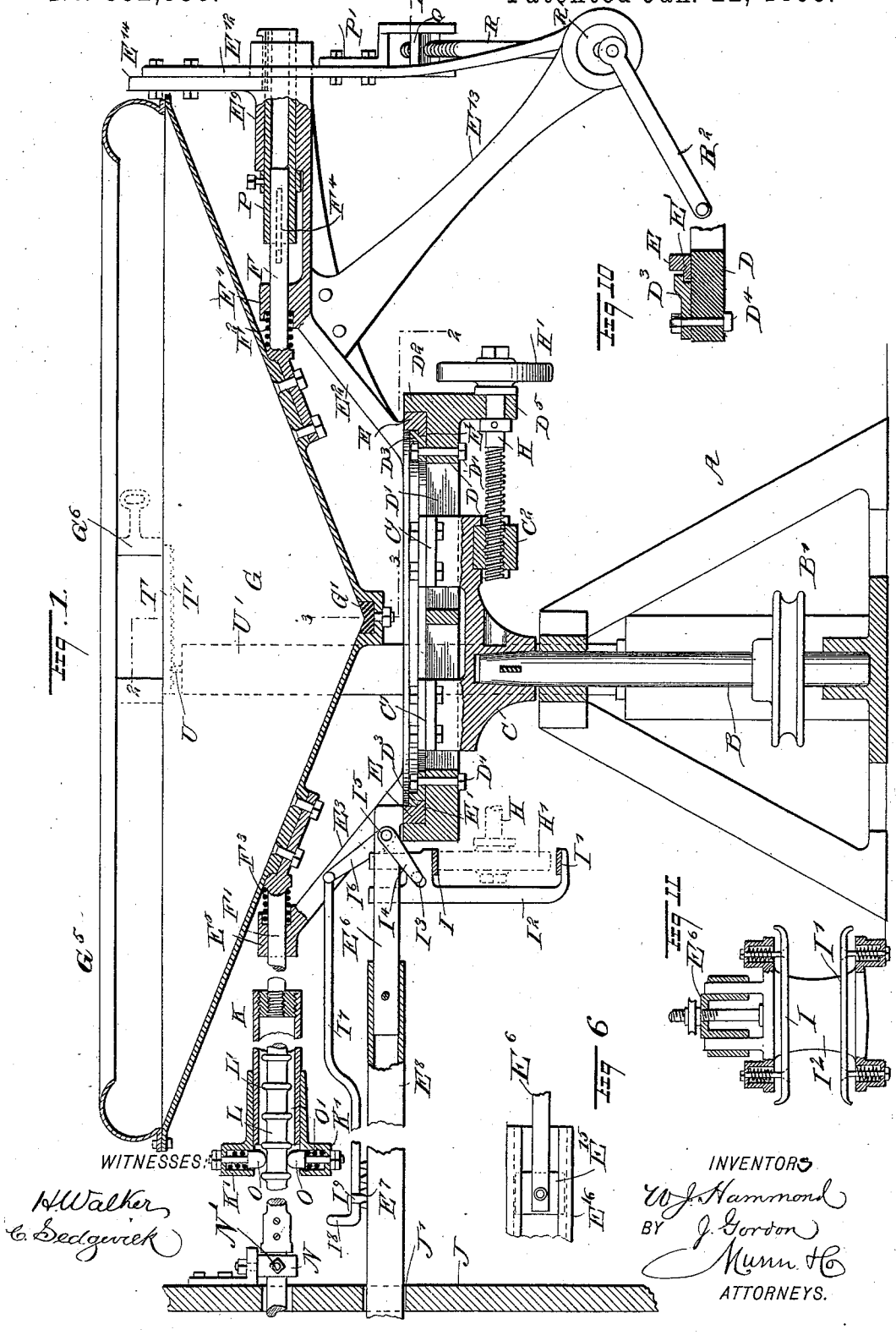
(No Model.) 3 Sheets—Sheet 1.

# W. J. HAMMOND & J. GORDON.

## MEANS FOR CONCENTRATING ORES OR OTHER SUBSTANCES.

No. 532,956. Patented Jan. 22, 1895.



