Feb. 27, 1934. T. M. CHANCE 1,949,242

APPARATUS FOR SEPARATING MATERIALS OF DIFFERENT SPECIFIC GRAVITIES

Original Filed Feb. 11, 1930 2 Sheets-Sheet 1

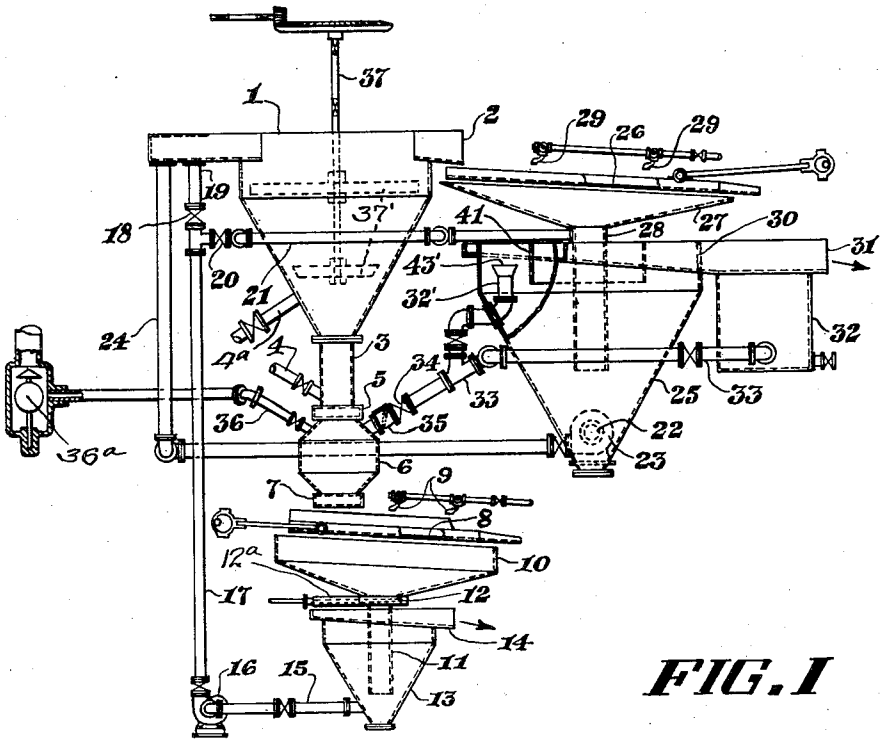


FIG. I

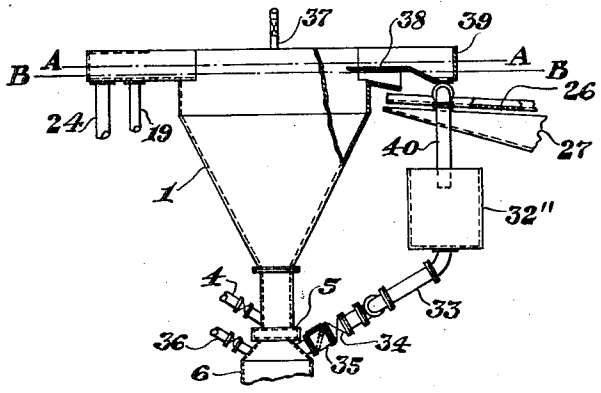


FIG. II

Witnesses
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APPARATUS FOR SEPARATING MATERIALS OF DIFFERENT SPECIFIC GRAVITIES

