C. I. GLASSBROOK.

ORE CONCENTRATOR.

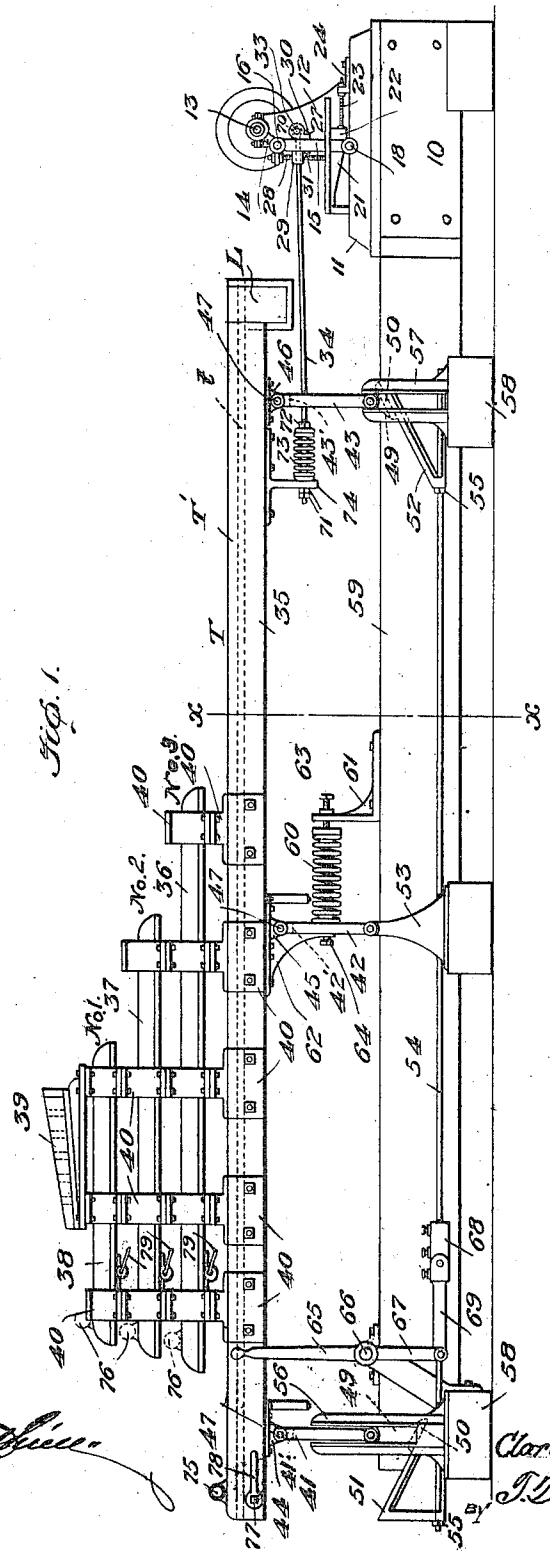
APPLICATION FILED FEB. 9, 1911.

1,038,871.

Patented Sept. 17, 1912.

4 SHEETS—SHEET 1.

Fig. 1.



Witnesses

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4 SHEETS—SHEET 2.

Fig. 2.

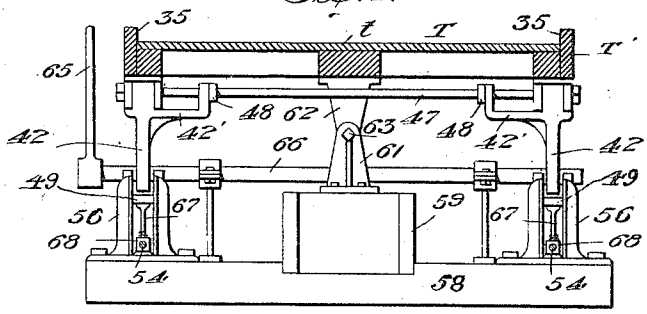


Fig. 3.

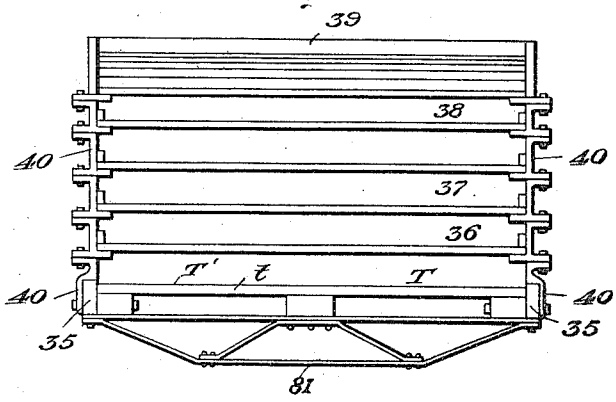
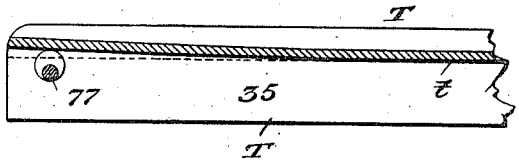


Fig. 7.



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4 SHEETS—SHEET 3.

Fig. 5.

