

Oct. 24, 1944.

B. HORSFIELD

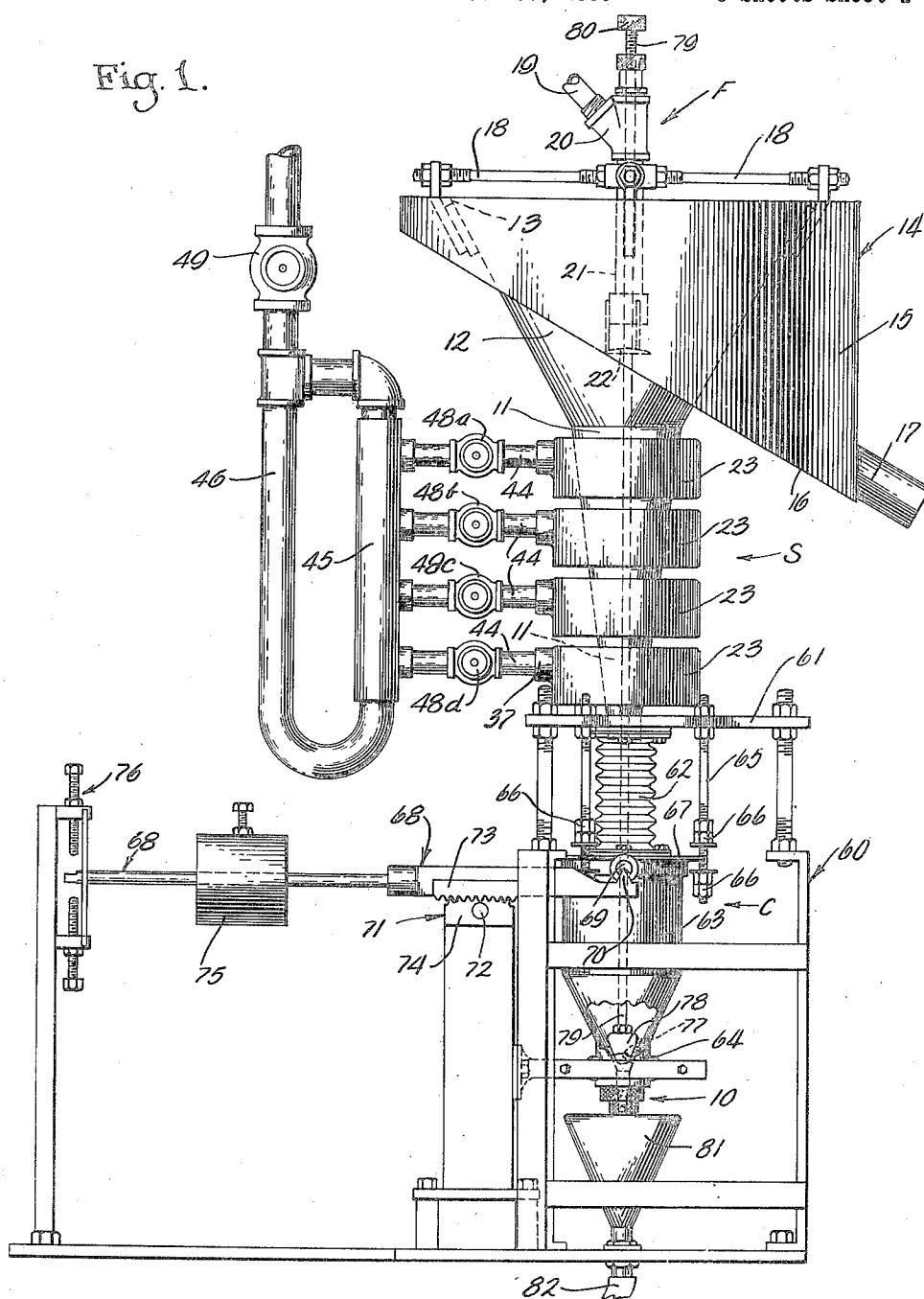
2,361,207

SEPARATION

Filed Dec. 30, 1939

3 Sheets-Sheet 1

Fig. 1.



