July 28, 1942. G. J. STREZYNSKI 2,291,117

CENTRIFUGAL SEPARATOR

Filed Dec. 29, 1939 2 Sheets-Sheet 1

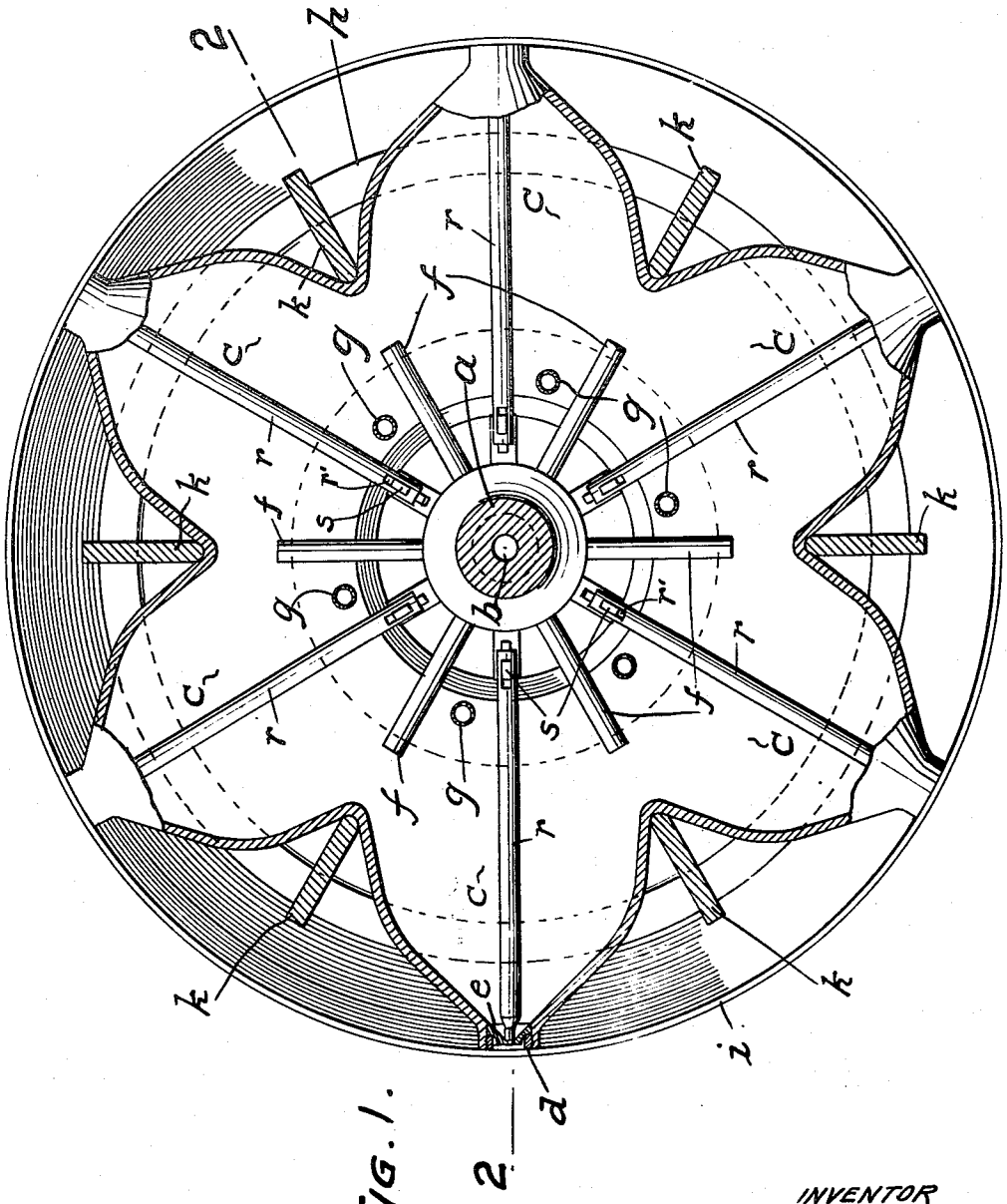

FIG. 1.

