Aug. 31, 1937. E. L. WILLIAMS 2,091,620

GOLD WASHING MACHINE

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Fig. 1.

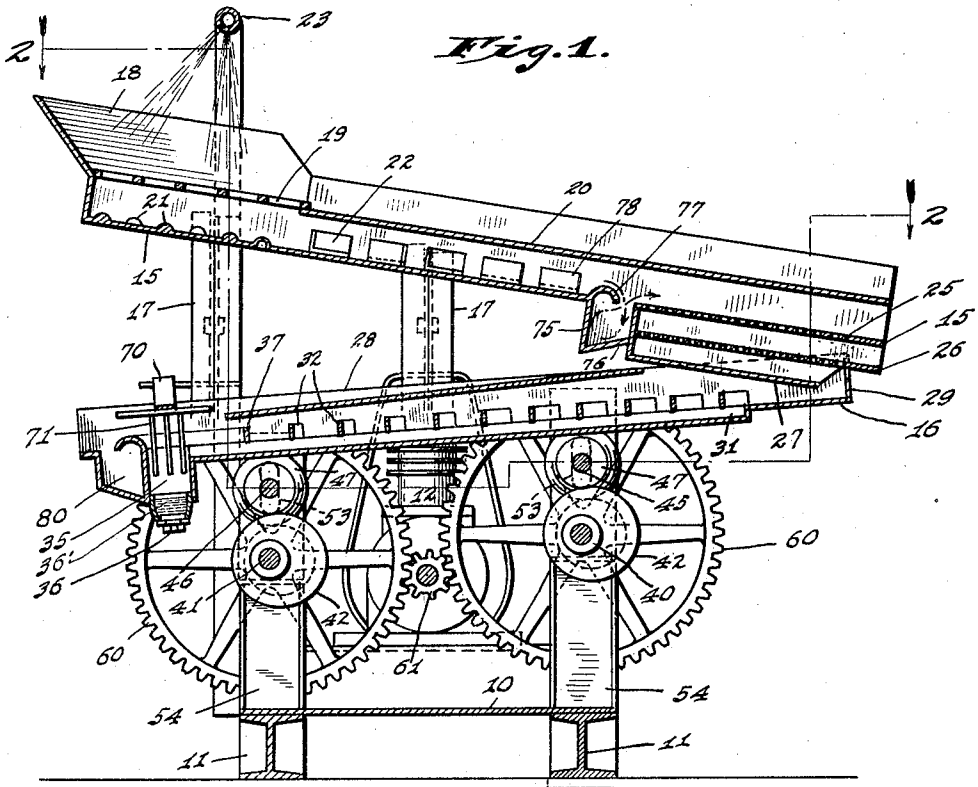
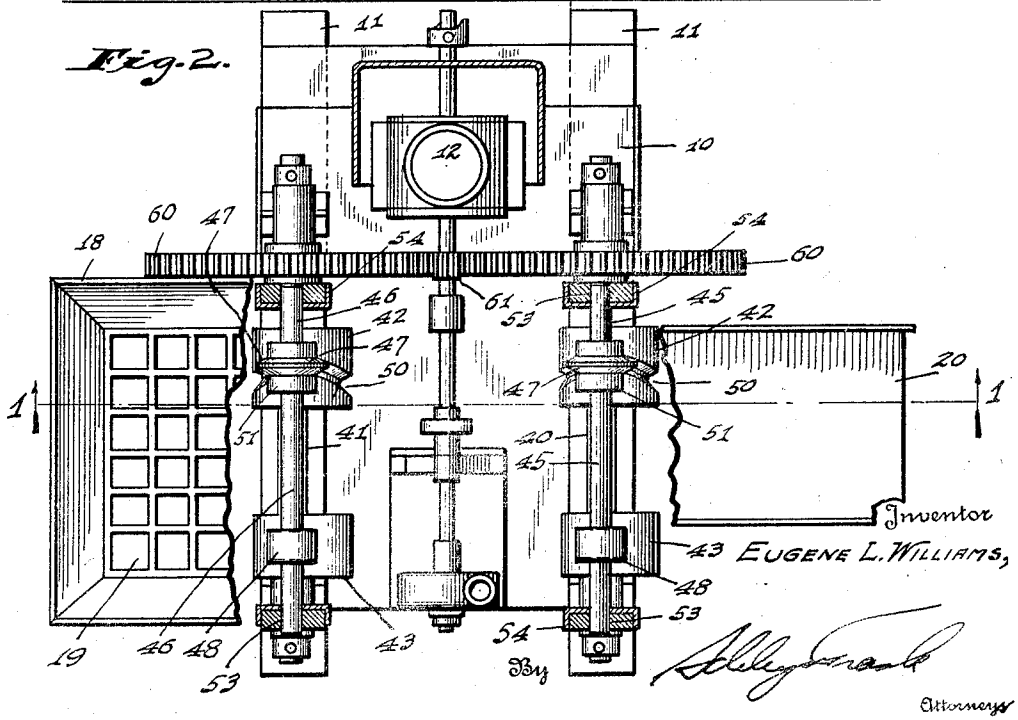


