June 12, 1956 C. W. G. DOWSETT 2,749,928

APPARATUS FOR CONTROLLING THE GRAVITY DISCHARGE OF DESLIMING CONES

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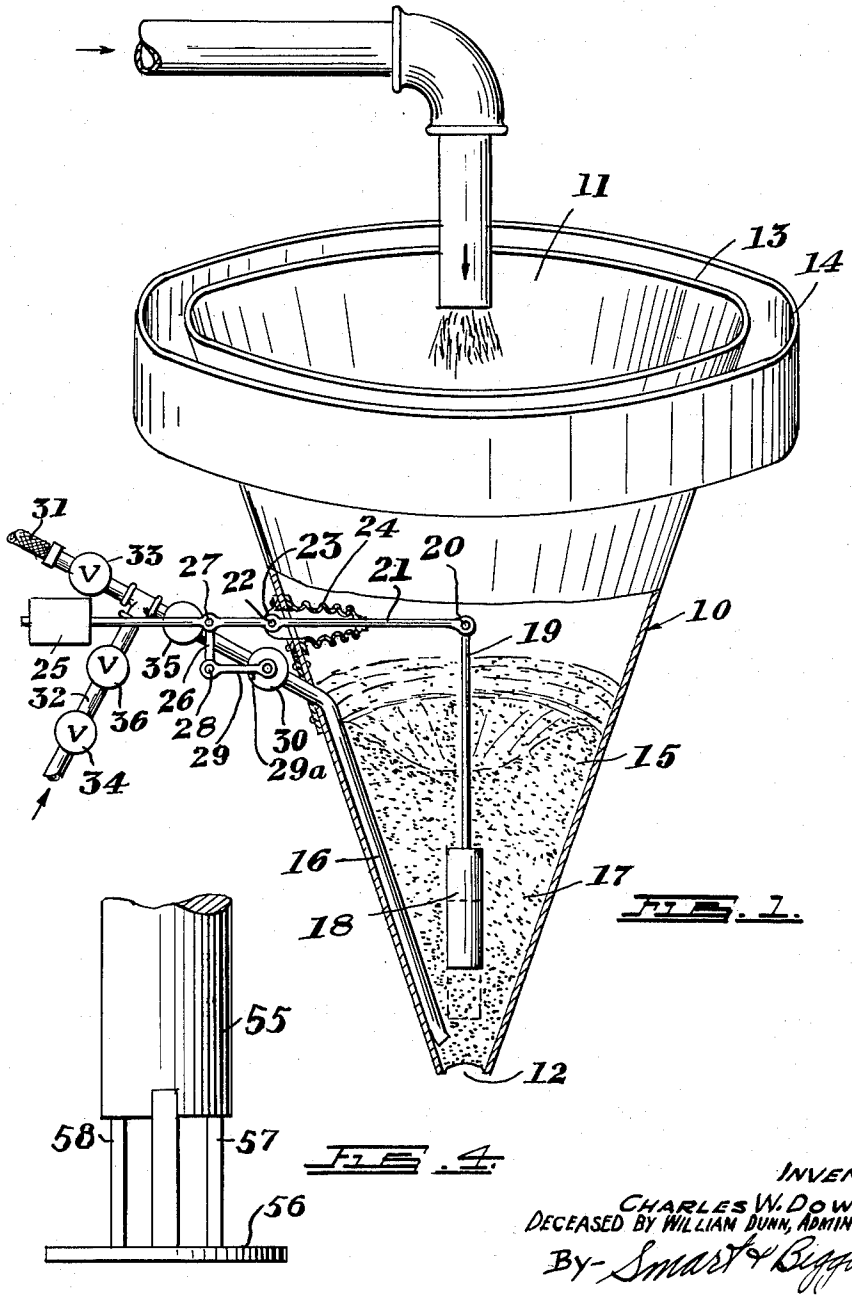


FIG. 1.

FIG. 4.

