J. McCALLUM.

CENTRIFUGAL SEPARATOR.

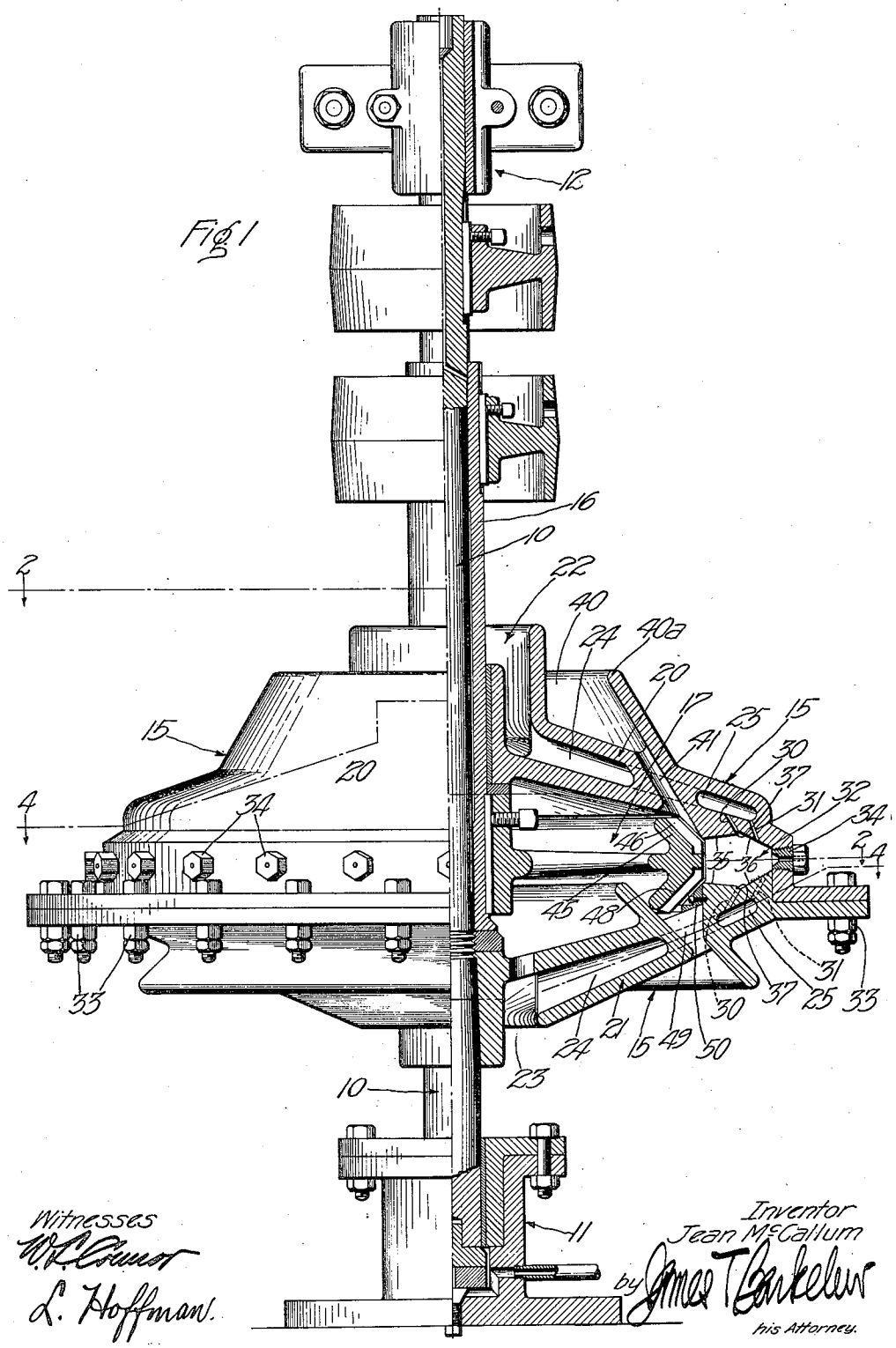
APPLICATION FILED MAR. 11, 1914.

1,154,575.

Patented Sept. 21, 1915.

3 SHEETS—SHEET 1.

Fig 1



Witnesses

W. R. Connor

L. Hoffman.

Inventor

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by James T. Barkeley

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3 SHEETS—SHEET 2.

