Aug. 20, 1935. W. J. HANCOCK 2,012,192

MINERALS SEPARATING AND CONCENTRATING MACHINE

Filed Oct. 7, 1932 2 Sheets-Sheet 1

Fig. 2.

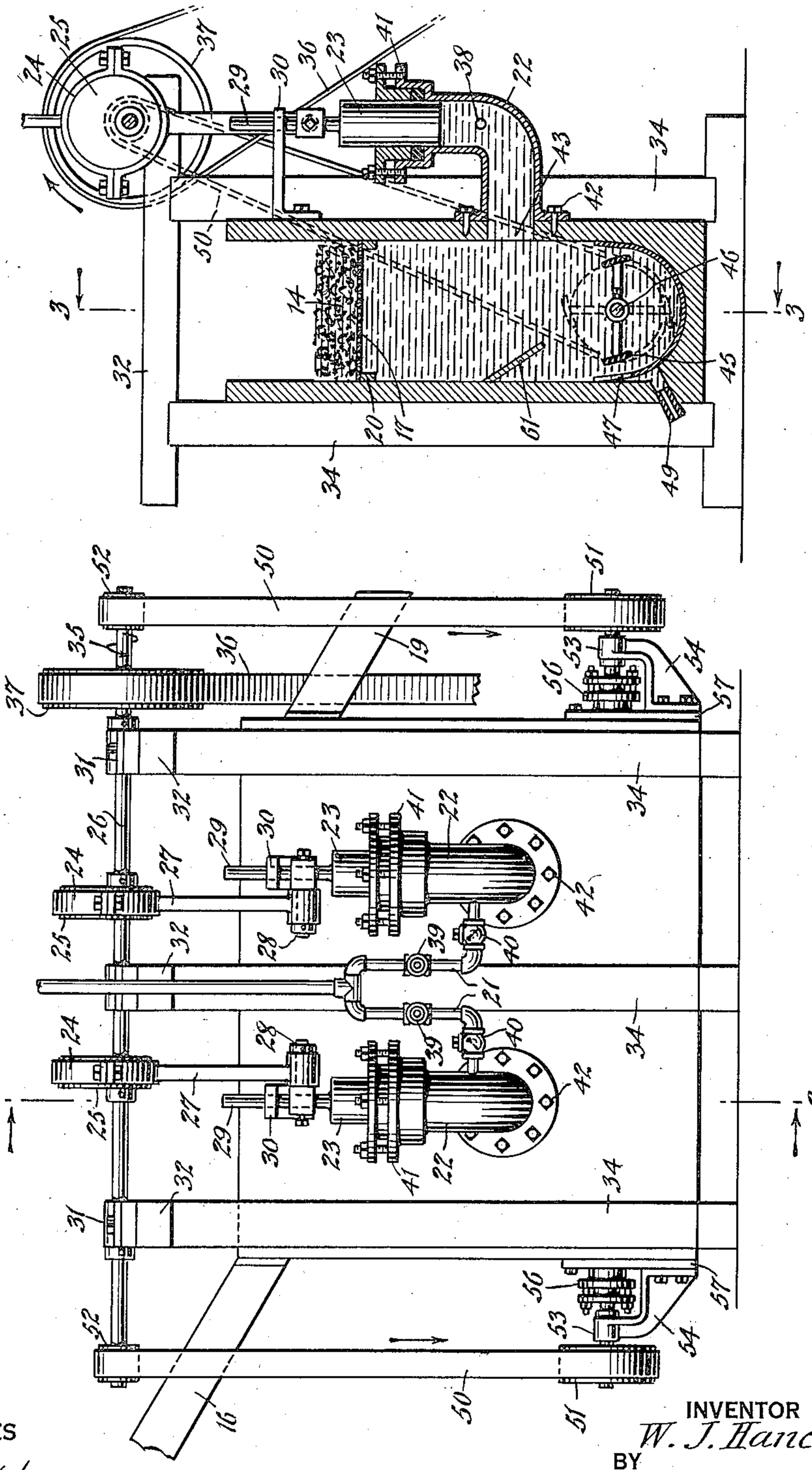

Fig. 1.

