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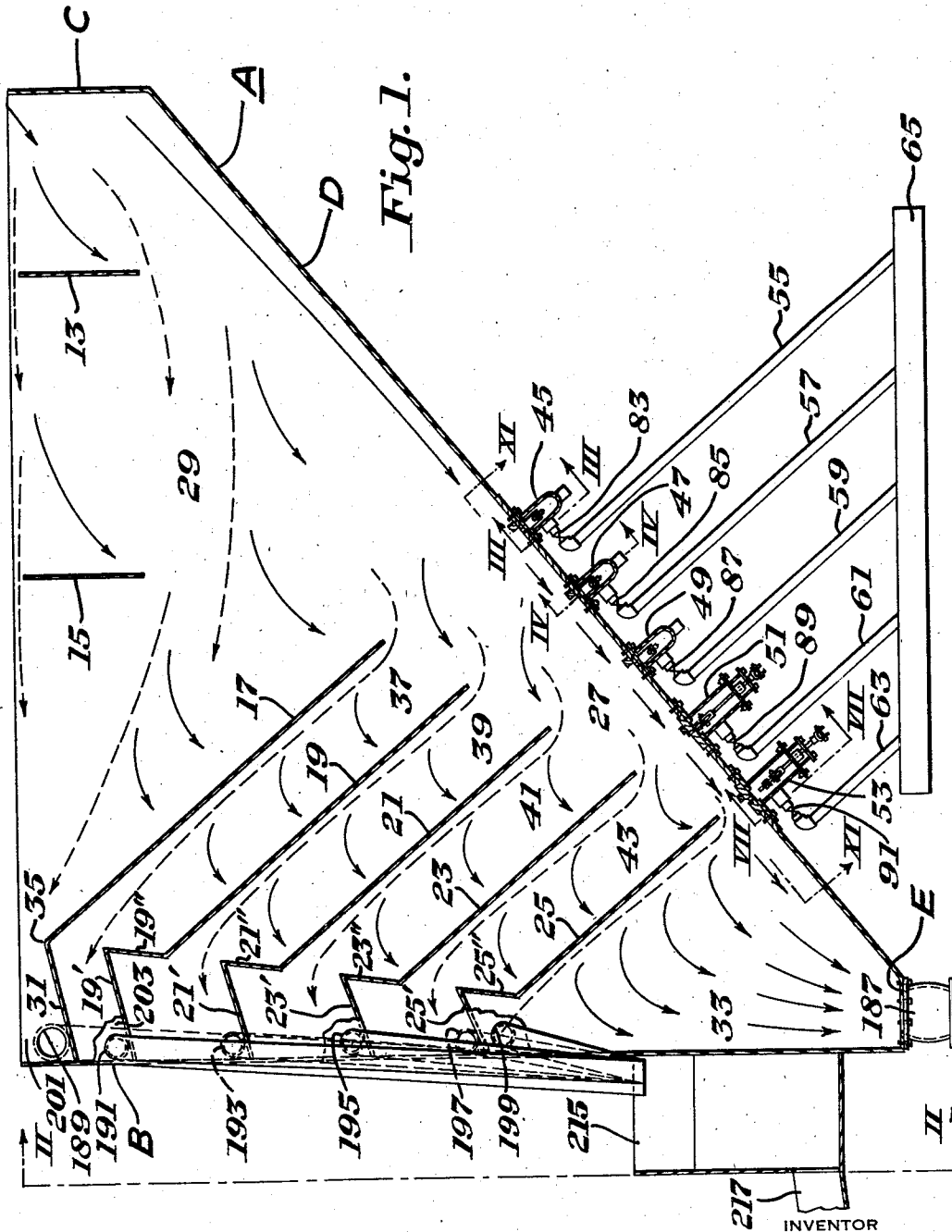
C. C. CLIFFORD

2,429,925

INCLINED CURRENT HYDRAULIC CLASSIFIER

Filed Dec. 13, 1945

5 Sheets-Sheet 1



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Oct. 28, 1947.

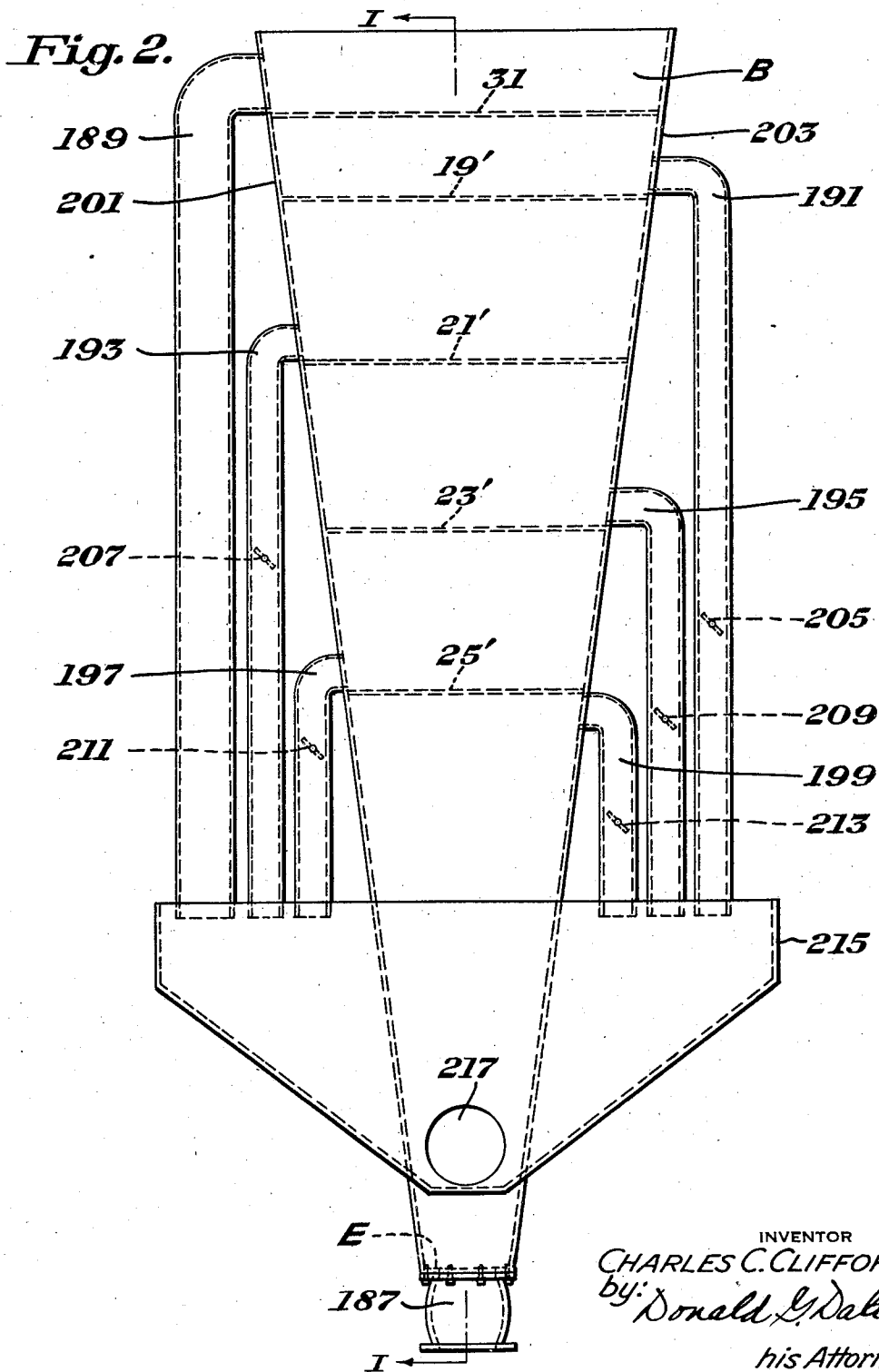
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5 Sheets-Sheet 2