INVENTOR
CHARLES W. DOWSETT
DECEASED BY WILLIAM DUNN, ADMINISTRATOR
By- Smart & Biggar
ATTORNEYS

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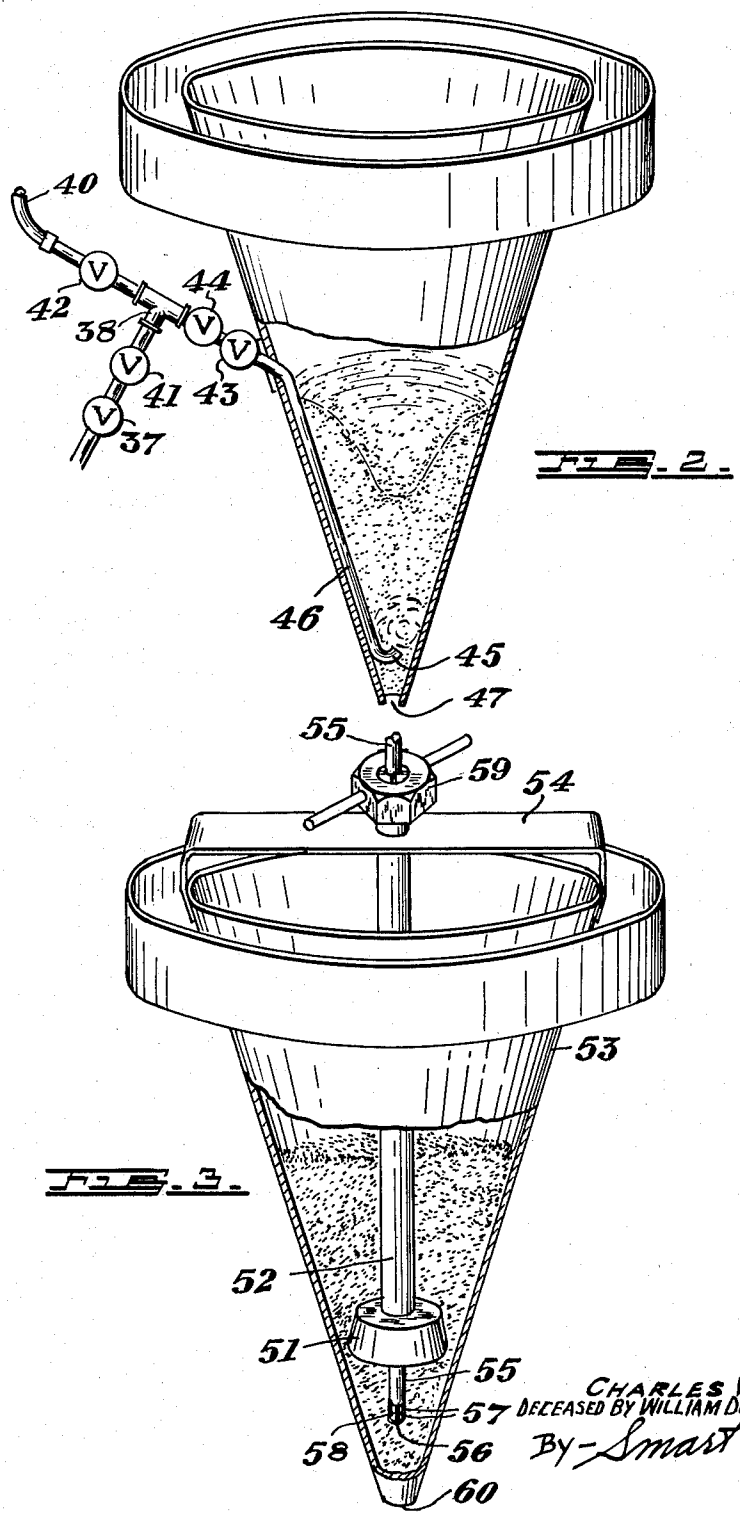


FIG. 2.

FIG. 3.