Fig. 2.



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Fig. 3.

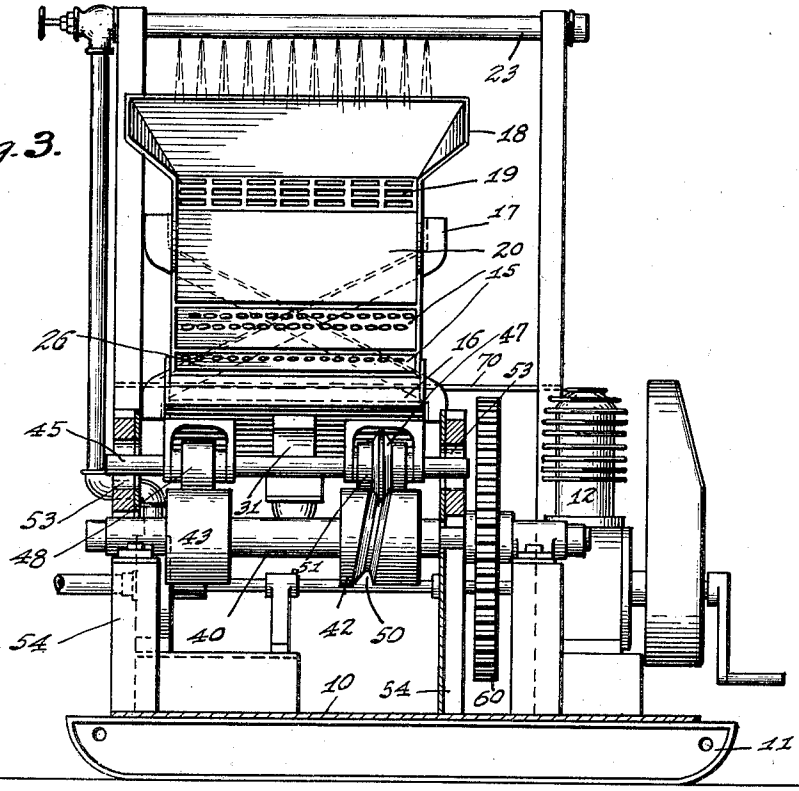
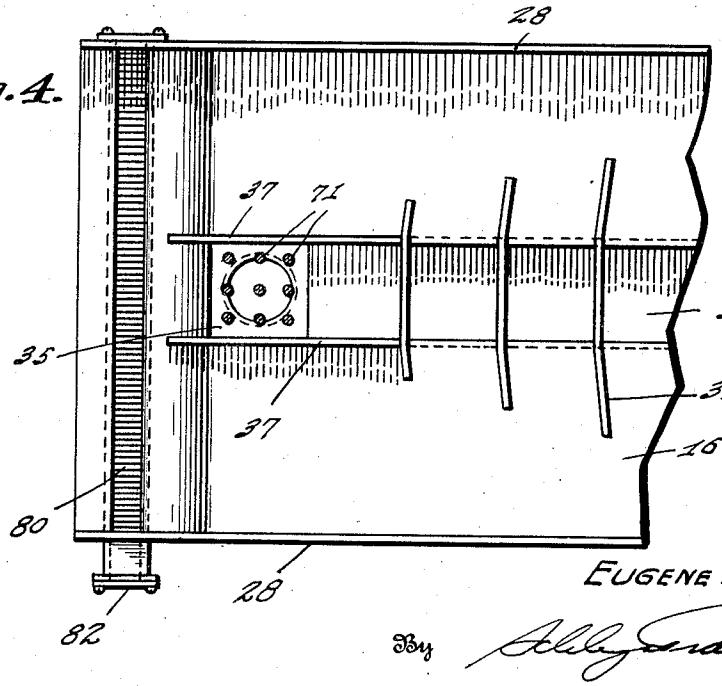


