April 15, 1947. H. HARDINGE 2,418,973

THICKENER

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FIG. 1.

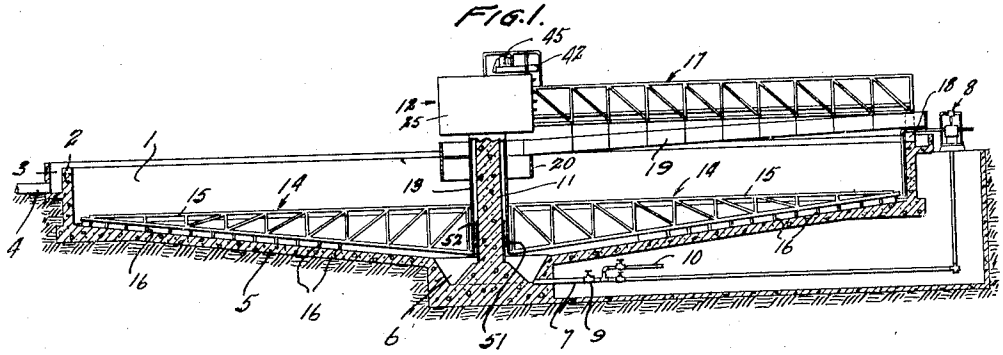
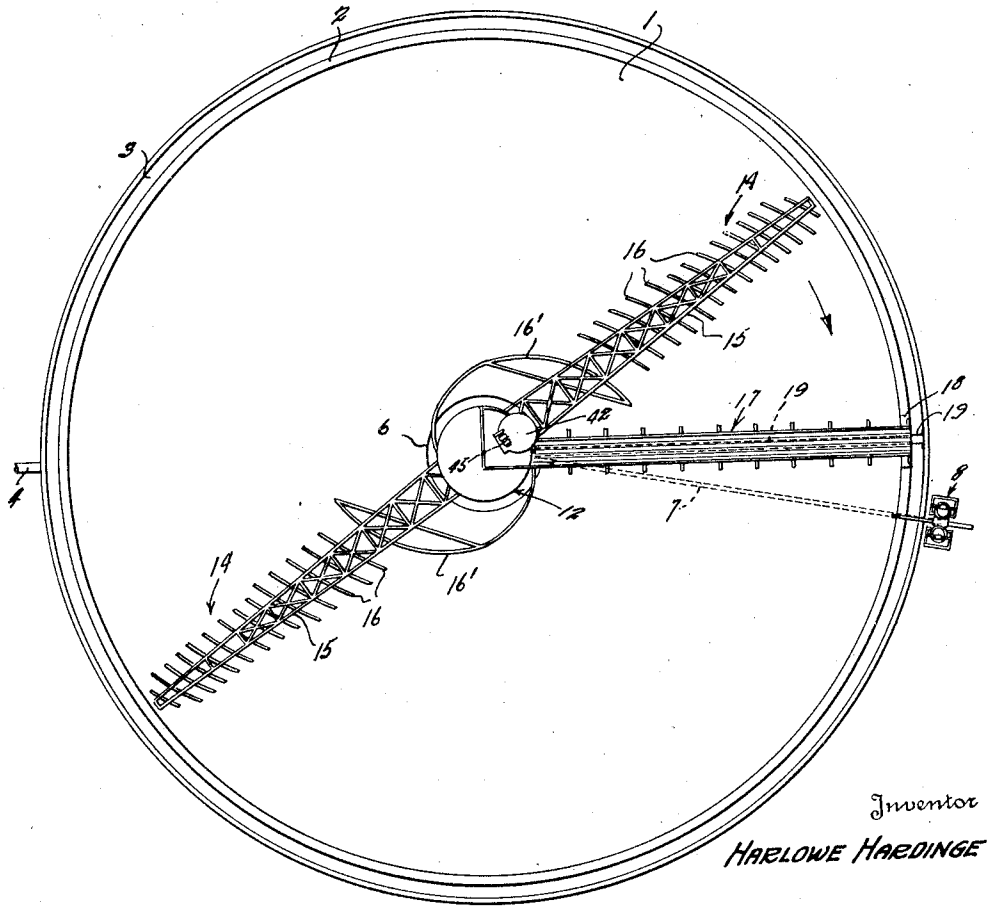


FIG. 2.



