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C. H. SCOTT

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BALANCED DRIVE MECHANISM FOR LARGE THICKENERS

Filed March 6, 1956

4 Sheets-Sheet 1

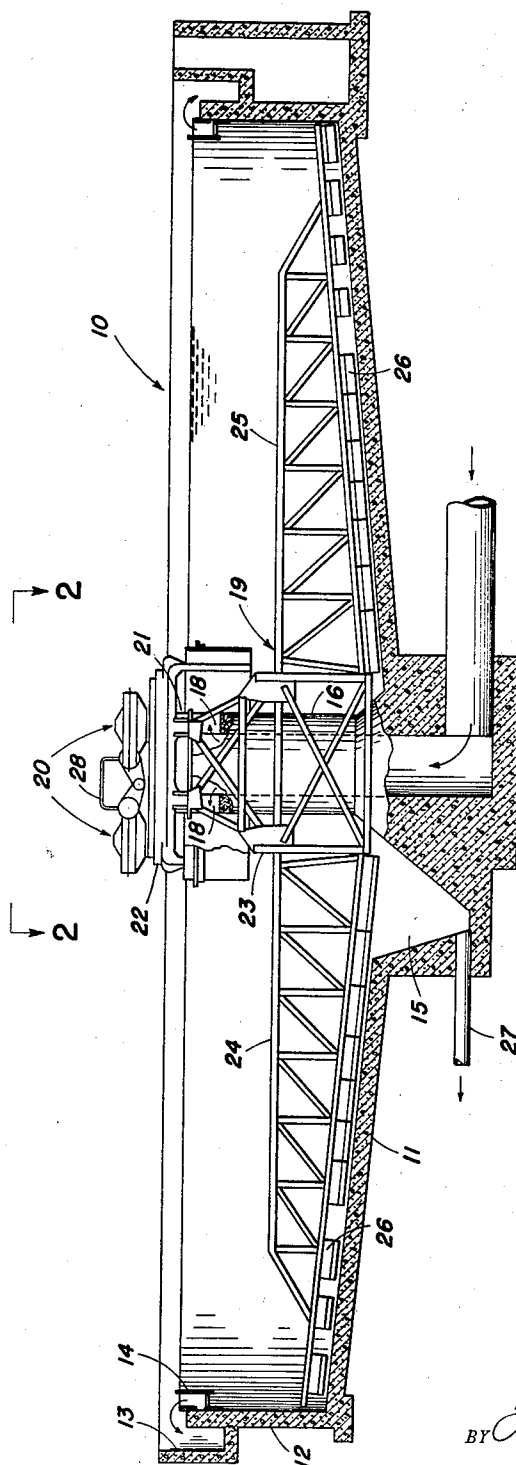


Fig. 1.