Fig. 4.



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Fig. 5.

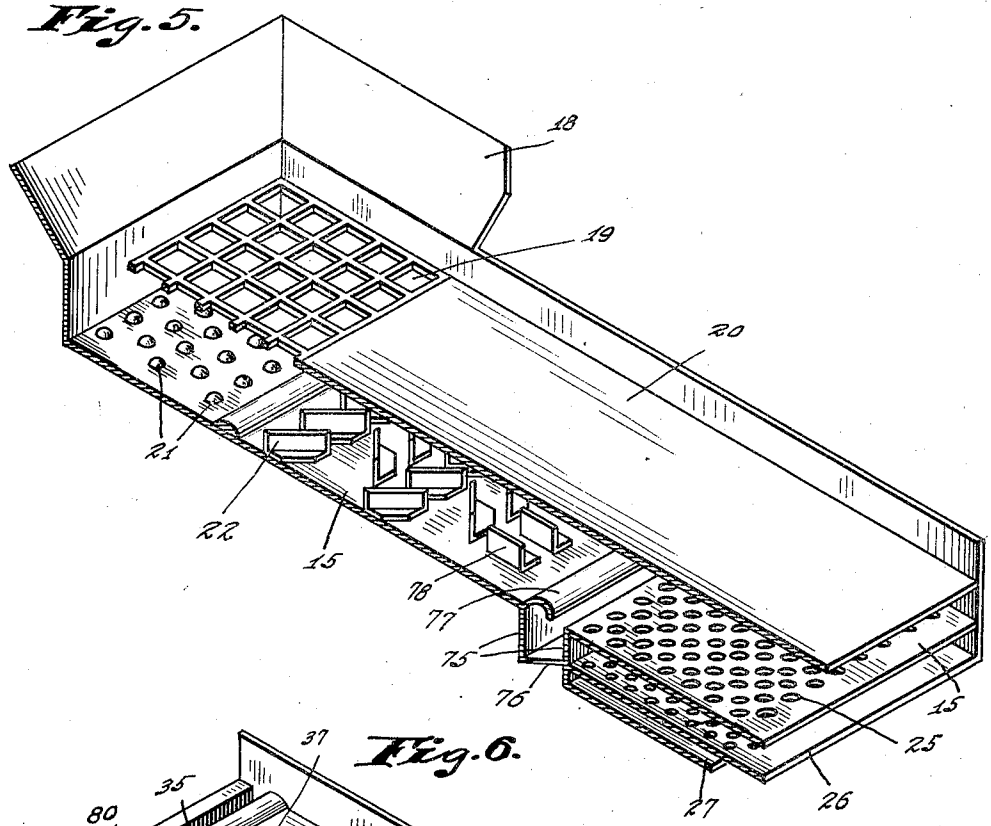
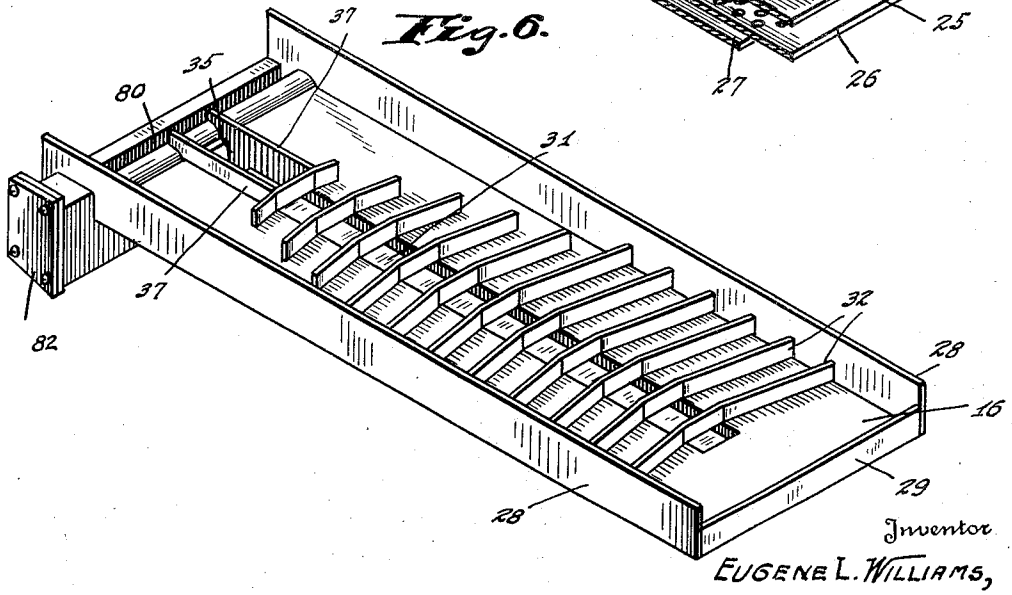