Original Filed Feb. 11, 1930 2 Sheets-Sheet 2

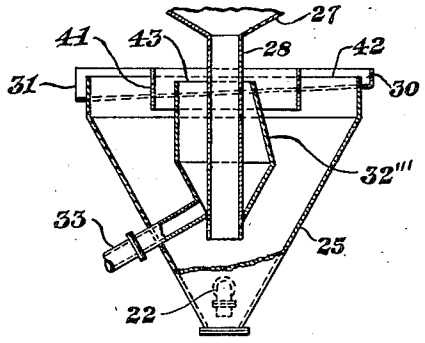


FIG. III

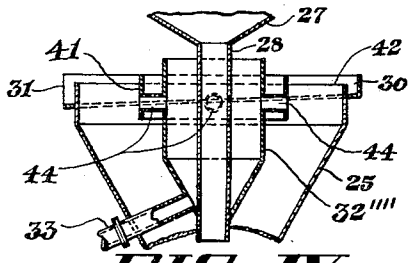


FIG. IV

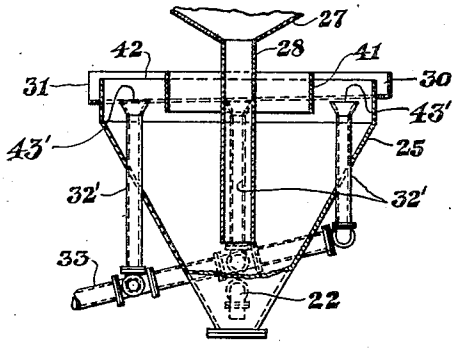


FIG. V

Witnesses
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Patented Feb. 27, 1934 1,949,242

UNITED STATES PATENT OFFICE

1,949,242

APPARATUS FOR SEPARATING MATERIALS OF DIFFERENT SPECIFIC GRAVITIES

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Application February 11, 1930, Serial No. 427,532
Renewed May 16, 1933

4 Claims. (Cl. 209—173)

My invention relates to those embodiments of apparatus for the separation of materials of different specific gravities by means of a fluid mass of relatively high specific gravity, heretofore disclosed in my United States Patents Nos. 1,224,138, 1,392,401 and 1,559,937, in which the heavy materials sinking in said fluid mass are removed therefrom by means of a valved receptacle or refuse chamber, subjacent to said fluid mass and adapted to intermittently receive and discharge said heavy materials, said discharge being accompanied with a complete or partial discharge of the water contained in said chamber.

One object of my invention is the filling of said refuse chamber with water from a source of supply consisting of process water wasted from the apparatus, under a head adapted to serve as such a source, without the application of additional energy thereto. Another object is the provision of a controlled flow of the water content of said refuse chamber during discharge therefrom, designed to minimize loss of solid constituents of the fluid mass during and after their removal from the heavy materials. A third object is an improved construction of sand sump and operation thereof adapted to the efficient filling of said chamber. Other advantages will be apparent from the further disclosures contained herein.

The several drawings are diagrammatic vertical elevations, partially in cross-section, illustrating various types of apparatus which I may employ. The drawings, Figure I represents apparatus designed to use water overflowing from a sand sump for refuse chamber filling, Figure II apparatus securing such water from a supernatant layer above the fluid mass in the main separating receptacle, and Figures III, IV and V specific types of sand sump. Like numbers indicate like parts in the several drawings.

In the following description of the drawings and the claims hereof, the terms "sand" and "water" are used to describe any suitable comminuted solid and liquid used to produce the separating fluid mass, and the terms "coal" and "refuse" designate any materials respectively floating and sinking in the fluid mass if said fluid mass is a flotational one, or falling at relatively low and high velocities if said fluid mass acts as a classifying medium. The term "fluid mass" is meant to include any fluidic mixture of a liquid and comminuted solids substantially insoluble therein that requires appreciable agitation to attain and maintain the properties of a fluid of specific gravity higher than that of said liquid.

In Figure I, receptacle 1, containing a fluid mass consisting of an agitated mixture of sand and water, is provided with clean coal overflow 2 and refuse classifier column 3, fitted with valved water agitation inlet 4. Classifier column 3 discharges refuse sinking from the fluid mass through refuse valve 5 to refuse chamber 6 which in turn discharges said refuse through refuse valve 7 to refuse screen 8. Screen 8, which may be provided water sprays 9, is fitted with hopper 10 and discharge 11, delivering sand and water to refuse sand sump 13. Discharge 11 may be constructed with movable, or fixed, orifice 12 for regulating discharge from hopper 10, the use of a movable orifice being indicated by the slide gate 12*a*. Refuse sand sump 13 delivers excess water through overflow 14 and returns sand and water through conduit 15, elevating device 16 (here shown as a sand pump) and conduit 17. Conduit 17 may deliver directly to the fluid mass through valve 18 and conduit 19, or indirectly, by way of the main sand return, by valve 20 and conduit 21.