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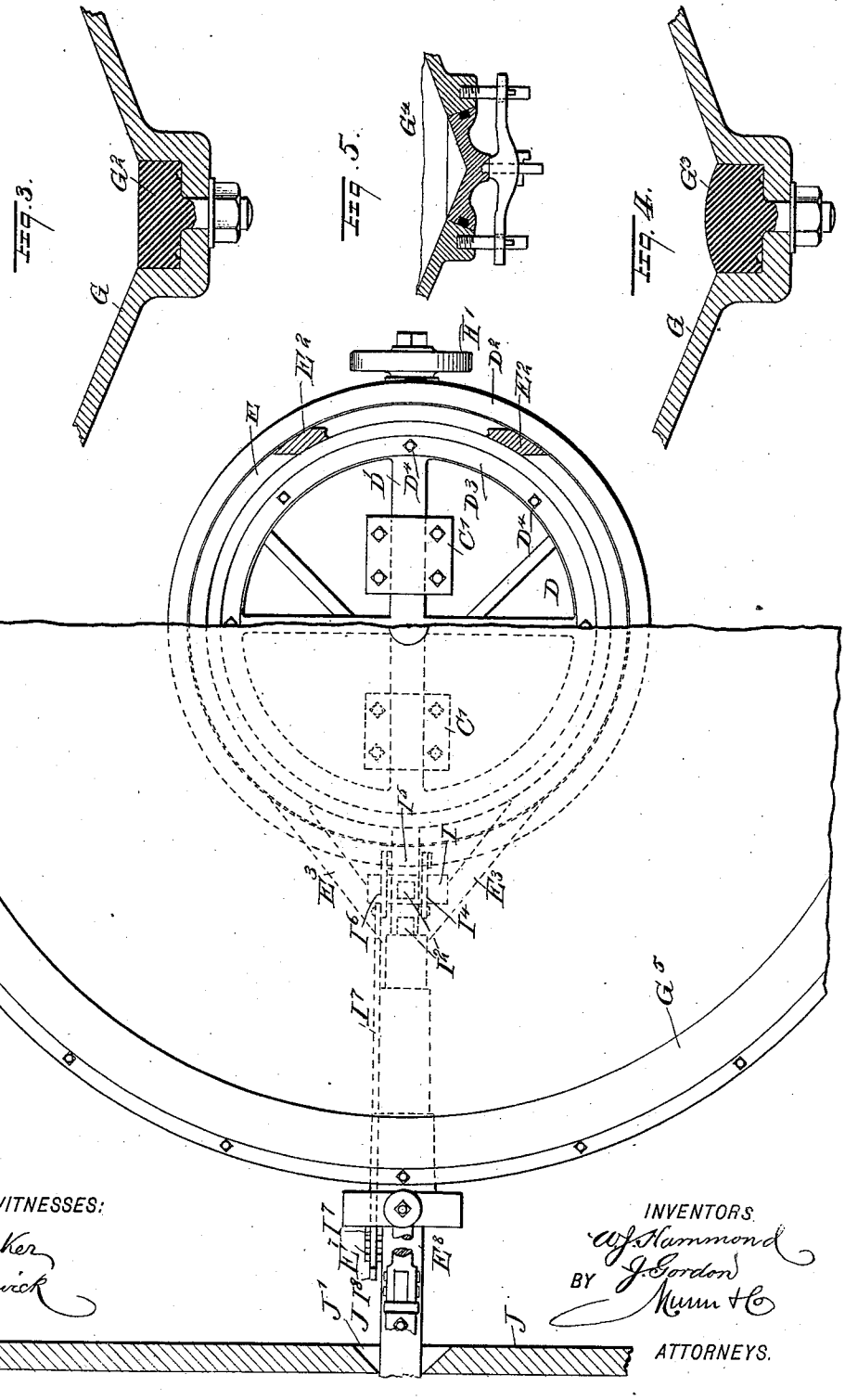

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Fig. 7.