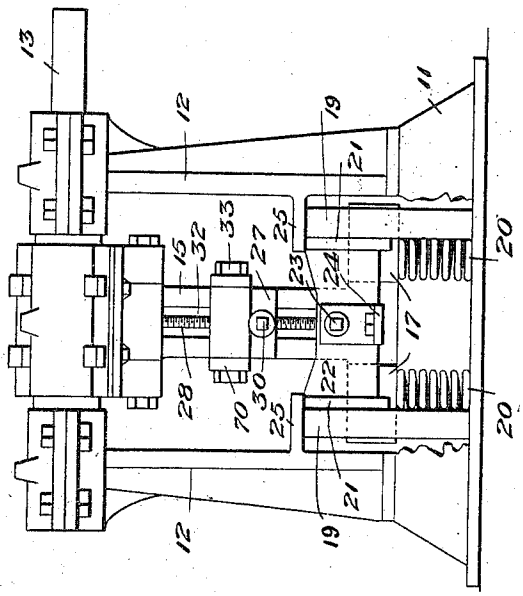
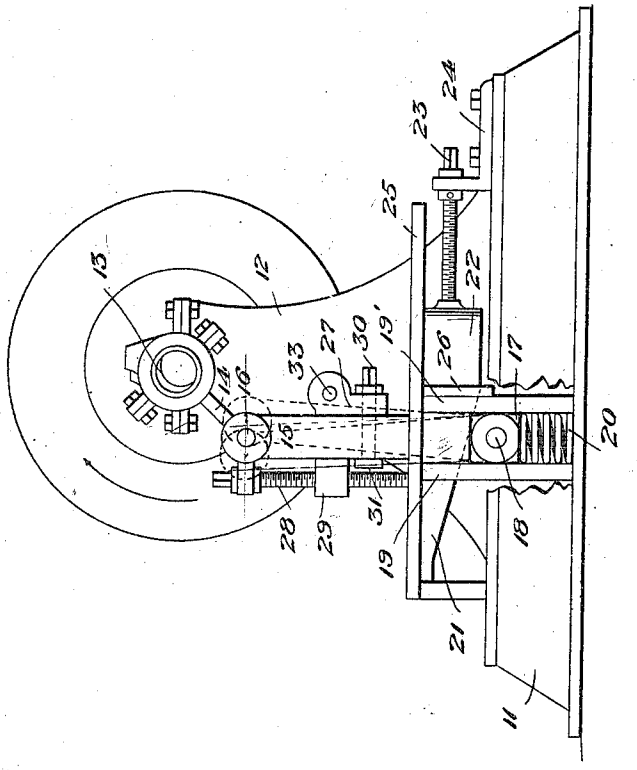


Fig. 4.



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4 SHEETS—SHEET 4.

