J. B. FREEMAN.

CONCENTRATOR.

APPLICATION FILED DEC. 23, 1913. RENEWED MAY 23, 1917.

1,232,783.

Patented July 10, 1917.

4 SHEETS—SHEET 1.

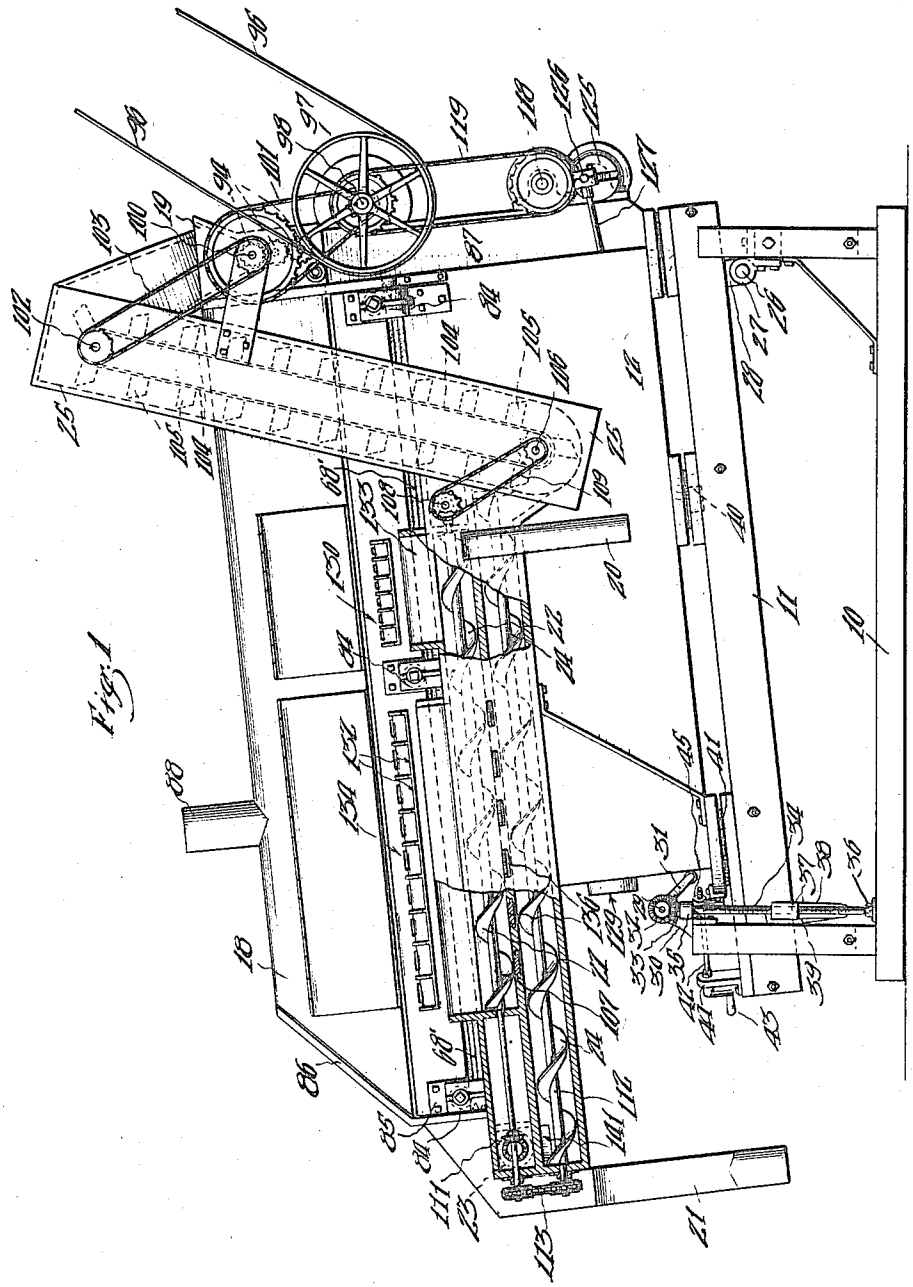


Fig. 1.

Witnesses:
M. Mansfield
Ford W. Harris

Inventor:
James B. Freeman,
by Townsend & Graham
his Attys.

