Feb. 3, 1942. M. KRAUT 2,271,650

JIG

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Fig. 2.

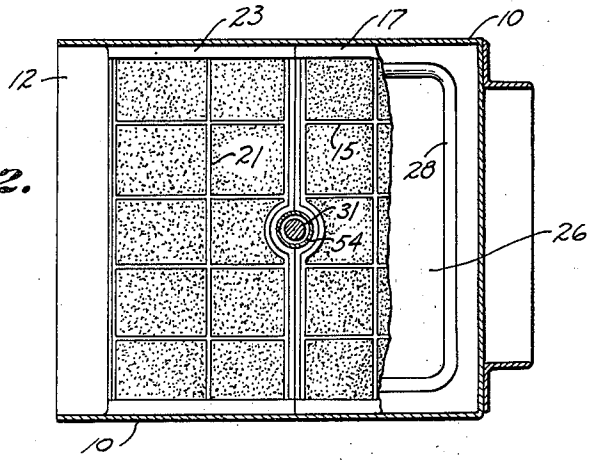
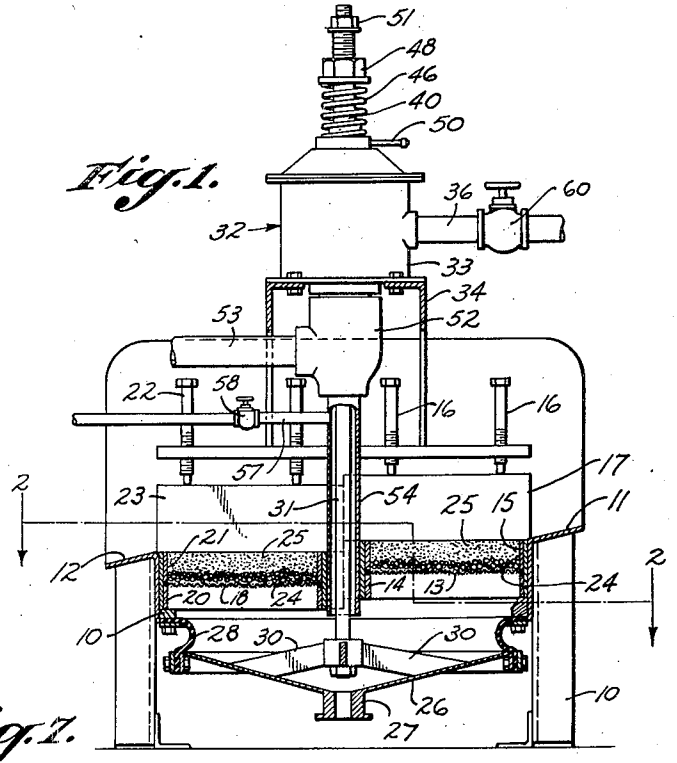
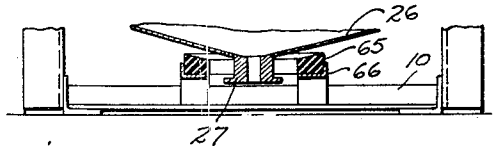


Fig. 1.





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Fig. 3.