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Filed Dec. 30, 1939

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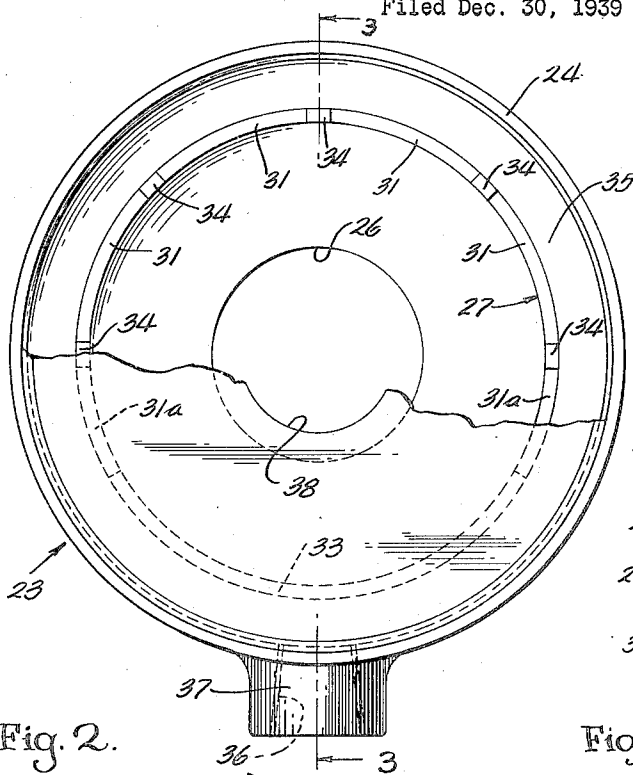


Fig. 2.

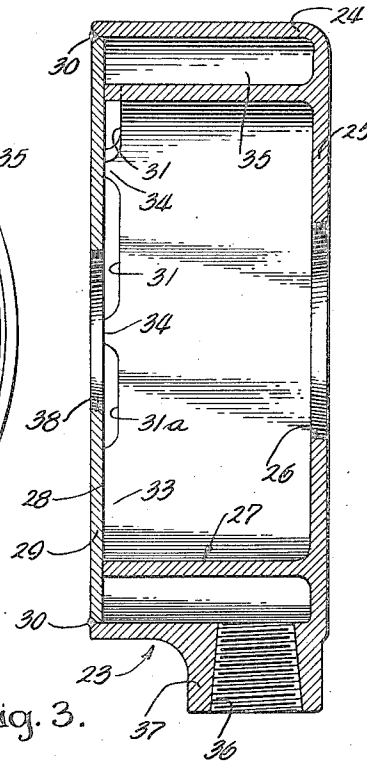
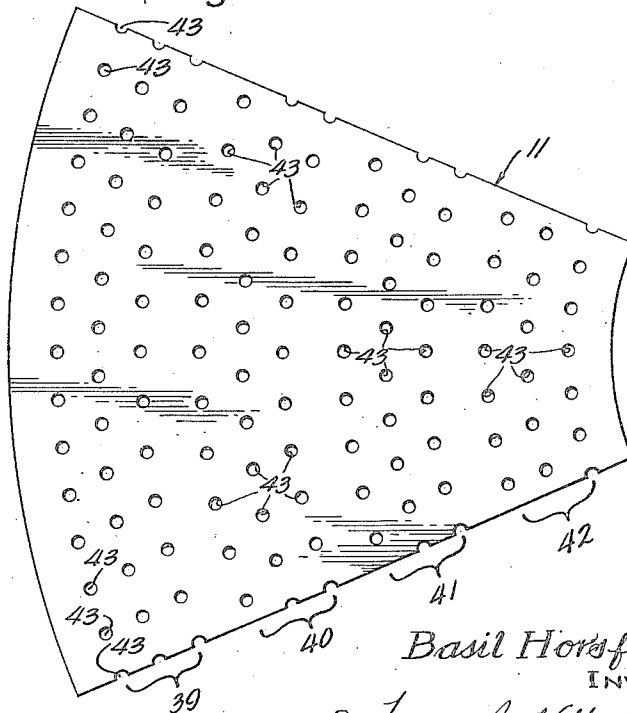


Fig. 3.

Fig. 4.



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2,361,207

SEPARATION

Filed Dec. 30, 1939

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Fig. 5.