WITNESS:
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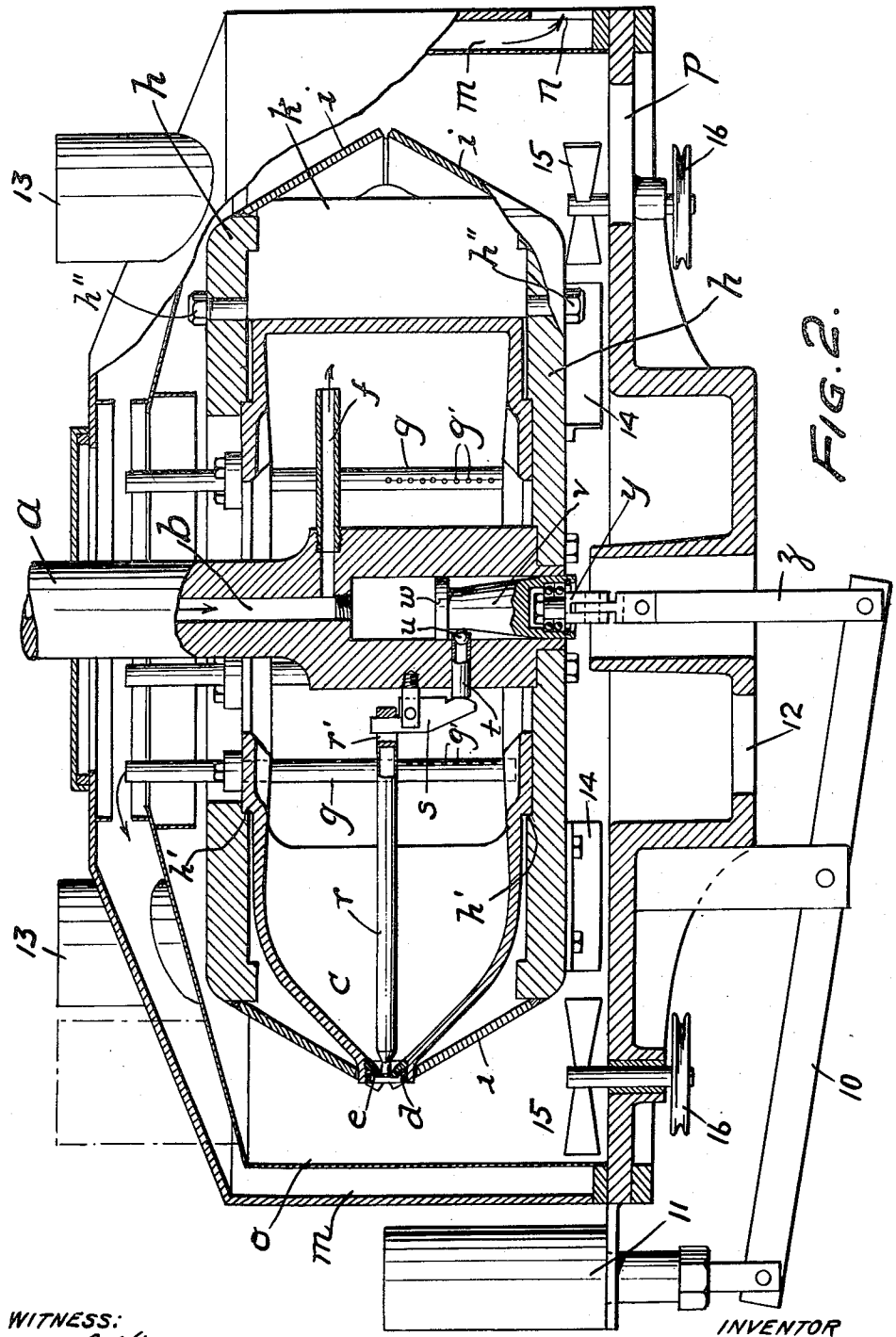

FIG. 2.

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UNITED STATES PATENT OFFICE

2,291,117

CENTRIFUGAL SEPARATOR

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Application December 29, 1939, Serial No. 311,529

14 Claims. (Cl. 233—17)

In an application filed by me September 24, 1938, Serial No. 231,459 is disclosed a centrifugal separator bowl comprising a number of separating chambers radiating from a common center, the separating chambers being in pairs, the two members of which are arranged diametrically opposite each other. The inner end of each chamber is of rectangular cross section, which merges into an outer conical section. Opposite chambers of each pair are rigidly connected together.

