W. A. BUTCHART.

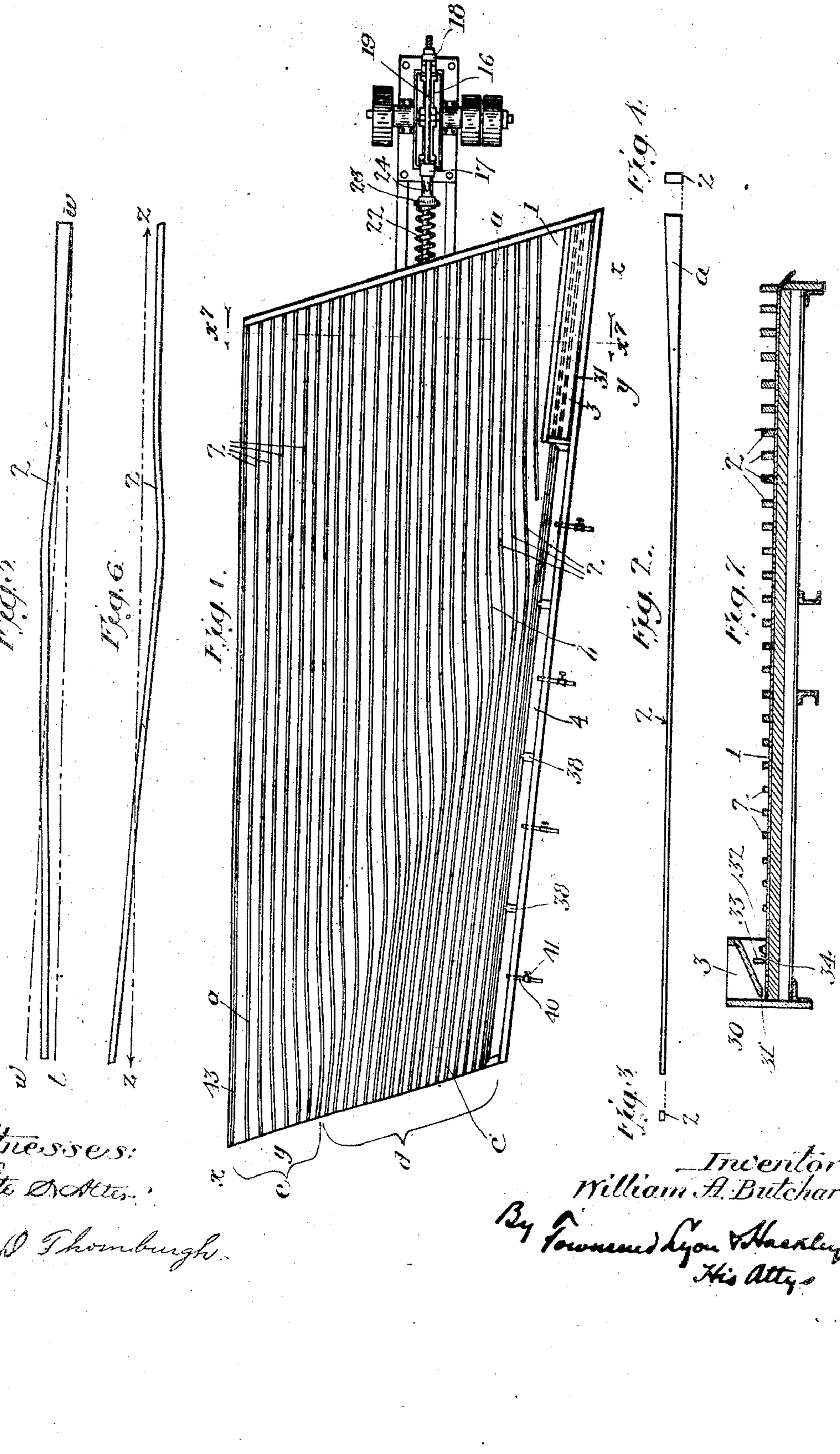
CONCENTRATOR.

APPLICATION FILED FEB. 13, 1911.

997,235.

Patented July 4, 1911.

2 SHEETS—SHEET 1.



Witnesses:

Lute D. Atterbury

A. D. Thornburgh.

Inventor:

William A. Butchart

By Townsend Lyon & Hawley

His Attys.

