Dec. 9, 1969 T. M. JABLON 3,482,704

SETTLING TANK WITH CENTER-PIER SUPPORTED RAKE STRUCTURE

Filed May 15, 1968 5 Sheets-Sheet 1

FIG. 2

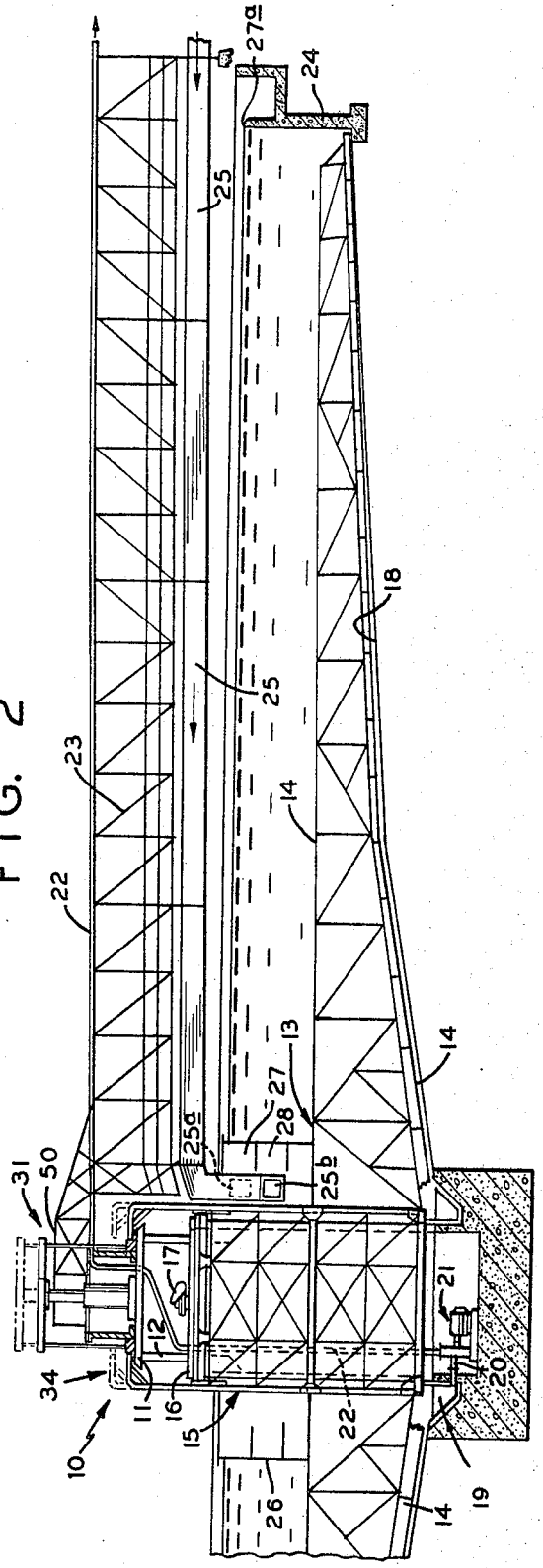
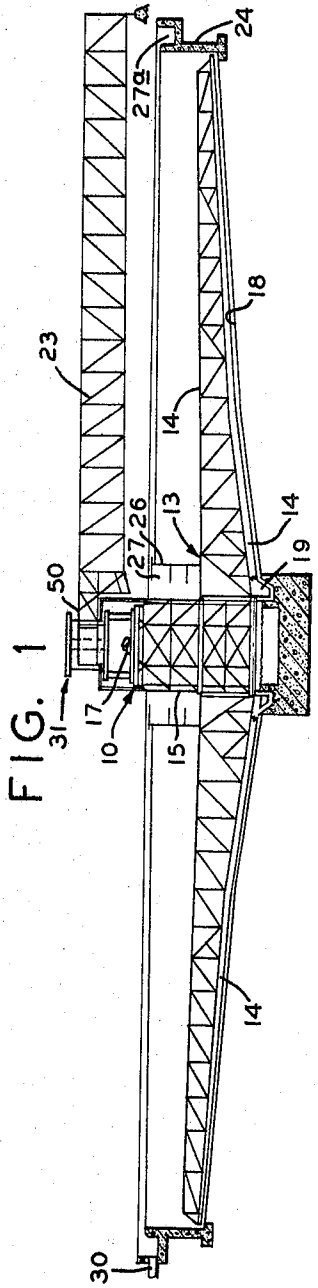


