(No Model.) 3 Sheets—Sheet 1.

W. L. & F. S. CARD.

APPARATUS FOR CONCENTRATING ORES.

No. 519,987. Patented May 15, 1894.

Fig. I.

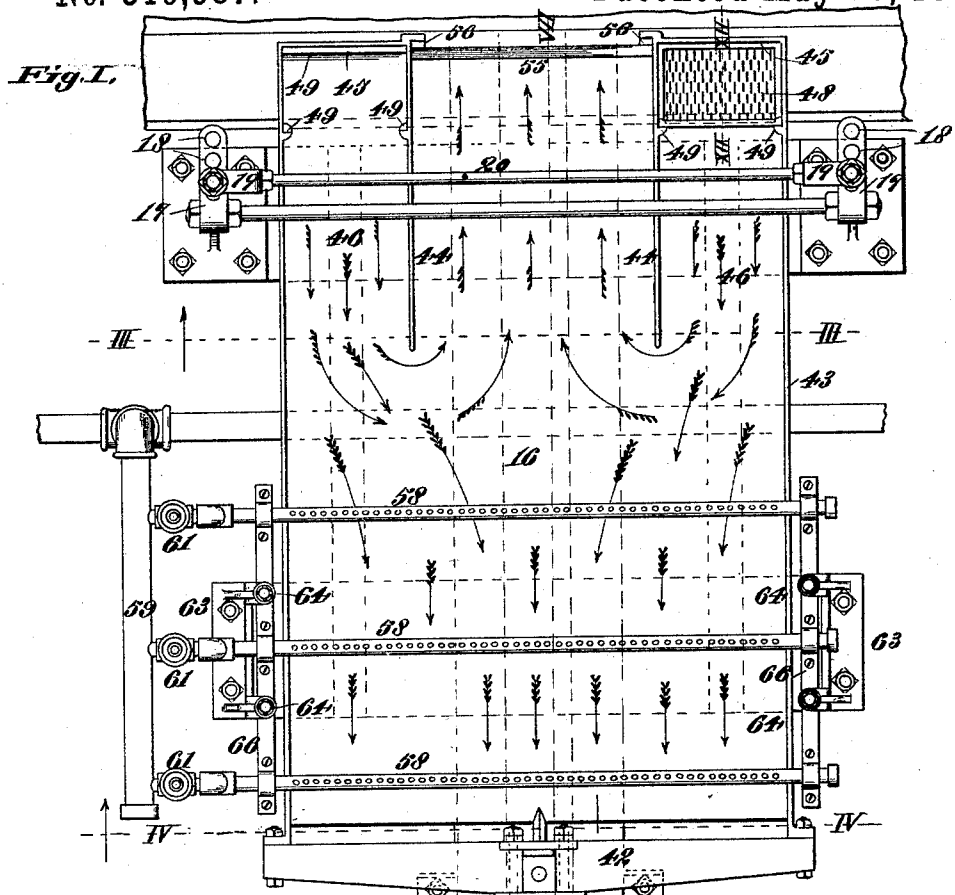
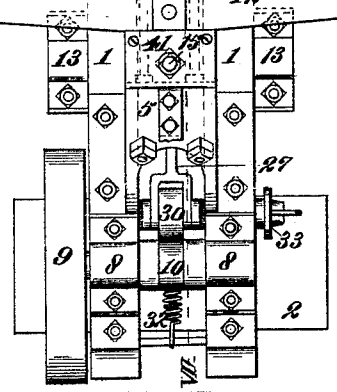
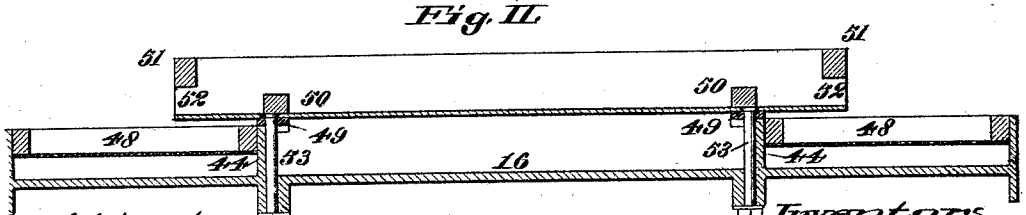


Fig. II.





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(No Model.) 3 Sheets—Sheet 2.

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Fig. III

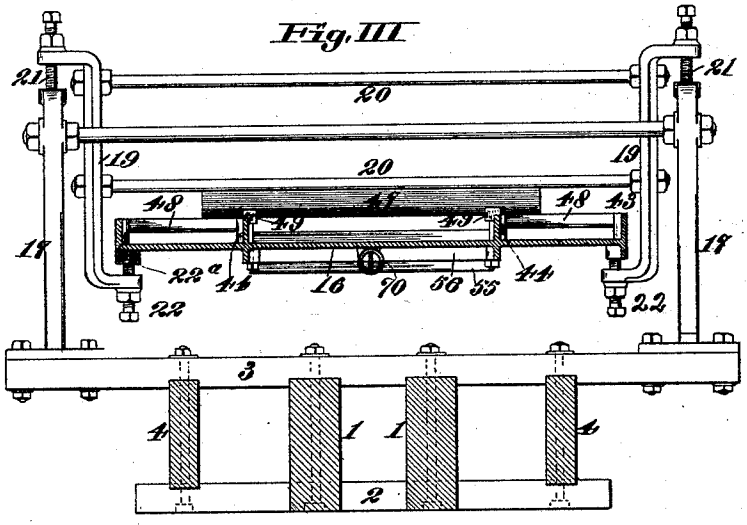


Fig. IV.

