Aug. 26, 1941. M. ARANGO 2,253,500

LIQUID CLARIFYING APPARATUS

Filed Aug. 30, 1938 3 Sheets-Sheet 1

Fig. 1.

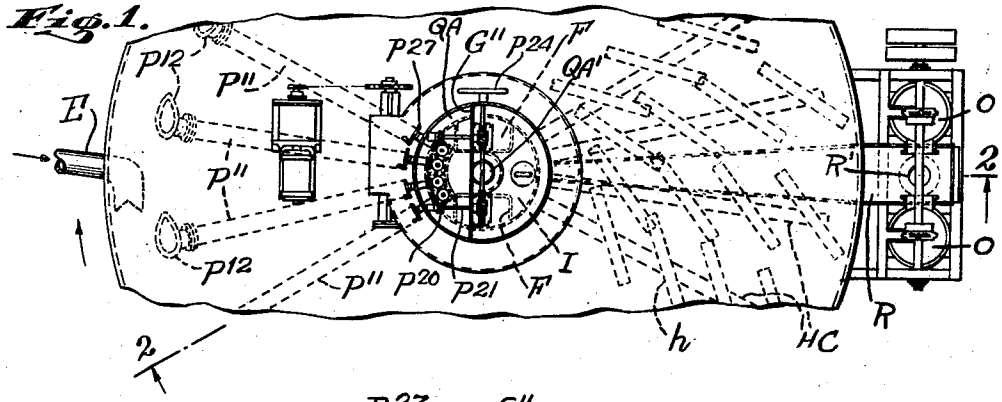
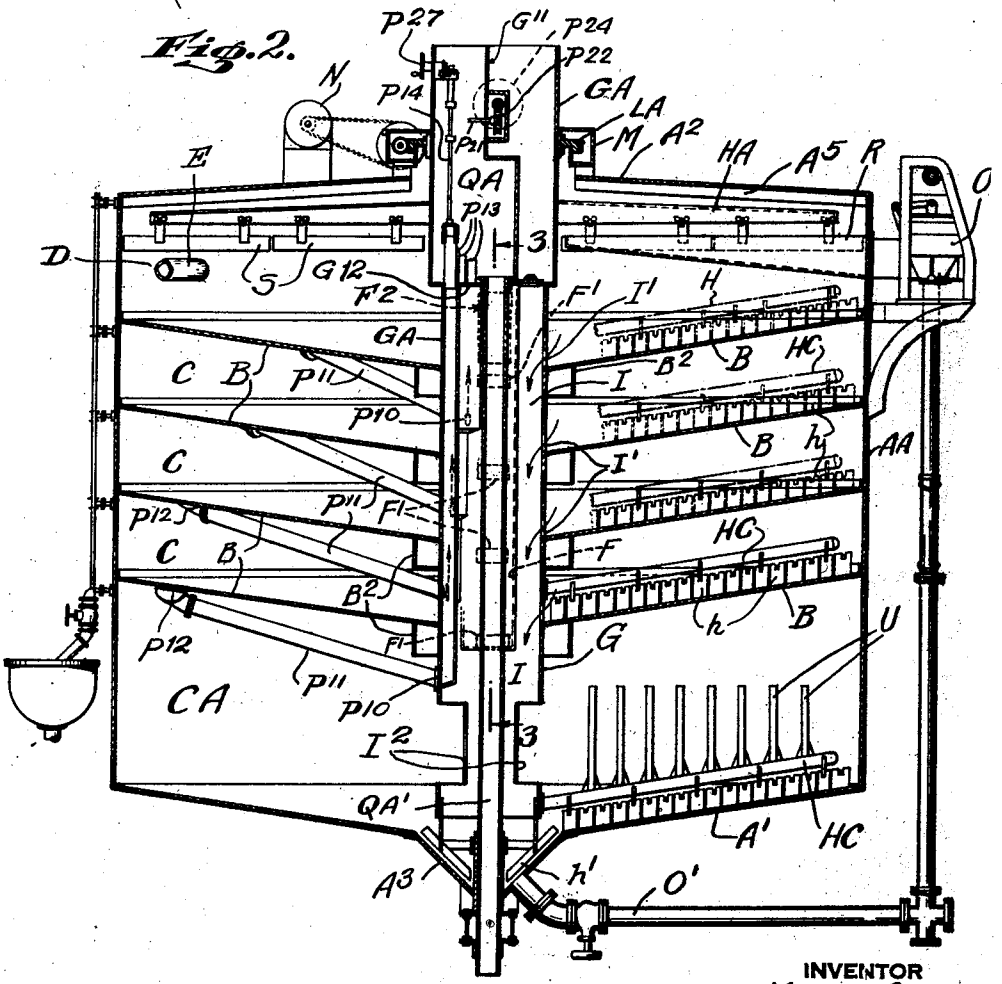