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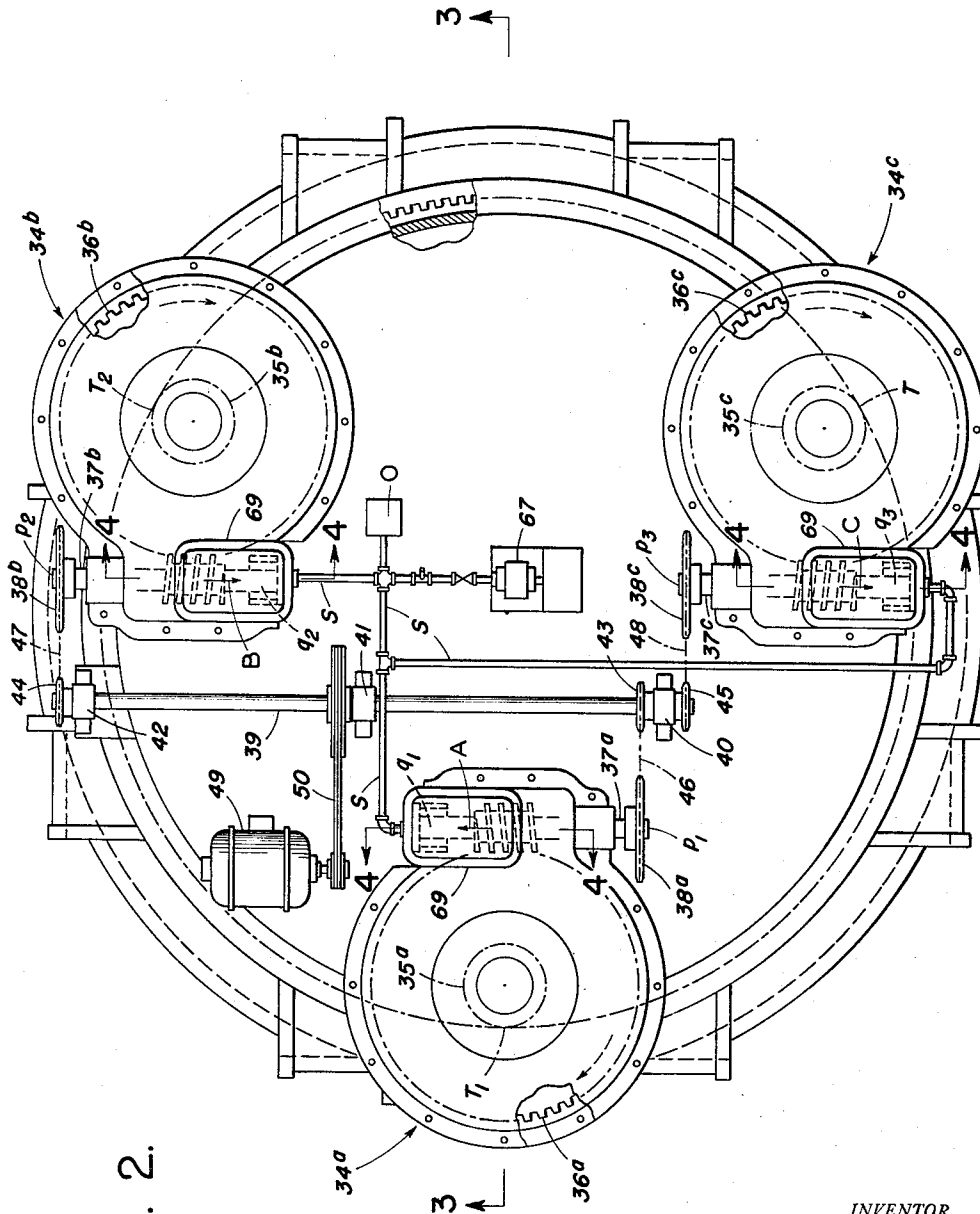


Fig. 2.

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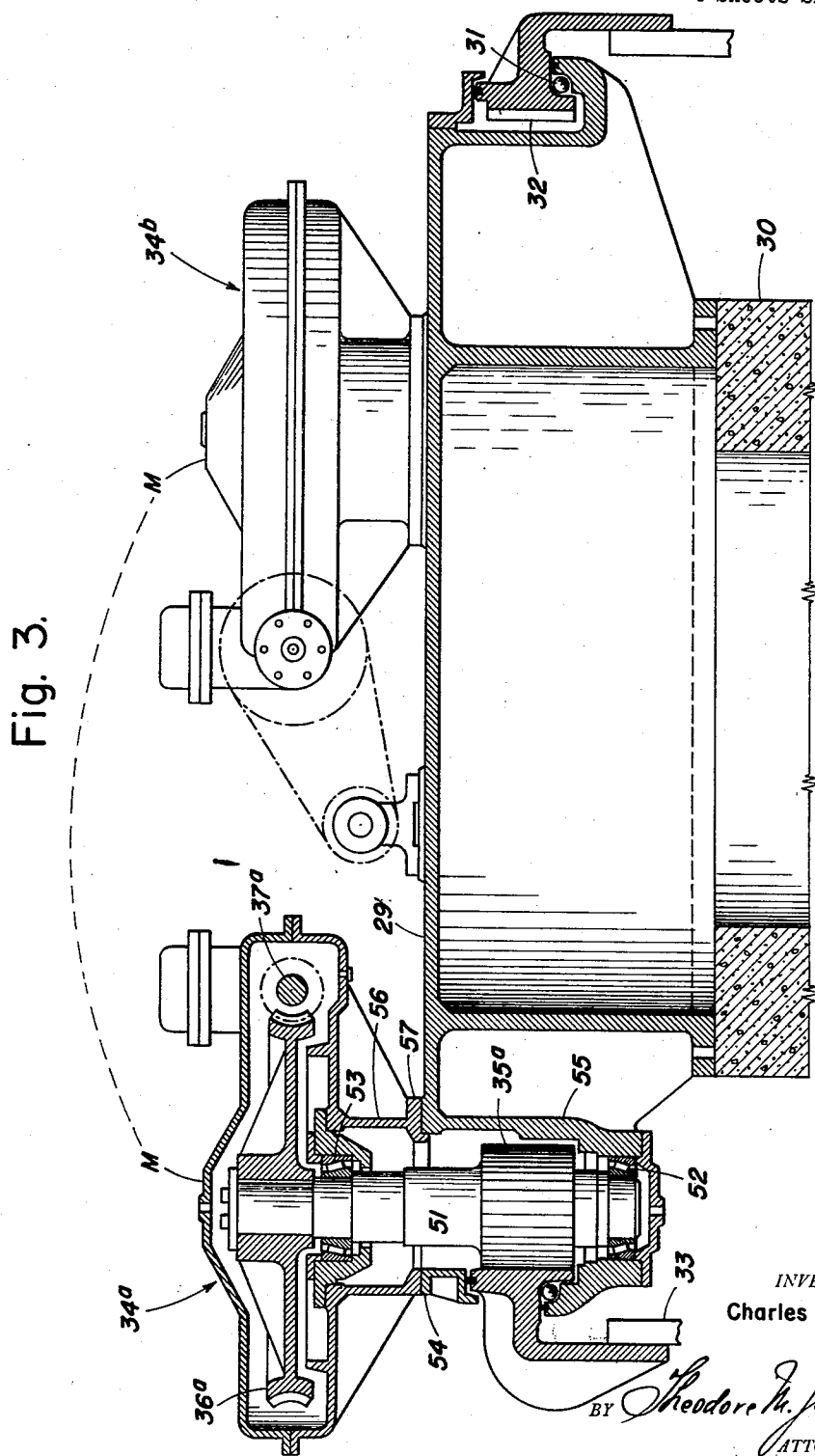
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BALANCED DRIVE MECHANISM FOR LARGE THICKENERS