It has been found that centrifuges constructed in accordance with this invention can safely operate at a speed of rotation much higher than within the maximum safe limit of rotation of a cylindrical bowl, that the bursting stress is much reduced and that the clarifying effect, the storage volume and the throughput greatly exceed that of a cylindrical bowl. While the invention is adapted to the separation of any constituents of different specific gravities, one of its most useful applications is the separation of fine solids from a liquid or liquids of lower specific gravity than the solids, the outer end of the outer conical part of each separating chamber being fitted with a removable tip containing a small orifice, which is alternately opened and closed by a needle valve operable by suitable mechanism.

The specific embodiments of the invention disclosed in said application are found to be practically operative and to possess all the advantages ascribed to the invention in the specification. Such practical operation, however, has disclosed the fact that certain features of the specific construction disclosed in the application are open to objections which, while not affecting operativeness, would, if eliminated, greatly increase efficiency, secure better balancing with unequal loads in different separating chambers, permit the weight of the separator to be substantially increased, and allow more ready access to the bowl for cleaning.

For example it has been found that while the use of tension members aligning with the walls of oppositely disposed separating chambers and thereby connecting them together so as to form a rigid construction are admirably adapted to effect their intended purpose, they obstruct ready access to the bowl. It has also been found desirable to make the separating chambers, which are preferably constructed of a metal alloy, comparatively heavy and with walls much thicker toward the center than toward the ends, so as to secure better balancing, but this has been found to be impracticable; first, because of the difficulty of casting a wall different parts of which vary greatly in thickness or in which the variation in thickness is approximately abrupt as distinguished from gradual, especially when the material of the wall is of alloy steel; and secondly, because of the great expense of metal alloys as compared with carbon steel.

The improved construction hereinafter described permits ready access to the bowl, enables the bowl to be made as heavy as desired and with a wall of varying cross-section without increasing the cost, maintains the bowl perfectly balanced while in operation, permits the separating chamber to extend inward nearer the axis of rotation, and simplifies the construction; all without sacrifice of, and indeed with measurable enhancement of, the advantages characterizing the earlier bowl, namely: high speed operation, resistance to bursting stress, superior clarifying effect and great storage volume and throughput.

In utilizing a separator bowl for the separation of solids from liquids, the solids, in many cases, are in the form of a wet sludge, which it has been found necessary to dry in several steps. The preliminary drying is done in settling tanks, presses, or centrifugal machines. After such preliminary drying the sludge contains anywhere between 70 to 90% moisture. This remaining moisture is usually evaporated in rotary dryers. However, it is found that in rotary dryers, if the moisture content of the sludge is more than about 75%, such sludge will lump in the dryers and clog the moving parts of the dryer. Therefore, it is highly desirable that the sludge going through the dryer shall contain less than 75% moisture. The attainment of this degree of dryness usually requires some intermediate step between the centrifugal operation and the dryer, or an increase in efficiency of the centrifugal machine. Any increase in the efficiency of the centrifugal machine involves a serious reduction in its capacity.

Another object of my invention is to increase the dryness of the sludge discharged from the chamber that receives the fine solids discharged from the bowl. This I have done by making changes in the external construction of the centrifugal bowl and in providing for its agitation and aeration in said chamber, from which it is discharged with a moisture content sufficiently low to avoid the necessity of an intermediate drying step; that is, the sludge is in condition to go from the receiving chamber around the centrifugal bowl direct to the final (rotary) dryers.

The present invention also embodies other improvements and will be understood by reference to the following description of a preferred embodiment, in connection with the accompanying drawings, wherein Figure 1 is a cross section of the bowl taken at right angles to the axis thereof and Figure 2 is a vertical section of the bowl and a part of the surrounding frame taken, in so far as the bowl is shown, on the line 2—2 of Fig. 1.

The bowl has a central shaft *a*, which may be supported and rotated by any suitable means including those known in the art. My improved bowl is preferably of the type in which the shaft *a* is suspended and driven from above and has an axial feed passage *b* through which the mixture to be separated is fed to the bowl.