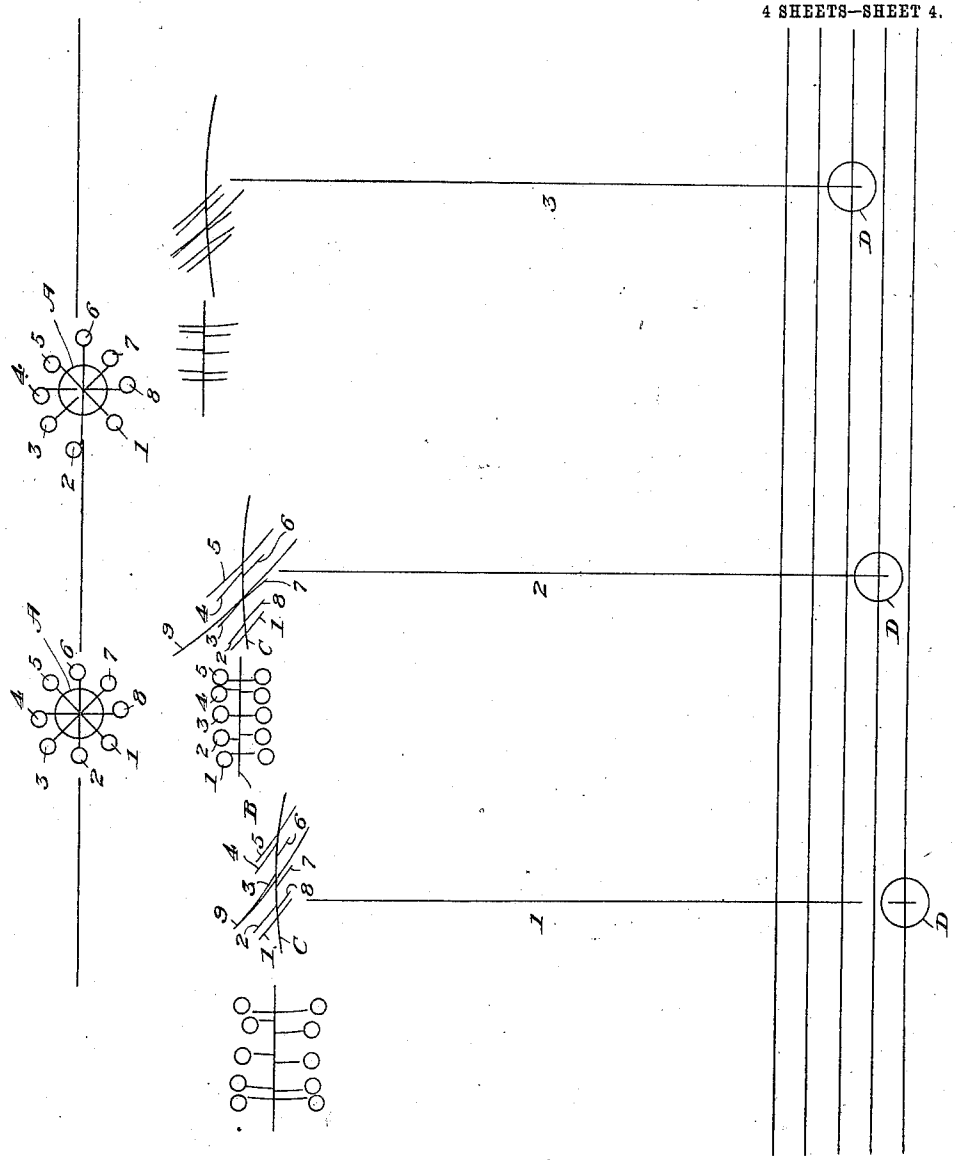

Fig. 6.

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UNITED STATES PATENT OFFICE.

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ORE-CONCENTRATOR.

1,038,871. Specification of Letters Patent. Patented Sept. 17, 1912.

Application filed February 9, 1911. Serial No. 607,559.

To all whom it may concern:

Be it known that I, CLARENCE I. GLASSBROOK, a citizen of the United States, residing at Salt Lake City, in the county of Salt Lake and State of Utah, have invented certain new and useful Improvements in Ore-Concentrators, of which the following is a specification.

This invention relates to certain new and useful improvements in machines for the concentration of ore and particularly ore having valuable constituents, as gold and silver, such machines being provided with mechanism for imparting to the concentrating tables, a vibratory motion for causing the ore particles to be advanced progressively over the table to a point of discharge.

The present invention consists of the parts, and the constructions, arrangements and combination of parts which I will hereinafter describe and claim.

In the accompanying drawings forming part of this specification, and in which similar reference characters indicate like parts in the several views, Figure 1 is a side elevation of an ore concentrator embodying the salient features of my invention. Fig. 2 is a cross sectional view of the same on the line *x*—*x* of Fig. 1. Fig. 3 is an end view of the additional planes which are mounted above the main concentrating table. Fig. 4 is an enlarged side elevation of the adjustable head mechanism. Fig. 5 is a front elevation of Fig. 4. Fig. 6 is a diagrammatic showing hereinafter referred to. Fig. 7 is a detail to be referred to.

In carrying out my invention I construct the machine with a main concentrating table, T, which is adapted for reciprocal movement and is connected with means by which the table may be leveled and which means and the specific character of which table I will hereinafter describe. This table is connected with a mechanism for operating the table and imparting thereto such movement that the ore particles will be progressively moved over the table toward the front or head-end thereof, and which mechanism I will now describe, reference being had to Figs. 1, 4 and 5 of the drawings.

Upon a suitable bed or foundation, 10, is appropriately secured or mounted a cast frame and base, 11, upon which suitable pedestals, 12, are mounted, these pedestals being adapted to support in appropriate journal boxes, the ends of a crank shaft, 13, said shaft having secured to it, a pitman, 14, which in turn is connected to a rocker, in the form of a link, 15, which is connected with a pin, 16, carried by the pitman; the lower end of the rocker, or link, is connected to square or parallel-sided bearing blocks, 17, by means of a pin or shaft, 18. The bearing blocks, 17, are preferably square in cross section or in any event they should have parallel vertical sides to operate with a sliding movement between appropriate vertical guide posts or slotted standards, 19, and 19′, when moved up and down by the mechanism which I will presently describe, said bearing blocks being supported on suitable springs, 20, the purpose of which is to hold these bearings against the lower edge of a wedge, 21, at all times. This wedge is movably mounted and is duplex in character, there being a wedge portion on each side of the rocker or link, 15, as shown in Figs. 4 and 5, said wedge portions being connected together at their rear ends by a solid piece of metal forming a circular back, 22, into which back is inserted the horizontal screw, 23, appropriately mounted in a bracket, 24, bolted or otherwise secured to the base frame, as by means of cap screws, as shown. By means of the aforesaid screw, 23, the double-wedge may be moved in and out in a horizontal plane and be securely held in its adjusted position. The wedge, 21, has for its permanent upper bearing the slides, 25, as shown in Figs. 4 and 5, which overhang the upper end of said wedge portions, the bearing being sufficiently long to give the wedge a support for substantially its entire surface in any position in which the said wedge may be moved. The wedge is further provided with a flange, 26, which is designed as a stop, to prevent the wedge from being inserted farther than the point at which the flange thereof comes in contact with the bearing blocks, 17, which bearing blocks are beveled on the upper surfaces to accommodate them to the inclination or angle of the wedge at the point of contact.