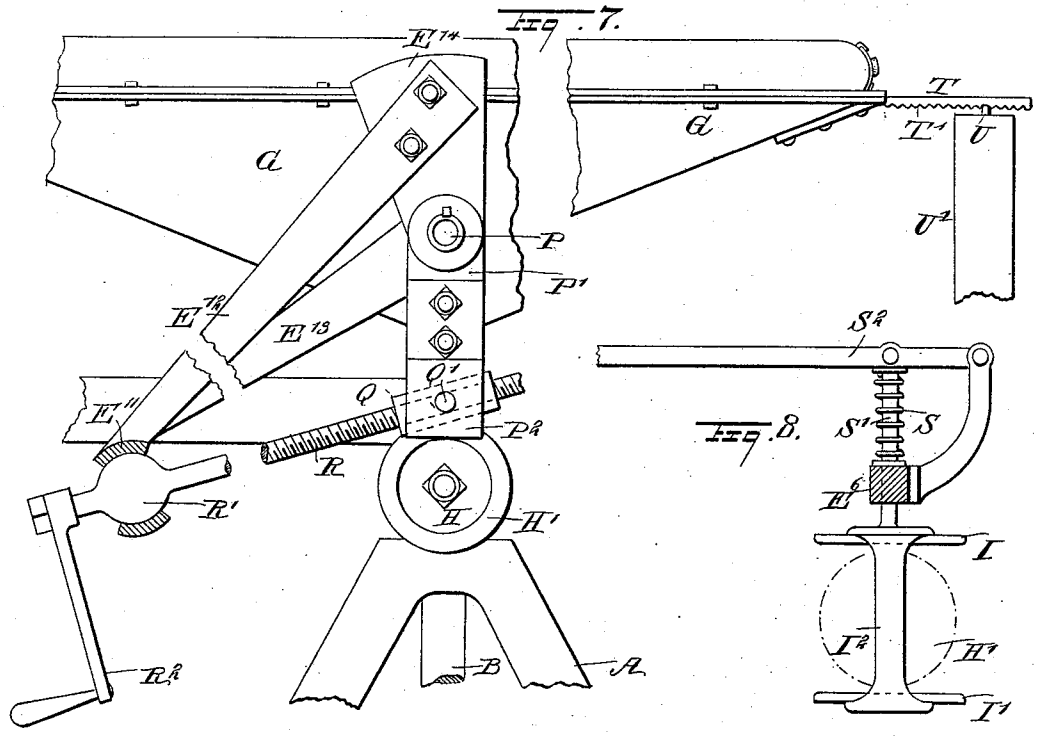
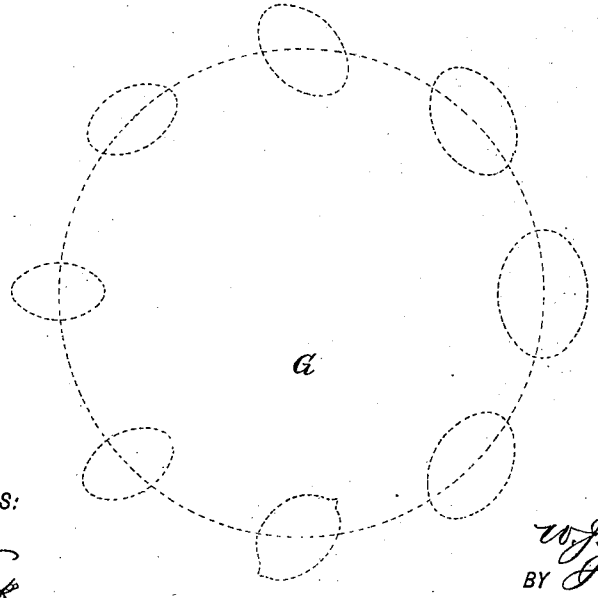



Fig. 8.




Fig. 9.

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# UNITED STATES PATENT OFFICE.

WALTER JOHN HAMMOND, OF LONDON, ENGLAND, AND JOHN GORDON, OF RIO JANEIRO, BRAZIL.

## MEANS FOR CONCENTRATING ORES OR OTHER SUBSTANCES.

SPECIFICATION forming part of Letters Patent No. 532,956, dated January 22, 1895.

Application filed December 12, 1893. Serial No. 493,499. (No model.)

*To all whom it may concern:*

Be it known that we, WALTER JOHN HAMMOND, a subject of the Queen of Great Britain, residing at London, England, and JOHN GORDON, a citizen of the United States, residing at Rio de Janeiro, Brazil, have invented a new and Improved Means for Concentrating Ores or other Substances, of which the following is a full, clear, and exact description.

The invention relates to concentrators such as shown and described in the Letters Patent of the United States, No. 450,013, granted to us April 7, 1891.

The object of the present invention is to provide a new and improved apparatus for mechanically separating lighter and heavier particles of ore and other substances, in the same manner as is now done by a skilled hand in "panning."

The apparatus consists principally of a vessel preferably made conical and mechanism for imparting to it a varying motion around a fixed center and an oscillating motion around its own center, the latter being eccentric to the center of the reciprocal motion.

The invention also consists of certain parts and details and combinations of the same, as as will be hereinafter described and then pointed out in the claims.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar letters of reference indicate corresponding parts in all the figures.

