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M. CRAWFORD.

APPARATUS FOR EXTRACTING PRECIOUS METALS FROM THEIR ORES.

No. 543,675. Patented July 30, 1895.

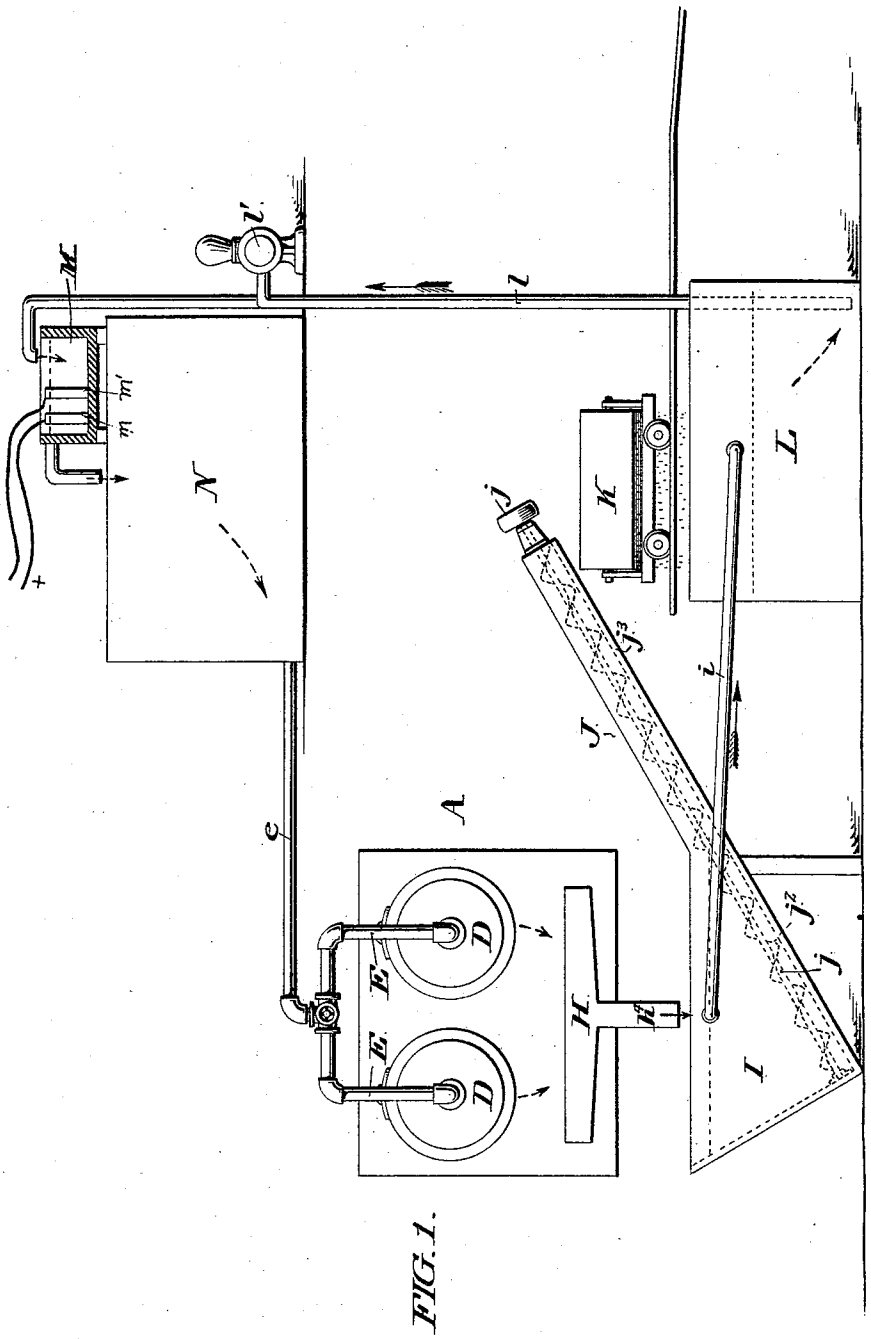

FIG. 1.