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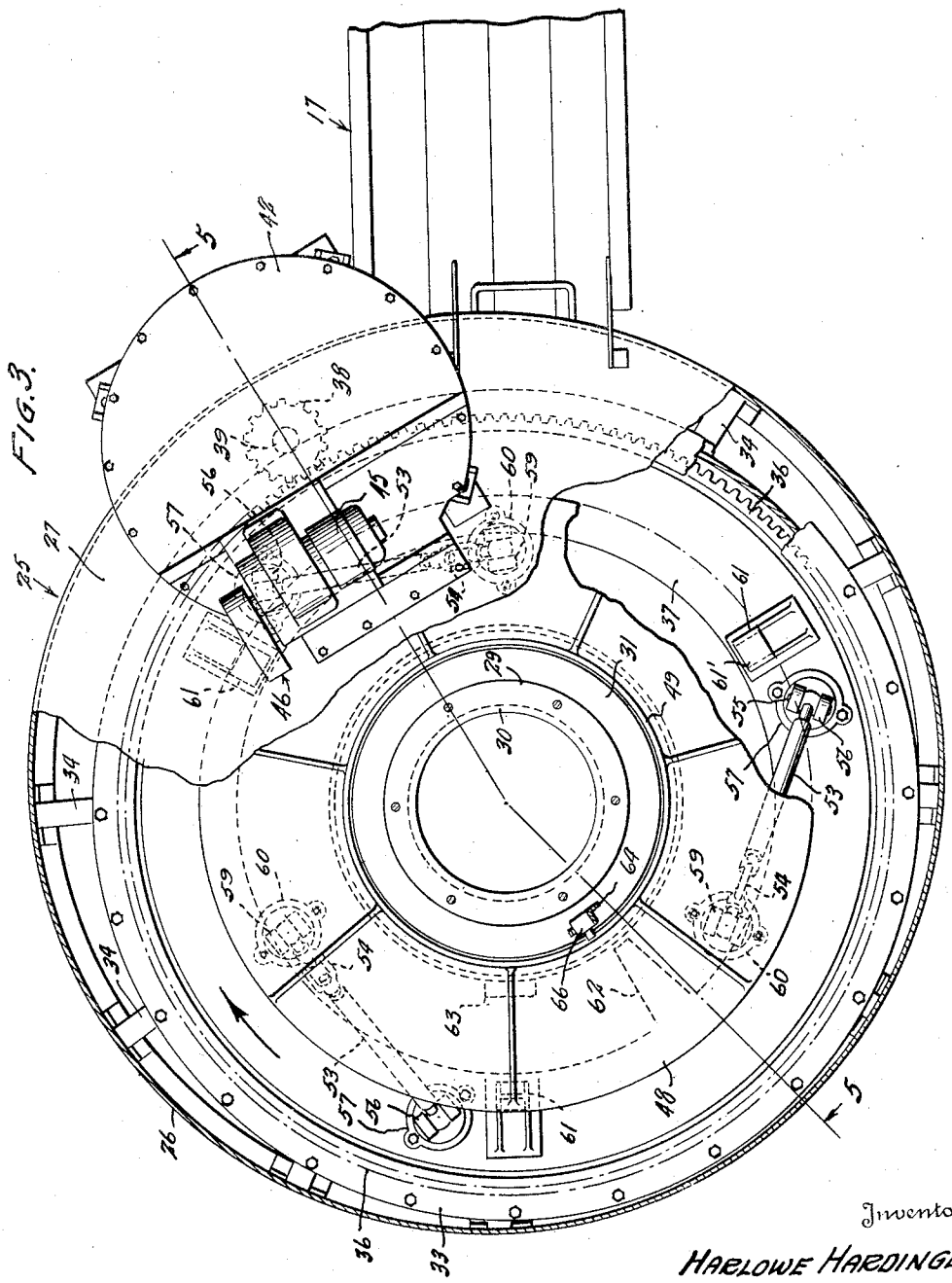
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FIG. 3.