Fig. 6.



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GOLD WASHING MACHINE

Eugene L. Williams, Kansas City, Mo.

Application November 1, 1933, Serial No. 696,124

14 Claims. (Cl. 209—443)

My invention is concerned generally with gravel-treating and gravel-cleaning machines and specifically with apparatus intended and adapted for the recovery of gold, and especially fitted for tthe recovery of gold from very low-grade placer deposits.

Among the objects of my invention are to produce a machine which will effectively handle in quantity material of a wide variety of sizes, which will break up agglomerated lumps, which will remove all fines adhering to the surfaces of larger particles, and which will effectively concentrate any gold occurring either in the fines or as particles of larger size. Another object of my invention is to produce such a machine which will be compact and durable and which can be operated at but slight expense.

More specific objects of my invention include that of producing an effective screening device which will be self-cleaning. Still another specific object of my invention is to impart to the scrubbing and riffle tables over which passes the material being treated a peculiar movement that has been found to be very effective in aiding scrubbing and the settling out of the heavy gold particles. A further object of my invention is to make it possible to use the large quantity of water necessary for effective scrubbing and washing operations and then quickly to free the material being treated of all excess water so that the quantity remaining will be no more than that necessary to an effective concentration of gold particles by a suspension process. An additional object is to provide a trap of novel form for collecting gold particles, especially large nuggets in the material being treated.

In carrying out my invention, I provide a scrubbing table and a riffle table over which the material being treated successively passes. These tables, in the small machine with which this application is primarily concerned, are rigidly interconnected in superposed relation and oppositely inclined, and mechanism is provided for imparting to them reciprocation in both a vertical and in a horizontal transverse direction. On the upper surface of the scrubbing table I provide a number of upwardly extending elements which, in the reciprocation of the tables, are brought violently into contact with the material being treated. This, aided by the action of water supplied in quantity, thoroughly scrubs the larger particles of gravel and breaks up any friable lumps.

