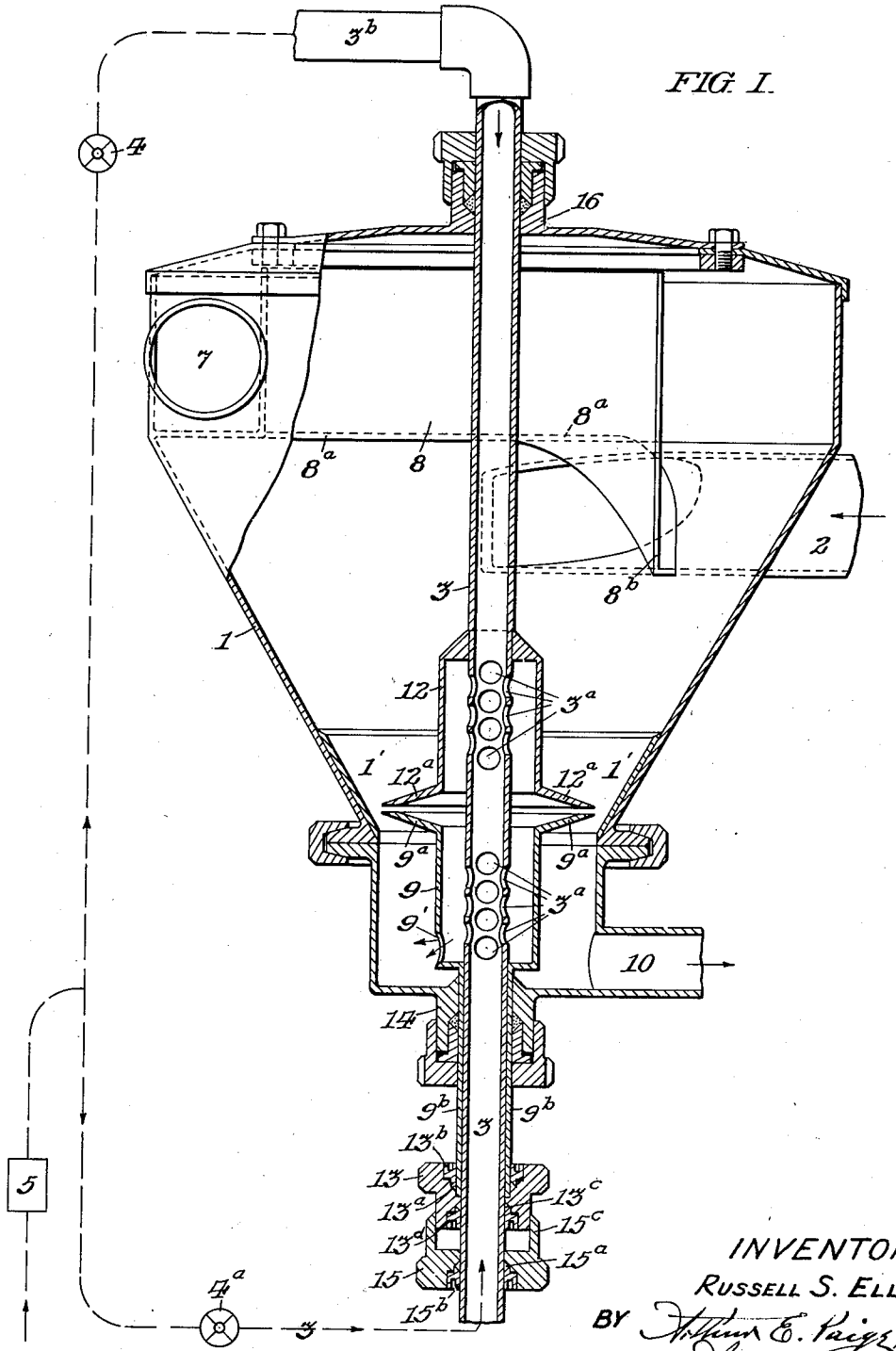
Feb. 7, 1939. R. S. ELLIS 2,146,672

MEANS FOR SEPARATING PARTICLES OF SOLID MATERIAL BY FLOTATION

Filed Aug. 15, 1938 2 Sheets-Sheet 1

FIG. 1.