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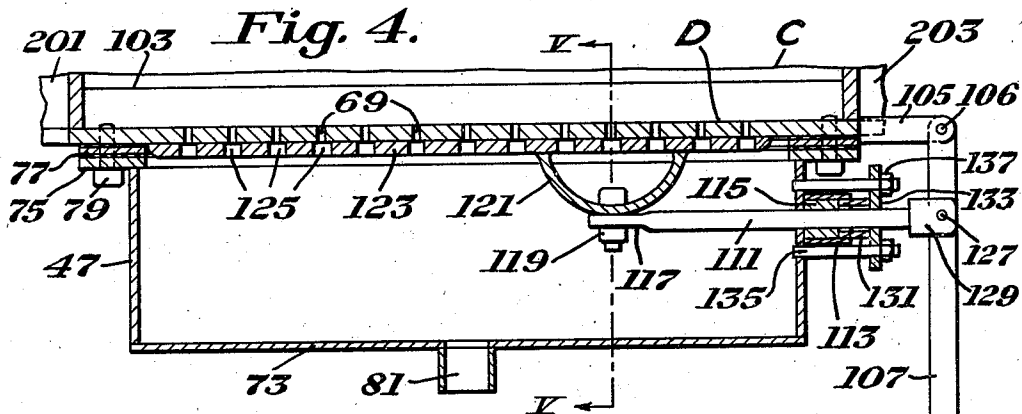
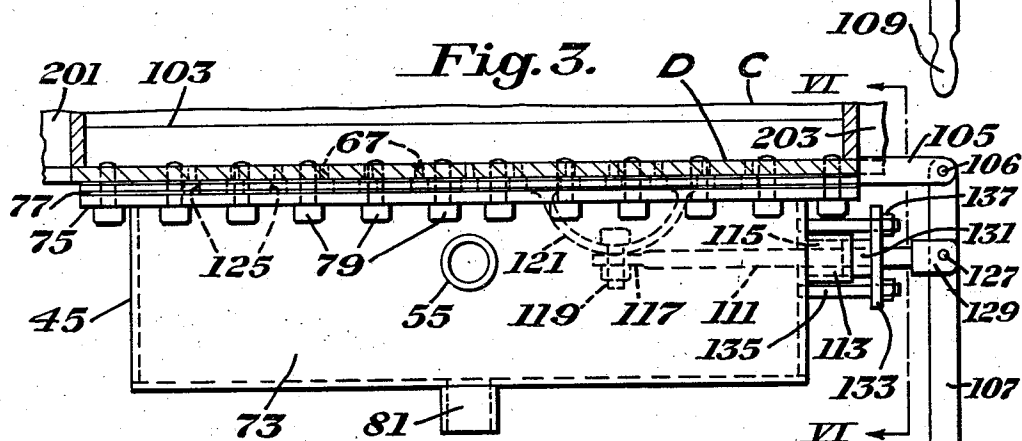
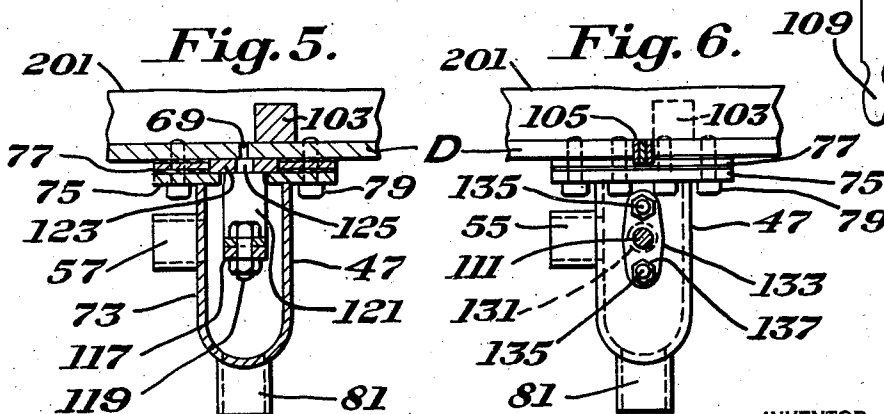
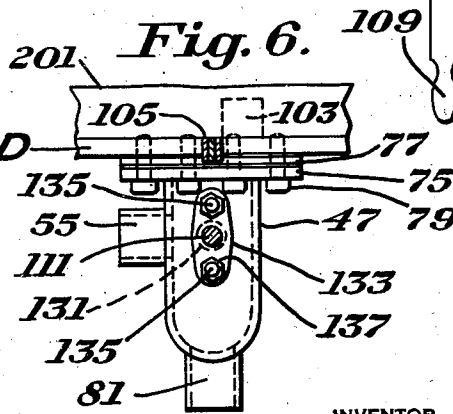
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5 Sheets-Sheet 3



