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[54] **SETTLING APPARATUS AND METHOD OF CONTROLLING THE OUTPUT THEREOF**
 4 Claims, 2 Drawing Figs.

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ABSTRACT: A method of controlling the output of settling apparatus of the type comprising a settling tank; and raking gear which is operable in the settling tank and whose vertical operating position in the tank is variable, which is characterized by the step of adjusting the buoyancy of at least part of the raking gear submerged in fluid in the settling tank, such as by varying the amount and/or kind of a flowable medium in a hollow and fluidtight tubular raking blade carrier arm.

Also settling apparatus of the type specified which is characterized by means for introducing fluid into and withdrawing fluid from a hollow, fluidtight chamber presented by the raking gear.

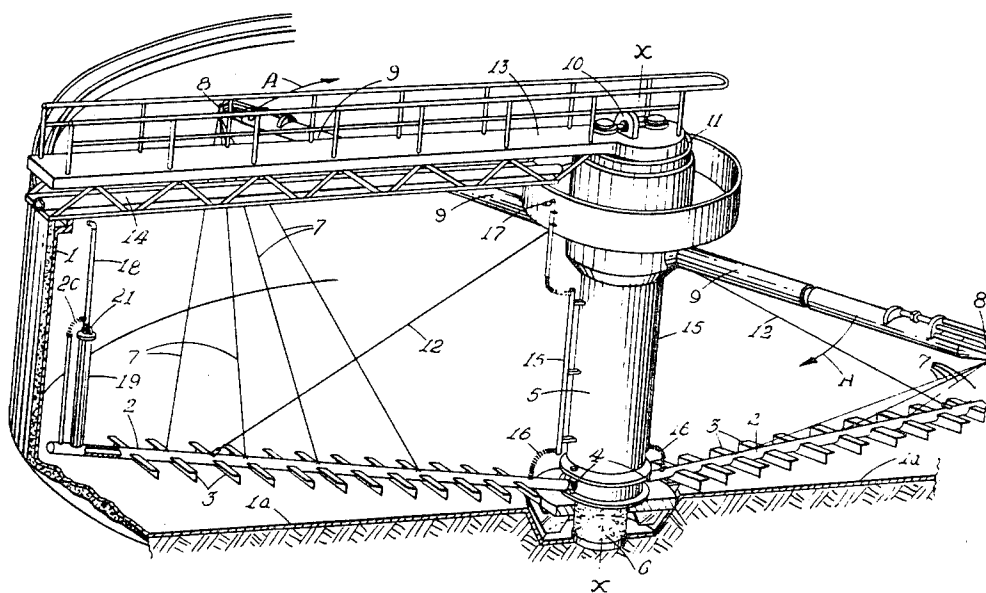
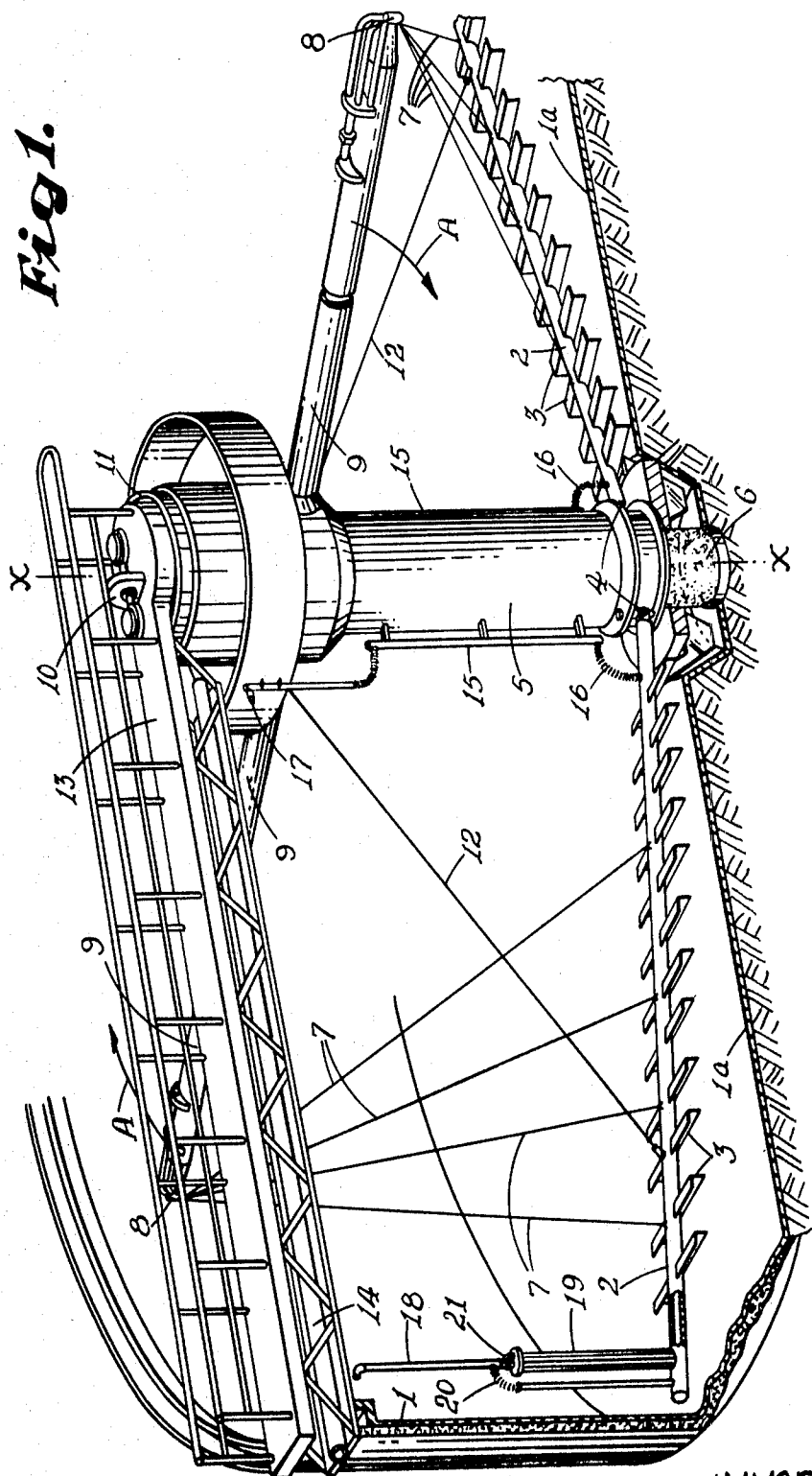