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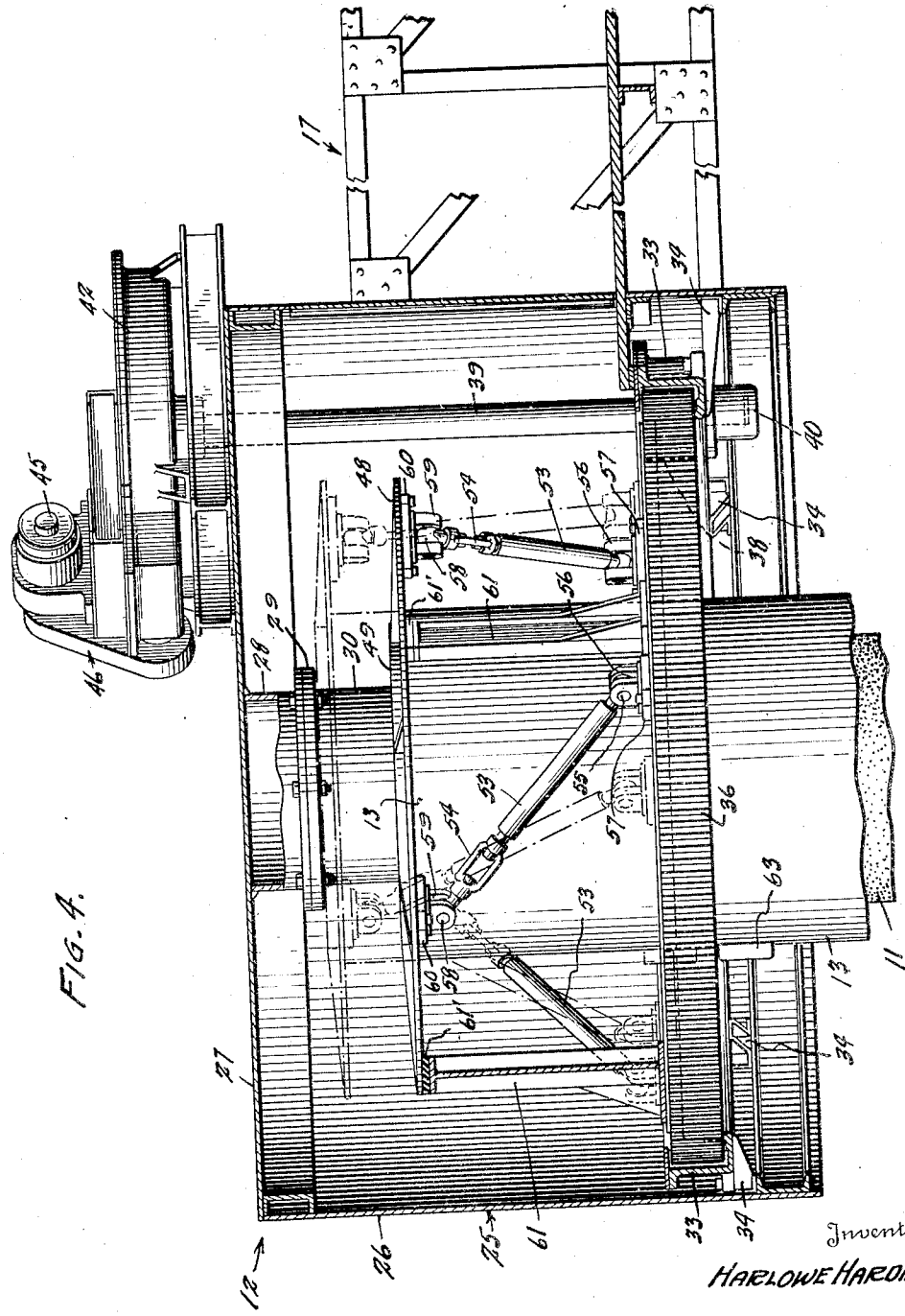


FIG. 4.

