

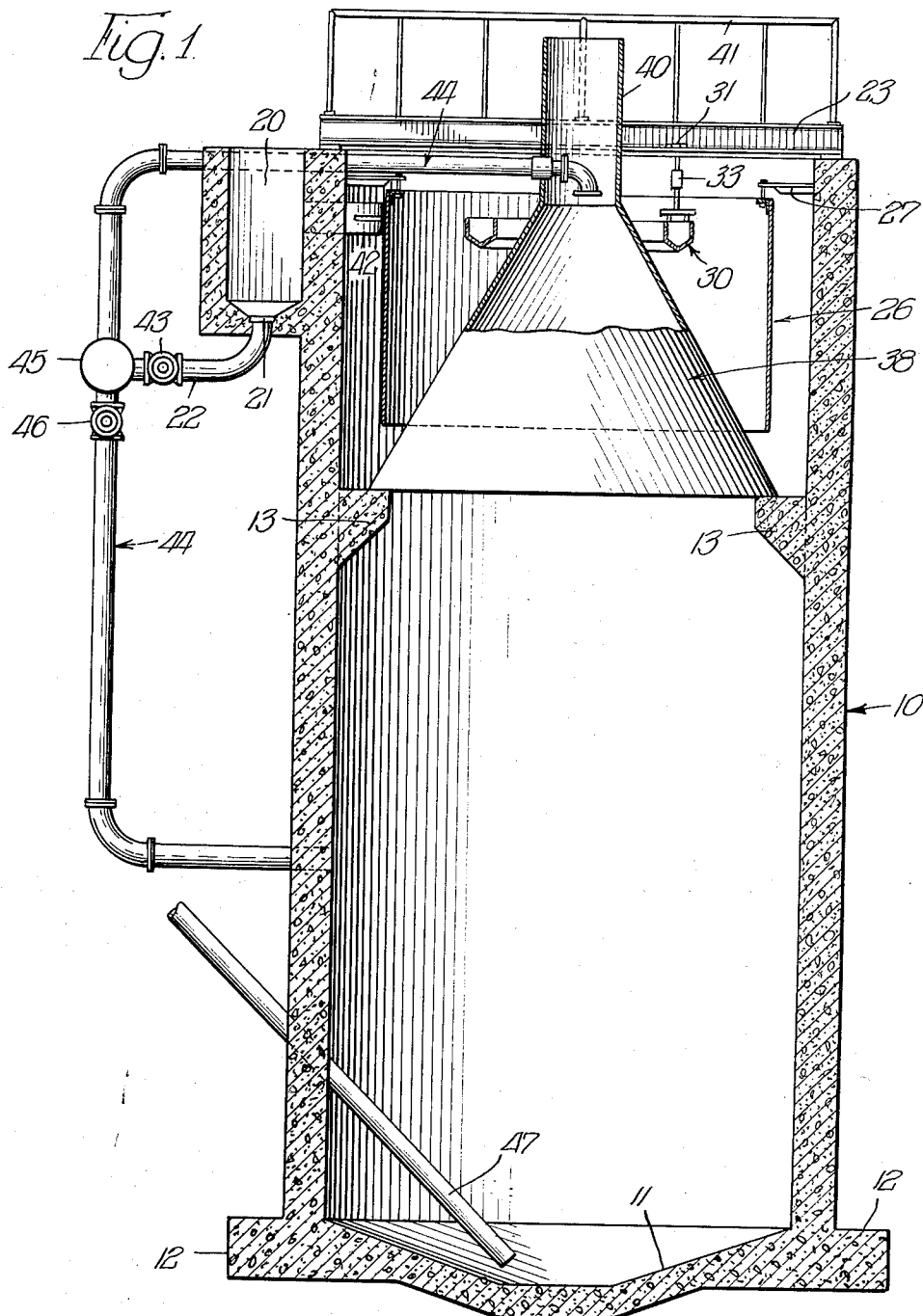
Sept. 13, 1955

J. A. MONTGOMERY ET AL
COMBINATION CLARIFIER AND DIGESTER

2,717,873

Filed July 19, 1952