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Fig. 5.

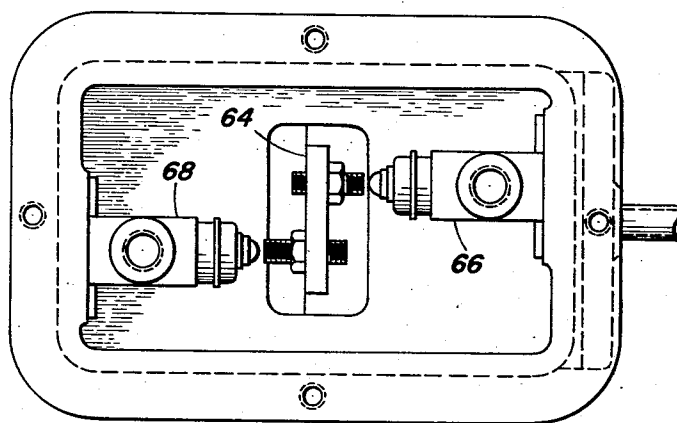
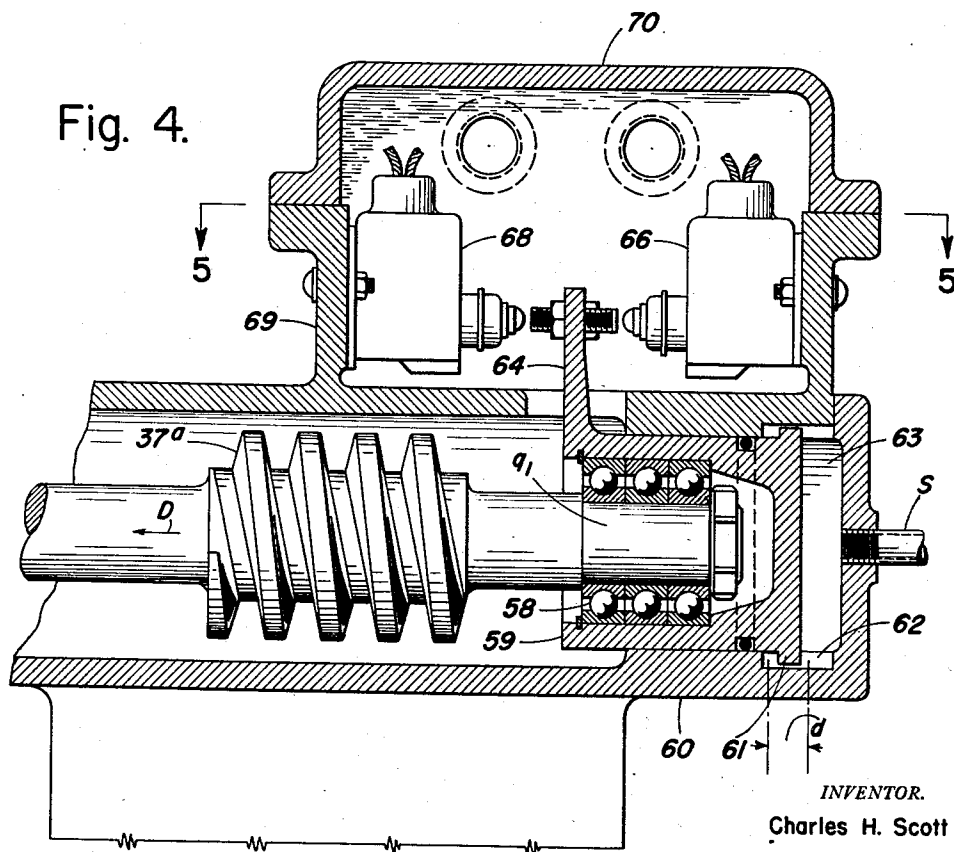


