C. H. NORDELL.

PROCESS OF SEDIMENTATION.

APPLICATION FILED FEB. 16, 1920.

1,400,622. Patented Dec. 20, 1921.

Fig. 1.

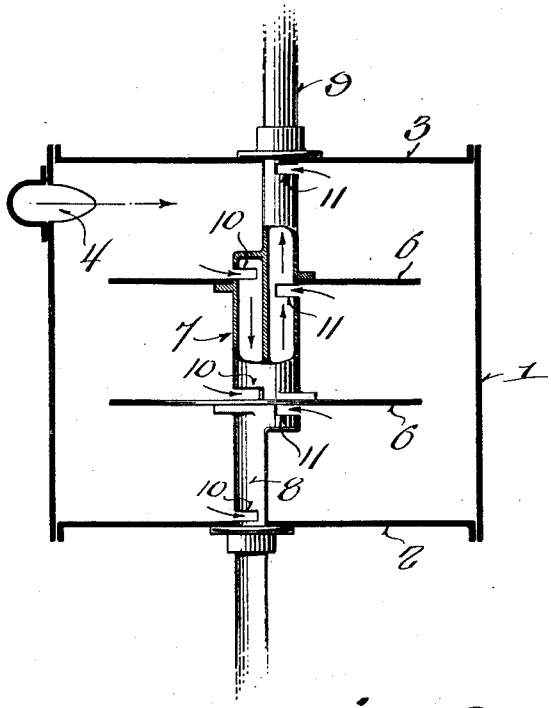
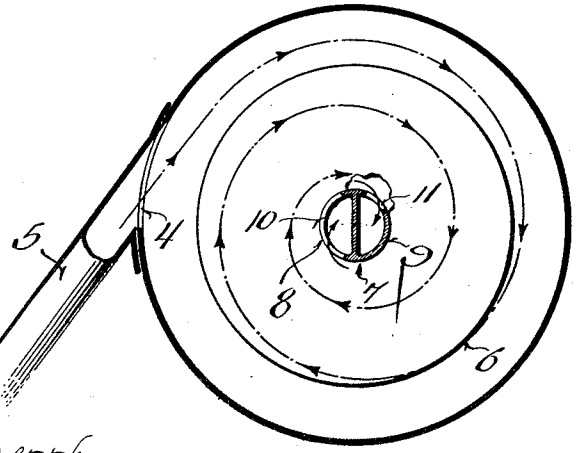


Fig. 2.



Witness:

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UNITED STATES PATENT OFFICE.

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PROCESS OF SEDIMENTATION.

1,400,622. Specification of Letters Patent. Patented Dec. 20, 1921.

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To all whom it may concern:

Be it known that I, CARL H. NORDELL, a citizen of the United States, and resident of Indianapolis, in the county of Marion and State of Indiana, have invented certain new and useful Improvements in Processes of Sedimentation; and I do hereby declare that the following is a full, clear, and exact description thereof.

My invention relates to new and useful improvements in the method of separating sediment from liquids in which it is held in suspension. The primary object of this invention is to provide a new method of withdrawing, from a body of liquid which is being settled, the clearest portion of the supernatant liquid and the most concentrated layer of sediment, without disturbance of the central zone between them. By the use of the process to which the invention pertains, the escape through the draw-off of liquid insufficiently sedimented or sludge or sediment insufficiently concentrated, is prevented, that is to say "short circuiting" of liquid from inlet to outlet without a proper interval of detention is obviated.

With the foregoing general object, and the obvious advantages to be derived therefrom in view, the invention resides in certain novel combinations and originalities of steps which may be carried out in connection with various forms of mechanism one of which is illustrated in the accompanying drawings wherein:

Figure 1, represents a vertical sectional view of a sediment tank constructed to carry out my improved process, and

Fig. 2, is a horizontal section view through this sedimentation tank.

Referring more particularly to the drawings the illustrated apparatus for carrying out the invention comprises a suitable container or tank 1, having a bottom 2 and top 3. The side wall of the tank, which is preferably cylindrical, is provided with an inlet opening 4, having an inlet pipe 5, communicating therewith, said pipe 5 being disposed substantially, tangentially of the tank as shown in Fig. 2. The incoming liquid is thus given a spiral motion toward the center of the tank as shown in the dot and dash line in the last mentioned figure. A similar action may be procured, however, by such mechanical means as stirring.

Superimposed within the container or tank 1, is a series of vertically spaced retardation members constructed in any preferred manner, they being shown as flat disk like plates 6 supported by a centrally arranged two part outlet 7. This outlet consists of a sediment pipe 8 and a clear liquid pipe 9, the former of which has an opening 10 adjacent the upper surface of each plate 6 and the bottom 2. The liquid pipe 9 is similarly provided with openings 11, one of which is located adjacent the under side of each plate 6 and top 3.

In practice the liquid to be sedimented is introduced into tank 1 relatively slowly so as to cause the body of liquid in the tank to rotate gently. In other words the rotation in most cases should be slow enough so that the liquid sweeping over the disks 6 is moving at a rate below "critical" velocity, that is to say slow enough to prevent turbulent flow. In certain cases, however, this "critical" velocity may be exceeded without harm.