The clean coal floating in the fluid mass is discharged through 2 by a sand and water overflow produced by discharge from sand sump 25 to receptacle 1, conduit 22, elevating device 23, (illustrated as a sand pump) and conduit 24 being provided therefor. Coal desanding screen 26, provided with hopper 27 and sand discharge 28 returns sand and water to sump 25. Screen 26 may be provided with water sprays 29.

Sand sump 25 discharges excess water (over that returned by pump 23) by overflow chute 30, said chute filling tank 32 and eventually discharging at 31. Tank 32 delivers water through conduit 33, valve 34 and check valve 35 to refuse chamber 6, which latter may be fitted with valved air vent 36. Sand sump 25 may alternatively be provided with an internal intake to conduit 33, as indicated by the vertical pipe 32′ adapted to secure water through orifice 43′ from the annulus between a baffle ring 41 and the outer well of said sump. A mechanical agitator 37 may be provided for assisting in the agitation of the fluid mass in receptacle 1 produced by hydraulic water introduced through inlet 4. Additional hydraulic water may also be introduced at other points in the receptacle, as illustrated in Patent 1,559,937, as indicated by the valved inlet 4*a*.

In Figure II, which illustrates apparatus similar to that of Figure I, the top surface of a

supernatant body of water overlying the fluid mass is indicated by dot and dash line A—A, the top surface of said fluid mass being likewise indicated by the line B—B. In this apparatus, the water for filling refuse chamber 6 is secured directly from said supernatant body of water, said filling water discharging over splitting diaphragm 38 into stay-box 39 and from thence by conduit 40, tank 32'', conduit 33, valve 34 and check valve 35, into refuse chamber 6.

In Figure III, filling tank 32''' is placed internally within sand sump 25, embracing sand discharge 28. 41 indicates a baffle ring that may be provided to localize surface disturbances due to the water rising from the lower part of the sump to discharge lip 42 and thus minimize the loss of fine sand. In this type of sump, the level of intake lip 43 of tank 32''', is below, or but slightly above discharge lip 42, to ensure the filling of tank 32''' with water. Under some conditions, I may reduce the top diameter of tank 32''' so as to bring lip 43 nearer discharge 28, thus giving greater opportunity for solids to settle as the filling water must move radially inward before it enters tank 32''', such an alternate construction being diagrammatically illustrated in Figure III by the inclined upper portion of tank 32''', shown on the right-hand side of said tank, it being understood that said tank may be unsymmetrical as shown or with symmetrically vertical or inclined sides.

Figure IV illustrates a construction similar to Figure III, but with the important difference that baffle ring 41 is an essential element of structure, the walls of tank 32'''' being carried sufficiently above lip 42 to preclude entrance of water and filling of tank 32'''' being accomplished by conduits 44 connecting the annular space between ring 41 and the outer wall of sand sump 25. This construction is advantageous when a disturbed condition obtains in the upper part of the annulus between ring 41 and filling tank 32'''', as the filling water is drawn from the quiescent area exterior to baffle 41, and sand that may be thrown up into said annulus is excluded. Conduits 44 may be placed at any suitable vertical position in baffle 41, provided that they are sufficiently immersed to permit filling tank 32''''.

In Figure V, which illustrates a type of sand sump in which the filling chamber is a part of the upper portion of the sand sump, four pipes, 32', serving as connecting conduits between an annulus, formed by baffle ring 41 and the external portion of the sand sump 25, and the common conduit 33 leading to the refuse chamber. The orifices 43' of the pipes 32' preferably may be expanded as shown to reduce entrance losses into the pipes and said orifices should be sufficiently below the discharge lip 42 to insure both a volume large enough to function efficiently in place of the filling chamber 32, 32'', 32''' and/or 32'''' of the other drawings and also to furnish the requisite velocity head for filling the refuse chamber in the desired time. In most cases it will be desirable to symmetrically locate the pipes 32' within the sand sump (three of these pipes being shown in the sectional view) but this is not an essential condition.