Fig. 2

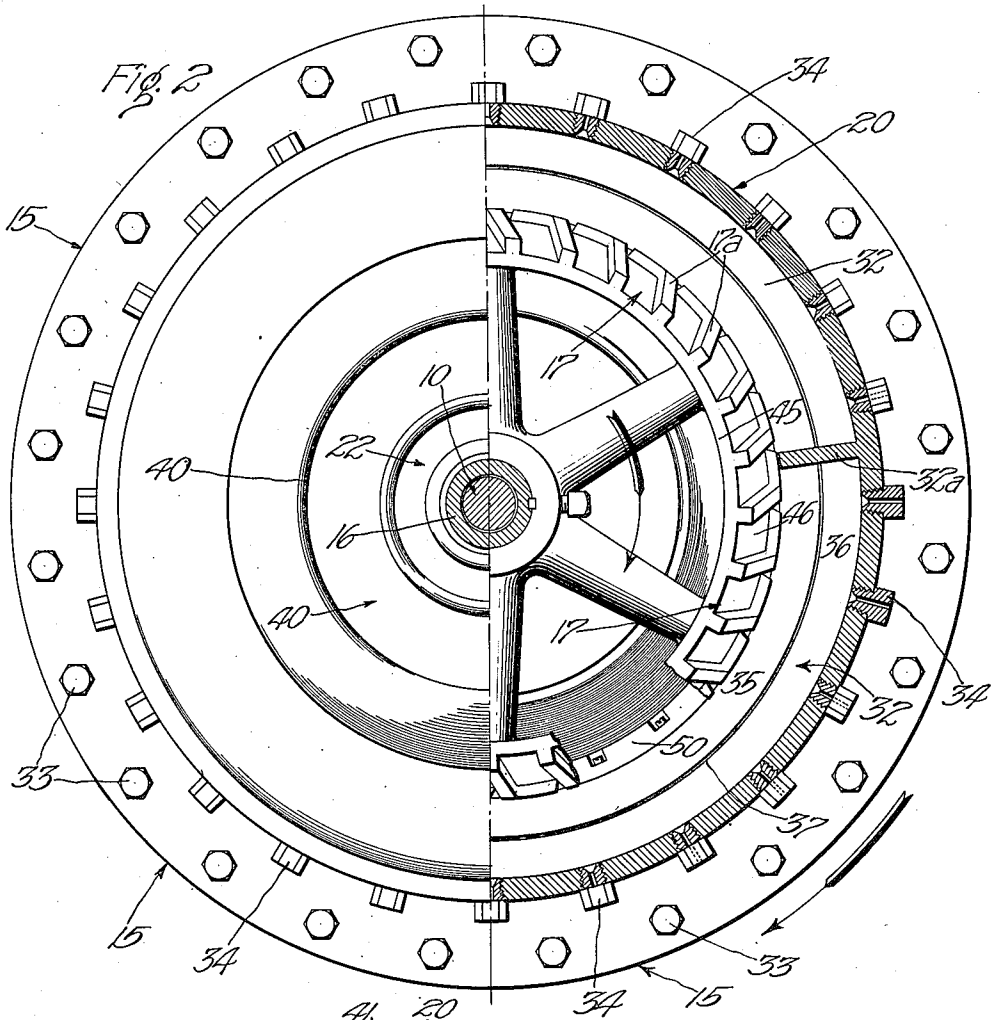
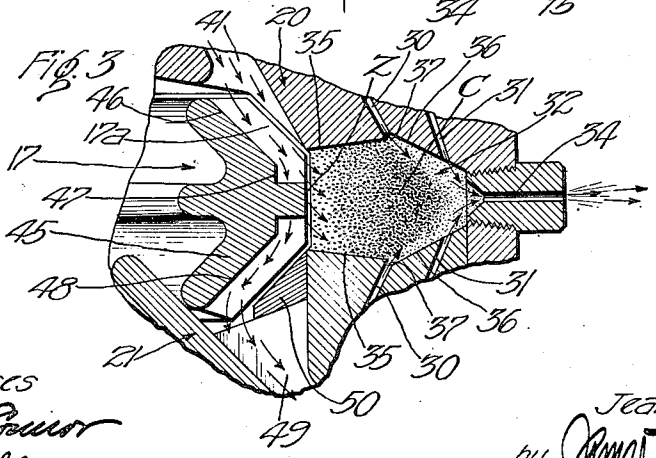


Fig. 3



Witnesses

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3 SHEETS—SHEET 3.