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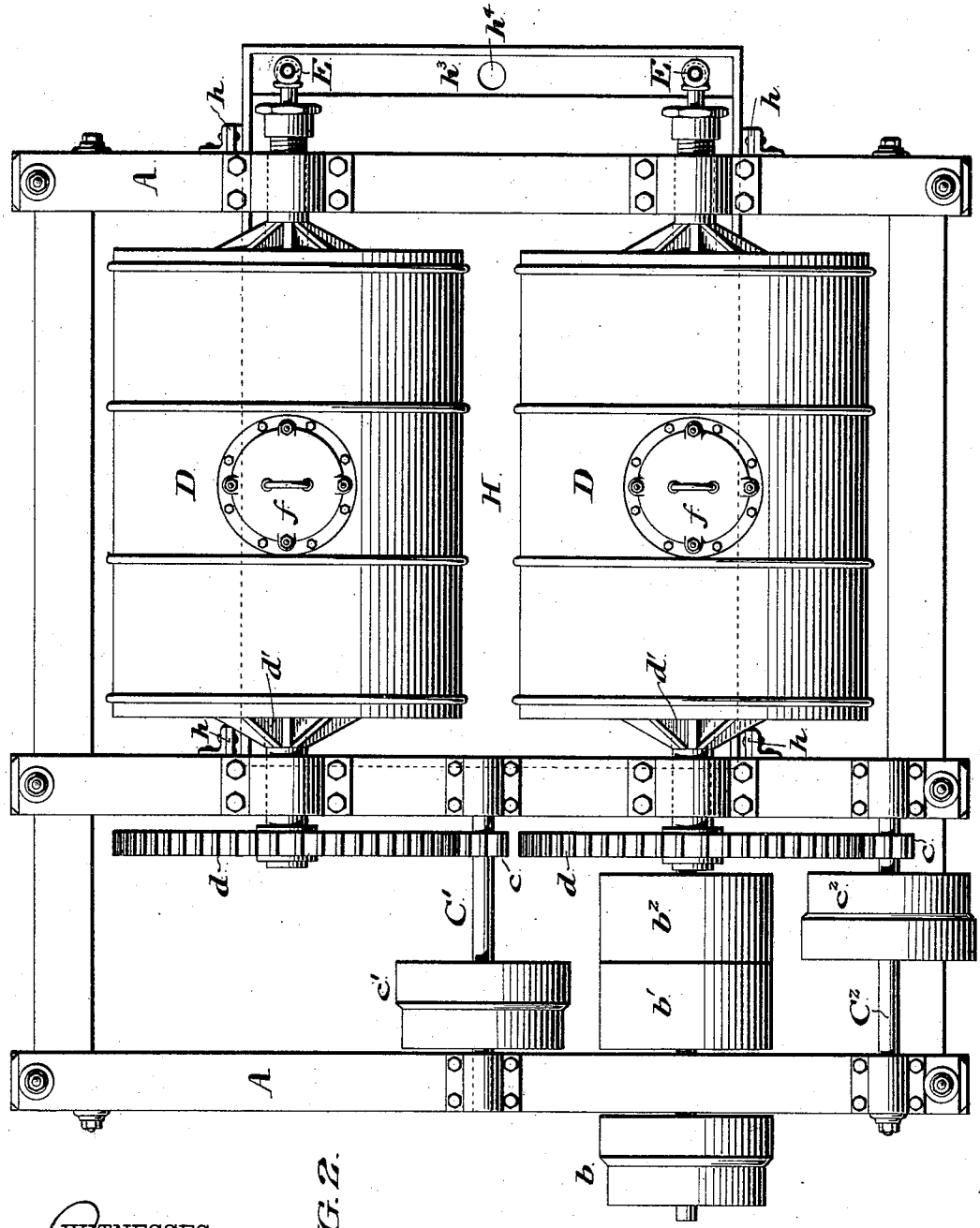

FIG. 2.

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(No Model.) 6 Sheets—Sheet 3.

