March 12, 1929. L. ANDREWS 1,705,351

METHOD AND APPARATUS FOR THE CLASSIFICATION OF MATERIALS BY ELUTRIATION

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Fig. 1.

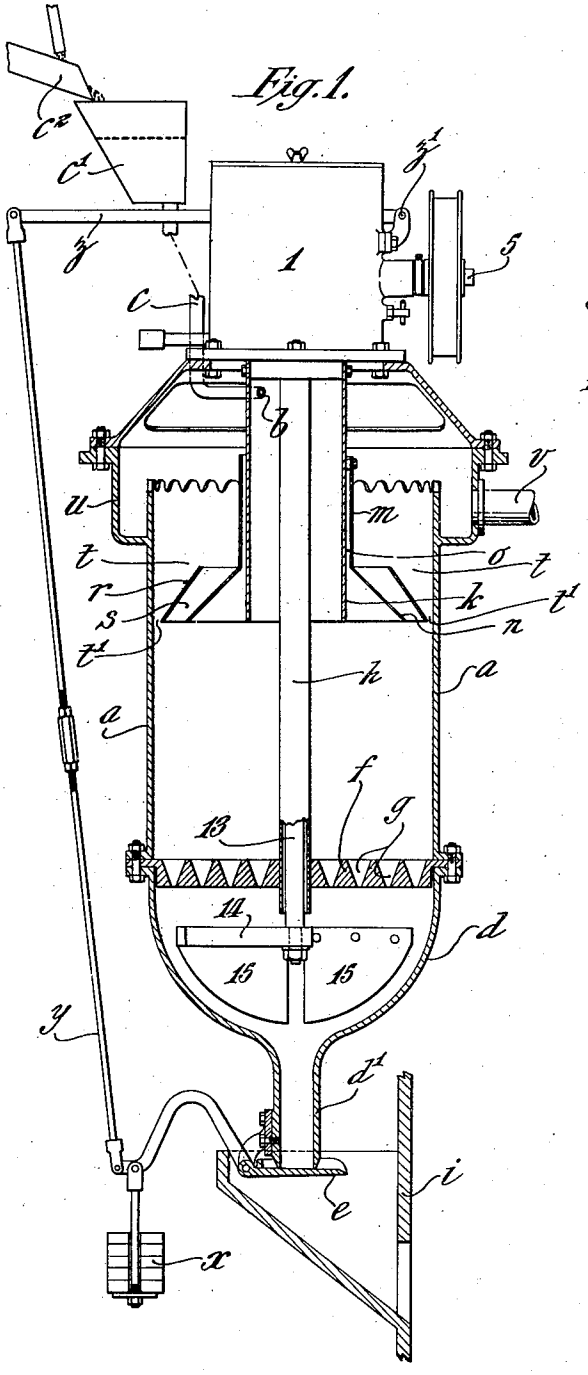


Fig. 2.

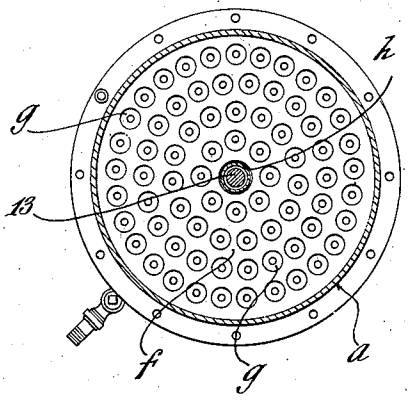
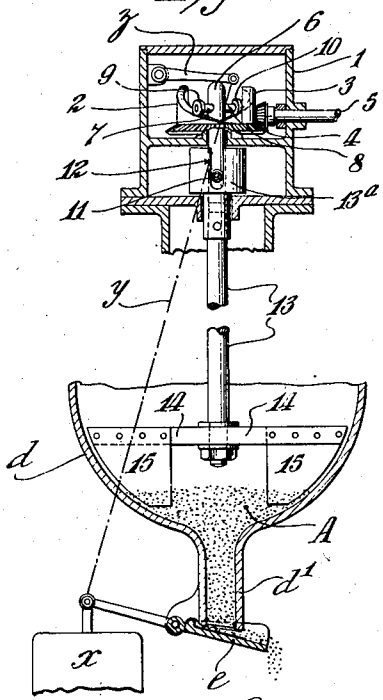


Fig. 3.