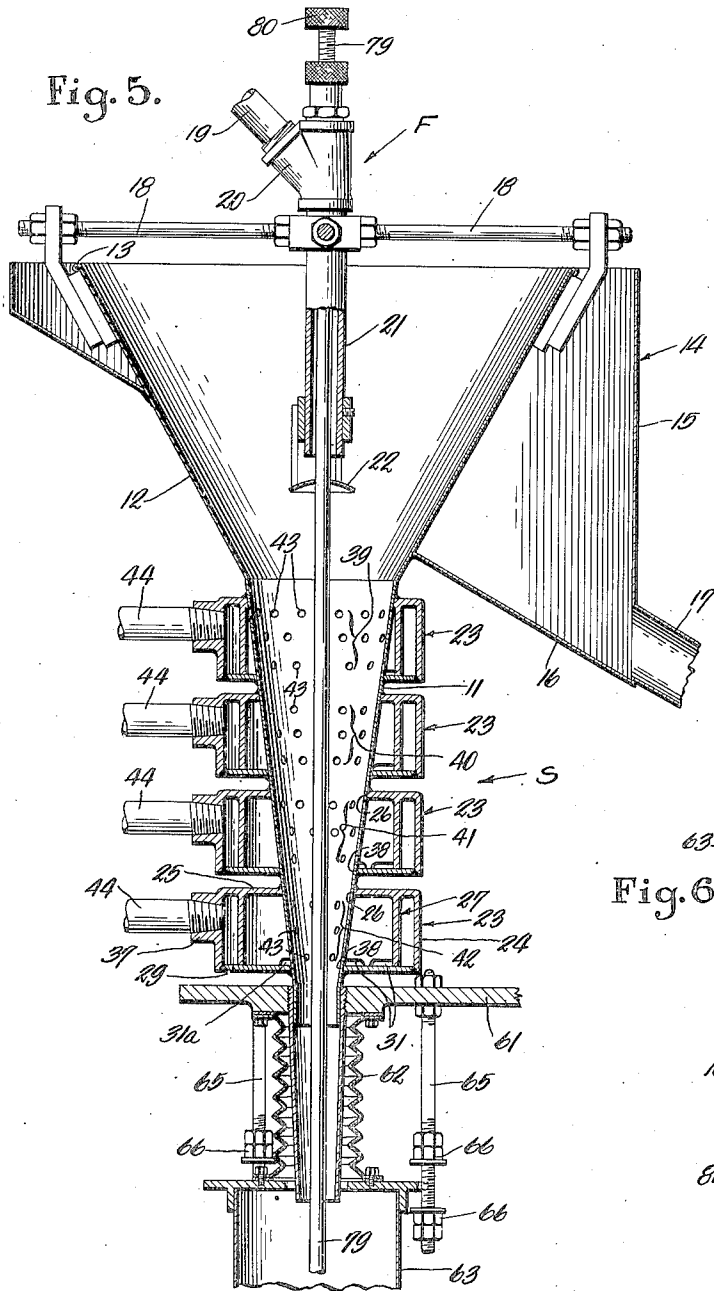
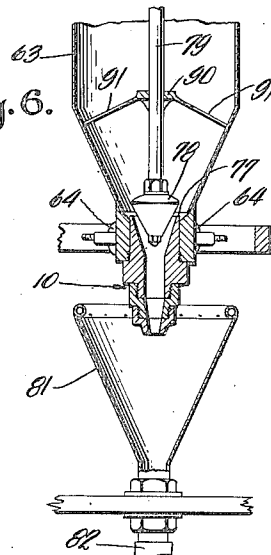


Fig. 6.



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2,361,207

SEPARATION

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Application December 30, 1939, Serial No. 311,793

8 Claims. (Cl. 209—160)

My invention relates to separation of material particles, and the principal object of my invention is to provide new and improved separations.

In the drawings accompanying this specification, and forming a part of this application, I have shown, for purposes of illustration, one form of apparatus, and in these drawings:

Figure 1 is a side elevation of this illustrative form of apparatus, a portion being broken away,

Figure 2 is a bottom view of one water feed chamber forming part of the apparatus shown in Figure 1, an element thereof being partly broken away,

Figure 3 is a section taken on the line 3—3 of Figure 2, looking in the direction of the arrows,

Figure 4 is a developmental view of a water tube forming part of the apparatus shown in Figure 1,

Figure 5 is a fragmentary vertical sectional view of an upper portion of the apparatus shown in Figure 1, and

Figure 6 is a fragmentary vertical sectional view of a lower portion of the apparatus shown in Figure 1.

The particular apparatus herein illustrated comprises, in general, hydraulic separating means S, feed means F for feeding particles to the hydraulic separating means S, and control means C for controlling the discharge of underage from the hydraulic separating means S. Material fed by the feed means F to the hydraulic separating means S is separated into two fractions, one of which, the underage, eventually is discharged from the lower end of the apparatus through discharge spud means 10, and the other of which, the overage, is discharged from the upper end of the hydraulic separating means S.

