valve stem carrying at one end thereof a valve plug operatively associated with said seat, a density responsive device functionally disposed with respect to the lower portion of the pool and having a density-controlled member movable in one direction when density conditions increase above a desired normal and movable in another direction when density conditions decrease therebelow and characterized in that it also includes a reversible electric motor having a forward-operating circuit with a control switch therefor and a reverse-operating circuit with a control switch therefor, said switches being operatively associated with the density controlled member whereby the latter effects a closing at one time of the switch of one circuit according to density conditions increased and a closing at another time of the switch of the other circuit according to density conditions decreased below said normal; a power transmission mechanism actuated from said motor and having a gear with an internally threaded hub for positioning the movable valve element relative to said seat, stationary means affording support to the motor, the power transmission means and said gear thereof; a sleeve member surrounding said stem constituting a part of the valve element and having an exteriorly screw threaded portion with which the

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internally threaded hub has operative engagement and also having an exteriorly-located vertically extending keyway provided thereupon, a key carried by the stationary support and extending into said keyway whereby to permit vertical movement of the sleeve member while resisting turning movement of the sleeve member about a vertically extending axis thereof, means between the valve stem and the sleeve member whereby to positively move the valve stem and valve plug carried thereby in one direction, and means embodying a yieldable element whereby a movement of the sleeve member in an opposite direction effects a yieldable movement of the valve stem and valve plug.

4. Automatic control apparatus according to claim 3, in which the sleeve member carries and has movable therewith vertically spaced circuit disrupting members effective to cause by movement in one direction the opening of one switch and by movement in another direction the opening of the other switch.

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