Fig. 2.



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Fig. 4.

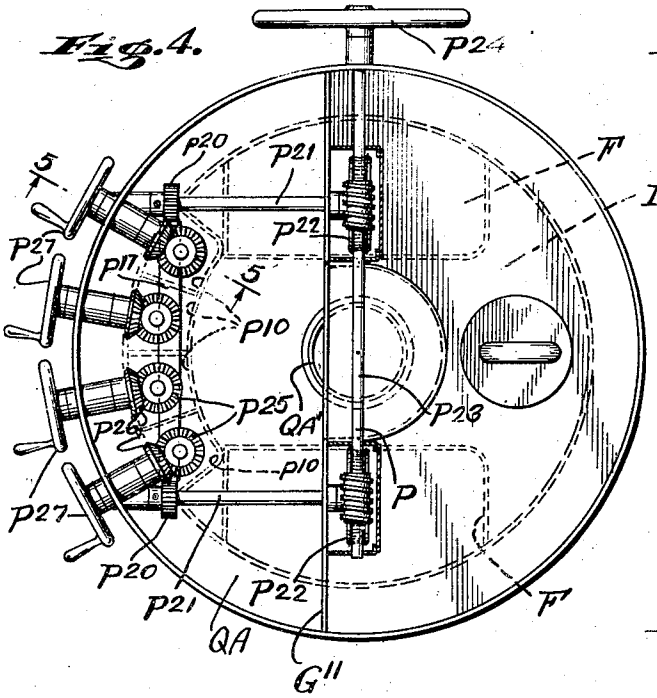


Fig. 3.

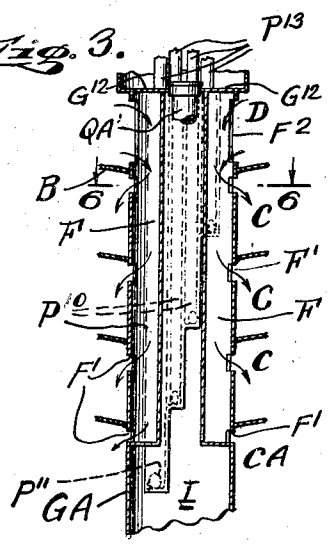


Fig. 5.

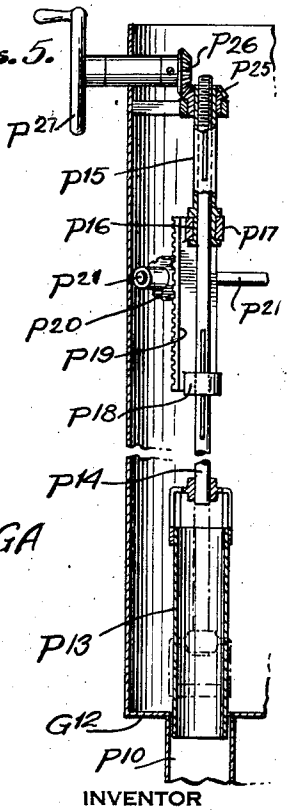


Fig. 7.