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UNITED STATES PATENT OFFICE.

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METHOD AND APPARATUS FOR THE CLASSIFICATION OF MATERIALS BY ELUTRIATION.

Application filed July 23, 1927, Serial No. 207,977, and in Great Britain July 30, 1926.

This invention has reference to a method and apparatus for the classification by elutriation of materials of various kinds as for instance those that have to be powdered before classification and also those that are naturally of a soft nature, as for example fuller's earth, china clay and the like that do not need to be powdered. It relates particularly to a method and apparatus whereby oversize particles can be separated from fine particles in a mixture thereof with water coming from another classifier in which powdered material has been subjected to a preliminary classification by elutriation and it may be desired to return the said oversize particles to a wet grinding mill to be reground. In the latter case, it is important as affecting the efficiency of grinding, that all fine particles remaining in the water, should be removed from the oversize particles and that the water escaping with the oversize particles should be reduced it may be to about one third of the weight of the particles being discharged.

Apparatus suitable for purposes such as mentioned, comprises according to the invention, a tank having an inlet at the top for the mixture of water with the material to be treated, a bowl, conical or like shaped lower end having a contracted outlet at the bottom for oversize particles, a valve for closing the said outlet, a horizontal partition arranged at an intermediate portion of its height and formed with a number of inverted conical passages, a clean water supply pipe terminating below the partition and means adapted to open and control the valve in an automatic manner and permit oversize particles to be discharged from the tank to a grinding mill, or other receptacle or place, to suit requirement, the valve operating means being dependent for action upon the accumulation of a predetermined depth of coarse particles in the lower portion of the tank.

In the accompanying illustrative drawings, Fig. 1 shows partly in side elevation and partly in vertical section, one construction of apparatus embodying the invention. Fig. 2 shows in plan, a part of such apparatus. Fig. 3 shows in vertical section one construction of means that may be used for automatically opening and controlling the outlet valve of such apparatus. Fig. 4 shows partly in elevation and partly in vertical section and Fig. 5 in plan, with parts removed, modified means for automatically opening and controlling the said outlet valve.

The apparatus shown in Figs. 1 and 2 comprise a tank a having at the top an inlet connected to a pipe c for supplying the mixture of water with oversize and fine particles of solid material to be classified, and a bowl or like shaped lower end d that forms a collecting chamber having a contracted outlet d^1 for partially dewatered coarse particles of solid material, a valve e for closing the said outlet, a horizontal partition f arranged at an intermediate portion of the height of the tank and formed with a number of inverted conical passages g, a clean water supply pipe h terminating below the partition and means adapted to open and control the valve in an automatic manner and permit oversize particles to be discharged from the chamber d to the feed box of a grinding mill, a portion of which is shown at i, the valve operating means being dependent for action upon the accumulation of coarse particles in the lower portion of the tank a. In the example now being described, the inlet at the upper part of the tank consists of a centrally arranged vertical tube k through which the mixture of water (hereinafter called for distinction carrier water) and oversize and fine particles supplied by the pipe c, it may be from a hopper c^1 into which it is fed from a chute c^2 with water, is projected downward into the tank a. An outer vertical tube m carrying at its lower end a truncated conical shell n surrounds the central tube k so as to form therewith an annular passage o, serving as a vent for bubbles of air in the carrier water, and between the said conical shell n and the wall of the tank a is a second truncated conical shell r forming, with the inner shell n, an inwardly and upwardly inclined annular passage s, and with the tank, an annular pocket t of substantially inverted conical shape in section and having an annular outlet opening t^1 at the bottom. The top of the tank a is provided with a water overflow trough u connected to an overflow pipe v. The arrangement is such that the mixture of oversize particles, fine particles and carrier water, coming from any suitable source, it may be from a vortex classifier, is projected downwards through the central tube k into the centre of the dewatering tank a. The coarse particles, under the combined influence of their own weight and the increased

momentum imparted to them by the downwardly flowing stream, are projected into the lower portion of the slowly rising stream in the portion of the tank above the partition *f*, where the rising velocity of water is insufficient to carry them up again, whereas the carrier water, with practically all fine particles suspended in it, will radiate in natural stream lines from the lower outlet of the central tube *k* to the annular outlet passage *s* between the two truncated conical shells *n* and *r* and thence into the upper part of the tank through which it rises to the top thereof where it overflows into the trough *u* and the overflow pipe *v* so that it can be led away to any desired place, it may be a settling tank in which the fine particles settle. Particles of intermediate size will fall, under the influence of gravity, through the water rising to the top of the tank *a* and collect in the outer annular pocket *t* and fall through the annular opening t^1 into the lower part of the tank above the partition *f* and there mingle with the oversize particles separating out in this portion of the tank.