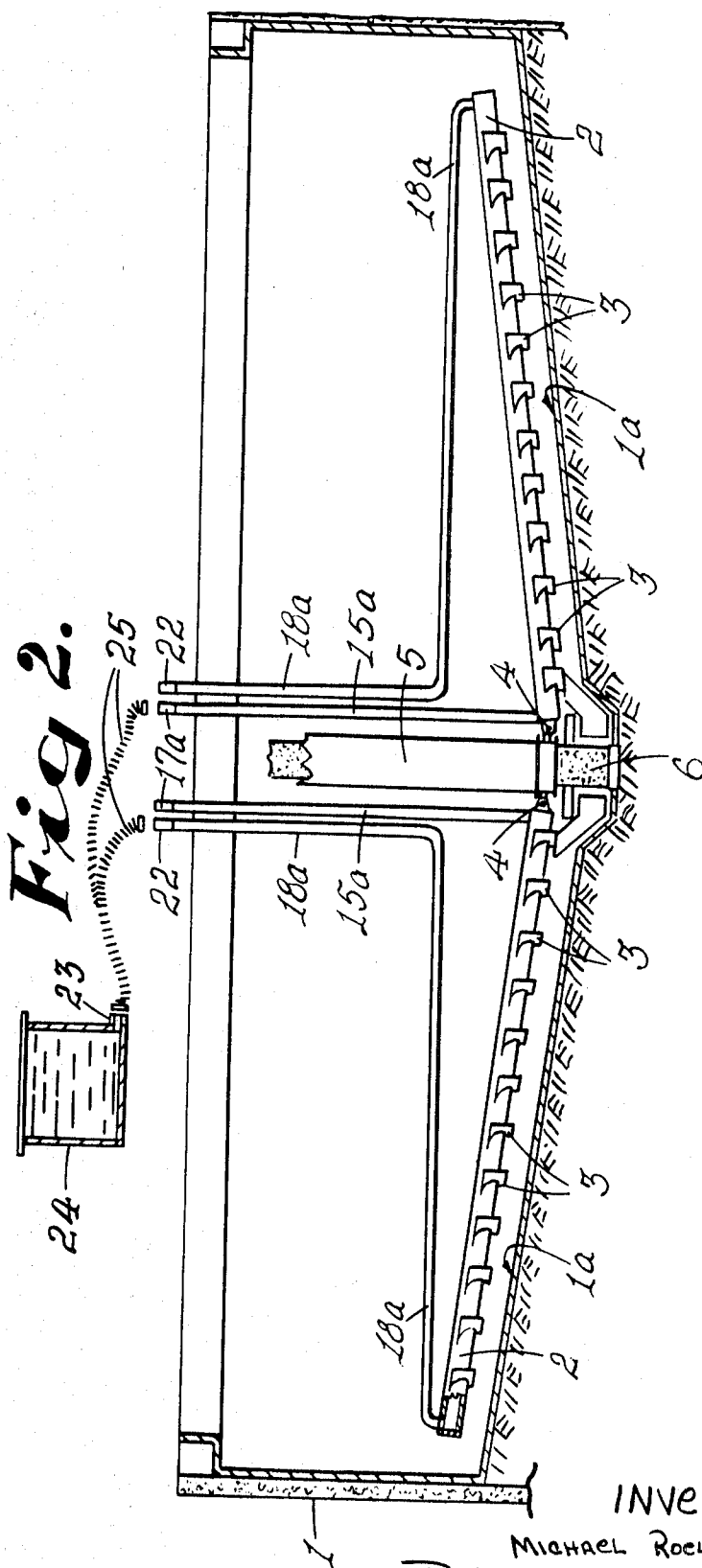
Fig. 1.