WITNESSES

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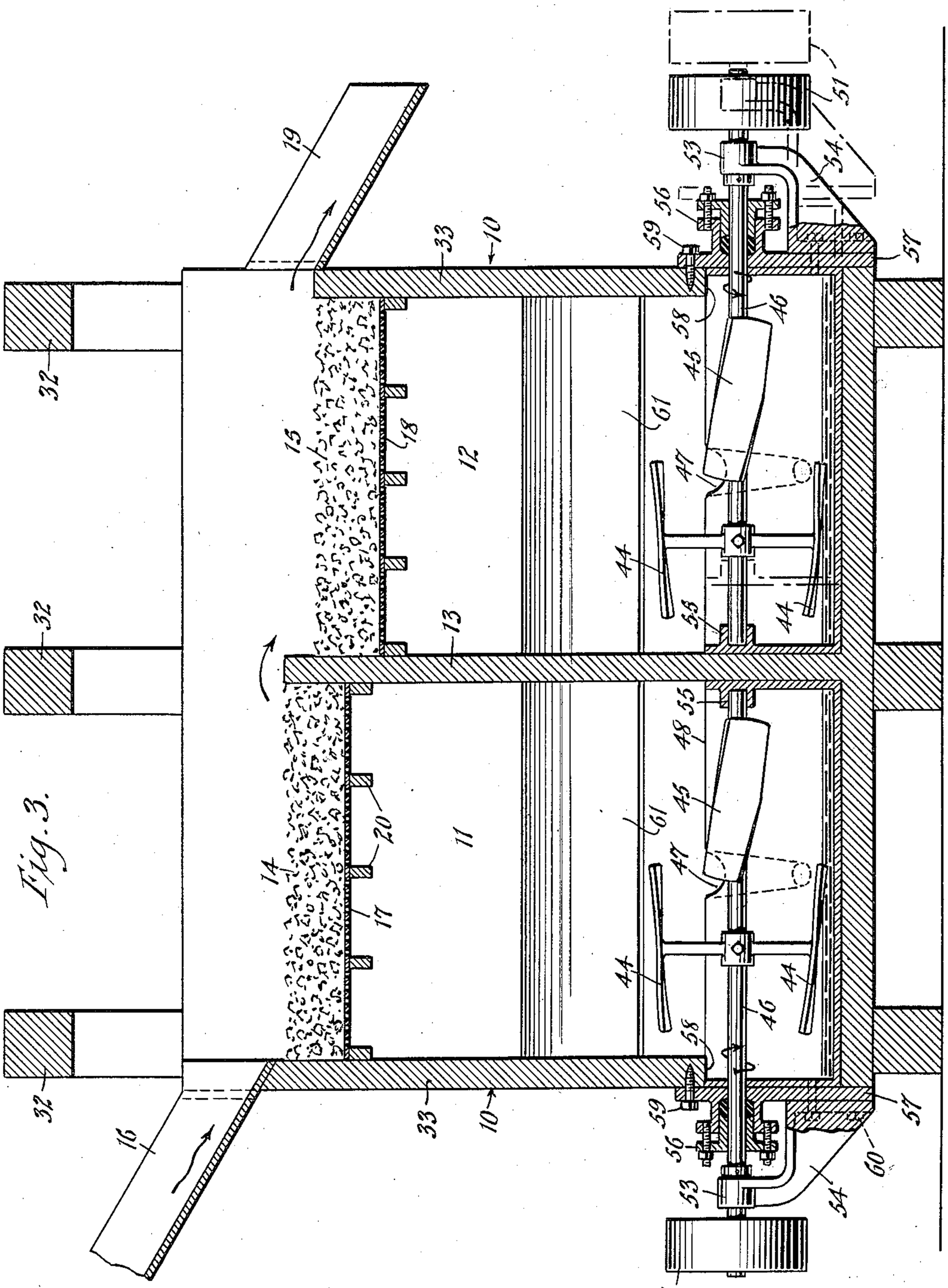

Fig. 3.

WITNESSES

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MINERALS SEPARATING AND CONCENTRATING MACHINE

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2 Claims. (Cl. 209—14)

This invention relates to machines for the separation of minerals from their ores, and has for an object to provide a machine for the separation of minerals of various specific gravities from their ores and the concentration of the minerals in amalgams.