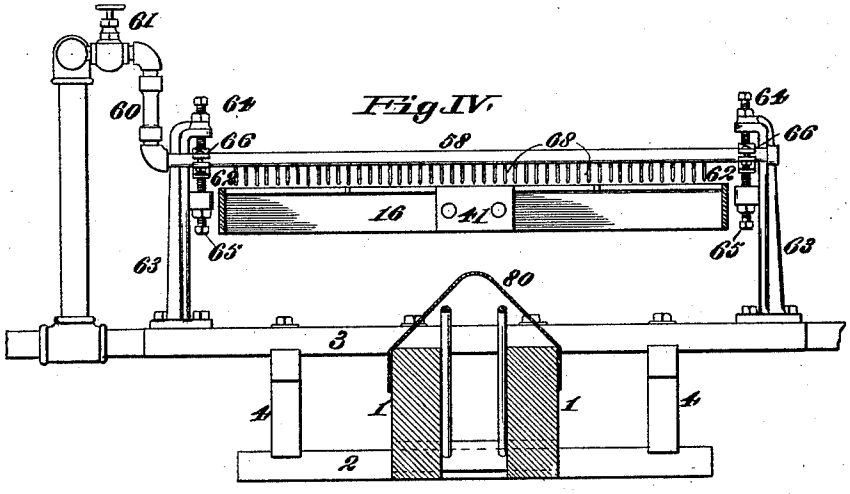
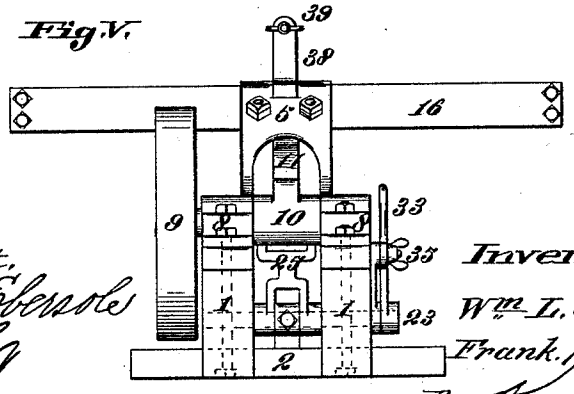


Fig. V.



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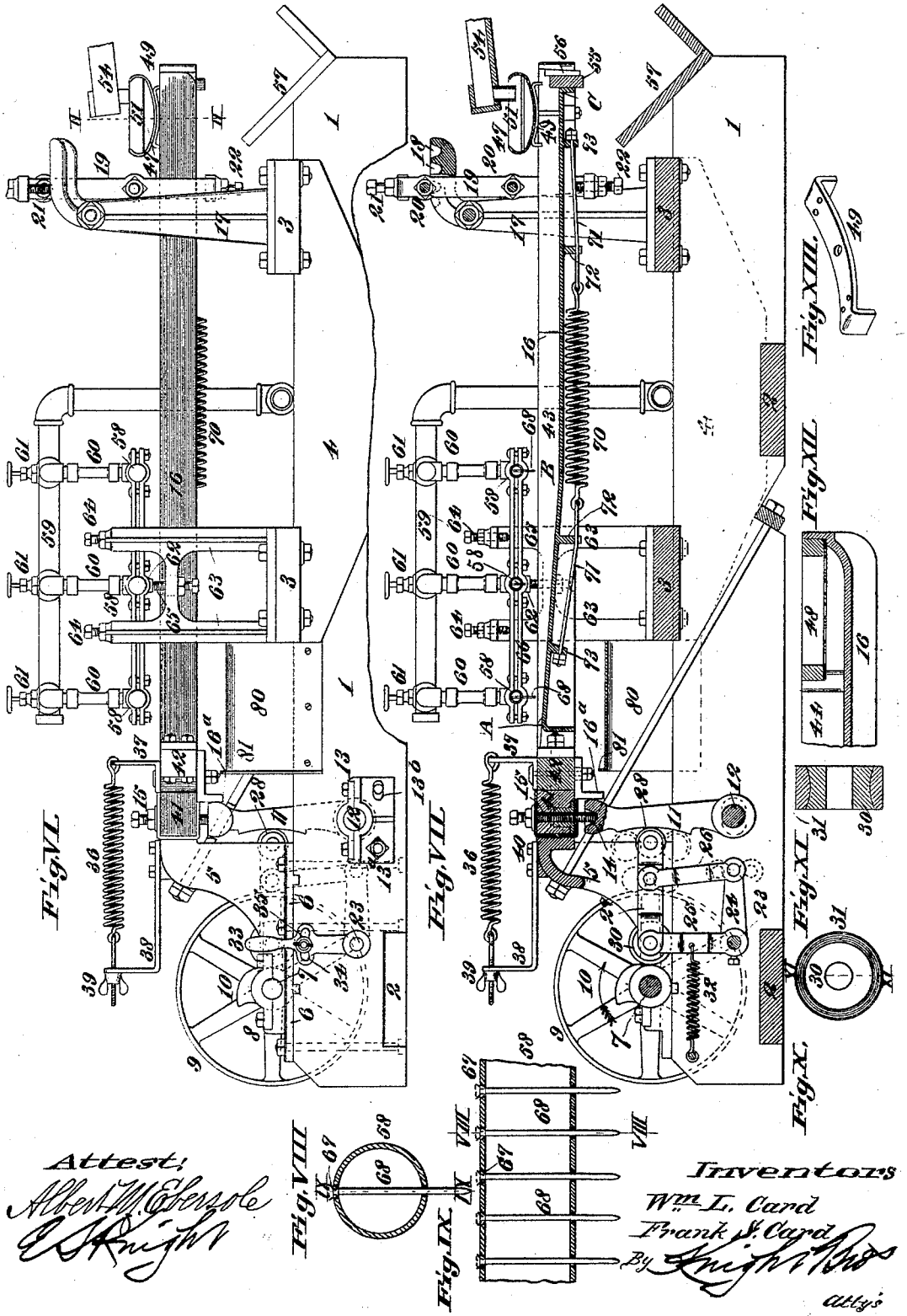

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UNITED STATES PATENT OFFICE.

WILLIAM L. CARD AND FRANK. S. CARD, OF ST. LOUIS, MISSOURI.