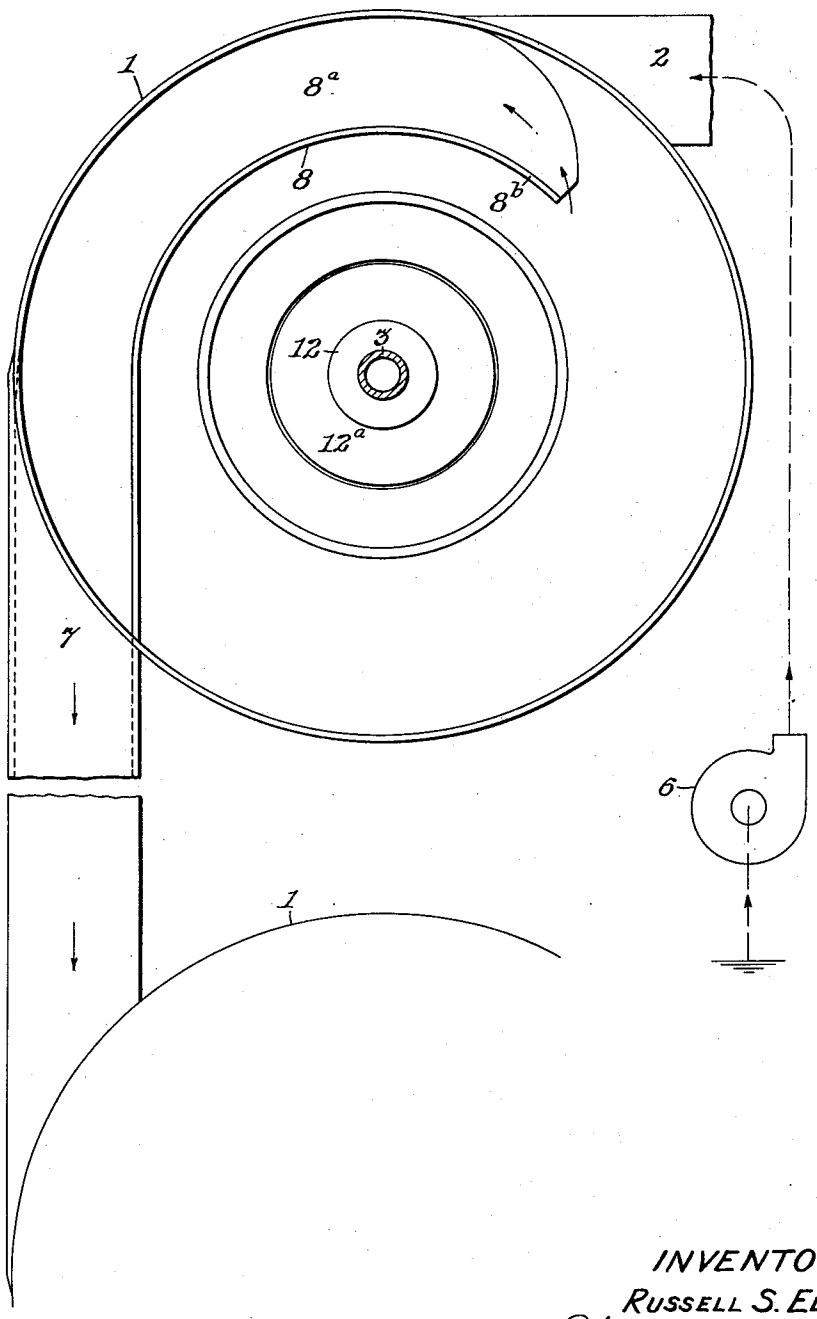
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FIG. II.



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Patented Feb. 7, 1939 2,146,672

UNITED STATES PATENT OFFICE

2,146,672

MEANS FOR SEPARATING PARTICLES OF SOLID MATERIAL BY FLOTATION

Russell S. Ellis, Vineland, N. J.

Application August 15, 1938, Serial No. 224,885

6 Claims. (Cl. 209—211)

My invention is of the class described in Letters Patent of the United States No. 2,104,537 granted to me January 4, 1938, and is applicable to any material particles of different sizes or specific gravity, or both, for instance, natural sands, comminuted stone, coal, vegetable grains, or any other substance, by the application thereto of water or other fluid, or mixture of fluids, under pressure, to effect flotation thereof.