J. B. FREEMAN.

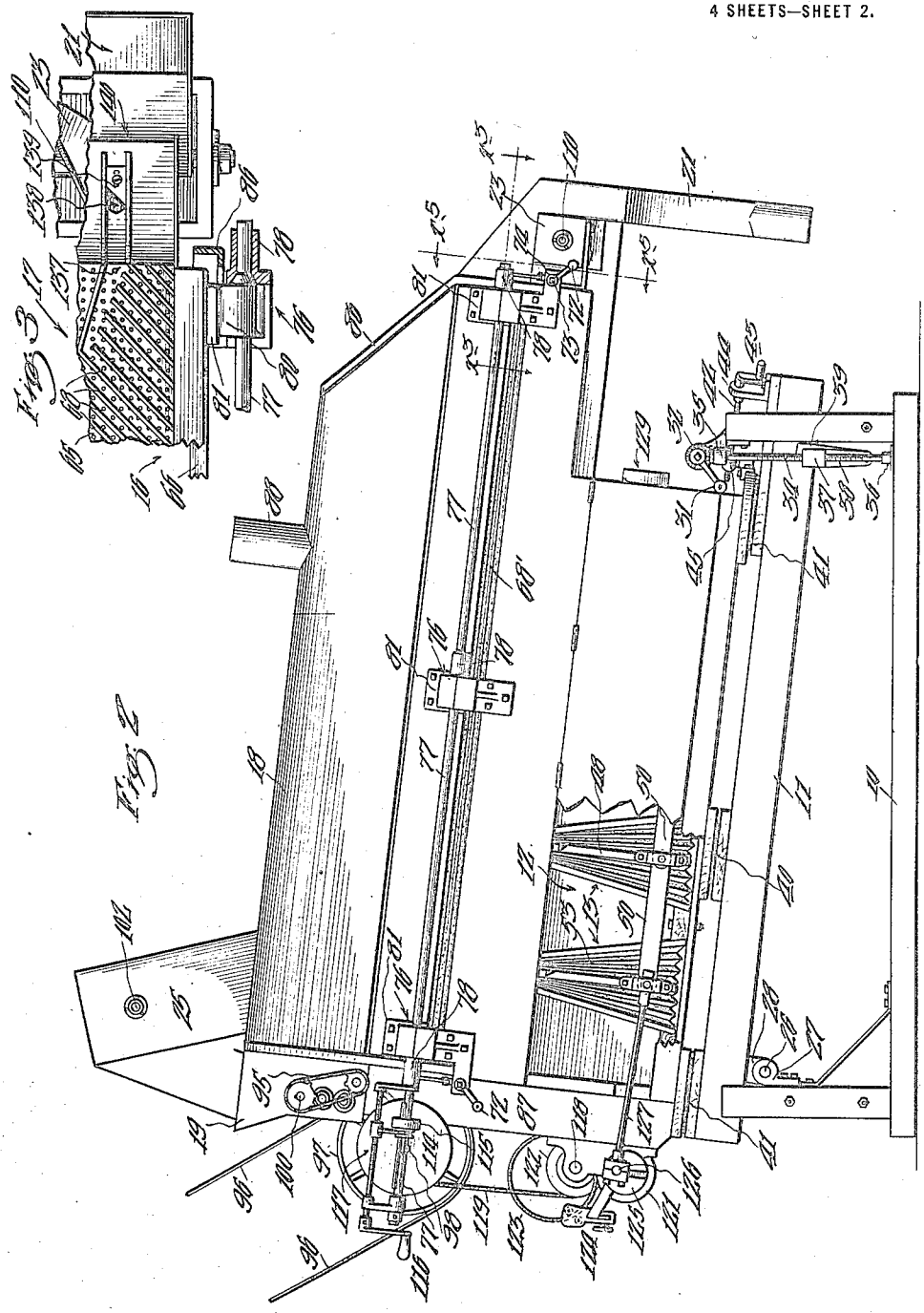
CONCENTRATOR.

APPLICATION FILED DEC. 23, 1913. RENEWED MAY 23, 1917.

1,232,783.

Patented July 10, 1917.

4 SHEETS—SHEET 2.



Witnesses:
W. Mansfield
Ford W. Harris

Inventor,
James B. Freeman,
by Burnham & Burnham
his attys.

J. B. FREEMAN.

CONCENTRATOR.

APPLICATION FILED DEC. 23, 1913. RENEWED MAY 23, 1917.

1,232,783.

Patented July 10, 1917.