INVENTOR
CHARLES W. DOWSETT
DECEASED BY WILLIAM DUNN, ADMINISTRATOR
By - Smart & Biggar
ATTORNEYS

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APPARATUS FOR CONTROLLING THE GRAVITY DISCHARGE OF DESLIMING CONES

Charles William George Dowsett, deceased, late of Toronto, Ontario, Canada, by William Dunn, administrator, Toronto, Ontario, Canada

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8 Claims. (Cl. 137—92)

This invention relates to pulp thickeners, deslimers, settling tanks and the like, and more particularly it relates to apparatus for controlling the delivery of thickened or dislimed material from cones whereby to provide a relatively constant discharge of material therefrom.

Desliming cones have been in use for many years in various applications where it is desired to reduce either the water content of pulps or the quantity of extremely fine material (i. e. slime) present therein. Highly satisfactory results have been achieved with apparatus of this nature by providing for intermittent discharge of the thickened pulp. Continuous discharge in such apparatus has invariably led to unsatisfactory results because of the tendency of the solid material to cling to the walls of the apparatus or plug the outlet opening.

In most cases intermittent discharge is satisfactory, but in certain instances, notably where the thickener or deslimer is followed immediately in the circuit by a tube mill or other circuit component requiring a relatively constant feed to ensure efficient operation, continuous discharge of the desliming apparatus is highly desirable, for in its absence, it is essential to provide some means for converting the intermittent discharge into a continuous feed for such circuit components. Since thickened pulp is a most difficult medium to handle, the provision of such components is expensive and necessarily adds materially to the cost of the operation.

The invention provides a novel apparatus which ensures a continuous regulated discharge from desliming cones and the like enabling the discharge to be fed directly into a tube mill or other circuit component requiring a substantially constant feed, and eliminating the necessity for additional components in the circuit for providing such constant feed.

Conventional design of an apparatus of this character demands an outlet opening which is smaller than will permit free discharge of the settled material as fast as it is deposited, and discharge is accomplished by admitting a controlled amount of fluid in the region of the outlet to thin the settled material just sufficiently to permit its discharge.

The control of the rate of discharge of the apparatus is complicated by the fact that whereas when the settled material is thinned to fluidity by the added water in the region of the outlet its flow, following the usual hydraulic laws, will increase as the static pressure in the region of the outlet increases, the settled material before thinning does not behave like a fluid and tends to bridge between the converging sides of the apparatus and support the column of fluid and deposited material. It will readily be appreciated therefore that during discharge of the apparatus the static pressure of the fluid at the discharge opening will be less than the total head of liquid, due to the retarding action of the settling bed as it tends to bridge between the converging sides of the apparatus. When discharge increases, however, the upper surface of the settling bed is lowered, and since the extent of the retarding action above referred to is a function of the depth of settled material, any decrease in the depth of the bed will result in an increase of the static pressure in the region of the outlet opening, which in turn will result in a tendency to increase the rate of discharge. Thus, unless control of some sort is present, the apparatus will tend to empty itself of settled material with increasing rapidity. Up until the present time, control of the discharge of this type of apparatus has been carried out manually with an operator controlling a valve which admits the water near the discharge opening of the apparatus, or use has been made of automatic intermittent discharge means which consists essentially of metering devices arranged to shut off the flow of fluidifying water each time a given quantity of material has been discharged.

It has been now found that use may be made of a characteristic force which is present in all apparatus of the type described to control the discharge thereof in a substantially uniform continuous manner while maintaining the level of settled material within the apparatus reasonably constant. The force of which use has been made in this invention results from the downward movement during the discharge of the apparatus of the settled bed itself arising from the continuous fresh deposit of material on the top thereof and discharge of material from the bottom thereof. The rate of movement becomes more pronounced as each individual particle moves from the surface of the bed in the direction of the outlet opening owing to the reduction in cross sectional area of the apparatus, the particles being thus squeezed together and becoming increasingly dewatered in their downward progress. The force tending to maintain this downward movement, once started, is considerable and is generally referred to as the "drag," possibly because of the fact that it will grip with considerable force any article which is lowered into the bed while discharge of the apparatus is taking place. As used herein the word drag refers to the downward force produced in the above manner upon any obstruction to the downward flow of dewatered material which is present in the cone.