The oversize particles fall on to the partition *f*, which forms a teetering bed, and through the conical passages *g* therein in which they will gravitate into the collecting chamber *d*. To prevent any fine material passing through the conical passages *g* in the partition, to the collecting chamber *d*, a small supply of clean water, hereinafter called teetering water, is fed into the said collecting chamber *d*, below the partition, through a fresh water supply pipe *h* and rises through the several conical passages in parallel at a velocity adjusted to allow relatively coarse particles only to descend.

So long as the conical passages *g* are all free of solid matter, the clear teetering water flows with equal velocity upward through all of them but as soon as the material has collected more in some passages than in others, the increased density in the charged passages restricts the flow of teetering water therethrough to such an extent as to allow the coarse particles to discharge until these passages become free ones, thus allowing other passages to discharge in their turn.

The oversize particles collected in the chamber *d* are discharged through the outlet d^1 in a partially dewatered condition and into, it may be, the feed box *i* of a grinding mill, or other receptacle or place under the control of the aforesaid valve *e* which, as hereinbefore stated, is more or less opened or closed in an automatic manner depending upon the height of the coarse particles collected in the chamber *d*. According to one arrangement for this purpose the valve *e*, conveniently in the form of a hinged shoe as shown, normally closes the outlet d^1 under the action of a weight *x* and is moved into a more or less open position by a tension device, for instance a rod *y*, connected to a lever arm *z* which is arranged to be raised or lowered by mechanism, dependent for action upon the depth of the coarse particles in the collecting chamber *d*.

This mechanism may, according to one construction and as shown in Fig. 3, comprise a gear box 1 mounted upon the top of the dewatering tank, a pair of semi-circular cams 2 and 3 having upwardly inclined faces, arranged to be rotated at a very slow speed, as by bevel gear 4 from a shaft 5 driven from any convenient source, and a vertical centrally arranged rotary spindle 6 (hereinafter called the floating spindle) which acts against the lever *z* and is provided with a pair of lateral arms 7 and 8 carrying rollers 9 and 10 which bear on the respective faces of the cams. The degree of slope of the cam faces is not constant but increases from bottom to top. The floating spindle 6 is provided with a second pair of co-axial arms 11 which engage in oppositely arranged vertical slots 12 in an enlarged end 13^a of a vertical spindle 13 that extends centrally through the dewatering tank *a* and partition *f* (Fig. 1) therein into the collecting chamber *d* and is there connected by a pair of arms 14 to two quadrant shaped blades 15 arranged within the collecting chamber *d* where they become more or less embedded in the coarse particles A collected therein. The arrangement is such that the floating spindle 6 is constantly subjected to two opposing stresses, namely, a downward pressure caused by the lever arm *z*, due to the weight *x* acting to close the valve *e* and acting to cause the rollers 9 and 10 to run down the faces of the cams 2 and 3 and thus permit the valve to be closed, and to a retarding torque, due to motion of the blades 15 in the mass of coarse particles A, and which tends to cause the rollers to roll up the faces of the said cams and thereby raise the floating spindle 6 and lever *z* and open the valve *e* to a greater or less extent.