In order that the head-mechanism may be operatively connected to the concentrating table, A, and more particularly that I may

form an adjustable connection between the head-mechanism and the table and thereby control or adjust the stroke of said mechanism I employ the following device, shown particularly in Figs. 3 and 4. A movable attachment, 27, is adjustably mounted on a vertical screw, 28, which is in turn mounted on a projecting member or lug, 29, which forms a part of the rocker or link, 15, before mentioned, said attachment being provided with a square headed and collared screw, 30, shown in Fig. 4, to which, a nut, 31, is engaged and by means of which the attachment, 27, may be permanently locked to the aforesaid rocker or link 15, which latter is provided with a central slot, 32, to accommodate the movable attachment, as shown in Fig. 5. The attachment is also provided with a steel pin, 33, by means of which a connecting rod, 34, is attached leading from the concentrating table, said rod being the medium by which the reciprocating motion is transmitted from the head-mechanism to said table.

Owing to the attachment being provided with the lug or nut, 29, on which is mounted the screw, 28, it is quite evident that said attachment may be moved up and down and fastened at any point on the rocker or link-connection, 15, between a position which is substantially close to the lower bearing pin, 18, which is the point of least motion, to a position near the upper bearing pin, 16, which may represent the point of greatest motion, and by this adjustment I am able to impart to the table any degree of stroke or reciprocating motion desired and within the range of the maximum and minimum movement produced by the rocker or link, 15, when it is actuated by the crank 13, and the connecting pitman, 14, the maximum and minimum movement hereinafter referred to being illustrated in part by the dotted lines in Fig. 4.

I will state that the vertical position of the rocker, 15, which controls the position or angle of the connecting pitman, determines the quantity or quality of differential or progressive motion that is imparted to the concentrating table and that this is more important than the length of the stroke which may be given the table, although both operations are important and it is especially desired that the mechanism be so arranged that the parts may be adjusted separately. I have heretofore explained how the length of the stroke can be adjusted and I will now explain the quick return or progressive motion which is produced by my invention, and which progressive motion is determined by the angle formed by the pitman, 14, and rocker, 15.

By reference to Fig. 4, it will be understood that if the rocker, 15, be elevated until the position of the pitman is exactly at a right angle from its connection with the crank-shaft to its connection with the rocker, thus forming an angle of 90°, the period of time required for the rocker to move front and back in response to the revolving crank, 13, would be exactly the same, but as the rocker is allowed to drop vertically, it being forced down, by the double-wedge, 21, it thus causes the pitman, 14, to assume an angle of say about 15° from the horizontal and the rocker will be drawn back toward the crank more quickly or in less time than that required to push it out or into its first-mentioned position. In this description the crank is supposed to be revolving in the direction indicated by the arrow, in Fig. 4; reversing the direction of the crank revolution, the quick-motion will be reversed. The nearer the position of the pitman is allowed to approach a straight line with the rocker, 15, the quicker will be the return movement of the connecting point at the bearing pin, 16. From this description it will be apparent that the angle of relation between the pitman and rocker determines the degree or percentage of differential or progressive movement, and this angle is adjusted by means of the vertical or nearly vertical position of the rocker up or down which is governed by the wedge, 21, before mentioned.

The diagrammatic drawing, Fig. 6 contains several diagrams representing different positions of the rocker and the relative position of the pitman. In this diagram, the circle, D, represents the rocker pin bearing, 18. The circle, A, represents the line traveled by the center of the crank, 13. The line C, represents the arc line described by the travel of the pitman and rocker connecting pin, 16. The circle, A, is divided into eight equal parts indicated by the lines, 1, 2, 3, 4, 5, 6, 7 and 8; each of these lines indicates a position of the center of the crank in making one complete revolution. The intersecting lines crossing the line, C, represent the corresponding position of the upper bearing pin, 16, as shown by the aforesaid lines, 1, 2, 3, 4, 5, 6, 7 and 8. It will be noted that starting at point 1 on the circle, A, and advancing to point 5, or one half of a revolution of the crank, 13, that the spaces traveled on the arc-line, C, are much greater between the intersecting lines, 2, 3 and 4, than the spaces shown between the intersecting lines, 6, 7 and 8, which latter represent the points traveled by the bearing pin, 16, as it is thrust back to the point of starting by the second half of the revolution of the crank, 13. The distance between the intersecting lines, 4 and 6, as shown on the extended line, B, in the first of the diagrams mentioned, represent the difference in the distance traveled by the rocker, 15, in the same period of time during the first half of the

crank revolution as compared with the return or second half of the complete revolution.

Diagram No. 2 shows the rocker, 15, elevated one half inch above the first position and shows also a corresponding shortening of the comparative spaces, 2 to 4 and 6 to 8.

Diagram No. 3 shows the comparative results obtained by an additional elevation of the rocker, and this might be continued to other diagrams of any similar character, but the showing of which is not thought to be necessary.

The long intersecting line, 9, represents the center of travel of the rocker, and it will be observed that as the rocker is elevated a line from D to the intersecting line, 9, and thence to the center of the circle, A, will show a gradual approach to a right-angle and a consequent diminution of the differential or progressive stroke.

