No. 648,549. Patented May 1, 1900.

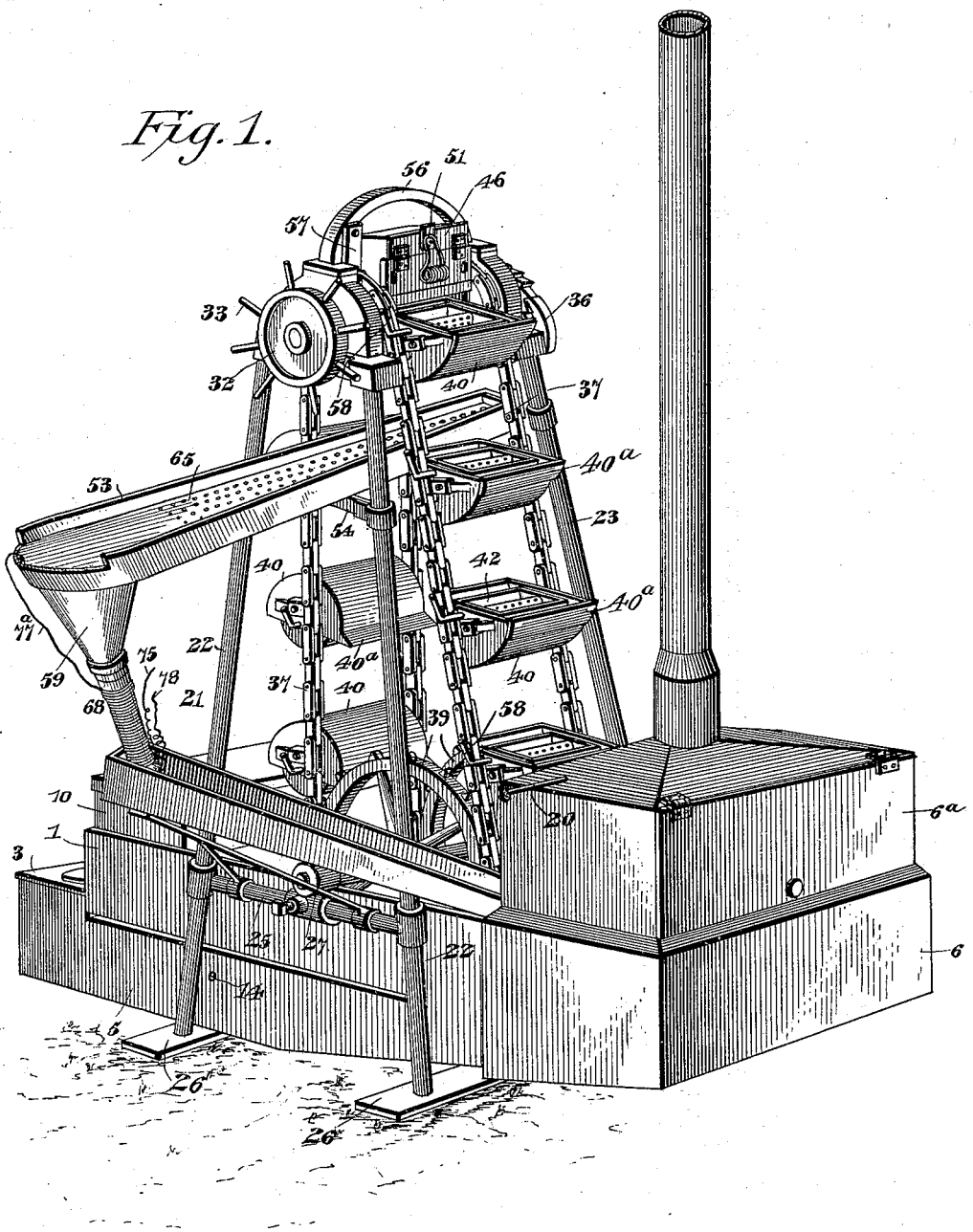
G. H. CLINE.

ORE SEPARATOR AND AMALGAMATOR.