M. CRAWFORD.

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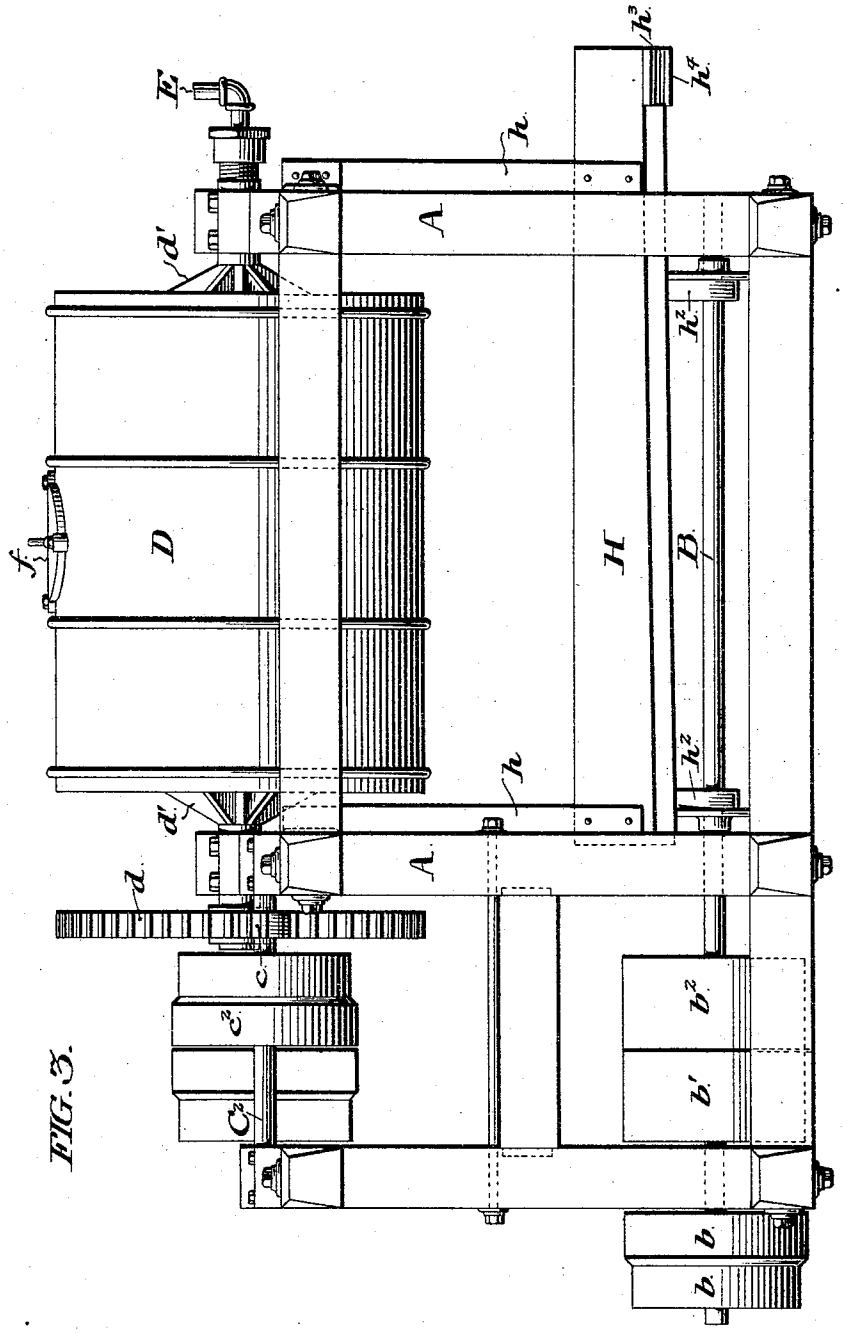

FIG. 3.

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(No Model.) 6 Sheets—Sheet 4.