It will be understood that, while I generally prefer a circular, symmetrical design for sumps of the types shown in Figures III, IV and V, this is not a necessary condition, either as to shape or symmetry, and further, that the volume of tank 32, 32'', 32''' and/32'''', whether internal or external to the sand sump (or connected directly to the separating receptacle as in Figure II), which ordinarily is as great, or greater, than that of the refuse chamber, may be reduced until it becomes merely an extension of conduit 33—said reduction in volume simply tending to reduce the filling rate when communication is established with the refuse chamber.

The operation of the apparatus shown in Figures I and II will be clear from the description of the drawings. Classifier column 3 may serve to return to the fluid mass more or less of the sand that tends to fall admixed with the refuse sinking from the fluid mass, the functioning of said classifier column not being essential to my present invention. The presence of a supernatant body of water overlying the fluid mass, such as shown by the lines A—A and B—B of Figure II, is ensured by suitably restraining the discharge through the overflow aperture, or apertures, from the upper portion of receptacle 1. In both drawings, the operation of refuse chamber 6, for the evacuation of refuse falling from the fluid mass, is as follows:

Refuse valve 5 is opened establishing communication between water filled refuse chamber 6 and the lower portion of said fluid mass, refuse valve 7 being closed. When sufficient falling refuse has accumulated in 6, valve 5 is closed and valve 7 then opened, discharging said refuse intermixed with all or part of the water contained therein, the volume of said discharged refuse and water being replaced with such atmospheric air as enters during said discharge. Valve 7 is then closed, chamber 6 filled with water from tank 32, valve 5 opened and the cycle repeated.

The refuse is reclaimed from the discharged water by dewatering screen 8 which also removes fluid mass sand that may be admixed with said refuse, the separated water and sand being returned to the system by sand sump 13 and its appurtenant devices as hitherto described. If a continuous return, such as would be produced by sand pump 16, is provided it is desirable that the intermittent feed introduced from screen 8 be compensated for. This may be partly effected by introducing a continuous flow, as through sprays 9 or otherwise, and permitting a continuous overflow from said sump as at 14. Under these conditions it is essential that said sump shall be of sufficient surface area to prevent the internal flow to the top of said sump from carrying sand to waste in said overflow that it is desired to return to the system. If the overflow be eliminated, then the sump 13, and in some cases hopper 10, must be so proportioned as to accommodate the excess introduced from screen 8 over that returned by pump 16, during discharge from chamber 6. In such cases the difficulty in exactly balancing the intake and discharge in sump 13 may be overcome by providing a float-controlled water inlet to said sump to ensure at all times a sufficient amount of fluid therein for the operation of said pump.

I have found that it is desirable to regulate the volume of discharge per unit of time from screen 8 into sump 13 to prevent violent and destructive surges in said sump. I may secure this by control of refuse valve 7, or by restriction through a fixed or movable orifice 12. If such a restricted orifice 12 is provided, hopper 10 must be so proportioned as to contain the maximum quantity of water and sand which it may be desired to restrain. The refuse desanding screen 8 is intended to diagrammatically represent any form of dewatering device adapted to remove sand and water from

the refuse after discharge from the refuse chamber 6.

After refuse valve 7 is closed, chamber 6 is filled with water from tank 32 by opening timing valve 34, permitting flow through conduit 33 and non-return check valve 35, the entrained air being displaced through air vent 36. If said air vent be carried upward to a height equal to the static head in 6 when valve 5 is open, it need not be valved—otherwise a valve, closed when refuse valve 5 is opened, is required, unless said vent is so restricted in area as to cause an inconsequential leakage when valve 5 opens. Vent 36 may advantageously be supplied with a pressure or float-controlled valve, automatically closing by the water after it fills chamber 6, such a float controlled valve being indicated by the numeral 36a on the drawing Figure I. Under some conditions, the volume of air discharged from chamber 6 may not seriously affect the fluid mass above if discharged directly therethrough, and in such case vent 36 may be omitted.