3 Sheets-Sheet 1



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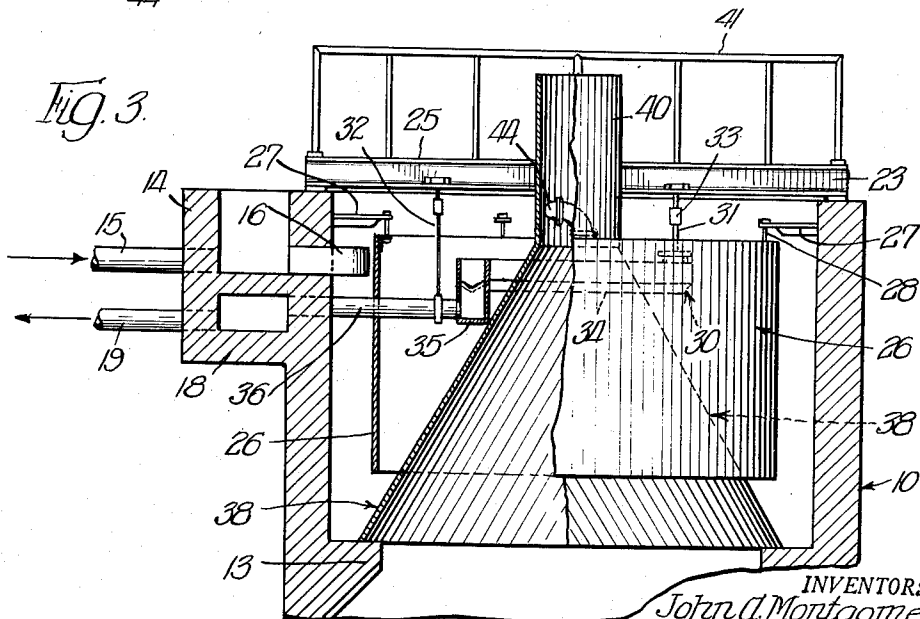
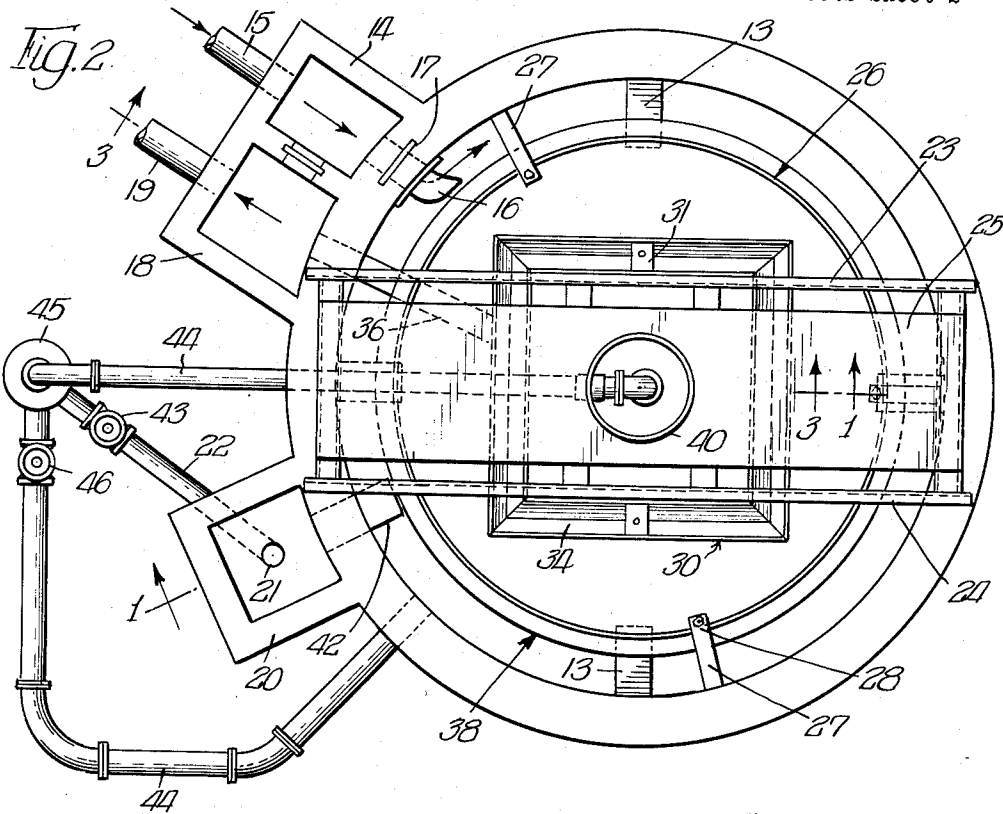