The particular hydraulic separating means S shown herein is designed to operate by hydraulic counter-current separation and includes an elongated chamber 11, in this instance of conical form, hereinafter called a water tube. The water tube 11 is here shown as joined directly to the lower end of a funnel 12 which terminates in an upper margin 13 over which the overage from the hydraulic separating means is adapted to be discharged into a launder 14 comprising a generally cylindrical portion 15 surrounding and spaced from the funnel 12 and provided with an inclined bottom 16 having a water-tight joint with the funnel 12. The launder 14 is provided with a discharge spout 17, through which the overage is discharged.

The means F for feeding material is suitably supported by bracket means 18, and comprises a

conduit 19 connected to a pipe fitting 20 in turn connected to an inlet pipe 21. Below and spaced from the outlet of the pipe 21 a suitable baffle 22 may be mounted in any suitable way.

The water tube 11 is provided with means for admitting water therein comprising two or more water feed chambers or jackets 23 in this instance, four.

One of the water jackets 23 is shown in Figures 2 and 3. The water jacket comprises a generally cup-shaped member having a cylindrical outer wall 24 and an end wall 25 having an aperture 26. Extending from the end wall 25 is a cylindrical wall 27. The wall 27 terminates in a plane 28 spaced sufficiently from the plane of the free end of the wall 24 to allow for a cover plate 29 which is welded or otherwise suitably fastened to the end of the wall 24 by a water-tight joint 30. The end of the wall 27 is provided with a plurality of recesses 31, 31a, extending around a desired part of the circumference, the end recesses 31a leaving between them an unrecessed portion 33 of the wall 27. The recesses 31, 31a leave relatively narrow wall portions 34 between them, and the cover plate 29 bears against the ends of the portions 34 and against the end of the wall portion 33.

The hereinbefore described construction provides an annular chamber 35 in communication with the space within the wall 27 only by way of the apertures formed by the recesses 31, 31a. Water is adapted to be fed into the chamber 35 through a hole 36 in a spud 37 extending from the wall 24, the hole 36 being approximately opposite the circumferential middle of the wall portion 33. The hole 36 is here shown as spaced in an axial direction from the general plane of the apertures 31, 31a.

The cover plate 29 is provided with an aperture 38 in axial alinement with the aperture 26. The surfaces of the apertures 26, 38, when the water jacket is to be used with a water tube of the form of the tube 11, desirably define a cone of the same taper as the tube 11, and the apertures 26, 38 of each water jacket 23 are made of such size that the respective water jackets 23 fit the water tube 11 at the desired spaced portions of its length, as shown in Figure 1.

The water tube 11 is provided with longitudinally spaced bands 39, 40, 41, 42 of holes, as shown in the developmental view, Figure 4. In this instance, each band comprises three circumferential extending rows of circumferentially spaced holes 43. The construction and arrangement is such that when the uppermost water jacket 23 is

in the position shown in Figure 1, the band 39 of holes is longitudinally between the end wall 25 and cover plate 29 of that water jacket, and the successively lower water jackets 23 are similarly positioned with respect to the bands 40, 41, 42 respectively. It will be understood that the margins of the apertures 26, 38 of each water jacket are brazed or otherwise suitably joined water-tight to the water tube 11.

One way in which the supply of water to the water jackets 23 may be controlled is shown in Figure 1. As here shown the spud 37 of each water jacket 23 is connected by a pipe section 44 to a manifold 45 which may be connected at both ends to a main water supply pipe 46. The pipe sections 44 have interposed therein valves 48, individually designated 48a, 48b, 48c, 48d respectively, and the main supply pipe 46 has a valve 49 interposed therein.