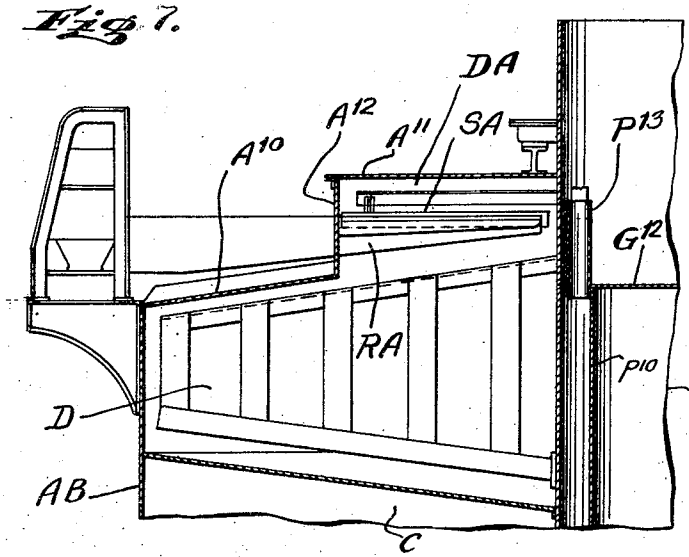
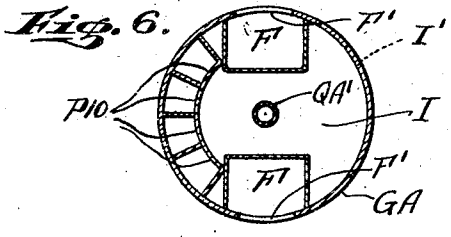


Fig. 6.



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Fig. 10.

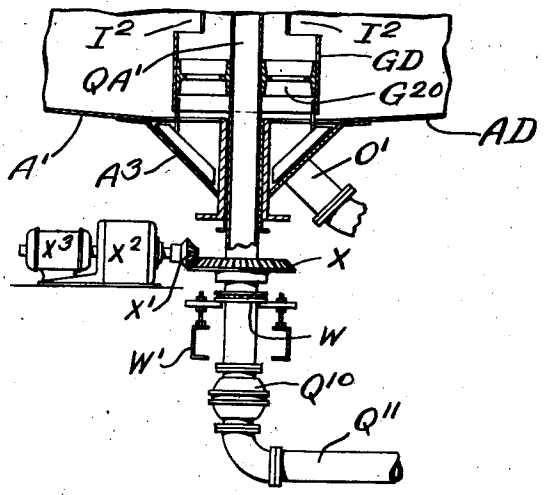


Fig. 8.