FIG. 1



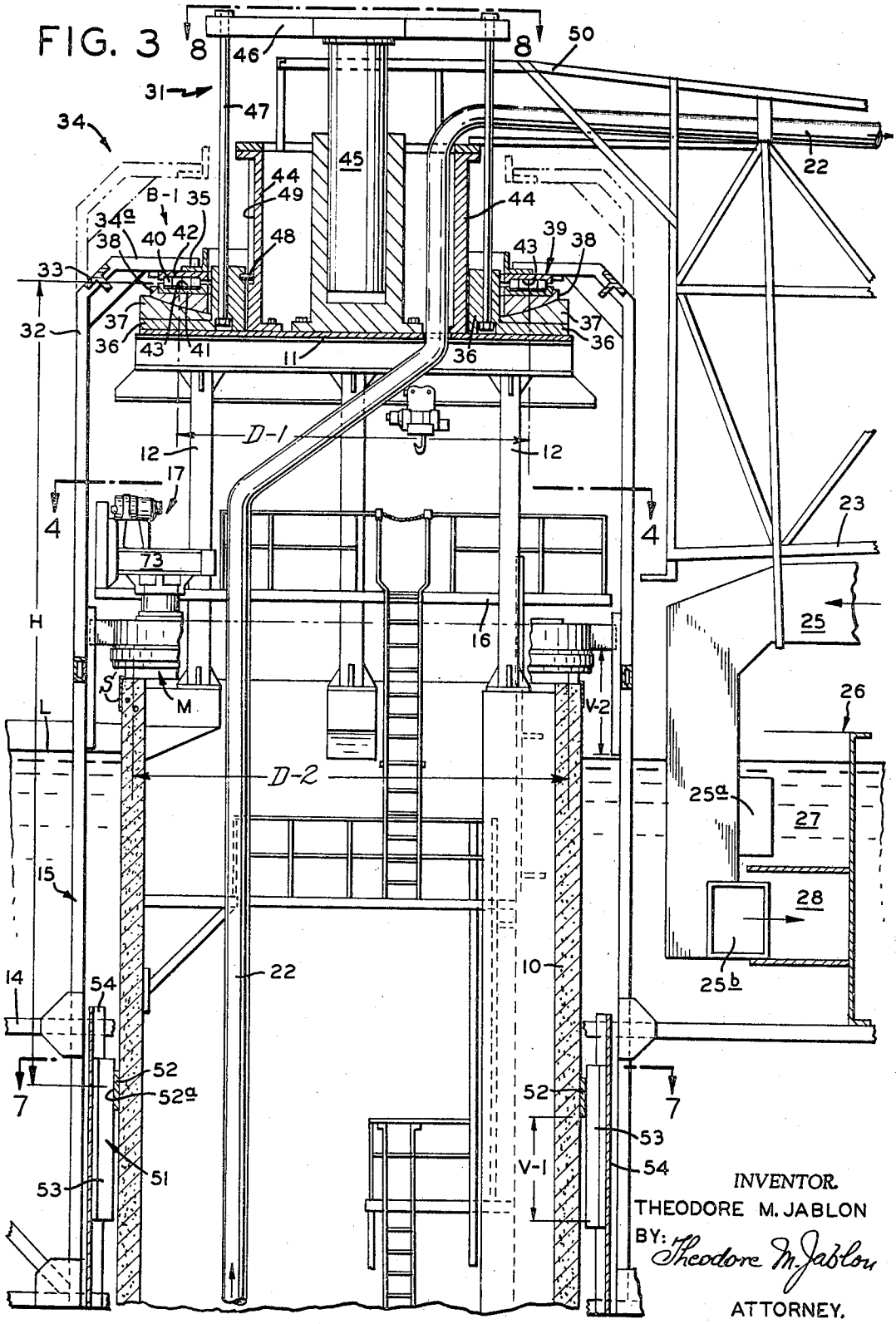
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SETTLING TANK WITH CENTER-PIER SUPPORTED RAKE STRUCTURE