The apparatus disclosed in said patent includes a plurality of separator casings utilized as distinct receptacles for the material to be treated, disposed in a vertical series, and connected in series relation by conduits through which solid material which is not precipitated in the lowermost receptacle is delivered into the next higher receptacle, and the material which is not precipitated in the second receptacle is delivered into a third receptacle, and so on, the materials precipitated in the several receptacles being discharged separately from the bottoms thereof, and the finest materials, finally separated by flotation, being discharged from the top receptacle.

In the form of my invention chosen for illustration, the separator casing is conical, with its apex downward, and has an inlet conduit for the material to be separated extending tangentially into one side thereof below the top, and an outlet conduit extending tangentially from the upper part of the casing. An axial inlet conduit for the flotation fluid extends vertically through said casing, in coaxial relation therewith. That conduit is connected with two distinct flotation fluid supply conduits, respectively above and below said casing, through either or both of which flotation fluid may be delivered into the casing under pressure between horizontal spreader plates provided with means for varying the area of a completely annular fluid passage between them, opening into said casing. An outlet is provided extending laterally at the lower end of the casing through which the material precipitated in the casing is discharged.

My present invention differs from that disclosed in said patent, in that I provide baffle means between said material inlet and the upper outlet of the casing, including a sector of a cylinder in coaxial and laterally inwardly spaced relation with the outer wall of said casing above said spreader plates. Said baffle means also includes a sector of an annular plate extending, in a substantially horizontal plane, at the bottom of said other sector, and between said inlet conduit for the material to be separated and said upper outlet conduit; said baffle plate having a downward extension at one end pendent over said material inlet. Said baffle means forms a partition in said casing whereby the upper lighter portion of the material to be separated is skimmed at the perimeter of said casing and compelled to flow up a helical path from said material inlet to said upper outlet.

The present invention differs further from the disclosures of said patent in that the flotation fluid inlet has vents in said casing in a cylindrical receptacle surrounding said inlet in coaxial relation therewith and having a jet orifice opening into said casing at one side thereof, opposite to the outlet for the precipitated material; whereby the stream of precipitated material passing in said casing downward to its outlet, is turbulated by a jet of flotation fluid, which facilitates the discharge of said precipitated material from the casing.

In the apparatus shown in said patent, the spreader plates in each casing are respectively supported from the bottom and top thereof and held in coaxial relation by a plurality of rods extending through both plates; each rod being rigidly connected with the casing at its upper and lower ends. In the form of my invention herein shown, such rods are omitted to afford a completely annular fluid orifice between said plates, and the lower spreader plate is rendered axially adjustable in coaxial relation with the upper spreader plate by sliding upon said axial flotation fluid inlet conduit.

My invention includes the various novel features of construction and arrangement and method of operation hereinafter more definitely specified.

In said drawings; Fig. I is a vertical sectional view of a single separator casing, conveniently embodying my improvements.

Fig. II is a plan view of the casing shown in Fig. I, but with the top plate removed to show said interior baffle means.

In said figures; 1 is a conical separator casing having its apex downward, and the inlet conduit 2 for the material to be separated, extending tangentially into the side thereof. The axial inlet conduit 3 for the flotation fluid extends vertically through the casing 1, in coaxial relation therewith, and has vents 3^a in said casing. Supply conduits 3^b and 3^c connect said conduit 3 with means for delivering flotation fluid through it into said casing 1, under pressure; for instance, a pump 5. The supply through conduits 3^b and 3^c may be controlled by respective valves 4 and 4^a. Natural sand is supplied through con-

duit 2 mixed with flotation water and under pressure, from pump 6.

I find that the maximum speed of separation of sand is attained by predetermining an upwardly extending helical path in each separator casing from the inlet 3 to the upper tangential outlet conduit 7, for the lighter material, which may extend to the next in a series of such separator casings as indicated at 1, at levels successively higher than the initial separator casing.