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SETTLING APPARATUS AND METHOD OF CONTROLLING THE OUTPUT THEREOF

This invention relates to settling apparatus, such as for slimes, slurries, sludges or the like, of the type including a settling tank; and raking gear which is operable in the settling tank and whose vertical operating position in the tank is variable.

Settling apparatus of the type in question is often referred to as settlers, thickeners or clarifiers and the raking gear of such apparatus act on material in the tank, such as to displace settled sludge, pulp or other solid material in the tank.

It is an object of the present invention to provide improved control of the output of settled material from settling apparatus of the type in question.

According to one aspect of the invention a method of controlling the output of settling apparatus of the type specified includes the step of adjusting the buoyancy of at least part of the raking gear submerged in fluid in the tank.

By varying the buoyancy of the raking gear, the vertical operative disposition of the raking gear in the fluid and hence the output from the apparatus can be varied. Normally, the output of settling apparatus of the type in question increases with increasing depth of submersion of the raking gear and decreases with decreasing depth of submersion.

The buoyancy may be varied by varying the amount and/or kind of flowable medium in a hollow chamber presented by raking gear.

According to another aspect of the invention, settling apparatus of the type specified includes raking gear presenting a hollow fluidtight chamber; and means for introducing and withdrawing fluid into and from the fluidtight chamber.