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FIG. 3



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SETTLING TANK WITH CENTER-PIER SUPPORTED RAKE STRUCTURE

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FIG. 4

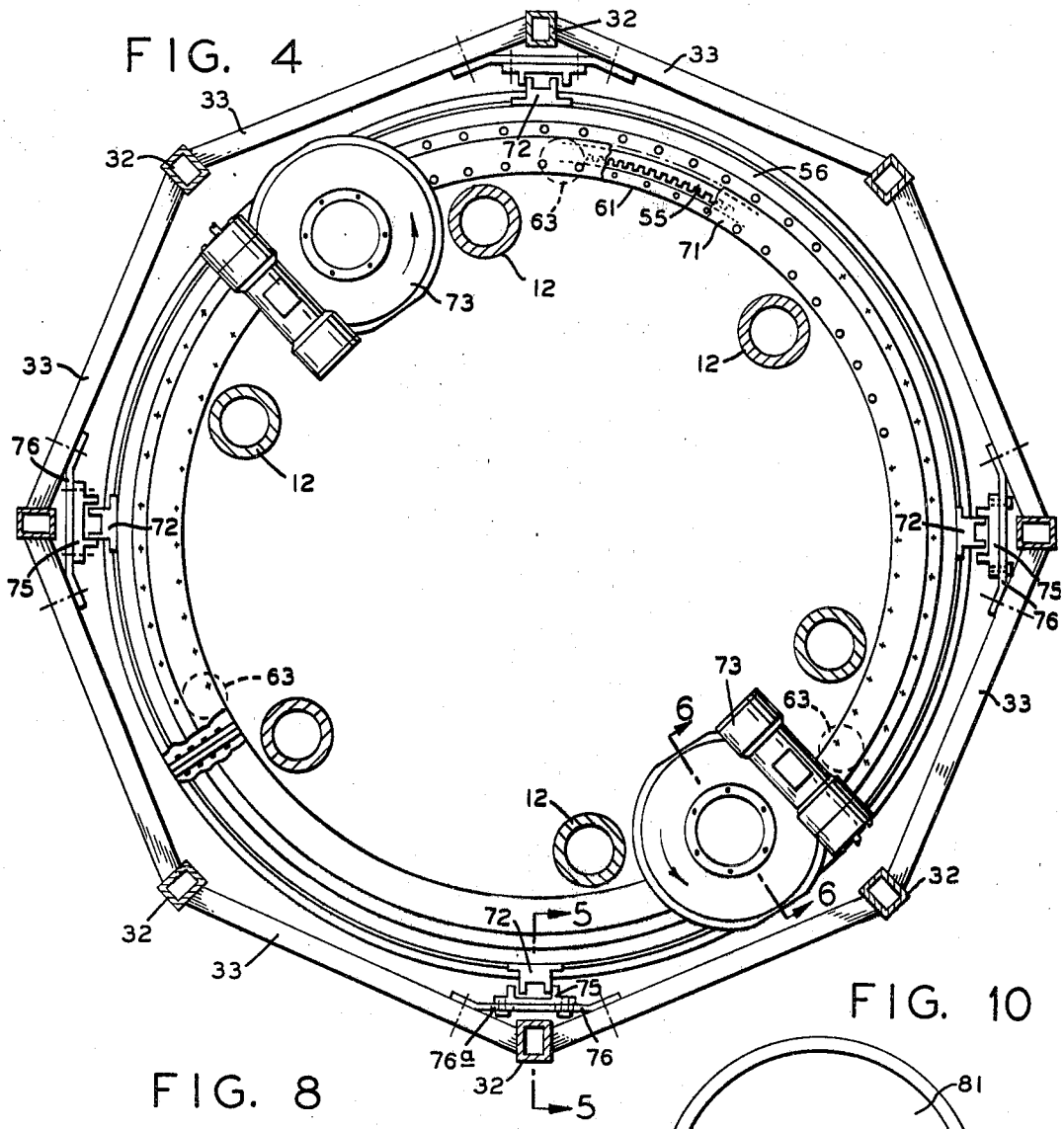


FIG. 8

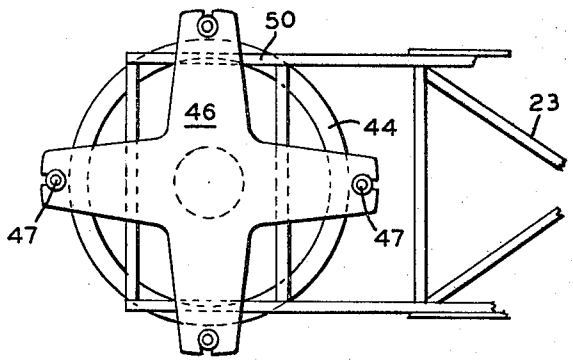
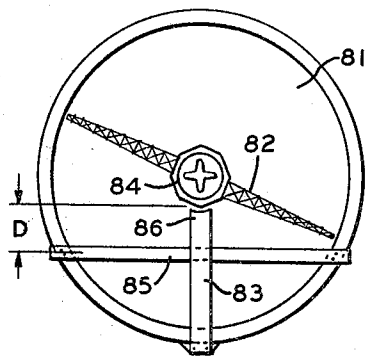


FIG. 10



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SETTLING TANK WITH CENTER-PIER SUPPORTED RAKE STRUCTURE

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FIG. 5

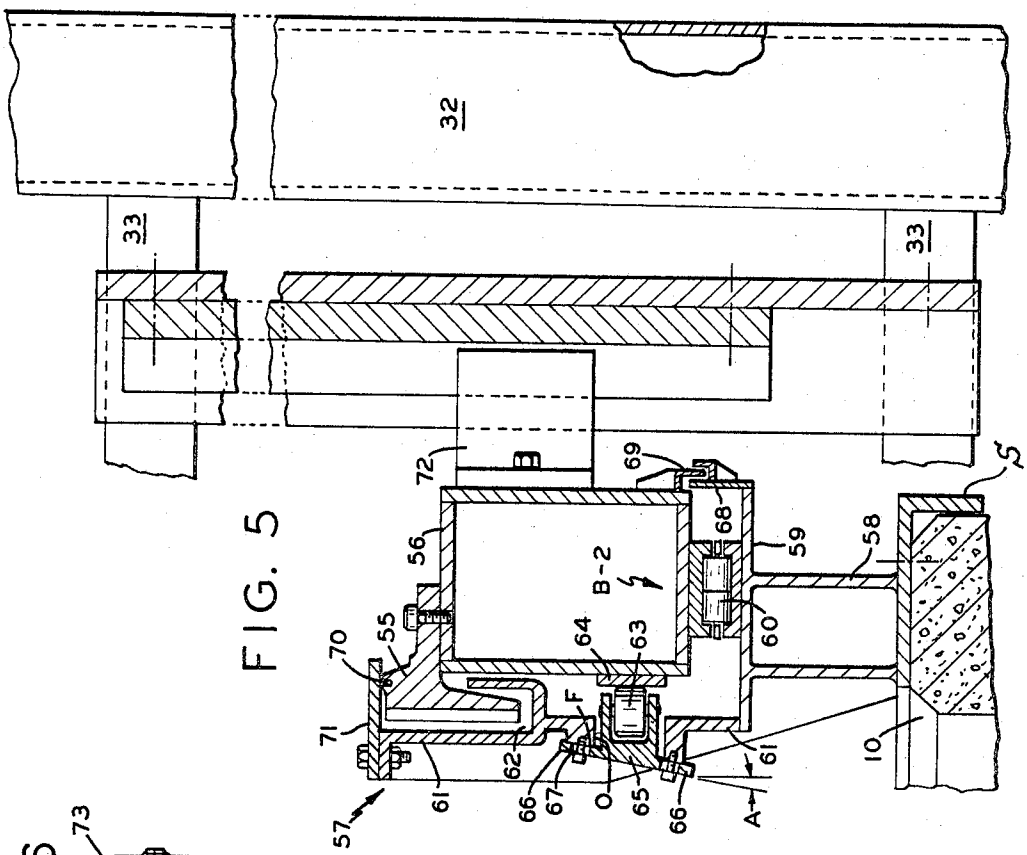
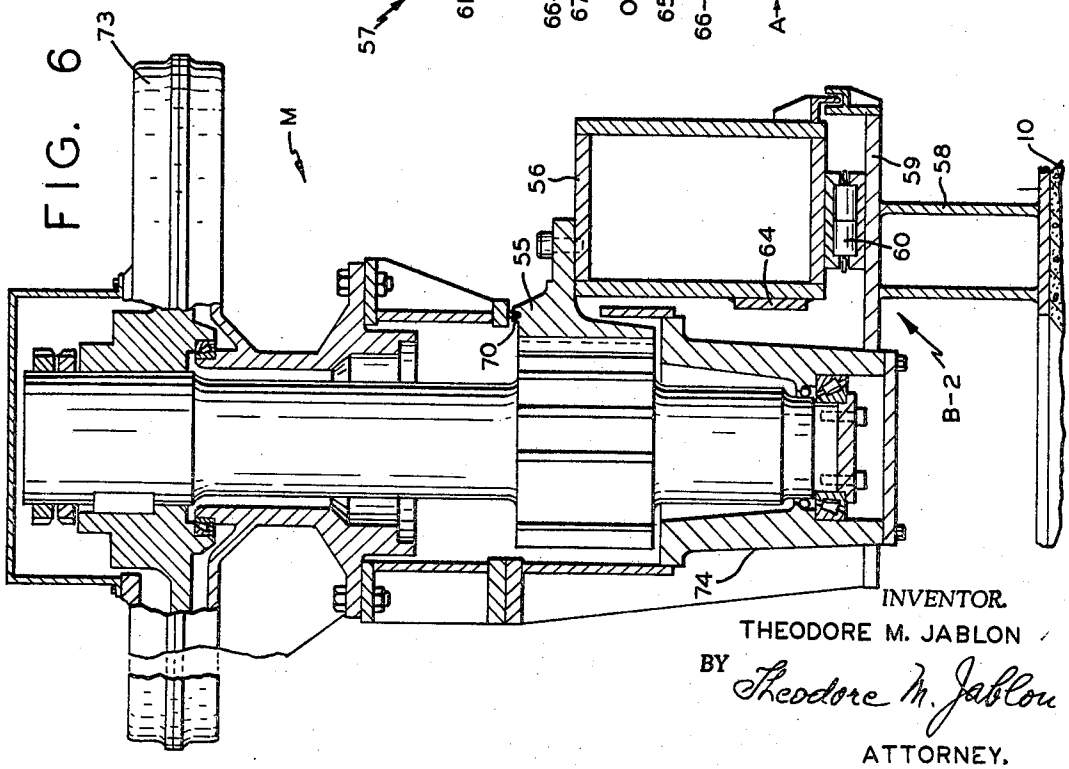