APPARATUS FOR CONCENTRATING ORES.

SPECIFICATION forming part of Letters Patent No. 519,987, dated May 15, 1894.

Application filed April 29, 1893. Serial No. 472,379. (No model.)

To all whom it may concern:

Be it known that we, WILLIAM L. CARD and FRANK. S. CARD, of the city of St. Louis, in the State of Missouri, have invented a certain new and useful Improvement in Apparatuses for and Methods of Concentrating Ores, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification.

Our present invention relates to the construction and method of operating that class of concentrators wherein the concentrating pan, or tray is, by means of suitable mechanism, given a reciprocatory motion, combined with shocks, or sudden jars, to effect the separation of the heavier, or metalliferous portion of the pulp from the lighter, or gangue portions thereof.

The first object we have in view, is to deliver the pulp into the central portion of the tray, in a stratified condition, and this we effect by feeding it into compartments at the rear end of the tray, which compartments are formed by thin partitions extending upward from the bottom and forward from the rear, and opening toward the front, near the center of the tray said partitions being substantially in line with the longitudinal to and fro movements of the tray; which method of feeding, or its equivalent, embodies the first feature of our invention.

The second object we have in view is to distribute the water at the head of the pan, over a large area, in a divided state, and under such control that the quantity or volume thereof may be increased or diminished at will, across the whole head of the tray, or at certain localities, as desired; and this we effect by a series of transversely arranged, perforated tubes or pipes provided with vertically movable valves, having stems for delivering the water in drops, or minute streams, which or its equivalent embodies the second feature of our invention.

The third object we have in view, is to so suspend the tray that its weight shall be so distributed between its supports as to avoid false motions, which interfere with stratification, to render the adjustments for leveling sidewise and varying the pitch endwise simple and convenient, and at the same time to reduce friction in the bearings to a minimum; and this we effect by suspending the tray from three points, by converting the ends of the adjusting screws, as near as may be, into anti-friction bearings, (the ordinary wear on which can be readily compensated for without expense, by simply turning the screws,) which combination, or its equivalent, embodies the third feature of our invention.

The fourth object we have in view is to feed the pulp (from the crushers, or stamps) in equal quantities, as near as may be, to each of the receiving compartments and in such manner as to facilitate rather than to disturb the process of stratification, and this we effect by the use of an equalizing trough discharging at each end upon perforated divider plates horizontally located just above the contents of the receiving compartments, and at the extreme rear ends thereof, which combination, or its equivalent, embodies the fourth feature of our invention.

The fifth object we have in view is to set up, in the suspended portion of the machine, a substantially invisible tremulous vibration, as nearly as possible analogous to musical vibration, and this we effect by the arrangement of a very rigid, coiled spring underneath the tray, whose straining wires pass under lugs cast upon the bottom of the tray, and which are adjustably secured to the ends of the tray, thus converting the tray bottom into a species of sounding-board, which, or its equivalent, embodies the fifth feature of our invention.

The sixth object of our invention is to leave the suspended tray free as possible, from all connection with the actuating mechanism, and which we effect by communicating the motion of the cam to the tray, by means of a parallel bar extending from the cam to the forward, oscillating support; said bar being carried upon links in such manner that the free end of said bar having contact with an arc upon the outer surface of the oscillating supporting bar, is susceptible of vertical adjustment for the purpose of varying the throw of the tray.

There are other minor features of invention, embodying special construction and particular combinations, all as will hereinafter more fully appear.

Our invention consists in features of novelty hereinafter fully described and pointed out in the claims.

Figure I is a top or plan view of a concentrator embodying our invention. Fig. II is an enlarged cross section, taken on line II—II, Fig. VI. Fig. III is a cross-section, taken on line III—III, Fig. I. Fig. IV is a similar view, taken on line IV—IV, Fig. I. Fig. V is an end view. Fig. VI is a side elevation. Fig. VII is a vertical, longitudinal section, taken on line VII—VII, Fig. I. Fig. VIII is a transverse section of one of the water tubes or pipes, the section being taken on line VIII—VIII, Fig. IX. Fig. IX is a detail, longitudinal section of one of the water pipes taken on line IX—IX, Fig. VIII. Fig. X is an end view of the roller against which the cam bears. Fig. XI is a section taken on line XI—XI, Fig. X. Fig. XII is an enlarged, detail section, taken on line XII—XII, Fig. I. Fig. XIII is an enlarged, perspective view of one of the feed trough supports.

We will now proceed to describe our invention with reference to the drawings, so that others skilled in the art to which it appertains, may apply the same.

1 represents the main, longitudinal timbers of the frame of the machine.

2 are the lower and 3 the upper cross timbers of the frame, which are recessed into the longitudinal timbers and properly secured thereto by suitable bolts, and the upper cross timbers 3 are further supported by braces 4.

Upon the forward ends of the timbers 1 is secured a bumper 5, by means of suitable bolts passing through the timbers and through the flanges 6 of the bumper, as shown in Fig. VI.

7 represents the main shaft of the machine, which is journaled in boxes 8, secured to the flanges 6 of the bumper.

On the shaft 7 are mounted the driving pulley 9, and a cam 10, which impart the rearward movement to the tray or pan of the machine.

Near the front end of the machine is a vibrating support 11, mounted upon a rock-shaft 12, to which it is secured. The shaft 12 has bearing in adjustable boxes 13 secured to the timbers 1 by means of bolts 13^a, fitting in slots 13^b in the boxes, to permit the adjustment of the boxes, longitudinally of the machine.

In the enlarged, upper end of the support 11 is a conical socket 14 forming a bearing for the lower end of an adjustable bearing-screw 15, carried by the forward end of the tray or pan 16, (see Fig. VII.) The support 11 sustains this end of the tray or pan, and the tray or pan is preferably provided with a bracket 16^a, against which the upper end of the support bears, as it is moved to vibrate the pan, the bracket serving to remove the strain from the set screw 15.