The separating spaces of the bowl are formed of a number of chambers *c* radiating from a common center. The chambers are arranged in pairs, the two chambers of a pair being located diametrically opposite the bowl's axis. Any even number of chambers is practicable, but a bowl comprising three pairs of chambers, comprising in all six chambers whose radial axes are located 60° apart, is preferred.

The upper and lower walls of the inner end portions of each separating chamber *c* extend in a plane at right angles to the axis of the bowl, their inner extremities being located inside, that is, nearer to the bowl's axis than, the light separated constituent outlet. The inner ends of the side walls of each chamber are also preferably flat, their up and down direction of extension being vertical, that is, parallel with the bowl's axis. The inner ends of the side walls are preferably not parallel but diverge somewhat toward the bowl's axis. Nor do the side walls extend inward as far as the upper and lower walls, their inner extremities being outside the inner zone of the separating space of the bowl, that is, further from the axis than the outlet for light separated liquid. Cross sections, however, taken through the inner end portions of the separating chambers are rectangular in cross-section. The above details of construction are not in all respects essential features of the invention, but they are of pronounced advantage, it being specially desirable that the inner ends of the upper and lower walls of the chambers should extend in a plane at right angles to the axis of the bowl, as will be clear from the description to follow.

The rectangular inner portions of each separating chamber *c* merge into outer sections which are circular in cross-section, the width of the chamber sharply diminishing toward its outer end, the outer portion of the chamber being therefore conical. The outer extremity of each separating chamber has a cylindrical neck with an internal screw thread and an inner shoulder and held therein by a nut *d* is a removable tip *e* having a small orifice through which the separated solids are discharged.

The central bowl supporting and driving shaft *a* carries six radial tubes *f* which connect, through radial holes in the wall of the feed shaft, with the feed passage *b*. These tubes open into the separating zone of the bowl at a substantial distance beyond the light liquid outlet tubes *g*. The feed tubes *f* correspond in number to the number of separating chambers *c* and are preferably located along the imaginary dividing line between the chambers. Thus each feed tube *f* supplies two chambers. The light liquid outlets *g* comprise vertically disposed tubes throughout the height of the separating chambers and are provided on their inner faces with perforations *g'* through which the inner layer of light liquid escapes from the bowl.

The separating chambers are made of an alloy steel that is chemically resistant to all materials that are ordinarily subjected to centrifugal separation or clarification. It is found that the type of bowl embodying my invention requires the separating chambers to be comparatively heavy. A heavy bowl is essential to secure proper balancing during operation. In a light bowl slightly unequal contents of dirt in the several chambers effect a pronounced unbalance. However, thick-walled separating chambers of a suitable metal alloy would be prohibitively expensive, and the casting of a bowl providing chambers having walls of non-uniform cross-section is impracticable. I have been able to overcome this difficulty by making the walls of the separating chamber of comparatively thin cross-section and by supporting their inner ends between two thick and wide annular plates *h*, *h*, one above and the other below the separating bowls. The lower plate *h* is secured to the central shaft *a*, or both plates may be so secured. The plates, which may be made of ordinary carbon steel, are provided with inwardly facing shoulders *h'* against which abut outwardly facing shoulders on the separating chambers. These plates, located as shown, enable the separating chambers to resist all stresses and strains and maintain the bowl in balance during operation.

Secured to the outer edge of each plate *h* is a shield *i* which extends down to the peripheral outlets of the separating bowl. These shields reduce air resistance to rotation and prevent entry of fine solids into the irregular spaces between the separating chambers and the outer ends of the plates *h*. The separating chambers may be further reinforced by means of plates *k* extending between the plates *h*, *h* and engaging the outer wall of the bowl at the junction between adjacent side walls of adjacent separating chambers. The plates *h* may be held against vertical displacement away from the separating chambers *c* by portions of the reinforcing plates *k* extending through holes in the plates and fitted with nuts *h''*.

The stationary framework shown provides an inner annular chamber *o* for the reception of the fine solids discharged from the peripheral outlets of the separating chambers and an outer annular chamber *m* which receives the separated light liquid discharged from the tubes *g*, the liquid escaping from the chamber *m* through openings *n* to a locus of collection (not shown). The fine solids in chamber *o* escape through openings *p* to another locus of collection (not shown).