4 SHEETS—SHEET 3.

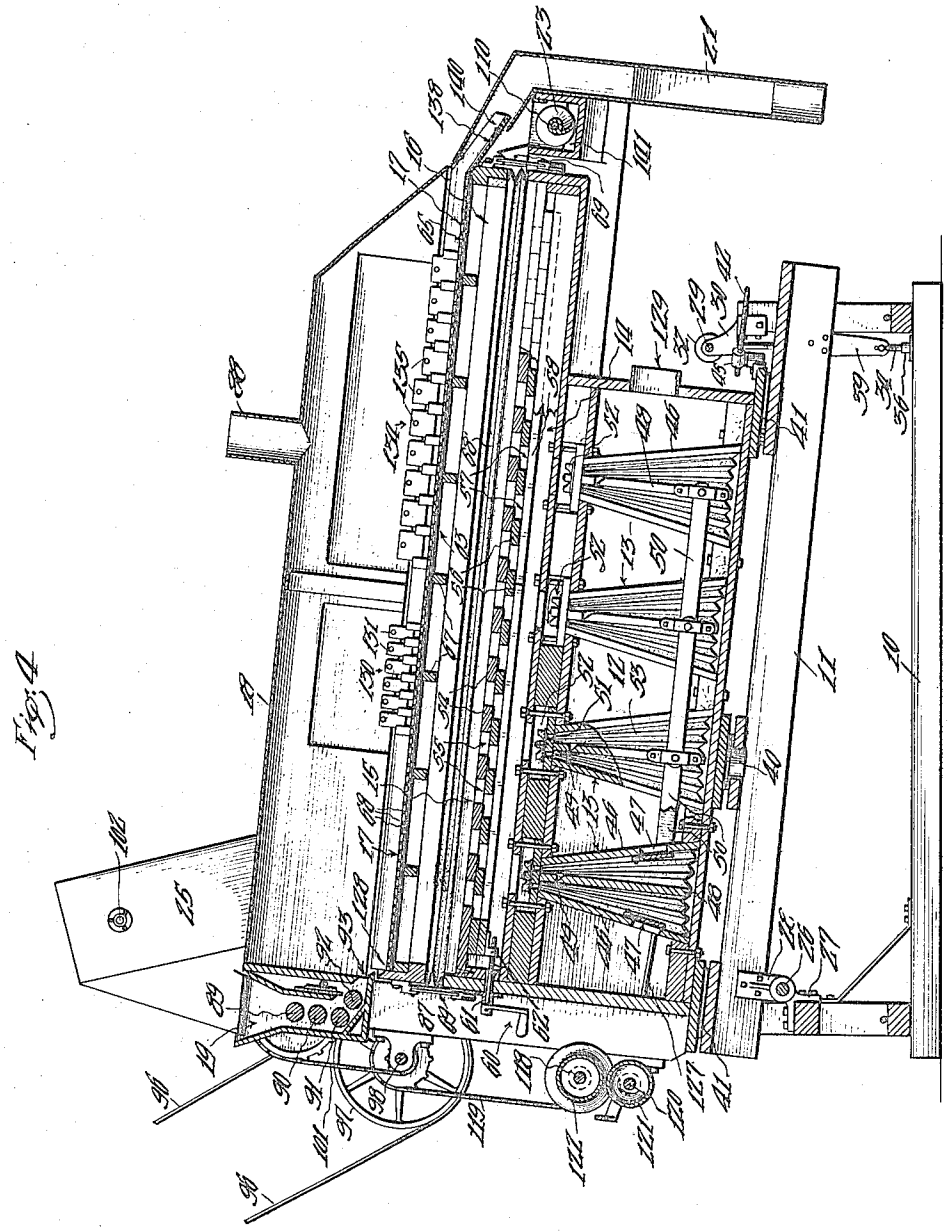


Fig. 4.

Witnesses:
J. Mansfield
Ford W. Harris

Inventor,
by James B. Freeman,
Burnett & Shelburne
his attys.

J. B. FREEMAN.

CONCENTRATOR.

APPLICATION FILED DEC. 23, 1913. RENEWED MAY 23, 1917.

1,232,783.

Patented July 10, 1917.