Fig. 4.



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BALANCED DRIVE MECHANISM FOR LARGE THICKENERS

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8 Claims. (Cl. 74-410)

This invention relates to settling tanks to which a feed suspension of solids is admitted, while clarified liquid overflows at the periphery, and a rotary rake structure conveys settled solids over the tank bottom to a zone or point of outlet usually at the center of the tank; more particularly, this invention relates to improvements in the power drive mechanism or drive head for the rotary sediment raking structure in such a tank.

This invention relates to settling tanks to which a feed suspension of solids is admitted, while clarified liquid overflows at the periphery, and a structure conveys settled solids over the tank bottom to a zone or point of outlet usually at the center of the tank.

More particularly, this invention relates to improvements in the power drive mechanism or drive head for the rotary rake structure, where the mechanism is of the kind that imparts to the rake structure a true or balanced drive torque. A balanced torque drive in the sense of this invention comprises a main or bull gear at the top of the rotary structure, a source of motor power, and torque transmitting means whereby interbalanced shares of the motor torque are applied equally at a plurality of points along the periphery of the main gear. In this way each point of torque application on the main gear receives its equal share of the motor torque so that there is imparted to the rake structure as a whole a mechanically efficient true driving torque at all times.

Also this invention relates to improvements in overload responsive means for indicating overloads encountered by the rake structure.

One object is to provide balanced torque drive means which are simple and dependable, as well as structurally highly adaptable in that they should readily lend themselves to apply interbalanced shares of driving torques at two or at more than two points of torque application along the periphery of the main gear.

That object according to this invention is attainable in a drive mechanism which comprises a torque-responsive yieldable member for each point of torque application and in which the respective yieldable members are operatively interconnected by a hydraulic pipe pressure system to restrain, and hydraulically interbalance the torque reactions of these members.

Another object is to provide simple and dependable means for indicating overload conditions affecting the rake structure. That object is attained by providing pressure responsive means governed by the fluid pressure of the hydraulic interbalancing system, whereby excessive pressure in the balancing system is employed is the criterion of overload.

In one embodiment the drive mechanism of each of the torque-responsive members is in the form of a wormshaft which is axially yieldable while exerting its torque reaction force.

More specifically, although in no limiting sense, that embodiment is here illustrated in connection with the rotary rake structure of the type that is supported upon,

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and rotates about a center pier. In that instance, the drive mechanism comprises an internal gear, a plurality of pinions engaging the gear at the respective points of torque application thereof, an axially yieldable torque-responsive wormshaft driving each pinion, and torque transmitting means for simultaneously imparting drive torque to the respective wormshafts from a source of motor power, all mounted upon a platform atop the pier and substantially within the area defined or surrounded by the internal gear. In addition, there is provided upon this platform an hydraulic pressure pipe system operatively interconnecting the respective torque-responsive wormshafts in a manner to restrain their respective yielding movements while interbalancing the respective axial torque reaction forces exerted by these shafts.

