G. A. FOWLER.

RECIPROCATING MULTIPLE COMPARTMENT CONCENTRATOR.

APPLICATION FILED APR. 13, 1909.

955,329. **Patented Apr. 19, 1910.**

2 SHEETS—SHEET 1.

Fig. 1.

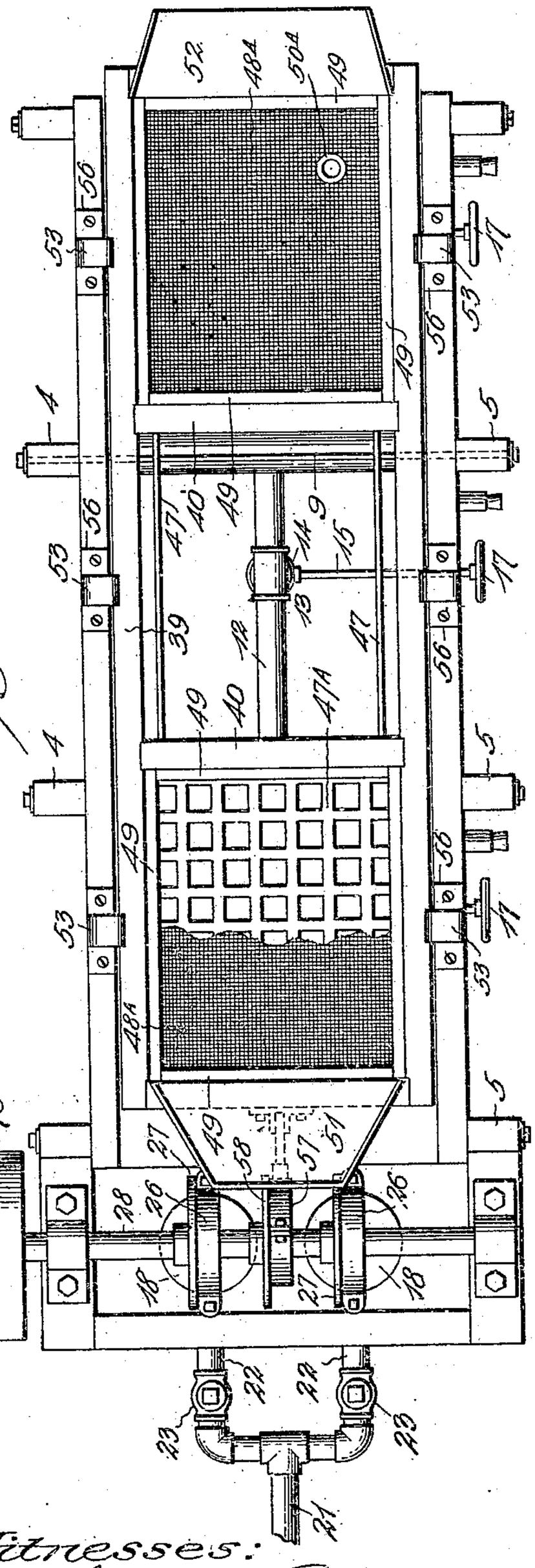

Fig. 7.