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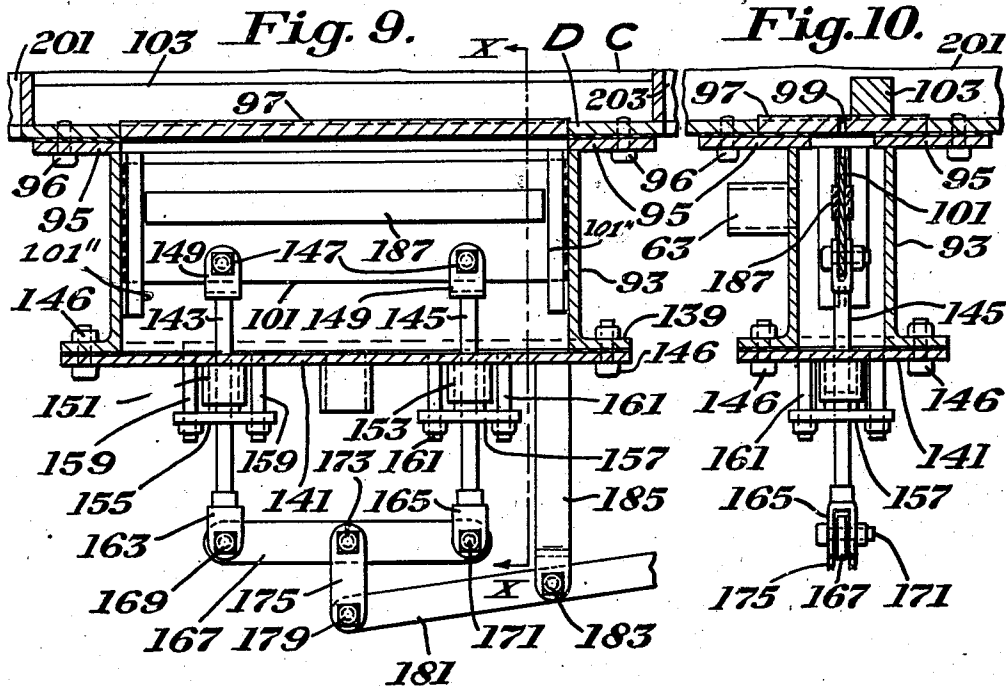
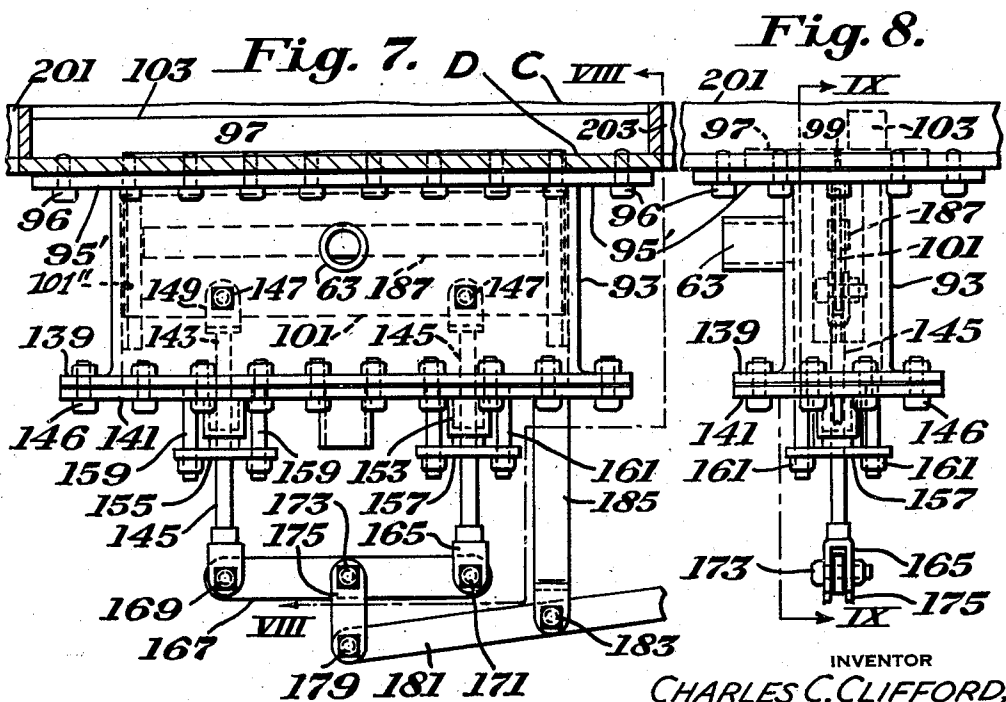
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INCLINED CURRENT HYDRAULIC CLASSIFIER

Filed Dec. 13, 1945

5 Sheets-Sheet 4



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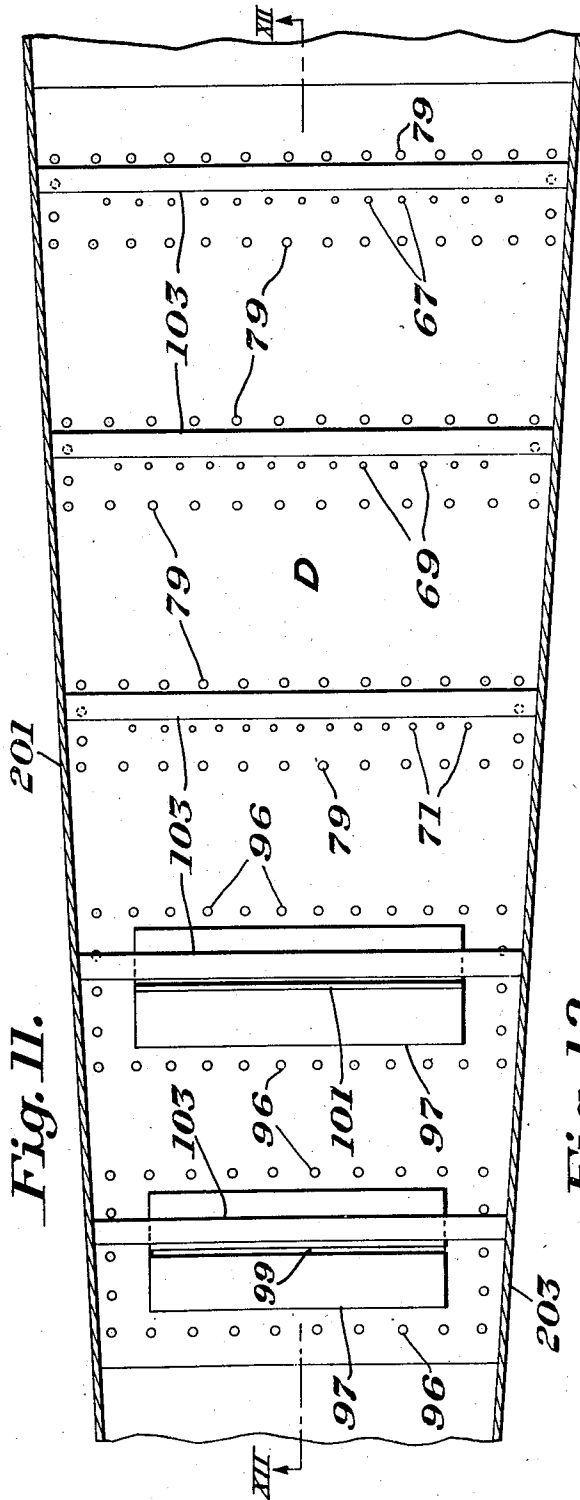
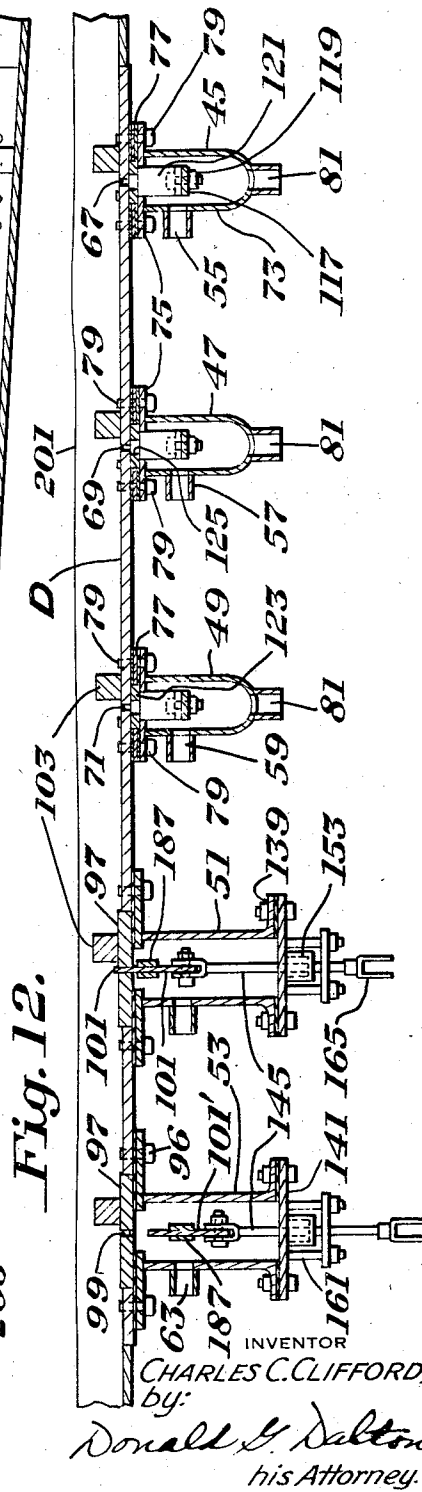
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INCLINED CURRENT HYDRAULIC CLASSIFIER