4 SHEETS—SHEET 4.

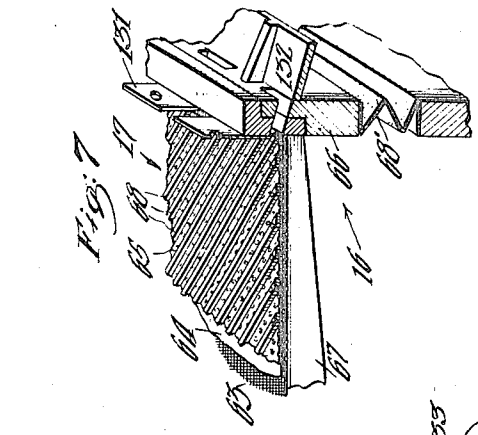


Fig. 7

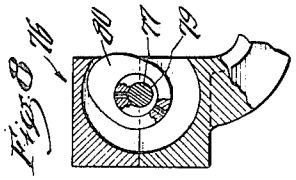


Fig. 8

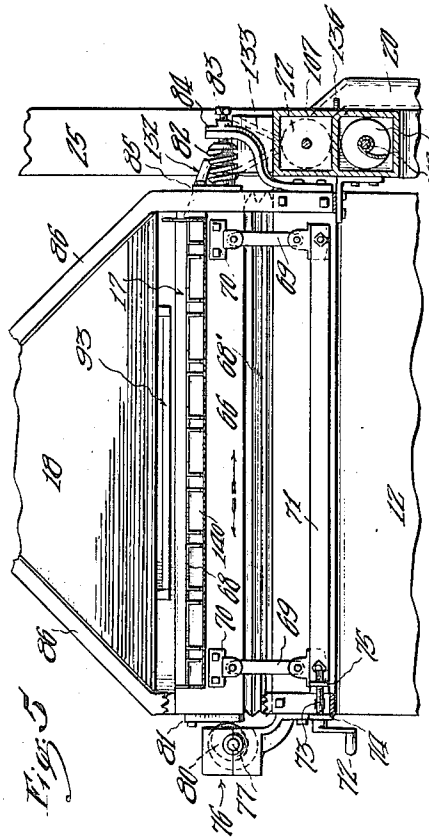


Fig. 5

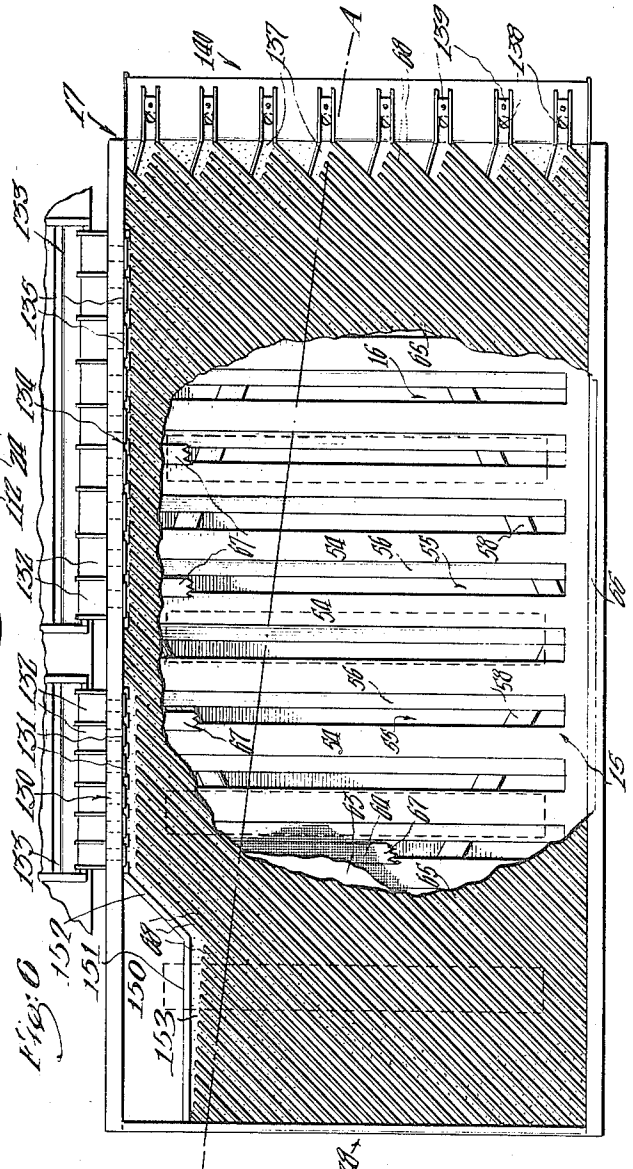


Fig. 6

Witnesses:

F. Mansfield

Ford W. Harris

Inventor,

by James B. Freeman;

Townsend & Mahaney

his attys.

UNITED STATES PATENT OFFICE.

JAMES B. FREEMAN, OF LOS ANGELES, CALIFORNIA.