Assuming that the valve 49 is open and that the valves 48b, 48c and 48d are closed, and that the valve 48a is opened a desired amount, water will flow through the valve 48a into the annular chamber 35 of the uppermost water jacket 23, and from this chamber it will flow through the apertures provided by the recesses 31, 31a into the annular space between the water tube 11 and the wall 27. From that space the water will flow through those holes 43 which constitute the band of holes 39, into the water tube 11, thereby subjecting material fed into the separating means S through the feed means F, to a desired upward current of water originating at the band 39 where the water tube 11 has a relatively large cross-sectional area. In like manner the valve 48b, or the valve 48c, or the valve 48d may be opened, all of the other valves being, in each instance, kept closed, whereby the material may be subjected to a desired upward current of water originating respectively at the bands of holes 40, or 41, or 42, with respect to each of which the cross-sectional area of the water tube 11 is successively smaller. Furthermore, the valves controlling adjacent pairs of water jackets 23, such as the valves 48a and 48b, or 48b and 48c, or 48c and 48d, may be opened, the remaining valves in each instance being kept closed; or three of the valves 48 controlling three adjacent water jackets 23 may be opened, the other valve being kept closed; or the valves 48 may be opened in any other combination; or all of the valves 48 may be opened. The valve 49 may of course be adjusted at any time but is particularly useful when more than one of the valves 48 is opened. Adjustment of the valve 49 adjusts the water pressure in the manifold 45 whereby, for any given setting of two or more of the valves 48, the effect of the respective water jackets 23 may be simultaneously adjusted while keeping the relative effect the same. If desired a manometer or other suitable pressure measuring or indicating device (not shown) may be provided at desired places in the water feed system. In each combination of use of the control valves each valve will be opened an amount such as will give hydrodynamic conditions in the separating means S best adapted to obtain the desired separations.

In the illustrated embodiment the diameter of the top of the funnel 12 is approximately 16 inches and the diameter of the bottom of this funnel is approximately $4\frac{1}{4}$ inches, this diameter, in this instance, being also the diameter of the top of the water tube 11. The diameter of the bottom of the water tube is approximately $1\frac{1}{2}$ inches. The axial length of the funnel 12 is

approximately 10 inches and the axial length of the water tube 11 is approximately $12\frac{1}{2}$ inches. The axial over-all length of each of the water jackets 23 is approximately $2\frac{1}{2}$ inches and the axial distance between adjacent water jackets is approximately $\frac{1}{2}$ an inch. The diameters of the water tube 11 at the lowest row of holes of the bands 39, 40, 41, and 42 are respectively approximately 4 inches, $3\frac{1}{2}$ inches, $2\frac{1}{2}$ inches, and $1\frac{1}{2}$ inches. The numbers of holes in the rows of holes comprising the bands 39, 40, 41, and 42, reading from highest to lowest, are 14, 13, 12 (for the band 39), 11, 11, 10 (for the band 40), 9, 9, 8 (for the band 41), and 7, 6, 6 (for the band 42). The foregoing dimensions and numbers have been given purely by way of illustration and it is to be understood that I do not limit my invention to these dimensions and numbers.

With respect to the numbers of holes in the rows of holes comprising the bands of holes 39, 40, 41, and 42, it is desirable that the construction and arrangement be such that when any band, or any combination of adjacent bands, or when all of the bands of holes are being supplied with water, the upward velocity in the water tube 11 from the lowermost band in use to and including the highest band in use may be caused to be substantially the same.

The discharge of underage from the water tube 11 may be controlled, if desired, as disclosed in the application of Edwin L. Wiegand, Serial Number 293,264, filed September 2, 1939, and to that end the hydraulic separating means S may be carried by supporting means 60 comprising a plate 61 through which the lower end of the water tube 11 extends into a metallic bellows 62 forming part of the control means C. The bellows 62 is connected at its upper end to the plate 61 and at its lower end to a sump tank 63, these connections being watertight. The bellows 62 permits upward and downward movement of the sump tank 63, the lower end of the tank being guided by suitable guide means including guide rollers 64, and the upper end being guided by rods 65 fastened to the plate 61. Stop nuts 66, cooperating with a flange 67 on the sump tank 63, are provided to adjustably limit up and down movement of the tank 63. The sump tank 63 carries, on opposite sides, knife edge bearings with which cooperate knife edges respectively provided on a beam 68, one knife edge bearing 69, and one knife edge 70 being visible in Figure 1. The beam 68 is adapted to rock on an arcuate upper surface of a fulcrum means 71 adjustable about a pivot 72. A rack 73 may be provided on the beam 68, to cooperate with a fragmentary gear 74 mounted adjacent the arcuate surface of the fulcrum engaged by the beam. The beam 68 carries a weight 75 adjustable along the beam, and adjustable limit stop means 76 is provided for the end of the beam 68. The sump tank 63 carries at its lower end a member providing a seat 77 for a valve body 78. The valve body 78 is fastened to a relatively fixed rod 79 which extends upwardly through the sump tank 63, the bellows 62, the separating means S, and the feed means F, and is in threaded engagement with a part of the feed means F so that the valve body 78 may be adjusted up and down by a knob 80 on the valve rod 79. The lower end of the rod 79 may, if desired, be guided by a suitable guide bearing 90 which may be supported by a plurality of circumferentially spaced legs 91 welded or otherwise suitably fastened to the bearing 90 and to the inside wall of the sump tank 63.