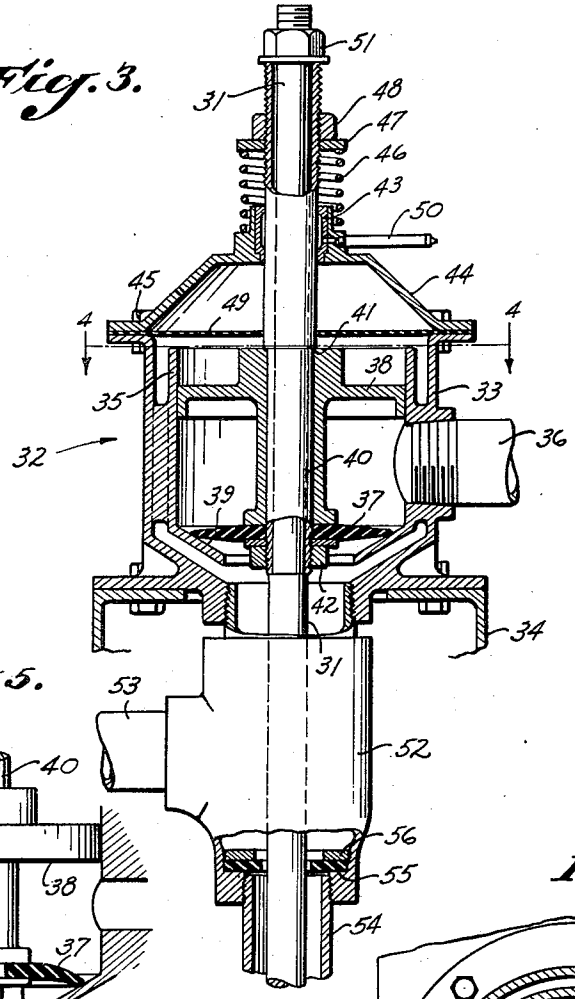


Fig. 5.

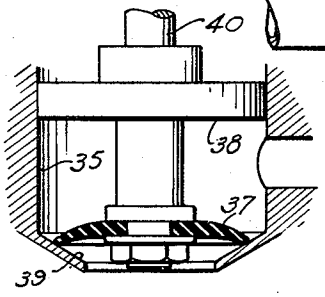


Fig. 6.

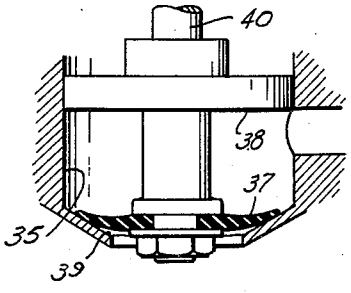
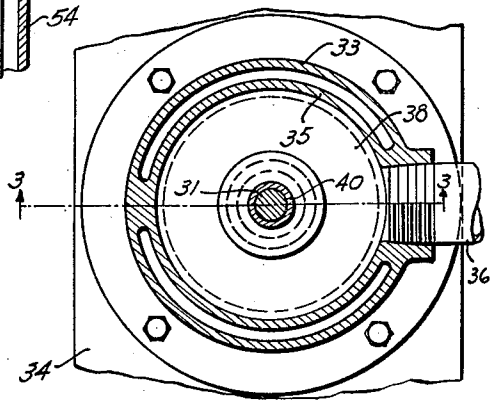


Fig. 4.



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UNITED STATES PATENT OFFICE

2,271,650

JIG

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Application September 6, 1938, Serial No. 228,518

4 Claims. (Cl. 209—455)

This invention relates to apparatus used for the purpose of recovering free minerals or metallic particles from ores or gravel mixtures. The apparatus of my invention is of that class known in the industry as a jig, and may be employed in the recovery of such materials as native gold, tin oxide (cassiterite), tungsten in the form of scheelite or wolframite, heavy sulphides of the base metals such as galena and pyrite, and other such materials.

Briefly, a jig is an apparatus comprising a permeable bed, preferably composed of sand and other particles, supported by a screen, over which flows a mixture of water, gangue and the mineral desired to be recovered, there being means to provide an intermittent upward flow of water through the bed resulting in a classifying action therein by which the relatively heavy mineral desired to be recovered passes through the bed into a hutch below while the gangue passes over the bed and out of the apparatus.

It is an object of my invention to provide an apparatus by use of which unusually high metallurgical recoveries are obtained.

Another object of the invention is to provide a jig in which water is positively moved alternately in the upward and downward directions through the bed and in which the action of the water on the bed is substantially uniform over its entire area.

Another object is to provide means for imparting a rapid reciprocating motion to the bottom of the jig, which motion is of such nature that the downward stroke is much faster than the upward stroke, resulting in more efficient separation of the particles desired to be recovered.

Another object of the invention is to provide a reciprocating means driven by water power.

Another object of my invention is to provide an apparatus which requires very little vertical space below the tailings discharge, and is free from all encumbrances due to moving mechanisms at the bottom of the jib below the hutch.

Another object is to provide a jig in which the mechanism for reciprocating the bottom is located at the top of the jig where it is readily accessible and does not interfere with the drawing off of concentrate from the bottom of the jig.