The object of a reciprocating progressive motion as applied to a concentrating table, is to separate the heavier and more valuable contents of a properly crushed ore from the lighter and less valuable gangue matter in which it is contained. For this purpose, some have heretofore employed a mechanical arrangement usually called a concentrating table or a vanner. My invention is directly related to the concentrating-table type of these machines and particularly to a table which may be described as follows, reference being had to Figs. 1, 2 and 3 of the drawings. Fig. 1 shows a side elevation of the complete table, T, mounted upon appropriate base timbers and connected to the head motion or reciprocating mechanism which has heretofore been described. The main body of this table consists of a substantially rectangular frame, T′ which may be five feet wide by fourteen feet long, although any other desired width or length may be employed. The table has a smooth bed or plain surface, *t*, and parallel side pieces, 35, as is common in such tables. The ends are left open, the front end, which in the present showing is the end most removed from the head-mechanism, being the concentrating-discharge end and the back or end nearest the head-mechanism being for the discharge of tailings or waste matter. When the table is in motion, it moves in a line longitudinally with the head-motion and has reciprocating or backward and forward motion, the length and character of which is determined by the adjustment of the head-mechanism before mentioned and to which is attached the connecting rod, 34, leading from the tailings-discharge end of the table. Mounted upon the main body of the table, as shown in Fig. 1, are a series of parallel horizontal planes or supplemental tables, 36, 37 and 38, and which parts I will hereinafter refer to as additional planes. They are approximately the same width as the main table, but it is evident that they may be of any desired and appropriate width and length. Above the uppermost of the superposed planes is a feed-box, 39, which is designed for the purpose of feeding and distributing the crushed ore to the underlying plane, 38, as it is conveyed to the feed-box in its carrying medium, water, by a proper pipe or launder. The additional planes, 36, 37 and 38 and of which there may be any desired number, are supported by sectional brackets, 40, shown particularly in Figs. 1 and 3, said brackets being bolted to the main frame, T′, of the table, and they are so constructed that any number of these brackets may be supported one on the other and securely bolted together whereby the vertical height of the superposed groups of additional planes may be determined at will and without any substantial alteration of the concentrating mechanism. The brackets may also be used to adjust the position of the added planes to any degree of inclination other than that of the main table, without departing from the spirit of the invention. This may be done by using brackets of varying heights.

To facilitate the movement and adjustment of the table and its supporting frame, together with the super-imposed planes, the said table is mounted upon rockers or legs, of which three, 41, 42, and 43, are shown, but it will be understood that there are three of these rockers or legs upon each side of the table. One of the legs (41—43) will be placed at each side, near each end and one (42) placed at each side near the middle, as shown in Fig. 1, the said legs being each pivotally secured at their upper ends to appropriate bearings, 44, 45 and 46, fixed to the underside of the table frame. The legs or rockers are preferably provided with horizontal inwardly extending wings or portions, 41′, 42′ and 43′, near their upper ends. and which portions are pierced to receive the transverse rods, 47, which form the pivots about which the upper ends of the legs or rockers oscillate, said rods having collars, 48, which abut the wings or extensions of the rockers and thereby prevent side movement when the table is in operation, thus holding the table so that it may reciprocate in a true longitudinal direction. At the lower ends, the legs or rockers, 41 and 43, at the end portions of the table are also pivotally connected to suitable bearing blocks, 49, the lower portions of which are provided with inclined foot-pieces, 50, which are adapted to rest in engagement with appropriate wedges, 51, and 52, there being four of these wedges, one located at each corner of the machine, as shown in Figs. 1 and 2. The lower bearing of the middle

rocker 42, is stationary, this rocker being pivotally mounted at its lower end, to the stationary bracket, 53, which is fixed to one of the transverse main timbers of the base or foundation.

The wedges 51 and 52, at opposite ends of the same side of the machine, are connected by an appropriate horizontal rod, 54, the end of which is threaded and provided with jam-nuts 55, in order that the position of these wedges may be changed at pleasure for the purpose of leveling and adjusting the table in its relation to other bearings. The four wedges (there are two at each side of the machine) and the rocker bearings, 49, which they support, are held in place by slotted standards or guides, 56, and 57, which standards or guides are bolted to the foundation sills 58, which also support and are bound together by the main longitudinal timber, 59, which extends beyond the rear end of the table and also furnishes a support for the head-mechanism first above mentioned, to which extended portion of the support the base of the supporting frame of the head-mechanism is secured in any appropriate manner.

Referring again to Fig. 1, it will be seen that there is employed a heavy coiled spring, 60, which is supported at one end by a bracket, 61, bolted or otherwise secured to the main longitudinal timber of the base support, the opposite end of said spring resting against a suitable bracket, 62, which is bolted to the underside of the table frame and extends downwardly to the corresponding end of the spring. In order that the tension of the spring may be increased or lessened as desired, each of the brackets, 61 and 62, is provided with an adjusting screw, 63, and 64; the object of the aforesaid spring is to assist the quick responsive action of the table, as said table is actuated by the head-mechanism and to take up all lost motion occasioned by loose connections.