CONCENTRATOR.

1,232,783. Specification of Letters Patent. Patented July 10, 1917.

Application filed December 23, 1913, Serial No. 808,512. Renewed May 23, 1917. Serial No. 170,566.

To all whom it may concern:

Be it known that I, JAMES B. FREEMAN, 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 Improvement in Concentrators, of which the following is a specification.

My invention relates to concentrators which are adapted to separate the heavier particles from finely divided ores or placer ground, and particularly to those which operate without water and which are known as dry concentrators. The various forms of wet concentrators have certain disadvantages. In very dry countries water is often very expensive, and in many locations is absolutely unattainable. Where valuable ore is obtainable in such locations it is necessary to haul it to water if it is desired to obtain the concentrates therefrom by the wet method. Such hauling is often so expensive as to make the working of the ore unprofitable. The principal object of my invention is to provide means whereby the concentrates may be obtained directly at the mine without the use of water, thereby overcoming the above mentioned difficulties.

Wet concentration is also not entirely successful in working some sorts of materials due to a variety of reasons, among which may be mentioned the tendency to float of certain valuable constituents of such ores which have a high specific gravity but are of a peculiar shape or size.

A further object of my invention is to provide means whereby a more complete separation of the valuable portions of a certain ore is obtained than has been possible by using the wet process.

There are further certain ores that are readily and successfully concentrated by the wet process, but which may be more cheaply separated by the dry process even where water is abundant and cheap.

A further object of my invention is to provide means whereby such separation may be carried on very cheaply.

These objects are attained by the use of an oscillating, perforated, table through which pulsating currents of air are forced and which is provided with a series of riffles for guiding and separating the heavier materials. I have found that the exact character and magnitude of such currents and the exact character and magnitude of the motion of the table must be carefully regulated to suit the various ores to be treated, and a further object of my invention is the providing of means for such regulation.

The table is inclined and the riffles are fixed at a certain angle across the table, and I have found that both the angle of the table with a horizontal plane and the angle of the riffles with relation to such a plane must be adjustable to suit the varying conditions of ore concentration desired. A further object of my invention is to provide for such adjustments.

The separation from any ore of a high grade concentrate is more or less impossible without producing in the intermediate stages a number of concentrates of lower but considerable value. These concentrates if allowed to mix with the high grade concentrates reduce the value thereof, and if thrown in with the tailings are a total loss. A further object of my invention is to return such concentrates to the head of the table for retreatment and to provide means whereby the exact division line between tailings and returned concentrates may be adjusted.

Further objects and advantages will appear hereinafter.

In the drawings, which are for illustrative purposes only:

Figure 1 and Fig. 2 are side elevations, partly broken away and partly in section.

Fig. 3 is a partial section on the line x^3—x^3 of Fig. 2.

Fig. 4 is a side elevation partly in section.

Fig. 5 is a partial section on the line x^5—x^5 of Fig. 2.

Fig. 6 is a plan of a portion of the machine partly broken away.

Fig. 7 is a sectional perspective, and

Fig. 8 is a sectional view of portions of the concentrator.

My invention consists broadly of a sub base 10 upon which is hinged a base 11 which carries a bellows chamber 12 in which are the bellows 13. The bellows force air into a pressure chamber 14 and through a regulating valve 15 into a table chamber 16. The vibrating table 17 is directly over the table chamber and the air is forced therethrough in unidirectional puffs. A hook 18 covers the top of the table, and a hopper 19

with suitable mechanism feeds the pulped ore onto the table. The concentrates are discharged from a spout 20 and the tailings from a spout 21. A conveyer 22 carries a portion of the lower grade concentrates to the spout 20 and conveyers 23 and 24 carry similar concentrates to the elevator 25 which returns them through the hopper 19 to the table for reworking. The table oscillates on its minor axis, the degree and path of such oscillation being controllable. Suitable mechanism is supplied for driving the parts as will be more fully described hereinafter.

Describing the invention more in detail, the sub base 10 may be of wood and carries a shaft 26 in bearings 27. Bearings 28 also turn on this shaft, being secured to the base 11, the parts 26, 27 and 28 forming a hinge upon which the base is pivoted. A shaft 29 is carried on bearings 30 which are carried on the base 11. The shaft 29 is actuated by a crank 31 and carries bevel gears 32 which mesh with bevel gears 33 on the screws 34. The screws 34 are carried in bearings 35 cast integral with the bearings 30 and in bearings 36 secured to the sub base 10. A nut 37 travels on each of these screws being connected by a link 38 to a casting 39 rigidly fastened to the base 11. By rotating the crank 31 the screws 34 are rotated thus raising and lowering the nuts 37 and elevating and depressing one end of the concentrator which turns about the shaft 26. This raising and lowering changes the angle of inclination to the horizontal of the table 17.