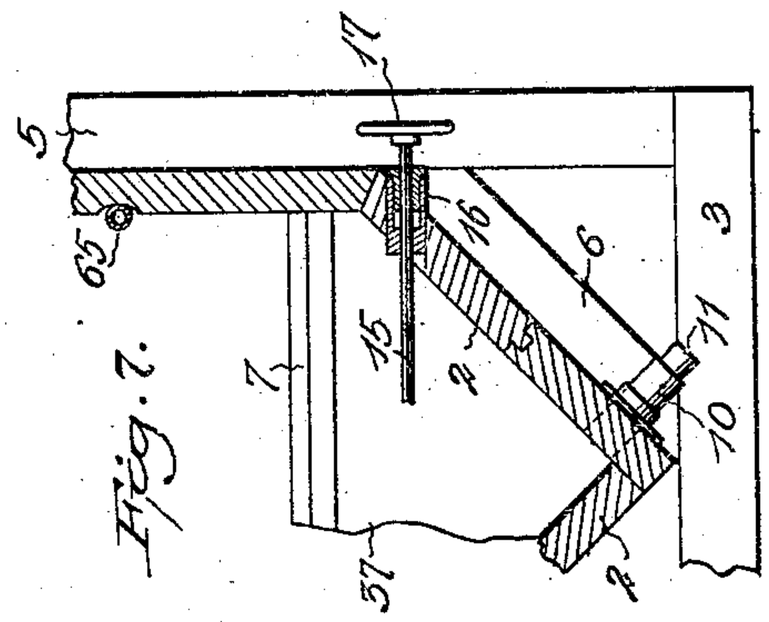

Fig. 6.

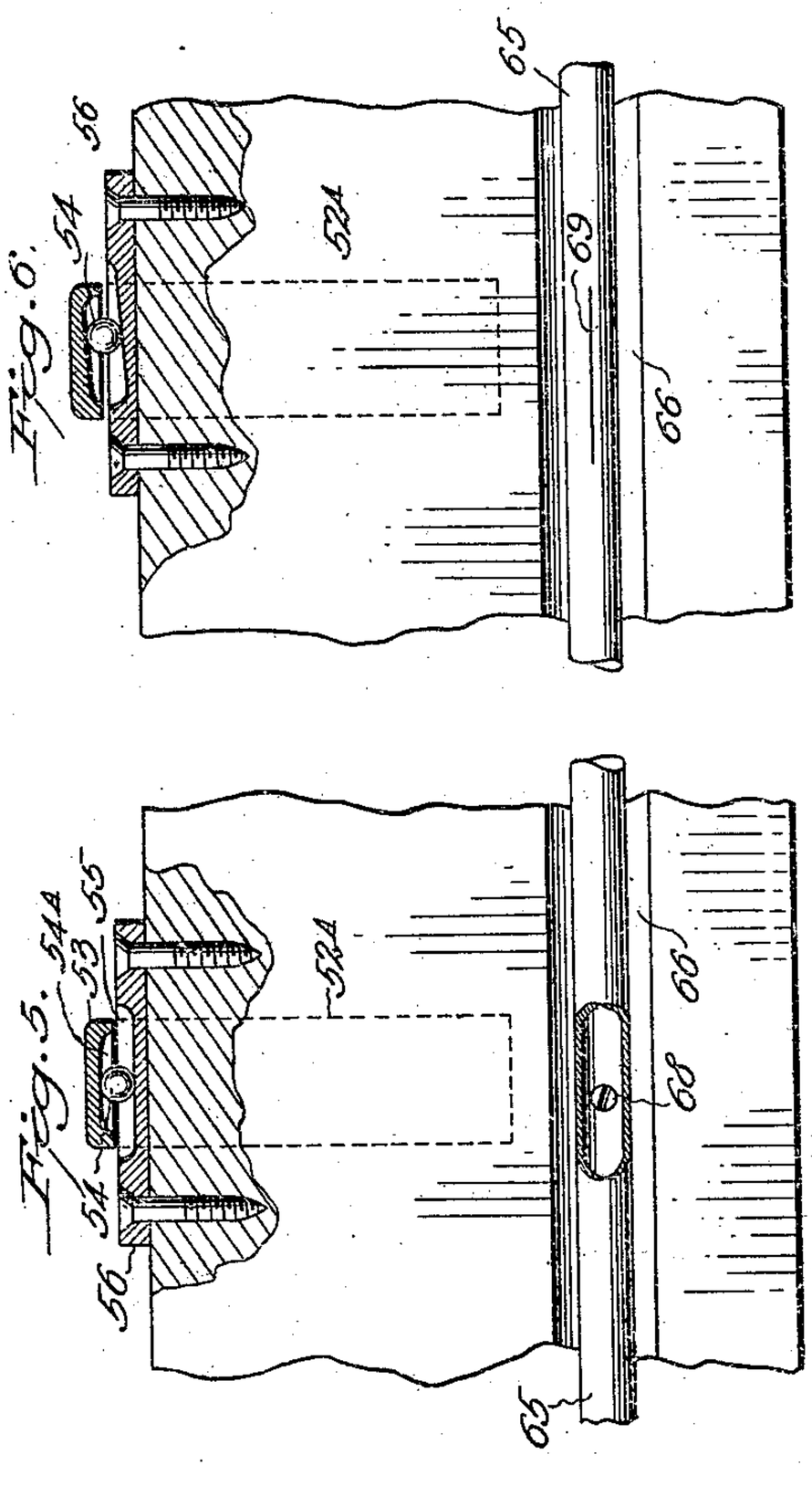

Fig. 5.