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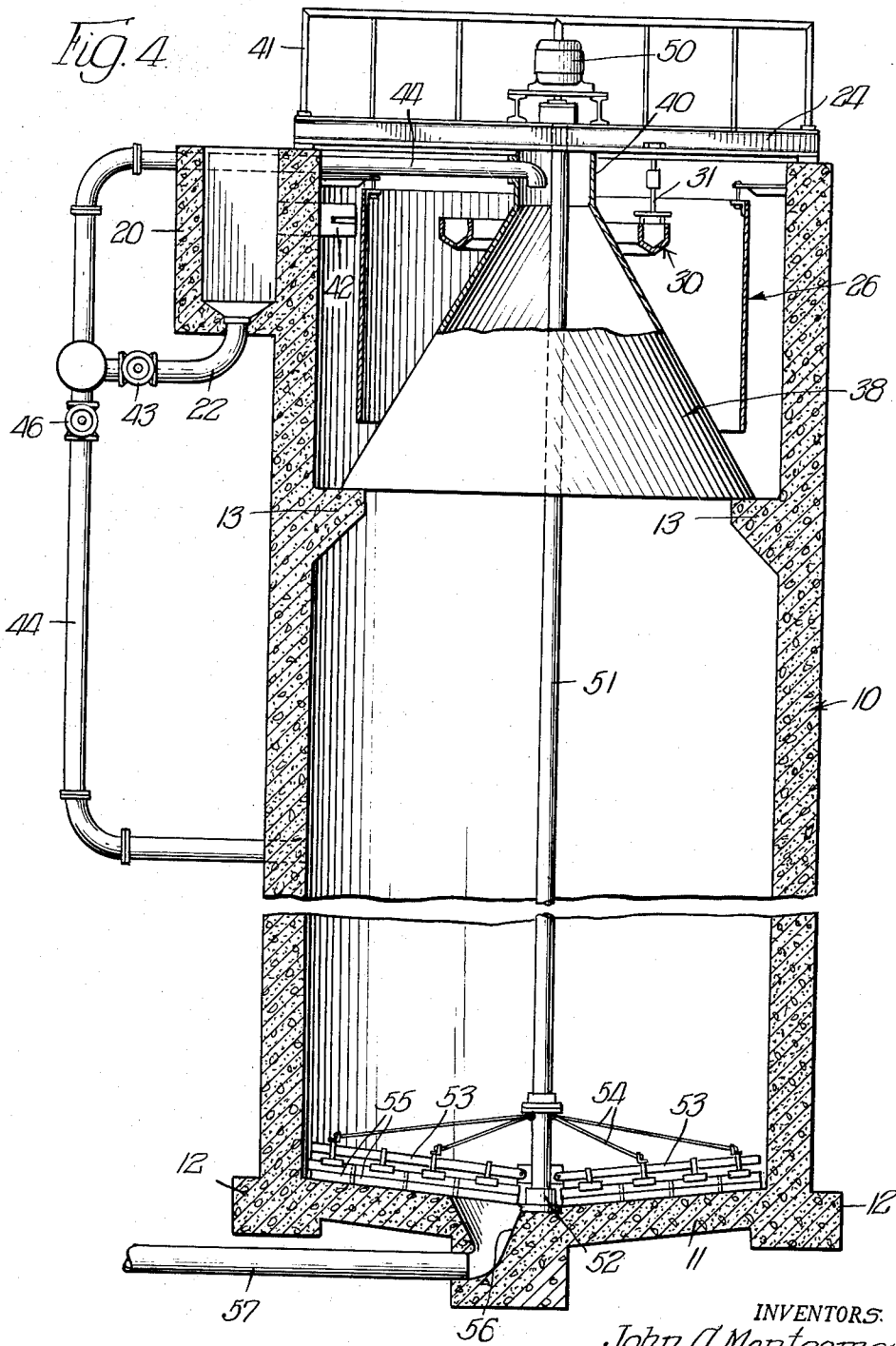
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3 Sneets-Sheet 3