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2 SHEETS—SHEET 2.

Fig. 12.

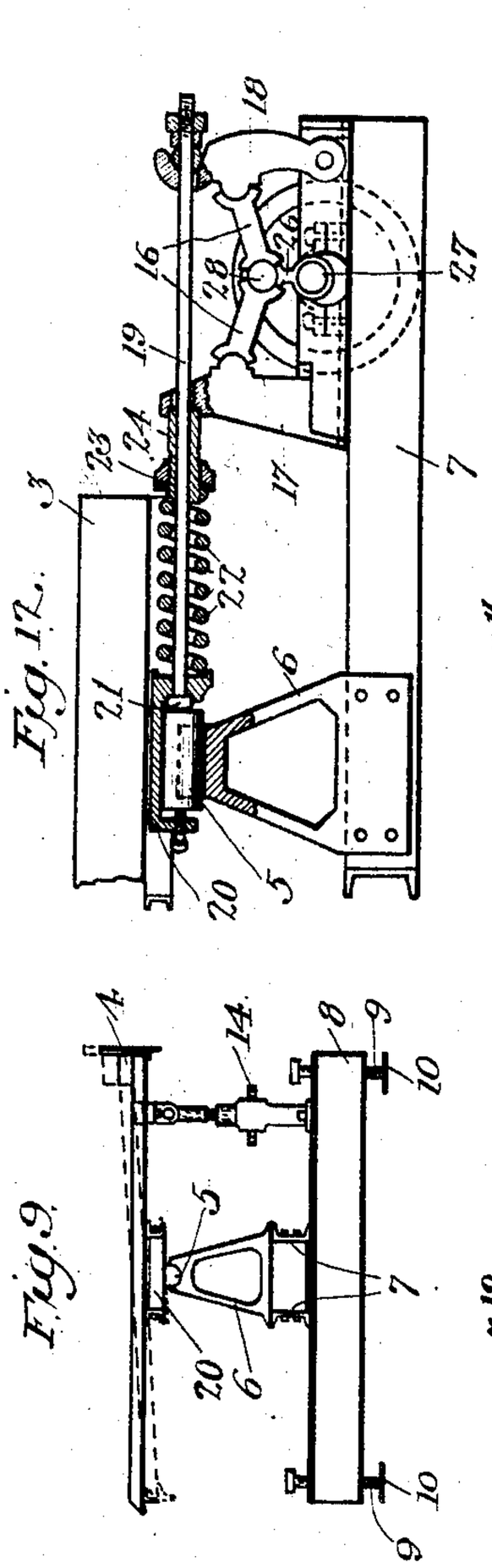


Fig. 8.

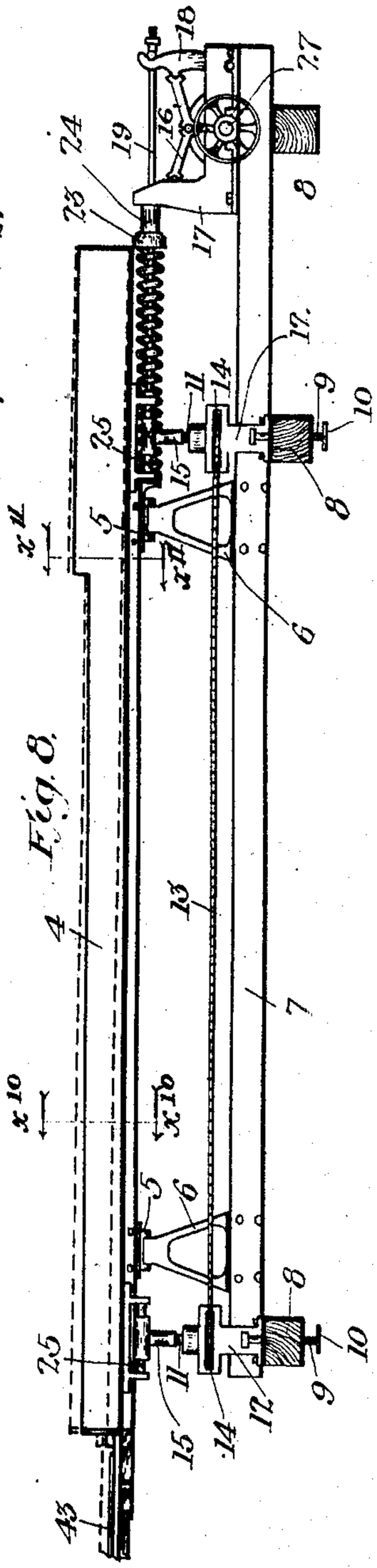


Fig. 11.