A further object is to provide an apparatus in which is assured a continuous discharge of concentrate from the bottom of the jig through a small discharge opening without the requirement of high head room underneath the jig.

Still another object of my invention is to provide an apparatus which is cheap to construct, requires a minimum of attention, and is of long life.

These and other apparent objects I attain in a manner which will be clear from consideration of the following description taken in connection with the accompanying drawings, of which:

Fig. 1 is an elevational view of my apparatus, shown partly in section.

Fig. 2 is a sectional view of my apparatus taken along the line 2—2 in Fig. 1.

Fig. 3 is an enlarged view, partly in section, of the means for causing reciprocation of the bottom of the jig, the controlling valve member being shown in the position in which it is undeflected.

Fig. 4 is a sectional view through the apparatus shown in Fig. 3 taken along the line 4—4.

Fig. 5 is a diagrammatic view showing the controlling valve in its uppermost position.

Fig. 6 is a diagrammatic view showing the controlling valve in its lowermost position.

Fig. 7 illustrates an alternative construction of the bottom of the jig.

In the embodiment of my invention chosen for illustration I provide a frame 10 preferably of generally rectangular shape in horizontal section, having a passage therethrough terminating at one side in an inlet trough 11 and at the other side in a discharge trough 12 which is located at a somewhat lower elevation than the inlet trough 11 to facilitate flow through the jig. Adjacent the inlet trough 11, a horizontal screen 13 is supported between a lower grid 14 resting on the frame 10 and an upper grid 15 forced downward against the screen 13 by screws 16 acting upon blocks 17 in contact with the upper surface of grid 15 at the sides of the jig. Adjacent the discharge trough 12 is another screen 18 supported, at a somewhat lower elevation than screen 13, between a lower grid 20 resting on frame 10 and an upper grid 21 which is forced downward against the screen 18 by screws 22 acting upon blocks 23 in contact with the upper surface of the grid 21 at the sides of the jig. The grids 14, 15, and 20, 21 preferably divide the horizontal area of the screens into a multiplicity of rectangularly shaped compartments, as seen best in Fig. 2. In the compartments formed by the grids above the screens is preferably placed a layer 24 of lead or steel shot about one inch thick and on top of this is built up a layer 25 of sand. The shot and sand layers 24 and 25 com-

prise a permeable bed of particles which is spoken of as the bed of the jig.

It is desirable to move water alternately upward and downward through the bed and to this end I provide below the grids 14 and 20 a vertically movable pan 26, preferably made of relatively thin resilient material such as thin sheet iron, and sloping gently from the periphery to the center where an outlet pipe 27 is connected and provides an outlet of relatively small capacity from the space above the pan. The pan 26, which is preferably of substantially the same size and shape as the bed of the jig, is attached at its periphery to a section of bellows 28 of flexible material such as rubber or canvas, the upper end of which is secured to the frame 10. The flexible material 28 thus constitutes an expansible connection between pan 26 and the screens above whereby is formed an enclosed space of variable volume between the pan and the bed. A spider 30 comprising a plurality of downwardly and outwardly extending arms is attached to the pan 26 and to a vertically extending rod 31 alternately moved upwardly and downwardly by the actuating means 32 located on the top of the jig.