M. CRAWFORD.

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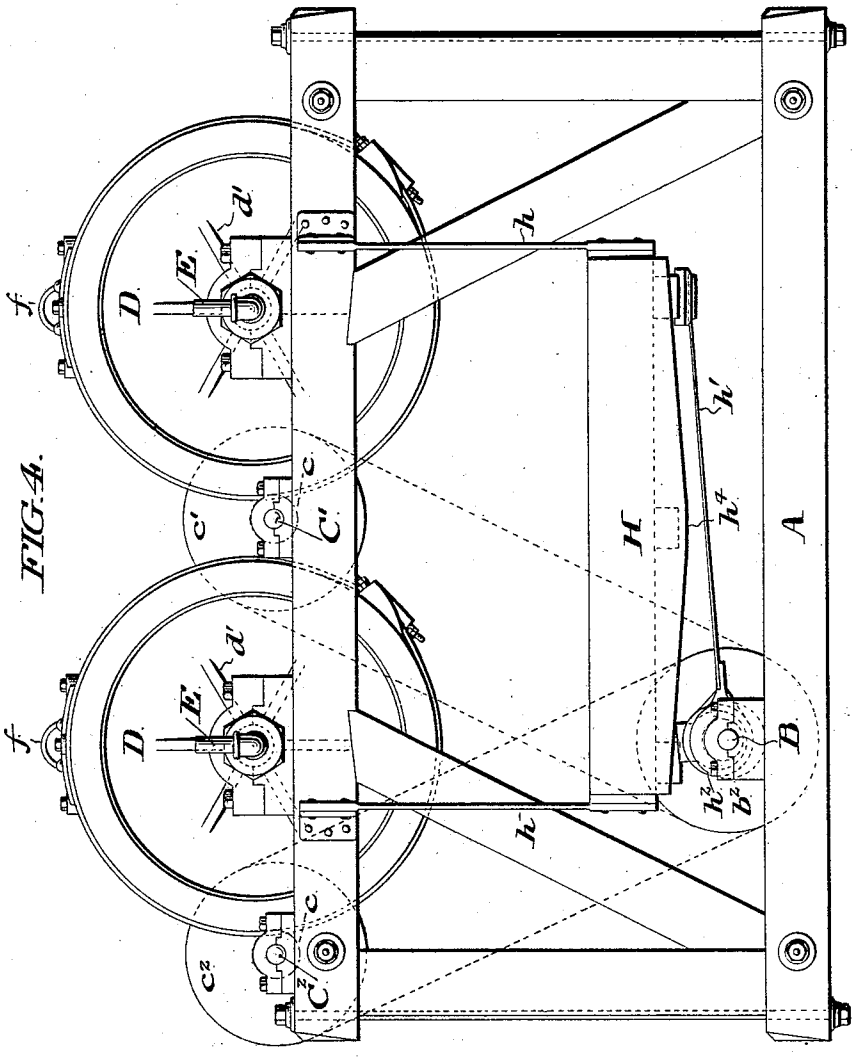
FIG. 4.



WITNESSES:
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(No Model.) 6 Sheets—Sheet 5.

M. CRAWFORD.

APPARATUS FOR EXTRACTING PRECIOUS METALS FROM THEIR ORES.

No. 543,675. Patented July 30, 1895.