At the lower end of the scrubbing table, the material being treated passes over screens through which the fines and the bulk of the water pass on to the upper end of the riffle table. The riffle table embodies a longitudinal central channel and a series of riffles inclined toward said channel. The agitation of the riffle table keeps lighter material in suspension in the water but permits the gold to settle against the faces of the riffles to be fed inwardly to the channel and to pass downwardly along such channel to a concentrating well located at the lower end of the riffle table.

The accompanying drawings illustrate my invention: Fig. 1 is a vertical section through the complete machine on the line 1—1 of Fig. 2; Fig. 2 is a plan view of the machine with parts thereof broken away on the line 2—2 of Fig. 1; Fig. 3 is an end elevation of the machine; Fig. 4 is a fragmental plan view of the lower end of the riffle table; Fig. 5 is an isometric view of the scrubbing table and screens with parts thereof broken away, and Fig. 6 is an isometric view of the complete riffle table.

The machine illustrated in the drawings compises a frame 10 which may conveniently be mounted upon skids 11 for ease in moving it over the ground. Upon this frame is supported a source of power which is represented in the drawings as a small gasoline engine 12.

The moving parts of the machine include a pair of tables 15 and 16 over which the material being treated successively passes. In the machine illustrated, where compactness is a prime object, the two tables 15 and 16 are disposed one above the other and oppositely inclined so that material discharged from the lower end of the upper table 15 will be received upon the upper end of the table 16. In addition, the two tables are rigidly interconnected as by means of bracing members 17 so that they will move as a unit in the operation of the apparatus.

At the upper end of the upper table 15 there may be placed a small hopper 18 adapted to receive the material being treated. Immediately below this hopper I provide a relatively large-mesh screen or grizzly 19 adapted quickly to separate large stones and similar objects. These large stones or other objects, failing to pass through the openings in the grizzly 19, fall down an inclined plate 20 and are discharged.

The finer material passing through the grizzly falls upon the upper end of the able 15 which, over the area below the grizzly, is provided with a series of upwardly extending projections 21, conveniently hemispherical in shape. As the table 15 is agitated by the mechanism to be hereinafter

described, these projections 21 tend to break up the agglomerated lumps of material and to dislodge fines which adhere to the surfaces of large particles.

Immediately below the area covered by the projections 21, the table 15 is provided with a series of rows of inclined baffles 22, adjacent rows of such baffles being oppositely inclined. Conveniently, each of these baffles is formed of a short piece of angle iron one flange of which is secured, as by welding, to the upper face of the table 15, while the other flange extends generally upwardly in a plane perpendicular to the face of the table. Desirably, the upper ends of the generally vertical flanges of the baffles 22 are sharpened so as to exercise a cutting action upon the material passing through the baffles, thus serving further to break up agglomerated lumps and remove fines adhering to the larger solid pieces.

The action of the projections 21 and baffles 22 in breaking up lumps of agglomerated material and removing fines from the surfaces of larger solid pieces is augmented by the action of water discharged through a spray pipe 23 that extends across the upper open end of the hopper 18.

Beyond that area of the table 15 which is covered by the baffles 22 I provide in the table a series of openings 25 which form in effect a screen serving to separate comparatively large pieces of material from the remainder. If considered desirable, the action of the screen provided by the holes 25 may be supplemented by an auxiliary screen 26 placed beneath and parallel to the screen 25 and having openings of smaller size.

Below the openings 25 in the table 15, and below the auxiliary screen 26 if such an auxiliary screen is used, I provide an inclined plate 27 which serves to carry to the upper end of the table 16 all material falling through the openings in the screen or screens. As is clear from Fig. 1, the table 15 and the auxiliary screen 26 extend beyond the upper end of the table 16 so that the material which does not pass through the openings 25 and through the screen 26 will be discharged.