In summary, this invention provides drive mechanism for engaging the main gear of the rotary rake structure at a plurality of points of torque application, which mechanism includes for each point of torque application a torque-responsive yieldable member, with the addition of a hydraulic pressure pipe system operatively interconnecting all the torque-responsive members in a manner to hydraulically interbalance the respective torque-reaction forces exerted by these members.

In the drawings:

Figure 1 is a semi-diagrammatical vertical sectional view of which certain type of settling tank with rake drive mechanism having axially yieldable wormshafts representing the torque responsive elements and also indicating the hydraulic pressure pipe system for interbalancing the wormshafts.

Figure 2 is an enlarged detail plan view taken on line 2-2 of Figure 1 of the drive mechanism.

Figure 3 is a further enlarged sectional view taken on line 3-3 of the drive mechanism of Figure 2.

Figure 4 is a greatly enlarged detail view of one of the limit switch boxes associated with the respective torque-responsive wormshafts, for automatically providing make-up fluid for the hydraulic pressure system.

Figure 5 is a top view, with box cover removed, of the limit switch device of Figure 4.

In the semi-diagrammatic Figure 1, there is shown, by way of example, a settling tank of the type in which a center pier supports the rotary structure as well as the mechanism for rotating the rake structure. The tank comprises a shallow conical bottom 11, a cylindrical wall 12, a peripheral overflow launder 13 with annular scum baffle 14. The bottom has a sludge discharge sump 15 near a center pier 16 which is hollow and into which leads a feed influent 17 below the tank bottom. Feed suspension rises in the hollow pier to discharge from the top end thereof radially in all directions as through feed openings 18.

The pier 16 is surrounded by, and provides support for a rake structure 19 as well as for driving mechanism 20. The pier is topped by a platform structure 21 providing annular bearing means for the rake structure 19 and more specifically for an internal bull gear indicated at 22. The rotary rake structure thus comprises the bull gear 22, a central cage structure 23 rigidly connected to the bull gear 22 and extending downwardly therefrom surrounding the pier. A pair of usual rake arms 24 and 25 extend from the central cage structure 23, carrying the usual sets of inclined plowing raking blades 26 which convey sediment or sludge over the tank bottom to and into the sump 15 when the rake structure rotates. Sludge discharge from the sump is indicated by a sludge withdrawal pipe 27.

The platform structure indicated at 21 carries the drive mechanism 20 mounted substantially within the area

defined by internal bull gear 22, and it also carries the hydraulic pipe system indicated at 28 which is for the purpose of hydraulically interbalancing the torque reaction forces arising from the respective points of torque application at the bull gear 22 as will be described in detail further below.

In the enlarged detail Figures 2 and 3, a cast-iron stationary platform structure 29 fixed atop a center pier indicated at 30, supports an annular ball bearing 31 which carries rotatable thereon an internal bull gear 32 constituting the top end portion of a rotary rake structure indicated at 33.

The platform structure 29 also carries a drive mechanism M for imparting torque to the internal bull gear 32 at a plurality of points of torque application T, T₁ and T₂. The drive mechanism M is here shown to comprise a plurality of three identical worm drive units 34^a, 34^b and 34^c mounted on the platform structure 29, each having a pinion 35^a, 35^b and 35^c respectively engaging the bull gear 32 at the respective points of torque application T, T₁ and T₂. Each of the drive pinions is rigidly and concentrically connected to a worm gear 36^a, 36^b and 36^c respectively, which worm gears are driven by wormshafts 37^a, 37^b and 37^c.

Each of these wormshafts has what is herein termed a free or protruding end portion p₁, p₂ and p₃ respectively carrying fixed thereon a sprocket 38^a, 38^b and 38^c respectively whereby the wormshafts are driven simultaneously from a single counter shaft 39 also mounted on the platform structure 29 as in horizontal bearings 40, 41 and 42. That is to say, the counter shaft 39 has fixed thereon a set of sprockets 43, 44, and 45 driving the sprockets 38^a, 38^b and 38^c respectively through chains indicated at 46, 47 and 48 respectively. A motor 49 drives the counter shaft 39 as through a chain element 50 or other suitable power transmitting drive element.