17 represents standards secured to the timbers 3 at the far end of the machine from the support 11, and which have a series of conical openings 18, as shown in Fig. VII. Upon these standards is swung a hanger composed of vertical bars 19 united by horizontal bolts 20. The hanger has adjustable bearing screws 21 at its upper corners, the conical ends of the screws fitting in the openings 18 in the standards. The hanger is further provided with adjustable bearing screws 22 at its lower corners, and these bearing screws have rounded ends fitting in sockets in the bottom of the tray, as shown at 22^a, Fig. III. This form of compound hanger pivoted on bearing screws, as shown, at its upper corners, and carrying the tray on bearing screws at its lower corners, reduces friction to a minimum, prevents all side motion of the tray, (which would interfere more or less with the stratification of the material in passing through the feeding compartments) thus eliminating the use of side guides, as used in some machines, and also furnishes a ready and convenient method of leveling the tray and distributer trough sidewise of the machine, as well as for varying the inclination of the tray, longitudinally of the machine. The tray 16 thus rests upon a tripod support, and has at all times, and under all circumstances, a firm bearing at each of the three points, thus preventing all rocking or jarring in the bearings. The form of this hanger, and the method of adjusting its pivotal points longitudinally of the machine, so as to modify its arcs of travel, and thereby the toss of the tail or rear end of the tray, can be changed and modified in many ways, without changing the effects produced; hence we do not confine ourselves to the particular construction shown.

23 represents a rock-shaft or rod journaled to the timbers 1, and which, as shown in Fig. VII, is provided with a fixed arm 24, and a vertical loose arm 25. Projecting upwardly from the arm 24 is a pivoted link 26.

27 is a push-bar having pivotal connection with and carried upon the upper free ends of the arm 25, and link 26, formed at each end to receive the anti-friction rollers 28 and 30 which roller 28 bears against an arc on the outer face of the vibrating support 11, and the roller 30 bears against and is actuated by the cam 10. These rollers 28 and 30 may be provided with tires 31, of some elastic material as rubber, (see Figs. X and XI,) so as to cushion the return blow upon the cam as well as to prevent undue wear in transmitting the movement through the above described mechanism from the cam 10 to the vibrating arm 11, by means of which rearward movement is imparted to the tray. It will be understood that as the cam 10 is turned in the direction of the arrow, Fig. VII, the bar 27, which has pivotal connection with the arm 25 and link 26, will be thrust rearward, which movement will be imparted to the vibrating support 11 and tray 16. When the cam leaves the roller, the bar 27, with its connecting parts, is

drawn quickly back by means of a spring 32, and these parts being light in weight, as compared with the tray and its parts, they will be drawn back in advance of the tray, so as not to, in any way, affect either the vibration or return movement of the tray. The rollers above mentioned are introduced simply to reduced friction and consequent wear and consumption of power, but are not absolutely essential to the operation of the parts, and could be dispensed with if desired.

In order to provide for different lengths of movement to the tray, we secure a lever 33 to the shaft or rod 23, (see Fig. VI.) This lever has a slot 34, in which fits a set screw 35, which passes through or into one of the timbers 1. It will be understood that by moving the shaft 23 by means of the lever 33, and holding it to that adjustment, the point of contact between the roller 28 and the support 11 can be changed, as shown by full and dotted lines, Fig. VII, and by moving this point of contact toward the shaft 12, the length of movement of the tray will be increased, and by moving the contact point in the other direction, or farther from the pivotal point, viz: the shaft 12, the length of movement of the tray will be diminished. As hereinafter stated, the cam which actuates this mechanism is constructed with such curve as will produce a retarded, rearward movement, and the object of this special arrangement of cam, push bar and vibrating support, is to enable the operator to vary the stroke of the tray, and at the same time, whether he is using a long, short, or intermediate stroke, have the full effect of the retarded, rearward movement due to the curvature of the face of the cam, from the fact that while the push bar is always moved the same distance, at each revolution of the cam, and over corresponding intervals of space, in the intervals of time due to the shape of the cam, the vibrating support has a variable throw, due to the distance from its pivotal point, of the point of contact between the push-bar and the concave on the outer side of said vibrating support, thus permitting a variation of the lengths of the strokes without any variation in the retarded, rearward movement of the tray, or the relative time occupied thereby, a feature absolutely essential to good results as the relations of the movements to time are exceedingly important.

From the fact that the troughs, conveyers, or spouts conducting the pulp to this class of machines in ore-dressing mills, are almost invariably arranged at the rear of, or across the beds of the machines, as well as that there is generally more or less dripping and slopping from the trays themselves, it will be seen that the location of the actuating mechanism above described is upon that part of the machine farthest removed from danger of injury and undue wear, often caused by the leaking or slopping of pulp or tailings thereupon. When the tray has been forced rearward, as explained, and the cam 10 has left the roller 30, the tray is drawn back against the bumper 5 by means of a spring 36 connected by means of a bracket 37, or otherwise, to the tray, and by means of a bracket 38 or otherwise to the bumper. The spring is provided with an adjusting screw 39, by which its tension may be regulated. The end of the tray which comes in contact with the bumper is preferably covered or faced by a piece of leather or equivalent material, as indicated at 40, Figs. VI and VII, for the purpose of reducing the wear of the bumping surfaces.

To facilitate the precipitation and delivery of the heavier mineralized portion of the pulp over the forward, or head end of the tray or pan, its rearward movement should have the greatest velocity at its initiative and diminish up to the end of its rearward stroke, where it gradually comes to a full stop; then, in the return forward movement, it should have an accelerated motion, until the stroke is arrested by contact with the bumper; and the length of the strokes and the number thereof per minute, should be adjusted, as near as may be to suspend the gangue, or barren matter in the water, at the same time allowing the heavier particles of mineral to settle upon the bottom of the tray and partake of its movements, whereby the travel of the gangue will be due principally to the water currents and the travel of the mineral will be due to the shocks imparted to the tray. The face of the cam 10 is therefore constructed upon such curve as will produce the above described retarded rearward movement of the tray, and as the return forward movement of the tray is produced by the spring 36, this movement is accelerated up to the instant of the shock produced by the impact of the tray against the bumper. As the tray stops against the bumper, the mineral, by reason of its acquired momentum, slides forward upon the tray bottom, and a portion is delivered over the front end thereof. At the beginning of the rearward movement, the tray slides back under the mineral, but owing to its retarded movement and the gentle stop and brief interval of rest at the end of the rearward stroke, the mineral again settles upon the bottom to be again brought forward with newly acquired momentum, by the accelerated movement of the forward stroke, due to the spring 36.