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2 SHEETS—SHEET 2.

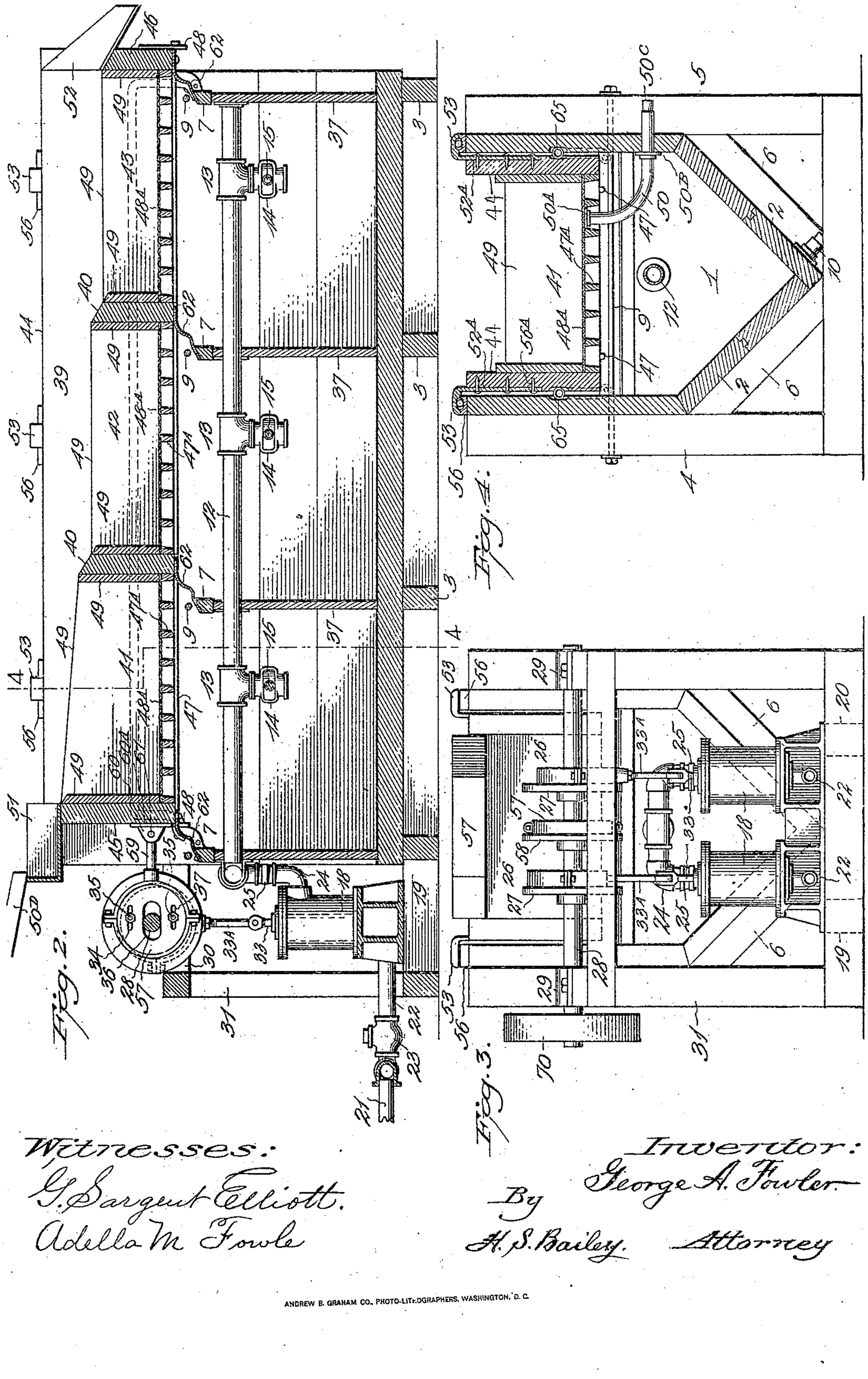

Fig. 2.