The underage is dischargeable from the sump tank 63 through the valve 77, 78, and through the spud means 10, into a funnel 81 leading to a conduit 82. The control means C automatically controls the discharge of underage as fully set forth in the hereinbefore mentioned copending application, and is advantageously used in connection with a separating means such as S in which water may be selectively admitted to portions of the tube 41 having different cross-sectional areas.

From the foregoing it will be apparent to those skilled in the art that the illustrated embodiment of my invention provides new and improved separations, and accordingly, accomplishes the principal object of my invention. On the other hand, it also will be obvious to those skilled in the art that the illustrated embodiment of my invention may be variously changed and modified, or features thereof, singly or collectively, embodied in other combination than those illustrated, without departing from the spirit of my invention, or sacrificing all of the advantages thereof, and that accordingly, the disclosure herein is illustrative only, and my invention is not limited thereto.

I claim:

1. Apparatus for separating material particles, comprising: hydraulic separating means so constructed and arranged that particles fed thereto are subjected to hydraulic counter-current settling, said separating means comprising means providing a separating chamber and means for admitting liquid to said separating chamber, said liquid admitting means including jacket means about said separating chamber, said jacket means including a first wall disposed about and spaced from an apertured portion of said separating chamber, and a second wall disposed about and spaced from said first wall, said first wall being apertured along only a portion of its circumference to place the space between said walls in communication with the space between said first wall and said apertured portion of said separating chamber, and said second wall having an opening for admitting liquid to the space between said second wall and said first wall, said opening being disposed opposite the unapertured portion of said first wall.

2. Apparatus for separating material particles, comprising: hydraulic separating means so constructed and arranged that particles fed thereto are subjected to hydraulic countercurrent settling, said separating means comprising a downwardly tapering separating chamber having a plurality of vertically spaced wall portions, successive wall portion being alternately unapertured and apertured, and comprising means for admitting liquid to said apertured portions; said liquid admitting means including a plurality of separate jacket means about said apertured wall portions of said chamber respectively, all of said jacket means being of the same outer peripheral dimensions, and each of said jacket means including upper and lower wall portions having transverse openings respectively fitting unapertured wall portions adjacent opposite sides of the respective apertured portion of said chamber, and each including wall means joining said upper and lower wall portions and disposed about and spaced from the respective apertured wall portion of said chamber.

3. Apparatus for separating material particles, comprising: hydraulic separating means so constructed and arranged that particles fed thereto

are subjected to hydraulic countercurrent settling, said separating means comprising means providing a separating chamber and means for admitting liquid to said separating chamber to cause an upward current of liquid in said separating chamber, said liquid admitting means including jacket means about said separating chamber, said jacket means including a first wall disposed about and spaced from an apertured portion of said separating chamber, and a second wall disposed about and spaced from said first wall, said first wall being apertured to place the space between said walls in communication with the space between said first wall and said apertured portion of said separating chamber, said jacket means being so constructed and arranged that liquid admitted to the space between said walls will be substantially uniformly fed about said apertured portion of said separating chamber to produce said upward current.

4. Apparatus for separating material particles, comprising: hydraulic separating means so constructed and arranged that particles fed thereto are subjected to hydraulic countercurrent settling, said separating means comprising a conical continuously downwardly tapering separating chamber having a plurality of vertically spaced tapering wall portions, successive wall portions being alternately unapertured and apertured, and comprising means for admitting liquid to said apertured portions; said liquid admitting means including a plurality of separate jacket means about said apertured wall portions of said chamber respectively, all of said jacket means being of the same outer peripheral dimensions, and each of said jacket means including upper and lower wall portions having transverse openings respectively fitting unapertured tapering wall portions adjacent opposite sides of the respective apertured portion of said chamber, and each including wall means joining said upper and lower wall portions and disposed about and spaced from the respective apertured wall portion of said chamber.