The machine is particularly applicable to the separation of free gold and silver from the gangue of alluvia or placer deposits or of rock formation after it has been pulverized. As gold and silver are usually commingled in such ore and have different specific gravities, they are effectively separated by the present invention and concentrated into amalgams, one of which is predominately gold amalgam and the other silver amalgam.

The invention has in view the separation of minerals from the gangue, and the separation of the minerals from each other by pulsations produced in the ore bed as the ore flows through the machine, which lift the ore from the bed causing the minerals to arrange themselves on the beds in accordance with their specific gravities.

Another object of the invention is to provide means for imparting a swirling motion to the water under the ore bed, thereby maintaining the minerals in motion on the bed, and means for producing pulsations in the water under the ore bed which raises the ore from the bed permitting the minerals which have a heavier specific gravity than the gangue to settle upon the screen forming the support for the ore bed and to pass through the screen and to be thus separated from the gangue or agglomerate.

Another object of the invention is the provision of means for regulating the strength of the pulsations and thereby the height or movement of the ore upon the bed, by adjusting the flow of water into the chamber under the bed, whereby minerals of various size and specific gravities may be separated from their ores.

Still another object of the invention is to provide a machine which is positive in its action whereby substantially all of the water flowing with the ore is caused to flow over the ore deposited upon the bed of the machine, which makes it possible to carry a relatively large ore body and reduces the quantity of gangue working through the screen forming the bed of the machine.

With these and other objects in view, the invention also consists of certain novel features and arrangement of parts which will be more fully described and claimed hereinafter.

The invention is shown in the accompanying drawings, in which

Figure 1 is a side elevation of the container and its operating mechanism;

Fig. 2 is a sectional view on the line 2—2 of Fig. 1;

Fig. 3 is a longitudinal sectional view on the line 3—3 of Fig. 2.

In the embodiment of the invention illustrated in the accompanying drawings, a two-stage apparatus is shown, one stage separating the heavier mineral from the ore and concentrating the same into an amalgam, and the second stage separating the light mineral from the gangue and concentrating the same into an amalgam.

The machine includes a suitable watertight container 10, which is divided centrally into compartments 11 and 12 by a dividing wall 13, the upper portion of the container 10 being constructed to form ore beds 14 and 15, over which the ore flows by gravity with the water carrying the ore through the machine. The ore with a suitable quantity of water is delivered to the container by an inclined delivery flume 16, secured to the container at one end, which deposits the ore upon the beds 14 and 15 formed by the screens 17 and 18, respectively. After the mineral is separated from the ore, the gangue or agglomerate is washed from the container through the discharge flume 19, secured to the container at the opposite end from the delivery flume 16. The screens 17 and 18 are arranged in the compartments 11 and 12, respectively, in stepped relation, the screen 17 which receives the ore direct from the delivery flume 16 being at a slightly higher elevation than the screen 18 which receives the lighter mineral which has not been separated after passing over the screen 17. The said screens are secured in position in the compartments, respectively, by any desired means, such as wooden cross bars 20, and at the required distances below the top of the wall 13 to provide relatively deep ore beds above the screens.

For the purpose of preventing the ore compacting on the screens and to lessen the suction under the screens, each of the compartments 11 and 12 is provided with a supplementary water supply 21, which is drawn into the pipe bends 22 by the upward stroke of pistons or plungers 23, which reciprocate in the vertical arms of the said pipe bends and which force the water into the compartments on the downward stroke of the pistons, respectively.

The pistons receive their vertical reciprocating movement from the cam followers 24, which are mounted upon eccentric cams 25 secured to a countershaft 26. The cam followers are provided

with crank arms 27, which are journaled on rocker shafts 28 carried by each of the piston rods 29. The upper ends of these rods each engage a guide bracket 30 secured at one end to the wall of the container 10, which brackets restrict the pistons to vertical reciprocating movement. The countershaft 26 is journaled at 31 upon the cross members 32 secured upon the top of posts 34, and this shaft is rotated in the direction of the arrow 35, by any desired motive power, such as by a motor, not shown, driving the belt 36 around a pulley 37 keyed to said countershaft adjacent one end thereof.