(Application filed Apr. 16, 1898.)

(No Model.) 5 Sheets—Sheet 1.

Fig. 1.



Witnesses
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No. 648,549. Patented May 1, 1900.

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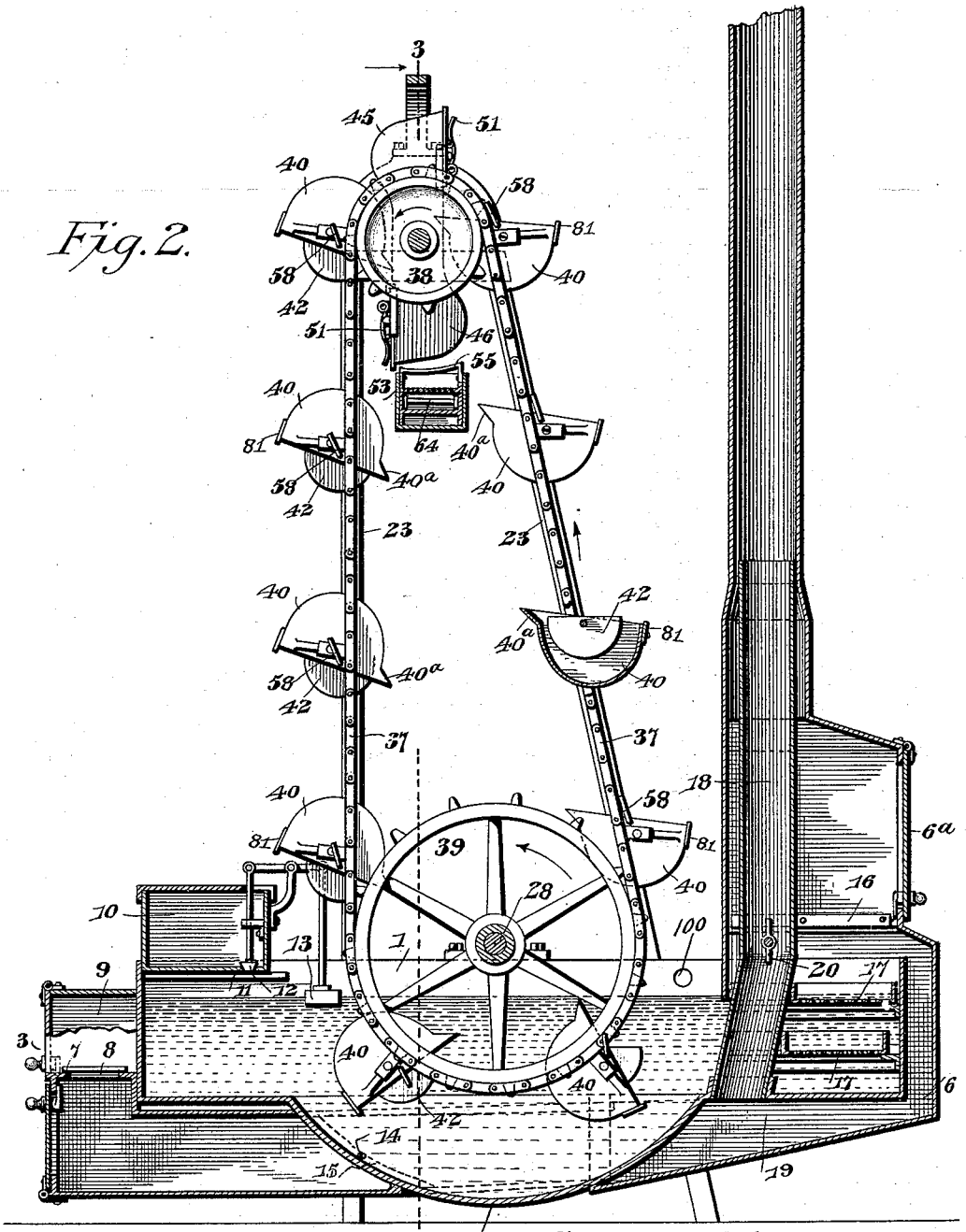
(No Model.) 5 Sheets—Sheet 2.