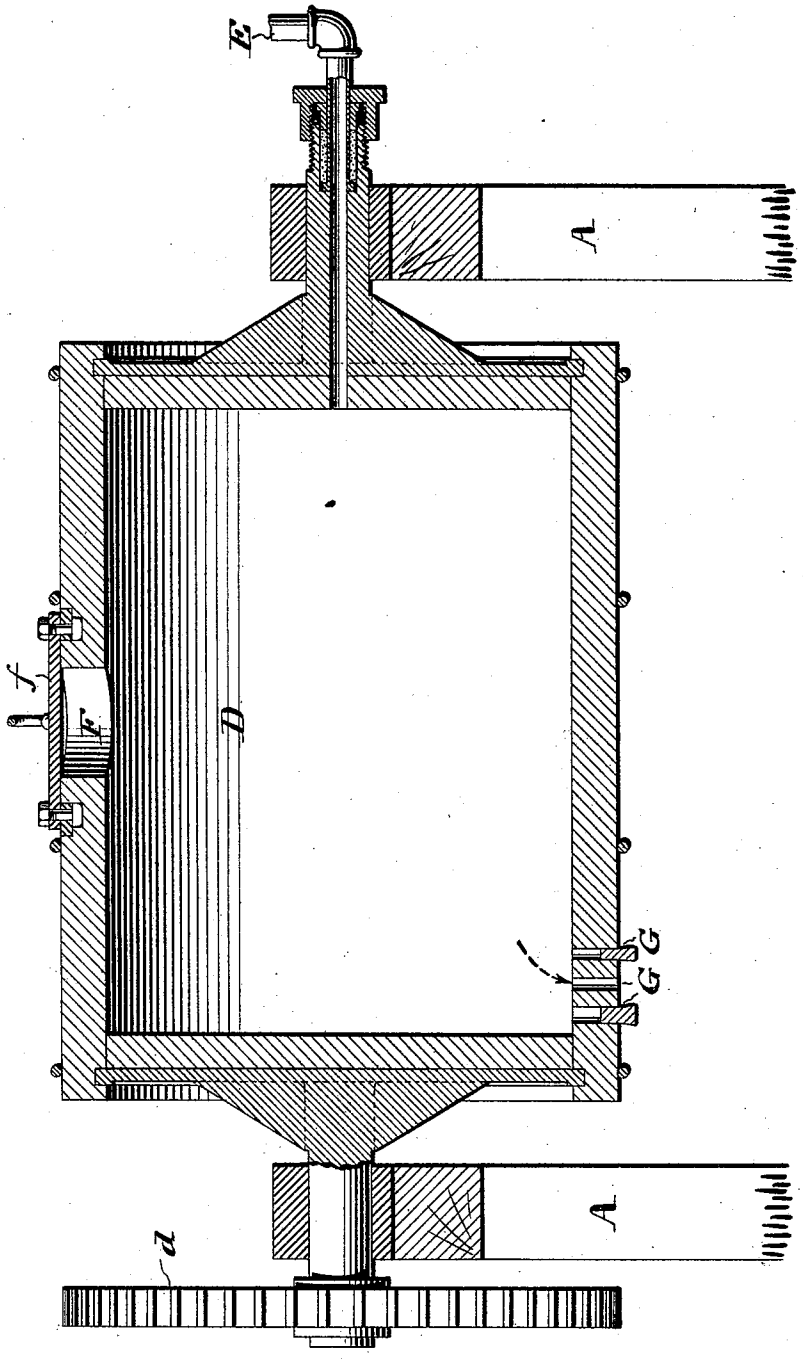

FIG. 5.

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(No Model.) 6 Sheets—Sheet 6.

M. CRAWFORD.

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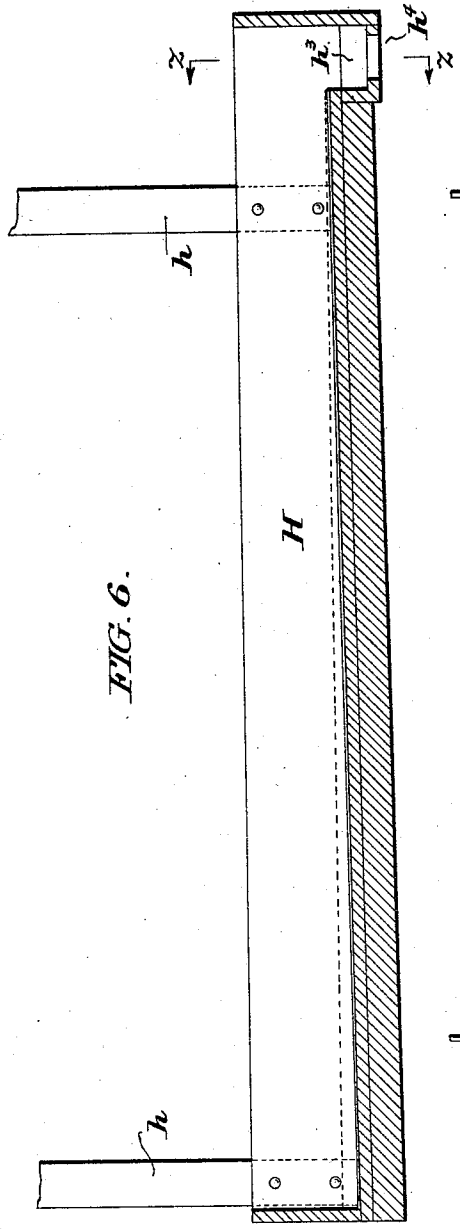

FIG. 6.