Filed Dec. 13, 1945

5 Sheets-Sheet 5



UNITED STATES PATENT OFFICE

2,429,925

INCLINED CURRENT HYDRAULIC
CLASSIFIERCharles C. Clifford, Coleraine, Minn., assignor to
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Application December 13, 1945, Serial No. 634,691

8 Claims. (Cl. 209—157)

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In the concentration of finely divided iron ores, such as low-grade, non-magnetic iron ores, by the so-called "sink-and-float" method, it is customary to separate the values—i. e., the finely divided iron ores such as hematite—from the associated tailings, to a classification in a liquid pulp medium, which is a suspension of a material in water that is so adjusted with reference to specific gravity as to allow the values to sink through the said "heavy medium" which retains floating the silica and other gangue materials that were originally associated with the iron ore. This separation is due to the difference in specific gravities of the ore and the silica, slimes, and other waste materials grouped together generally as "tailings"; and in practice, the separation of the ore and tailings is fairly clean, although a certain amount of ore is entrained in the tailings and the classifying heavy medium which, as has been said before, is an aqueous suspension of high-grade hematite in water, where low-grade hematite is the material being classified. This suspension is proportioned so that the specific gravity thereof is favorable to the gravity-settling therethrough of the ore values, and the retention of the waste tailings as a "float" on the heavy medium.

In another process, water itself may be used as the separating medium, the classification being effected by agitation of the water by air, the classification being performed again by gravity due to differences in specific gravity between the values and the tailings.

In either procedure, a certain amount of ore values is tied up in the tailings; also, where a heavy medium pulp comprising a water suspension of hematite, galena, or the like, is employed as the classifying medium, the suspensoid of the pulp needs to be recovered from time to time, and regenerated.

The present invention, therefore, provides a second, or "tailings" classifier, which receives tailings, or heavy medium, or both, from the main classifying tank where, in the tailings classifier, a further separation of values from the tailings is effected.

The improved construction of the tailings separator of the present invention is shown in the accompanying drawings, wherein:

Figure 1 represents a sectional elevation of the improved tailings separator of the present invention, the view being taken along the vertical center line of the tank.

Figure 2 is an end elevation of the apparatus

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of Figure 1, the view being taken on the plane of the line II—II looking in the direction of the arrows.

Figure 3 is a longitudinal sectional elevation through one of the spray boxes forming a part of the improved construction of the present invention, the view being taken on the section line III—III of Figure 1, looking in the direction of the arrows.

Figure 4 is a view similar to Figure 3, looking in the opposite direction, through a spray box similar to that shown in Figure 3, the view being taken on the line IV—IV of Figure 1, looking in the direction of the arrows.

Figure 5 is a detailed transverse sectional elevation showing further details of construction of the spray boxes of Figures 3 and 4, the view being taken on the line V—V of Figure 4, looking in the direction of the arrows.

Figure 6 is also a transverse sectional elevation of the spray boxes of Figures 3 and 4, the view being taken on the line VI—VI of Figure 3, looking in the direction of the arrows.

Figure 7 is a longitudinal sectional elevation of a second form of spray box employed in the present improved construction, the view being taken on the line VII—VII of Figure 1, looking in the direction of the arrows.

Figure 8 is a detailed transverse sectional elevation of the spray box of Figure 7, the view being taken on the line VIII—VIII of Figure 7, looking in the direction of the arrows.

Figure 9 is a further detailed sectional elevation of the spray box of Figures 7 and 8, the view being taken along the line IX—IX of Figure 8, looking in the direction of the arrows.

Figure 10 is a detailed transverse sectional elevation through the spray box of Figures 7 and 8, the view being taken on the line X—X of Figure 9, looking in the direction of the arrows.

Figure 11 is a sectional plan view showing details of a side wall structure of the tank of Figure 1, the view being taken on the line XI—XI of Figure 1, looking in the direction of the arrows.

Figure 12 is an enlarged sectional elevation showing the mounting of the spray boxes in detail on the side wall of the tank, the view being taken on the line XII—XII of Figure 11, looking in the direction of the arrows.

Referring more particularly to the drawings, and especially to Figures 1 and 2, the reference letter A represents a tailings separating tank embodying the improved features of the present invention, the tank A being maintained filled with water and having a substantially vertical

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end wall B extending the full height of the tank and a substantially vertical end wall C opposite to the end wall B, the wall C being a short vertical lip at the top of the tank, a sloping end wall D joining the lip C and the bottom E of the tank. The sloping end wall D slopes to the narrow bottom E of the tank at an angle of approximately 45° to the vertical. This angle is not critical beyond being sufficiently sharp so as to enable a rapid settling of the heavy values and sufficient retention of the lighter slimes and tailings.

As will be seen from Figure 1, the tank is provided with a number of baffles. The tailings to be classified are received into the tank A over the short wall C, as indicated by the arrows. In Figure 1, the solid arrows pointing downwardly indicate the values settling out, whether these be ore or heavy medium from the main separating tank, and the broken arrows indicate the direction of flow of the tailings.