The lower end of the bellows chamber 12 is provided with a pivot 40 which extends down into the base 11 and about which the concentrator proper may be turned. Roller bearings 41 are provided to reduce the friction of this turning which is regulated by a screw 42 actuated by a crank 43. The screw 42 is carried in a bearing 44 secured on the base 11 and engages a pivoted nut 45 carried on the bellows chamber of the concentrator. By rotating the screw 42 the concentrator proper may be turned upon the pivot 40. This turning changes the inclination of the riffles to the horizontal.

In the bellows chamber 12 are placed the bellows 13. Each of these bellows consists of two side boards 46 each of which is equipped with a valve 47 which allows air to pass into the bellows but resists its expulsion. A center board 48 is hinged at 49 and is swung backward and forward by the connecting bars 50 on either side thereof. An opening 51 is provided from either side of the bellows into the chamber 14, these openings being provided with valves 52 which will allow air to be expelled from the bellows but prevent its entrance. Leather members 53 connect the boards 46 and 48. The bellows are so mounted that they may be easily removed for inspection or repair.

The regulating valve 15 consists of a plurality of stationary slats 54 having openings 55 therebetween. A plurality of movable slats 56 with openings 57 therebetween are provided, the slats 56 being fastened together by the braces 58. The slats 56 are directly below and slightly narrower than the openings 55 which they are adapted to partially close, being actuated by the screw 59. This screw is provided with a handle 60 and is carried in a bearing 61 on the casing of the concentrator extending inwardly and engaging a nut 62 on a slat 56. By turning the handle 60 the slats 56 may be made to open and close the openings 55.

The table 17 consists of a layer of wire gauze 63, a layer of canvas 64, and a sheet of finely perforated metal 65, the parts 63, 64 and 65 being secured to a frame 66 having cross pieces 67. On top of the table are a series of riffles 68, these riffles being preferably secured to the cross pieces 67 by small brads passing through the parts 63, 64 and 65 and helping to bind these parts firmly together. An apron 68′ preferably of leather makes an air tight flexible closure between the frame 66 and the walls of the table chamber 16, allowing considerable air pressure to be maintained below the table 17. The riffles 68 are disposed diagonally across and slanting downward of the table and are preferably formed of light strips of wood. The frame 66 is supported on links 69 pivoted in bearings 70 carried on that frame and pivoted on a bar 71 slidably mounted on the ends of the table chamber 16. These bars may be shifted across the concentrator by means of the handle 72 of the screw 73 which is carried in a bearing 74 on the walls of the table chamber 16 and which extends out and engages a nut 75 carried on the bar 71. By shifting the bar 71 the path of the table may be varied, the table either lifting or dropping as it advances depending upon the position of the pivots of the links 69 which are determined by the position of the bar 71.

The table is vibrated by a series of eccentrics 76 secured to a shaft 77 which turns in bearings 78. The eccentrics 76 are preferably formed of two eccentric sleeves 79 and 80 which are mutually adjustable to vary the throw of the combination. The eccentrics 76 press against plates 81 upon the frame 66 of the table 17 and force the frame away from the shaft 77. A series of springs 82 mounted around bolts 83 and pressing against brackets 84 tend to resist the force of the eccentrics by exerting pressure on plates 85 mounted on the frame 66, forcing that frame toward the shaft 77. The turning of the eccentrics 76 forces the table 17 to move in one direction and the springs 82

force it back, the amount of throw being regulated by the adjustment of the sleeve 80 on the sleeve 79.

The hood 18 is mounted at one end on the brackets 86 and on the other end to an extension 87 of the table chamber. The hood is stationary and is provided with a dust outlet 88 to which suitable conduits may be attached for the purpose of carrying the finer particles of dust out of the concentrating room.

The hopper 19 is also secured to the upper end of the projection 87. A series of rolls 89, 90, 91 and 92 are placed inside the hopper and serve to regulate the rate of feed of the pulverized ore passing to the table 17 through the opening 93. The rolls 89, 90 and 91 are connected at one end by suitable gearing 94 and the rolls 89 and 92 are connected at the other end by a chain 95 passing over suitable sprockets.