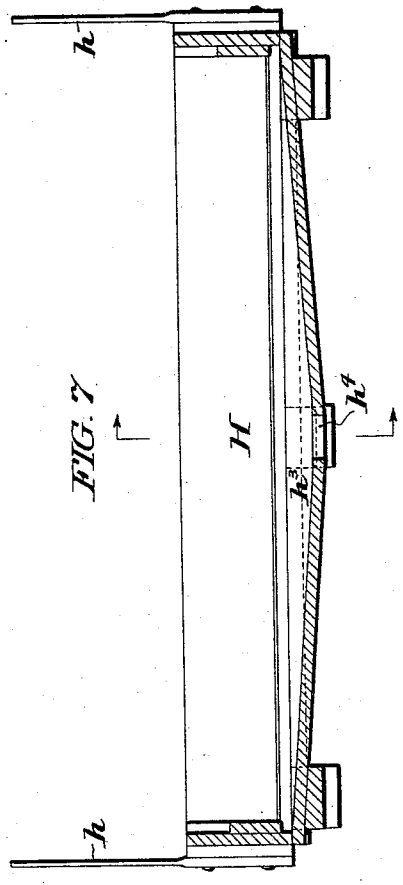

FIG. 7.

WITNESSES:
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UNITED STATES PATENT OFFICE.

MIDDLETON CRAWFORD, OF COLORADO SPRINGS, COLORADO, ASSIGNOR OF THREE-FOURTHS TO THOMAS C. PARRISH AND DUNCAN CHISHOLM, OF SAME PLACE, AND JAMES POURTALES, OF SILESIA, GERMANY.

APPARATUS FOR EXTRACTING PRECIOUS METALS FROM THEIR ORES.

SPECIFICATION forming part of Letters Patent No. 543,675, dated July 30, 1895.

Application filed December 14, 1894. Serial No. 531,751. (No model.)

To all whom it may concern:

Be it known that I, MIDDLETON CRAWFORD, a subject of the Queen of Great Britain, (but having declared my intention of becoming a citizen of the United States,) residing at Colorado Springs, in the State of Colorado, have invented a certain new and useful Apparatus for and Process of Extracting Precious Metals from Their Ores, (Case D,) whereof the following is a specification, reference being had to the accompanying drawings.

My invention has reference to apparatus employed in solution processes for the extraction of the precious metals as distinguished from those processes which employ only amalgamation and concentration. The apparatus comprises five groups of mechanism, which are preferably used in combination with each other and in substantially the order hereinafter set forth. When so used they render it practicable to continuously circulate the solvent liquid, the precious metals being dissolved at one point in this circulation and reclaimed at another point, and the solvent liquid being finally restored to its original efficiency. Certain of the devices or groups of devices are, however, capable of being used independently of the other groups in connection with which I have shown them for the purpose of illustrating my continuous process.

The groups of devices above referred to are as follows: first, devices for agitating the powdered ore with the solvent liquid; second, devices for subjecting the resultants of the solution process to an amalgamating process; third, devices for separating the solid portions of the resultants of the amalgamating process from their accompanying liquids; fourth, devices for removing the precious metals which are in solution from the solvent liquid which contains them; fifth, devices for causing the continuous circulation of the solvent liquid.

In the accompanying drawings, Figure 1 illustrates in conventional elevation the collocation of the various groups of devices just mentioned, whereby they may be employed in a continuous process. Fig. 2 is a plan view of the agitating and amalgamating machinery. Fig. 3 is a side elevation of the same. Fig. 4 is an end elevation from the right of Fig. 1. Fig. 5 is a sectional view of one of the agitating barrels. Fig. 6 is a central longitudinal section of the amalgamating-table. Fig. 7 is a cross-section of the same along the line *z z*, Fig. 6.

The agitating and amalgamating devices are both mounted on the same framework A A of heavy timbers. The main driving-shaft B is carried by bearings in these timbers and imparts motion to both of these devices. This shaft is driven from the fast and loose pulleys *b b* and carries near its left-hand end two broad pulleys b' b^2. Two counter-shafts C' C^2 carry fast and loose pulleys c' c^2, through which they are driven respectively from the pulleys b' b^2. Upon both shafts C' C^2 are situated small gear-wheels *c c*, and each of these gear-wheels meshes with a large gear-wheel *d*, mounted upon the axle of a rotating barrel D, which axles are mounted in suitable bearings in the framework A A. The barrels are precisely alike and are so constructed as to present interiorly no metallic surface which might be affected by the action of the solvent liquid which they contain. To this end the barrel is constructed of heavy oaken staves. At each end the head is formed interiorly of a solid piece of the same material. Exteriorly to this wooden head is a solid iron circular plate carrying a large trunnion at its center, the trunnion being braced to the plate by a series of triangular radial webs *d'*. The plate is not united to the wooden head against which it lies by any metallic bolts, but is held in position by the overlapping edges of the chine within a deep groove in which its edges fit. The two trunnions form the axles of the barrels. The trunnion of each barrel which is situated at the opposite end from the gearing mechanism is hollow, and corresponds interiorly to an aperture in the wooden head and exteriorly to a pipe E, through which communication may be had at all times to the interior of the barrel, even though it be in revolution. In the center of one side of the periphery of each barrel is a large circular aperture F, furnished with a tightly-fitting iron cover *f* and means for securing the same firmly and readily over the aperture. Upon the opposite side from