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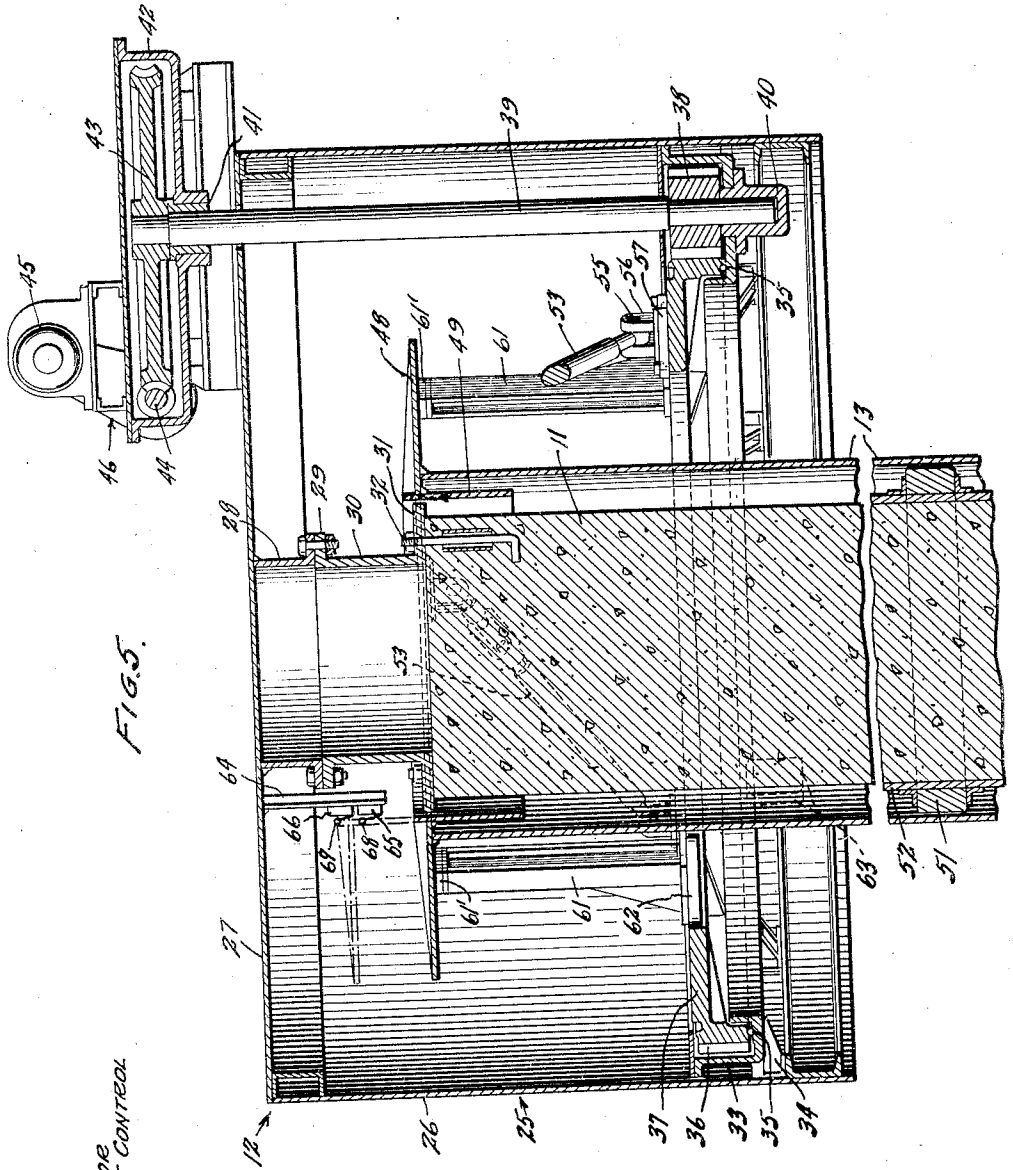


FIG. 5.

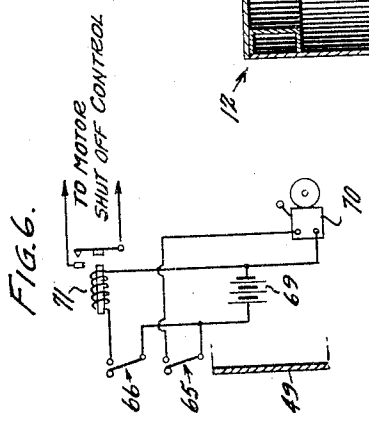


FIG. 6.

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Patented Apr. 15, 1947

2,418,973

UNITED STATES PATENT OFFICE

2,418,973

THICKENER

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Application February 18, 1942, Serial No. 431,438

5 Claims. (Cl. 210—55)

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The present invention relates generally to sedimentation apparatus of the thickener type and specifically to mechanism for relieving strains on the moving parts of such apparatus. While the principle underlying this invention is particularly adaptable to center pier thickeners employing a central method of driving the scrapers, its application is not limited to such apparatus but is equally applicable to the so-called truss construction or thickener using beams supported at the tank rim.

In the thickening operation, large masses of solids often accumulate in the tank, sometimes due to clogged sludge discharge or sludge discharge of insufficient capacity; at other times these solids build up on the sides of the tank and the scrapers, then drop off, causing a massive bank of material in the path of the scrapers. Still again, a heavy tool or other foreign substances may be dropped into the tank. In all cases when such an obstruction occurs, an overload is placed on the scraping mechanism often resulting in complete breakdown of the machine before the obstruction can be removed.

Various attempts have been made in the past to overcome this difficulty by raising the scrapers or a portion of the scrapers above the obstruction, but in all cases, in my knowledge, the designs for these strain-relieving mechanisms have had inherent disadvantages.