The material passing both screens is carried by the inclined plate 27 to the extreme top end of the table 16, falls upon such table, and tends to pass downwardly thereover under the influence of gravity. Further, a large part of the water discharged from the pipe 23 also passes through the screens 25 and 26 to be discharged upon the upper end of the table 16 upon which it is confined by side walls 28 and an end wall 29.

The table 16 is provided with a centrally disposed longitudinally extending channel 31 which opens upwardly. The table is also provided with a series of baffles or riffles 32 which project upwardly from the face of the table 16 and extend generally transversely of such table.

Each of the riffles 32 has a central portion bridging the channel 31 and disposed at substantially right angles to the longitudinal center-line of the table and channel. At or about the side edges of the channel 31, each of the riffles 32 is bent through an angle approximately 10°, the bent portions extending upwardly of the table 16. Near the upper end of the table 16, the riffles 32 extend from one side wall 28 to the other; but I have found it advisable, beginning about one-third the way down the table 16, to shorten the riffles gradually and successively, as is clear from Fig. 6, until the last riffle 32 has a length equal to but a fraction of the width of the table 16.

At its extreme lower end, the channel 31 communicates with a well 35 having a removable bottom closure 36, the purpose of which will become evident hereinafter.

To confine the material entering the well 35 to that which flows downwardly in the channel 31, I provide on each side of the channel below the lower riffle 32 an upwardly projecting plate 37 which extends downwardly of the table 16 from the lower riffle to a point beyond the open upper end of the well 35.

For the purpose of securing the desired movement of the two tables 15 and 16 I employ the mechanism shown in the drawings which includes two shafts 40 and 41 which are mounted for rotation in the frame 10 and which extend transversely of the tables 15 and 16. Upon each of these shafts I mount a pair of eccentric cams 42 and 43 which are of equal diameter and similar eccentricity. From the lower table 16 I mount two transversely extending shafts 45 and 46 each of which carries two rolls 47 and 48 which rest upon the eccentric cylindrical surfaces of the cams 42 and 43 respectively. As is evident, rotation of the two shafts 40 and 41 results in vertical reciprocation of the two tables 15 and 16.

I find that vertical reciprocation of the tables is not sufficient to give the best results, and I therefore provide means for causing the tables to reciprocate horizontally as well as vertically. To this end, one of the cams on each of the shafts 40 and 41, here shown as the cam 42, is provided with a groove 50 lying in a plane oblique to the axis of the shaft with which the cam rotates and the corresponding roller 47 is provided with an outwardly projecting annular flange 51 which is received in the groove 50. This is clear from Figs. 2 and 3.

The shafts 45 and 46 which are supported from the lower table 16 may project outwardly through vertical slots 53 in vertical members 54 on the frame of the machine to guide the tables. The shafts 45 and 46 are free to move longitudinally of themselves in the slots 53, so that neither horizontal reciprocation nor vertical reciprocation of the tables is interfered with.

For the purpose of driving the shafts 40 and 41, each may be provided with a gear 60 which meshes with a common pinion 61 on the crank shaft of the engine 12.

The eccentric cams 42 and 43 on the two shafts 40 and 41 are preferably set so that their eccentricities are corresponding so that each of the tables 15 and 16 will always remain parallel to itself as it moves up and down. Each oblique groove 50 is so disposed relative to the direction of eccentricity of the cam 42 that the tables reach the limit of their vertical movement at a time different from that at which they reach the limits of their horizontal movement. In other words, the vertical and horizontal reciprocatory movements of the tables are out of phase with each other; and as a result, the two tables 15 and 16 move in unison in a closed curved path located in a plane which is vertical and which extends transversely of the tables.

The agitation which is produced by the table-movement above set forth has proven very effective for my purpose. The material falling through the grizzly 19 is severely agitated in contact with the projections 15 and baffles 22; and this agitation, supplemented by the action of water, very effectively breaks up all lumps of agglomerated material and removes the fines from the surface of large stones. In addition, the table agitation is very effective in the screen-

ing by the holes **25** and the auxiliary screen **26**, the vertical reciprocation serving to prevent the building up of an accumulation of fine material around the edges of the screen openings. As a result, by the time the material reaches the lower end of the table **15** substantially all fines have been removed and pass through the screens on to the upper end of the table **16** together with a large part of the water discharged from the pipe **23**.