Fig. 1.

Fig. 3.

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UNITED STATES PATENT OFFICE.

GEORGE A. FOWLER, OF DENVER, COLORADO, ASSIGNOR TO THE FOWLER CONCENTRATOR COMPANY, OF DENVER, COLORADO, A CORPORATION OF ARIZONA TERRITORY.

RECIPROCATING MULTIPLE-COMPARTMENT CONCENTRATOR.

955,329. Specification of Letters Patent. **Patented Apr. 19, 1910.**

Application filed April 13, 1909. Serial No. 489,683.

To all whom it may concern:

Be it known that I, GEORGE A. FOWLER, a citizen of the United States of America, residing at the city and county of Denver and State of Colorado, have invented a new and useful Reciprocating Multiple-Compartment Concentrator, of which the following is a specification.

My invention relates to improvements in concentrators, and the objects of my invention are: first, to provide a reciprocating multiple compartment concentrator; second, to provide a reciprocating multiple compartment concentrator in which the compartments are arranged to receive ore pulp in successive feeding order and in which mineral particles of different specific gravities are settled and stratified in different compartments in the order of their specific gravities; and third, to provide a reciprocating compartment concentrator in which each compartment is arranged to hold a body of ore pulp and each body of ore pulp is provided with an independent flow of wash water arranged to exert a lifting and separating effect on the lighter material of the bed or ore pulp. I attain these objects by the mechanism illustrated in the accompanying drawings, in which:

Figure 1, is a plan view of the improved concentrator, the screen in the first compartment of the reciprocating member or frame being partly removed to show the support for said screen, while both the screen and support in the second compartment are removed for purposes of greater clearness. Fig. 2, is a central, vertical, longitudinal sectional view through the concentrator. Fig. 3, is a front end elevation thereof. Fig. 4, is a transverse sectional view taken on the line 4—4 of Fig. 2. Fig. 5, is a fragmental view on an enlarged scale, of the anti-friction supporting device for the reciprocal frame. Fig. 6 is a similar view of a modification; and Fig. 7, is a fragmental sectional view, showing the packing boxes for the valve operating rods, which extend out through the side of the tank.

Similar characters of reference refer to similar parts throughout the several views.

Referring to the drawings, the numeral 1, designates a solution holding tank, which may be made of either wood or of metal, such as cast iron, sheet iron or steel. I preferably illustrate it constructed of wooden tongue and groove planks 2, which form the body portion thereof. The tank is supported upon foundation sills 3, side joists 4, and 5, struts 6, and cross braces 7. These various pieces are framed and bolted together by transverse bolts 9, which extend through the side joists and side planks 2 of the tank in positions to clamp them all together. The upper portion of this tank is preferably rectangular in form for a portion of its depth from its upper end, but the sides of the lower portion of the tank converge together to a point at the center of the length of the foundation sills 3, and to the center of the width of the tank, thus forming a V-shaped lower portion to the tank.

Discharge outlet pipes 10 are inserted in the bottom of the V-shaped portion of the tank, the outlet ends of which are closed by plugs 11, preferably made of wood, but if desired these outlet pipes may be provided with valves. A water supply pipe 12 enters the head end of this tank, at about the center of its width and height, and extends longitudinally through it from end to end, and at predetermined points of its length within the tank valve controlled outlets 13 are provided, which consist of tee pipe fittings to which valves 14 are connected. These valves are provided with valve stems 15, which extend preferably laterally through and beyond the sides of the tank and through suitable stuffing boxes 16, secured to the outside of the tank, and their ends are provided with hand wheels 17. These valves are arranged to discharge a supply of clear wash water vertically downward toward the bottom of the tank, but this water spreads in all directions and rises upward to the top portion of the tank, which is kept filled with this flowing clear water, as will be fully described hereinafter. The head end of this clear water supply pipe extends to a pumping plant, which consists of one or two or more single or double acting pumps 18, which may be positioned close to the tank and arranged to form a part of the concentrator or may be positioned at any practical distance from it. I preferably include and arrange this pumping plant as a part of the operative mechanism of the concentrator,