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COMBINATION CLARIFIER AND DIGESTER

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5 Claims. (Cl. 210—2)

The invention relates to the disposal of sewage and industrial wastes and has reference to an improved method and apparatus for treating raw sewage by sedimentation, clarification and digestion in a single tank, with provision being made for spiralling the flow of the incoming liquid in a peripheral race forming part of the clarification chamber together with improved sedimentation and digestion in a digestion compartment located below the clarifying chamber and separated therefrom by a cone-shaped partition member.

The combination clarifier tank and digester as contemplated by the present invention employs an annular skirt which provides the peripheral race and a contiguous clarifying chamber. A cone-shaped partition member, having the cone end of the member extending above the liquid level, is employed to separate the clarifying chamber from the digestion compartment. The incoming liquid enters the peripheral race of the clarifier in a tangential direction. The rotation of the liquid in the race also imparts rotation to the entire liquid content of the clarifier. The solids, except the floating materials including oil and grease, travel downwardly to the bottom of the skirt where the heavy matter passes into the digestion compartment through the clearance opening provided between the bottom of the cone-shaped partition and the tank wall. The liquid and the lighter solids are carried underneath the skirt into the clarifying chamber and since the velocity in said chamber is relatively slow and travel is upward, the lighter solids settle out and are deposited on the cone to be eventually discharged into the digester chamber. The rotation of the liquid in the clarifier assists in moving the solids into the digester.

In view of the foregoing, the primary object of the present invention is to provide a combination clarifier and digester having improved skimming, settling and clarifying operations, all combined with the conventional functions of a digester, and wherein the latter functions are improved by reason of the spiral flow of the incoming liquid in the peripheral race of the clarifier and by the provision of the cone-shaped member which covers most of the digestion compartment so that the floating material rising in the digestion compartment will pass into the cone.

Another object of the invention is to provide a combination tank for processing sewage and industrial wastes which will have a high volumetric efficiency with low construction costs. This objective is attained by arranging a clarifier and digester in superposed relation and wherein the position and mode of operation of the clarifier tends to improve the functioning of the digester to the end that the combination tank is highly efficient in operation.

Another object resides in the provision of improved apparatus for treating sewage in a single tank which will settle and clarify in addition to performing the functions of a digester, and wherein thorough seeding of the upper portion of the digestion compartment is maintained by circulating liquid drawn off from the central, or an

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alternate portion of the digestion compartment. The liquid so drawn off is pumped into the projecting cone end of the cone-shaped partition member and is thus returned to the digestion compartment in the upper end thereof. By thus recirculating liquid from the digester the upper portion of the digestion compartment is properly seeded, the scum which may be floating on the surface is broken up, and foaming, which often causes trouble in digesters, is minimized, if not entirely eliminated.

With these and various other objects in view, the invention may consist of certain novel features of construction and operation as will be more fully described and particularly pointed out in the specification, drawings and claims appended hereto.

In the drawings which illustrate an embodiment of the invention and wherein like reference characters are used to designate like parts—

Figure 1 is a vertical sectional view of a combination clarifier and digester tank constructed in accordance with and embodying the features of the present invention;

Figure 2 is a top plan view of the combination tank shown in Figure 1;

Figure 3 is a fragmentary sectional view taken substantially along line 3—3 of Figure 2 and illustrates structural details of the clarifying chamber including the cone-shaped partition member which separates the chamber from the digestion compartment; and

Figure 4 is a vertical sectional view of a modified form of combination clarifier and digester tank which is characterized by the provision of motor driven scraper means in the digester for mixing the contents of the digester and for conveying sediment on the tank bottom toward and into the central outlet.