Fig. 4

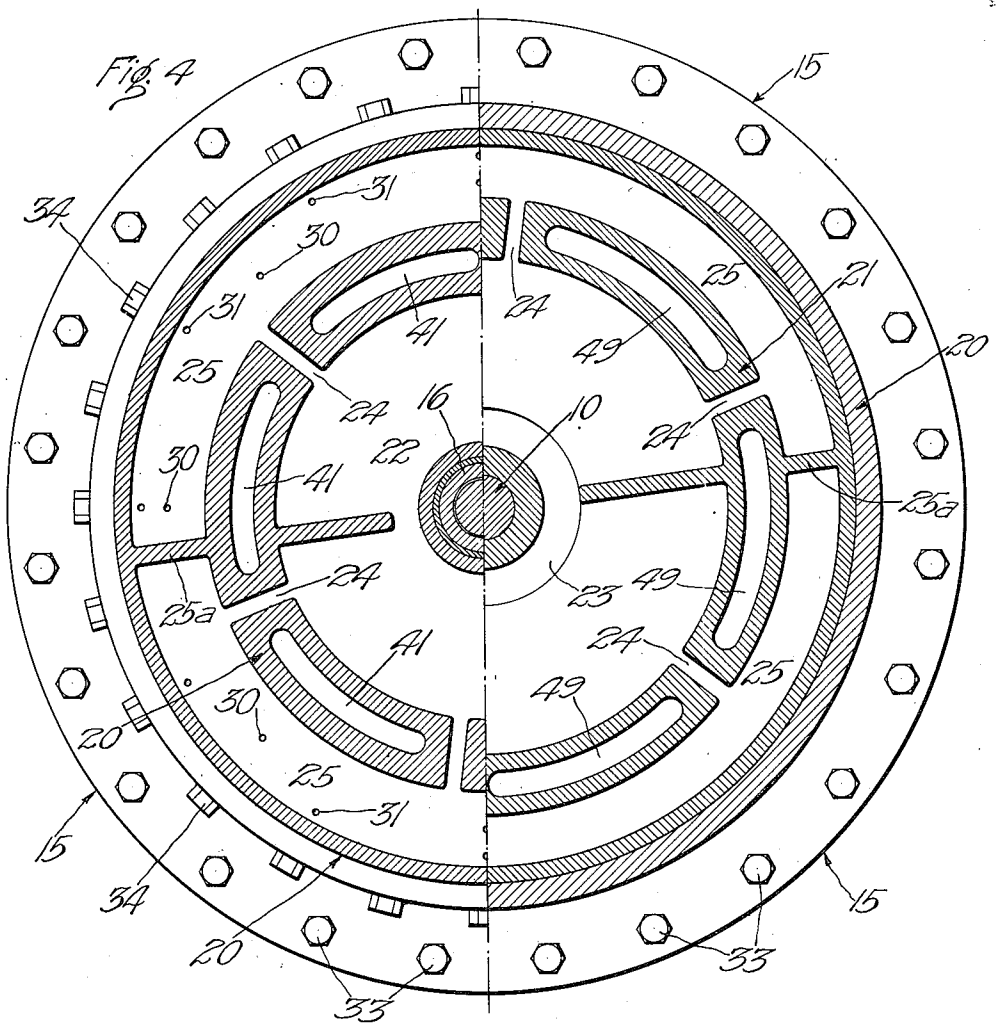
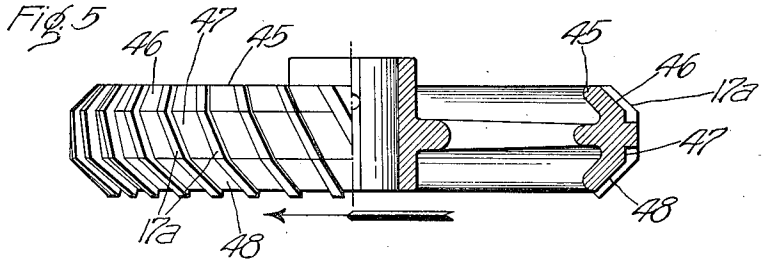


Fig. 5



Witnesses

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UNITED STATES PATENT OFFICE.

JEAN McCALLUM, OF HURLEY, NEW MEXICO, ASSIGNOR OF TWO-NINTHS TO WILLIS W. JOURDIN AND TWO-NINTHS TO ARNOLD W. HARRIS.