FIG. 6



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FIG. 9

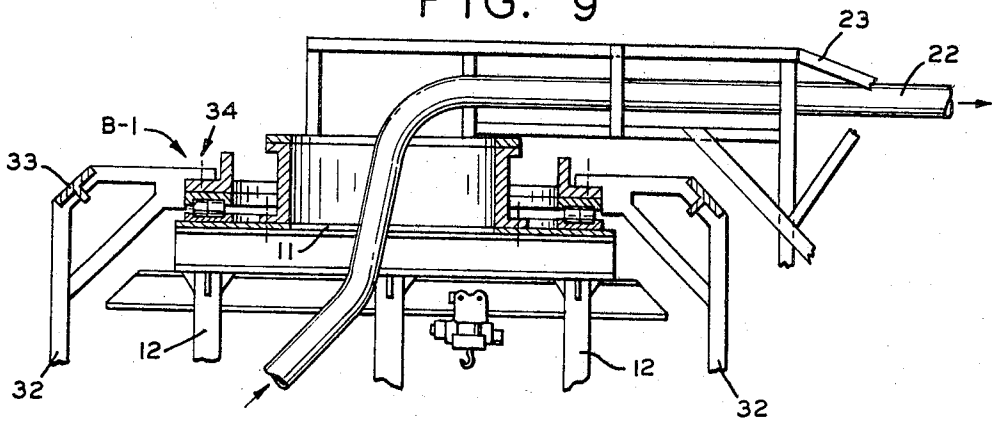


FIG. 7

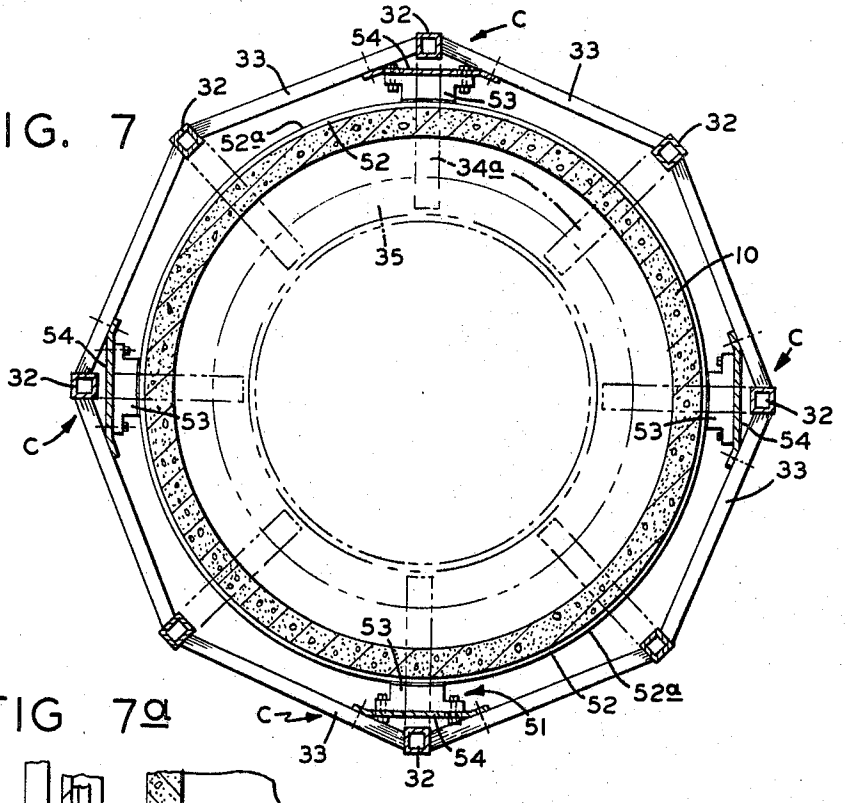
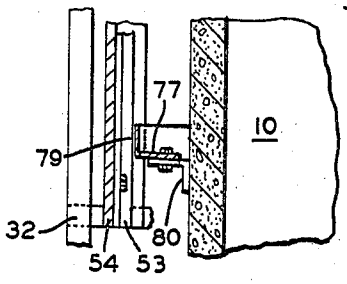


FIG 7a



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3,482,704

SETTLING TANK WITH CENTER-PIER SUPPORTED RAKE STRUCTURE

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Int. Cl. B01d 21/06
U.S. Cl. 210—531 18 Claims

ABSTRACT OF THE DISCLOSURE

Center pier-supported rotary sludge raking structure for a sedimentation tank, wherein the dead load of the rake structure is supported through the center cage on an upper or elevated bearing platform, while a bull gear is independently supported on a lower bearing platform, in torque transmitting relationship with the surrounding cage.