Referring to the drawings and more particularly to Figures 1, 2 and 3, the numeral 10 indicates the circular wall of the tank or container of the combination clarifier and digester selected for illustration. The tank is formed of concrete having the conical bottom 11 and base supporting portions such as 12. Centrally of the tank on the inside surface thereof corbels are provided, indicated by numeral 13, which are located in spaced relation around the cylindrical tank walls for supporting a cone-shaped partition member to be presently described. The incoming liquid to be treated is delivered to an influent well 14 likewise formed of concrete and preferably integral with the cylindrical wall 10 of the tank, being located exteriorly thereof adjacent the top of the tank. The raw liquid such as sewage and the like is delivered by the conduit 15 to the influent well 14 and said well in turn delivers to an influent deflector 16 which extends through the wall 10 and is provided with the gate 17 for controlling flow of the incoming liquid. An effluent well 18 is likewise formed integral with the cylindrical wall 10 of the tank and integral with well 14. The effluent well receives clear liquid from the clarifying chamber of the combination tank and said liquid is in turn delivered to the effluent discharge pipe 19 connected to the well in such a manner as to drain the same. A third well 20 also constitutes part of the present tank, the same constituting a scum well and which is located exteriorly of the wall 10 adjacent the upper part of the tank. The scum well is formed of concrete in all respects similar to the influent and effluent wells, with the exception that its bottom surface is preferably conical, leading to the scum outlet 21, which has connection with the scum discharge pipe 22.

The circular wall 10 of the tank supports super-structure which may include the diametrically extending beams 23 and 24 which provide a walk such as 25 across the top of the tank for the convenience of the attendant. Said beams may also assist in supporting the depending circular skirt indicated by numeral 26. The said skirt divides the

interior of the present tank into two chambers, the same having been previously referred to as the peripheral race and the contiguous clarifying chamber. The radially extending supports 27 are suitably secured to the interior of the circular wall 10 by means of anchor bolts which are not shown, and the depending skirt is suitably secured to said supports by the threaded rods 23. In the embodiment disclosed the depending skirt 26 is substantially concentric with the cylindrical wall 10 of the tank although the same could be supported eccentrically to form an annular race progressively decreasing in width from the influent deflector 16 to the scum outlet located more than 180 degrees therefrom. However, as disclosed, the depending skirt forms an annular race of uniform width around the tank and it will be noted that the skirt terminates some distance short of the corbels 13. The peripheral race extends around the exterior of the depending skirt and the contiguous clarifying chamber is located within the depending skirt. The two compartments are joined by a communicating passage below the skirt.

The said peripheral race initially receives the liquid delivered to the tank and in accordance with the invention the liquid is discharged into the peripheral race in a tangential direction so as to cause movement of the liquid around the race and spiralling movement of the liquid in a direction downward toward the bottom of the skirt. For this purpose the influent deflector 16 is constructed to discharge the liquid in a clockwise direction, Figure 2, within the peripheral race. During operation the rotation of the liquid in the race imparts rotation to the entire liquid content of the clarifier. As a result the solids, except the floating materials, including oil and grease, travel downwardly to the bottom of the skirt. The heavy solids will pass into the digestion compartment to be presently described. Some of the liquid and the lighter solids will pass underneath the depending skirt into the main section of the clarifier. Here the lighter solids settle out and since the velocity is relatively slow and travel is upward, satisfactory clarification is effected and clear liquid is decanted by the launder, which will now be described.

The launder, indicated by numeral 30, consists of a square trough and which accordingly provides eight sides over which the clear liquid discharges into the trough. The rods 31 and 32 support the launder from the beams 23 and 24. By adjustment of the members 33 forming part of the respective rods the elevation of the launder can be varied and the same can be positioned horizontally so that the clear liquid is withdrawn in the most satisfactory manner. All eight sides of the launder are preferably notched along the top edge to provide weirs over which the liquid will flow. Another constructional feature as regards the present launder 30 is the provision of a V-shaped bottom such as indicated by numeral 34, Figure 3. The invention is not restricted to this particular shape for the bottom of the launder although it is preferred that the launder have a bottom which is not flat. At a suitable point the launder is provided with an outlet connection 35 which discharges through the pipe 36 into the effluent well 18.