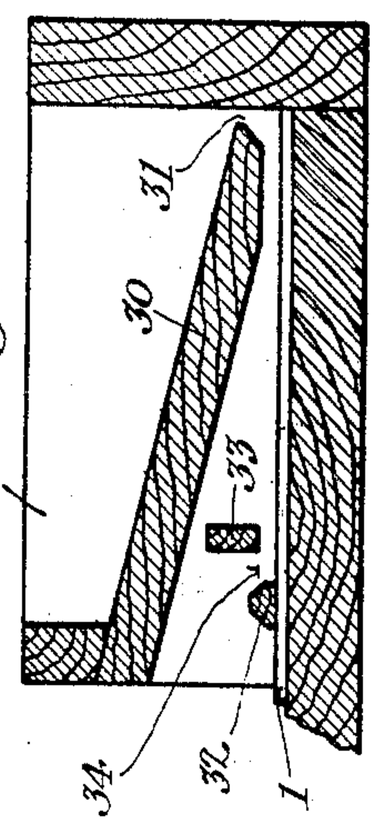
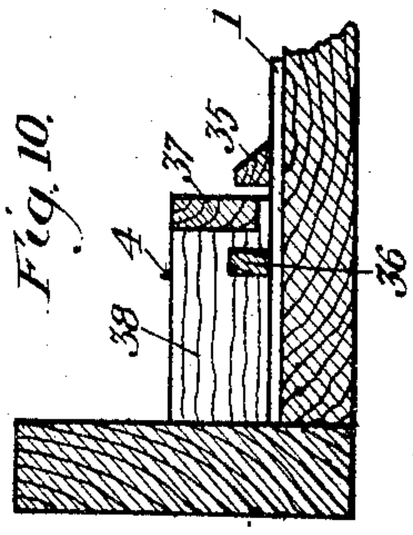


Fig. 9.

Fig. 10.



Witnesses:

Lulu A. Otter.

I. D. Thornburgh.

Inventor:

William A. Butchart

By Townsend Lyon & Hardy

His Attys

UNITED STATES PATENT OFFICE.

WILLIAM A. BUTCHART, OF LOS ANGELES, CALIFORNIA.

CONCENTRATOR.

997,235. Specification of Letters Patent. Patented July 4, 1911.

Application filed February 13, 1911. Serial No. 608,455.

To all whom it may concern:

Be it known that I, WILLIAM A. BUTCHART, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented a new and useful Concentrator, of which the following is a specification.

This invention relates to a concentrator for separating mineral from the pulverized rock or sand in which it may be contained, and the main object of the invention is to accomplish such separation in a more rapid, efficient and economical manner than has been heretofore done.

The invention relates to concentrators of the class wherein a table having a plane surface is provided with riffles extending longitudinally of the table, such table being supported so as to present longitudinal and lateral inclinations, and means being provided for feeding pulverized rock and its mineral contents and water at the upper side of the table, and means also being provided for subjecting the table to longitudinal, reciprocating, differential motion, whereby the values are caused to gradually advance to the discharge end of the table and the lighter material is washed over the lower side of the table.

An important object of the invention is to so construct the riffles in such a table as to allow the wash water to act with maximum efficiency and rapidity in separating the lighter material from the concentrates.

Another object of the invention is to so construct the riffles on the table as to enable the concentrates to be carried away and discharged with minimum loss.

Another object of the invention is to so construct the riffles on the table as to provide for successive stratifying, cleaning and discharging zones.

Other objects of the invention will appear hereinafter.