In order that the wedges, 51, 52, may be adjusted in unison from a convenient point I employ a hand lever, 65, which is mounted on a rocker shaft, 66, extending transversely across the base of the machine, and is mounted in appropriate bearings thereon, said shaft being provided with downwardly extending arms, or levers, 67, each of which is connected to an appropriate clamp, 68, which firmly engages the horizontal rod, 54, each of said arms or levers being connected to a clamp by means of a distance bar, 69. The lever just mentioned enables me to adjust the longitudinal inclination of the table by shifting the horizontal rod, 54, with its attached wedges, to that precise angle required in effecting the separating or concentrating function of the table when in action. By moving the upper end of the lever, 65, forward, or toward the front of the machine, or that part of the machine over which the concentrates are discharged, the rods, 54, of which there will be one on each side of the machine, are moved backward, causing one of the wedges at each side to raise the front end of the concentrating table, as its connections slide in the guides or slotted standards, 56, the rear end of the table being at the same time caused to drop a corresponding distance because of the bearing blocks, 49, at this end of the table moving down the declining portions of the wedges, it being observed that the wedges at opposite ends of the table are placed with their inclines in reverse directions so that as one set of wedges raise one portion of the table, the other set of wedges permit the other end of the table to be correspondingly lowered, the bearing blocks, which rest in contact with the wedges being slidably mounted in the slotted standards before mentioned. By this method the table can be given any angle of inclination desired within the range of the apparatus; the wedges at each end of the table may be raised and lowered in unison to effect the longitudinal inclination and the wedges at the same side of the table may be operated to adjust the table transversely for leveling purposes, as will be readily understood by one skilled in this art. When the lever, 65, is moved in the opposite direction from that described it reverses the action of the wedges and reduces the inclination of the table to any point down to an absolute level.

The table end of the rod, 34, is threaded and is provided with jam-nuts, 71, and 72, also with a backing-spring, 73, said rod passing through a bracket, 74, secured to and extending from the underside of the table, and said jam-nuts, 71 and 72 enabling the operator to adjust the position of the table so that the rockers or legs, 41, 42 and 43, shall be in the proper vertical position, it being understood that the adjustment of these nuts, 71 and 72, in one direction shortens up on the rod and thus results in the table being moved toward the head mechanism and the rockers being caused to assume a more or less vertical position.

The table is shown as having the end next to the head mechanism provided with a waste or tailings launder, L, which is placed for the purpose of catching the flow of waste, as it passes off of the table and to convey it to one side and into a proper receiver, not shown.

At the head end of the table or that end over which the concentrates are delivered, is mounted a horizontal transversely extending perforated pipe, 75, adapted to deliver dressing-water for the purpose of cleaning the concentrates as they pass forward and off of the table. A similar spray-

pipe, 76, may also be connected to each of the added planes, 36, 37 and 38, as shown by dotted lines, in Fig. 1.

An eccentric shaft, 77, passes transversely across the table frame and beneath the table surface at the head end of the same, as shown in Figs. 1 and 7, and the outer end of this shaft is connected with a hand lever, 78, by the movement of which the shaft is turned to bring the eccentric portion up under the table and to thereby give an additional elevation of say ¾ of an inch, or any part thereof, in two feet, as shown by dotted lines in said Fig. 7, without changing the general inclination of the table, or the superimposed plane or planes, it being understood that the table surface is so constructed as to be sufficiently flexible to permit of thus springing or otherwise moving a portion at the head end into a different inclination from that which the balance of the table has and which portion of the table may be caused to assume its normal position in line with the balance of the table, by turning the hand lever to bring the eccentric portion of the shaft out of engagement with the bottom of the movable portion of the table proper. A similar eccentric shaft, 79, may also be provided for each of the added planes, 36, 37, and 38, and for the purpose above stated.

In Figs. 1 and 3, I show a feed box, 39, which is mounted above the uppermost added plane; in said Fig. 3, the table is also shown as being provided with a truss brace, 81.

The added planes may be each progressively longer than the other as shown in Fig. 1, or the planes may be of substantially the same length but arranged in overlapping planes in which case the end of the added planes nearest the head end of the machine will terminate approximately at the dotted line, 82, in said figure.

While the drawings show the added planes as being disposed above the concentrates-end of the table, I do not limit the invention to these added planes as being essential to this particular portion of the table, as it will be obvious to one skilled in this art, that said added planes may be placed in other positions relative to the table, and still be within the scope of my invention.