In dressing a lean ore, it is desirable to discharge the gangue over the rear or tail of the tray quite rapidly, and to discharge the mineral over the head of the machine sufficiently slow to maintain a bed of mineral in the central portion of the tray, which shall receive the fine slimed mineral and bring it over the head of the tray; and vice versa, in dressing a very rich ore, or one composed largely of mineral, it is desirable to bring the mineral over the head as rapidly as possible, and to discharge the gangue slowly over the tail, so as to avoid a loss in slimes which would other-

wise occur. Again, in dressing an ore where there is great difference in the specific gravity of the mineral and gangue, (as for instance, a lead sulphide, from a quartz matrix,) the capacity of the machine may be increased by causing it to discharge as rapidly as possible from both ends of the tray.

There is a number of adjustments which are within the knowledge of the skilled operator, and intelligently manipulated tend to produce the above desirable results as for instance, violence of shock, stroke of tray, number of strokes per minute, quantity of water fed with the pulp, quantity of head water used, longitudinal inclination of tray, &c., but there will be found in this machine another adjunct which can be made materially to assist in accomplishing these objects; viz: means for varying the arcs in which the ends of the tray move, during its strokes, and causing the shocks to occur at any desired part of said arcs, which ends are attained by making the journal boxes 13 of the shaft 12, and the upper bearings of the compound hanger 19, adjustable longitudinally, as stated. When it is desired to have the shock occur at the instant the tray is moving as near as may be in a horizontal plane, the journal boxes 13 and the bearing screws 21, should be adjusted as shown in the drawings, so that both the vibrating support 11 and the hanger 19 will be in a vertical position at the end of the forward stroke. When it is desired to have the shock occur while the pan is moving in an upward plane, the journal boxes 13, and the bearing screws 21 should be so adjusted that the vibrating arm 11, and the hanger 19 will be inclined toward the rear or tail of the machine at the end of the forward stroke. When it is desired to have the shock occur when the tray is moving in a downward plane, the journal boxes 13 and the bearing screws 21 should be so adjusted that the vibrating arm 11, and the hanger 19 will incline toward the head end of the machine (or from the tail) at the end of the forward stroke. The greatest tendency of movement toward the head (due to adjustment of arc to shock) is produced when the shock occurs while the tray is moving in an upward plane, the least when it is moving in a downward plane, and the medium effect when it is moving in a horizontal plane. It will be apparent that a cause which will affect the whole tray (as above described) will affect either end thereof. Therefore by so adjusting the vibrating support 11, and hanger 19 that one end will be moving in an upward and the other in a downward plane, at the instant of shock, one in an upward, or downward, and the other in a horizontal plane at the instant of shock, &c., will produce a great variety of new and useful results in the dressing of ores, very essential from the fact that scarcely any two are found to be exactly alike. For convenience of expression, we will call these adjustable movements, the "toss" of the tray.

We are aware that conveyers have been constructed on this tossing principle, as also that it enters into the results produced by many of the belt machines and percussion tables in and out of use; but we are not aware that this principle has before received the attention it merits, and means provided in a concentrating machine, whereby the beneficial effects arising from this cause may be taken advantage of, and the injurious effects avoided. In all cases where a concentrating machine is supported upon vibrating supports, or suspended upon hangers, so that the movement of any part of the concentrating surface is in an arc or arcs of a circle, this cause is producing effects, either beneficial, or injurious. An arc which would be beneficial in the treatment of one ore, (of say a rich lead sulphide) would be very detrimental in the treatment of another ore, (say a lean, zinc blende,) hence the importance of this principle being studied and understood and adjustments being provided in concentrating machines, by means of which its benefits may be gained, and its injurious effects avoided.

The concentrating pan or tray 16 may be of cast metal, or constructed with a wooden frame, having a sheet metal bottom. It has a slightly inclined bottom portion from A to B, and a substantially or approximately level bottom portion extending from B to the end C. When the pan is made of cast metal, it has bolted to its forward end a cross-beam 42 for receiving the impact of the bumper 5. The tray has sides 43 projecting a short distance above the bottom, and it has one or more longitudinal partitions 44, placed substantially in line with the main to and fro movement of the tray which sides and partitions with the ends 45 form a compartment or compartments 46 in the rear end of the pan, which compartments receive the pulp as it is fed from the distributer trough 47. The partitions 44 extend substantially half way from the rear toward the front end of the pan or tray, as shown in Fig. I.

In all the belt machines and percussion tables of which we have any knowledge, the pulp is fed onto the belt or table a short distance below the head end thereof, from distributer boxes or troughs, in a series of streams, or a thin sheet, and to this cause alone, more than to any other, is due a very large per cent. of the loss of mineral in the tailings from such machines. The loss due to this cause has been observed, discussed and deprecated, but up to the present no way of overcoming the difficulty has been devised.

The heaviest bed of mineral, on all this class of machines, when in operation, will be found a short distance below where the dressing water is applied; in fact, almost exactly where the streams of fresh pulp, (mineral, gangue and water) are being fed. The inevitable effect is, that this bed of mineral, which the machine is struggling to carry over the head, is torn up, its stratification in great

measure destroyed, and its constituents (principally mineral), are thereby washed toward the tail to be again precipitated or stratified, and again brought forward to again run the gauntlet of this pernicious down pour of the fresh pulp being fed to the machines. Such particles as pass between these streams of pulp, are carried over the head; but a large percentage of those that encounter these streams, are carried over the tail with the waste, and are lost. This is especially true of the more minute particles of mineral. We overcome this difficulty entirely, by introducing these feed compartments, wherein the mineral is thoroughly stratified before it enters the main tray. They not only serve as feeding channels, but as stratifying compartments, and render the full length of the tray available for precipitation, stratification and hence recovering the mineral constituents of the pulp, conditions which we do not know to exist in any other device.