The principal object of my invention is therefore to provide means having a maximum operating efficiency and adapted to relieve the strains imposed on the scraping mechanism of sedimentation apparatus and thereby preventing costly breakdowns and interruptions to operations, as well as permitting a design using known maximum force requirements.

Another object is to provide a mechanism for raising the scraping rakes in thickening apparatus that will function only when a certain minimum overload has been placed on said rakes.

Yet another object is to provide a mechanism for raising the rakes which will allow the rakes to function normally until a substantial overload has been imposed on them and then cause the rakes as a unit to move vertically upwardly when an immovable obstruction is encountered by the rakes.

Another important object is to provide means which impart torque to the rakes of a thickener and also function to raise the rakes as a unit when an overload is placed on them, said means producing a raising force which increases progressively as the rakes are raised.

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A further object is to provide warning means operable at a predetermined height of the rake to indicate a serious overloaded condition of the thickener and additional means to stop operation of the thickener should this overload not be relieved.

Other objects and advantages will be apparent to those skilled in the art from the following description and by reference to the accompanying drawings.

In the drawings:

Figure 1 is a transverse sectional view of a thickener which incorporates my improvements;

Figure 2 is a plan view of the apparatus shown in Figure 1;

Figure 3 is a plan view, partly broken away, of the operating mechanism;

Figure 4 is a transverse sectional view through the mechanism housing showing the operating mechanism in side elevation;

Figure 5 is a transverse sectional view taken along the line 5—5 of Figure 3 looking in the direction of the arrows; and

Figure 6 is a simplified diagram of the electrical connection to the warning and shut-off devices.

Briefly, my invention comprises an annular sedimentation tank in the center of which is a vertical pier or column which supports a cylindrical housing. Carried by the housing and revoluble therein is a flanged ring gear driven at reduced speed by an electric motor mounted on the housing. A torque tube surrounds the column and has one of its ends externally flanged and projecting through and above the plane of the ring gear. The opposite end of the torque tube has attached thereto the scraping rakes of the thickener which are adapted to move settled sludge toward the center of the tank.

Between the flanges of the ring gear and the torque tube, and attached thereto for universal movement, are a plurality of push rods disposed at equal acute angles to the planes of the flanges. These rods are adapted to impart the torque of the ring gear to the tube and thence to the rakes, giving them a rotary movement in the tank. However, should a load occur in the tank which is incapable of being moved by the normal operating position of the rakes, which is adjacent the bottom of the tank, the angle of these push rods is increased by the driving torque of the gear, resulting in a vertical displacement of the torque tube relative to the gear and consequent raising of the rakes to a more fluid stratum of the sludge.

The normal angle of the push rods is of such degree that the rods will produce only their torque imparting function to the rakes until a considerable force has been imposed thereon before they will be displaced to raise the rakes. However, once this overload point is reached, the raising force imparted by the rods increases rapidly as they approach the vertical. This arrangement maintains the rakes at their normal operating level until an obstruction which would cause a serious overload on the rakes and drive has occurred. However, after such overload has been imposed, the rakes will rise quickly and easily above the obstruction.

Stops are provided to limit both the upward and downward movement of the torque tube.

A pair of superposed electric, circuit closing, switches are positioned in the path of vertical movement of the torque tube to be operated thereby when the tube approaches the limit of its upward movement. The lower of these switches operates an audible alarm to indicate to the operator of the machine a dangerous overload. The upper of the switches is adapted to be contacted by the torque tube should it rise above the first switch and functions to stop the driving motor of the machine.

As illustrated in Figures 1 and 2, the sedimentation apparatus comprises a settling tank 1 having an annular vertical side wall 2, the rim of which is provided with an overflow trough 3 adapted to be drained by an effluent conduit 4. The bottom 5 of the tank is conical and has at its apex an annular discharge basin 6, having in communication therewith, a discharge pipe 7 connected with a diaphragm pump 8. A control valve 9 is interposed in the pipe 8 for controlling the rate of discharge. A high pressure water line 10, likewise valve-controlled, is also connected into the discharge line 7. This facilitates the discharge of solids through line 7.

Projecting upwardly from the bottom 5 and concentric with the side wall 2 is a vertical pier 11 which supports a superstructure 12, which carries the operating mechanism for the thickener and which will be described in detail later.