and position it on foundation sills 19 and 20, that connect with the adjacent sills 3 of the tank, and I illustrate a pumping plant consisting of two single acting operative pumps, which are placed side by side and are connected coöperatively together to a common suction pipe 21, by branch pipes 22. These branch pipes 22 are provided with check valves 23. Branch delivering pipes 24 which are also provided with check valves 25, extend from these pumps and connect with the adjacent end of the tank pipe 12. These pumps are preferably operated by eccentrics 26, which are secured to the sides of disks 27, which are mounted on and secured to a shaft 28, which is journaled in boxes 29, that are mounted on timbers 30, that are supported by standards 31, and the adjacent end joist of the tank. These standards extend from the sill joist to the top portion of the frame. The pumps are preferably provided with adjustable stroke pistons and piston rods 33. The piston rods 33 are connected to rods 33^{A}, which are connected to the eccentrics.

I preferably effect the adjustment of the stroke of the pistons and rods by providing the eccentrics with an adjustable throw, which I accomplish by providing the side portions of the eccentrics with slots 34, through which bolts 35 extend from the disks 27. The eccentric is also provided with a slot 36, which surrounds the driving shaft. These slots are arranged to allow the eccentrics to be moved laterally on the disks and shaft, and adjusted to secure the desired stroke of the pistons by loosening and tightening the bolts 35. This arrangement allows the stroke of the pump to be changed so that different quantities of water can be pumped into the tank, which is necessary to meet the requirements of different kinds of ores. This tank 1, is divided transversely by partitions 37, into preferably three compartments; one of the clear water discharging valves is placed in the water supply pipe to discharge into one of these compartments, and these partitions extend slightly above the clear water supply pipe 12. This tank, together with its pipes, I term the ore washing and settling tank.

Within the top portion of the tank, I place a reciprocating concentrator, which comprises a frame 39, which is suspended within the tank 1, and is divided into compartments by the transverse partitions 40. These compartments are adapted to receive ore pulp from a source of supply, and treat it automatically in successive and continuous steps, and to separate the metallic particles of different metals, such as lead, iron and zinc, in the order of their specific gravities. I have preferably illustrated a concentrator provided with three of these concentrating compartments 41, 42 and 43, although more or less may be used if desired. These concentrating compartments are preferably made of equal length and breadth, but the second compartment 42 is made of less depth than the first compartment 41, at the head end of the machine, and the third compartment is made a little less in height than compartment 42. The amount of decreased height is equal in each tank, and is enough to allow a sufficient quantity of ore pulp to be held in the compartment 42 after a portion of the mineral particles in the body of the compartment 41 have been concentrated and discharged from it, and the compartment 43 is made lower in height than the compartment 42, as the lead and iron having been taken from the ore pulp in compartments 41 and 42 respectively, the volume of ore left to be treated in compartment 43 is considerably smaller than the amount required to fill compartment 41, as the first compartment is kept full enough of ore for a stream of ore pulp to flow from it into the compartment 42, and the compartment 42 is kept full enough for a stream of ore pulp to flow from it into the compartment 43, as will be more fully explained hereinafter. These compartments comprise the frame 39, which is composed of the sides 44 and ends 45 and 46. These side and end joists 44 and 45 are framed together and are also clamped together by longitudinal rods 47, which extend beneath the partitions 40 and far enough from the sides 44 to cross the bottoms of the compartments 41, 42 and 43, within their sides. The ends of these bolts extend through plates 48, which extend across the end joists, and are bolted thereto. These plates and the bolts clamp the end and side joists and partitions together. In these compartments I place on these bolts a cross ribbed open spaced frame 47^{A}, which is preferably constructed of cast iron. The cross ribs of this frame are made to taper from their top surface down to their bottom ends, so that the cells between these cross ribs will be wider at the bottom than at the top, and taper to the top. Upon these frames I lay wire screens 48^{A} of any desired mesh, adapted to screen the size of the ore pulp under treatment. These screens are secured at their ends to the top of the iron frame by side and end boards 49 of wood, which are arranged to fit against the ends and be pressed down along the sides and ends of each compartment until they rest on and press the edges of the screens against the iron frames. To the bottom of each screen one end of a discharge nipple 50^{A} is secured, to which one end of a large piece of hose or other flexible piping 50 is secured, the opposite end of which extends to a nipple 50^{B}, to which it is secured, and which is secured to the inside of the outer tank, and a pipe extends from this flange