It will be seen from the view of Figure 1 that there are two transversely extending, substantially spaced baffles 13, 15 extending across the top of the tank A. The tank A is divided longitudinally into a series of compartments by a plurality of sloping baffle plates 17, 19, 21, 23 and 25, all of which compartments communicate with downward end passage 27 which in effect is a downward continuation of a space or compartment 29 at the top of the tank, this space or compartment 29 being defined by the angle of slope of the baffle plate 17 and the length thereof. This chamber 29 is large in volumetric content, the passage 27 progressively narrowing from the top to the bottom of the tank owing to the slope of the end wall D.

The baffle plate 17 has an upwardly sloping portion 31 which narrows the chamber 29, as shown, adjacent to the tailings off-take end of the chamber, the remainder of the baffle sloping downwardly at approximately right angles to the end wall D. This angle is not particularly critical, although it should be substantially greater than the angle of repose of the values, so that these values will fall readily from the baffle into the passage 27, which passage serves as a collecting passage for the values, guiding them into a bottom or collecting compartment 33 for these values.

The compartment 29 may be termed the primary separation compartment, since in this compartment the velocity of the incoming tailings is dropped sufficiently to allow sedimentation of the major portion of the heavy values from the slimes and gangue, the velocity being reduced first by impact of the incoming mixture against the transverse baffle plates 13, 15, and secondly by the large volume of the compartment 29. Some of the heavy values settle immediately through passage 27 and pass to the collecting compartment 33. Other portions of the initially separated values fall on the baffle plate 17, sliding therefrom into passage 27. In this connection it may be noted that the apex 35 of the angle of bend of the baffle plate 17 serves as an additional baffle for retarding the flow of material thereover, causing additional values to settle out.

This action continues in the remaining compartments, each baffle plate 19, 21, 23 and 25 having a similarly bent configuration as shown. Sections 19', 21', 23' and 25' are sloped upwardly from the juncture of the baffle plates at the rear wall B, and then bent downwardly to

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form a substantially disposed vertical baffle, indicated at 19'', 21'', 23'' and 25'', the baffle then sloping downwardly to the passage 27 in spaced-apart parallel relation, forming compartments 37, 39, 41 and 43 between adjacent baffle plates. These successive compartments are necessary in order to effect progressive separation between the heavy values and lighter gangue that is entrained in the values descending from the initial separating compartment 29.

In order to effect this further classification, the sloping end wall D is provided with a plurality of spray boxes indicated at 45, 47, 49, 51 and 53 in Figure 1, which are positioned, respectively, oppositely to the compartments 37, 39, 41 and 43, and are adapted to direct jets or sprays of water, delivered thereto through supply pipes 55, 57, 59, 61 and 63 in communication with supply header 65, into these compartments across the passage 27, as will be explained in detail hereinafter, although the resulting separating currents and effects thereof are clear from Figure 1. The detailed construction of these spray boxes will be pointed out hereinafter, but it will be seen that these spray boxes are of two types, those indicated at 45, 47 and 49 being similar but different in type from spray boxes 51 and 53 which, however, are similar to each other, the spray boxes 45, 47 and 49 being adapted to deliver smaller jets of water into the compartments 37, 39 and 41, where less water is required to wash the pulp passing downwardly through passage 27. The bottom of the sloping end wall D is constructed accordingly. From Figures 3, 4, 5 and 6 it will be seen that the spray boxes 45, 47 and 49 embrace a control that is in the nature of a sliding valve which controls the ingress of the water from these spray boxes, whereas spray boxes 51 and 53 show a blade arrangement for controlling the larger volumes of water required for washing the ore into compartments 41 and 43.

Figures 11 and 12 show the construction of the bottom of the sloping end wall and details of the mountings of the spray boxes thereon.

For receiving jets from the spray boxes 45, 47 and 49, the bottom of the sloping end wall D has a plurality of holes extending across the surface of the end wall. These holes are indicated at 67, 69 and 71. Each spray box 45, 47 and 49 comprises a housing 73 which is U-shaped in longitudinal cross section, the ends of the sides of the U having oppositely extending attachment flanges 75, 75 which rest on the water-tight gasket 77, the housing 73 being attached suitably to the end wall D by screws, rivets, or bolts indicated at 79 which pass through the water-tight gasket or packing 77 and tightly hold the housing 73 against the packing 77 for preventing leakage of water therearound. Supply pipes for incoming water enter the housings 75 laterally thereof, as shown in detail in Figure 12. Excess water leaves these housings 75 through outlets 81, which are sufficiently large to permit cleaning out of any sediment which may collect in the housing. These outlets 81 discharge into suitable drain instrumentalities, not shown. Incoming water entering by way of pipes 55, 57, 59, 61 and 63 is controlled by valves 83, 85, 87, 89 and 91 in the pipes. Spray boxes 51 and 53 are of a different type and construction, as indicated above.

These spray boxes each comprise a housing 93 having end attachment flanges 95, 95', flanges 95 being bolted, riveted, screwed, or otherwise secured, as indicated at 96, tightly to the bottom

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of sloping end wall D. The surface of this end wall is cut out to receive an insert plate 97 which has a slot 99 extending thereacross, as shown in Figure 11, this slot being controlled in turn by a blade-valve 101 suitably mounted in guide 101' and which lifts out and in relative to the slots 99 by proper lever instrumentalities, as shown in detail in Figures 7, 8, 9 and 10 of the drawings.

In Figure 12, the right-hand blade 101 is shown as being in closing position relative to its slot 99, whereas the left-hand blade 101' is shown in retracted, or open position. Also, the inner surface of the end wall D is shown as being provided with a plurality of spaced transverse ribs 103 which extend across the inner surface of the wall. These ribs 103 are in alignment with the baffle plates 17, 19, 21, 23 and 25, and serve to deflect the jets or sprays of water from the spray boxes onto the baffle plates and into the compartments 37, 39, 41, and 43. The main function of these ribs, however, is to form a dam or hurdle to check the flow of the heavier particles that are not in suspension but which lie on the sloping end wall D and which are sliding downwardly thereon. These particles, if not guarded or checked in their flow, might obstruct the spray openings to prevent proper operation thereof and of the control valves therefor. These ribs 103 also form reinforcing means for the end wall D at the point where the heavy valves are attached to the end wall. It will be understood that the tank structure is of thin plate steel and the control valves for the spray openings are heavy in construction. From Figure 5 it will be seen that the slide bar controlling the spray openings must fit tightly and evenly in contact with the sloping end wall D in which the spray holes are located, in order that the sliding bar function properly to permit effective control or cutting off the area of the holes. If the plates of the sloping end wall D become warped, the slide valve would be ineffective to control the openings.