Figure 1 is a sectional side elevation of the improvement. Fig. 2 is a plan view of the same with parts in section on the line 2—2 of Fig. 1. Fig. 3 is an enlarged sectional plan view of a modified form of the apex of the conical vessel, the section being taken on the line 3—3 of Fig. 1. Fig. 4 is a similar view of another modified form of the same. Fig. 5 is a like view of another form of the same. Fig. 6 is a plan view of a modified form of bearing for the handle of the pan. Fig. 7 is an enlarged side elevation, with part in section, of the tilting mechanism. Fig. 8 is a sectional side elevation of a modified form of the device for varying the throw of the vessel. Fig. 9 is a diagrammatical view of the motion of the vessel. Fig. 10 is a sectional side elevation of a modified form of ring; and Fig. 11 is a side elevation of a modified form of shoe.

In order fully to understand the method which is carried out by means of our improved apparatus, it is necessary to state the principles on which the invention is based. As is well known, heavy materials which will sink in water when the latter is at rest, will float in and be carried by the same water when it is in motion. If this motion is slow, only light substances will be lifted and carried, and if the motion is rapid, heavier materials will be caught up. In fact, there is a direct relation between the specific gravity of a body and velocity required to lift and carry it. In consequence of this relation, if a mixture of substances of different specific gravities be put into a fluid, say water, to which is gradually imparted an increasing velocity, then the fluid will begin by picking up the lighter particles first and then, as the velocity increases, the heavier particles in regular order, until finally, if a high enough velocity is given, all the particles, light and heavy, will be kept in suspension. If now the velocity is slowly diminished, the particles will begin to deposit themselves, but in a reverse order; that is to say, the heavier particles will come down first, the lighter settling the last of all.

If at any time the velocity is allowed to continue constant, a certain part of the substances will be deposited and the rest will remain indefinitely in suspension; that is, so long as the velocity remains constant, so long will the bodies held up continue in suspension. It is therefore evident that to effect a separation of the mixed bodies it is only necessary to increase the velocity until all are in suspension and then to decrease it again, stopping the change at that point when the lighest particles only are suspended, then removing these lightest particles, repeating the operation to get rid of or to eliminate the next lightest, and so on, until finally the heaviest particles remain alone.

The operation is greatly facilitated by giving little shakes or jigs to the mass of water and suspended material, or by suddenly and temporarily checking the motion of the water, not only because such jigs by momentarily changing the velocity of the fluid produce in

a minor degree the same effects as the more apparent changes of motion described above, but also because they help to prevent the accumulation of particles into lumps and groups, enabling the individual particle to free itself from contact with others and so follow freely in its own course. For example, a heavy particle may be prevented from falling by a number of light ones adhering to it, while a light particle may be held down in a similar manner by heavier ones. A quick jerk or jig frees them all, and it is evident that as in the process of sifting any material, the more varied the jigs or jerks are in force and direction, the more quickly and easily will the particles be freed from each other.

In order to obtain the above described result and to carry the method into effect, we provide the apparatus shown in the drawings and presently to be described.

The concentrator is provided with a suitably constructed frame A, on which is journaled in suitable bearings and steps the vertically disposed shaft B provided with a pulley B′ connected by a belt with suitable machinery for imparting a rotary motion to the said shaft B, the motion being preferably varying in speed. It is understood however that other suitable means may be employed for imparting a rotary motion of any kind to the shaft. On the upper end of the shaft B is secured a socket C, provided with two bearings C′, in which is fitted to slide the diametrical arm or spoke D′ of a wheel D, disposed horizontally and carrying on the upper surface of its rim a ring E, provided with an inwardly-extending flange E′, engaged by a flanged ring $D^3$, bolted or otherwise secured to the rim of the wheel D, as is plainly illustrated in Figs. 1 and 2. The outermost face of the ring E abuts on an annular flange $D^2$, formed on the rim of the wheel D, so that the ring E is free to turn on the rim of the wheel D, but is prevented by its flange E′ engaged by the flanged ring $D^3$ from moving upward out of its bearing. If desired, the flange E′ may be formed exteriorly as shown in Fig. 10.