through the side of the outer tank and its end is closed preferably by a plug 50^{C}, but a valve may be used instead of a plug if desired. This discharge pipe is used to draw off the mineral particles that settle on the screen, and are larger than the mesh of the screen, and therefore can not pass through it. These particles are called oversize. A thin bed of this oversize mineral is maintained in each screen, but as this bed increases in depth, it is necessary to draw off some of it from time to time as it would in time occupy too much of the bottom space of the compartments, and interfere with a proper separation and concentration of the mineral particles from the gangue material of the ore pulp.

A feed spout 50^{D} discharges ore pulp from a source of supply into a feed hopper 51, which is secured to the head end of the compartment 41, and the adjacent head end joist, and a discharge spout 52 is secured to the rear end of the compartment 43, and the adjacent end joist. This compartment concentrator is suspended from the side joists of the tank 1, by straps 52^{A}, which are secured to the tanks at several points of their length. The upper ends of these straps are provided with right angled bend portions 53, that extend over the top of the side joists of the outer tank 1, and each strap rests on a roller 54, preferably a ball roller, which is seated in a runaway 55, that is formed in a box 56, that is secured to the top side joists of the outside tank 1. The under sides of the angled bends of the straps 52^{A} are also preferably provided with roller raceways 54^{A}, which fit down over the upper portion of the roller and form together with the runways in the boxes a raceway housing for the ball rollers.

I preferably make the runways of the boxes with a slightly upwardly inclined bottom surface, extending upward from the head end portion of the tanks, and of the boxes 56, toward the discharge end of the tanks, so that when the concentrator is under longitudinal reciprocal movement each roller will run upward on the movement of the concentrator toward its discharge end and downward when it moves toward the head end or feeding end of the tanks. This slight upward and downward movement has a tendency to move the screens in the compartments downward away from the bed of ore resting on them, as will be explained hereinafter. The lower ends of these straps are secured to the opposite sides of the concentrator by screws 56^{A}. These straps are preferably inserted into the sides of the concentrator frame, which is arranged close to but with a clear space between it and the inside of the tank. A reciprocating motion is imparted to the concentrator from the driving shaft 28 preferably by means of an eccentric 57, which is bolted to the side of a disk 58, which is mounted and secured on the driving shaft. A connecting rod 59 is secured at one end to this eccentric, and is pivotally secured to the lugs 60 formed on a plate 60^{A} by a bolt 61. By means of the adjustable throw eccentric a variable reciprocal movement can be given to the concentrator frame. The compartment partitions in the outer tank 1, are located directly below the partitions of the concentrating compartments of the concentrator frame, and as the screening products of each of these compartments fall into the compartment below it, it is necessary in order to keep the concentrated screening product of each compartment from moving through the water of the outer tank into an adjoining compartment, that the partitions of the concentrating compartments and of the water tank be united, and it is also essential that that portion of the partitions that connects the reciprocally moving partitions with the fixed partitions of the water tank be flexible partitions, and while there are several ways in which I can carry out this feature of my invention, I preferably connect these partitions in the following manner:

To the under side of each of the partitions of the concentrator frame I secure one end of a strip 62 of any suitable pliable material, preferably using sheet rubber or rubber cloth, and use a strip of rubber long enough to extend down beyond the upper ends of the fixed partitions of the water tank, and then draw the lower end of the sheet of rubber up to the upper end of the cross braces, which form the upper end of the fixed partitions and secure its lower edge to it by any suitable means, such as by screws. The rubber strip then contains a loose fold portion, which permits the concentrator to reciprocate freely without receiving any detrimental frictional drag from the flexible portion of the partitions. The lower outer tank is kept filled with water to the top portion of the concentrator frame, the exact height varying somewhat with light and heavy ores, and owing to the reciprocal movement of the concentrator frame the water would rise between the sides of the water tank and of the concentrator tank, and possibly overflow into the lower of the concentrating compartments from the sides of the concentrator frame, when this wash water should come up through the screens of the compartment.

I place a water tight packing 65 between the sides of the two tanks in an oblong groove 66, which is formed in the inside of the outer tank, and on the outside of the side planks of the concentrator frame to register with each other. In this oblong groove I place the packing 65, preferably using a piece of rubber hose, long enough

to extend along the length of the concentrator frame and to be curved down at its ends and lapped over onto the top of the rubber partitions to which it is secured. This hose is enough larger in diameter than the width of the slot to be pinched and flattened enough to be under expansive resilient pressure sufficient to maintain a water tight joint between the adjacent sides of the tanks. I secure this hose to either one side or the other of these tanks, preferably the side of the outer tank, by any suitable means, preferably by screws 68, which I insert within the hose through short slits 69, made in the side of the hose; each screw is then inserted through a slit and is extended through the opposite side of the hose from the slit into the side of the groove of the outer tank. A belt receiving pulley 70 is mounted on and secured to the driving shaft by which power may be transmitted from a source of rotative power to the driving shaft, and the eccentric rotated to reciprocate the concentrator, and the pumps operated to supply clear water to the outer tank.

The operation of my improved compartment concentrator is as follows: Ore pulp by which is meant a flowing stream of finely crushed ore and water, flows from a source of supply, such as from a stamp or Huntington or other mill, and is fed through the launder or feed spout 50^{D} into the feed hopper 51 and flows from the hopper into the first compartment 41, and this ore pulp in this first compartment overflows into the compartment 42, over the partition 40 separating these two compartments 41 and 42, and the ore pulp in the compartment 42 overflows into the compartment 43 and the gangue matter flows out of this compartment 43 through the discharge spout 52 to waste or to further treatment. The concentrating action on the ore pulp from the first to and through the compartments, is as follows: The ore pulp fills the compartments, and under the movement imparted to them by the eccentric, the heavier mineral particles in the ore pulp settle down, the lead and the free gold, should there be any, being the heaviest, settling to the bottom, and that portion of it that is finer than the screen will pass through the meshes of the screen and settle through the body of water in the outer tank and settle in the bottom of the V-shaped portion of the outer tank, while such mineral particles of the heaviest mineral in the compartment as are too large to pass through the screen, will lodge on the screen and a thin bed of this lead ore will be formed. Then assuming that the ore is crushed to six mesh and eight mesh screens are used, all of the lead mineral particles less than or smaller than the spaces of an eight mesh screen will pass through it, and will settle to the bottom of the outer tank, while those larger than the mesh of the screen and between the size of eight and six, will settle through the ore pulp and lodge on the screen and form a bed of lead ore. Then in the first compartment 41 the iron mineral particles being the next heaviest mineral, will stratify above the bed of lead, and the zinc, being lighter than the iron, above the iron, but the outer tank being full of water which flows into these concentrating compartments through their screens, contains a body of water which is subjected to a constantly upward buoying pressure from this upwardly flowing stream, which is being pumped constantly into the pipe by the pumps, and is under pressure enough to flow upward through the mineral particles on and above the screen, and wash from among them the lighter gangue matter, and also to lift up and carry over the discharge end partition of this compartment 41, the iron and zinc mineral particles into the compartment 42, where the iron being the heaviest mineral, settles first, and its particles that are fine enough to pass the screen of this compartment, settle to the bottom of the outer water tank compartment below the concentrating compartment, while the zinc and the fine gangue matter are carried over the discharge end partition between this compartment 42 and the compartment 43. In this compartment the zinc being the heaviest material that is left in the ore pulp, settles to the bottom, and a bed of the oversize of this material is formed on the screen of this compartment, and the screenings settle down into the compartment of the water tank below the compartment 43, as concentrates, while the gangue material, ore pulp and the clear water flowing up through the screen of the compartment 43, together with the clear water that has flowed into the compartment 43 from the compartments 42 and 41, flow into the discharge chute and run to waste or to further treatment. The screenings products of all of the compartments that settle in the botton of the compartments of the water tank, are drawn off when desired through the discharge pipes 10 by simply removing the plugs 11 in their ends. The oversize concentrates of lead, iron and zinc are drawn off from their respective screens through the discharge hose pipes.