The opposite end of each wormshaft herein termed the encased ends q₁, q₂ and q₃ respectively, is surrounded by a housing portion in which it is allowed to exert its axial thrust reaction against a body of hydraulic pressure fluid confined in an hydraulic pressure pipe system common to all three wormshafts, so that the torque reaction forces or thrust reactions of the three wormshafts are in fact interbalanced through this fluid body and thus equalized at all times during the operation of the mechanism. This hydraulic interbalance insures that equal shares of the motor torque are thus applied at the respective points of torque application T, T₁ and T₂ on the bull gear 32.

The interbalancing hydraulic system as indicated in Figure 2 is in the form of a pipe system "S" containing the hydraulic fluid, operatively by interconnecting the encased ends q₁, q₂ and q₃ of the respective wormshafts in a manner described in detail further below.

The worm drive units 34^a, 34^b and 34^c are identical so that only one of them, for instance the unit 34^a need here be described in further detail.

The worm drive unit 34^a comprises the aforementioned pinion 35^a, worm gear 36^a, and wormshaft 37^a. Pinion 35^a has a vertical pinion shaft 51 the upper end of which has fixed thereon the worm gear 36^a. The pinion shaft 51, rotates in a lower thrust bearing 52 and an upper guide bearing 53. Both bearings 52 and 53 are mounted in a gear housing 54 comprising a lower section 55 and an upper section 56. The lower housing section 55 containing the pinion 35^a with the lower bearing 52, constitutes a pocket formed by the platform structure 29 itself. The upper housing section 56 containing the upper bearing 53 as well as the worm gear 36^a and wormshaft 37^a is fastened as by flange connection 57 to the top of the platform structure 29.

Since all three wormshafts 37^a, 37^b and 37^c are operatively connected to the hydraulic pressure pipe system "S" in the identical manner, namely by way of their respective encased end portions q₁, q₂ and q₃, it will suffice here to refer to detail Figures 4 and 5 in describ-

ing this relationship as exemplified by wormshaft 37^a of worm drive unit 34^a.

In detail Figures 4 and 5 the encased end portion q₁ of wormshaft 37^a rotates in a combination transverse and thrust bearing 58 contained in a cylindrical or piston-shaped member herein briefly termed the piston 59 which is sealingly slidable horizontally within a cylindrical housing portion 60 that is part of the upper gear housing section 56 and horizontally protruding therefrom. However, this potential axial sliding movement of the wormshaft is limited to a distance "d" due to the fact that the outer end of the piston member 59 has a protrusion 61 lodging in a recess 62 formed in the surrounding cylindrical portion 60. The piston 59 thus forms with the surrounding cylindrical portion 60 a hydraulic pressure pipe system "S."

Hence, if the pipe system "S" is properly supplied with hydraulic fluid to the extent of filling the respective hydraulic chambers 63 and forcing the respective pistons 59 into their most retracted position within the recess 62, and if drive motor torque is applied to the drive mechanism, each point of torque application T, T₁ and T₂ at the bull gear 32 will receive its equal share of the driving torque because of the hydraulic interbalance through pipe system "S" of the thrust reaction forces exerted by the respective wormshafts 37^a, 37^b, 37^c in the directions indicated by arrows A, B and C (see Fig. 2).

In connection with the hydraulic interbalancing system "S" there are here also provided devices for automatically supplying make-up fluid to that system. That is to say, loss or leakage of hydraulic fluid from the pipe system "S" will result in a corresponding axial displacement of the wormshafts in the direction of the thrust reactions A, B and C (see Fig. 2), even though without necessarily disturbing the existing hydraulic interbalance itself.

When this axial displacement of the wormshafts reaches a predetermined degree, a contact carrier or finger 64 being unitary with the piston 59 closes a limit switch 66 to start a pump-motor unit 67 (see Fig. 2). At the rate at which make-up fluid thus enters the pipe system "S," the axial displacement of the wormshafts will be corrected as the shafts are being forced back in the direction of thrust arrow D (see Fig. 4) until finger 64 actuates an opposite limit switch 68 to stop the pump motor. The limit switches 66 and 68 are mounted in a switch box 69 rising from the horizontal housing portion 60, and provided with a box cover 70. Such switch box in the plan view of Figure 2 is shown to overlie the respective encased end portions q₁, q₂ and q₃ of the respective wormshafts 37^a, 37^b and 37^c.

At "O" there is diagrammatically indicated an overload responsive device that will react to an excessive rise in the pressure of the fluid in the hydraulic balancing system "S." That is to say, in case the rake structure in the tank should encounter an excessive sludge load, such overload will manifest itself in a corresponding rise in pressure of the hydraulic fluid that is trapped in the interbalancing system "S."