Surrounding the pier 11 is a torque tube 13 having rigidly attached to the lower end thereof a plurality of plows or rakes indicated generally as 14. These rakes are adapted to rotate around, and are also capable of vertical movement with respect to, the pier 11. The rakes may be of any suitable construction but, as illustrated, each comprises a trussed arm 15 extending radially from the torque tube 13. The lower beams of the arms 15 are angularly disposed to correspond to the conical angle of the tank bottom 2 and are provided with a series of angular scrapers 16. Supplemental spiral scrapers, as indicated at 16', may also be attached to the arms 14. The scrapers 16 and 16' are adapted to move adjacent the bottom 2 when the rakes 14 are in their normal operating position to move settled sludge toward the basin 6.

Access to the superstructure 12 is obtained by means of a catwalk 17 supported at one end by the superstructure and at the other by a pier 18 carried on the rim of the wall 2. Suspended beneath the catwalk 17 is an influent launder 19 adapted to feed material to the tank 1 through a stilling well 20 with which the inner or discharge end of the launder 19 connects.

As stated above, the superstructure 12 carries the driving mechanism for the scrapers. This superstructure comprises a housing 25, Figure 5,

composed of a cylindrical side wall 26 and a top 27 attached thereto. Projecting downwardly from the center of the top 27 is a flanged tube 28 secured to an upper flange 29 of a second tubular member 30 which is provided at its lower extremity with a substantially wide flange 31. The tube 30 is attached to the upper end of the pier 11 by means of anchor bolts 32 which pass through the flange 31.

Carried within the housing 25 near its lower end is a ball race 33 suitably attached to the cylinder 26 by means of brackets 34. The race 33 is provided with balls 35 which support for antifrictional movement a ring gear 36 which is provided with an internal flange 37. The gear 36 is adapted to mesh with a pinion 38 attached to one end of a shaft 39, the lower end of which is supported in a bearing 40.

The shaft 39 extends through the top member 27 of the housing and is journalled in a bearing 41 of a gear housing 42. The housing 42 contains a worm gear 43 which is attached to the extreme upper end of the shaft 39 and meshes with a worm 44. The worm 44 is driven by a geared motor 45 by means of a chain drive indicated generally as 46.

The torque tube 13 which, as stated, carries the scrapers 14 at its lower end, surrounds the pier 11 and is disposed concentric with the ring gear 36 and has rigidly attached to its upper end an annular flange 48, to the inner circumference of which is fastened a depending sleeve 49 which is concentric with the tube 13. The inside diameter of the sleeve 49 is approximately the diameter of and surrounds the flange 31 of the tube 30 and forms therewith a slide bearing for aligning the upper end of the torque tube 13.

A second slide bearing member 51 is attached to a sleeve 52 secured, as is shown in Figure 1, to the lower end of the pier 11. This bearing member 51 concentrically aligns the lower end of the tube 13 with the pier and, together with the sleeve 49, provide for substantially vertical movement of the torque tube 13.

To transmit the rotational movement of the gear 36 to the tube 13 I provide a plurality of push rods 53. These push rods are arranged circumferentially and equidistant around the torque tube 13 between the gear flange 37 and the torque tube flange 48. As shown in Figure 3, three of such rods are employed. However, more or less may be used depending on the size and operating conditions of the thickener.

The push rods 53 are provided with turnbuckles 54 for longitudinal adjustment and their lower ends are pivotally mounted in bifurcated eye members 56 which, in turn, are swivelly held in annular rings 57 securely attached to the upper face of the flange 37 of the gear 36. The upper end of the rods 53 are similarly pivotally attached as at 58 into eye members 59 swivelly attached as at 60 to the underside of the torque tube flange 48. These push rods are disposed at an acute angle to the planes of the gear flange 37 and the torque tube flange 48 and are inclined toward the direction of rotation of the gear 36. By means of the pivotal and swivelling connections of the rod 53 to the driving gear 36 and the flange 48, they are capable of angular displacement with respect to these members.

As shown in Figure 4, the full line position of these push rods 53 indicates their angle for normal operation of the scrapers 14, that is, when the scrapers move adjacent the bottom of the tank 1. This position is maintained so long as

the downward force exerted by the weight of the rakes and torque tube exceeds the drag imposed on the rakes by the sludge in the tank. The amount of this drag is dependent upon the mass density of the material in the tank through which the rakes must move. Should this density become so great as to overload the rakes, the torque of the driving gear **36** will cause the angle of the push rods **53** to increase as indicated by dot-dash lines in Figure 4, such increase in angle resulting in the raising of the torque tube and rakes above the plane of the tank bottom.

It will be observed that by inclining the push rods in the direction of rotation of the driving gear **36** their torque moment is greatest and their lifting moment least when the rakes are in their lowest or normal operating position. This lifting moment, however, rapidly increases with upward movement of the rakes.