According to the invention, the liquid which is introduced in the region of the outlet of the apparatus is provided with a predetermined head of pressure, and the "drag" is utilized to control the rate of discharge by reducing the influx of liquid in accordance with the magnitude of the drag force. In the first instance, a plug may be suspended within the bed, balanced with a counterweight and so positioned that drag upon the plug above a given magnitude will move the latter downwardly to operate a valve to reduce the influx of water in the region of the outlet opening. In the second instance, the outlet for the fluidifying liquid is modified and positioned in such a manner that the downwardly moving bed itself applies a force on the outlet restricting the supply of fluid in proportion to the extent of the force thus applied. Each of these systems of carrying out the invention has its own advantages. In the first system, for instance, the outlet for the fluidifying liquid may be placed in a fixed position adjacent the outlet opening of the apparatus, and the mechanical means may then be adjusted to provide for uniform discharge having regard to the rate of feed to the apparatus and the characteristics of the pulp which is being treated. In the second instance, the level at which the fluidifying liquid is introduced is itself adjusted until the outlet is located at a level where the "drag" is of the correct order of magnitude to exert a suitable influence upon the supply of fluidifying liquid to provide for a substantially constant discharge under the conditions of operation of the apparatus.

A number of embodiments of the apparatus according to the invention are described in detail in the following specification with reference to the accompanying

drawings, and the invention will be more clearly understood from a consideration of the description of these illustrative embodiments.

In the drawings:

Figure 1 is a perspective view, partly broken away of a desliming cone incorporating an embodiment of the invention,

Figure 2 is a perspective view partly broken away to illustrate interior structure of a desliming cone embodying a further form of apparatus according to the invention,

Figure 3 is a perspective view partly broken away to illustrate interior components of a desliming cone incorporating a preferred embodiment of the invention used in conjunction with means for maintaining a substantially level settled bed surface, and

Figure 4 is a fragmentary detail of the outlet portion of the pipe shown in Figure 3.

Referring more particularly to the drawings, the embodiment of the invention illustrated in Figure 1 is mounted on a desliming cone **10** which is of generally conventional design. Pulp is fed to the top **11** of the cone. Thickened pulp is withdrawn from the cone through the outlet orifice **12** at the bottom thereof, while water and suspended lighter and finer material overflow the periphery **13** at the top of the cone into the collar-launder **14** from where it is carried away for further treatment. The heavier and coarser material sinks in the cone and becomes increasingly dewatered until it reaches some point at approximately **15** where it becomes almost completely dewatered by settlement. The state of dewatering at this point may be expressed by saying that the solid particles are in contact with each other, but the spaces are filled with water. The discharge orifice **12** at the bottom of the cone is of a size which is quite insufficient to pass the required volume of pulp in the above dewatered condition, but it is capable of passing the desired amount of pulp after suitable dilution by water discharged from the pipe **16**. The thick bed **17** of dewatered material wedged in between the coverging walls of the cone moves slowly downward as material is discharged from the orifice **12**. Centrally suspended in the cone within the bed **17** is the cylindrical plug **18** supported by the rod **19** which is pivoted at **20** to the lever arm **21**. The lever arm **21** is pivoted at **22** to a bracket **23** supported on the side wall of the cone **10**, escape of fluid being prevented by a suitable flexible bellows **24**. On the free end of the lever arm is the adjustable counterweight **25**. The link **26** is pivoted at **27** to the lever arm **21** and pivoted at **28** to the arm **29** which actuates the valve **30**, which valve controls the flow of water through the pipe **16**. It will be seen that any movement up or down of the plug **18** will rotate the lever arm **21** and alter the setting of the valve **30**.

As explained previously, the dewatered material moving downwardly in the bed **17** tends to bridge somewhat between the converging walls of the cone **10** and to some extent support the column of fluid above it. Thus the static pressure at the lower end of the pipe **16** will normally be less than it would be if there were no bed **17** of dewatered material in the cone. The extent of the difference depends upon the depth of the bed **17** and the rate of downward movement thereof.