The fluidtight chamber may comprise a tubular member preferably a raking blade carrier arm.

The means for introducing fluid into and withdrawing fluid from the fluidtight chamber may comprise a fluid line communicating with the interior of the chamber and a vent from the interior of the chamber.

The present invention is particularly applicable to settling apparatus according to our British Pat. No. 1,106,524 but it is not limited to such application and may be applied to any other suitable settling apparatus of the type specified.

Preferred embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:

FIG. 1 is a perspective view with parts broken away for the sake of clarity, of one form of settling apparatus according to the invention.

FIG. 2 is a diagrammatic vertical sectional view of another form of apparatus according to the invention.

Referring to FIG. 1, the apparatus comprises settling tank 1 and rotary gear operable in the tank. The raking gear comprises a pair of hollow, tubular carrier arms 2 which mount a series of transversely extending axially spaced raking blades 3 and which are located within settling tank 1 and extend radially in opposite directions from a vertical axis of rotation X—X. Mountings 4 at the inner ends of carrier arms 2, pivotally connect the carrier arms 2 to cylindrical shroud 5 which surrounds stationary support column 6 and which is rotatable about axis X—X and about column 6. Mountings 4 permit the two carrier arms 2 to rotate together about the common vertical axis of rotation with shroud 5 and also permit each carrier arm 2 individual rearward and upward pivotal movement about its inner end independently of the other carrier arm 2 about a horizontal axis as well as substantially vertical axis.

A plurality of draught ropes 7 are anchored to each carrier arm 2 in spaced relationship along its length and converge upwardly and forwardly relative to the direction of rotation of carrier arms 2 as indicated by arrows A to securing means 8 on the outer end of an associate drive arm 9 which is fast with shroud 5 for rotation therewith.

Drive means 10 is stationarily mounted on the upper end of support column 6 and is adapted rotatably to drive internally toothed ring gear 11 to which shroud 5 is secured so that the

shroud is suspended from ring gear 11 and is rotatable therewith. When shroud 5 is rotatably driven through ring gear 11 about the vertical axis of rotation X—X, drive arms 9 are also rotatably driven about axis X—X in the direction of arrows A that each set of draught ropes 7 are moved at their upper ends along a closed path about axis X—X in a position spaced from the axis and located above and in advance of the associated carrier arm 2, so that the two carrier arms 2 are rotated together about axis X—X by the draught ropes 7.

In the event of the raking blades 3 of a carrier arm 2 encountering an obstacle during rotation about vertical axis X—X, the tension in the associated set of draught ropes 7 increases and the carrier arm 2 is able to pivot upwardly and rearwardly with a universal swinging movement about the horizontal and vertical pivotal axes at its inner end independently of the other carrier arm, thereby to decrease the drag on the carrier arm 2. Load on the raking gear and on the driving means 10 is accordingly adjusted automatically.

A suspension rope 12 for each carrier arm 2 is fast at one end with the associated overhead drive arm 9 in a position adjacent the vertical axis of rotation X—X and is fast at the other end with the carrier arm 2 in a suitable position intermediate the ends of the latter. Suspension ropes 12 merely determine the lowest position of carrier arms 2 to prevent them from scraping base 1a and tank 1 during starting and stopping and do not interfere with upward and rearward pivotal movement of carrier arms 2.

Overhead bridge 13 extends from the side of settling tank 1, to the upper end of support column 6 and carries feed launder 14.

So far the apparatus is generally in accordance with our British Pat. No. 1,106,524.

According to the present invention, each hollow carrier arm 2 is made fluidtight and is provided at its inner end with a fluid line 15 which is fast with shroud 5 for rotation therewith, and which communicates with the interior rotation, the carrier arm 2 through flexible connection 16 which does not impede upward and rearward swinging movement of the carrier arm end. Each fluid line 15 extends upwardly along shroud 5 to above the liquid level in settling tank 2 and is provided at its upper end with a suitable coupling 17 permitting the introduction of a suitable flowable medium into the hollow carrier arms 2.