This invention relates to continuously operating sedimentation tanks wherein a rake structure rotating about a vertical axis moves the sediment or sludge continuously over the tank bottom to a discharge zone.

More particularly, this relates to the type of sedimentation apparatus wherein the rake structure is mounted for rotation on a center pier or hollow column, which also supports the drive means or mechanism for imparting the rotation. This invention is concerned with improvements in the means for supporting and driving the rake structure on the center pier.

A conventional rake structure of the pier-supported type comprises a central vertical cage portion surrounding the pier, with sediment engaging rake arms extending horizontally or radially from the cage. This rake structure is rotatable about a vertical axis with the upper end of the cage portion supported from a drive head which is mounted on the pier.

A conventional drive head mounted atop the pier comprises a horizontal supporting frame or turntable base provided with annular thrust bearing means for rotatably supporting the cage and rake structure. A bull gear is rigidly fixed to the upper end of the cage concentric with the axis of rotation. A motor drive unit mounted on the turntable base engages the bull gear to impart rotation to the rake structure. The bull gear fixed to the rake structure renders the load carrying annular thrust bearing relatively inaccessible, and may contribute to rendering the bearing susceptible to localized load concentrations or tilting stresses.

One factor in the design of drive heads for the pier-supported type of rake structure is the amount of torque required, which may govern the choice of the bull gear diameter. Another factor is the load carrying capacity required of the annular thrust bearing means for the rake structure, which may govern the choice of the bearing diameter and its construction. Another factor is due to the problem of providing anti-tilting stability for the rake structure.

Furthermore, special problems in the design and construction of the drive head arise, for example with very large sedimentation tanks, for instance in the 300 ft. to 500 ft. diameter range, wherein the center pier may be of the hollow or "caisson" type. In that type the interior of the pier or pit is wide enough to accommodate an internal stairway and platform system leading to the bottom of the pit where one or more sludge pumps may be located for withdrawing the collected sludge directly from the annular sump surrounding the foot end of the pier. A riser pipe from the pump delivers the sludge upwardly and across a bridge structure to disposal. In such case it is the

large diameter of the hollow pier, in the order of 18 to 20 ft., that may govern the basic dimensions of an annular drive head structure mounted upon the annular top end of the pier, involving mechanical bearing problems in conjunction with antitilting stability required of the rake structure.

Hence, another problem is to provide center pier-supported bearing means especially in such large size tanks substantially free of, or protected against such undue localized bearing pressures, by provision of effective anti-tilting- or compensating means.

In view of the problems above set forth, it is among the objects of this invention to provide load support bearing means for the pier-supported rake structure, as well as drive means therefor, so constructed and arranged relative to one another that the foegoing factors or problems governing the design may be reconciled. This should provide a flexibility of design, especially for large tanks wherein diverse requirements may thus be satisfied, rather than changing one design factor at the expense of another.

The invention further aims to provide simple and effective means for raising and lowering the pier-supported rake structure even for very large tanks, combined with high anti-tilting stability for the rake structure.

The foregoing objectives are attainable by the provision of an annular bearing located at an upper level spaced upwardly from the top end of the pier, for supporting the dead load of the rake structure, and another annular bearing located at a lower level for individually supporting the bull gear in torque transmitting relationship with the surrounding cage portion of the rake structure. Drive means for the bulll gear, for example one or more pinion drive units, may also be located at this lower level.

Preferably, this provides an upper or elevated platform structure for the upper bearing, supported by a plurality of columns or posts extending upwardly from the top end of the pier, and a lower platform structure accessible as an opeating platform. Access to this lower platform and to the drive means may be had through open areas of the cage, or by way of a vertical passage through the area surrounded by the upper annular bearing.

Rake lifting means in the form of an hydraulic or mechanical jack may be provided upon the upper platform structure for raising or lowering the upper bearing together with the rake structure, along suitably arranged vertical anti-tilting guides.

In a preferred embodiment, the sludge pump is located at the bottom of a hollow pier, with the sludge delivery pipe rising within the pier through open areas surrounded by the lower and upper annular bearings, and then across a radially extending bridge.

Specific features are found in the bearing arrangements, in the rake lifting means, in the provision of effective anti-tilting devices for the rake structure, and in the arrangement of the bridge.

Other features and advantages will hereinafter appear.

FIG. 1 is a diagrammatic vertical sectional view of a settling tank of the type embodying the invention in a center pier supported rake structure, with an access bridge leading to the pier.

FIG. 2 shows the tank of FIG. 1 enlarged and somewhat more detailed.

FIG. 3 taken from FIG. 2 shows the center pier and the mounting of the rake structure thereon greatly enlarged, including lifting mechanism for the rake structure and vertical guide means therefor.

FIG. 4 is a cross-sectional view taken on line 4—4 of FIG. 3, showing the lower platform structure supporting a bull gear drive means for the surrounding rake structure.

FIG. 5 is a part-sectional view taken on line 5—5 in FIG. 4 showing details of the drive mechanism, including vertical guide track means effective between the bull gear and the rake structure.

FIG. 6 is a part-sectional view taken on line 6—6 in FIG. 4, showing further details of the drive mechanism.