Whereas the depending skirt 26 divides the upper section of the tank into a peripheral race and a clarifying chamber, the cone-shaped member 38 in turn partitions the clarifying chamber and provides the digestion compartment of the present combination tank. The cone member 38 is suitably supported by the corbels 13 and it will be seen that the top open end 40 of the cone member is extended above the tank so as to project some distance above walk 25. The stack thus provided serves as an expansion tank should foaming take place within the digestion compartment. Said stack also provides a very convenient sampling well. For the convenience of the operator the walk 25 may be provided with hand rails such as 41. The location of the cone member 38 within the skirt 26 is such as to provide an entrance opening at the bottom of the skirt between the same and the sloping walls

of the cone member. Since this opening extends completely around the cone, the length of the opening is sufficient to induce a low influent velocity as regards the liquid passing under the skirt and entering the clarifying chamber. The effluent velocity of the clear liquid is also maintained relatively low by reason of the length of the weir trough provided by launder 30.

The cone covers most of the digestion compartment which is principally located within the tank below the corbels 13. The rotation of the liquid in the peripheral race assists in moving the solids into the digester and which enter the digester as a result of the clearance opening provided between the bottom edge of the cone member 38 and the adjacent side walls 10 of the tank. Here again the clearance opening is circular and extends completely around the tank except for the corbels which interrupt the clearance opening at four places. The peripheral entrance to the digestion compartment, provided by the clearance opening, helps to distribute the sludge in the digestion compartment.

Since the cone-shaped member 38 substantially covers the digestion compartment most of the floating material rising in the digester will pass into the cone. Some of the gas and the lighter solids may rise into the peripheral race of the clarifier through the clearance opening. Should these eventually reach the liquid level in the peripheral race they will be moved around, as a result of the circular flow of liquid, to the scum pipe 42. The said scum pipe is located in the peripheral race a considerable angular distance from the influent deflector 16. Said pipe may be slotted horizontally at the liquid level to facilitate the discharge of scum and other floating materials from the race into the scum well 20. From the well the discharge is delivered to pipe 22 having the valve 43 therein and which suitably connects with the recirculation pipe 44. Pipe 44 connects the digestion compartment at a point substantially centrally of the vertical height of the compartment with the stack 40 of the cone-shaped member. A motor driven pump or similar means such as 45 may be provided in order to withdraw liquid from the digestion compartment and pump the same under pressure through pipe 44 to deliver the liquid to the stack and thus to the digestion compartment at the upper portion thereof within the cone-shaped member 38. By recirculating the liquid in the digester it is possible to maintain thorough seeding of the entire compartment. The liquid delivered to the compartment also aids in breaking up any floating scum and also minimizes, if not eliminates, foaming which very often causes trouble in digesters. Since the scum pipe 22 connects with the recirculation pipe 44 the scum removed from the peripheral race is also returned to the digestion compartment. The recirculation pipe 44 is suitably provided with valve 46. When valve 46 is closed and valve 43 is open recirculation from the digester is stopped although scum removal continues, with the same being returned to the digester. With both valves 46 and 43 open the pump will deliver to the stack the scum from the scum well 20 and will additionally deliver the liquid withdrawn from the digestion compartment.

For removing the sludge from the digestion compartment a sludge removal pipe such as 47 is provided.