5. Apparatus for separating material particles, comprising: hydraulic separating means so constructed and arranged that particles fed thereto are subjected to hydraulic countercurrent settling and the underage of said separating means is normally continuously dischargeable at the lower end of said separating means through an opening free to atmosphere, said separating means comprising means providing a chamber having a unitary inside wall the space therewithin being free of transverse obstructions thereby to enable unobstructed vertical flow of liquid, and means for admitting liquid to longitudinally spaced portions of said chamber, the cross-sectional area of a lower one of said portions being less than the cross-sectional area of a higher one of said portions, the parts of said unitary wall defining said portions being each provided with a set of circumferentially spaced apertures extending transversely through said wall parts so as to provide inwardly directed streams of liquid substantially normal to said wall parts; and means for selectively controlling by sets the admission of liquid to said sets of apertures, said means comprising individual conduits, a single conduit for each set of said apertures, connectable to a source of liquid under pressure, and individual valve means interposed in said conduits for controlling the admission of liquid to the respective sets of apertures whereby by closure of one or more of said valve

means admission of liquid to a selected one or more of said sets of apertures may be entirely interrupted and liquid admitted only to the remaining sets.

6. Apparatus for separating material particles, comprising: hydraulic separating means so constructed and arranged that particles fed thereto are subjected to hydraulic countercurrent settling and the underage of said separating means is normally continuously dischargeable at the lower end of said separating means through an opening free to atmosphere, said separating means comprising means providing a chamber having a unitary inside wall the space therewithin being free of transverse obstructions thereby to enable unobstructed vertical flow of liquid, and means for admitting liquid to longitudinally spaced portions of said chamber, the cross-sectional area of a lower one of said portions being less than the cross-sectional area of a higher one of said portions, the parts of said unitary wall defining said portions being each provided with a set of circumferentially spaced apertures extending transversely through said wall parts so as to provide inwardly directed streams of liquid substantially normal to said wall parts; means for selectively controlling by sets the admission of liquid to said sets of apertures, said means comprising individual valve means, a single valve means for each set of apertures, constructed and arranged to control the admission of liquid to the respective sets of apertures whereby by closure of one or more of said valve means admission of liquid to a selected one or more of said sets of apertures may be entirely interrupted and liquid admitted only to the remaining sets of apertures; common conduit means connectable to a source of liquid under pressure and connected simultaneously to feed liquid under pressure to all of said individual valve means; and single valve means interposed in said common conduit means for simultaneously controlling feeding of liquid to said individual valve means.

7. Apparatus for separating material particles, comprising: hydraulic separating means so constructed and arranged that particles fed thereto are subjected to hydraulic countercurrent settling and the underage of said separating means is normally continuously dischargeable at the lower end of said separating means through an opening free to atmosphere, said separating means comprising a conical wall providing a continuously downwardly tapering chamber the space

therewithin being free of transverse obstructions thereby to enable unobstructed vertical flow of liquid, and means for admitting liquid to longitudinally spaced portions of said chamber, the wall parts of said conical wall defining said longitudinally spaced portions being each provided with a set of circumferentially spaced apertures extending through said wall parts so as to provide inwardly directed streams substantially normal to said wall parts; means for selectively controlling the admission of liquid to said sets of apertures, said means comprising individual conduits, a single conduit for each set of apertures, connectable to a source of fluid under pressure, and individual valve means interposed in said conduits for controlling the admission of liquid to the respective sets of apertures whereby by closure of one or more of said valve means admission of liquid to a selected one or more of said sets of apertures may be entirely interrupted and liquid admitted only to the remaining sets.

8. Apparatus for separating material particles, comprising: hydraulic separating means so constructed and arranged that particles fed thereto are subjected to hydraulic countercurrent settling and the underage of said settling means is normally continuously dischargeable at the lower end of said separating means through an opening free to atmosphere, said separating means comprising a downwardly tapering separating chamber the space therewithin being free of transverse obstructions thereby to enable unobstructed vertical flow of liquid, said chamber having a plurality of vertically spaced wall portions, successive wall portions being alternately unapertured and apertured, and comprising means for admitting liquid to said separating chamber; said liquid admitting means including a plurality of separate jacket means about said apertured wall portions of said chamber respectively, each of said jacket means being of the same outer peripheral dimensions, and each of said jacket means including upper and lower wall portions having transverse openings respectively fitting unapertured wall portions adjacent opposite sides of the respective apertured portion of said chamber, and each including wall means joining said upper and lower wall portions and disposed about and spaced from the respective apertured wall portion of said chamber.

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