Mounted on the upper face of the gear flange **37** are a plurality of support members **61** provided at their upper extremities with resilient pads **61'**. These pads **61'** are adapted to contact the outer edge of the flange **48** and serve as a limit stop for the lowest position of the rakes **14**. The length of the support member **61** is such that when the flange **48** is in contact with the pad **61** the rakes **14** will be in their normal operating position adjacent the bottom of the tank **1**. To provide a limit for the upward movement of the rakes **14**, rigid fingers **62** project radially inwardly from the flange **37** to a point adjacent the periphery of the tube **13**. The inner ends of these fingers **62** are in the path of movement of radial lugs **63** secured to the outer surface of the torque tube **13**. As will be seen from Figures 3 and 4, as the tube rises and revolves relative to the gear **36** to its extreme upper limit, the lugs **63** will contact the fingers **62** and thereby prevent any further displacement of the torque tube with respect to the driving gear.

Attached to the under face of the top member **27** of the housing **25** is a depending bracket **64**. This bracket **64** carries at its lower end a pair of superposed circuit-closing switches **65** and **66** provided with operating arms **67** and **68**, respectively. The bracket **64** is so positioned that the ends of the operating arms **67** and **68** will be in the path of movement of the upper end of the sleeve **49** to be contacted thereby as the torque tube **13** rises to its upper position. The lower of these switches **65**, that is, the first to be contacted by the sleeve **49**, completes the circuit, as is shown in Figure 6, from a source of current **69** to a warning device **70**, such as a bell. The upper of the switches **66**, adapted to be closed by the sleeve **49** after it has moved past the switch **65**, is adapted to complete the electric circuit from the source of current **69** to a relay **71** which, in turn, supplies electrical energy to stop the driving motor **45**.

In operation, liquid in which solids are suspended is fed to the tank **1** through the influent launder **19** where the suspended solids settle to the bottom of the tank. These solids are scraped inwardly toward the center discharge basin by means of the rakes **14** which slowly revolve over the bottom of the tank driven by means of the motor **45** through the medium of the gear **36**, push rods **53** and the torque tube **13**. The solids thus scraped are withdrawn from the basin through discharge line **7** by means of the pump **8**. Liquid in the tank overflows the rim into the trough **3** where it is withdrawn through the effluent conduit **4**.

During the sedimentation process solids sometimes build up in the center of the tank by insufficient discharge rate through the discharge line **7**. This may be caused by a clogged line, insufficient pumping rate, too high a rate of input or for other reasons. Also during the settling process, sludge may accumulate on the side walls of the tank and on the blades of the scrapers. When sufficient sludge has so built up, it will fall from these surfaces so as to cause a heavy deposit or bank of solids in the path of movement of the scrapers. Either or both of these extraordinary accumulations of solids, as well as any heavy foreign substance dropped into the tank, will cause an overload on the scrapers and their driving mechanism.

To permit of a reasonably heavy operating load for the machine whereby its full capacity may be utilized, a certain amount of such overloading must be permitted. However, should the overloading reach a degree that it would impose a serious strain on either the rakes or the operating mechanism, this overloading must be rapidly and easily relieved.

My novel arrangement of push rods angularly disposed in the direction of rotation of the driving gear will permit both of these functions, that is, maintain normal operating conditions of the rakes until a serious or substantial overload occurs, and then because of their inherent characteristics will cause the rakes to be moved rapidly with constantly increasing moving force above the obstruction from which point the rakes will either by their normal function gradually reduce this obstruction or will remain in this raised position until this obstruction is manually removed. Should the obstruction in the tank be such as to cause the rakes to move to their extreme upper limit, the sleeve **49** on the torque tube **13** will contact and close the switch **65** operating thereby an alarm to indicate to the operator of the machine that a serious obstruction has been formed in the thickener, which obstruction must be removed either by increasing the rate of discharge or clearing the discharge pipe or, if these fail, by manually removing the obstruction from the tank. If for some reason this obstruction is not removed—for instance, if the operator is engaged elsewhere or is incapable of rapidly removing the obstruction—the torque tube will continue to rise past the warning switch **65** and contact to close the switch **66**. When this switch is closed, circuit is completed to the control circuit of the motor **46** to stop this motor and stop the movement of the rakes.

Thus it will be seen I have devised an operating mechanism for sedimentation apparatus which has such characteristics as to permit operation of the apparatus at an optimum efficiency whereby the maximum capacity of the machine may be utilized.