From opposing sides of the ring E extend upward and outward, the brackets $E^2$ and $E^3$, provided with bearings $E^4$ and $E^5$ respectively, in which are mounted to turn the trunnions F and F′ respectively, bolted or otherwise secured to the outer face of the vessel G, preferably made conical in shape as is plainly illustrated in Fig. 1, the apex of the vessel being in vertical alignment with the center of the ring E. The ring E is provided with a handle $E^6$ having an extension $E^8$ extending outwardly parallel to and below the trunnion F′, as will be readily understood by reference to Fig. 1. The apex of the vessel G is preferably made in the shape of a block, having either the form shown in Fig. 1, or that, $G^2$ or $G^3$, shown in Figs. 3 and 4. The block G′, has a conical recess, while the block $G^2$ is straight, and the block $G^3$, convexed, on its upper surface. Each of the blocks is secured in place by a bolt and nut, as is plainly shown in the said figures, and the varying forms are necessary according to the material to be treated.

As illustrated in Fig. 5, the apex $G^4$ is exteriorly removable so that the concentrates accumulating in the apex of the pan, can from time to time be removed without disturbing the other solid matter in the other part of the pan. The base or top of the vessel G is preferably provided with a separate and upwardly and inwardly curved annular rim $G^5$, to prevent splashing of the material under treatment over the upper edge of the vessel. In this rim $G^5$ is arranged a gate $G^6$, of any approved construction and serving to discharge part of the contents of the vessel when the latter is tilted as hereinafter more fully described.

From the under side of the rim of the wheel D depends a bracket $D^5$, in which is journaled a screw rod H, directly under and parallel to the arm D′, said screw being provided on its outer end with a wheel H′, and having its inner, threaded end screwing in a nut $C^2$ attached to one of the bearings C′ of the socket C. Now, by turning the wheel H′ in one direction the wheel D, and consequently the ring E and vessel G, are caused to slide inward, as the arm D′ is fitted to slide in the bearings C′ of the socket C. By turning the wheel H′ in the other direction the said wheel D is fitted to slide in the opposite direction, carrying the ring E and the vessel G with it. The screw rod H is located directly under the arm D′, so that the center of the wheel D may be made to coincide with the shaft B if desired, but in order to successfully operate the machine the center of the wheel D must be held eccentric to the shaft B.

In order to automatically impart the forward and backward motion to the wheel H′ above described, to move the center of the wheel D nearer to or farther from the center of the shaft B, the following device is provided. On the handle $E^6$ extending from the ring E is fitted to slide vertically a frame $I^2$, provided with brake or friction shoes I and I′, located opposite each other and arranged in such manner as to engage either the top or bottom of the wheel H′ on each revolution of the shaft B, whenever the said wheel passes between the said shoes.

By shifting the frame $I^2$ downward into the position shown in Fig. 1, the shoe I will be engaged by the wheel H′, as the latter passes between the two shoes, but the lowermost shoe I′ will then be out of contact with the said wheel, and consequently the latter is turned in one direction as long as it is in contact with and rolls off on the upper shoe I. Now, when the frame $I^2$ is moved upward, then the wheel H′, in passing between the brake shoes, will roll off on the brake shoe I′ and be out of contact with the brake shoe I, and as the said brake shoe I′ engages the wheel H′ at the bottom, the said wheel will be

turned in an opposite direction. If desired, the frame $I^2$ may be moved into an intermediate position, so that the wheel H′ will engage neither of the shoes I nor I′ and no feeding of the screw H in either direction will take place, but the said screw will remain at a standstill.

In order to shift the frame $I^2$ in the manner above described, the said frame is provided with an elongated aperture $I^3$ engaged by a pin on an arm $I^4$ held on a shaft $I^5$, extending transversely and mounted to turn in the handle $E^6$ previously described. On the shaft $I^5$ is secured a second arm $I^6$ standing approximately at right angles to the arm $I^4$ and pivotally connected with a rod $I^7$ having a handle $I^8$, adapted to be taken hold of by the operator to move the said rod forward or backward, to impart a swinging motion to the shaft $I^5$ and the arm $I^4$ to raise or lower the frame $I^2$ for the purpose above described. On the rod $I^7$, near the handle $I^8$, is arranged a pin $I^9$ adapted to engage one of a series of notches $E^7$ arranged on an extension $E^8$ forming part of the handle $E^6$ previously mentioned. The operator, after shifting the rod $I^7$ to move the frame $I^2$ into the desired position, engages the lug $I^9$ in the corresponding notch $E^7$ to lock the said rod and consequently the frame $I^2$ in position until it is desired to change the motion of the screw rod H as above described. The extension $E^8$ of the handle $E^6$ has a bearing in a fixed board J, and for this purpose the latter is provided with an opening J′ having beveled sides so as to permit a sidewise swinging of the handle, and also to permit a forward and backward sliding of the handle in the said board.