The prime object is to deliver the pulp into the main tray, with the mineral at the bottom, and the gangue as near as may be, in suspension in the water. This result is facilitated by the form of the compartments, the bottom being curved upwardly at the rear; and the outer side and partition forming the inner side, being substantially in line with the reciprocating movement of the tray; as well as by the fact that the entire mass moves in one direction, (toward the head,) while passing through these compartments, thus having less tendency to roll and mix, than where the bottom material is moving toward the head and the surface toward the tail.

Another point of superiority lies in the fact that while in the other machines, with which comparison is being made,—the mineral must be carried forward directly against, or in opposition to the current formed by the water of the pulp, as well as the dressing water, in this device, it is thrown off and out of the outer side, of a stream moving in a semi-circle, as the current is reversed in turning from the feeding and stratifying compartments, into the tailings channel between them. The difference between rowing a boat at right angles, or in opposition to the current of a river, furnishes a good illustration of the principle here involved. The suspended, and partially suspended gangue, turns about in the opposite direction, and goes over the tail readily with the water, but the mineral leaves the gangue where the current is turned about from the stratifying, feeding channel, into the tail sluice; and from this point, to and over the head of the tray, encounters no obstacle to its forward progress, except the head or dressing water, the volume of which is so adjusted by the cocks, as to hold back only gangue matter, and to deliver the mineral, thoroughly cleaned, over the head of the tray. The trough 47 delivers the pulp onto perforated plates or dividers 48, (one of these plates is removed from Fig. I,) which are supported at the corners on lugs 49 on the sides 43 and partitions 44, and on the ends 45 of the tray, (see Fig. I.) The perforated plates are supported slightly above the surface of pulp in the pan, as shown in Fig. XII. The purpose of these perforated divider plates 48, is to subdivide the streams of pulp flowing from the passages 52, of the distributer trough 47 into a great number of minute streams, or drops; as a shower, falling the shortest possible distance, upon the surface of the pulp, at the rear end of the feeding channel 46, in such manner as to interfere as little as possible with the process of stratification going on underneath said plates, in the rearward portion of the feeding channels, or compartments 46. As the drops of pulp fall through these plates into the water, in the compartments below, their mineral constituents sink at once to the bottom, while the gangue remains in suspension, thus making these plates a most important adjunct to that perfection of stratification so necessary to close work.

The distributing trough 47 is preferably formed with a rounded bottom, as shown in Figs. VI and VII, and it is supported by saddles or plates 49, notched into the partitions 44, see Figs. III and XIII. As shown in Fig. II the trough is provided with low strips 50, at its bottom, a short distance back from its ends, over which the pulp has to pass: these strips serving to contain a small portion of pulp in the bottom of the trough, over which the pulp is caused to move. The extreme ends of the trough are preferably bridged by strips 51 beneath which are the passages 52, through which the pulp is discharged from the trough. The trough is held on the saddles 49 by being riveted thereto, and is held to the tray by means of bolts 53 which pass through the trough, through the saddle and through the bottom of the tray, as shown in Fig. II.

54 represents the chute or spout through which the pulp is delivered into the trough 47.

55 represents an adjustable tail-board secured to the rear end of the tray between the partitions 44, (see Figs. I and VII.) This tail-board does not extend as high as the partitions and it may be held in place by wedges 56 or by other suitable means. The purpose of this adjustable tail board, is to control at will the depth of the material under treatment in the tray, thereby, among other things, controlling the velocity of the flow around the forward ends of the partitions 44, and through the tailings channel between them, as well as to modify such currents in the central portion of the tray. This adjustment is very important as in combination with volume of water, inclination of tray, and intensity of shock, it enables the operator to save a much larger percentage of mineral than he could otherwise do.

57 is a trough secured to the timbers 1, for the purpose of receiving the tailings as they drop from the pan.

58 represents one or more water pipes, (we have shown three,) arranged transversely over the pan or tray, and which are fed from the main pipe 59, through connections 60, provided with valves 61. The connections 60 are preferably made of flexible material, such as hose, so as to avoid the necessity of an accurate fitting, and adjustment of the parts. The pipe or pipes 58 are supported over one of the cross-pieces 3, secured to the timbers 1, by means of standards 63 having upper set screws 64, the ends of which impinge against a form of clamp 66, which is made to embrace the pipes, as shown in Figs. I, VI and VII, and a lower set screw 65, the upper end of which enters a socket 62 cast in the lower side of the clamp (66) for the purpose of retaining said clamp in the position shown. By means of these set-screws 64 and 65, the pipes 58 may be properly leveled so as to deliver the water equally from side to side, across the head of the tray. The pipes are arranged over the forward end of the tray, and they are provided with a series of perforations fitted with valves 67 fitting in the perforations at the top of the pipes, and the stems 68 of which extend through the perforations in the bottom of the pipes, and extend beneath the pipes, as shown in Figs. VIII and IX. Wire nails answer very well for these valves, the openings or perforations in the top of the pipes being counter sunk to receive the heads of the nails or valves, and the openings in the bottom of the pipes being larger than the stems 68, so as to permit the water to escape from the perforations around the stems. The stems are preferably pointed at their lower ends. The water from the pipes slowly passes through the lower perforations, and drips from the lower ends of the valve stems into the head of the tray, and should the valves or any part of them become clogged and retard the passage of the water, an increased pressure turned on through the cocks 61, for a short interval, will lift the valves by pressure from their seats, and cause their stems to move vertically, and thus any clogging that may occur is very readily and quickly removed.