It is known to provide in a separating bowl having discharge orifices in its peripheral wall, needle valve rods which are intermittently operated to close the discharge orifices for a short time to allow solids to accumulate and then, for a much shorter time, to open the orifices and allow the solids to discharge, but known mechanism for operating such valve rods has not been found applicable to a bowl embodymy invention. I have devised the following means for operating the valve rods *r*.

Pivoted to brackets on the bowl shaft are levers *s*. Each lever is pivoted between its ends, one free end engaging a slot *r'* in the inner end of

the corresponding rod *r* and the other end abutting against a pin *t* extending through the annular wall of the bowl shaft. The inner end of pin *t* is tubular in form and carries a ball *u* engageable with the outer frusto-conical shaped wall of a block *v* having an overhanging head *w* and rotatable with the shaft *a*. The lower end of the block is hollow to enclose a ball bearing between it and the reduced circular upper end of a short member *y* being a universal joint connection with a connecting rod *z*. The latter is pivoted to one end of an intermediately pivoted lever 10, the other end of which is pivoted to any suitable, preferably hydraulically operable, device 11, which, by known means, controlled by known timing mechanism (not shown), may be intermittently operated.

In the position of the parts shown, when the separator is in operation, each valve rod *r*, by centrifugal force, occupies its outer position and closes the peripheral discharge outlet of the separating chamber. When the block *v* is lifted intermittently by the mechanism above described, the valve rod *r* is retracted, allowing the solids that have accumulated in the extreme end of the separating chamber to discharge into the surrounding receiving chamber *o*. As soon as the block *v* is lowered the valve rod *r* is returned to closed position by centrifugal force.

The means for reducing the moisture content of the sludge discharged through the peripheral orifices *e* into chamber *o* will now be described. This chamber is provided with a dry air inlet 12 and air outlets 13. Wings or vanes 14 on the lower plate *h* of the centrifugal bowl suck air from the room, or heated air, or any other drying medium, and blow it through the sludge chamber *o* at the same time that the sludge is being discharged in a finely atomized spray from the centrifugal bowl. As this sludge drops to the bottom of the chamber it is picked up by the fan-like rotors 15 (driven from pulleys 16) in the lower part of the chamber and scattered through the chamber for additional aeration and drying. This keeps the whole body of the sludge in continual turbulence and the air which is rotating with the centrifugal bowl brings this moving mass to the discharge port *p*, thereby eliminating the necessity for any conveyors. The drying means described is effective in increasing the dryness of the sludge by about 20%, so that its moisture content is safely below that required for introduction to the final dryers.

What I claim and desire to protect by Letters Patent is:

1. A centrifugal separator bowl comprising a central driving shaft, a set of separate comparatively thin-walled separating chambers having different radially extending axes spaced arcuately equal distances apart around the axis of the bowl, said chambers being located adjacent one to another at equal distances from the bowl's axis, each of the said chambers being adapted to be filled with and enclose a body of liquid while its outer surface is, except as hereinafter specified, exposed to the atmosphere, and, concentric with the bowl's axis, comparatively thick-walled heavy annular plates respectively overlying and underlying the set of separating chambers and between which the separating chambers are secured.

2. A centrifugal separating bowl as defined in claim 1 in which the upper and lower walls of the separating chambers are provided with outwardly extending shoulders and the thick-walled plates are provided with inwardly extending shoulders against which the shoulders on the separating chambers abut.

3. A centrifugal separator bowl as defined in claim 1 in which the separating chambers and the overlying and underlying plates have mutually contacting faces which are flat throughout substantially the width of the separating chambers to insure effective support and reinforcement of the separating chambers over a large area.

4. A centrifugal separator bowl as defined in claim 1 in which only the inner end portions of the separating chambers are secured as defined while the outer ends of the separating chambers are unsupported and of conical cross-section and are provided at their reduced peripheral ends with escape orifices.

5. A centrifugal separator bowl as defined in claim 1 in which only the inner end portions of the separating chambers are secured as defined while the outer ends of the separating chambers are unsupported and of conical cross-section and are provided at their reduced peripheral ends with escape orifices, and comprising also annular shields extending from the outer ends of the plates radially outward and axially toward the plane of peripheral discharge of the separating chambers and closing the spaces between said plates and the said separating chamber walls.