The general operation of my invention may be described as follows: The head-mechanism being connected to the power line by belt and the speed regulated to the required number of revolutions per minute which may vary according to requirements from 250 to 350, more or less, the table is given a longitudinal inclination from the concentrates discharge end down toward the tailings discharge end and having been previously leveled at right angles to its inclination, it is ready to receive the crushed ore usually called pulp. The pulp is delivered to the center of the feed-box by proper pipe or launder. The construction of feed-box is such that as the pulp flows through, its volume is spread and delivered onto the first or upper plane, which is directly under the feed-box in a uniform and steady stream, extending across the entire width of the plane. This is the point of first contact with the concentrating surfaces of the table, and at this point a portion or all of the free mineral may be eliminated from the accompanying water and gangue matter by the reciprocating and progressive action imparted to the table by the head-motion. This reciprocating and progressive action in its effect may be described as follows: The reciprocating action of the table when the vibrations are sufficiently rapid, impart these vibrations to the mass of mixed sands, mineral particles, and water as it is deposited upon the several plane surfaces of the table, and as a result of its vibrating movement the particles are kept in constant motion loose and free from any tendency to pack and become solid. In this condition the pulp is allowed to flow freely from the feed-box and drop upon the surface below. As in all cases (with few, if any, exceptions) the more valuable mineral particles of the pulp are those of the greatest specific gravity their greater weight carries them through the moving mass of sand particles and brings them in contact with the moving surface of the first plane. Here the influence of the progressive or differential quality of the reciprocating movement becomes at once apparent. At the instant of contact, the particles of solid matter commence to move forward toward the concentrates discharge end, because the return movement of the table toward the head-motion or actuating mechanism being quicker than the forward, away from the head motion, the surface upon which the mass rests is jerked from beneath it before the inertia of the mass is overcome by the return motion. This movement repeated with great frequency causes the mass to travel with greater or less speed according to the adjustment toward the forward or concentrates discharge end of the table. As it is not desired to bring forward the whole mass, but only the more valuable and heavier mineral particles, the table and its added planes are given as previously stated, an inclination from the concentrates discharge end downward toward the tailings discharge end. The effect of this inclination is that when it is adjusted to the proper degree of pitch, the lighter and less valuable particles will flow or roll under the influence of the volume of water in which it is contained, aided by the inclined surface toward the tailings discharge end, this action being rendered easier and more positive by the vibrat-

ing or reciprocating motion, which allows the particles to stratify with the heaviest at the bottom and the lightest on top, where they are readily influenced by the current of flowing water. In this way, is the process of separation or concentration accomplished, by moving the heavier particles or concentrates up hill mechanically and off the table at the concentrates end and the lighter particles or tailings down hill by gravity and off of the table at the tailings end. Now the perfection of this process is governed by the adjustment of the differential or progressive movement in combination with the adjustment of the inclination of the plane surfaces of the table and the speed or number of strokes imparted to the table and plane surfaces in a given period of time. The nearer the sands and mineral particles approach each other in their factors of specific gravity, the closer must be the adjustments of the operation to effect their separation, and as a perfect separation is seldom if ever obtained in one operation under conditions of even the most perfect adjustment, I have conceived the idea of repeating the operation as many times as may be found profitable before allowing the pulp to pass off of the machine. With this end in view I have added the superimposed planes heretofore mentioned and more particularly shown in Figs. 1 and 2, from which figures it will be seen that as the pulp flows from the feed-box on to plane No. 1 where the first concentrating action takes place, the tailings drop onto plane No. 2 for the second process of concentration thence to plane No. 3 for the third process, thence onto the main table for the fourth and last process, from which the residual tailings are allowed to go to waste or to be conveyed to some other apparatus for further treatment.

From the foregoing it will be seen that the main and additional concentrating planes or surfaces afford a means of concentrating and separating different minerals, such for example as lead, iron, and zinc producing each separate mineral from a different plane; to illustrate, I will say that a lead concentrate may be obtained from plane No. 1, an iron concentrate from plane, No. 2, a zinc concentrate from plane No. 3 and the middlings or mixed product from the main table bed.

By the arrangement as shown, it is intended that the operator may have the option of placing upon the table, one, two, three, or as many planes as the conditions of the ore may require.

It will be noted that the concentrates-end of the main table bed is provided with the spray pipe, for the purpose of washing the concentrates as they advance, and cleaning them of any desirable gangue matter that may be carried forward with them. It will also be noted that this end of the table is provided with the adjusting eccentric, by which an additional inclination may be given to this end of the table, more particularly shown in Fig. 7. Both of these appliances may be attached to the added planes above and it is intended to so use them whenever and wherever it may be found advisable.

I do not confine myself to any particular width or length of either the main table, or the added planes above. I do not confine myself to the distance which one plane may be placed above the table or any other plane. I do not confine myself to any given position, longitudinally which one plane may have in relation to the main table or another plane. I do not confine myself to the manner in which the pulp flows from one plane to another. It may be conveyed forward from the rear end of one plane, and underneath to any point on the next lower plane. The concentrates may be conveyed from any plane to a proper receptacle or drop on the next lower plane or to the surface of the main table for re-treatment.

I do not claim in this application the means shown and described for imparting the operating and progressive action to the concentrating table, as this part of my invention forms the claimed subject-matter of a separate application filed by me of even date herewith.

Having thus described my invention what I claim as new and desire to secure by Letters Patent, is:—

1. A shaking table having supports at the ends and central portion, said table being transversely horizontal and said supports being rockable in the direction of the length of the table, said central supports having connections adapted to restrain the vertical displacement of the central portion of the table, and means for shaking the table.