As the liquid rotates it is subjected to centrifugal force which causes it to rise or stand at a head or pressure increasing with the square of the distance from the center of the tank. The layers of liquid immediately adjacent to the disks 6, bottom 2, and top 3 are prevented by friction from rotating at all, or they rotate only very slowly, and are therefore subjected to a much lesser degree of centrifugal force. As a consequence these layers of liquid are caused to flow to the center of the tank by the superior pressure existing in the rotating body of liquid in the regions out from the center. Therefore such layers of liquid adjacent to the disks flow toward the center quite directly, and as the liquid adjacent to the under side of the disks 6 and top 3 is the clearest and that closest to the top of the disks 6, and bottom 2 is most loaded with sediment, and since such layers are more quickly removed through the outlet 7 than the central zone of liquid the chief object of the invention is realized. Short circuiting is also cut to a minimum as the liquid must flow from the periphery of the tank to the center thereof in a spiral path for the reason that the centrifugal force imposed upon such liquid cannot readily short circuit, but must flow out through the full length of the spiral path with its static head gradually diminished by resistance to flow.

The clear supernatant liquid is thus cleared of sediment more than it would be by gravity alone by reason of the motion of the fluid past the disks. Ordinarily sediment is lifted from the bottom of a stream because the frictional drag retards the liquid in these regions and its retardation is accompanied by a gain in static head. Such superior static head forces particles of sediment into the upper layer and they are usually distributed more or less evenly throughout the body of liquid by turbulent cross currents. With this improved process the same phenomenon is encountered near the surface of the disks as the liquid sweeps past them. The particles of sediment are pushed away from the disks and the top and bottom of the container through the force just described, and if the liquid was homogeneous between the disks and top and bottom, the net result would be zero as the acceleration of sedimentation near the under side of the disks and top would be exactly counterbalanced by the retardation near the upper side of the disks and the bottom. The fact that liquid near the upper side of the disks and bottom is loaded with sediment, however, increases its viscosity and results in quite a different distribution of velocities than occurs near the under side of the disks and the top, and in practice it is found that the acceleration of sediment is actually greater than the retardation that occurs near the surface of the disks.

Consequently that portion of the body of liquid which is adjacent to the top 3 and under side of the disks 6 is clear and is drawn off through the pipe 9. On the other hand the portions of the liquid closest to the bottom 2 and the upper sides of the disks 6 contain the concentrated sediment which is removed from the tank 1 through the outlet pipe 8.

One quite important use of this improved process is found in sedimenting pulps and sludges which ordinarily require an appreciable period of quiescence before the flocs will draw together and settle (the pulps or sludges will not settle at all until these flocs are formed and they will not form until the liquid is quiescent). It is difficult to have quiescent liquid in a continuously operated settling tank as the entering liquid must have some velocity and it is very difficult, if not impossible, to check this velocity without causing a great number of swirling eddies which effectively prevent floc formation and sedimentation. However, with my process the entering liquid has a very low relative velocity compared with the main body of the liquid in the tank. Hence there is practically no disturbance of the liquid by the incoming flow and thereafter the flocs can immediately form and settle.

I claim:

1. The method of sedimentation which consists in rotating a body of liquid in contact with a series of retardation members arranged one above the other and extending transverse to the axis of rotation so as to retard the motion of those portions of said body in contact with said members relatively to the remainder, and withdrawing clarified liquid from the vicinity of the under side of each of said members and sludge from the vicinity of the upper side of each of said members.

2. The method of sedimentation which consists in rotating a body of liquid in contact with a series of retardation members arranged one above the other and extending transverse to the axis of rotation so as to retard the motion of those portions of the liquid in contact with said members relatively to the remainder, withdrawing clarified liquid from the vicinity of the under side of each of said members at said axis, and withdrawing sludge from the vicinity of the upper side of each of said members.

3. The method of sedimentation which consists in rotating a body of liquid in contact with a series of retardation members arranged one above the other and extending transverse to the axis of rotation so as to retard the motion of those portions of the liquid in contact with said members relatively to the remainder, withdrawing clarified liquid from the vicinity of the under side of each of said members at said axis, and withdrawing sludge from the vicinity of the upper side of each of said members at said axis.

4. A system of sedimentation comprising a container closed at the top, a plurality of transverse retardation members arranged within the container and spaced apart from the top and the bottom of the container, means for producing a vortex action in contact with said members and the top and bottom of the container of liquid to be sedimented, and means for withdrawing clarified liquid from the vicinity of the under side of the top and the under side of each of said members, and means for withdrawing sludge from the vicinity of the bottom of the container and the upper side of each of said members.

5. A system of sedimentation comprising a plurality of retardation members arranged one above the other, means for rotating a body of liquid about a vertical axis and in contact with said members, and means for withdrawing clarified liquid from the vicinity of the under side of each of said members, and means for withdrawing sludge from the vicinity of the upper side of each of said members.

6. A system of sedimentation comprising

a plurality of retardation members arranged one above the other, means for rotating a body of liquid between and in contact with said members, means for withdrawing clarified liquid from the vicinity of the under side of each of said members at the axis of rotation, and means for withdrawing sludge from the vicinity of the upper side of each of said members.

7. A system of sedimentation comprising a plurality of retardation members arranged one above the other, means for rotating a body of liquid between and in contact with said members, means for withdrawing clarified liquid from the vicinity of the under side of each of said members at the axis of rotation, and means for withdrawing sludge from the vicinity of each of said members at said axis.

8. A system of sedimentation comprising a container, a plurality of transverse retardation members arranged one above the other in said container, said members being smaller than the cross-sectional area of the container so as to leave a space between them and the sides of the container, means for rotating a body of liquid in said container in contact with said members, means for withdrawing clarified liquid from the vicinity of the under side of each of said members, and means for withdrawing sludge from the vicinity of the upper side of each of said members.

In testimony that I claim the foregoing I have hereunto set my hand at Milwaukee, in the county of Milwaukee and State of Wisconsin.

CARL H. NORDELL.