The function of the rollers is not only to regulate the flow of pulped ore onto the table, but in addition to provide a scouring action for freeing the valuable metal from any adhering particles of quartz.

The moving parts described above are all primarily actuated through the belt 96 which is driven from a source not shown and which actuates the pulley 97 on the shaft 98. The shaft 98 drives a shaft 100 which carries the roll 89 by means of a chain 101 which passes over suitable sprockets on the shafts 98 and 100. The shaft 100 drives a shaft 102 through a chain 103, suitable sprockets being provided on the shafts 100 and 102 for this chain. The shaft 102 forms the head shaft of the elevator 25 which is composed of chains 104 and buckets 105. The elevator 25 is provided with a foot shaft 106, suitable sprockets being supplied on the shafts 102 and 106 so that they move together. The conveyer 22 is provided with a shaft 107 which is driven from a shaft 108 by suitable bevel gearing, the shaft 108 being driven by means of suitable sprockets and a chain 109 from the shaft 106. A shaft 110 of the conveyer 23 is driven by bevel gears 111 from the shaft 107. The conveyer 24 has a shaft 112 which is driven by means of a chain 113 and suitable sprockets from the shaft 107.

The shaft 98 also extends across the machine and is provided with a friction disk 114. A friction roller 115 slidably keyed to the shaft 77 presses upon and is driven by the disk 114. The roller 115 may be moved radially on the disk 114 by means of the handle 116 which is attached to a screw 117. By adjusting the radial position of the roller 115 the speed of the shaft 77 may be varied, this shaft carrying the eccentrics 76 which vibrate the table 17.

The shaft 98 also actuates a shaft 118 through a chain 119 and suitable sprockets. The shaft 118 drives a shaft 120 by means of a pair of cone pulleys 121 and 122 and a floating belt 123. The position of this belt may be varied by the adjusting mechanism 124 so that the speed of the shaft 120 may be varied with relation to the shaft 118. On either end of the shaft 120 is an adjustable crank plate 125 which has a diametrically placed slot in which a crank pin 126 may be adjusted at various radial distances. Pivoted to this crank pin is a connection rod 127 which is attached to the connection bars 50 which actuate the bellows. By adjusting the radial distance of the pin 126 with relation to the center of the shaft 120, the throw of the pin 126 may be varied and consequently the movement of the center boards 48 may be regulated.

The method of operation of my invention is as follows: Pulverized ore or placer ground being fed into the hopper 19 is distributed evenly in that hopper by the rolls 89, 90, 91 and 92 and fed through the opening 93 onto the table 17 at the head thereof or at 128 as shown in Fig. 6. The table has an oscillating motion imparted as described above and air pressure is admitted to the table chamber 16 from the bellows 13 which are actuated as described above. An opening 129 is provided in the bellows chamber for the admission of air. Either the length of stroke or the frequency of the stroke of the bellows can be regulated, the length of stroke by shifting the pin 126 and the frequency by shifting the belt 123. The natural output of the bellows is compressed air which is delivered in a succession of short sharp puffs to the pressure chamber 14. For the purpose of modifying the character of these puffs, the valve 15 is provided. By manipulating this valve the character of the puffs may be very considerably modified. If the valve 15 is very nearly closed the air will pass from the pressure chamber 14 into the table chamber 16 continuously and with a nearly constant force. As the valve is opened further variations in the pressure will become more marked until finally with the valve wide open the maximums and minimums of pressure inherent to the bellows will appear in the air as it emerges from the table chamber 16 through the table 17. In practice, the valve 15 is manipulated so that the puffs are of the proper magnitude to suit the ore to be treated.

The pulverized ore falling on the head of the table at 128 is subjected to an agitating or shifting action due to the vibration of the table and to a simultaneous winnowing action due to the air pressure. This pressure is so adjusted that it lifts the lighter and less valuable particles, leaving the heavier concentrates to travel along the spaces between the riffles. As the table is inclined the lighter particles are lifted and

fall over the riffles, traveling lengthwise along the table. In practice, the heavier and more valuable concentrates travel diagonally across the table to the gates 130. The gates 130 are partially closed by slides 131 which are so set as to skim off the lighter tailings and allow the concentrates to fall over the spouts 132 into the hopper 133 of the conveyer 22 which carries them upwardly and discharges them through the spout 20. The lighter concentrates are slightly acted upon by the action of the air and the motion of the table and are deflected by the riffles so that their motion is a composite one. A portion of these lighter concentrates travel across the table to the gates 134 which are closed by slides 135 so placed as to allow only the bottom particles to pass under them. The concentrates from the gates 134 also pass into the conveyer 22 and may be carried upwardly thereby to the spout 20 or they may be dropped through by-pass gates 136 into the conveyer 24 and be carried by that conveyer to the elevator 25, and from the elevator through the hopper 19 to the table for reworking. The concentrates that reach the gates 134 may either be passed down the table by closing the slides 135 or may be passed through. When passed through they may be carried either to the spout 20 or to the head of the table. They may thus be either rejected, passed for reworking, or directly saved.