Therefore, I provide baffle means between said inlet and outlet, to form such a path in said casing 1 between said material inlet 2 and said upper outlet 7. Such baffle means includes the sector of a cylinder 8 in coaxial, and laterally inwardly spaced, relation with the perimeter of said casing 1 and having at its lower end the sector of an annular plate 8^a extending in a substantially horizontal plane, and having the downward extension 8^b at one end, pendent over said material inlet 2; whereby the lighter material is skimmed from the material being precipitated, and its upward passage from beneath said partition plate 8^a to said outlet 7 is facilitated.

The cylindrical receptacle 9 for flotation fluid surrounds said inlet conduit 3 in coaxial relation therewith and has a jet outlet 9' at the side thereof opposite to the outlet 10 from said casing 1 through which the material precipitated in said casing is discharged. The effect of that arrangement is that a jet of the flotation fluid supplied through the inlet 3 passes radially outward into the stream of precipitating material gravitating toward said discharge outlet 10; whereby the precipitated material is turbulated in and by such jet of flotation fluid, and its progress to and through said discharge outlet 10 thus facilitated. However, the upper end of said receptacle 9 has the outwardly flared completely annular spreader flange 9^a terminating in a horizontal lip at its perimeter, over which the major portion of the flotation fluid is distributed uniformly into the annular space 1' in said casing 1.

A second cylindrical receptacle 12 for flotation fluid, having a completely annular spreader flange 12^a, is axially opposed to said flange 9^a above the latter and is fixed on said axial conduit 3. But the spreader 9^a is axially adjustable so that the operator may precisely determine and vary the area of the completely annular fluid passageway between said spreaders 9^a and 12^a. For that purpose, the receptacle 9 is rigidly connected with the pendent cylindrical sleeve 9^b which is slip-fitted on said axial conduit 3 and rigidly, but detachably, connected with the packing collar 13, by which the receptacle 9 and spreader 9^a may be manually raised and lowered, through the stuffing box 14 on the bottom of said casing 1.

Said collar 13 contains two packing rings; first, the ring 13^a, preferably formed of ductile metal, as tin, lead or copper, adjustable by the screw gland 13^b to normally rigidly connect said collar and the sleeve 9^b, and, second, the flexible ring 13^c adjustable by the screw gland 13^d to prevent fluid leakage from the interstice between axial conduit 3 and sleeve 9^b.

The packing collar 15 contains but one packing ring 15^a preferably formed of ductile metal and adjustable by the screw gland 15^b to normally rigidly connect said collar with said axial inlet conduit 3. I find it convenient to provide said collar 15 with the annular flange 15^c fitted to overlap the packing collar 13 so that said collar 15 may be clamped upon the conduit 3 to lock the collar 13 and the spreader flange 9^a connected therewith in any position to which it may be adjusted by the operator to vary the effective area of the completely annular passageway between the perimeters of the spreader flanges 9^a and 12^a.

Moreover, I find it convenient to provide said casing 1 and each of the other casings in the series with respective stuffing boxes 16 at the top thereof through which said axial conduit 3 is axially adjustable so that the operator may place the upper spreader flange 12^a in any desired position with respect to the height of said casing 1, said casing 1 and the inlet conduit 3 being rigidly connected in any position of relative adjustment by pressing the packing in said stuffing box 16.

The precipitated material discharge outlet conduit 10 of casing 1, and each casing in the series employed, may be supplemented to convey the precipitated material from each separator casing into respective bins. The upper discharge outlet conduit 7 from the uppermost separator casing in the series may be likewise supplemented with a conduit leading to a bin for the overflow material discharged therethrough.

As an example of the utility of the present invention; I note that in an apparatus including eleven separator casings similar to said casing 1, and connected in a series one above the other as above contemplated, I have treated natural sand taken from the neighborhood of Newport, in the county of Cumberland and State of New Jersey, and heretofore used for various purposes. Although that natural sand is principally substantially pure white silica it contains a sufficient percentage of extremely fine granules, tinted light brown with iron oxide to render it objectionable for the manufacture of glass. By a single passage of that natural sand through said apparatus it was separated into eleven grades of white sand, all of such purity as to be available for glass manufacture, and the overflow at the top of the apparatus contained all of the iron oxide embodied in granules finer than any precipitated in said eleven receptacles. The coarsest of the white granules had an average maximum dimension of .035. The finest precipitate of white sand consisted of granules having an average maximum dimension of .006, whereas, the overflow contained tinted particles having an average maximum dimension of .002. Incidentally, the granules comprised in all of the precipitates and in said overflow were thoroughly washed. Moreover, such separation and cleansing can be effected by my present invention, with that particular sand, at the rate of one hundred twenty tons per hour; without any manual labor other than that of one man competent to see that the pumps remain in operation supplying the material to be separated and the flotation fluid throughout the process of separation.