In the modification of Figure 4, motor driven scraper means are provided in the bottom of the digestion compartment for conveying sediment on the tank bottom toward and into the sludge outlet. In this modification the diametrically extending beams 23 and 24 provide the necessary supporting means for the motor, generally indicated by numeral 50. The motor is supported centrally of the tank and the drive shaft 51 depends downwardly therefrom to terminate adjacent the bottom 11 of the tank, said terminal end of the drive shaft 51 being journaled and positioned by the thrust plate 52. At least two oppositely inclined scraper arms 53 are suitably supported from the lower end of the drive shaft 51 and it will be seen that each arm is suitably braced by

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means of the tie rods 54. Each arm carries a plurality of flat, sheet metal plows 55 which are secured in proper relation to the scraper arms 53 by means of clamps or the like. The sheet metal plows 55 are set at an angle with respect to the direction of rotation of the scraper arms so as to scrape the sludge from the bottom 11 of the tank and propel the same to the sludge opening 56, the sludge being eventually removed by pipe 57 having connection with said sludge opening.

In other respects the modification of Figure 4 is similar to that described with respect to Figures 1, 2 and 3. The incoming liquid enters the peripheral race provided by the depending skirt 26, being discharged tangentially so as to effect a spiralling movement of the liquid in the race. The clarification chamber having the launder 30 for decanting clear liquid is located within the depending skirt 26. The depending skirt terminates some distance above the corbels 13 in order to provide an annular entrance opening between the skirt and the cone member for the liquid to enter the clarification chamber. Also the bottom edge of the cone-shaped member is spaced from the circular wall 10 of the tank in order to provide an annular clearance opening into the digestion compartment formed by that portion of the tank below the corbels and extending upward within the cone-shaped member. In this modification the stack 40 has been reduced somewhat in height although the top edge of the same is well above the liquid level of the tank so as to take care of any foaming which may develop. The recirculation pipe 44 enters the stack 40 to one side of the drive shaft 51 for discharging its contents into the digestion compartment. By arranging the clarifier in position over a digester a combination tank is provided capable of effecting a high degree of clarification and which is performed in a manner to assist the operation of the digester, with the result that the combination tank has a high volumetric efficiency with low construction costs.

The invention is not to be limited to or by details of construction of the particular embodiment thereof illustrated by the drawings as various other forms of the device will of course be apparent to those skilled in the art without departing from the spirit of the invention or the scope of the claims.

What is claimed is:

1. In a combination clarifier and digester, a substantially circular tank having a vertical cylindrical wall and an approximately horizontal bottom wall, an annular skirt depending within the tank in spaced relation to the cylindrical wall thereof, said skirt depending within the tank for less than one-half the vertical height of the tank and dividing its top portion of the tank into a peripheral race extending around the skirt and into a centrally disposed clarifying chamber within the skirt, an inlet conduit supplying incoming liquid to the peripheral race, a launder positioned within the clarifying chamber for decanting clear liquid, an outlet in the cylindrical wall of the tank angularly spaced from the inlet conduit for discharging the scum and floating matter removed from the liquid in the peripheral race, a cone-shaped member positioned within the tank in the top portion thereof substantially concentrically within the depending skirt, said depending skirt terminating a short distance above the sloping exterior wall of the cone-shaped member to provide an annular entrance opening to the clarifying chamber, means provided by the cylindrical wall of the tank for supporting the cone-shaped member in spaced relation with said cylindrical wall, whereby the cone-shaped member partitions the tank into a clarifying compartment above the member and a digestion compartment below the member, and whereby the spaced relation of the member with the cylindrical wall of the tank provides an annular entrance opening to the digestion compartment, said cone-shaped member having a stack opening at its apex located above the

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liquid level, and a recirculating pipe for the digestion compartment having connection at its inlet end with the digestion compartment approximately centrally of the height thereof and having its discharge end located over the stack opening for discharge into said opening.