CENTRIFUGAL SEPARATOR.

1,154,575. Specification of Letters Patent. Patented Sept. 21, 1915.

Application filed March 11, 1914. Serial No. 823,886.

To all whom it may concern:

Be it known that I, JEAN McCALLUM, a citizen of the United States, residing at Hurley, in the county of Grant, State of New Mexico, have invented new and useful Improvements in Centrifugal Separators, of which the following is a specification.

This invention relates to a centrifugal separator for the separation of matter of different specific gravities or of particles of different sizes, or of particles of both different sizes and different gravities; and the invention relates more particularly to centrifugal separators of the class used for separating pulps, slimes and the like to remove the valuable particles therefrom; and the invention consists in the provision of certain apparatus novel in itself and novel in its mode of action to produce the desired results in simple and efficient manner.

My invention may be put to a variety of uses. It may be used as a separator, concentrator, filter or decanter or as a dewaterer; and in the following specification and claims I broadly describe a device capable of all of these uses; while I particularly describe a device adapted to be specifically used as a separator or concentrator. The fundamental operation of my machine includes the formation of an annular mass of more or less consolidated matter (the cake herein spoken of) by accretion at its inner periphery in or near an annular separation zone, and the discharge of this consolidated matter (concentrate) from the outer portions of its annular mass. In the annular separation zone there is maintained a body of mixed material (slime, pulp or the like) under the action of centrifugal force, the action of the stream of material being fed in, and, in the case of a separator, under the action of a scrubber which works on the inner portions of the annular mass of material consolidated in the cake. The function of the scrubber is to scrub off and agitate the inner layer of the annular mass (in the separation zone) so that the particles of this inner layer are free to arrange themselves under the action of the various forces. The heavier particles are thrown outwardly by centrifugal force into the cake; the lighter particles are rejected.

I provide an annular chamber rotating in its own plane, (that is, rotating about its own axis of generation), which chamber is the separation and cake chamber herein referred to. The separation zone is at or near the inner periphery of this chamber; the cake is accumulated in the chamber outside the separation zone. Means are provided for feeding material to the separation zone and discharge outlets are arranged at the outer parts of the chamber. Water, or other fluid, is fed into the chamber for two purposes, (1) to form more or less of a lubricating film or thin coating between the mass of material and the walls of the annular chamber, and (2) to impregnate and fluidize the outer portions of the annular mass so that the mass may freely and uniformly pass through the discharge openings under centrifugal action. The lighter portions are rejected at the inner edge of the annular chamber, at the separation zone. The scrubber acts against the inner layer of the annular mass to agitate that layer and free the lighter particles so that they may be rejected over the weir, leaving the heavier particles to pass into and form the more or less consolidated cake in the annular chamber. It will be noted that the concentrate discharge is somewhat removed from the separation zone; that the cake mass is between the separation zone and the discharge; so that the discharge of concentrate does not interfere with, nor is affected by, the separation and accretion process. The annulus of concentrate is continuously added to on the inside and continuously discharged at the outside; the parts of the machine being so proportioned that these two actions balance each other and constantly maintain a mass of concentrate in the annular chamber.

The details of my invention in its preferred form are described in the following specification and are illustrated in the accompanying drawings, in which,

Figure 1 is a half section and half elevation of my improved device, Fig. 2 is a section taken as indicated by line 2—2 of Fig. 1, Fig. 3 is a detail section illustrating the action of my machine, Fig. 4 is a section taken as indicated by lines 4—4 of Fig. 1, Fig. 5 is a half side elevation and half section of the scrubber.

In the drawings, the numeral 10 may designate the main upright shaft mounted in suitable bearings 11 and 12, this shaft performing the service of transmitting rotation

to the outer member 15 of my device. A driving sleeve 16 surrounds the shaft 10 and performs the service of rotating the inner member 17 of my device, this inner member being the scrubber hereinbefore referred to. The outer and inner members revolve concentrically and preferably revolve in the same direction, as indicated by the arrows in Fig. 2, the inner member or scrubber rotating at a higher speed than the outer member.