The accompanying drawings illustrate the invention, and referring thereto:—Figure 1 is a plan of the concentrating table embodying the invention. Fig. 2 is a side elevation, and Figs. 3 and 4 end elevations of one of the riffles of such table. Fig. 5 is a profile of one of the riffles, and Fig. 6 a contour thereof. Fig. 7 is a transverse section on line x^7—x^7 in Fig. 1. Fig. 8 is a side elevation of the table. Fig. 9 is an end elevation thereof. Fig. 10 is a vertical section on line x^{10}—x^{10} Fig. 8, showing the construction of the water box or launder. Fig. 11 is a vertical section on line x^{11}—x^{11} Fig. 8, showing the construction of the feed box. Fig. 12 is a longitudinal section through the head motion.

1 designates the concentrator table or deck. Said table is provided with riffles 2 extending longitudinally thereon with a feed box 3 at the rear end and at the side which, in the operation of the machine, is the higher side of the table, and with a water box 4 on the same side as the feed box and extending the remainder of the length of the table, for supplying wash water to the higher side thereof.

Each of the riffles consists of two portions, a portion extending from the rear or feed end of the table for a certain distance along its length, said portion tapering or being uniformly reduced in height as its advances; and a portion extending from the termination of such tapered part to the end of the table, this portion of the riffle being of practically uniform height throughout its length. Such riffles may be made of any suitable material, and the two portions described may be made separately and joined in a suitable manner upon the table, or the whole riffle may be made in one continuous strip having the characteristic features mentioned. Such riffles may also be constructed by cutting or otherwise removing from a suitable surface such portion thereof as will leave said riffles projecting therefrom in the shape and form above described. Said riffles, constructed in any of the manners mentioned, may vary from the cross-sectional form shown in Figs. 3 and 4, as may be required by the peculiarities of the ore to be treated. Such riffles are placed upon the concentrating table in such manner as to divide it into three distinct areas or zones, as follows:

(1) The rearward or tapering portions *a* of the riffles are laid parallel to the line of motion of the table, the height and length of such tapering portions being increased regularly and progressively from the feed side toward the tailings discharge side of the table, said tapering portions ending on a diagonal line extending from the higher toward the lower or tailings discharge side of the table. Although no two of these tapering portions are of the same height at their rear ends, they are all of substantially equal height at their termination along said diagonal line, their height depending upon

the class of material which the table is designed to handle. It may, however, be at times necessary to make such riffles of unequal heights at their forward termination as well as at their rear ends.

(2) From the termination of the tapering portions *a* of such riffles, another portion *b* of each riffle extends obliquely with reference to the line of motion, being deflected at an angle thereto and toward the feed or wash water side of the table, for a distance and at an angle or upon a curve varying with the requirements of the ore to be treated. This portion of the table constitutes the separating and cleaning zone and extends in a diagonal direction between the lines X X and *y y*, from the higher or feed side of the table toward its lower front corner. This separating and cleaning zone may be varied as to shape and direction as required either by the class of material being handled by the table or by the form or type of table upon which this riffle system may be used. These deflected portions are so placed upon the table surface as to form channels which, about midway of their length, are of greater width than those formed by the riffles in the stratifying zone, and thence converge in such manner as to form channels narrower than elsewhere of the length of such deflected riffle portions. The initial and final ends of each deflected riffle portion are somewhat advanced or placed nearer the end of the table than those of the corresponding portion next higher on the table.

(3) From the forward end of the deflected riffle section or cleaning zone just described, the riffles are deflected toward the lower side of the table, with relation to the direction of the preceding riffle portions and also preferably with relation to the line of motion of the table, as indicated at *c*, the degree of curve or angle of deflection being determined by the requirements of the ore to be treated and other considerations. These riffles are continued toward the front end of the table over which the concentrates, or mineral contents of the ore, are discharged, and constitute the delivery or discharge zone of said table. This second deflection of the riffles has the further object of supplying and properly distributing the necessary wash water to that portion of the riffles adjacent to the concentrates discharge end of the table, thus rendering optional the use of an additional water box or spray pipe. These portions of the riffles extend in lines such that the longitudinal and transverse inclinations of the table compensate each other, so that the channels between the riffles are approximately horizontal.

Means are provided for supporting the table so that the front or concentrates discharge end is higher than the rear or feed end thereof and so that the feed and wash water side of the table is higher than the tailings discharge side.