As illustrated in Fig. 6 the handle $E^6$ may be pivotally connected at its outer end with a cross head or block $E^{15}$ fitted to slide longitudinally in suitable fixed guideways $E^{16}$.

In order to impart a jerking motion occasionally to the vessel G, the following device is provided: On the outer end of the trunnion F′ is secured the horizontally-extending tube K, parallel with the handle $E^6$. Into the said tube extends a rod L provided with a series of annular ridges L′, placed suitable distances apart, as is plainly shown in Fig. 1. The extreme outer end of the rod L is normally mounted to slide and to turn in a universal joint N supported from the board J previously mentioned, as long as jerks are not desired; but when the jerks are required, the rod L is fastened by a pin N′ or other device to the universal joint N, so that a longitudinal motion of the rod L is prevented but it is free to follow the gyrating motion of the vessel G. The rod L, between its ridges L′, is engaged by two oppositely arranged plungers O, mounted to slide in suitable bearings K′ secured on the outer end of the tube K. The plungers O are pressed in contact with the rod L by springs O′ held in the said bearings K′, as is plainly shown in Fig. 1. Now, when motion is given to the apparatus, the tube K is caused to slide so that the plungers O held in the bearings K′ of the said tube ride over the ridges L′ on the rod L, thus imparting certain jerks or shakes to the vessel. In order to keep the vessel G trembling slightly between successive jerks springs $F^2$ and $F^3$ are interposed between the bearings $E^4$ $E^5$ respectively and the vessel G, as is plainly shown in Fig. 1.

In order to tilt the vessel G to remove the separated lighter particles, a tilting device is provided which is shown fully in Figs. 1 and 7. The trunnion F is provided with a key $F^4$ engaging a slot in a sleeve P mounted to turn in a bearing $E^9$ formed on the bracket $E^2$ in alignment with the bearing $E^4$. On the outer end of this sleeve P is keyed or otherwise secured an arm P′ extending downward and formed with a forked end $P^2$ in which are journaled the trunnions Q′ of a nut Q in which screws a screw rod R formed with a ball R′ mounted to turn in a ball bearing $E^{11}$ secured on brackets $E^{12}$ and $E^{13}$, of which the bracket $E^{12}$ is bolted to an arm $E^{14}$ extending from the bearing $E^9$, and the other bracket $E^{13}$ is bolted to the bracket $E^2$. On the extreme outer end of the screw rod R is secured a handle or crank arm $R^2$ adapted to be turned by the operator to screw the screw rod R forward or backward in the nut Q, to exert a pull or push on the arm P′, to turn the sleeve P, and consequently the trunnion F, so that a tilting motion is given to the vessel G. By turning the crank arm $R^2$ in an opposite direction the vessel G is returned to its normal horizontal position.

In order to give additional jerks to the vessel G, we provide the latter with an outwardly-extending arm T formed at its under side with angularly extending ridges T′ adapted to ride over a pin U held on a post U′ set at the rear of the machine in the ground or floor, as is plainly shown in Figs. 1 and 7.

In order to hold the shoes I and I′ normally out of contact with the wheel H′, the device shown in Fig. 8 may be provided, the said shoes having their supporting frame $I^2$ formed with a rod S′ fitted to slide in the handle $E^6$, the upper end of the said rod being pivotally-connected with a shifting lever $S^2$ which takes the place of the rod $I^7$. A spring S is coiled on the rod S′ and rests with one end on the handle $E^6$, pressing with its other end on the lever $S^2$ so as to hold the latter and the frame $I^2$ in such a position that the shoes I and I′ do not engage the wheel H′ as the latter passes between the shoes, and only when the lever $S^2$ is pressed or raised do the shoes I and I′ engage the wheel either on the top or bottom. The frame $I^2$ may be lifted or dropped by a screw and nut wheel as shown in Fig. 11; the said wheel being worked by a chain under the control of the operator. The shoes I and I′ may also be mounted yieldingly on the frame $I^2$ as shown in the said Fig. 11 to insure proper contact with the wheel H′.