The supplemental water supply 21 is admitted to each of the pipe bends 22 at a point 38 below the bottom of the stroke of the pistons in order that the full suction or upward stroke of the pistons may be utilized in drawing the water into the pipe bends, and the full downward stroke of the pistons utilized in forcing the water into the compartment. The amount of water entering each compartment through the supply 21 determines the amount of lift imparted to the ore upon the screens 17 and 18.

When separating minerals of relatively large granules from their ores, stronger pulsations are required. For this reason, the quantity of water entering through the supply 21 is adapted to be regulated by means of a valve 39, located in each supply line. On the downward stroke of the pistons, the said water lines are automatically closed by check valves 40.

The upper ends of the pipe bends 22 are each provided with a stuffing box 41, which prevents the escape of water about the pistons, the lower ends of the pipe bends being secured to the rear wall of the container by lag screws 42.

The downward stroke of the pistons displaces the water in the pipe bends, forcing the same into the compartments, respectively, through the openings 43, and raising the elevation of the water in the compartments, producing an overflow over the top of the intermediate wall 13 and the end wall 33, and a lifting action upon the ore on the screens. This lifting of the ore causes the material having lighter specific gravity to be forced up higher than the materials having a relatively heavier specific gravity, which quickly falls again upon the screen; the lighter gangue material being drawn into the influence of the water passing over the bed upon the screen, is washed first from the screen 17 onto the screen 18 and then out through the discharge flume 19. The upward stroke of the pistons draws into the pipe bends sufficient auxiliary water to break the suction of the upward stroke, thus substantially no suction is felt on the ore on the screens.

The smaller particles of the mineral separated from the ore on the screens fall through the openings in the screens and down through the compartments and into the influence of revolving blades 44 and 45 mounted upon a shaft 46 arranged in each compartment. These blades are arranged upon the said shaft in spaced relation, one of which has a right-hand spiral pitch and the other a left-hand spiral pitch. These blades turning upon the shafts 46 impart turning motion to the water from the ends of the compartments towards the center and draw the finer particles of the mineral and such fine particles of the gangue that have fallen through the screens towards the center. The revolution of these blades also maintains the water below the screens in constant motion, and prevents the ore above the screens from becoming compacted thereupon. The fine particles of gangue pass out through the notches 47 in the pans 48 and through the spigot or opening 49 in the bottom of the container 10, through which water is continually flowing. The said pans 48 are semi-circular in cross section, as shown in Fig. 3, and are each provided with a quantity of mercury which is churned up with the turning of the blades 44 and 45 so that the particles of the mineral which have passed through the screens are brought into contact therewith and produce a concentrated amalgam.

The shafts 46 are oppositely disposed in the compartments 11 and 12, respectively, but are driven in the same direction by belts 50 operating over pulleys 51 secured to the outer ends of the said shafts and over pulleys 52 secured on the ends of the countershaft 26. The shafts 46 each revolve in a bearing 53 on the outer ends of brackets 54 and in bearings 55 formed integrally with the end walls of the pans 48. Each of the shafts 46 extends through a stuffing box 56 which prevents the escape of water from the compartments about the said shafts. These boxes are provided with flanged plates 57 which are arranged over openings 58 in the lower part of the compartments 11 and 12, closing the said openings and holding the pans 48 in position. Lag screws 59 and 60 secure the said flanged plates and the brackets 54 in position against the end walls of the container. When the mercury in the pans 48 has become saturated with the minerals passing through the screens 17 and 18, the pans may be removed and fresh mercury placed in the pans by removing the lag screws 59 and 60, thus enabling the pans and the shafts 46 to be withdrawn from the compartments, as shown by the dot-and-dash line in Fig. 3.

It will be understood that the separating and amalgamating operations are the same in each of the compartments 11 and 12, the compartment 11 separating the mineral having the heavier specific gravity, while in the compartment 12 the lighter mineral is separated from the ore.

As herein described, the pans 48 are formed semi-circular in cross section in order that the mineral falling down through the compartment upon the side wall of the pans, will drop to the bottom of the pans into the mercury, thus eliminating any "dead" pockets in the pans. A deflector plate 61 is provided in each of the compartments above the opening 49, which deflects the minerals towards the center of the pans away from the said opening.