The table is mounted to have a longitudinal reciprocating motion, said table being, for example, carried by longitudinal shaft sections 5 secured to a bracket 20 slidably mounted upon pedestals 6 on the base 7. Said base 7 is provided with transverse members 8 mounted on screws 9 engaging with the floor or support, indicated at 10, or otherwise mounted in any suitable manner so as to provide for adjustment or variation of the inclination of the table in a longitudinal direction. The table is also provided with means for variation of its inclination in a transverse direction, the said shaft sections 5, for example, being adapted to turn as well as slide in their bearings and adjustable supporting means 11 being provided at one side of the table and connecting the table with the transverse members 8 of the base, said adjusting means consisting, for example, of screws mounted to turn in vertical standards 12 and adapted to be rotated by any suitable means such as a chain 13 engaging with sprocket wheels 14 on said screws, said screws working in threaded sockets in heads 15 sliding on rods 25 connected to the table 1 on the bottom thereof. This sliding connection of the head 15 allows for reciprocating movement of the table. Such reciprocating movement may be effected by any suitable head motion consisting, for example, of a toggle 16 engaging at one end with a fixed frame 17 on base 7 and at the other end with a rocker arm 18 having a rocking connection with a bar 19, said bar extending through the bracket 20 on the table, said bar having a head 21 at one end for engaging said bracket, and a spring 22 being provided between said bracket and a collar 23 adjustably mounted on a sleeve 24 surrounding the bar 19 and engaging the fixed member 17. The toggle 16 is connected at its center pivot 28 by means of a pitman 26 to an eccentric or crank 27, whereby a vertical vibratory motion is imparted to the toggle, and longitudinal reciprocating motion is thereby imparted by rocker arm 18 to the bar 19 and to the table 1, said longitudinal motion being differential, or with a difference in velocity between its forward and back strokes, by reason of the combined effect of the crank and toggle, and of the action of the spring 22. The construction is preferably such that the forward stroke is relatively slow and the back stroke is relatively rapid, so that the material on the table tends to move with the table during the forward stroke, and the table tends to slip back from under the material in the back stroke, resulting in a progressive creeping of the material toward the delivery end.

While any suitable form of feed and wash water boxes may be used, I prefer to use the forms shown in the drawings, the feed box 3 having an inclined bottom 30 approaching the side of the box, but leaving a slot 31 for the passage of material and feed water onto the table near its upper edge. A strip or molding 32 is secured on the top of table 1 below the bottom of the feed box, this strip acting as a distributer, and another strip 33 serving as a flash board is secured to the ends of the box and extends parallel and adjacent to the strip 32 on the side toward the feed slot 31, forming an intermediate slot 34 through which the water is discharged over the distributer strip 32. The wash water box 4 is provided also with an outside distributer strip 35 and an inside distributer strip 36, and a flash board 37 removably seated on partitions 38 so that said flash board can be removed when necessary to enable the distributers to be cleared of sand or obstructions. The wash water box is preferably divided into a plurality of sections by partitions 38, and separate water pipes 40 having valves 41 are provided for the respective sections of the water box. The water supply from said pipes runs over the inside distributer, under the flash board and over the outside distributer of each section, and passes onto the top of the concentrating table at the upper side thereof in uniform and graduated quantity.

At the lower side of the table, and extending from the corner thereof back a certain variable distance, is a separator, consisting of a portion 43 of the riffle at that side of the table, reaching above the water level, placed for the purpose of making a positive division between tailings and middlings, the length of such separator being varied to suit the requirements of the ore under treatment.

In that section of the table covered by the riffle portions *a*, there is a gradual uniform rise in the bottoms of channels between said riffles, due to the longitudinal inclination of the table, and without any lateral deviation. In that section of the table occupied by the riffle portions *b*, there is an accentuated or increased rise in said channels due to the transverse inclination of the table or its elevation at the wash water side, the effect of this longitudinal inclination being increased by that of the transverse inclination in proportion to the lateral deflection of the riffles at this part of the table. This is illustrated in Figs. 5 and 6, Fig. 6 showing the horizontal contour or course of a riffle with relation to the line of motion indicated at *z*—*z*, and Fig. 5 showing the profile or effective elevation of the riffle resulting from the longitudinal elevation of the table along the line *w*—*w*, with relation to the horizontal line *t*—*w*, combined with the lateral tipping as indicated in dotted lines in Fig. 8. It will be understood in reference to Fig. 1, that the top or surface of the table is flat or plane, and that the variation in elevation of the riffles is due to their curvature or deflection in a horizontal plane and not to vertical curvature.