However, I do not desire to limit myself to the precise details of construction, arrangement or method of operation herein set forth, as it is obvious that various modifications may be made therein without departing from the essential features of my invention as defined in the appended claims.

I claim:

1. In means for separating particles of solid material by flotation; the combination with a conical separator casing having its apex downward; of an inlet conduit for the material to

be separated, extending laterally into the side of the casing; an axial inlet conduit for the flotation fluid, extending upwardly into the bottom of said casing in coaxial relation therewith; means for delivering flotation fluid through said fluid conduit into said casing, under pressure; an outlet conduit extending tangentially from the upper part of said casing; and baffle means extending, in a substantially horizontal plane, between said inlet conduit for the material to be separated, and said outlet conduit, forming a sectoral partition in said casing; said baffle means having associated therewith a portion of a cylinder in coaxial, and laterally spaced, relation with said casing; whereby the material to be separated is compelled to follow a circumferential path in said casing between said material inlet and said upper outlet.

2. A structure as in claim 1; wherein the sectoral partition has a downward extension at one end, pendent over said material inlet, to the rear of the inlet in the direction of inflow; whereby the passage of liquid from beneath said partition to said upper outlet is facilitated.

3. A structure as in claim 1; wherein the axial inlet conduit extends through the top of the casing and has connections with a source of fluid pressure at both of its ends.

4. A structure as in claim 1; wherein the inlet for the flotation fluid is surrounded by a cylindrical receptacle in coaxial relation therewith, and having a jet outlet into said casing at one side thereof; and said casing has an outlet for precipitated material opposite to said jet outlet from said receptacle into said casing; whereby, the stream of precipitated material passing in said casing to its outlet is turbulated by the flotation fluid escaping through said outlet from said receptacle and the discharge of said precipitated material thus facilitated.

5. In means for separating particles of solid material by flotation; the combination with a conical separator casing having its apex downward; of an inlet conduit for the material to be separated, extending laterally into the side of the casing; an inlet conduit for the flotation fluid, extending upwardly into the bottom of said casing in coaxial relation therewith; a cylindrical receptacle surrounding said inlet in coaxial relation therewith, and having an outlet into said casing at one side thereof; an outlet for precipitated material, in said casing, opposite to said outlet from said receptacle; means for delivering flotation fluid through said fluid conduit into said casing, under pressure; an outlet conduit extending tangentially from the upper part of said casing; and baffle means including a sector of a cylinder in coaxial, and laterally spaced relation with said casing; a sector of an annular plate extending, in a substantially horizontal plane, between said inlet conduit for the material to be separated, and said outlet conduit, forming a sectoral partition in said casing; said plate having a downward extension at one end, pendent over said material inlet, to the rear of the inlet in the direction of inflow; whereby the lighter material being separated is skimmed and directed upward in a circumferential path in said casing between said material inlet and said upper outlet, and the stream of precipitated material passing in said casing to its outlet is turbulated by the flotation fluid escaping through said jet outlet, and the discharge of said precipitated material thus facilitated.

6. In means for separating particles of solid material by flotation; the combination with a conical separator casing having its apex downward; of an inlet conduit for the material to be separated, extending laterally into the side of said casing; an inlet conduit for the flotation fluid, extending upwardly into the bottom of said casing; means for delivering flotation fluid through said fluid conduit into said casing, under pressure; an outlet conduit extending tangentially from the upper part of said casing; and baffle means, including a sector of an annular plate extending in a substantially horizontal plane, between said inlet for the material to be separated and said outlet conduit, forming a sectoral partition in said casing, and having a downward extension at one end, pendent over said material inlet, to the rear of the inlet in the direction of inflow; whereby the lighter material to be separated is skimmed and directed upward in a circumferential path in said casing between said material inlet and said upper outlet, and the passage of liquid from beneath said partition to said upper outlet is facilitated.

RUSSELL S. ELLIS.