The arrangement is such that, at starting, when there are no oversize particles in the collecting chamber *d*, the valve *e* is held in its closed position by the weight *x* and the cams 2 and 3, rollers 9 and 10, floating spindle 6, vertical spindle 13 and blades 15 rotate slowly as a whole. When oversize particles have collected in the chamber *d* and offer a certain degree of resistance to motion of the blades 15, the rollers 9 and 10 are caused to move a short distance up the faces of the cams 2 and 3 and thereby open the valve *e* to a small extent which allows coarse particles to escape, and if coarse particles are deposited in the chamber 12 at the same rate as coarse particles are being discharged through the outlet *d'*, the valve will remain practically stationary and allow coarse particles to be discharged continuously at a constant rate. If coarse particles are deposited in the cham-

ber *d* faster than they are being discharged, the mass of particles will increase and offer a greater resistance to motion of the blades 15 and thereby cause the said rollers 9 and 10 to travel to a higher position on the faces of the cams 2 and 3 and thereby cause the valve *e* to open to a greater extent and permit of a greater discharge of particles to take place. If the coarse particles are being discharged at a greater rate than they are being deposited, the mass of particles will offer less resistance to the motion of the blades, and the said rollers will descend the faces of the cams and permit the valve to move and reduce the rate of discharge of particles. If the rate of deposit of coarse particles falls to such an extent that the mass thereof offers little or no resistance to movement of the blades, the said rollers will fall sufficiently to enable the valve to close the discharge outlet and the valve will not be again opened until a sufficient mass thereof has formed to offer sufficient resistance to motion of the blades as to cause the rollers to travel up the faces of the cams and thereby again open the valve to a greater or less extent to enable the discharge of particles to again take place. Thus, the discharge of coarse particles from the tank is caused to take place continuously or intermittently, in an automatic manner, according to the rate of deposit of coarse particles in the lower portion of the tank.

Figs. 4 and 5 show a modified and preferred arrangement for automatically controlling the outlet valve. This arrangement is shown applied to the dewatering arrangement shown in Fig. 1, in this example, the cams 2 and 3 are fixed to a worm wheel 16 driven by a worm 17 on a driving shaft 5 and journalled upon the upper end of a central support 1^a carried by the bottom plate 1^b of the gear box 1. This gear box is adapted to be fixed to the top of the tank *a* as in the arrangement shown in Fig. 1. The pair of rollers 9 and 10 are carried by a horizontal shaft 18 to the central portion of which is fixed a vertical spindle 19 extending freely into a hole 20 in the shaft 13 to the lower end of which the blades 15 (Fig. 1) are fixed. To the upper end of the said shaft is fixed a horizontal plate 21 supported by a ball bearing 22 and provided with a pair of vertical guide bars 23 of V section that engage with the V shaped grooved peripheries of a pair of wheels 24 mounted to turn on the transverse shaft 18. *z* is a lever pivoted at one end at z^1, and connected at its other end through a rod to the weighted end of an outlet valve, like the lever *z* in Figs. 1 and 2. An intermediate portion of the said lever has jointed thereto at z^2, an abutment device 25 that bears through a ball bearing 26, upon the central portion of the horizontal shaft 18. In this modified arrangement the vertical shaft 13 is driven from the rotating cams 2 and 3 through the rollers 9 and 10, shaft 18, grooved wheels 24, guide bars 23 and plate 21, the whole rotating as one piece when there are no coarse particles in the collecting chamber in which the blades connected to the shaft 13 rotate. When the motion of the blades is retarded, owing to accumulation of coarse particles in the said chamber, as hereinbefore described, the cams 2 and 3 move faster than the rollers 9 and 10 bearing thereon and lift the latter and the shaft 18, which, through the abutment device 25 lifts the lever *z* about its pivot z^1 and opens the discharge valve to a greater or less degree, as in the arrangement shown in Figs. 1 and 2.

In the example shown in Fig. 4, the pipe *h* used for supplying teetering water to the collecting chamber *d* below the teetering partition *f* (Fig. 1) is arranged to surround the shaft 13 and extends, like such shaft, through the said partition into the collecting chamber *d* (Fig. 1). It receives its supply of water from a chamber 27 formed in the central support 1^a and connected to a supply pipe 28. A liquid tight packing 29 is arranged between the support 1^a and shaft 13 at the top of the chamber 27.

The details of construction can be modified in various ways.

What I claim is:—

1. A method of classifying material by elutriation, said method consisting in projecting a mixture of the said material with water into a body of water that is flowing upwardly at a less velocity than the downwardly projected mixture, whereby the heavier particles of material in the mixture will be projected to the bottom of the body of water while lighter particles in the mixture will be carried upward by the rising water, dividing the heavier particles into separate accumulations thereof, washing said accumulations of heavier particles by clean water caused to flow upward through them so as to remove lighter particles attached to the heavier particles and carry such lighter particles upward into the rising body of water and allowing the heavier and cleaned particles to fall through the washing water.