Each carrier arm 2 is further provided with a vent tube 18 which is pivotally mounted on support 19 on the carrier arm 2 and which communicates with the interior of the hollow carrier arm 2 towards its outer end through flexible connection 20.

In use, a water hose (not shown) may be connected to the coupling 17 at the upper end of each fluid line 15 when the raking gear is stationary, and water introduced into the carrier arms 2 through the fluid lines 15. Vent tubes 18 permit the escape of air from the hollow carrier arms 2 so that the latter may be filled with a required amount of water. Water may be removed from the hollow carrier arms 2 by connecting the couplings 17 at the upper ends of fluid lines 15 to a pump (not shown) when the raking gear is stationary and withdrawing the water through fluid lines 15. Alternatively, water may be removed from the carrier arms 2 by connecting a compressed airhose (not shown) to the couplings 17 on fluid lines 15 when the raking gear is stationary and blowing out water through vent tubes 18 by means of compressed air.

Any buoyancy control fluid may be introduced into the hollow carrier arms 2, instead of introducing water or other liquid medium into hollow carrier arms 2, a suitable gaseous medium such as compressed air, may be introduced into the carrier arms to vary the buoyancy thereof.

It will be appreciated that the buoyancy of the carrier arms 2 will depend on the quality of gaseous or liquid medium contained therein.

Carrier arms 2 will pivot up and down about their horizontal axes in accordance with their buoyancy to assume an operative level dictated by the buoyancy. Therefore, by varying the quantity and/or nature of the fluid medium in carrier arms 2,

their vertical operative positions in settling tank 1, can be varied, thereby to control the output of the settling apparatus.

The weight of the carrier arms 2 may be adjusted by varying the quantity and/or nature of fluid medium therein so that each carrier arm will remain in its lowermost position supported by suspension cables 12 as long as the drag on the carrier arms 2 and therefore the torque applied by the drive arms 9 is below a predetermined value. As the drag on the carrier arms 2 increases with increasing density or depth of pulp or other material in the settling tank 1, the vertical component of the tension in the draught ropes 7 increases until it is sufficient to support the carrier arms 2 and to lift them from their lowermost position.

By varying the weight of the carrier arms 2, the predetermined value of driving torque at which the carrier arms will lift from their lowermost positions and the vertical positions that the carrier arms will assume at any given driving torque in excess of the predetermined minimum value, can be varied as required.

Vent tubes 18 on the outer ends of carrier arms 2 may be utilized to indicate the vertical positions of carrier arms 2 in settling tank 1, by the extent to which vent tubes 18 project above the level of liquid in settling tank 1. In order to avoid damage due to collision between vent tubes 18 and bridge 13 when the carrier arms 2 reach an elevated level in settling tank 1, vent tubes 18 are pivotally mounted on support 19 at 21.

Where a liquid medium for varying the buoyancy of hollow carrier arms 2 is expensive or not readily available, so that it is important to conserve the liquid medium, the arrangement of FIG. 2 may be used. Fluid lines 15a communicate with the interiors of hollow, tubular carrier arms 2 at their inner ends and vent tubes 18a communicate with the interiors of carrier arms 2 at their outer ends. Vent tubes 18a run radially inwardly along carrier arms 2 and upwardly along fluid lines 15a. At their upper ends, fluid lines 15a are provided with couplings 17a and vent tubes 18a are provided with couplings 22.

In order to introduce a liquid medium into carrier arms 2, outlet 23 of liquid reservoir 24 is connected to couplings 17a on fluid lines 15a by means of hoses 25 to permit a flow of liquid under gravity from reservoir 24 into the hollow carrier arms 2 when the apparatus is stationary. In order to remove liquid medium from hollow carrier arms 2, compressed air hoses (not shown) may be connected to couplings 22 on the upper ends of vent tubes 18a when the apparatus is stationary and the liquid blown out of the carrier arms 2 back into reservoir 24 through hoses 25 by means of compressed air.