The actuating means 32 is adapted to be operated by water pressure and to produce reciprocating motion of the rod 31. An outer cylindrical housing 33 is secured to a bridge-like structure 34 spanning the jig from side to side and attached to the frame 10. Within the housing 33 is located a cylinder 35 attached to the housing 33 at circumferentially spaced locations and opening at top and bottom into the housing 33. A water supply pipe 36 is screwed into the housing 33 and cylinder 35 and feeds water under pressure directly into the cylinder 35. The cylinder 35 at its lower end is conical in shape and serves as a valve seat 39 for a circular valve disc 37 of resilient material such as rubber which is preferably of tapering cross-section, facilitating flexing of the disc. A piston 38 closely fitting the cylinder 35 is adapted to move therein above the water inlet pipe 36. The piston 38 and valve disc 37 are mounted on an axial tube 40, being pressed against the shoulder 41 by the tightening of nut 42. The valve disc 37 is of area less than that of the piston 38 and is mounted so as to be unsupported in its peripheral portion. The tube 40 extends upwardly through a bearing 43 mounted in a cover 44 secured to the top of housing 33 by bolts 45. A lubricating fitting 50 is connected through the cover 44 to conduct lubricant to the bearing 43. A diaphragm 49, preferably of rubber or canvas, and apertured to permit tube 40 to pass therethrough, is clamped between housing 33 and cover 44 to protect the bearing 43 from splash of water. The rod 31 passes through the tube 40, has a shoulder abutting the lower end of tube 40, and carries a nut 51 in threaded engagement therewith at its upper end which securely clamps the tube 40 and associated parts on the rod 31 for movement therewith. A spring 46 surrounds the tube 40, bears at one end on the cover 44 and at the other end against a washer 47 retained in an adjustable position by nut 48 in threaded engagement with tube 40. The spring 46 acts to balance part of the load due to the weight of pan 26, water above the pan, rod 31 and associated parts, whereby the pressure and amount of water required to operate the reciprocating means 32 is reduced. It should be noted that the spring 46 should never be made so strong as to completely balance all the load on rod 31 for then there would be nothing to return the valve to the closed position.

Attached to the housing 33 at its lower end and in communication with the space within the housing 33 and cylinder 35 is a fitting 52 having a side outlet pipe 53 connected thereto and a pipe 54 connected to the bottom surrounding rod 31, there being space left between the rod 31 and pipe 54. The pipe 54 passes downwardly through the bed of the jig and opens into the hutch, which is the space below the grids 14 and 20 and above the pan 26. The grids 14, 15, 20, and 21 and screens 13 and 18 are shaped, as seen best in Fig. 2, to permit the tube 54 to pass through the bed. In the bottom of fitting 52 is preferably located a washer 55, preferably of rubber, clamped between a shoulder of the fitting and a nut 56 in threaded engagement with the fitting. The washer 55 may pack the rod 31 in contact therewith to prevent passage of any fluid into the pipe 54 or it may be of any suitable internal diameter to permit passage of any desired proportion of the available fluid past the washer, through the pipe 54 and into the hutch. A water supply pipe 57, provided with a valve 58, is preferably connected to pipe 54 below the fitting 52 to supplement the supply of water to the hutch, if desired, or to alone supply the make-up water required if none is permitted to pass from the fitting 52 into the pipe 54.

In the operation of the actuating means 32 to reciprocate the rod 31, water under pressure enters cylinder 35 through pipe 36 and acts upon both piston 38 and disc 37, the force on piston 38 in an upward direction being greater than the downwardly directed force on disc 37 by reason of the greater area of piston 38. The piston 38 therefore moves upwardly. If the disc 37 were inflexible it would also move upwardly coincidentally with piston 38; but being flexible, the periphery of disc 37 is held down in contact with the conical seat 39 while the center of the disc connected to piston 38 rises with the piston, as shown in Fig. 5. The piston 38 continues to rise until a critical point is reached where the periphery of the disc 37 can no longer be held in contact with the seat 39 by the water pressure, and the disc 37 then breaks from the seat. The valve disc snaps open quickly as the pressure on opposite sides of it quickly equalizes. At the same time the piston 38 moves farther up in the cylinder due to the momentum it has acquired. Thus the opening closed by disc 37 is rapidly opened, resulting in an instantaneous drop in pressure which, among other things, depends upon the restriction of the valve 60 in supply pipe 36. The sudden drop in pressure within the cylinder 35 together with the reduced pressure underneath disc 37 due to the high velocity of water passing through the narrow opening between the seat 39 and the disc 37 and associated parts causes the piston 38 to be pulled rapidly downward by the weight of rod 31, pan 26, and the water and concentrate in the hutch. As soon as the piston and valve structure has fallen to a point where disc 37 contacts seat 39 pressure starts to build up in cylinder 35. Since, however, the disc 37 is flexible, it can be distorted into the shape shown in Fig. 6 in which condition the volume within the cylinder between piston 38 and valve disc 37 is greater than in the condition illustrated in Fig. 3. It will be obvious that pressure cannot build up to a normal value within the cylinder so long as this

volume is increasing. For this reason the piston 38 and valve disc 37 sink to a lowermost position illustrated in Fig. 6. The pressure within the cylinder then builds up quickly and causes the piston 38 to be raised while the periphery of the disc 37 is held in contact with seat 39, the piston and disc going through the position shown in Fig. 3 and on through the remainder of the cycle as previously described. Since any momentum possessed by the moving parts at the time of unseating of the valve disk 37 is quickly overcome by the unbalanced force of gravity, there is very little upward movement after this time, and nearly all of the upward stroke of the member 31 takes place while the valve disc 37 is seated on the seat 39.