The material which passes the gates 130 and 134 still contains considerable valuable material and the riffles terminate at the bottom of the table in a series of lanes 137, each terminating at a hole 138 which is closed by a thin metal slide 139. The lighter and less valuable materials spill out of the lanes and are discharged over the apron 140 into the spout 21. The lower portion only of the material in the lanes 137 is skimmed out by the slides 139 and passes downwardly through the holes 138 into the conveyer 23. This conveyer discharges through a hole 141 into the conveyer 24 through which it passes on its way to the head of the table for retreatment.

In the operation of my invention it is necessary to make the various adjustments to suit the ores. For example, it is necessary to regulate the throw of the table by adjusting the eccentrics 76 by adjusting the sleeves 80 on the sleeve 79. It is further necessary to adjust the speed of the eccentrics by adjusting the roller 115 on the disk 114.

It is further necessary to adjust the speed of the bellows by adjusting the belt 123 and the throw by adjusting the pin 126. The character of the puffs of air is adjusted by the valve 15. The inclination of the table is adjusted by the screws 34 and the inclination of the riffles by turning the concentrator bodily around the pivot 40 by means of the handle 43. As the table operates the operator watches the various materials and uses his judgment as to what portion should be saved, what portion should be retreated, and what portion should be thrown into the tailings. The operator may also adjust the throw of the table by actuating the crank 72.

It will be noted from Fig. 6 that a portion 150 at the head of the table is blocked off by walls 151 and 152. It will be further noted that the ends of the riffles 68 are cut away adjacent to the walls 151 forming a narrow cleaning lane adjacent thereto and that this lane extends down in front of concentrator gates 130. The purpose of the area 150 is to start the pulped ore away from the concentrates discharge side of the table and the table is so inclined that the tailings travel still farther away taking the course indicated by the line A—A. The space between this line and the concentrates discharge side of the table forms a cleaning area in which the concentrates are still further separated from tailings.

The cleaning lanes 153 are formed for the purpose of relieving the extreme end of the riffles 68 from concentrates and allowing the same to travel down the lanes to the gates 130.

When the partial concentrates are returned to the head of the table for retreatment it will be noted that they are fed into the hopper at a point immediately adjacent to the area 150 and pass onto the table near that area. As this material is already partially concentrated the travel down the table and across the cleaning area results in a final concentration of the ore.

I claim as my invention:—

1. A dry concentrator comprising an inclined perforated table provided with diagonal riffles, means for oscillating said table, means for passing air through said table, and means for adjusting said table about an axis perpendicular to the plane of the table.

2. A dry concentrator comprising an inclined perforated table provided with diagonal riffles, means for oscillating said table, means for passing air through said table, and means for adjusting said table about an axis perpendicular to the plane of the table to vary the effective angle of said riffles with the horizontal.

3. In a dry concentrator, a table formed of a layer of wire mesh, a layer of canvas, and a smooth sheet of perforated material with riffles secured thereto.

4. In a dry concentrator, a table having on its upper surface a series of diagonal riffles, these riffles converging and terminating at the discharge end of the table in a series of narrow lanes formed with low walls over which the gangue may be spilled, the

concentrates passing outwardly between said walls, means being provided for skimming off the lower portion of the material passing between said walls.

5. In a dry concentrator, a table having on its upper surface a series of diagonal riffles, a series of low converging walls at the lower end of said table so placed as to form narrow lanes to take all the discharge from said riffles, and thin plates between said walls in said lanes partially covering a series of holes in the table.

6. A dry concentrator comprising a perforated inclined oscillating table having diagonal riffles thereon, means for oscillating said table, and a pivot at right angles to the plane of the table about which the table may be turned to vary the effective angle of the riffles with the horizontal.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 13th day of December, 1913.

JAMES B. FREEMAN.

In presence of—
FRED A. MANSFIELD,
FORD W. HARRIS.