2. The combination of a shaking table, rockable supports at both sides of the ends and central portion thereof, said table being transversely horizontal and said supports being rockable in the direction of the length of the table, the central supports having connections adapted to restrain the vertical displacement of the central portion of the table, means to restrain the supports from movement transversely of the table, and means for shaking the table.

3. The combination of a concentrating table, supplemental concentrating planes, or surfaces arranged in superposed order thereover, said planes or surfaces affording a means performing a plurality of independent complete concentrating operations at the same time in one machine, rockable supports at the sides and central portion of the table, said table being transversely horizontal, and said supports being rockable

in the direction of the length of the table, means to restrain the supports from movement transversely of the table, the central supports having stationary bearings for preserving the central longitudinal position of the table by restraining the vertical displacement thereof, means to restrain the supports from movement transversely of the table, the supplemental plan having rigid connections with the table adapted to prevent distortion and to transmit movements of the table to said planes, and means for reciprocating said table.

4. The combination of shaking table, rockable supports at both sides of the ends and central portion thereof, said table being transversely horizontal and said supports being rockable in the direction of the length of the table, the central supports having connections adapted to restrain the vertical displacement of the central portion of the table, means to restrain the supports from movement transversely of the table, and means at one end of the table for imparting to said table a reciprocating and differential motion.

5. In combination, a longitudinally tiltable table, supports at the ends and intermediate portion thereof comprising rockers, the intermediate rockers having stationary bearings and being connected to the bearings and the table to restrain vertical displacement of the central portion of the table, means engaging the rockers at the ends of the table and adapted to impart simultaneous opposite movements at opposite ends of the table to said rockers, and means for reciprocating the table.

6. In combination, a longitudinally tiltable table, supports at the ends and intermediate portion thereof comprising rockers, the intermediate rockers having stationary bearings and being connected to the bearings and the table to restrain vertical displacement of the central portion of the table, means engaging the rockers at the ends of the table and adapted to impart simultaneous opposite movements at opposite ends of the table to said rockers, said means comprising connected raising and lowering mechanism forming supports for the end rockers, and means for reciprocating the table.

7. In combination, a longitudinally tiltable table, supports at the ends and intermediate portion thereof, said supports comprising rockers movable in the direction of the length of the table, the intermediate rockers having connections adapted to restrain the vertical displacement of the central portion of the table, means to restrain the rockers from movement transversely of the table, and means engaging the rockers at the ends of the table and adapted to impart simultaneous opposite vertical movements to the rockers at opposite ends of the table, said last-named means forming supports for the end rockers, and means for reciprocating the table in the direction of its length.

8. The combination with a transversely horizontal shaking table having rockable supports at the ends and central portion, said supports being rockable in the direction of the length of the table and the central supports having connections adapted to restrain the vertical displacement of the central portion of the table, supplemental concentrating planes arranged in superposed order over said table, each of said planes constituting a separate and distinct concentrating surface which delivers a concentrated product of a given mineral, each succeeding supplemental plane receiving pulp from the plane above it and adapted to concentrate from this pulp a finished product, said supplemental planes having rigid connections with the table adapted to prevent distortion and to transmit movement of the table to said planes, and means for reciprocating said table.

9. In combination, a shaking table, means for supporting the table, said means including a rocker at the central portion of each side of the table, other rockers at each end of opposite sides of the table, said rockers being movable in the direction of the length of the table, means to restrain the rockers from movement transversely of the table, said central rockers having stationary bearings for preserving the central longitudinal position of the table by restraining the vertical displacement thereof, pivotally connected bearing blocks at the lower ends of said end rockers, vertical guides in which the bearing blocks operate, wedges engaging said movable bearing blocks, and means for operating the wedges in series, the wedges at opposite ends of the table being reversely arranged whereby one end of the table is lowered when the other is raised and the longitudinal adjustment of inclination of the table is afforded while the central longitudinal position of said table is preserved constant, and means for reciprocating the table.

10. The combination of a concentrating table, supplemental concentrating planes or surfaces arranged in superposed order thereover, said planes or surfaces affording a means performing a plurality of independent complete concentrating operations at the same time in one machine, rockable supports at the sides and central portion of the table, said table being transversely horizontal and said supports being rockable in the direction of the length of the table, means to restrain the supports from movement transversely of the table, the central supports having stationary bearings for preserving the central longitudinal position of the table by re-

straining the vertical displacement thereof, means to restrain the supports from movement transversely of the table, the supplemental planes having rigid connections with the table adapted to prevent distortion and to transmit movements of the table to said planes, and means for reciprocating said table, each of said supplemental planes being provided with means whereby said planes and each of them may be independently adjusted at different angles to longitudinal inclination thereby increasing or decreasing the frictional resistance to a progressing body of concentrates moving thereon, the degree of such frictional resistance or hindered progression being determined by the angle of elevation of said planes in the relation of said angle or angles to the arc described by said rockable supports.

In testimony whereof I affix my signature in presence of two witnesses.

CLARENCE I. GLASSBROOK.

Witnesses:
GRACE I. HICKOK,
D. EDGAR WILSON.