2. In a combination clarifier and digester, a substantially circular tank having a vertical cylindrical wall and an influent well for receiving incoming liquid, an annular skirt depending within the tank in spaced relation to the cylindrical wall thereof, said skirt depending within the tank for less than one-half the vertical height of the tank and dividing its top portion of the tank into a peripheral race extending between the tank and the skirt and into a centrally disposed clarifying chamber within the skirt, an influent deflector within the peripheral race and connecting with the influent well for discharging the incoming liquid tangentially within the peripheral race, an overflow launder positioned within the clarifying chamber, a scum outlet in the peripheral race, a cone-shaped member positioned within the tank in the top portion thereof substantially concentrically within the depending skirt, said depending skirt terminating a short distance above the sloping exterior wall of the cone-shaped member to provide an annular entrance opening to the clarifying chamber, means provided by the cylindrical wall of the tank for supporting the cone-shaped member in spaced relation with said cylindrical wall, whereby the cone-shaped member partitions the tank into a clarifying compartment above the member and a digestion compartment below the member, and whereby the spaced relation of the member with the cylindrical wall of the tank provides an annular entrance opening to the digestion compartment, said cone-shaped member having a stack opening at its apex located above the liquid level, and means for withdrawing liquid from the digestion compartment and for returning the same to said compartment by discharging the withdrawn liquid into said stack opening.

3. In a combination clarifier and digester, a substantially circular tank having a vertical cylindrical wall, a circular skirt depending within the upper portion of the tank in concentric relation with the cylindrical wall thereof, whereby to divide said upper portion into a peripheral race extending between the tank and the skirt and into a central clarifying chamber within the skirt, an inlet for supplying incoming liquid to the peripheral race, an overflow launder positioned within the clarifying chamber, a partition member of cone-shape located in the tank concentrically within but spaced from the lower edge of the depending skirt, means supporting the partition member in spaced relation with said cylindrical wall, whereby the partition member separates the tank into a clarifying compartment above the member and a digestion compartment below the member, and whereby the spaced relation of the member with the cylindrical wall of the tank provides an annular entrance opening to the digestion compartment, said partition member having a stack opening at its apex located above the liquid level, and means for withdrawing liquid from the digestion compartment and for returning the same to said compartment by discharging the withdrawn liquid into said stack opening.

4. In a combination clarifier and digester, a substantially circular tank having a vertical cylindrical wall, a cone-shaped partition member supported by the tank and located within the upper portion thereof, said partition member having a stack opening at the cone end thereof and which is located above the liquid level of the tank, the said partition member dividing the tank into a clarifying compartment above the member and into a digestion compartment below the member, a circular skirt depending within the clarifying compartment in spaced relation with both the partition member and the cylindrical wall of the tank, whereby to divide the clarifying compartment into a peripheral race extending around the skirt and into a clarifying chamber within the skirt and above the

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partition member, an inlet for discharging incoming liquid into the peripheral race, an overflow launder positioned within the clarifying chamber, a scum outlet pipe for receiving scum from the peripheral race, and a recirculation pipe for withdrawing liquid from the digestion compartment and returning the same to said compartment by discharging the withdrawn liquid into the stack opening, said scum outlet pipe having connection with the recirculation pipe whereby the scum removed from the peripheral race is also delivered to the digestion compartment by being discharged into the stack opening.

5. In a combination clarifier and digester, a substantially circular tank having a vertical cylindrical wall, a cone-shaped partition member supported by the tank and located within the upper portion thereof, said member dividing the tank into a clarifying compartment above the member and into a digestion compartment below the member, said member having a stack at the cone end thereof providing a stack opening located above the liquid level of the tank, the opposite open flaring end of the partition member being disposed over substantially the entire area of the digestion compartment, and said flaring end being spaced from the cylindrical wall of the tank to provide an annular entrance opening to the digestion compartment, a circular skirt depending within the clarifying compartment in spaced relation with both the par-

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tion member and the cylindrical wall of the tank, whereby to divide the clarifying compartment into a peripheral race extending around the skirt and into a clarifying chamber within the skirt and above the partition member, an inlet for discharging incoming liquid into the peripheral race in a manner to cause a spiralling flow in the race, an overflow launder positioned within the clarifying chamber, a scum outlet pipe for receiving scum from the peripheral race, and a recirculation pipe having connection at its inlet end with the digestion compartment and at its discharge end with the stack for withdrawing liquid from the compartment and discharging the same into the stack opening, said scum outlet pipe having connection with the recirculation pipe whereby the scum removed from the peripheral race is also delivered to the digestion compartment by being discharged into the stack opening.

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