The details of the controls for the spray openings 67, 69 and 71 and for the slots 99 will be explained in greater detail hereinafter.

It will be apparent that the water entering through the spray openings must be under sufficient pressure to penetrate the mass of solid material settling through the tank and to wash the said materials into the classifying compartments, as explained above. The pressure behind such water is to be controlled in accordance with the density of the material being classified, higher pressures and velocities being required for dense or heavy slurries of mud-like consistencies entering the tank than when the material has less density. The said pressures, however, must be sufficient to support the material flowing through the tank and prevent the said material from running out through the spray openings.

Details of operation of the spray box controls may now be referred to, reference being had particularly to Figures 3, 4, 5 and 6 for the details of construction of spray boxes 45, 47 and 49 shown in Figure 1. As has been noted above, Figure 3 is a sectional elevation on the line III-III of Figure 1, looking at the end of the spray box housing, and showing operating mechanism for opening and closing the intake holes 67 in end wall D. Figure 4 is a section through the housing showing details of such mechanism inside the spray box housing.

Mounted on the end wall D is an extending bracket 105 which forms the fulcrum 106 for lever 107, as well as the mounting for this lever. Lever

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107 has a handle portion 109 which is adapted to be grasped manually by an operator. An actuating piston rod 111 passes through the wall of the spray box housing through a bearing 113 which includes a packing gland 115, as shown, for preventing leakage of water therearound. The piston rod 111 has a flattened end 117 for receiving a bolt or equivalent attachment 119 that connects the rod 111 to an actuating bracket 121 that connects with a sliding valve control member 123 having holes 125 therethrough which register with holes 67 in the end wall D. It will be noted that the holes 125 are larger than the holes 67, in order to assure a free flow of water through holes 67.

The sliding valve member is, in practice, a sliding bar, the ends of which are slidably mounted between the flanges 75 of the spray box housings 73, and the packing gasket 77 between the flange 75 and the end wall D of the tank, sufficient movement being permitted for the valve bar 123 to slide until holes 67 become closed by the solid portions of the bar between and around the holes 125. The valve-actuating rod 111 is pivoted to lever 107 by a pin 127 passing through yoke end 129 of the rod 111 and through a hole in the lever provided for this pin. It will be seen that this juncture between the valve-actuating rod 111 and lever 107 is toward the fulcrum 106, but between the fulcrum and handle 109, lever 107 acting in a manner similar to a brake lever. Bearing 113 for the rod 111 is assembled with a cover which rests on annular sleeve 131, cover 133 being held in place by spacer bolts 135 held by nuts 137. Holes 125 in valve bar 123 are substantially larger in diameter than the holes 67, thus assuring a supply of clean water to the holes 67 and thence into the compartments between the baffles.

Reference may now be had to the construction of the spray boxes 51 and 53, shown in Figures 1 and 12, and in detail in Figures 7, 8, 9 and 10.

As has been pointed out above, the housings 93 are bolted on the sloping end wall D through flanges 95 and screws, bolts or other securing means 96. Outer end flanges 139 on the housings 93 form seats for a cover 141 that is bolted or attached in equivalent manner to each flange 139, by fastening means 146. The cover 141 has holes therethrough for the passage of lever arms 143, 145 that are joined at their inner ends to the valve blades 101, 101' through bolts or equivalent attachment means 147 which pass through bifurcated end yokes 149.

The lever arms 143, 145 pass through packing glands 151, 153 on cover plate 141, and the arms 143, 145 are guided in bearings in plates 155, 157 that are held spaced from the housing closure 141 by spacer bolts 159, 161. The lever arms 143 and 145 have outer connecting yokes 163, 165 that receive an equalizer link 167 that is pivotally connected to the arms 143, 145 through bolts 169, 171.

Pivotally connected to equalizer link 167 through bolt 173 is a floating link 175 to which floating link is attached pivotally through bolt 179 the end of a lever 181 that is fulcrumed at 183 to a standard 185 that is suitably attached to the end wall D. By this arrangement the valve blades 101, 101' are raised and lowered relative to the slots 99, thereby controlling flow of water therethrough. The blades 101, 101' are provided with a stop or abutment rib 187 thereon which limits movement of the blades into their respective slots.

As has been explained above herein, the feed

enters the tank A which is filled with water, over the vertical lip C of the end wall where, owing to the large space in the compartment 29 and the baffle plates 13 and 15, the speed of flow is checked and the ore or pulp immediately starts to settle out, while lightest portions of slimes and gangue are carried up over angle 35 which permits passage thereof to the tailings discharge which will be referred to hereinafter.

As the values flow from compartment 29 into passage 27, they are met with a stream of clean water from spray box 45. This stream or jet is under considerable pressure, and forces values and entrained tailings upwardly in compartment 37 and against vertical baffle 19'', over which lighter portions of slimes and tailings are driven to the discharge therefor.

The heavy values settle on top of baffle 19, from which they are removed partly by sliding therefrom by gravity and partly washed off by the jet or spray of water from spray box 45, the heavy values returning to the settling passage 27 where they meet the jet or spray from spray box 47, the above action being repeated in compartment 39, and thence in the successive compartments until the thoroughly cleaned values settle into collecting compartment 33 for withdrawal through outlet 187 in the bottom E of the tank.

There now remains to be described the withdrawal of the slimes, gangue, and other constituents of the tailings. In this connection, reference may be had particularly to Figures 1 and 2.

It has been pointed out above that the baffles 17, 19, 21, 23 and 25 are composed of an upwardly sloping section 31, 19', 21', 23' and 25', which sloping section ends in baffles defined by the angle 35 of the top baffle 17 and the vertical baffle walls 19'', 21'', 23'' and 25''. The slope of the said sections is upwardly from the end wall B of the tank H, so that the intersection of these upwardly sloping sections and the end wall constitutes the lowest level in each separating compartment in which the slimes, gangue and other tailings constituents separated in each compartment can collect. At this lowest level in each compartment opens the withdrawal ducts indicated at 189, 191, 193, 195, 197 and 199 respectively, these ducts passing alternately through opposite side walls 201, 203 of the tank A, these ducts acting as siphons in each compartment, to withdraw the lighter materials and tailings carried into the respective sections of the classifying compartments by the action of the water jets or sprays. Except for the top tailings duct or pipe 189, the remainder of the tailings ducts are provided with a butterfly valve in each, indicated respectively at 205, 207, 209, 211 and 213. Proper regulation of those butterfly valves will force the greatest part of the tailings flow through the top pipe 189, the flow through these pipes creating a circulation through the tank that facilitates the settling of the values or pulp and free passage thereof into the bottom collecting compartment 33. The bottom discharge pipe 199 is provided beneath the lowest level of the section 25' of the bottom baffle 25 for withdrawing any light or tailings constituents that have not been separated previously and which float on the pulp collected in the settling compartment 33, the siphon action of the pipe 199 skimming off these floating constituents from the top of the pulp collecting in the compartment 33. The tailings and light materials withdrawn from each compartment are collected in receiver 215 from which they are withdrawn through outlet 217.