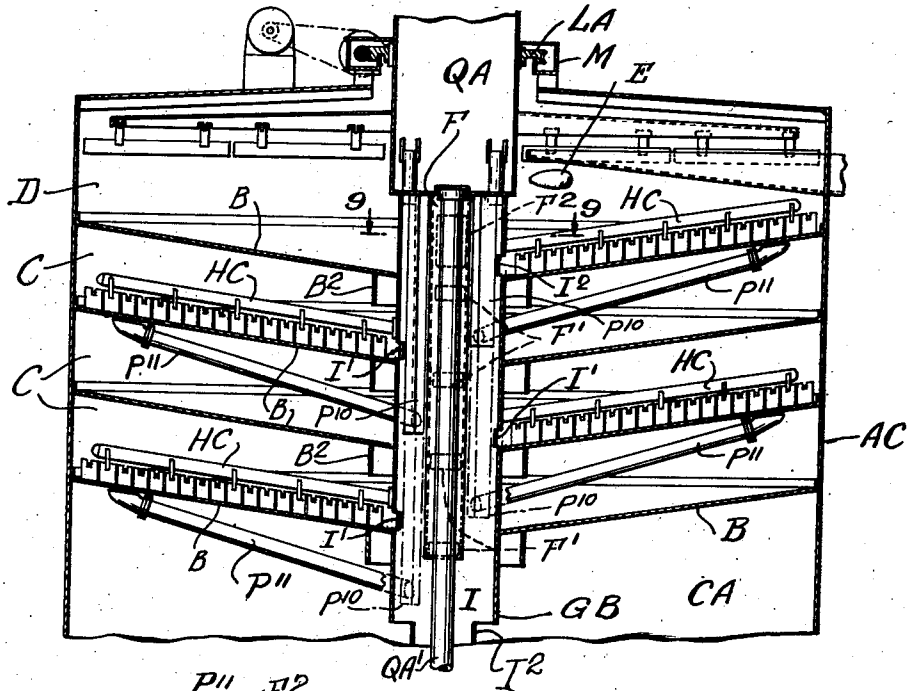
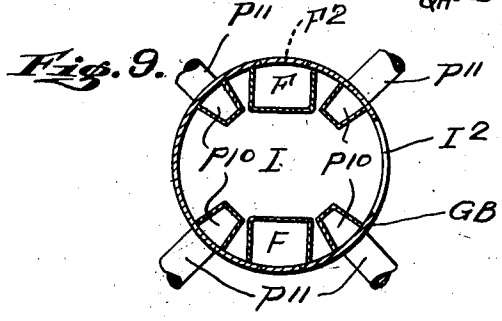


Fig. 9.



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UNITED STATES PATENT OFFICE

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LIQUID CLARIFYING APPARATUS

Miguel Arango, Habana, Cuba, assignor to Petree & Dorr Engineers, Inc., New York, N. Y., a corporation of Cuba

Application August 30, 1938, Serial No. 227,481

4 Claims. (Cl. 210—55)

The invention relates to tray clarifier or thickeners, for the sedimentation of solids suspended in liquids and the removal of the sedimented solids. More particularly the invention is designed for use in the clarification of the juices to be treated incident to the making of cane and beet sugar, although it has other uses.

The primary object of the invention is to provide improved means for withdrawing clarified liquid from the different superposed clarifying compartments of the tray clarifier or thickener. More specifically, it is the object of the invention to locate within the clarifier tank, clear liquid drawoff provisions heretofore located externally of the tank, whereby the cost and weight of the clarifying unit may be reduced, and some reduction may be effected in the space required to accommodate the unit.

My invention is characterized by the incorporation of clarified liquid drawoff provisions in a rotating structure, provided, in accordance with standard practice, to work solids collecting on each of the trays forming the bottom walls of the different clarifying compartments, to the center of the corresponding compartment, so that said solids, or mud, may pass downwardly out of the compartment, through a central opening in its bottom wall, said rotating structure comprising a vertical body or shaft portion extending through the central openings in the bottom walls of the compartments, and supporting one or more scraper arms with attached scraping means in each clarifying compartment.

In the preferred practical form of the present invention, the shaft or body portion of the rotating structure is a hollow drum with internal partitions providing a clarified liquid receiving chamber adjacent the top of the clarifier, and separate vertical, standpipe or up-flow passages receiving clarified liquid at their lower ends from the different clarifying compartments, and each discharging at its upper end into said receiving chamber. In the preferred form of the invention, each standpipe or up-flow passage receives clarifying liquid from the corresponding compartment through a hollow arm or pipe attached at one end to the shaft or body portion of the rotating structure, and having an inlet at its free end which opens to the compartment in the upper portion thereof and at a distance from said shaft. The preferred construction also includes means accessible for adjustment from the exterior of the clarifier, for regulating the relative amounts of clarified liquid withdrawn from the different clarifying compartments.

The improved drawoff provisions are adapted for use in tray clarifiers of various known types and forms, including, in particular, the most usual type of Dorr clarifier, in which liquid to be clarified is supplied to the different clarifying compartments from a feed chamber above said compartments through a central feed and mud-well passage through which settled solids are moved into the lowermost compartment from each compartment above it. The invention may be used with especial advantage, however, in a clarifier of the novel type disclosed and claimed in a co-pending application for patent of William C. Weber and William E. Geissler, Serial No. 227,464, filed August 30, 1938.