When the ore contains minerals of different specific gravities, such as gold and silver, or lead and zinc, the mineral having the heavier specific gravity, such as gold in the case of gold-and-silver ore, will be separated from the ore in the first compartment and passing through the screen will become amalgamated with the mercury in the bottom of the said compartment. The silver in the ore having lighter specific gravity will pass with the gangue to the second compartment and settling upon the screen 18 will pass therethrough and being brought into the influence of the mercury will form an amalgam therewith.

When the ore contains lead and zinc, the lead will be separated from the ore in the first compartment since it has the heavier specific gravity, while the zinc having the lighter specific gravity will be separated from the gangue in the second compartment. When separating lead and zinc from their ore, the pans 48, which are preferably formed of copper when treating gold-and-silver ore, are replaced with steel pans. The lead and zinc falling into the steel pans in the respective

compartments are churned up with the water by the revolving blades 44 and 45 and continually discharged through the spigots 49. The first compartment will discharge through its spigot a concentrate predominately lead, while the second compartment will discharge a predominately zinc concentrate.

It is important to note that in the operation of the machine the water contained therein is constantly agitated by the churning action of the revolving blades in the amalgamating pans which are so formed as to draw the water from the opposite ends of the chambers towards the center, thus acting at all times on the beds of ore supported on the screens, while at intervals, by means of the plungers, the ore beds are raised and lowered bodily, thus causing the heavier metals therein contained to gravitate towards the screens and to pass therethrough to the amalgamating pans at the bottom; also that the raising of the ore beds by the downward stroke of the plungers acts to effect the transfer of ore from one screen to the other and finally to discharge the same from the machine by the raising of the water level so that the incoming stream at the same time that it deposits new ore on the ore bed in the first section, takes off the top of that bed of ore and delivers it to the next section. By means of valves controlling the flow of water to the plungers, and the check valves, the upward movement of the plungers is facilitated and the amount of water admitted to the container may be regulated, and thus adjusting the upward pressure on the ore beds caused by pulsations to accommodate the action to minerals of different specific gravity. The varying of the water pressure on the check valves and the pulsations, is an important feature of the present invention. When it is desired that the lighter minerals shall drop into the amalgamating pans the regulating valves are closed to the desired point thereby decreasing the upward pressure on the mineral beds, while the admission of more water through the valves increases the upward pressure carrying the lighter mineral and sand upward where it is carried off by the wash water.

What I claim is:

1. A machine for separating minerals from their ores including a container, a pair of independent compartments arranged in said container, a screen in each of said compartments at or near the top and supported at different levels forming beds on which ore is deposited by water flowing through the machine, and the screens being disposed so that the ore on the bed disposed in the higher plane discharges on the bed disposed in the lower plane, an inlet duct for supplying ore leading to the ore bed disposed in the higher plane, an outlet duct for discharging the slag leading from the ore bed disposed in the lower plane, said compartments being adapted to contain water of a height corresponding to the level of the top of the ore on said screens, pipe bends connected to each of said compartments beneath the screens, pumps including reciprocating plungers arranged in each of said pipe bends, water supply pipes connected to said pipe bends below the lower end of the stroke of the plunger, check valves in said water supply pipes to automatically control the flow of water from the pumps to the compartments, regulatory valves in said supply pipes to control the amount of water delivered to the pumps, an amalgamating chamber in each of said compartments beneath the screens, outlets formed adjacent the center of said amalgamating chambers, and a plurality of spirally disposed blades cooperable to agitate the water and direct its flow towards said outlets.

2. A machine for separating minerals from their ores including a container, a screen disposed adjacent the top of said container and forming a bed on which ore is disposed, means for supplying ore to the bed, means for discharging slag from said bed, said compartment being adapted to contain water of a height corresponding to the level of the top of the ore in said screen, a pipe bend connected to said compartment beneath the screen, a pump including a reciprocating plunger disposed in said pipe bend, a water supply pipe connected to said pipe bend below the lower end of the stroke of the plunger, a check valve in said water supply pipe to automatically control the flow of water from the pump to the compartment, a regulatory valve in said supply pipe to control the amount of water delivered to the pump, an amalgamating chamber adjacent the bottom of said compartment, said amalgamating chamber having an outlet formed in its central portion, and a plurality of spirally disposed blades mounted for rotating movement and cooperable to agitate the water and direct its flow towards said outlet.

WILLIAM J. HANCOCK.