Since the greatest volume of slimes, tailings and the like is carried over the apex of angle 35 in the compartment 29, the top off-take pipe 189 is the largest in internal diameter of all of these offtake pipes. It will be understood that the tank A is filled with water, and the currents set up by the jets or sprays from the spray boxes are impeded by the substantially vertical baffle surfaces presented in each of the classifying compartments, such baffle surfaces (represented at 35, 19'', 21'', 23'' and 25'') forming retaining walls which prevent any substantial amounts of the heavy values from passing into the sump sections of these classifying compartments, in which sump sections the respective offtake pipes open, only the lighter constituents such as slimes and tailings passing over these retaining walls into the said sump sections. The siphon action of the offtake pipes withdraws such slimes and tailings from the sumps with the minimum of agitation, thereby avoiding any remixing of such constituents with the values.

There is effected a progressive cleaning of the values as they pass from the top to the bottom of the tank through the action of the laterally directed series of jets or sprays of clean water that continuously engage the material at successive descending vertical levels, washing the material upwardly onto the succeeding baffle plates where the progressive cleaning occurs; whereas in all other known separators of this general type the water jet at the bottom of the tanks must force all of their tailings over the top. Another advantage of the present improved apparatus is that it is designed to take all of the tailings from any preceding classifying equipment in the system without the interposition of any thickening or dewatering instrumentalities; and the separator of the present invention requires no power or pumps to operate it, the separation being accomplished entirely by gravity and clean water pressure.

I claim:

1. Apparatus for concentrating mineral materials, which comprises, in combination, a classifying tank having upwardly diverging side walls, a vertical end wall, a sloping end wall oppositely disposed with respect to the vertical end wall, and a bottom, the said tank being adapted to receive through its upper portions a flow of liquid bearing the materials to be classified, a plurality of horizontally spaced vertical baffles adjacent to the liquid intake of the tank and adapted to check the velocity of the incoming liquid, the said baffles extending transversely across the tank, a plurality of vertically spaced baffle plates extending longitudinally of the tank between the side walls of the tank and from the vertical end wall towards the sloping end wall, the said baffle plates being positioned one above another and defining classifying compartments between them, each of the said baffle plates comprising a plurality of sections which define, respectively, a sump section adjacent to the vertical end wall and to the side walls, a restraining section for preventing passage of heavy material being concentrated to the sump section, and a sloping section which slopes downwardly towards the sloping end wall but terminates short thereof for defining a settling passage through the tank, the slope of the sloping section of each baffle plate and the slope of the sloping end wall of the tank being greater than the angle of repose of the heavy material being concentrated, there being a collecting compartment for cleaned heavy mate-

rial between the bottom baffle plate and the bottom of the tank and a relatively large material receiving compartment in the upper portion of the tank above the top baffle plate and including the said vertical transversely extending baffles, the settling passage having the material-receiving compartment, the classifying compartments and the collecting compartment opening into it, means for washing material settling through the settling passage upwardly along the said baffle plates in series and in the classifying compartments, whereby lighter constituents of the materials and slimes are caused to pass over the restraining section of each baffle plate which the heavy materials return to the settling passage for progressive removal of lighter constituents and slimes therefrom in each succeeding classifying compartment, the heavy materials flowing countercurrently to admission of washing liquid through each classifying compartment and being subjected to clean washing liquid as the heavy materials settle through the settling passage while lighter tailing constituents and slimes collect in the sump sections of the baffle plates, means for siphoning collected tailings and slimes from the said sump sections, and means for withdrawing cleaned heavy materials from the collecting compartment.

2. Apparatus for concentrating mineral materials, which comprises, in combination, a classifying tank having vertical side walls, a vertical end wall, a sloping end wall oppositely disposed with respect to the vertical end wall, and a bottom, the said tank being adapted to receive through the upper portions a flow of liquid bearing the materials to be classified, the said tank being also adapted to be filled with classifying liquid, a plurality of spaced baffle plates extending longitudinally of the tank between the side walls of the tank and from the vertical end wall towards the sloping end wall, the said baffle plates being positioned one above another and defining classifying compartments between them, each of the said baffle plates comprising a plurality of sections which define, respectively, a sump section adjacent to the vertical end wall and to the side walls, a restraining section for preventing passage of heavy material being concentrated to the sump section, and a sloping section which slopes downwardly towards the sloping end wall but terminates short thereof for defining a settling passage through the tank, the slope of the sloping section of each baffle plate and the slope of the sloping end wall of the tank being greater than the angle of repose of the heavy material being concentrated, orifices in the sloping end wall of the tank for injecting classifying liquid into the tank, the orifices being disposed substantially in alignment with the baffle plates for forcing material to be classified from the settling passage upwardly of the baffle plates, jets of liquid from the said orifices carrying lighter tailings and slimes upwardly of the baffle plates over the restraining section thereof for retention in the sump section while heavier values pass downwardly of the baffle plates countercurrently of the said jets, and means for supplying fluid to the said orifices under pressure for forming the said jets, the orifices extending transversely across the sloping end wall of the tank.

3. Apparatus for concentrating mineral materials, which comprises, in combination, a classifying tank having vertical side walls, a vertical end wall, a sloping end wall oppositely disposed with respect to the vertical end wall, and a bot-

tom, the said tank being adapted to receive through the upper portions a flow of liquid bearing the materials to be classified, the said tank being also adapted to be filled with classifying liquid, a plurality of spaced baffle plates extending longitudinally of the tank between the side walls of the tank and from the vertical end wall towards the sloping end wall, the said baffle plates being positioned one above another and defining classifying compartments between them, each of the said baffle plates comprising a plurality of sections which define, respectively, a sump section adjacent to the vertical end wall and to the side walls, a restraining section for preventing passage of heavy material being concentrated to the sump section, and a sloping section which slopes downwardly towards the sloping end wall but terminates short thereof for defining a settling passage through the tank, the slope of the sloping section of each baffle plate and the slope of the sloping end wall of the tank being greater than the angle of repose of the heavy material being concentrated, orifices in the sloping end wall of the tank for injecting classifying liquid into the tank, the orifices being disposed substantially in alignment with the baffle plates for forcing material to be classified from the settling passage upwardly of the baffle plates, jets of liquid from the said orifices carrying lighter tailings and slimes upwardly of the baffle plates over the restraining section thereof for retention in the sump section while heavier values pass downwardly of the baffle plates countercurrently to the said jets, means for controlling the said orifices and instrumentalities for supplying fluid under pressure to the said orifices for forming the said jets, the said orifices extending across the sloping end walls of the tank.