In the clarifier disclosed in said co-pending application, the body or shaft of the rotating structure carrying the mud scrapers in the clarifying compartments, is formed with vertical passages and lateral ports which provide a solids flowpath for the downflow of solids received through separate lateral ports from the different upper clarifying compartments, and which provide a separate vertical feed flow-path for the downflow of liquid to be clarified to the different clarifying compartments, from a feed chamber above the clarifying compartments in which the liquid to be clarified is conditioned to form relatively large and readily settleable floc aggregates, which may pass without objectionable disintegration through said feed flowpath. A rotating structure shaft practically suitable for the purposes of said co-pending application, may be readily adapted to the purposes of the present invention, without interference with the attainment of the purposes of said co-pending application, and with little or no increase in the size of the shaft.

The clarifying liquid received in said receiving chamber, is advantageously withdrawn from the clarifier unit through a vertical pipe extending within the rotating structure shaft, from the receiving chamber down to and through the bottom wall of the clarifier. Said pipe may be either stationary or arranged to rotate with the rotating structure.

The various features of novelty which characterize the present invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages, and specific objects obtained with its use, reference should be had to the accompanying drawings and descriptive matter, in which various forms of apparatus adapted for use

in the practice of the invention are illustrated and described.

Of the drawings:

Fig. 1 is a somewhat diagrammatic plan view, and

Fig. 2 is a section on the broken lines 2—2 of Fig. 1, illustrating one form of the improved clarifier unit.

Fig. 3 is a partial vertical section on the line 3—3 of Fig. 2.

Fig. 4 is an enlarged reproduction of a portion of Fig. 1.

Fig. 5 is a partial section on the line 5—5 of Fig. 4.

Fig. 6 is a section on the line 6—6 of Fig. 3.

Fig. 7 is a partial sectional elevation, illustrating a modified form of the upper portion of the clarifier unit shown in Figs. 1 to 6.

Fig. 8 is a partial vertical section of a clarifier unit differing somewhat in form from that shown in Figs. 1 to 6.

Fig. 9 is a section on the line 9—9 of Fig. 8.

Fig. 10 is an elevation of the lower portion of a clarifier provided with a bottom drive for the central shaft.

The clarifier AA shown in Figs. 1 to 6 comprises a cylindrical tank body with bottom and top walls A′ and A^2, which are preferably conical, with the concave side of the bottom wall A′, and the convex side of the top wall A^2 uppermost. The space within the tank is divided into a plurality of superposed settling or clarifying compartments C, a lower clarifying and thickening compartment CA, and a top feed conditioning chamber or compartment D, by partitions or trays B, each formed with a central opening. Each of the trays B, as shown is conical, with its concave side uppermost, and extends to, and has its peripheral edges connected to the tank body. As shown, the compartments C, of which three are included in the clarifier shown are all alike, each being relatively shallow and of substantially less vertical depth than the bottom compartment CA, from which all of the solids settling out of the liquid are finally discharged.

The liquid to be clarified is passed into the feed chamber D of the clarifier AA through a supply pipe E, which terminates in a discharge portion alongside the cylindrical tank wall, so directed as to tend to set up a movement of the liquid in the chamber D about the tank axis. From the feed chamber D the liquid passes to the subjacent compartments through feed passages F, vertically disposed in a vertical hollow shaft or rotatable drum GA, and having vertically distributed outlet ports F′ opening to the different compartments C and CA. The shaft extends through the aligned central openings in the trays B, and supports scraper arms HC carrying scrapers *h*. The latter, as the shaft GA rotates, work the settled solids, commonly called "mud," collecting on each tray B, through a corresponding port I′, immediately above the tray, and opening into a vertical channel I in the shaft GA. Similarly arms HC and scrapers *h* and *h′* work mud accumulating on the bottom wall of A′ of the tank into the tank mud outlet A^3, shown as comprising a central conical depression in said bottom wall.