The operation is as follows: A charge of gravel, sand, earth or crushed ore consisting

of particles of different specific gravities, is put into the vessel G and enough water, the amount of which is determined by experience, is added to the material, and after establishing the proper distance between the center of motion and the center of the vessel G the machine is started by revolving the shaft B in the manner above described. The revolving of the shaft B causes the socket C to move the wheel D around, eccentrically to the shaft B, and as the ring E is mounted to turn in the rim of the said wheel and is connected by the handle $E^6$ with the slot J′ in the board J, the said bar serves as a handle to turn the ring in its bearing in the rim of the wheel D, so that an elliptical motion is given to the vessel G, the handle $E^6$ at its extension $E^8$ sliding in and out of the slot J′ and moving sidewise therein. Such a velocity is gradually imparted to the vessel G that all the materials, or nearly all, rise and remain in suspension. The motion is then gradually slowed until a top skin or an upper layer of the lightest materials present is left in suspension. The increasing velocity and the subsequent decreasing velocity is given to the vessel G by the operator varying the motion of the main driving shaft or manipulating the frame $I^3$ so as to move either of the brake shoes I or I′ in engagement with the wheel H′, as the latter comes around on each side of the shaft B. When the upper layer or top skin seems quite free from heavier particles, the vessel G is slowly tilted or tipped over by the operator turning the crank arm $R^2$ as above described. The top skin still floats in the revolving water and gradually passes with the water to the lower side of the vessel, and is finally thrown over the edge of the latter by the force of the moving water. The vessel G is now again righted by the operator turning the crank arm $R^2$ in the opposite direction, as above described, some water is added, and another skin separated and eliminated, until finally a button or lump of the heaviest substances present in the material remains in the bottom of the vessel G. It depends on the particular material to be separated out whether the skins or the buttons or lumps are saved. The machine is principally employed, however, for separating gold from gravel, and sulphurets from quartz, but apatite or phosphate of lime can also be separated from heavier, less valuable material.

It is understood that the tilting of the vessel G takes place while the latter is in motion, as above described, so that the water in motion carries the top skin with it over the lower edge of the tilted vessel; although it can be tilted, if necessary, in a state of rest. It will also be seen that as the vessel G approaches in its motion the fixed board J, which forms the varying fulcrum for the sliding handle $E^6$, a push is given to the said vessel, and when it recedes a pull is given to the same, both due to the friction of the handle $E^6$ in the slot J′ of the board J. The sides of the slot J′ are beveled, as previously described, to permit an oscillating motion of the vessel G about its own center. It is apparent that this oscillating motion is a progressive one, as one complete oscillation of the vessel on its own axis is made in the same time that one revolution is made around the central shaft B.

By reference to Fig. 9, it will be seen that the peculiar motion given to the vessel G causes each point of the vessel to describe an ellipse on each full revolution of the shaft B, and the position of the ellipses and their size vary according to the revolution of the respective point; that is to say, the point nearest the slot J′ describes a smaller ellipse than that farthest from the slot. Furthermore, the position of the ellipses varies, owing to the eccentric position of the wheel D relative to the shaft B, and the friction caused by the ring E in its bearings on the top surface of the rim of the said wheel D. The form of the ellipse also varies whenever jerks are given to the vessel, each ellipse then having protuberances as shown in one of the ellipses in the said Fig. 9.

It is understood that the bar T and fixed pin U give a vertical jig to the vessel G, only when the latter is in a horizontal position, and the frequency of the side jig given by the plungers O and the ridged rod L to the vessel G depends on the rapidity of the motion of the main shaft B. It is evident, however, that the frequency of jerks can be altered by giving an independent reciprocating motion to the ridged rod L inside the tube K, either when the machine is in motion or more especially when it is at rest. This independent reciprocating motion may be given by hand or by mechanical means.

It is understood that this machine may be successfully employed for treating milk to obtain cream, or for separating and concentrating other liquids and substances not named herein.

Having thus thus described our invention, we claim as new and desire to secure by Letters Patent—

1. A concentrator, comprising a revoluble shaft, a disk or wheel eccentrically mounted thereon, and a vessel-carrying ring mounted to turn on the said wheel and provided with an extension or handle having guided movement in a fixed bearing, substantially as described.

2. A concentrator, comprising a revoluble shaft, a disk or wheel eccentrically mounted thereon a vessel-carrying ring mounted on the disk to turn relatively thereto, and provided with an extension or handle, and a fixed bearing in which the said extension has guided movement, to impart to the ring and vessel a gyrating motion about the center of the shaft, and an oscillating motion about the vessel's own center, substantially as described.

3. A concentrator, comprising a revoluble shaft carrying bearings, a wheel fitted to

slide in said bearings, and a ring mounted to turn on the said wheel, a vessel carried by the said ring, and means for causing the vessel to oscillate relatively to the wheel, substantially as described.