The water discharged from the cylinder past the disc 37 when in the open position passes into the fitting 52 and out through pipe 53, a portion thereof, depending upon the opening between washer 55 and rod 31, passing down the pipe 54 to supply make-up water to the hutch. Any water leaking past the piston 38 enters the space between housing 33 and cylinder 35 and runs down to join the discharge water in fitting 52. The diaphragm shield 49 prevents any of this water from splashing up into the bearing 43.

The resulting reciprocation of rod 31 is very rapid and regular. The number of strokes per minute may be adjusted by varying the diameter of the disc 37 or by varying the restriction of the water supply. In one embodiment of the device about 200 complete cycles per minute were obtainable with a disc 5 inches in diameter, and with a disc 4 inches in diameter the number of cycles could be adjusted from 400 to 1000 per minute, finally reaching a vibratory movement. The extent of the movement depends upon the diameter of the disc 37, greater movement being obtained, within limits, by use of a disc of larger diameter. In the device above referred to, a movement of 1½ inches was obtained by use of a disc 5 inches in diameter, while a movement of ¼ inch was obtained by use of a disc of 4 inches diameter.

The movement of the piston 38 is relatively slow on its upward stroke because a relatively great weight is being lifted by the water pressure acting only on the differential area of piston 38 and disc 37, while on the downward stroke the weight connected with rod 31 pulls the piston down very rapidly against a greatly reduced pressure. This type of reciprocation involving a rapid downward stroke and a relatively slow upward stroke has been found to be particularly adapted to operation of a jig, resulting in more efficient recovery than with reciprocation of equal velocity on the two oppositely directed strokes. It is understood that the reciprocating means 32 may be advantageously employed in jigs of different construction from the one herein disclosed and may be used for purposes other than reciprocation of a jig.

In the operation of the jig as a whole, the feed, which may comprise gravel or sands in placer operations, or ball mill discharge in milling operations, which have been sluiced with water, is led over the inlet trough 11, onto the bed of sand and shot above the screens 13 and 18, and out over the discharge trough 12. The water fed with the material onto the bed of the jig passes through the screen, and this, together with part or all of the water which motivates the reciprocating means, fills all the space between the bed and the pan 26. The reciprocation of the pan 26 causes alternately rising and descending currents of water through the bed of the jig above the screen. These currents activating the bed have a classifying action on the material passing through the jig, only the particles of relatively great specific gravity being able to sink through the bed against the rising current. As a result of this action the relatively heavy particles gradually work down through the bed, through the screen, and settle on the pan 26, while the lighter gangue particles pass over the bed and out over the discharge trough 12. The type of reciprocation produced by the means 32 in which the water below the bed is moved rapidly on the downward stroke and more slowly on the upward stroke has been found to result in more efficient recovery than reciprocation in which the velocity is the same on the two strokes. Another feature of improved operation is that the velocity of water through the bed is substantially uniform over the entire surface of the bed due to the fact that the pan 26, whose motion is responsible for the movement of water through the bed, is of substantially the same size and shape as the bed itself. There is a direct vertical movement of water under all parts of the bed which prevents the existence of "boiling" action in some areas while other areas are "dead," a condition present in some jigs which seriously interferes with the metallurgical efficiency of the jig.

The concentrate which falls on the pan 26 moves down the sloping pan and out through the outlet 27 together with a continuous small stream of water. It will be obvious that some make-up water must be supplied to the space below the screens. If desired the size of washer 55 may be made such as to permit water to pass down the pipe 54 in sufficient quantity to satisfy this demand; or if desired the washer 55 may pack the rod 31 to prevent any water from passing and the make-up water may be supplied through pipe 57 by adjustment of valve 58.