In addition, the operating mechanism provides means for raising the rakes over a certain predetermined minimum obstruction in their path by utilizing the torque of the driving mechanism to also impart a lifting force to the rakes, which lifting force increases progressively with the amount the rakes are raised. Such mechanism allows the rakes to function in their normal operating position until dangerous strains have been imposed on them, but after such strains are imposed, it quickly and with progressive ease moves the rakes out of the path of such dangerous obstructions.

There is also provided mechanism cooperating with the above by which a warning alarm is

first given to indicate a dangerous obstruction which, if not removed, will cause the driving mechanism of the apparatus to stop.

While I have shown and described the preferred embodiment of my invention, I wish it to be understood that I do not confine myself to the precise details of construction herein set forth by way of illustration, as it is apparent that many changes and variations may be made therein, by those skilled in the art, without departing from the spirit of the invention, or exceeding the scope of the appended claims.

I claim:

1. Apparatus for treating liquid containing solids comprising a tank for the reception of a mixture of liquid and solids, a support mounted for rotary and vertical movement within the tank, blade members carried by the support and adapted to impart motion to said solids in the tank, a rotary driving member mounted for rotation coaxially with the support and in a fixed plane perpendicular to the axis of rotation of the support, means for actuating the driving member, push rods flexibly connecting the driving member and support, said push rods being inclined upwardly from the plane of rotation of the driving member and in the direction of rotation thereof for imparting a lifting force to the support to raise the same and the bladed members when an overload of solids is imposed on the latter.

2. Apparatus for treating liquid containing solids comprising a tank for the reception of a mixture of liquid and solids, a support mounted for rotary and vertical movement within the tank, blade members carried by the support and adapted to impart motion to said solids in the tank, a rotary driving member mounted for rotation coaxially with the support and in a fixed plane perpendicular to the axis of rotation of the support, means for actuating the driving member, longitudinally extensible push rods flexibly connecting the driving member and support, said push rods being inclined upwardly from the plane of rotation of the driving member and in the direction of rotation thereof for imparting a lifting force to the support to raise the same and blade members when an overload of solid is imposed on the latter, and means for adjusting the length of said push rods to thereby adjust the angle of inclination thereof with respect to the driving member.

3. Apparatus for treating liquid containing solids comprising a tank for the reception of a mixture of liquid and solids, a support mounted for rotary and vertical movement within the tank, blade members carried by the support and adapted to impart motion to said solids in the tank, a rotary driving member mounted for rotation coaxially with the support and in a fixed plane perpendicular to the axis of rotation of the support, means for actuating the driving member, push rods flexibly connecting the driving member and support, said push rods being inclined upwardly from the plane of rotation of the driving member and in the direction of rotation thereof for imparting a lifting force to the support to raise the same and the bladed members when an overload of solids is imposed on the latter, and cooperating stop members carried respectively by the driving member and support for limiting vertical movement of the support.

4. Apparatus for treating liquid containing solids comprising an annular tank for the reception of a mixture of liquid and solids, a vertical pier mounted centrally in said tank, a tubular torque member rotatable about the pier and movable axially with respect thereto, blade members carried by the lower end of the torque member and adapted to impart motion to the solids, a rotary driving member mounted for rotation in a fixed plane perpendicular to the axis of and intermediate the ends of the torque member, means for actuating the driving member, push rods flexibly connecting the driving member with the torque member adjacent the upper end thereof, said push rods being inclined with respect to the plane of rotation of said driving member and in the direction of rotation thereof for imparting a lifting force to said torque member and blade members to raise the same when an overload of solids is imposed on the blade members, and cooperating guide means associated with the pier and torque member for guiding the latter and blade members in substantially vertical movement.

5. A sedimentation apparatus comprising an annular tank for the reception of a mixture of liquid and solids, said tank having an inlet and an outlet, a vertical pier positioned axially within the tank, a tubular torque member mounted for rotational and axial movement with respect to the pier, a scraping device carried by the torque member adjacent the lower end thereof, for moving said solids toward the outlet, a supporting member carried by the pier, a horizontal driving member carried by the supporting member for rotation coaxially with the torque member, said driving member being capable of relative rotary movement with respect to the torque member, means for rotating the driving member, and push rods having a pivotal connection with both the driving member and torque member to rotate the latter, said push rods being inclined normally upwardly from the plane of the driving member and in the direction of rotation thereof, the angle of inclination of said push rods being increased upon relative rotary movement of the driving member with respect to the torque member due to the application of an overload of solids on said scraping device to impart a lift force to the torque member to raise the scraping device relative to said solids.

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