6. A centrifugal separator bowl as defined in claim 1 in which the inner end portions of the separating chambers are rectangular in cross-section and their outer portions circular in cross-section and in which the said plates engage only the upper and lower walls of the rectangular inner portions of the separating chambers.

7. A centrifugal separator bowl as defined in claim 1 in which the upper and lower walls of the separating chambers extend inwardly toward the bowl's axis substantially further than the side walls of the separating chambers, and comprising also light liquid discharge outlets located at a radial distance from the bowl's axis greater than the radial distance from the bowl's axis of the inner ends of the upper and lower walls of the separating chambers but smaller than the radial distance from the bowl's axis of the inner ends of the side walls of said chamber.

8. A centrifugal separator bowl as defined in claim 1 in which the upper and lower walls of the separating chambers extend inwardly toward the bowl's axis substantially further than the side walls of the separating chambers, and comprising also inlets for the mixture to be separated located at a radial distance from the bowl's axis substantially greater than the radial distance from the bowl's axis of the inner ends of the upper and lower walls of the separating chambers but smaller than the radial distance from the bowl's axis of the inner ends of the side walls of said chamber.

9. A centrifugal separator bowl as defined in claim 1 in which the upper and lower walls of the separating chambers extend inwardly toward the bowl's axis substantially further than the side walls of the separating chambers, and comprising also inlets for the mixture to be separated located at a radial distance from the bowl's axis substantially greater than the radial distance from the bowl's axis of the inner ends of the upper and lower walls of the separating chambers but smaller than the radial distance from the bowl's axis of the inner ends of the side walls of said chamber, said inlets comprising tubes each

extending along a radius dividing adjacent separating chambers and directly feeding both chambers.

10. A centrifugal separator bowl comprising a central driving shaft, a number of comparatively thin-walled adjacent separating chambers having radially extending axes and spaced arcuately at equal distances apart and located at equal distances from the axis of rotation of the bowl and, concentric with the axis of the bowl, comparatively thick-walled heavy annular plates, one at least of which is secured to the shaft, which confine between them the separating chambers, and comprising also reinforcing plates connecting said thick-walled plates and engaging the outer wall of the bowl at the junctions between adjacent separating chambers.

11. A centrifugal separating bowl comprising a central driving shaft, a number of separating chambers supported from, and extending radially of, the shaft and spaced uniformly around the shaft, said chambers having conical outer ends provided with peripheral discharge orifices, valve rods one for each orifice, a block having a conical outer wall extending into the hollow interior of the bowl shaft, radially movable pins extending through the wall of the drive shaft, levers operable by said pins and thereby adapted to retract said valve rods and thereby open said orifices, said block being rotatable with the drive shaft, and non-rotatable mechanism connected with said block and adapted to move said block axially within the drive shaft and thereby move said pins in a radially outward direction and thereby effect the retraction of the valve rods.

12. A centrifugal separator bowl comprising a central driving shaft, a set of separate comparatively thin-walled radially extending separating chambers having their different radially extending axes spaced arcuately equal distances around the axis of the bowl, said chambers being located adjacent one to another at equal distances from the axis of the bowl, and comparatively thick-walled heavy plates extending outward from the central part of the bowl at right angles to the bowl's axis and respectively overlying and underlying and contacting with the upper and lower walls of the set of separating chambers and between which the separating chambers are secured.

13. A centrifugal machine for separating liquids from solids comprising a rotary bowl and a sludge-receiving chamber surrounding, and extending above and below, the bowl, said bowl having peripheral orifices through which the solids are discharged, in the form of atomized sprays of sludge, into said chamber a substantial distance above its bottom, the sludge-receiving chamber being provided with an air inlet, an air outlet and a sludge discharge port, vanes on the bowl adapted in the bowl's rotation to draw a drying medium into said chamber and circulate it therethrough, and rotors in the lower part of the chamber adapted to pick up down-dropping sludge and scatter it through the chamber, the action of the air upon the thus scattered sludge effecting its partial drying prior to its expulsion through the discharge port in condition for final drying.

14. A centrifugal separator in accordance with claim 1 in which the said annular plates respectively overlying and underlying the separating chambers directly contact with only the inner portions of the upper and lower walls of the separating chambers.

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