In certain cases, a sufficient supply of water may be available from tank 32 to permit flow therefrom during the period that refuse valve 7 is open, and under some conditions this flow may be great enough to prevent the entrance of air to chamber 6 during said open period. Timing valve 34 (which prevents flow when 7 is open) may then be omitted, check valve 35 serving to prevent return flow in conduit 33 when the opening of refuse valve 5 produces a static head in chamber 6 greater than that caused by tank 32, or stay box 39 of Figure II if tank 32'' is omitted in such type of apparatus. Again, check valve 35 may be omitted if timing valve 34 is closed before refuse valve 5 opens. It will be understood that the control of valved air vent 36 and timing valve 34 may be manual or automatic, but that in either case the operating sequences must be in suitable timed relations with the working of refuse valves 5 and 7, which working may in itself be under manual or automatic control.

The clean coal desanding screen 26 of Figures I and II is intended to diagrammatically represent any form of dewatering device adapted to remove sand and water from the coal after discharge from the fluid mass.

The sand sump 25 is operated to separate the dilute mixture of sand and water passing through desanding screen 26 into a more concentrated mixture for return by sand pump 23 and a volume of comparatively clear water rising to the upper portion of said sump and passing out overflow 31. Said sump may advantageously be operated as described in United States Reissue Patent 16,674 to remove fine light materials, such as fine coal, from said sand that is to be returned, use being made of said rising water to accomplish this end. It will be understood that said volume of rising water is provided by that extraneously introduced through agitation inlet 4 and sprays 29 for agitating and washing purposes, that portion of the overflow through 2 produced by pump 23 being immediately removed from the lower part of sump 25 by said pump 23. The waste water passing out sand sump overflow 31 may advantageously be returned, with or without removal of contained fine solids, for agitating and washing purposes; that which is returned to agitating inlet 4 must be pumped under a pressure sufficient to overcome the static head due to the fluid mass contained in receptacle 1.

In previous commercial applications of the apparatus shown in Figure I, of Patent 1,559,937, the water for filling the refuse chamber has been secured from the main agitating circuit, as disclosed in that drawing. My present invention eliminates two serious drawbacks to such a method of operation (a) fluctuations in agitating pressure due to the sudden withdrawal of relatively large volume of filling water from the agitation supply main and (b) the expenditure of excess energy for pumping this filling volume under the agitation main pressure. In practice, it is frequently necessary to pump the agitating water to a head of 100 feet, due to the location of the agitation water sump and the necessity of providing a sufficient excess pressure over that developed by the fluid mass to ensure proper regulation of the agitation supply.

For a fifteen foot diameter fluid mass, the volume of agitation water introduced through the agitator pipes may be under 300 gallons per minute whereas the volume of filling water will be about 400 gallons per minute, with the 600 gallon refuse chamber, operating on a 90 second cycle, that is used with this size of apparatus. Hence, if the agitation supply is used for this filling water, the energy so required is greater than that hydraulically applied to the fluid mass itself, whereas under my present invention no energy is extraneously added for this purpose, the filling water being secured from process water that has already performed a useful function in the system. It should be noted that the refuse sand return pump 16 would still be required if the filling water were taken from the agitation main because it is necessary to return the refuse sand to the fluid mass, and if the main sand sump 25 were lowered to eliminate this pump, the extra work thrown on the high capacity main sand pump 23 would much more than offset the saving by the elimination of pump 16.

While the foregoing description of the drawings applies particularly to operation under the flotational method disclosed in United States Patent 1,224,138, it will be clear to any skilled in the art that the method and apparatus herein described may be usefully applied to the methods of classifying materials disclosed in United States Patent 1,392,401, by maintaining the fluid mass at a specific gravity less than that of some or all of the lighter materials and causing the separation to be effected by differences in rates of fall of the lighter and heavier materials in said fluid mass.

Having described my invention, I claim:

1. In apparatus for separating materials of different specific gravities by means of a fluid mass composed of an agitated mixture of comminuted solids and liquid, in which the heavier of said materials sinking in said fluid mass are collected in a valved refuse chamber containing liquid and adapted to discharge said materials, admixed with liquid therefrom, after said collection, the improved apparatus comprising in combination a refuse chamber of the described type; a valved refuse inlet to said chamber; a valved refuse discharge from said chamber; a liquid supply to said chamber; dewatering means in operative relation to said valved refuse discharge; a receptacle adapted to receive comminuted solids and liquid separated by said dewatering means from said heavier materials after their discharge from said chamber; and means for the return of said separated solids from said receptacle to said fluid mass, said receptacle being of sufficient storage volume to substantially accommodate the difference between the volume of said solids and liq-

uid received from said dewatering means during discharge from said chamber and the volume of said solids and liquid coincidently removed from said receptacle by said returning means.