As shown, the shaft GA is a drum, made of steel plate, and two longitudinally extending trough shaped plate parts within the drum and welded at their edges to the drum, unite with the latter to form two feed passages F, separate from the single so-called "mud well" or solids passage I. Each feed passage F communicates with each of the compartments C and CA, through a corresponding port F′ opening through the peripheral wall of the drum into the upper portion of the compartment. To diffuse the entering feed, each tray B is formed with an annular depending flange B^2, positioned to form an annular feed receiving space in the upper portion of each of the compartments C and CA adjacent and surrounding the shaft G. Each such space is open at its underside to the corresponding compartment, and receives liquid to be clarified therein from the corresponding port or ports F′. As shown in Fig. 2, each feed passage F has its open upper end within the feed compartment D, and receives liquid therefrom through a vertically elongated port F^2 in the peripheral wall of the shaft G.

As shown, the mixture of solids and liquid, or mud, passing down through the channel I, is allowed to spread out in the thickening compartment CA, and the shaft G need not extend appreciably below the bottom of the feed channels F, except to avoid the necessity for supporting mud scraper arm or arms at the bottom of the compartment CA. As shown in Fig. 2, the shaft G extends nearly to the bottom of the compartment CA, but is formed with large, vertically elongated, mud outlet ports I^2.

As shown in Fig. 2, the tank top wall A^2 is stiffened by radially disposed beams A^5 so that the top wall may directly support the shaft GA and the mechanism for rotating it. As shown in Fig. 2, the shaft GA extends through and is secured to an annular rotatable gear member LA, supported in a bearing structure M, directly supported by the tank top wall A^2. The bearing structure M may comprise ball bearings supporting the member LA, and the latter may be rotated through suitable speed reducing means, by an electric motor N which also drives the mud pumps O connected in the usual manner by piping O′ to the mud outlet portion A^3 of the bottom tank wall.

Scum or floating impurities on the liquid in the feed compartment D are discharged from the latter through a foam canal or trough R extending radially through the vertical wall of the tank, and opening into a mud outlet pipe R′, which may also receive the discharge from the pumps O. Horizontal skimming blades S linked to, and suspended from arm HA carried by the shaft G, sweep the scum or floating impurities into the foam canal R. The latter also serves as an overflow trough, preventing an excessive accidental increase in the height of liquid level in the compartment D.

As shown in Fig. 2, arms U, which may be angle bar sections, are welded or riveted to the corresponding scraper arms HC, for movement through the mixture of liquid and flocculated material in the lower thickening portion of the compartment CA, to facilitate the liberation of liquid from said mixture, and thereby contribute to the thickening of the solid discharged through the outlet pipe O′, as is more fully disclosed in said co-pending application.

Said co-pending application discloses special provisions, which may be used in clarifiers constructed in accordance with the present invention, but which form no part of the present invention, and need not be illustrated or described herein, and which are adapted to accommodate some lateral displacement of the shaft GA relative to the central tray opening through which

the shaft passes, while at the same time preventing leakage through the joints between the shaft and the margins of said above openings.

Insofar as specifically described, the clarifier unit AA shown in Figs. 1–6 includes nothing claimed as original herein, but the unit, because its shaft GA is formed to include the separate feed and solids pathways formed by the passages F and I characteristic of said co-pending application, is especially well adapted for the incorporation of the improved clarified liquid drawoff provisions now to be described.

In accordance with, and for the purposes of the present invention, a clarified juice receiving chamber QA is formed within the upper portion of the shaft GA of the unit AA, by a vertically disposed partition member G^{11}, which unites with a portion of the wall of the shaft to form the side walls of said chamber, a transverse portion G^{12} which forms the bottom wall of the chamber. As shown, the bottom of the chamber QA is slightly below the normal liquid level of the chamber D.