FIG. 7 is a cross-sectional view taken on line 7—7 in FIG. 3, showing guide means effective between the foot end portion of the pier and the surrounding rake structure.

FIG. 7*a* is a more detailed vertical sectional view of vertical guide means between the foot end portion of the pier and the surrounding rake structure.

FIG. 8 is a top view upon the upper platform structure, taken on line 8—8 in FIG. 3, showing rake lifting devices and support for the access bridge.

FIG. 9 is a vertical sectional view of the upper platform structure, showing support for the access bridge, without rake lifting mechanism.

FIG. 10 is a diagrammatic top view of the settling tank, showing a different support arrangement for the access bridge.

A settling tank of the center pier type embodying the invention, is shown semi-diagrammatically in FIGS. 1 and 2. In this example the tank has a hollow center pier **10** provided with an upper platform structure **11** supported by columns **12** extending upwardly from the top end of the pier. This upper platform structure has mounted thereon an annular vertical thrust bearing for rotatably supporting a rake structure **13** which comprises rake arms **14** extending from a central vertical cage **15** surrounding the pier, and supported on the bearing of the upper platform structure, as will be furthermore described below.

A lower platform structure **16** is mounted atop the pier, surrounded by the cage portion of the rake structure. Mounted at this lower level are gear drive means **17** for rotating a bull gear supported on a lower annular bearing provided on the lower platform structure. This bull gear having torque transmitting engagement with the surrounding cage, rotates the rake structure thus moving sediment or sludge over the tank bottom **18** to an annular sump **19** surrounding the foot end of the pier. Withdrawal of the thus collected sludge from the sump may be affected through intake pipe **20** by a pump **21** located inside at the bottom of the hollow pier. A sludge delivery pipe **22** extends from the pump upwardly within the pier, and through the area surrounded by the lower and upper annular bearings, and then horizontally over a bridge **23** connecting the upper platform structure with the peripheral wall **24** of the tank.

In this example the bridge also serves to support a feed supply conduit or pipe **25** terminating in a feed well **26** supported by and rotating with the rake arms **14**. This feed conduit has two opposedly directed terminal discharge branches **25***a* and **25***b*, delivering separate streams in opposite directions into an upper race way **27** and a lower race way **28** respectively, formed within the feed well **26**. It will be understood that with the feed slurry introduced in this manner, sludge solids will settle on the tank bottom, while clarified liquid will reach the peripheral overflow weir **27***a* for collection into the surrounding effluent launder **29**, and delivery therefrom through a discharge pipe **30**. A rake lifting device **31**, that is a device for raising and lowering the rake structure is also indicated somewhat diagrammatically in the embodiment of FIGS. 1 and 2. However, as will be seen from the more detailed description below, only relatively simple changes would be required in the basic construction of the apparatus of this invention, to either include or exclude the rake lifting mechanism.

Referring now to the enlarged central portion of the machine in FIGS. 3 to 7, the cage portion of the rake structure by way of example is of octagonal cross-sectional configuration defined by vertical members **32** at the corners, interconnected by transverse members and braces **33**. The cage has an inwardly overhanging top end portion **34** supported on an annular bearing assembly B–1 herein termed the upper bearing, mounted on the upper platform structure **11**. As herein shown, this top end portion **34** of the cage is formed by arms **34***a* which extend radially inwardly from the top ends of the vertical members **32**, and by a ring member **35** rigidly interconnecting the inner ends of these arms.

The bearing B–1 is preferably of the spherically self-adjusting type to cooperate with guide bearing means provided at the lower end of the cage and further to be described below. The bearing itself is shown to comprise an annular base member **36**, a pair of spherically self-adjusting ring members **37** and **38**, and an anti-friction bearing roller assembly **39** resting upon the upper ring member **38**, and in turn supporting the cage and thus the rake structure as a whole. This bearing roller assembly may be of a type comprising sets of rollers **40** suitably combined and caged and interposed between a lower annular bearing race member **41** and an upper annular bearing race member **42** upon which in turn rests the weight of the rake structure. The effetctive diameter of this bearing assembly is indicated as D–1.

The sets of anti-friction bearing rollers are herein shown to operate in shallow annular recesses **43** formed in the upper and lower bearing race members.

Raising and lowering of the rake structure in this embodiment may be effected by the provision of jack devices operable to bodily move the upper bearing assembly B–1 together with the rake structure, along vertical guides relative to the upper platform structure. To this end, the upper bearing assembly B–1 cooperates with a vertical cylindrical guide member **44** mounted upon the upper platform structure, and surrounded by the bearing base member **36** in sliding-fit relationship therewith. A jack device for lifting the bearing assembly may be in the form of an hydraulic cylinder with piston **45**, located within the guide cylinder and supported by the upper platform structure. The upper end of the hydraulic piston or its mechanical equivalent may have a cross-head structure **46** (see also FIG. 8) here shown to have four arms each of which is connected by a depending tension rod or element **47** to the bearing base member **36** which in turn may be secured against rotation relative to the guide cylinder **44** as by a key **48** or the like engaging a vertical groove **49** in the cylinder.

The cylindrical guide member rising from the upper platform structure may also serve to support the inner end **50** of access bridge **23**, with the cross-head of the jack device located above this inner end.

The upper self-adjusting bearing assembly B–1 cooperates with guide means spaced downwardly therefrom, to provide a vertical stabilization base for the rake structure relative to the pier. Depending upon the extent of vertical stabilization desired for the rake structure, the guide means may be located above the liquid level L in the tank, or has herein shown, submerged guide means **51** may be provided effective between the foot end portion of the pier and the surrounding cage, presenting a vertical stabilization base H.