4. Apparatus for concentrating mineral materials, which comprises, in combination, a classifying tank having vertical side walls, a vertical end wall, a sloping end wall oppositely disposed with respect to the vertical end wall, and a bottom, the said tank being adapted to receive through the upper portion a flow of liquid bearing the materials to be classified, the said tank being also adapted to be filled with classifying liquid, a plurality of vertically spaced baffle plates defining classifying compartments between the baffle plates, a plurality of series of transversely extending fluid intakes extending across the sloping end wall in substantial alignment with the baffles, means for injecting liquid through the intakes for washing material settling through the tank onto the baffles in succession, thereby progressively freeing the settling materials from slimes and light tailings while permitting cleaned heavier values to settle to the bottom of the tank, a spray box for supplying liquid under pressure to each series of intakes, and means for controlling flow of liquid through the apertures.

5. Apparatus for concentrating mineral materials, which comprises, in combination, a classifying tank having side walls, a vertical end wall, a sloping end wall oppositely disposed with respect to the vertical end wall, and a bottom, the said tank being adapted to receive through the upper portion a flow of liquid bearing the material to be classified, the said tank being adapted to be filled with classifying liquid, a plurality of vertically spaced baffle plates defining classifying compartments between them, liquid injection means extending across the sloping end wall and being disposed to inject classifying liquid into material settling through the tank for washing the

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said material into each succeeding classifying compartment as the material settles through the tank, thereby progressively cleaning the material of slimes and lighter tailing constituents, means for supplying liquid under pressure to the liquid injection means, and mechanism for controlling the amount of liquid passing through the liquid injection means.

6. Apparatus for concentrating mineral materials, which comprises, in combination, a classifying tank having side walls and end walls, and a bottom, one of the end walls sloping inwardly to the bottom, the said tank being adapted to receive through its upper portion a flow of liquid bearing the material to be classified, the said tank being adapted to be filled with classifying liquid, a plurality of vertically spaced baffle plates defining classifying compartments between the baffle plates, a plurality of vertically spaced liquid intake orifices extending transversely across the sloping end wall of the tank, the orifices being disposed to project jets of liquid into the said classifying compartments and across a stream of material settling through the tank, whereby the said material becomes washed upwardly into each succeeding compartment for successive separation of slimes and light tailing constituents therefrom, certain of the said orifices being series of spaced holes through the sloping end wall, others being slots in the end wall, spray boxes mounted over the orifices for introducing liquid under pressure through the orifices, control means for the orifices, the control means for each series of spaced holes comprising a horizontally movable drawbar having holes therein of a diameter larger than the diameter of the holes in the sloping end wall but corresponding in number and spacing to the holes in the end wall, the control means for each slot comprising a vertically movable blade adapted to fit into the slot for closing the same, means for actuating the drawbars for moving the holes therein into and out of registry with the holes in the sloping end wall, and mechanism for operating the blades, the said mechanism including equalizing linkages for the blades and a lever for applying power to the equalizing linkages.

7. Apparatus for concentrating mineral materials, which comprises, in combination, a classifying tank having side and end walls and a bottom, one of the end walls sloping inwardly to the bottom, the said tank being adapted to receive through its upper portion a flow of liquid bearing the materials to be classified, a plurality of vertically spaced baffle plates in the tank extending towards the sloping end wall but stopping short thereof to provide a material settling passage, the said baffle plates defining classifying compartments between them, each of the said baffle plates comprising a plurality of sections which define, respectively, an inner sump section adjacent to the side walls and to an end wall opposite to the sloping end wall, an intermediate restraining section for preventing passage of heavy material being concentrated to the sump section, and a sloping section which slopes downwardly to the settling passage, the slope of the sloping section of each baffle plate and the slope of the sloping end wall of the tank being greater than the angle or repose of the heavy material being concentrated while impeding settling of the heavy material, there being a collecting compartment for cleaned heavy material between the bottom baffle plate and the bottom of the tank and a relatively large material receiving compart-

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ment in the upper portion of the tank above the top baffle plate, the said settling passage having the material receiving compartment, the classifying compartments and the collecting compartment communicating therewith, a plurality of liquid intake orifices extending transversely of the sloping end wall, the said orifices being spaced lengthwise of the sloping end wall in rows one above another, the said orifices being disposed to project jets of classifying liquid across the settling passage for washing material settling through the settling passage into the said classifying compartments whereby the said material becomes washed in each succeeding classifying compartment for successive separation of slimes and light tailing constituents therefrom, certain of the said orifices being rows of spaced holes extending through the sloping end wall, others being slots in the said sloping end wall, spray boxes mounted over the orifice for introducing liquid under pressure through the orifices, control means for the orifices positioned in the spray boxes, the control means for each series of spaced holes comprising a horizontally movable drawbar having aligned holes therein of a diameter larger than the diameter of the holes in the sloping end wall but corresponding in number and spacing to the series of holes in the end wall, the control means for each slot comprising a vertically movable blade adapted to fit into the slot for closing the same, lever means for actuating the drawbars for moving the holes therein into and out of registry with the holes in the sloping end wall, mechanism for operating the blades, the said mechanism including equalizing linkages for the blades and a lever for applying power to the equalizing linkages, siphon means for removing slimes and lighter tailings from the sump sections of the baffle plates, and means for withdrawing cleaned concentrate through the bottom of the tank.

8. Apparatus for concentrating mineral materials, which comprises, in combination, a classifying tank having side and end walls, a plurality of spaced baffle plates, vertical side walls, a vertical end wall, and a sloping end wall oppositely disposed with respect to the vertical end wall, and a bottom, the said tank being adapted to receive through its top a flow of liquid bearing the materials to be classified, the sloping end wall receiving primary settling of heavy materials to be classified, the said slope being of an inclination effective for substantial retardation of movement of materials passing therealong to the bottom of the tank but greater than the angle of slope of such materials, a plurality of spaced baffle plates subdividing the tank interiorly into a plurality of classifying compartments, the said baffle plates terminating short of the sloping end wall of the tank for defining a settling passage therethrough between the baffle plates and the sloping end wall, a plurality of aligned spray orifices for introducing jets of water through the sloping end wall of the tank into the material settling through the settling passage and along the sloping end wall, means for injecting the water through the orifices under pressures effective for penetrating the material in the settling passage for washing the material progressively into the classifying compartments, reinforcing ribs for the sloping end wall extending transversely thereof on its inner side, the said ribs being positioned adjacent to but in advance of the spray orifices with respect to movement of

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the material along the sloping end wall and through the settling passage, the said ribs forming dams for material moving along the sloping end wall for preventing access thereof to the spray orifices with attendant stoppage of the orifices, 5 spray boxes under the spray orifices mounted on the outside of the sloping end wall, means in the spray boxes for controlling passage of water through the spray orifices, and operating mechanism positioned exteriorly of the spray boxes for 10 operating the said control means.

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