70 represents a heavy, coiled spring secured beneath the bottom of the tray by means of adjustable rods 71. The rods 71 pass beneath ribs or bridge-pieces 72, secured to or formed upon the bottom of the tray, and the ends of the adjustable rods are held by projections 73 on the bottom of the tray. This spring 70, with the described manner of arranging it, causes a substantially invisible and tremulous vibration of the tray, as it is oscillated, this vibration being analogous to the vibration of the sounding-board of a musical instrument, and by adjusting the rods 71, the tension of the spring can be regulated to produce stronger or weaker vibrations, at will.

80 represents a deflector, upon which the mineral that is delivered over the head of the machine falls, and is conducted to either side of the timbers 1, see Fig. IV. As shown in Fig. VII, the forward end of this deflector has an up-turned flange 81, to prevent any portion of the mineral falling over this end of the deflector, and coming in contact with any part of the working mechanism, which imparts the rearward movement to the pan or tray.

The operation of our improved machine is as follows: The proper tension having been given the springs 32, 36, and 70, as near as may be, the cocks or valves 61 are slightly opened, and the machine is set in motion, and the pulp from the crushing machine is turned into the distributer trough 47. The adjustment of the springs and the speed with which the shaft 7 is turned, together with the amount of water admitted through the valves 61, are within the knowledge of a skilled operator, who can now re-adjust the parts to exactly meet the requirements of the ore being treated. While the tray is being vibrated upon its tripod support, which prevents rocking or jarring, and permits only longitudinal movement, the effect is to suspend the gangue in the water, while the mineral settles upon the bottom of the tray and partakes of the motion of the tray, in which it is materially assisted by the sounding-board-like vibrations of the tray produced by the action of the spring 70, so that by the time the pulp leaves the compartments 46, it is in a stratified condition. The water and suspended gangue then turn first toward the center, as they pass the ends of the partitions 44, and then turn toward the rear of the pan, as shown by the half-feathered arrows, and finally pass off through the tailings channel between the partitions over the adjustable tail-piece 55, while the mineral, being acted upon, principally by the shocks, owing to the fact of its being heavier and nearer the bottom, or upon the bottom of the tray, with nothing but the required dressing water opposed to its progress is carried to and over the head of the tray, as shown by the full arrows, Fig. I, and any heavier pieces or particles of gangue which might otherwise be discharged over the head with the mineral, are washed back by the dressing water dripping from the pipes 58, and as the quantity or volume of this water is under absolute control, and is distributed uniformly over the head of the pan, this portion of the work can be rendered almost absolutely perfect.

The method of introducing the pulp into the rear ends of the compartments 46, through the perforated plates 48, and causing it to move forward until it passes the ends of the partitions 44, facilitates stratification, and the fact that all the constituents of the pulp move simultaneously toward the head of the machine, through the compartments 46, together with the fact that in no part of the operation

is there anything to disturb the stratification, while the pulp is passing through these compartments, renders the operation of a clean separation of mineral and gangue as nearly perfect as may be, and at the same time gives a very large capacity for work in proportion to the size of the machine, and the consumption of water and power, both of which are by these means reduced to a minimum.

We claim as our invention—

1. In an ore concentrator, the combination of a tray, mechanism for moving the tray, and means for depositing the ore onto the tray; said tray having one or more longitudinal partitions extending part way of its length to form feeding channels approximately in line with the longitudinal, reciprocating movements of the tray, substantially as and for the purpose set forth.

2. In an ore concentrator, the combination of a tray, mechanism for agitating the tray, and means for depositing the ore onto the tray; said tray having one or more partitions extending from its rear end forwardly, part way of the length of the tray approximately in line with its to and fro movement; substantially as and for the purpose set forth.

3. In an ore concentrator, a tray having parallel sides and provided with a partition extending part way of the length of the tray, approximately parallel with the sides of the tray, and forming a compartment through which the material is caused to pass; substantially as set forth.

4. In an ore concentrator, a tray having a partition extending part way of the length of the tray, forming a compartment, through which the material has to pass, and a perforated divider plate located at the inner end of said compartment, substantially as and for the purpose set forth.

5. In an ore concentrator, a tray having parallel sides and a pair of partitions extending part way of the length of the tray, around the ends of which the tailings have to pass, and forming stratifying compartments through which the pulp has to pass, and a channel between them through which the tailings flow in an opposite direction over the rear end of the tray; substantially as and for the purpose set forth.

6. In an ore concentrator, a tray having parallel sides and a pair of parallel partitions extending part way of the length of the tray, and forming compartments through which the material has to pass, and a central space through which the tailings pass, and divider plates located at the inner ends of said compartments; substantially as and for the purpose set forth.

7. In an ore concentrator, a tray provided with a pair of parallel partitions extending part way of the length of the tray, and forming side compartments through which the material has to pass, and a central passage for the tailings, and an adjustable tail-board located at the end of said central passage; substantially as and for the purpose set forth.

8. In an ore concentrator, the combination of a tray having side feed compartments extending part way of the length of the tray, and a distributer trough located over the tray, and adapted to deliver the material into said compartments; substantially as and for the purpose set forth.

9. In an ore concentrator, the combination of a tray having side feed compartments extending part way of the length of the tray, perforated divider plates located in said feed compartments, and a distributer trough located over said tray, for delivering the material onto said divider plates; substantially as and for the purpose set forth.

10. In an ore concentrator, the combination of a tray having side feed compartments, divider plates located in said feed compartments, a trough located over said tray for delivering the material onto said divider plates and means for imparting movement to said tray, and trough, to cause the material to pass from the trough onto said divider plates, and to cause it to pass through said divider plates and compartments; substantially as and for the purpose set forth.

11. In an ore concentrator, the combination of a tray, a trough having a discharge opening in each end and located over the tray, and stay ribs or strips located in said trough, a distance from the ends thereof; substantially as and for the purpose set forth.