As seen from FIGS. 3 and 7, the submerged guide means **51** comprise a circular track member **52** surrounding the pier and fixed thereto substantially concentric with the vertical axis of rotation of the rake structure, and presenting a cylindrical track face **52***a*. Cooperating with this track face are guide blocks **53** which may consist of cast iron, located in respective corners C of the octagonal cage structure. Each such guide block is bolted to a vertical bracket plate **54** which in turn is fitted into and fixed to the respective corner portion of the cage. The vertical extent V–1 of these guide blocks relative to the associated track is such as to allow for the vertical movement of the rake structure as by rake lifting devices such as herein exemplified and described above.

As an alternative, a set of guide blocks or other guide elements (not shown) may be provided in the respective corner portions of the cage above the liquid, so as to engage a circular track surrounding the upper end portion of the pier. This track may be in the form of a cylindrical skirt portion S depending from the base of drive mechanism M described below.

There will now be described the drive mechanism M located on the lower platform structure **16** for imparting driving torque to the cage **15** and thereby to the rake structure as a whole.

Referring to FIG. 3 and more particularly to FIGS. 4, 5, 6, 7, a lower bearing assembly B–2 provides separate and independent support for an internally toothed bull gear **55**. In the example of drive means herein shown, the internally toothed bull gear **55** is mounted atop an annular member or runner **56** which may have box-shaped cross-sectional configuration, and have an effective bearing diameter D–2.

The annular runner **56** is supported for rotation in an annular gear casing structure **57** having an annular base **58** mounted upon the top end of the pier. The casing structure itself has an annular bottom plate **59**, with an annular vertical thrust bearing **60** supporting the runner thereon for rotation.

Rising from the inner peripheral edge of the bottom plate is a substantially cylindrical high wall **61** formed at the top with an oil trough **62** for the bull gear **55**. Radial guidance for the annular runner **56** and the bull gear is provided by means of guide rollers **63** cooperating with a circular track **64** provided upon the inner cylindrical wall of runner **56**. These guide rollers are mounted in wall **61** of the casing structure, below the oil trough **62** for the gear. The guide rollers are mounted each in a bracket **65** which has a mounting flange **66** disposed at a slight angle A relative to the vertical axis of rotation of the rollers, and bolted to a similarly inclined prepared companion face F surrounding an opening O in the casing wall through which the bracket extends. Vertical slots **67** provided in flange **66** allow the bracket to be adjusted vertically along the inclined face F, thereby providing radial adjustability for the guide roller relative to the associated track.

The annular bearing **60** for the bull gear **55** may be of any suitable form, but is herein shown to be in the form of a roller bearing somewhat similar to the anti-friction bearing assembly described above in connection with upper bearing assembly B–1. The bearing **60** may operate in an oil bath contained by a low outer cylindrical boundary wall **68** of the gear casing structure **57**. An annular liquid seal **69** is effective between this boundary wall and the runner **56**, while another annular seal comprising a felt strip **70** is effective between the bull gear and an annular top cover plate **71** bolted to the top end of the casing structure.

The runner **56** has outwardly extending torque lugs **72** arranged to engage the surrounding cage portion of the rake structure to rotate the same when driving torque is applied to the bull gear as by one or more motorized pinion drive units **73**. A pair of such pinion drive units opposedly arranged are shown to drive the bull gear in FIG. 4. These drive units may be functionally interconnected by suitable torque-balancing means so that equal shares of the torque load will be imposed upon these drive units. Such equalization is attainable by way of hydraulic torque balancing means such as disclosed in the U.S. patent to Widdrington No. 3,252,349.

FIG. 6 illustrates the manner in which the mounting of these drive units is integrated in the gear casing structure, by the formation of pockets **74** formed in the inner or high wall of the casing structure. Otherwise, the construction and function of these drive units is self-explanatory.

More in particular, from FIG. 4 it is seen that the torque imparting lugs or torque lugs **72** engage vertical track members **75** mounted in respective corners of the octagonal shape of the cage portion of the rake structure. Accordingly, a vertical bracket plate **76** fixed to the cage portion has bolted thereto such a vertical track member **75**. Slots **76***a* in the plate indicate lateral adjustability of these track members, whereby uniform torque transmission from the runner **56** to the surrounding cage portion is attainable. It will be noted here that the vertical extent V–2 of track members **75** corresponds to the vertical extent V–1 of the guide blocks **53** below, to accommodate the extent of lift to be imparted to the rake structure by rake lifting mechanism such as the one set forth above.

The construction of the mounting of the rake structure exemplified in FIG. 9 is self-explanatory for the reason that it differs from the FIG. 3 construction above described substantially only by the omission of the mechanism for raising or lowering the rake structure.

A more detailed construction of the lower guide means for the rake structure in FIG. 7*a* comprises a ring member **77** presenting the outer cylindrical guide track face **79**. This ring member is adjustable in a horizontal plane upon supporting brackets **80** or the like extending from the outside of the pier. In this way, the track ring member **77** may be adjusted to substantially establish concentricity thereof with the axis of rotation of the rake structure.

FIG. 10 represents the diagrammatic plan view of a settling tank **81** with center-pier supported rake structure **82** embodying this invention, showing a different manner of supporting an access bridge **83** leading from the tank wall to the center pier **84**.

Accordingly, the radially extending access bridge **83** is supported by a horizontal beam construction **85** instead of by the center pier itself. The beam construction traverses the tank in secant fashion, so that it may be spaced a distance D from the cage portion of the rake structure. Therefore, access to the center pier is had over a freely overhanging inner end portion **86** of the access bridge.

In summary, it is seen that this invention provides a drive head construction for a center pier-supported rotary rake structure, wherein an annular bearing mounted on an upper platform structure supports the weight of the rake structure, while the drive means operating at a lower level have a bull gear rotated on a separate annular bearing, in torque transmitting relationship with the surrounding cage portion of the rake structure. In design, construction, and diameter, the two vertically spaced annular bearings are independent of each other.