As the material passes over the table **16**, the agitation thereof tends to cause all the heavier gold particles to settle while maintaining the lighter fines in suspension. The gold particles separating out collect against the upper faces of the riffles **32**, work their way inwardly as the result of the slight inclination of such riffles, and eventually drop into the channel **31** through which they pass to the well **35**.

In placer deposits, there frequently occur quantities of iron in the form known as "black sand" which is relatively heavy and a part at least of which may, by reason of its weight, find its way into the well **35**. In the well **35**, therefore, I may place a quantity of mercury with which the gold will amalgamate leaving the iron-bearing black sand free.

For the purpose of agitating the material in the well **35** I may support from the frame **10** a transverse bar **70** which carries a series of downwardly extending rods **71** that project into the well **35**. As the bar **70** is stationarily supported from the frame of the machine, and as the material in the well moves back and forth and up and down with the tables, the rods **71** violently agitate the contents of the well **35** and act as a stirring means. The resulting agitation brings all the gold particles into contact with the mercury **36'** and at the same time prevents the black sand from settling and packing in the well.

The particular arrangement of riffles illustrated best in Fig. 6 has a very definite advantage. In order to insure that all fines will be washed from the surface of larger particles it is essential that a large quantity of water be discharged from the pipe **23**. The quantity of water necessary for this purpose is far more than is necessary for the separating process carried out on the table **16**. It is for this reason that the riffles **32** near the lower end of the table **16** are made shorter, as free escape of water with the lighter fines around the ends of the shortened riffles is permitted.

I find it desirable to provide ahead of the screens **25** and **26** a trap adapted to collect any nuggets of gold which may be in the material treated. One such trap is illustrated in Figs. 1 and 5 immediately above the holes **25** in the table **15**. This trap lies below the plane of the table and extends completely across it. It has two side walls **75** disposed generally perpendicular to the table **15** and a bottom wall **76** which is inclined to the horizontal in a direction opposite to the inclination of the table **15**.

From the upper edge of the open upper end of the trap there extends a lip **77**. Conveniently, this lip is of a width approximately half that of the trap-opening. The upper surface of the lip is generally semicircular in cross-section, as is clear from Fig. 1.

When a trap, such as the trap just described, is located immediately below the inclined baffles **22**, I find it desirable to interpose between the last set of such baffles and the lip **77** a series of baffles **78** which extend longitudinally of the table **15** and serve to straighten the direction of movement of the material discharged from the baffles **22**, thus eliminating any tendency of such material to collect at one side of the table **15**.

With a trap such as above described the water passing generally downwardly along the table **15** is elevated somewhat by the slope of the upstream face of the lip **77** and then drops as it passes beyond the crest of the lip. As a result, the water immediately above the trap opening has a downward component of movement and some of it will enter the trap together with any fairly large sized gold particles freed by the scrubbing action to which the gravel has been subjected. The direction of this water entering the trap is in effect tangential to the body of water already in the trap so that such water will be subjected to a whirling action. Relatively heavy gold particles will be deposited in the acute-angled corner between the bottom trap-wall **76** and the upper side wall **75** while particles of lighter material will be maintained in suspension and prevented from packing in the trap.

If desired, one or more check-traps **80** may be provided at the lower end of the table **16** beyond the well **35** to catch any gold particles which have escaped concentration. Such a trap will also serve to collect any floured mercury which escapes from the well **35** after having become suspended in finely divided state in the water in the well.

At the conclusion of operations, the machine is stopped and gold is removed from the traps which may be provided with removable end-closures **82** for that purpose. The bottom-closure **36** of the well **35** is removed and the gold amalgam drained from the well **35**. The gold in the amalgam may be recovered by known methods which form no part of my present invention.