The operation of the table is as follows: Material is led upon the table through the feed box 3, from any suitable supply discharging into said box, the motion of the table spreading it in a broad band or sheet, water being fed continuously upon the table through the boxes or box sections 4. The sheet of material upon the table becomes progressively thinner as it crosses the stratifying zone and approaches the end of the tapered portion of the riffles, the motion of the table and the presence of water causing the mineral contents to stratify or accumulate in the bottoms of the channels between the riffles by reason of higher specific gravity. Upon reaching the edge of the separating and cleaning zone, *i. e.*, the point at which the riffles commence to curve or deflect upward toward the wash water side of the table, as indicated by the line *x*—*x*, the mass encounters the descending flow of water from boxes 4, a portion of said flow being parallel to the riffles and in a direction the reverse of that in which the mass is moving, due to the height and curvature or deviation of the riffles at this point, as already described. The mineral contents follow the riffle, being held thereby, while the sand, by reason of lower specific gravity, is continuously washed back, thereby becoming deeper than the height of the riffle, and passes over the successive riffles, being finally discharged as tailings or waste. After passing the separating and cleaning zone the mineral enters the downwardly inclined portion of the riffles, in which there is a flow of water toward the discharge end of the table, by which the forward movement of such mineral, caused by the differential motion of the table, is accelerated and its discharge facilitated. Concentrates are discharged over the portion *d* of the front end of the table; middlings or less thoroughly cleaned mineral over the portion *e* and tailings or waste material over the lower side of the table.

It will be noted that the effect of the deviation of the riffles in the separating zone, as compared with their direction in the stratifying zone, is to separate the riffles and widen the spaces therebetween in which the material passes. The advance of the initial end of the deflected section of each riffle, as compared with the corresponding end of the preceding riffle, also has the effect of increasing the width of the channels between the deflected sections of the riffles. That is to say, the channels in the separating zone are wider than the chan-

nels in the stratifying zone by reason of the deflection of the riffles in the separating zone and by reason to the fact that the initial ends of these deflected sections extend in an oblique line, as indicated at X X, from the rear upper portion to the front lower portion of the table. This is of advantage in that as the forward movement of the material is retarded by the upward inclination of these spaces, a wider channel for the passage of material is essential, and permits more effective action by the flow of water in the opposite direction the material being spread out for more effectual cleaning by the wash water. After passing from the separating to the delivery zone, the riffles are brought closer together by reason of their deviation in the opposite direction, and this is also of advantage in that as the forward movements of the mineral is accelerated in this portion, less lateral space is required for its passage, and greater effect is given to the superimposed flow of water moving in the same direction. Moreover the thoroughly cleaned concentrates are by reason of this construction, gathered into a deep compact mass for protection against further action by the wash water.

What I claim is:—

1. A concentrator table having a plane surface provided with riffles comprising tapering rear portions parallel to the line of motion of the table, terminating upon a diagonal line and at equal height above the surface of the table, adjacent riffle portions deflected obliquely toward the higher side of the table and at an angle to the line of motion thereof, said deflected portions commencing upon the diagonal line formed by the ends of the tapering portions, and said deflected portions ending along a line also diagonal to the longitudinal extension of the table, and being, through a part of their length, separated by wider channels than those between the portions of the riffles at the rear of the table, to cause the concentrates to be spread for more effective cleaning by the wash water, and to provide adequate space for the retarded travel of concentrates along the upwardly inclined inter-riffle channels, the initial and final ends of said deflected portion of each riffle being nearer to the concentrates discharge end of the table than the corresponding ends of the deflected riffle portion next higher on the table in combination with means for feeding material at the upper rear portion of the table and means for supplying wash water at the upper portion of the table.