However, if the water delivered by pipe **16** is delivered at constant pressure, the amount of water delivered by it will become greater as a static pressure within the cone in the region of the end of pipe **16** becomes less, as it does whenever the rate of discharge through orifice **12** increases. It will be appreciated, however, that the greater the downward velocity of materials within the bed becomes, the greater will be the grip with which the bed **17** grips the cylindrical plug **18** and tends to move it downwardly to the position indicated in the dotted lines. Should this downward force on the plug **18** more than balance the weight **25** on the lever arm **21**, the plug will actually move downwardly pulling with it the lever arm **21** and through the medium of the link **26** moves the valve arm **29** which actuates the valve **30** to reduce the flow of fluid through the pipe **16**. This in turn will decrease the discharge of material through the orifice **12**.

It will readily be observed that by appropriate adjustment of the position of the weight **25** on the outer end of the lever arm **21** the discharge from the orifice **12** may be maintained at any desired level.

In order to provide a constant pressure at the lower end of the pipe **16**, use is made of a flexible hose **31**. The water is supplied through the pipe **32** and with the valves **33** and **34** open, the valves **35** and **36** are adjusted to permit an appropriate flow of water through the pipe **16**, the top end of the hose **31** being adjusted to provide an appropriate head of pressure at the lower end of the pipe **16**. When in the position illustrated, the valve **30** is fully open with the valve arm **29** resting against the stop **29***a* and the discharge of material through the orifice **12** will, therefore, build up until a point is reached where the drag on the plug **18** more than balances the weight **25**. If a lesser rate of discharge is required, the weight **25** may be moved inwardly and conversely, should a greater rate of discharge appear desirable, the weight **25** may be moved outwardly.

Regarding the hose **31** when the line supply valves **34** and **36** are open to a limited extent, and the valve **33** is closed, the pressure behind any water in the pipe **16** will be the full line pressure. When, however, the valve **33** is open as it is during normal operation, the effective pressure driving the water down pipe **16** can be no greater than a pressure corresponding to a column of water having a height which is equivalent to the difference in height between the bottom of tube **16** and the end of the hose **31** under static conditions or under conditions of flow the same pressure plus the resistance to flow of the hose **31**. As the flow through the pipe **16** is never very great, it can for practical purposes be taken that the effective pressure at the bottom of pipe **16** is governed by the height of the end of the hose **31**. The hose, therefore, is effectively a pressure limiting device and has the same function as an overflow tank in this regard. A hose is generally used rather than an overflow tank because it is convenient to be able to adjust the height of the end of the hose by simple manual adjustment.

In the cone illustrated in Figure 2, substantially dewatered material is discharged through the outlet opening **47**, and as in the case of the cone illustrated in Figure 1, this discharge orifice is of insufficient diameter to discharge the material in its dewatered condition, and it is necessary to dilute the pulp at this point with a small amount of water discharged into it through end **45** of the pipe **46**. In this embodiment of the invention application of the drag force to restrict the influx of diluent is accomplished in a very simple manner merely by bending the end **45** of the pipe **46** upwardly, so that at least a portion of the force produced by the downward movement and wedging between the walls of the cone of the particles in the bed is applied against the pressure head of water in the pipe **46**. In this manner, an increase in discharge from the orifice **47** will tend to decrease the delivery of water from the lower end **45** of the pipe **46**, while a decrease in discharge will tend to increase the flow through the pipe **46**, the result being that the discharge will tend to remain constant at a rate which is governed by the height of the free end of the hose **40**, and the position of the lower end **45** of the pipe **46**.

In operation, the valve **37** will be set in a position which permits the passage of sufficient water at all times, and the valves **42**, **43** and **44** will be open, the valve **41** being used to shut the water supply off whenever it is desired to do so, and the valve **42** only being closed when it is desired to apply the full pressure head of the water

supply to the pipe 46, for instance, when the end 45 thereof becomes clogged.

Figure 3 shows a preferred form of the invention illustrating an arrangement whereby it may be combined with a suspended diaphragm designed to insure substantially uniform settling of the dewatered material on all sides of the cone.