The lower level or platform structure provides access to the drive mechanism as well as to the interior of the hollow pier, since the upper platform structure is supported on columns rising from the top end of the pier. An underflow sludge delivery pipe may extend upwardly through the area surrounded by the bearings, and then accross an access bridge to the boundary wall of the settling tank.

A vertical stabliity base for the rake structure is provided as defined by the vertical distance between an upper preferably self-adjusting bearing and associated guide bearing means effective between the pier and the surrounding cage, a maximum vertical distance being available when the guide bearing means are located in submergence in the lower portion of the cage. Rake lifting means can be readily incorporated in the above basic structure, as by the addition of jack devices on the upper platform structure, operable to raise and lower the upper bearing assembly together with the rake structure.

It will be understood that each of the elements or two or more together, of the apparatus herein described, may also find useful application in other types of sedimentation apparatus having pier-supported rake structures, differing from the type described above.

Furthermore, while the invention has been illustrated and described as embodied in a pier-supported sediment raking apparatus having one annular bearing at an up-

per level for supporting the rake structure, and another annular bearing at a lower level for the bull gear having torque transmitting relationship with the surrounding cage portion of the rake structure, the invention is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing from the spirit of the present invention.

I claim:

1. In a sedimentation tank the combination which comprises a center pier, rising from the tank bottom.

an upper platform structure elevated above the top end of the pier in fixed relationship therewith,

an upper annular bearing provided on said upper platform structure concentric with said pier,

a rake structure having a central vertical cage portion with rake arms extending therefrom, the upper end of said cage portion having an annular portion supported by said upper annular bearing thereby supporting the dead load of the rake structure,

a lower platform structure provided on the top end of the pier,

a lower annular bearing provided on said lower platform structure, substantially concentric with said upper bearing,

a bull gear mounted for rotating independently upon said lower bearing, and having torque transmitting relationship with the surrounding cage of the rake structure, and

drive means mounted on said lower platform structure, in driving engagement with the bull gear, and thus effective to impart driving torque to the rake structure.

2. The apparatus according to claim **1**, with the addition of a bridge structure extending radially of the tank having its inner end supported on said upper platform structure within the area surrounded by said upper annular bearing.

3. The apparatus according to claim **1**, wherein the pier is in the form of a hollow structure providing a pit, wherein sludge pump means with pipe connections are arranged for moving sludge collected by the rake structure upwardly through said pit as well as through the areas surrounded by said lower- and upper annular bearings and then laterally across the tank to disposal.

4. The apparatus according to claim **3**, with the addition of a bridge structure extending radially of the tank, and having its inner end supported upon said upper platform structure in the area surrounded by said upper annular bearing, and wherein said pipe connections comprise a delivery section extending along and supported by said bridge.

5. The appartus according to claim **1**, wherein said upper platform structure is supported by a plurality of columns extending upwardly from the top end of said pier.

6. The apparatus according to claim **1**, wherein said upper bearing has an annular base portion, with the addition of means for raising and lowering said annular base portion together with the rake structure, while maintaining concentricity of said base portion with the axis of rotation of the rake structure.

7. The apparatus according to claim **1**, wherein said upper bearing has an annular base member, wherein an upright cylindrical vertical guide structure is mounted upon said upper platform structure concentric with said bearing, for guiding vertical movement of said annular base member for raising and lowering said bearing and said rake structure.

wherein a bridge structure is provided extending radially of the tank, and having its inner end supported upon said vertical guide member, and

wherein a jack device is provided within said vertical guide member, supported by said upper platform structure, and havng a crosshead at the top located above said inner end of the bridge structure, and having depending support connection with the annular base member of said upper bearing for raising and lowering the rake structure incident to up-and-down movement of said crosshead by the operation of said jack device.

8. The apparatus according to claim **1**, with the addition of guide means effective between the pier and the surrounding cage portion, and located below the liquid level in the tank.

9. The apparatus according to claim **1**, with the addition of guide means effective between the foot end portion of the pier and the surrounding cage portion of the rake structure.

10. The apparatus according to claim **1**, wherein said upper bearing has an annular base portion, with the addition of lifting means for raising and lowering the rake structure, which comprise jack devices operatively connected to said annular base portion of the upper bearing for raising and lowering the same together with the rake structure, and vertical guide means for said base portion.

11. The apparatus according to claim **10**, wherein said vertical guide means comprise a vertical cylindrical member mounted atop said upper platform structure.

12. The apparatus according to claim **10**, wherein said vertical guide means comprise a vertical cylindrical member mounted atop said upper platform structure, and wherein said lifting means extend within said cylindrical member.

13. The apparatus according to claim **10**, with the addition of combined peripheral and vertical guide means effective between the foot end portion of the pier and the surrounding cage portion of the rake structure.

14. The apparatus according to claim **10**, wherein said vertical guide means comprise a vertical cylindrical member mounted atop said upper platform structure, with the addition of a bridge structure extending radially of the tank, and having its inner end supported upon said cylindrical member.

15. The apparatus according to claim **14**, wherein said pier is in the form of a hollow structure providing therein an operating pit, wherein pump means with pipe connections are arranged for moving sludge collected by the rake structure, upwardly through said pit as well as through the areas surrounded by said upper and lower annular bearings, and by said cylindrical vertical guide member, and wherein said pipe connections comprise a delivery section extending along, and supported by said bridge structure.

16. The apparatus according to claim **10**, wherein the upper bearing comprises means providing self-adjustability, and wherein stabilizing guide means are provided effective between said center pier and the surrounding cage portion.

17. The apparatus according to claim **16**, wherein said stabilizing guide means are located below the liquid level in the tank.

18. The apparatus according to claim **16**, wherein said stabilizing guide means are associated with the foot end portion of the pier.

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JAMES L. DECESARE, Primary Examiner

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210—519