Fig. 2.



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(No Model.) 5 Sheets—Sheet 3.

Fig. 5.

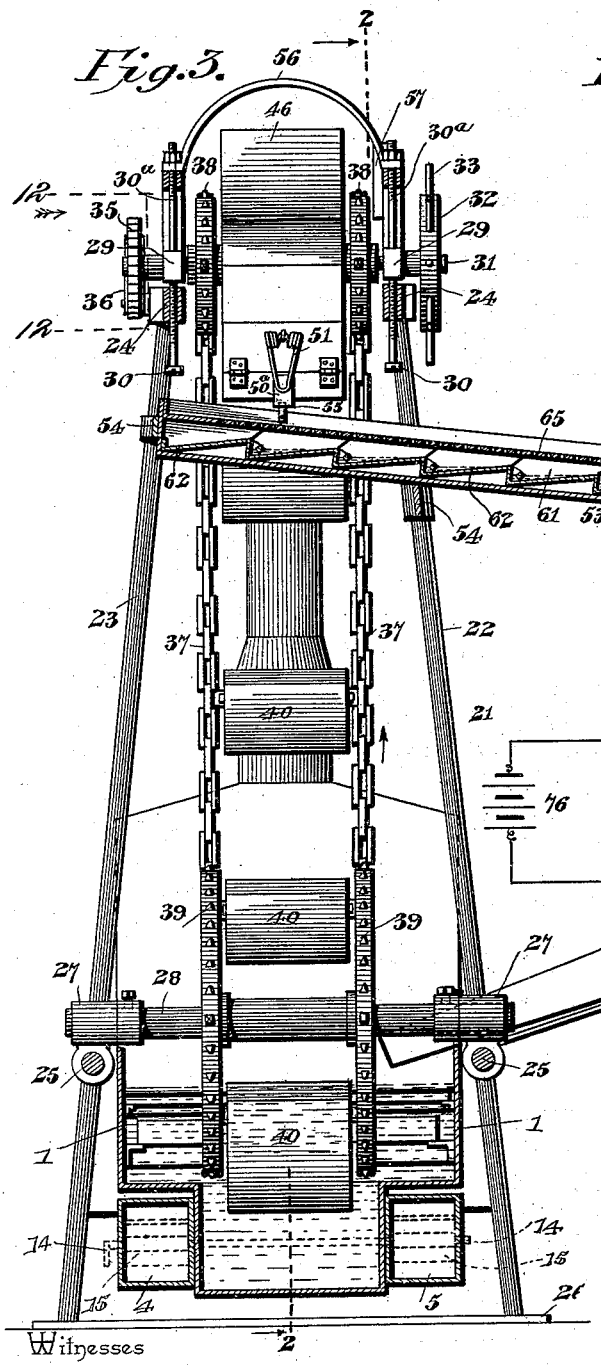


Fig. 12.

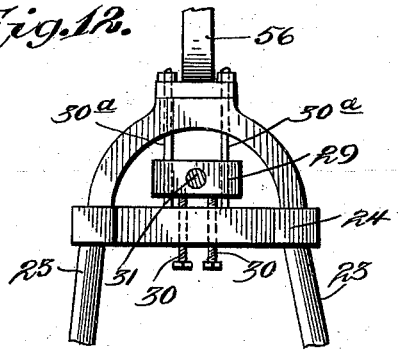
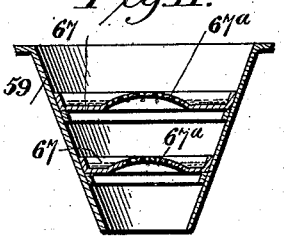


Fig. 11.



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(No Model.) 5 Sheets—Sheet 4.

Fig. 5.