One of the features of my apparatus is that very little vertical space is required from the discharge trough down to the floor. This valuable feature is in part achieved by employing the very shallow pan 26, which slopes only very gently toward the center. With such a gentle slope it would ordinarily be difficult for the concentrate to move down to the outlet 27. But since the pan 26 is made of thin flexible material it is distorted upwardly and downwardly from its normal shape as it is reciprocated. Thus the pan 26 is continually shaken and the particles of concentrate which settle on it are gradually moved toward the outlet 27.

The pan 26 may be made of any flexible material which distorts while undergoing reciprocation, thin metal being preferable; but it may, for example, be made of rubber in which case the spider arms 30 may be attached to a metal frame inside the pan and another outside the pan between the members of which the flexible material is clamped.

An alternative construction by which the concentrate may be moved down the pan to the outlet is shown in Fig. 7. In this form a bumper, preferably in the form of a rubber ring 65 whose upper surface conforms to the pan 26, is mounted under the pan 26 surrounding the outlet 27 on a support 66 attached to the frame 10. This bumper 65 is adapted to be bumped by the pan 26 on its downward stroke with the result that the concentrate inside the pan is jarred down the inclined surface toward the outlet 27. It is evi-

dent that the bumper 65 may be employed in connection with a thin flexible pan as previously described or with a thicker and less flexible pan which would not of itself cause the concentrate to move.

It will be understood that various changes and modifications in design and construction from the apparatus disclosed herein may be made by those skilled in the art without departing from the spirit and scope of the invention as defined in the appended claims.

I claim as my invention:

1. A jig comprising in combination: a stationary screen; a permeable bed of particles supported by said screen; a pan positioned below said screen and having an outlet opening therein, said pan being inclined downwardly at an angle toward said opening; an expansible connection between said pan and said screen, whereby is formed an enclosed space of variable volume between said pan and said screen; means including a fluid motor for reciprocating said pan in a vertical direction; and a bumper adapted to be bumped by said pan at the end of one of its strokes, whereby concentrate settling on said pan is moved toward said opening by the continued vibration thus set up.

2. A jig comprising in combination: a stationary screen; a permeable bed of particles supported by said screen; a pan positioned below said screen; an expansible connection between said pan and said screen, whereby is formed an enclosed space of variable volume between said pan and said screen; a water-driven motor positioned above said bed; a pipe connected to the discharge of said water motor, said pipe extending through said bed and having an outlet in said enclosed space of variable volume; and a member connected to said pan and passing through said pipe, said member being connected to a movable part of said water-driven motor for reciprocation thereby in a vertical direction.

3. A jig comprising in combination: a stationary screen; a permeable bed of particles supported by said screen; a pan having a bottom in the form of an inverted flat cone having an outlet opening in the center thereof, said bottom sloping downwardly toward said outlet opening at an incline which would normally be insufficient to cause concentrate particles settling on said bottom to move toward said outlet opening; an expansible connection between said pan and said screen forming an enclosed space of variable volume between said pan and said screen; reciprocating means connected to the bottom of said pan for vertical reciprocation thereof, the bottom of said pan being constructed of relatively flexible material of such character that application thereto of forces sufficient to reciprocate said pan causes the bottom thereof to be distorted to such an extent that concentrate particles settling on said pan are moved to said outlet opening by reason of said distortion.

4. A jig comprising in combination: a stationary screen; a permeable bed of particles supported by said screen; a pan positioned below said screen and having an outlet opening in the bottom thereof, the bottom of said pan sloping downwardly toward said outlet opening at an incline which would normally be insufficient to cause free movement of concentrate particles to said outlet opening; an expansible connection between said pan and said screen forming an enclosed space of variable volume between said pan and said screen; the bottom of said pan being constructed of relatively flexible material of such character that application thereto of forces sufficient to reciprocate said pan causes the bottom thereof to be distorted to such an extent that concentrate particles settling on said pan are moved to said outlet opening by reason of said distortion; and reciprocating means connected to the flexible portion of said pan for vertical reciprocation of said pan.

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