2. A method of classifying material by elutriation, said method consisting in projecting a mixture of the said material with water into a body of water that is flowing upwardly at a less velocity than the downwardly projected mixture, whereby the heavier particles of material in the mixture will be projected to the bottom of the body of water while lighter particles in the mixture will be carried upward by the rising water, dividing the heavier particles into separate accumulations thereof, washing said accumulations of heavier particles by clean water caused to flow upward through them so as to remove lighter particles attached to the heavier particles and carry such lighter particles

upward into the rising body of water, allowing the heavier and cleaned particles to fall through the washing water, running off the rising water with lighter particles and automatically removing the heavier and cleaned particles from the washing water.

3. Apparatus for the classification of material by elutriation, comprising a tank having an outlet at the top, a valve controlled outlet at the bottom, a horizontal partition arranged at an intermediate portion of the height of said tank and having a plurality of inverted truncated conical passages therethrough, a vertical conduit arranged in the upper central portion of said tank and above said partition, the space between the lower end of said conduit and partition being unobstructed, means for causing a mixture of the material to be classified and water to be projected downward through said conduit and means for supplying clean washing water to said tank below said partition.

4. Apparatus for the classification of material by elutriation, comprising a tank having an outlet at the top, a valve controlled outlet at the bottom, a horizontal partition arranged at an intermediate portion of the height of said tank and having a plurality of inverted truncated conical passages therethrough, a vertical conduit arranged in the upper central portion of said tank and above said partition, the space between the lower end of said conduit and partition being unobstructed, a receptacle for a mixture of the material to be classified, and water, connected to and arranged at a height above said conduit sufficient to cause the mixture to be projected downward through said conduit into the portion of the tank above said partition, and means for delivering a stream of clean washing water to said tank below said partition.

5. Apparatus for the classification of material by elutriation, comprising a tank having upper and lower outlets, a loaded valve adapted normally to close the lower outlet, a horizontal partition arranged at an intermediate portion of the height of said tank between said outlets, and having a plurality of inverted conical passages therein, a vertical conduit arranged in the upper central portion of said tank and above said partition, the space between the lower end of said conduit and partition being unobstructed, means for causing a mixture of the material to be classified, with water, to be delivered in a downward direction under pressure through said conduit, means for supplying clean washing water to said tank below said partition and rotary means adapted to open said valve automatically against the action of the closing load thereon, said valve opening means being dependent for action on accumulation of coarse material in the lower portion of said tank.

6. Apparatus for the classification of material by elutriation, comprising a tank, having an upper outlet overflow, a horizontal partition arranged at an intermediate portion of the height of said tank and having a plurality of inverted truncated openings therethrough, a vertical conduit arranged in the upper central portion of said tank and above said partition, means for delivering a mixture of material to be classified, and water, under pressure, in a downward direction through said conduit into the tank towards said partition, means for delivering clean washing water into said tank below said partition, and a tube surrounding said conduit and carrying at its lower end a truncated conical shell, said tube with shell forming with said conduit, an annular air vent terminating above the overflow outlet, and with the wall of the tank, an annular outlet passage communicating with the overflow outlet for water carrying fine particles of powdered material.

7. Apparatus for the classification of material by elutriation, comprising a tank having an upper outlet overflow, a horizontal partition arranged at an intermediate portion of the height of said tank and having a plurality of inverted truncated openings therethrough, a vertical conduit arranged in the upper central portion of said tank and above said partition, means for delivering a mixture of material to be classified, and water, under pressure, in a downward direction through said conduit into the tank towards said partition, means for delivering clean washing water into said tank below said partition and a second truncated conical shell arranged between the first mentioned shell and the wall of the tank and forming with the said first mentioned shell an annular passage communicating with the overflow outlet for water carrying fine particles of powdered material, and with the wall of the tank, an inverted conical pocket having an annular outlet at the bottom through which particles of intermediate size can fall into the portion of the tank above said partition.

Signed at London, England, this 14th day of July, 1927.

LEONARD ANDREWS.