The outer member includes in its construction some of the most salient and novel features of my invention. This member 15 comprises upper and lower castings 20 and 21 more or less symmetrical in cross section. In each of these castings there is a water or other fluid inlet 22 or 23, fluid passages 24 and fluid pressure chambers 25. Fluid fed into the inlet 22 or 23 is thrown outward by centrifugal force, and pressure in the pressure chambers 25 forces the water through the perforations 30 and 31 into the annular separation and cake chamber 32. This annular chamber 32 is formed between opposing walls of the upper and lower castings 20 and 21. The castings are secured together by flange and bolt connection as at 33. Outlet nozzles 34 are provided around the annular chamber; and it is through these outlets that the concentrate is discharged.

It will be noted that the annular separation and cake chamber is of peculiar cross section. The chamber is inclosed above and below by walls 35 and 36 of the two castings 20 and 21. Walls 35 diverge from each other outwardly away from the central axis and walls 36 converge toward each other in the same direction, so that the annular chamber 32 is widest in a vertical direction intermediate its inner and outer peripheries. Between the two walls 35 and 36 I provide lubricating grooves 37, and it is into these lubricating grooves that the perforations 30 discharge their fluid. The perforations 31 discharge their fluid between the lubricating grooves and the jet or nozzle outlets 34. It is primarily the purpose of the fluid delivered to the lubricating grooves to spread out over the surface 36 and to prevent the mass of material in the annular separation and cake chamber from direct frictional contact with the walls. It is the direct purpose of the perforations 31 to deliver water or other fluid into the portion of the material near the outlets 34 to thoroughly fluidize those portions of the cake and allow the fine solid heavier particles to pass out easily through the outlets under the action of centrifugal force.

The material to be separated is delivered to the machine through the mouth 40 and through passages 41 into the separation and cake chamber 32. This material may be slime or pulp or any similar material in which it is desired to effect a separation or concentration. The material flowing through the annular separation and cake chamber 32 passes over the rim 45 of the inner revolving member or scrubber 17. The rim 45 is constructed as is best shown in Fig. 1 and Fig. 5, so that it presents an upper diagonal face 46, a central vertical face 47, and a lower diagonal face 48. The entering pulp passes over the upper diagonal face 46 of the scrubber between the vanes 17^a; and as the pulp enters the separation and cake chamber it is under (1) the effect of pressure generated by centrifugal force, (2) the effect of the flow of pulp through the passage 41 and into the separation zone in the annular chamber and (3) the effect of impact with the revolving scrubber. When treating fine material, the effect of the flow or current downward through the passages 41 and between the vanes 17^a is approximately the same on all particles; so that the flow tends to carry the particles downwardly along the inner peripheral part of the annular chamber 32. Centrifugal force, however, acting most strongly on those particles of greatest specific gravity, and having greatest resultant effect also upon those bodies of smallest size, tends to throw all such particles toward the outer parts of the annular chamber 42 out of the separation zone into the cake, whence they finally pass out through discharge nozzles 34. The discharge of this fine heavy matter is greatly facilitated by the injection of water near the outer portions of the annular separation chamber, so that the mass of solid particles which would otherwise form is broken up and made sufficiently fluid to pass out through the discharge openings.

The whole of the incoming pulp being divided in the manner set forth by the constant action of the machine, the total constant outflow is equal to the constant inflow. The larger part of the outflow is from the inner portion of the annular separation chamber over the weir ring 50 and under the lower diagonal surface 48 of the scrubber wheel 17 and out through discharge openings 49. It will be noted that a constant outward and downward flow of feed or pulp is maintained through the passages 41 into the separation zone. This flow is maintained largely by centrifugal force, due to the fact that the lip 40^a of the feed mouth 40 is situated inward (toward the axis of the machine) of the inner edge of the discharge weir 50. The scrubber wheel scrubs the inner portion or surface of the body of material in the separation and cake chamber so as to loosen and agitate those portions of the pulp body and allow free movement of the different particles in that part of the body under the action of centrifugal force and other forces herein described. As a result

of the action of all of these forces the heavier and finer particles gradually and continuously work their way to the outer portion of the annular separation chamber into the consolidated mass therein while the lighter and coarser particles pass downwardly through the separation zone in the inner portion of the chamber. The lighter larger particles flow downwardly through the inner peripheral portion of the separation and cake chamber; the heavier finer particles deflect outwardly toward the outer peripheral portion of the chamber, whence they are continuously discharged. Displacement of material from the separation and cake chamber by the incoming pulp forces the inner portions of the separation mass over the inner weir ring 50. Continuous feed of the pulp or the like causes, under the action of the machine, continuous separation and continuous discharge of the concentrate and of the reject. The outlet nozzles, the fluid feed, the material feed, etc., are so proportioned that for any given material the outflow balances the inflow when there is an accumulation of consolidated matter in the cake chamber; that is, when the machine starts in operation, the normal full discharge of concentrate does not begin until the normal amount of cake has been attained; and thereafter there is a constant amount of concentrate cake which is being continuously added on the inside and continuously discharged on the outside.