I claim as my invention:

1. In mineral concentrating apparatus, an inclined table provided with a longitudinally extending channel, a series of riffles each extending transversely of said riffle table, each of said riffles having a central portion bridging said channel and end portions bent to extend obliquely upward on the table, the riffles near the upper end of the table extending substantially completely across it and those near the lower end of the table having a length less than the width of the table, and means for causing said table to reciprocate both horizontally and vertically.

2. In mineral concentrating apparatus, a longitudinally inclined table provided with a longitudinally extending channel, a series of riffles each extending transversely of said riffle table, each of said riffles having a central portion bridging said channel and end portions bent to extend obliquely upward on the table, and means for causing said table to reciprocate both laterally and vertically.

3. In mineral concentrating apparatus, an inclined table provided with a longitudinally extending channel, a series of riffles each extending transversely of said riffle table, each of said riffles having a central portion bridging said channel and end portions bent to extend obliquely outward from said channel and upward on the table, the riffles near the upper end of the table extending substantially completely across it and those near the lower end of the table having a length less than the width of the table, and means for agitating said table.

4. In mineral concentrating apparatus, an inclined table provided with a longitudinally extending channel, a series of riffles each extending transversely of said riffle table, each of said riffles

having a central portion bridging said channel and end portions bent to extend obliquely outward from said channel and upward on the table, the riffles near the upper end of the table extending substantially completely across it and those near the lower end of the table having a length less than the width of the table.

5. In mineral concentrating apparatus, a riffle table, a pair of rotatable, horizontally spaced, parallel eccentrics disposed adjacent said riffle table, said eccentrics being provided with peripheral grooves, said grooves being continuous and having generally helical portions of opposite hand, means guiding said table for movement in a plane parallel to the axes of rotation of said eccentrics, and rollers mounted on said table and received in said grooves.

6. The invention set forth in claim 5 with the addition that said riffle table is inclined in a plane substantially perpendicular to the axes of rotation of said eccentrics.

7. In mineral concentrating apparatus, a table, means for causing mineral-bearing liquid to flow longitudinally over said table, said table having a longitudinally extending opening and below such opening a longitudinal trough, and a plurality of inclined baffles on the upper surface of said table inclined toward said trough in the direction of liquid-flow.

8. The invention set forth in claim 7 with the addition that said trough is of substantially rectangular cross-section.

9. The invention set forth in claim 7 with the addition of means for reciprocating said table in a plane transverse to the path of liquid-flow.

10. In a device of the class described, a longitudinally inclined scrubbing table, a longitudinally inclined riffle table positioned to receive material discharged from said scrubbing table, means confining each of said tables to movement in a vertical plane which is transverse to the table, and means for causing each table to move in a closed curved path in such plane.

11. In combination, means for scrubbing and washing gravel, a longitudinally inclined riffle table for receiving the washings from said scrubbing and washing means, means confining said riffle table to movement in a vertical plane which is transverse to said riffle table, and means for causing said riffle table to move in a closed curved path in such plane.

12. In mineral concentrating apparatus, a riffle table, eccentrics supporting said table, said eccentrics being disposed on horizontally spaced parallel axes and rotatable about such axes to cause generally vertical reciprocation of said table, and provisions for reciprocating said table generally horizontally as it reciprocates vertically, said vertical and horizontal reciprocation being at the same rate but out of phase with each other whereby said table is moved in a closed curved path.

13. In a mineral concentration apparatus, a riffle table, mechanisms for reciprocating said table translationally in two different directions in the same plane transverse to said table, said mechanisms producing respective reciprocations which are at the same rate but out of phase with each other whereby said table is moved in a closed curved path.

14. In mineral concentration apparatus, a riffle table, mechanism for causing said table to move in a closed curved path in a plane transverse to the table, said table being provided with riffles which are oblique to the plane in which the table is moved.

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