This apparatus comprises the frustro conical diaphragm 51 which is secured to the lower end of the tube 52 which is freely suspended to hang centrally within the cone 53 from a strap 54 extending across the top of the cone 53. The diaphragm 51 is at its base, of somewhat smaller diameter than the diameter of the cone 53 at the height at which the diaphragm is suspended, and the function of the diaphragm is to permit an even downflow of the bed from all sides of the cone. It will be appreciated that should the cone discharge more freely on one side thereof the weight of the bed acting upon the frustro conical surface of the diaphragm 51 on the other side will force the diaphragm laterally tending to increase the area available for discharge immediately below that portion of the bed whose discharge has been retarded. Passing downward centrally through the tube 52 is the delivery pipe 55 which is provided with a water supply of constant head, for instance, of the same type illustrated in Figures 1 and 2. Instead of having an upturn at its lower end, the delivery pipe 55 has connected to it the circular plate 56 by means of the three small straps 57 leaving a space 58 for delivery of water between the plate 56 and the end of the delivery pipe 55. The vertical position of the end of the pipe 55 within the cone is adjustable, for instance, by means of the turn buckle 59 which is arranged to engage a screw threaded portion of the pipe 55 and support the latter in fixed position by resting upon the top of the tube 52. In operation, the impingement of the downwardly moving bed upon the plate 56 causes a reaction against the fluid pressure at the end of the delivery pipe 55 which is similar in all respects to that produced in the case of the apparatus illustrated in Figure 2. Since the "drag" will be greater the nearer the plate 56 is to the outlet opening 60 the extent of the effective reduction of delivery of the delivery pipe 55, which will be caused by any given rate of discharge through the discharge opening 60, will be greater the lower end of the pipe 55 is situated, and appropriate adjustment of the equipment to produce conditions of equilibrium at any given rate of discharge can be accomplished by raising or lowering the delivery pipe 55 by adjusting the turn buckle 59. The rate of discharge may then be adjusted in the manner previously explained by increasing or decreasing the static head of fluid within the delivery pipe 55.

The apparatus illustrated in Figure 3 has the added advantage in that there is a relatively small zone within the lower end of the cone within which the end of the delivery pipe should be situated to produce satisfactory results under given conditions, and the feature of the ease of adjustment of the position of the end of the delivery pipe in the last described apparatus is, therefore, an important advantage affording a wider versatility in operation for an apparatus of any particular design. The apparatus of Figure 2 may be modified to provide for a similar adjustment by carrying the delivery pipe 46 out the top of the cone rather than through the side thereof as illustrated.

It will be observed that the three embodiments of the invention which have been described all perform their function according to the same general principle, that is to say, they all control the amount of water which is introduced to dilute the pulp at the discharge opening of the apparatus by utilizing the "drag" of the downwardly moving bed of dewatered material. It makes no difference whether the "drag" is used indirectly through a mechanical hook-up as indicated in Figure 1 or directly against the water pressure at the outlet end

of the pipe which introduces the diluted water as illustrated in Figures 2 and 3. It will be appreciated moreover that the principles of the invention are of wide application and apply broadly to the control of discharge of any mineral pulps from the bottom of conical settling tanks.

In the foregoing, there has been illustrated the adjustment of the static head within the delivery pipe by means of a flexible hose, but it will be appreciated that there are many devices for accomplishing the same object and any of these would be just as satisfactory for purposes of the invention. Moreover, while there has been described a number of ways in which the invention may be put into practice, it will be appreciated that the samples of the invention described are illustrative only, and there are in fact many modifications to the apparatus disclosed which will provide equivalent results.

What is claimed is:

1. Apparatus for the automatic control of the gravity discharge of settled materials in desliming cones and the like comprising, an outlet orifice on said cone of insufficient diameter to pass the settled materials at the desired rate, a pipe extending into the cone and terminating adjacent said outlet orifice, means for supplying water through said pipe under a predetermined constant head of pressure and means for applying drag produced by downward movement of settled materials within said cone to reduce the volume of water delivered by said pipe when the drag increases and vice versa.