In Fig. 3 I have shown the accumulated cake at "C" and have designated the separation zone by the letter "Z". The arrows indicate the general movements of material, fluid and cake. The pulp moves into the separation and cake chamber by centrifugal force and by the impetus acquired from the scrubber wheel; and there is always a certain centrifugal pressure in the separation and cake chamber 32, which centrifugal pressure at any determined speed depends directly upon the radial distance between the inner edge of the weir ring and the point in the chamber 32 at which the pressure is being measured. Thus, the pressure of the pulp at the discharge ends of the perforations 30 and 31 is dependent directly upon the radial distance to the inner edge of the weir ring. Now the pressure developed upon the fluid in the pressure chambers 25, and upon the fluid at the discharges of the perforations 30 and 31, is dependent upon the radial distance between the inlet points 22 and 23 and the points of discharge of the perforations 30 and 31. These last mentioned radial distances are much greater than the first mentioned radial distances, and as a result, the pressure upon the fluid is sufficient to force it through the perforations 30 and 31 against the pressure of the pulp in the chamber 32. The amount of fluid fed through these perforations may be varied by varying the number and size thereof; and the amount of fluid desired will depend upon the nature of the material being treated in my machine. For certain materials and for certain purposes the lubricating grooves and the perforations 30 may be omitted, the perforations 31 only being used. The jets of fluid entering through these perforations 31 may be the discharge jets as they are for the purpose of breaking up or fluidizing the cake or material into a thin liquid pulp so that it may freely discharge through the nozzles 34.

It will be noted that the various fluid and pulp passages are separated by dividing walls and are distinct from one another so that the inclosed fluids are given the proper rotary motion. The annular chamber 32 may be divided by webs 32^a so that the material therein is positively driven. Webs 25^a are placed in fluid pressure chambers 25 for the same purpose. It will be understood that wherever I speak of annular chamber, annular mass, etc., I do not limit myself to such a construction as would preclude the subdivision of such chamber, mass, etc., into parts which, taken together, would form such an annulus. In fact, as here explained, the fluid chambers and the chamber 32 are divided into parts, but such division does not remove the characteristic features of my invention.

I do not wish to confine myself to the specific details herein described; but there are several novel features to which I particularly draw attention. One of the novel features is the general arrangement of the separation and cake chamber or zone with its inward discharge over an interior weir ring and the provision of the fluid feed to the outer portions of the separation and cake chamber to aid the outward discharge of the outer portions of the material in the chamber. I also wish to call attention particularly to the configuration of the annular separation and cake chamber, as herein described. The approaching walls 36 of this chamber aid very materially in causing uniform discharge of the heavier materials at the outer part of the chamber. I also wish to draw particular attention to the scrubber wheel which acts upon the inner portions or surface of the mass in the separation and cake chamber, and to the action of the wheel in loosening a thin layer of the cake, and permitting it to be arranged according to the specific gravity of the particles effected.

I claim—

1. In a device of the character described, a rotatable member including a chamber radially open and unobstructed toward the axis of said member, means for supplying pulp or the like to a separation zone at the inner part of said chamber, means for con-

tinuously agitating the pulp in the separation zone at the inner part of said chamber so that the heavier particles are continuously freed to be centrifugally thrown into the outer parts of the chamber to form a mass of consolidated material occupying said chamber and extending inwardly to said separating zone, means for continuously restrictedly discharging said solid cake or consolidated mass of heavy particles embodying a restricted orifice at outer part of said chamber, whereby the consolidated mass of heavy particles is maintained continuously between the separation zone and discharge orifice, and means independent of the pulp agitating means whereby independent fluid is applied in the form of strong jets at the outer part of said consolidated mass, immediately adjacent to the discharge orifice, said means being adapted to deliver the jets substantially outwardly and with such force as to break up the consolidated mass immediately in front of the orifice without breaking up the mass as a whole.