When that condition develops, the overload-responsive device will function automatically to sound an alarm or to stop the drive motor 49, or to do both. The overload responsive function may be such as to sound an alarm and to stop the motor sequentially or simultaneously.

It is to be understood that this invention need not be limited to the mechanism as embodied in the center pier type of settling tank herein shown. For instance, the invention may also be embodied in a drive mechanism in which the torque-responsive yieldable elements are other than the axially yieldable wormshafts herein shown.

Still another embodiment would be in a mechanism in which the bull gear itself is in the form of a worm gear, and the torque-responsive drive elements are represented by a plurality of wormshafts directly engaging this bull gear at the respective points of torque application

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thereof. A suitable application of that embodiment is in the type of settling tank in which the rotary raking structure and its drive mechanism are supported from an overhead structure spanning the tank. In that instance, the rotary rake structure may comprise a vertical, solid or tubular shaft, the top end of which has fixed thereto a gear to which the driving torque is applied at a plurality of points.

Furthermore, the invention is not limited to the points of torque applications T , T_1 and T_2 of the embodiment shown, inasmuch as there may be only two such points diametrically opposite to one another, or else even more than three such points equidistantly spaced with respect to one another.

As this invention may be embodied in several forms without departing from the spirit of essential characteristics thereof, the present embodiment is therefore illustrative and not restrictive, since the scope of the invention is defined by the appended claims rather than by the description preceding them, and all changes that fall within the metes and bounds of the claims, or equivalents of such metes and bounds, are therefore intended to be embraced by the claims.

I claim:

1. Drive mechanism for a rotary structure turntable about a vertical axis upon an annular thrust bearing mounted upon a supporting frame, such as the rotary rake structure of a center pier type sedimentation tank where the rake has a central cage portion rotatably supported upon and surrounding the center pier, and the mechanism is mounted upon said frame supported by said pier, which mechanism comprises an internally toothed bull gear provided at the top end of the cage portion for rotating the rake structure, a plurality of trains of torque transmitting elements, disposed within the space substantially defined by the area of said bull gear, said trains terminating at their outer ends in drive pinions having driving engagements with said bull gear, a torque imparting motor with torque distributing means for imparting positive drive torque to each said train, and means for interbalancing said drive torques imparted to said trains to attain substantially a net balanced drive torque effective upon the bull gear; characterized thereby that each said train comprises a torque-responsive yieldable member exerting a thrust reaction when the mechanism is in operation, with the addition of a hydraulic pressure communicating pipe system containing a fluid pressure-propagating medium, operatively interconnecting said torque-responsive members to exert upon them interbalanced restraining forces simultaneously through said fluid medium thereby interbalancing the torque reaction forces exerted by said yieldable members, which system comprises intercommunicating pressure branch pipes leading to the respective torque-responsive members, and a communicating chamber at the outer end of each branch pipe and operatively associated with a respective torque-responsive member and being expandable in opposition to the torque reaction force thereof, each said train comprises a worm drive for each respective drive pinion, which worm drive has a housing and a horizontal worm shaft representing said respective torque-responsive member and having a driven end and a free end, and in which said expandable member comprises a cylinder constituting part of said housing and a hollow piston having provided in the hollow thereof combined transverse and thrust-bearing means for said free end of the worm shaft.

2. Drive mechanism according to claim 1, in which said plurality comprises three trains of torque transmitting elements, each train comprising a worm drive to each respective drive pinion, which worm drive has a horizontal wormshaft representing said torque-responsive member and having a driven end and a free end, said free end having operatively associated therewith said

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communicating chamber, and in which said torque distributing means comprise a master shaft mounted on said frame to extend parallel to said worm shafts and positive rotation transmitting means between said master shaft and each driven end of the said worm shaft.