12. In an ore concentrator, the combination of a tray, a trough having a discharge opening in each end thereof and arranged over the tray, saddles upon which the trough rests, and bolts passing through the tray, saddles and trough, substantially as and for the purpose set forth.

13. In an ore concentrator, the combination of a tray having an attached distributing trough, and longitudinal feed compartments, extending part way of the length of the tray, and a compound hanger adapted to facilitate the leveling of the distributing trough and the longitudinal inclination of the tray, substantially as and for the purpose set forth.

14. In an ore concentrator, the combination of a tray, and a tripod supporting the tray on adjustable points, all the pivotal points of said tripod support, being adjustable as to position, longitudinally of the tray, or machine, substantially as and for the purpose set forth.

15. In an ore concentrator, the combination of a tray, a support having a longitudinally adjustable pivot, sustaining one end of the tray, and through which variable stroke is imparted to the tray, a set screw fitting in a socket in the upper end of said support, and holding the tray thereon, and a hanger or hangers supporting the other end of the tray,

having its pivotal points adjustable longitudinally of the machine, substantially as and for the purpose set forth.

16. In an ore concentrator, the combination of a tray, a support upon which one end of the tray is mounted, means for sustaining the other end of the tray, a means for imparting a variable stroke to the tray; said support being mounted on a movable shaft or pivot, carried in bearings adapted to be adjusted longitudinally of the machine; substantially as and for the purpose set forth.

17. In an ore concentrator, the combination of a tray, a single support and set screw sustaining one end of the tray, and a compound hanger and set screws forming a double support for the other end of the tray said hanger and support being pivoted upon longitudinally adjustable bearings; substantially as and for the purpose set forth.

18. In an ore concentrator, the combination of a tray, a support sustaining the tray at one end, and a compound hanger and standards supporting the other end of the tray; said hanger having set screws adapted to fit in openings in said standards, and having set screws at its lower corners adapted to bear in inverted sockets upon the bottom of the tray the pivotal points of said support and hanger being adjustable longitudinally of the machines; substantially as and for the purpose set forth.

19. In an ore concentrator, the combination of a tray, a support sustaining one end of the tray, a compound hanger sustaining the other end of the tray, a push-bar adapted to bear against said support, and provided with friction rollers, a cam for moving said push-bar, a rock-shaft, arms on the rock-shaft, and a link connecting said push-bar to one of said arms; substantially as and for the purpose set forth.

20. In an ore concentrator, the combination of a tray, and means for moving the tray, consisting essentially of a shaft, an arm on the shaft, a push-bar, a link connecting said arm to said push-bar, a cam for engaging the push bar, and an adjustable lever secured to said shaft; substantially as and for the purpose set forth.

21. In an ore concentrator, the combination of a percussion tray, a specially formed cam for imparting movement of a certain character to the tray, a vibrating arm supporting one end of the tray, a push bar located between said arm and said cam and having means for holding it normally against the cam, and mechanism for changing the point of contact between said bar and arm, whereby the character of the movement remains unchanged while the degree of movement is regulated at will, substantially as and for the purpose set forth.

22. In an ore concentrator, the combination of a percussion tray, a specially formed cam for moving the tray, a push bar located between the cam and tray, and held normally in contact with both at the commencement of movement, and means for adjusting the inner end of said push bar; substantially as and for the purpose set forth.

23. In an ore concentrator, the combination of a tray, a cam formed with a sudden initial pitch and gradually decreasing pitch toward the apex, a push bar having means for holding it constantly against the cam, and a vibrating arm in constant contact with said push bar, except during forward movement, said parts co-acting to produce a rearward movement to the tray from the entire face of the cam, a spring to produce forward movement and means for adjusting the free end of said push-bar; substantially as and for the purpose set forth.

24. In an ore concentrator, the combination of a percussion tray, a cam for moving the tray, and mechanism located between the cam and the tray, for the purpose of imparting a longer or shorter stroke to the tray, without using less than the full stroke of the cam; said mechanism consisting essentially of a vibrating arm, a push bar located between said arm and said cam, and kept in constant contact with the cam and arm, except when receding from the latter and mechanism for changing the point of contact between said bar and arm; substantially as set forth.

25. In an ore concentrator, the combination of a tray, a vibrating arm for actuating the tray, a bar for actuating the arm, a cam having its face formed to impart a special movement to the bar, and means for keeping the bar constantly against the cam, means for adjusting the point of bearing between the bar and arm without separating them so as thereby to vary the strokes of the tray without changing the time in which said longer or shorter strokes are made and to cause the tray to receive rearward movement from all parts of the cam; substantially as and for the purpose set forth.

26. In an ore concentrator, the combination of a tray, perforated water pipes located over the tray and valves fitting in the perforations of the pipes, and having stems extending beneath the pipes; said stems being smaller than the perforations in the bottoms of the pipes, to permit the water to pass through said perforations, and drip from the stems; substantially as and for the purpose set forth.

27. In an ore concentrator, the combination of a tray, water pipes located over the tray, and having perforations therethrough, and vertically movable valves fitting in said perforations, and adapted to deliver the water from the pipes into the tray; substantially as and for the purpose set forth.

28. In an ore concentrator, the combination of a tray, pipes located over the tray, a clamp holding the pipes and brackets provided with set-screws engaging said clamps; said pipes

being formed with perforations and provided with valves, substantially as and for the purpose set forth.

29. In an ore concentrator, the combination of a tray, and a spring stretched along the bottom of the tray and connected at both ends to the tray; substantially as and for the purpose set forth.

30. In an ore concentrator, the combination of a tray, and a spring stretched along the bottom of the tray over bridge-pieces and attached at both ends to the tray, substantially as and for the purpose set forth.

31. In an ore concentrator, the combination of a tray, and a spring adjustably stretched along the bottom of the tray, over bridge-pieces and connected at both ends to the tray; substantially as and for the purpose set forth.

WILLIAM L. CARD.
FRANK. S. CARD.

In presence of—
E. S. KNIGHT,
ALBERT M. EBERSOLE.