2. Apparatus for the automatic control of the gravity discharge of settled materials in desliming cones and the like comprising, an outlet orifice on said cone of insufficient diameter to pass the settled materials at the desired rate, a pipe extending into the cone and terminating adjacent said outlet orifice, means for supplying water through said pipe under a predetermined constant head of pressure and an upturned portion at the end of said pipe arranged to deliver water therefrom in a direction opposed to the drag produced by downward movement of settled materials within said cone to reduce the volume of water delivered by said pipe when the drag increases and vice versa.

3. Apparatus for the automatic control of the gravity discharge of settled materials in desliming cones and the like comprising, an outlet orifice on said cone of insufficient diameter to pass the settled materials at the desired rate, a pipe extending into the cone and terminating adjacent said outlet orifice, means for supplying water through said pipe under a predetermined constant head of pressure and an outlet at the end of said pipe arranged to deliver water therefrom in opposition to the drag produced by downward movement of settled materials within said cone to reduce the volume of water delivered by said pipe when the drag increases and vice versa.

4. Apparatus for the automatic control of the gravity discharge of settled materials in desliming cones and the like comprising, an outlet orifice on said cone of insufficient diameter to pass the settled materials at the desired rate, a substantially vertical pipe extending into the cone and terminating adjacent said outlet orifice, means for supplying water through said pipe under a predetermined constant head of pressure and a substantially horizontal plate secured to the end of said pipe in spaced juxtaposition thereto whereby to cause the delivery of water therefrom to oppose the drag produced by downward movement of settled materials within said cone to reduce the volume of water delivered by said pipe when the drag increases and vice versa.

5. Apparatus for the automatic control of the gravity discharge of settled materials in desliming cones and the like comprising, an outlet orifice on said cone of insufficient diameter to pass the settled materials at the desired rate, a pipe extending into the cone and terminating adjacent said outlet orifice, means for supplying water

through said pipe under a predetermined constant head of pressure, an outlet at the end of said pipe arranged to deliver water therefrom in opposition to the drag produced by downward movement of settled materials within said cone to reduce the volume of water delivered by said pipe when the drag increases and vice versa, and means for adjusting the level of the end of said pipe within said apparatus.

6. Apparatus for the automatic control of the gravity discharge of settled materials in desliming cones and the like comprising, an outlet orifice on said cone of insufficient diameter to pass the settled materials at the desired rate, a substantially vertical pipe extending into the cone and terminating adjacent said outlet orifice, means for supplying water through said pipe under a predetermined constant head of pressure, a substantially horizontal plate secured to the end of said pipe in spaced juxtaposition thereto whereby to cause the delivery of water therefrom to oppose the drag produced by downward movement of settled materials within said cone to reduce the volume of water delivered by said pipe when the drag increases and vice versa, and means for adjusting the level of the end of said pipe within said apparatus.

7. Apparatus as defined in claim 1 wherein the means for supplying water through said pipe under a predetermined constant head of pressure comprises; a water supply connected to supply water to said pipe; and a flexible hose one end whereof is connected to said pipe, the other end whereof is free, whereby the pressure head existing at the end of said pipe in said apparatus always corresponds to the height of the free end of said hose when sufficient water is supplied to cause water to flow out said free end.

8. In a desliming cone; an outlet orifice of insufficient diameter to pass dewatered material at the required rate; a pipe extending into said cone and terminating in the region of said outlet orifice; means for supplying water through said pipe at a predetermined constant pressure; a plug suspended centrally within said cone in position to lie within settled dewatered materials deposited therein during normal operation of the cone; a valve arranged to control flow of fluid through said pipe; a centrally pivoted lever arm extending through the side of said cone, one end of said lever arm supporting said plug; an adjustable counterweight mounted on the other end of said lever arm; and mechanical linkage means connecting said lever arm to said valve, said linkage means being arranged to actuate said valve to reduce flow of water through said pipe when said plug moves in a downward direction under the influence of drag produced by downward movement of settled materials in said cone.

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