2. Apparatus for separating materials of different specific gravities, comprising in combination a receptacle; a fluid mass composed of an agitated mixture of liquid and comminuted solids in said receptacle, the specific gravity of said fluid mass being less than that of the heavier of said materials; means for removing the heavier of said materials from said fluid mass, comprising a valved chamber adapted to alternately receive and evacuate said materials and liquid; means for removing the lighter of said materials from the upper portion of said fluid mass; means for separating comminuted solids from said materials after the removal of said materials from said fluid mass; means for returning said solids so separated to said fluid mass; means for introducing liquid under a relatively high pressure head to the circuit comprising said fluid mass, said separatory means and said returning means; means for then collecting said introduced liquid at a relatively lower pressure head substantially free of the coarser of said materials; and means permitting the fall of liquid, so collected, from said lower head into said chamber to replace the volume of heavier materials and liquid evacuated therefrom, in which apparatus said collecting means consists of a sump adapted to return a concentrated mixture of said solids and liquid from the lower portion thereof to said fluid mass and to discharge liquid substantially free of said solids from the upper portion thereof, said sump including liquid discharging means connecting said upper portion to said valved chamber.

3. Apparatus for separating materials of different specific gravities, comprising in combination a receptacle; a fluid mass composed of an agitated mixture of liquid and comminuted solids in said receptacle, the specific gravity of said fluid mass being less than that of the heavier of said materials; means for removing the heavier of said materials from said fluid mass, comprising a valved chamber adapted to alternately receive and evacuate said materials and liquid; means for removing the lighter of said materials from the upper portion of said fluid mass; means for separating comminuted solids from said materials after the removal of said materials from said fluid mass; means for returning said solids so separated to said fluid mass; means for introducing liquid under a relatively high pressure head to the circuit comprising said fluid mass, said separatory means and said returning means; means for then collecting said introduced liquid at a relatively lower pressure head substantially free of the coarser of said materials; and means permitting the fall of liquid, so collected, from said lower head into said chamber to replace the volume of heavier materials and liquid evacuated therefrom, in which apparatus said collecting means consists of a sump adapted to return a concentrated mixture of said solids and liquid from the lower portion thereof to said fluid mass and to cause liquid to rise substantially free of said solids to the upper portion thereof to a discharge therefrom, said upper portion being provided with an internal shield deflecting said liquid rising to said discharge to the zone between said shield and the outer wall of said sump, and said zone being provided with discharging means periodically conveying liquid to said valved chamber, whereby solids, carried into the central part of said upper portion by eddy currents of said rising liquid, are prevented by said baffle from passing into said overflow and said valved chamber.

4. The improved apparatus for separating materials of different specific gravities comprising in combination a receptacle containing a separatory fluid mass composed of a mixture of comminuted solids and liquid maintained by agitation at a specific gravity less than the heavier of said materials, a separatory fluid mass of the described type contained therein, agitating means for maintaining the fluidic properties of said fluid mass, means for the removal of the heavier of said materials from said fluid mass comprising a liquid filled chamber subjacent thereto and adapted to alternately communicate therewith and with an external discharge, means for discharging the lighter of said materials from the upper zone of said fluid mass, means for separating said lighter materials from portions of fluid mass and liquid commingled therewith after passing through said discharge, a receptacle containing a body of liquid adapted to receive said separated portions of fluid mass and liquid, the surface of said body being below said upper zone and above said external discharge locus, means for the return of said portions from said body to said separatory fluid mass, an external discharge adapted to remove said heavier materials from said chamber admixed with the liquid contents thereof, means for separating from said heavier materials portions of fluid mass and liquid commingled therewith after said removal, means for discharging said last named portions into a receptacle containing a second body of liquid, the surface of which is below said first body of liquid, means for returning the portions of fluid mass so discharged into said second body to said fluid mass, and means for refilling said chamber with liquid after said discharge of its liquid contents.

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