4. A concentrator, comprising a revoluble shaft, a ring mounted on the shaft and constructed to slide toward and from the center thereof, a vessel carried by the said ring, means for causing the vessel to oscillate relatively to the wheel and means for adjusting the said ring to vary its eccentricity and the range of its gyratory motion, substantially as described.

5. A concentrator, comprising a revoluble shaft, a ring mounted on the shaft and constructed to slide toward and from the center thereof a vessel carried by the said ring, means for causing the vessel to oscillate relatively to the wheel, an adjusting screw for moving the said ring to vary the eccentricity thereof, said screw being provided with a wheel, and a shoe arranged to engage the said wheel as the screw revolves with the shaft, to rotate the screw and move the vessel-carrying ring in an essentially radial direction, substantially as described.

6. The combination of a revoluble shaft, a vessel-carrying ring mounted on the shaft and constructed to slide toward and from the center thereof, an adjusting screw for moving the said ring to vary the eccentricity thereof, said screw being provided with a wheel, and a movable frame provided with shoes adapted to engage the said wheel as the screw revolves with the shaft, to rotate the screw and move the vessel-carrying ring inward or outward, substantially as described.

7. A concentrator, comprising a vessel provided with trunnions, a ring or support provided with bearings to receive the said trunnions, and means for imparting a gyratory motion to the ring, substantially as described.

8. A concentrator, comprising a vessel having trunnions mounted to slide in suitable bearings, a sleeve in which one of the trunnions has sliding movement, and with which the said trunnion is held to turn, and means for turning the sleeve to tilt the vessel, substantially as described.

9. A concentrator, comprising a revoluble shaft carrying a socket having bearings, a wheel fitted to slide horizontally in the said bearings, a ring mounted to turn on the rim of the said wheel, and a vessel having trunnions journaled in bearings supported on the said ring, substantially as shown and described.

10. A concentrator, comprising a revoluble shaft carrying a socket having bearings, a wheel fitted to slide horizontally in the said bearings, a ring mounted to turn on the rim of the said wheel, a vessel having trunnions journaled in bearings supported on the said ring, and a handle extending from the said ring and guided in fixed bearings, substantially as shown and described.

11. A concentrator comprising a revoluble shaft carrying a socket having bearings, a wheel fitted to slide horizontally in the said bearings, a ring mounted to turn on the rim of the said wheel, a vessel having trunnions journaled in bearings supported on the said ring, a handle extending from the said ring and guided on fixed bearings, a screw rod screwing in the said wheel and engaging a nut in the said socket, a wheel held on said screw rod, and a frame fitted to slide and carrying two shoes adapted to engage the top and bottom of the said wheel, substantially as shown and described.

12. A concentrator, comprising a revoluble shaft carrying a socket having bearings, a wheel fitted to slide horizontally in the said bearings, a ring mounted to turn on the rim of the said wheel, a vessel having trunnions journaled in bearings supported on said ring, and a handle extending from the said ring and guided in fixed bearings, a screw rod screwing in the said wheel and engaging a nut in the said socket, a wheel held on said screw rod, a frame fitted to slide and carrying two shoes adapted to engage the top and bottom of the said wheel, and a mechanism for imparting a sliding motion to the said frame, as set forth.

13. A concentrator, comprising a vessel having trunnions mounted to slide in suitable bearings, a sleeve turning with one of the said trunnions, and permitting the latter to slide in the sleeve, an arm secured on the said sleeve, a nut mounted to turn in the said arm, and a screw rod screwing in the said nut and journaled in fixed bearings, substantially as shown and described.

14. A concentrator, comprising a vessel having trunnions, a ring having bearings engaged by the said trunnions, a tube extending from one of the said trunnions and carrying spring-pressed plungers, a rod having ridges and extending into the said tube and adapted to engage or be engaged by the said plungers, and a fixed support with which the said rod is adapted to be connected, the vessel being adapted to move toward and from the said support substantially as shown and described.

15. A concentrator, comprising a vessel having trunnions, a ring having bearings engaged by the said trunnions, a tube extending from one of the said trunnions and carrying spring-pressed plungers, a rod having ridges and extending into the said tube and adapted to engage or be engaged by the said plungers, a stationary universal joint for carrying the outer end of the said rod, the vessel having movement toward and from the said joint, and means for preventing longitudinal movement of the rod in the said joint substantially as shown and described.

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