the aperture F, and near the left-hand end of the barrel, a series of small holes is drilled through the periphery of the barrel. These holes are of varying diameter, and are closed by suitable plugs. They may be seen at G G, Fig. 5.

Below the level of the two rotating barrels is an amalgamating-table H. It is hung from above by flexible rod-hangers h, and is of sufficient size to receive the entire contents of either barrel. To the lower side of this table are attached the connecting-rods h' h', mounted upon the eccentrics h^2 h^2 upon the main shaft B, by the revolution of which a continuous vibratory motion is imparted to the table. The upper surface of this table is covered with an amalgamating-plate and its edges are sufficiently high to prevent its contents from being thrown over them in any direction. The surface of this amalgamating-plate is perfectly level with respect to the direction in which the table vibrates, but slopes slightly upward toward its right-hand edge, as seen in Figs. 2, 3, and 6. Along this edge runs the overflow-trough h^3, the bottom of which slopes downwardly from either end to the exit-pipe h^4.

The operation of the groups of devices which have so far been described is as follows: The powdered ore from the stamp-mill is introduced alternately into one or other of the barrels through the large aperture F and the cover tightly replaced. The solution wherewith it is desired to lixiviate the ore is then introduced into the barrel through the pipe E. This solution in Fig. 1 is contained in the storage-tank N, from which it is led out by the pipe e, which communicates by a two-way cock with either of the pipes E. The ore and the lixiviating-liquid having been introduced into the barrel the mechanism for revolving the barrel is set in motion. When the revolution has proceeded for the requisite length of time, one of the plugs closing the small holes G G is removed. The revolution is then continued, and at each turn of the barrel a certain portion of its contents is discharged through this small hole into the amalgamating-table below. From among the different small holes G G, of which, as has been stated, the diameters vary, that one is chosen for opening which, having reference to the varying fineness of the contents of the barrel, will allow the entire contents to be discharged during a period of revolution precisely equal to that which is required to complete the lixiviating process in the barrel before the plug has been removed from the aperture G. While one of the barrels is rotating and emptying itself of its contents the other one is filled anew with ore and solution and rotated for the purpose of lixiviation. The barrels are thus continuously emptied alternately, so that at all times there is a fresh supply of lixiviated ore falling upon the amalgamating-table. If desirable more than two barrels may be used, the machinery which has been described being simply duplicated for that purpose. This may be necessary when the time required for complete lixiviation is long, but in case it is short, say about one hour, two barrels are quite sufficient. The amalgamating-table is kept in continuous vibration by the revolution of the shaft B. The drippings from whichever one of the barrels is emptying itself of its contents fall continuously near the left-hand end of the table, as seen in Fig. 6, and continuously work their way over the amalgamating-surface up the slight incline and over the edge into the overflow-trough h^3. In passing over the amalgamating-surface any coarse gold which the lixiviating solution has been unable to dissolve comes into contact with the mercury and is reclaimed; and as the solvent action of the lixiviating solution, even though it has not dissolved the gold, will at least have brightened its surface, the efficiency of the amalgamating-plate is to this extent rendered the more complete by combining the two processes in the order described. From the amalgamating-table the gangue and the solution pass, by means of the exit-pipe h^4, directly into the tank I. This tank has sloping sides, and from its bottom along one of these sides runs a screw-separator J. This consists of the shaft j, driven by a belt-pulley j'. Around this shaft runs the screw-thread j^2, having a width of two or three inches and a pitch of about one turn to the foot. The screw-conveyer continues for some distance beyond the edge of the tank I and is surrounded by a casing j^3. The space between the inner edge of this casing and the outer edge of the screw-thread is sufficiently great to allow any liquid which may be carried up out of the tank I by the conveyer to run back. The continuous revolution of this separator continually withdraws the solid material from the bottom of the tank I and delivers it at its top into the filter-car K, while at the same time an exit-pipe i removes the excess of solvent liquid continuously from the top of the tank I and delivers it into a second tank L. The filter-car is mounted upon a track directly over the tank L and is one of several which are used in alternation. It contains a canvas bottom, through which any of the lixiviating liquid which may have been carried up by the screw-separator is allowed to slowly percolate into the tank L. If desirable this percolation may be increased by throwing a small quantity of water from time to time upon the surface of the contents of the car by a hose. Whenever the car K is full of tailings it is run off and another substituted in its place. From the tank L the solution is pumped continuously, by a pipe l and pump l', up to a receptacle M, where the process for removing the precious metal from the solution is continuously carried on. In Fig. 1 electrodes m m', with suitable connections, are shown within this receptacle, by means