It will be appreciated that many variations in detail are possible without departing from the scope of the appended claims. For example, suitable valves may be provided on the outlet 23 from reservoir 24 and/or at the upper ends of fluid lines 15, 15a and/or vent tubes 18, 18a in FIG. 1 and 2, in order to control the flow of the fluid into and out of the carrier arms 2 and/or to seal off the interior of the carrier arms 2.

Where it is not desirable to stop the apparatus when it is required to vary the buoyancy of the raking gear, the rotary fluid lines and vent pipes may be connected in any suitable manner as will be clear to a man skilled in the art, such as through swivel or rotary couplings, with a stationary conduit or conduits on bridge 13 to which supply hoses, pumps, reservoirs or the like may be connected through suitable valves, couplings or the like, as required.

Instead of utilizing hollow carrier arms 2 as fluidtight chambers, any other suitably fluidtight chamber or chambers

adapted to be submerged in fluid in settling tank 1, may be provided on the raking gear. The invention is therefore, applicable to raking gear which do not include tubular members below the liquid level.

It will be appreciated that the variable buoyancy feature of the present invention may be sued as an adjunct to the safety lifting feature disclosed in our British Pat. Specification No. 1,106,524 and is not a substitution thereof.

I claim:

1. A method of controlling the output of a settling apparatus comprising a rotary carrier arm carrying raking blades along its length and operable within fluid in a settling tank, the carrier arm extending radially from a vertical axis of rotation, and mounting means at the inner end of the carrier arm permitting the arm to rotate about the vertical axis of rotation within the settling tank and also to pivot upwardly and rearwardly, about its inner end, said method comprising the step of adjusting the operative level of the carrier arm in the fluid in the settling tank by varying the buoyancy of the carrier arm, by introducing a buoyancy control fluid at one end of said carrier arm and removing said fluid at a location spaced from said end along said arm.

2. A method of controlling the output of a settling apparatus comprising a rotary carrier arm carrying raking blades along its length and operable within fluid in the settling tank, the carrier arm extending radially from a vertical axis of rotation within the settling tank and also pivotable upwardly and rearwardly about its inner end, said method comprising varying the amount of flowable material in the interior of the carrier arm by introducing a buoyancy control fluid at one end of the said carrier arm and removing said fluid at a location spaced from said end along said arm; thereby adjusting the operative level of the carrier arm in the fluid in the settling tank.

3. Variable output settling apparatus comprising a settling tank; a hollow fluidtight carrier arm carrying the raking blades along its length and operable within fluid in the settling tank, the carrier arm extending radially from a vertical axis of rotation; mounting means at the inner end of the carrier arm permitting the arm to rotate about the vertical axis of rotation within the settling tank and also to pivot upwardly and rearwardly about its inner end; and means for introducing buoyancy control fluid at a location on said carrier arm and means for removing said buoyancy control fluid from the interior of said carrier arm at a location spaced from said first location along said carrier arm.

4. Variable output settling apparatus comprising a settling tank, a hollow, fluidtight tubular carrier arm carrying a plurality of transversely extending axially spaced raking blades along its length and operable within fluid in the settling tank, the carrier arm extending radially from a vertical axis of rotation; mounting means at the inner end of the carrier arm permitting the arm to rotate about the vertical axis of rotation within the settling tank and also to pivot upwardly and rearwardly about its inner end; and means for introducing buoyancy control fluid at one location on said carrier arm said means comprising a fluid line communicating with the interior of the carrier arm and extending from the tank to above the normal liquid level in the tank and means for removing said buoyancy control fluid from said carrier arm at a location spaced from said one location along said carrier arm, said means comprising a fluid line communicating with the interior of the carrier arm and extending from the tank to above the normal liquid level in the tank.