2. In a device of the character described, a rotatable member including a chamber radially open and unobstructed toward the axis of said member, means for supplying pulp or the like to a separation zone at the inner part of said chamber, means for continuously agitating the pulp in the separation zone so that the heaviest particles are continuously freed to be centrifugally thrown into the outer parts of the chamber to form a mass of consolidated material occupying said chamber and extending inwardly to said separating zone, means forming a discharge orifice for continuously restrictedly discharging said consolidated mass of heavy particles from the outer part of said chamber whereby the consolidated mass of heavy particles is maintained continually between the separation zone and discharge orifice, and means independent of the pulp agitating means whereby independent fluid is applied in the form of strong jets at the outer part of said consolidated mass, immediately adjacent to the discharge orifice, said means directing the jets substantially outwardly and being adapted to break up the outer portion only of the consolidated mass.

3. In a device of the character described, a rotatable member including a chamber with a discharge orifice at its outer periphery, said chamber being radially open and unobstructed toward the axis of said member, means for supplying pulp or the like to a separation zone at the inner part of the said chamber, means for continuously agitating the pulp in the separation zone at the inner part of the chamber, said means acting on the pulp directly at the inner part of the chamber so that the heavier solid particles of the pulp are continuously freed to be centrifugally thrown into the outer part of said chamber to form therein a consolidated mass of heavy particles, and means independent of said agitating means for fluidizing the consolidated mass to facilitate its discharge, said means embodying means for applying jets of fluid to the outer peripheral portions of the mass directed toward the discharge orifice.

4. In a device of the character described, a member including an annular chamber rotatable about an axis, said chamber being radially open and unobstructed toward said axis, said chamber having axially spaced walls converging toward each other at the outer periphery of the chamber, there being restricted outlet orifices at the outer periphery of the chamber, the inner periphery of the chamber being entirely open, means for supplying pulp or the like to the inner open periphery of the chamber, mechanical means to continuously agitate the pulp at the inner open periphery of the chamber so that the heavier solid particles are freed to be centrifugally thrown outwardly into the outer portions of the chamber to form a consolidated mass of heavy particles, and means independent of the pulp agitating means for continuously fluidizing the outer peripheral portions of said consolidated mass, said means including means for injecting jets of fluid into the outer portions of said chamber at the converging walls of the chamber, said jets being directed outwardly toward the discharge orifices.

5. In a device of the character described, a member including an annular chamber rotatable about an axis, said chamber being radially open and unobstructed toward said axis, its axially spaced walls adjacent its inner periphery diverging outwardly from each other to approximately the center of the chamber and then converging toward each other the outer periphery of the chamber, there being restricted outlet orifices at the outer periphery of the chamber, means for feeding pulp to the open inner periphery of the chamber, a rotating scrubber wheel immediately adjacent the open inner periphery of the chamber adapted to agitate the pulp over the whole of the open inner periphery, so that the heavier particles are freed to be centrifugally thrown outwardly into the outer parts of the annular chamber to form therein a consolidated mass, and means independent of the pulp feeding means for fluidizing the outer portions of said consolidated mass to facilitate its discharge through the outlet orifices, said means including means for injecting jets of fluid into the outer portions of said chamber at points in the outer converging walls thereof and in outward directions toward the outlet orifices.

6. In a device of the character described, a rotatable member having an annular

chamber rotatable about an axis, said chamber being open and unrestricted and having its inner periphery entirely open, the axially spaced walls of said chamber diverging slightly outwardly to about the center of the chamber and then converging toward each other to the outer periphery of the chamber, there being outlet orifices at the outer periphery of the chamber, and there being water jet inlet orifices at the lines of junction of the diverging and converging walls of the chamber and also at points in the converging walls, all said orifices directing jets into the chamber and toward the outlet orifices at the periphery thereof, means to feed pulp to the open inner periphery of the chamber, and independent means to feed water to the jet orifices.

7. In a device of the character described, a rotatable member having an annular chamber rotatable about an axis, said chamber being open and unrestricted and having its inner periphery entirely open, the axially spaced walls of said chamber diverging slightly outwardly to about the center of the chamber and then converging toward each other to the outer periphery of the chamber, there being outlet orifices at the outer periphery of the chamber, and there being water jet inlet orifices at the lines of junction of the diverging and converging walls of the chamber and also at points in the converging walls, all said orifices directing jets into the chamber and toward the outlet orifices at the periphery thereof, means to feed pulp to the open inner periphery of the chamber, independent means to feed water to the jet orifices, and means to agitate the pulp over the whole of the inner periphery of the chamber.