3. Drive mechanism for a rotary structure supported by a frame, which structure has a bull gear for rotating the same, and has associated therewith a plurality of torque transmitting drive pinions engaging said bull gear, at a plurality of points of simultaneous torque application, said points of application being substantially evenly spaced with respect to one another along the periphery of said bull gear, a drive motor and torque distributing gear train means for imparting positive drive torque simultaneously to said drive pinions, characterized thereby that each said train comprises a torque-responsive yieldable member, with the addition of a hydraulic pressure pipe system containing a pressure propagating fluid medium, operatively interconnecting said torque-responsive members to provide interbalanced restraining forces through said medium simultaneously upon said yieldable members thereby interbalancing the torque reaction forces exerted by said yieldable members, said system comprising intercommunicating pressure branch pipes leading to the respective torque-responsive members, and a communicating pressure chamber at the end of each branch pipe and operatively associated with a torque-responsive member and being expandable in opposition to the torque reaction force thereof, said system including means responsive to predetermined movement of said yieldable members to supply said system with additional fluid medium.

4. In a multi-drive transmission the combination which comprises a plurality of gear trains each having a worm gear mounted on an input shaft and an intermediate reduction gear train driven by said worm gear, drive means driving said input shafts, a single bull gear driven by said plurality of reduction gear trains, a plurality of cylinders, a plurality of pistons slidable in each said cylinder, bearing means mounting one end of each said shafts for rotation relative to an associated piston and against relative axial movement, and a hydraulic pressure system operatively associated with each said cylinder whereby each said worm gear through fluid medium in said system is yieldably intermeshed with its associated gear reduction train and all said worm gears and reduction train are intermeshed under equal pressure.

5. In combination with a transmission comprising a plurality of gear trains, each said gear train having an input gear, an intermediate reduction gear and a single output gear, a driven shaft carrying each said input gear, single drive means driving said input shafts transverse and thrust-bearing means interconnecting each said shaft with a piston, said piston slidable within a cylinder, a hydraulic fluid pressure system operatively associated with each said cylinder, means responsive to predetermined movement of said pistons to supply said system with additional fluid under pressure, and hydraulic pressure responsive overload means responsive to the hydraulic pressure of said system to cut off said drive means.

6. In a multi-drive transmission the combination which comprises, a plurality of gear trains each having a worm gear mounted on an input shaft and an intermediate reduction gear train driven by said worm gear; drive means driving said input shaft; a single bull gear driven by said plurality of reduction gear trains; a plurality of cylinders; a plurality of pistons slideable in each of said cylinders; transverse and thrust bearing means mounting one end of said shaft for rotation relative to an associated piston and against axial movement relative thereto so that said shaft and piston will axially move together, wherein at least said transverse bearing means are anti-friction bearing means; and a hydraulic pressure system operatively associated with each of said cylinders whereby each

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said worm gear through fluid medium in said system is yieldably intermeshed with its associated gear reduction train and all said worm gears and reduction trains are intermeshed under equal pressure.

7. In a multi-drive transmission the combination which comprises, a plurality of gear trains each having a worm gear mounted on an input shaft and an intermediate reduction gear train driven by said worm gear; drive means driving said input shaft; a single bull gear driven by said plurality of reduction gear trains; a plurality of cylinders; a plurality of pistons slideable in said cylinder at least one of which pistons has an actuating portion extending laterally therefrom; means mounting one end of said shaft for rotation relative to an associated piston and against axial movement relative thereto so that said shaft and piston will axially move together; a hydraulic pressure system operatively associated with each of said cylinders whereby each said worm gear through fluid pressure medium in said system is yieldably intermeshed with its associated gear reduction train and all said worm gears and reduction train are intermeshed under equal pressure; and means actuated by the actuating portion of said piston to start the supply of additional fluid medium to said system in response to predetermined axial movement of said piston in one direction, and to stop the supply in response to predetermined movement in the opposite direction.

8. In a multi-drive transmission the combination which comprises, a plurality of gear trains each having a worm gear mounted on an input shaft and reduction gear train driven by said worm gear; drive means driving said input

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shaft; a single bull gear driven by said plurality of reduction gear trains; a plurality of cylinders; a plurality of pistons slideable in said cylinders; bearing means mounting one end of said shaft for rotation relative to an associated piston and against axial movement relative thereto so that said shaft and piston will axially move together; a hydraulic pressure system operatively associated with each of said cylinders whereby each said worm gear through fluid pressure medium in said system is yieldably intermeshed with its associated gear reduction train and all said worm gears and reduction trains are intermeshed under equal pressure; and means actuated by said piston to supply additional fluid pressure medium to said system comprising a first limit switch actuated by said piston for starting the supply in response to predetermined axial movement of said system in one direction, and a second limit switch actuated by said piston for stopping the supply in response to predetermined axial movement of said piston in the opposite direction.

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