Each of the clarifying compartments C and CA delivers clarified juice to the chamber QA through an individual standpipe passage P^{10} within the shaft GA, and formed, as shown, by welding suitably shaped metal parts to the inner wall of the hollow shaft GA. Each standpipe passage P^{10} receives clarified juice at its lower end from the corresponding compartment C or CA through a connection shown as comprising a hollow arm P^{11} secured at one end to the shaft GA and extending away from the shaft in a radial and upwardly inclined direction, and provided at its free end P^{12} with a juice inlet, which opens to the corresponding clarifying compartment adjacent its upper outer corner. As shown, the ends P^{12} of the arms P^{11} are of streamline form to minimize disturbances of the clear liquid in the portions of the clarifying compartments through which the ends P^{12} move.

Each standpipe passage P^{10} has a vertically adjustable extension at its upper end in the form of a vertically disposed pipe section P^{13}, which extends, telescopic fashion, into the upper end of the passage. Preferably, means are associated with the different standpipe extension P^{13} for vertically adjusting the different extensions independently and also simultaneously, and similarly. The adjusting means shown for the purpose comprise a separate vertically disposed rod-like part P^{14} for each extension P^{13} for, and connected at its lower end to the upper end of said pipe section. Each part P^{14} has its upper end in threaded engagement with an internally threaded sleeve member P^{15}. Each of the sleeve members P^{15} has a swivelled connection P^{16} at its lower end and with a normally stationary but vertically adjustable cross head P^{17}. The latter is also formed with a spline connection P^{18} with each of the parts P^{14}. The means shown for vertically adjusting cross head P^{17} comprises rack bar portions P^{19} of the cross head at its opposite ends, engaged each by a spur gear P^{20} carried by a corresponding shaft P^{21}. The two shafts P^{21} carry worm wheels P^{22} in mesh with worms carried by a horizontal worm shaft P^{23} journalled in bearings supported by the shaft GA and provided externally of the latter with a hand wheel P^{24}.

Each standpipe extension pipe P^{13} may be vertically adjusted independently of the others by rotating the sleeve P^{15} in threaded engagement with the corresponding part P^{14}. To effect such rotation, each sleeve part P^{15} passes through, and is in splined engagement with a bevelled gear P^{25} in mesh with a bevelled gear P^{26} which may be rotated by means of a hand wheel P^{27} carried at the outer end of a shaft which extends through the wall of the shaft GA and carries at its inner end a corresponding gear P^{26}.

The clarified liquid discharged through the standpipes and their extensions into the chambers QA, passes away from the latter through a clarified liquid delivery pipe QA′ which extends longitudinally through the hollow shaft GA and through the bottom wall of the clarified tank. Pipe QA′ may rotate with the shaft or drum GA, in which case the pipe and drum are necessarily coaxial, and stuffing box or other known provisions suitable for the purpose may be used to prevent leakage along the joint between pipe QA′ and the portion of the tank wall through which it extends, and between the pipe QA′ and the external piping receiving the liquid discharged through the pipe QA′. Or, alternatively, the pipe QA′ may be non-rotatable, in which case, stuffing box or analogous provisions may be used to prevent leakage through the joint between the pipe QA′ and the wall of the chamber QA. As shown in Fig. 2, the pipe QA′ extends axially through the conical portion A^3 of the tank bottom wall, and the mud outlet pipe O′ communicates with the compartment CA through a lateral port formed in said portion A^3.

The clarifier unit shown in Figs. 1 to 6 possesses the general characteristics and advantages of tray clarifiers of the most approved type and form. In addition, the location of the clarified liquid drawoff provisions within the tank permits of a desirable reduction in the weight and construction cost of the clarifier and also permits of some reduction in the clarifier unit floor space requirements, which may be of practical importance in some cases.