of which the separation may be effected electrically. When the precious metal has been removed from the solution it runs over into the large storage-tank N, from which the solution is drawn off continuously for use over again in the lixiviating-barrels. If, during the process of its withdrawal from this tank and return thereto, its efficiency has been weakened, the necessary means for restoring the efficiency, whether the addition of chemicals or the application of an electric current, may be here employed.

The advantages of the apparatus which has been described are derived from the continuity of the solution process, from the ready and continuous extraction of the tailings from the solvent liquid, and particularly the completeness of this extraction, and finally from the continuous circulation of the solvent liquid, whereby almost none of it is lost, but it is used over and over again.

Having thus described my invention, I claim—

1. An apparatus for extracting precious metals from their ores, which consists in the combination of a plurality of revoluble lixiviating barrels; a single amalgamating table upon which they all discharge their contents; and means for causing the barrels to discharge successively in regular alternation, substantially as described.

2. An apparatus for extracting precious metals from their ores, which consists in the combination of a plurality of revoluble lixiviating barrels each containing a series of discharge openings of graduated size; a single amalgamating table upon which they all discharge their contents; and means whereby the said discharge is effected continuously from one barrel at a time in regular alternation, substantially as described.

3. An apparatus for extracting precious metals from their ores, which consists in the combination of a plurality of revoluble lixiviating barrels each containing a discharge opening; a single amalgamating table situated beneath the series of barrels over one end of which all of the discharge openings of the barrels are situated, and an overflow trough situated along the opposite end of said amalgamating table, into which the contents of the barrels pass after having traversed the surface of the amalgamating table, substantially as described.

4. An apparatus for extracting precious metals from their ores, which consists in the combination of a plurality of revoluble lixiviating barrels each containing a discharge opening; a single amalgamating table situated beneath the series of barrels, over one end of which all of the discharge openings of the barrels are situated; an overflow trough extending along the opposite end of said amalgamating table into which the contents of the barrels pass after having traversed the surface of the amalgamating table; and means for imparting to said amalgamating table a continuous vibratory motion at right angles to the line along which the contents of the barrels cross the table, substantially as described.

5. An apparatus for extracting precious metals from their ores, which consists in the combination of a tank wherein the solvent liquid is stored; a revoluble lixiviating receptacle; a pipe running from said storage tank to the lixiviating receptacle; an amalgamating table; means for causing the lixiviating receptacle to discharge its contents continuously upon the amalgamating table; a separating tank; means for conducting ore which has passed over the amalgamating table into the separating tank; means for separating the solid contents of this separating tank from its liquid contents; a third tank; connections whereby the solvent liquid thus separated is passed to said third tank; means for reclaiming the precious metals from the solution in said third tank; and connections whereby the solvent liquid is run from the third tank to the storage tank, substantially as described.

6. A separator for removing the tailings of the ores of precious metals from their accompanying solvent solution, which consists in the combination of a tank into which the ores and solution are discharged; a conveyer running from the bottom of said tank to a point exterior thereto by which the solids are separated from the liquids; a car filter with a permeable bottom situated below the discharge end of the conveyer; and a second tank below said car filter, substantially as described.

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