8. In a device of the character described, a rotatable member having an annular chamber rotatable about an axis, said chamber being open and unrestricted and having its inner periphery entirely open, the axially spaced walls of said chamber diverging slightly outwardly to about the center of the chamber and then converging toward each other to the outer periphery of the chamber, there being outlet orifices at the outer periphery of the chamber, and there being water jet inlet orifices at the lines of junction of the diverging and converging walls of the chamber and also at points in the converging walls, all said orifices directing jets into the chamber and toward the outlet orifices at the periphery thereof, means to feed pulp to the open inner periphery of the chamber, independent means to feed water to the jet orifices, and means to agitate the pulp over the whole of the inner periphery of the chamber, said means embodying a rotatable scrubber wheel with its periphery adjacent said inner periphery of the chamber.

9. The combination of a rotatable member including a chamber which is open and unobstructed toward the axis of said member, there being a restricted discharge outlet at the outer part of the chamber, means to feed pulp or the like past the inner open part of said chamber so that the heavier particles may be thrown outwardly into said chamber to accumulate and form a cake of said particles, a restricted discharge outlet at the outer part of said chamber, and means to fluidize the outer portions exclusively of the cake accumulating in said chamber, said fluidizing means embodying means for projecting a fluid jet independent of the pulp into the outer portion only of said chamber and into the outer portion of said cake in an outward direction toward the discharge outlet, so as to fluidize the outer portions of the cake for discharge through said outlet and so as to leave the inner portions of the cake undisturbed.

10. The combination of a rotatable member including a chamber which is open and unobstructed toward the axis of said member, the outer portion of said chamber having outwardly converging walls, there being a restricted discharge outlet at the outer part of the chamber at the outer edges of said outwardly converging walls, means to feed pulp or the like past the inner open part of said chamber so that the heavier particles may be thrown outwardly into said chamber to accumulate and form a cake of said particles, and means to fluidize the outer portions exclusively of the cake accumulating in said chamber, said fluidizing means embodying means for projecting jets of fluid oppositely from the said converging walls of said chamber directed diagonally toward each other and outwardly toward said discharge outlet into the outer portions of said chamber and into the outer portions of said cake, so as to fluidize the outer portions of the cake for discharge through said outlet and so as to leave the inner portions of the cake undisturbed.

11. The combination of a rotatable member including an annular chamber which is open and unobstructed toward the axis of said member, the outer portion of said chamber having opposite walls converging outwardly to the outer periphery of said chamber, there being restricted discharge outlets spaced around the outer periphery of said chamber, means to feed pulp or the like past the inner open periphery of said chamber so that the heavier particles may be thrown outwardly into said chamber to accumulate from an annular cake of said particles, and means to fluidize the outer portions only of said cake accumulating in said chamber, said fluidizing means embodying means for projecting jets of fluid oppositely from the opposite converging walls of the

annular chamber directed diagonally toward each other and outwardly toward the discharge outlets into the outer portions only of said chamber and into the outer portions only of said cake, so as to fluidize the outer portions of the cake for discharge through said outlets and so as to leave the inner portions of the cake undisturbed.

12. The combination of a rotatable member including an annular chamber which is open and unobstructed toward the axis of said member, the outer portion of said chamber having opposite walls converging outwardly to the outer periphery of said chamber, there being restricted discharge outlets spaced around the outer periphery of said chamber, means to feed pulp or the like past the inner open periphery of said chamber and means for agitating the pulp over substantially the whole of the inner open periphery to free the heavier particles so that the heavier particles may be thrown outwardly into said chamber to accumulate and form an annular cake of said particles, and means to fluidize the outer portions only of said cake accumulating in said chamber, said fluidizing means embodying means for projecting jets of fluid oppositely from the opposite converging walls of the annular chamber directed diagonally toward each other and outwardly toward the discharge outlets into the outer portions only of said chamber and into the outer portions only of said cake, so as to fluidize the outer portions of the cake for discharge through said outlets and so as to leave the inner portions of the cake undisturbed.

In witness that I claim the foregoing I have hereunto subscribed my name this 27th day of February 1914.

JEAN McCALLUM.

Witnesses:

FRANK B. HARRIS,

ARNOLD W. HARRIS.