Fig. 7 illustrates a clarifier AB in which the top wall of the clarifier tank includes a conical annular outer portion A^{10}, and a separate annular inner portion A^{11} at a higher level than the portion A^{10}, and having its outer edge connected to the inner edge of the portion A^{10} by a cylindrical tank portion A^{12}. The normal liquid level in the tank wall AB, is well above the bottom of the cylindrical portion A^{12}, so that the scum skimmer SA and the cooperating scum trough RA are in the small diameter extension DA of the chamber A within the cylindrical wall A^{12}. The tank top wall portion A^{11} forms a convenient walkway for the attendant who adjusts takeoff connections arranged in accordance with the present invention.

In the clarifier AA shown in Figs. 1–6, the side by side arrangement of the various standpipe passages P^{10}, leads to the arrangement of all of the drawoff arms P^{11} within a small angular range at one side of the central shaft, as shown in Fig. 6, and a similar arrangement of the scraper arms HC at the opposite side of the shaft. A more symmetrical and balanced arrangement is shown in Figs. 8 and 9, wherein the scraper arms for the adjacent superposed compartments are located at opposite sides of the shaft GB, as are the drawoff arms P″. To accommodate the drawoff pipe arrangement employed, the standpipe passages P^{10} may be arranged as shown in Fig. 4.

In each of the clarifier units hereinbefore described, the central shaft is suspended and driven through connections to its upper end, but where

conditions make this desirable, the shaft may be supported by a thrust bearing at or below the bottom of the clarifier, and may be rotated by mechanism below the clarifier. For example, as shown in Fig. 10, the shaft GD may be connected to and supported by the central rotatable drawoff pipe QA', which, in this case, is supported by a thrust bearing W mounted on a platform W' beneath the clarifier. The connection between the shaft GD and the pipe QA' may include a lower spider, or spoked wheel, element G^{20}, and one or more similar elements at higher levels. The pipe QA' is rotated by means of a large beveled gear X secured to the shaft QA' below the clarifier, and in mesh with a beveled gear X' rotated through a speed reducing gear mechanism X^2 by a motor X^3. The lower end of the pipe QA' is connected to a non-rotatable lateral extension Q^{10} of the delivery pipe QA' through a coupling Q^{10} comprising suitable means for preventing leakage through the joint between the rotatable and lower non-rotatable parts.

As will be apparent to those skilled in the art, the general principles of the present invention may be employed with apparatus widely differing in form from that illustrated and described in detail herein.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. The combination in a tray clarifier having a plurality of superposed clarification compartments, of means for passing liquid to be clarified into said compartments, means for removing settled solids from said compartments including a rotating structure comprising a vertical body portion centrally disposed in said clarifier and means in each compartment for moving solids settling in its lower portion to its center, and means for withdrawing clarified liquid from the different compartments comprising a separate vertical up-flow passage formed in the body portion of said rotating structure for each compartment and a conduit carried within each compartment by said rotating structure and having its outlet connected to the lower end of the corresponding up-flow passage and having its inlet opening to said compartment in its upper portion at a distance from the body portion of said rotating structure, and means providing a receiving chamber, in the upper portion of the clarifier into which each of said up-flow passages discharges.

2. A clarifier as specified in claim 1, including means mounted in said rotatable structure and accessible at the top of the clarifier, for regulating the relative rates of discharge of clarified liquid from the different compartments.

3. A clarifier as specified in claim 1, including means for removing clarified liquid from the receiving chamber, comprising a pipe extending downward from said receiving chamber, centrally of said rotating structure to the exterior of the clarifier.

4. A clarifier as specified in claim 1, in which the clarifier includes a feed chamber above the clarifying compartments, and in which the body portion of the rotating structure is a hollow drum with ports in its wall, and internal partitions in said drum which cooperate with said drum and ports to form two separate flow-paths alongside the up-flow passages for clarified liquid, one for the downflow of liquid from said feed chamber to the different clarifying compartments, and the other for the downflow of solids into the lowermost compartment from the compartments above.

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