2. A concentrator table provided with means for imparting longitudinal reciprocating motion thereto, means for supporting the table to permit of such motion and providing for longitudinal and transverse inclination of the table, means for supply and distribution of material and wash water at the higher side of the table, riffles on the table comprising rear portions parallel to the line of motion of the table, intermediate portions extending from said rear portions and deflected obliquely toward the higher side of the table, and front portions extending from said intermediate portions and deflected obliquely toward the opposite side of the table.

3. A reciprocating concentrator table of plane surface provided with riffles comprising tapering rear portions laid parallel to the line of motion of the table, adjacent portions deflected obliquely toward the higher side of the table and at an angle to the line of motion thereof, said deflected portions commencing upon the diagonal line formed by the ends of the tapering portions, and said deflected portions ending along a line also diagonal to the longitudinal extension of the table, and being, through a part of their length, separated by wider channels than those between the portions of the riffles at the rear of the table, said deflected portions converging at their forward ends in such manner as to be there separated by channels narrower than elsewhere in the length of such deflected portions for the purpose of gathering up the cleaned concentrates into a deep compact mass for protection against further action by wash water, the initial and final ends of said deflected portion of each riffle being nearer to the concentrates discharge end of the table than the corresponding ends of the deflected portion of the riffle next higher on the table in combination with means for feeding material at the upper rear portion of the table, and means for supplying wash water at the upper side of the table.

4. A concentrator table having a plane surface and provided with riffles on said surface, a portion of said riffles near the rear end of the table extending longitudinally of the table to form with their intervening channels a stratifying zone, another portion of the riffles extending from the ends of the preceding riffle portions and deflected toward the upper side of the table to form with their intervening channels a separating and cleaning zone, and a third riffle portion extending from the riffle portions in the separating and cleaning zone and deflected therefrom toward the lower side of the table to form with their intervening channels a discharging zone.

5. A concentrator table having a plane surface and provided with riffles thereon, means for supporting the table in position such that its surface inclines downwardly toward the tailings side and upwardly toward the concentrates discharge end, means for longitudinal reciprocation of the table means for feeding material and for supply-

ing water to the upper side of the table, said riffles having portions extending from the feed end of the table toward the discharge end and adapted to operate in connection with the water passing transversely over the table to stratify and clean the material fed onto the table, and terminal riffles extending from the discharge ends of the aforesaid riffle portions obliquely toward the lower side of the table upon lines in which the longitudinal and transverse inclinations compensate each other so that the channels between the riffles are approximately level, so as to retain water upon the table surface and whereby the concentrates are conducted with the aid of such retained water, to the discharge end of the table.

6. A concentrator comprising a longitudinally differentially reciprocable, transversely and longitudinally inclined table, means for supplying pulp and wash water at the higher side, riffles upon the table and extending the length thereof, portions of said riffles at a substantial distance from the beginning having an upward trend toward the supply side, and from thence to the concentrates discharge end having a downward trend toward the gangue discharge side.

7. A reciprocating concentrator table having a plane surface, means for supporting said table so that its surface inclines downwardly toward the tailings discharge side and upwardly toward the concentrates discharge end, means for feeding material at the upper rear portion of the table, means for supplying wash water along the upper side of the table, said table being provided with riffles comprising tapering rear portions laid parallel to the line of motion of the table, adjacent portions deflected obliquely toward the higher side of the table and at an angle to the line of motion thereof, said deflected portions commencing upon the diagonal line formed by the forward ends of the tapering portions, and said deflected portions ending along a line also diagonal to the longitudinal extension of the table, and being, through a part of their length, separated by wider channels than those between the portions of the riffles at the rear of the table, said deflected portions converging at their forward ends in such manner as to be there separated by channels narrower than elsewhere in the length of such deflected portions, the initial and final ends of said deflected portions of each riffle being nearer to the concentrates discharge end of the table than the corresponding ends of the deflected portion of the riffle next higher on the table, and terminal riffles commencing upon the diagonal line formed by the forward ends of said upwardly deflected portions, extending thence obliquely toward the lower side of the table upon straight lines in which the longitudinal and transverse inclinations compensate each other, so that the channels between the riffles are approximately level.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 4th day of February 1911.

WILLIAM A. BUTCHART.

In presence of—
ARTHUR P. KNIGHT,
FRANK L. A. GRAHAM.