While I preferably use the same size mesh of screen in each of the concentrating compartments, they may be of different mesh if desired, in which case the finest mesh would be placed in the compartment 41, the next coarser in 42, and the next coarser in 43.

While I have illustrated the preferred construction and arrangement of my improved compartment concentrator, I do not wish to be limited to the construction and

arrangement shown, as many changes might be made without departing from the spirit of my invention.

Having described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In a concentrator, a tank provided with a supply of water and provided with a plurality of compartments, and provided with a valve controlled inlet into each compartment, means for operating said valves from the outside of said tank, said tank being provided in the bottom of each of its compartments with a controllable discharge pipe, and a multi-compartmented reciprocating concentrator suspended within said tank in its body of water, provided with a plurality of concentrating compartments, each of which registers with one of each of said water tank's compartments, plates on the opposite ends of said concentrator frame, bolts extending through said plates and along the bottom of said concentrator, a latticed plate in the bottom of each compartment resting on said bolts, a screen resting on each latticed plate, means connected to said water supply pipe for forcing clear water through the latticed plate and screen of each of said concentrator's compartments from its coöperating compartment in said water holding tank, independent of the other compartments of said tank, and means including a power driven shaft for imparting a variable throw reciprocating movement to said concentrator.

2. In a concentrator, the combination of a tank provided with a rectangular top portion and a V-shaped bottom portion, a plurality of compartments in said tank separated from each other by partitions, said tank being provided with a controllable concentrates discharge pipe in the bottom of each of its said plurality of compartments, a clear wash water supply pipe extending through the center of said tank through said partitions into each of said compartments, and a valve controlled discharge outlet in said pipe in each compartment, a multi-compartmented reciprocating compartment concentrator depending into said tank and into its body of water, each of the compartments of said compartment concentrator being provided with an ore pulp screening bottom portion, a hose secured to said tank and compressed between said tank and concentrator and arranged to act as a packing to prevent water from flowing upward between said tank and said concentrator beyond a predetermined point, a power driven shaft on said concentrator, means including an adjustable throw eccentric for imparting different lengths of reciprocal strokes to said concentrator, a flexible partition portion between said concentrator compartment and the partitions of said tank, means for flowing a supply of clear wash water into said pipe and into each compartment of said tank and upward through the screened bottom portions of said concentrator into each of its compartments.

3. In a concentrator, the combination with a tank provided with partitions arranged to divide it into a plurality of compartments, a multi-compartmented reciprocating concentrator depending into said compartment tank, ball bearings in said tank, straps mounted on each of said ball bearings at one end and secured to said concentrator at their opposite end, a flexible partition connected to each compartment at one end and to the adjacent partition of said tank, whereby a closed independent compartment is formed in said tank that registers with and below each compartment of said concentrator, means including a supply pipe for flowing a body of clear wash water up through said compartments of said tank and concentrator compartments, means including a power shaft and an adjustable eccentric for imparting a variable reciprocal stroke to said concentrator, a hose secured to said tank between said tank and said concentrator and arranged to prevent water from flowing up between said tank and said concentrator.

In testimony whereof I affix my signature in presence of two witnesses.

GEORGE A. FOWLER.

Witnesses:

G. Sargent Elliott,

Adella M. Towle.