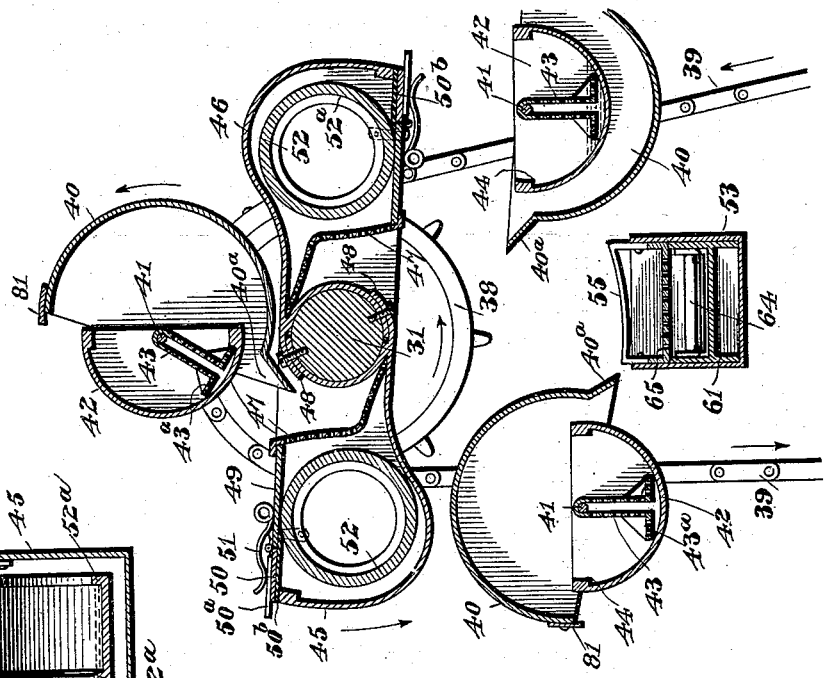


Fig. 8.

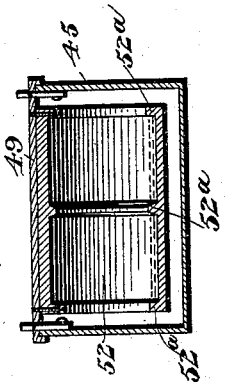
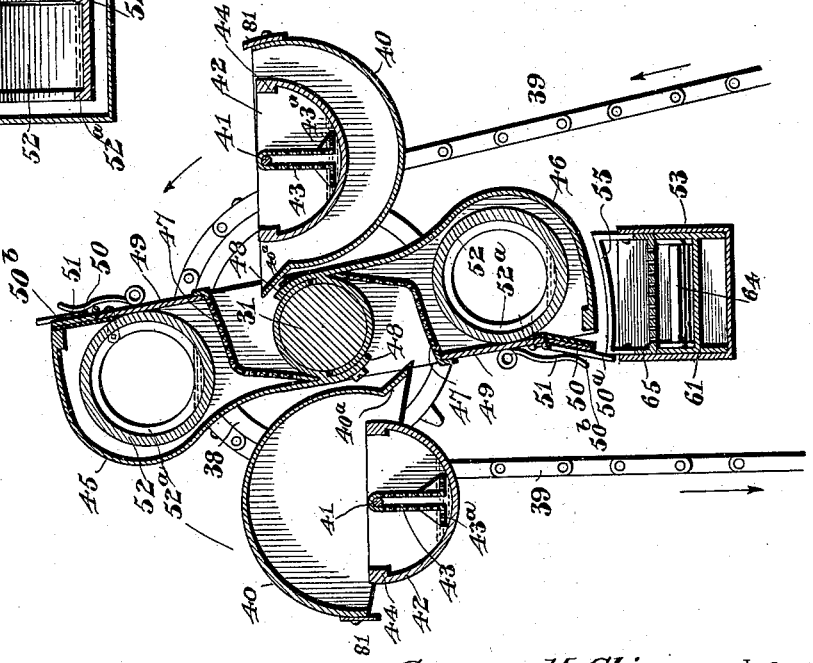


Fig. 4.



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(No Model.) 5 Sheets—Sheet 5.

Fig. 6.

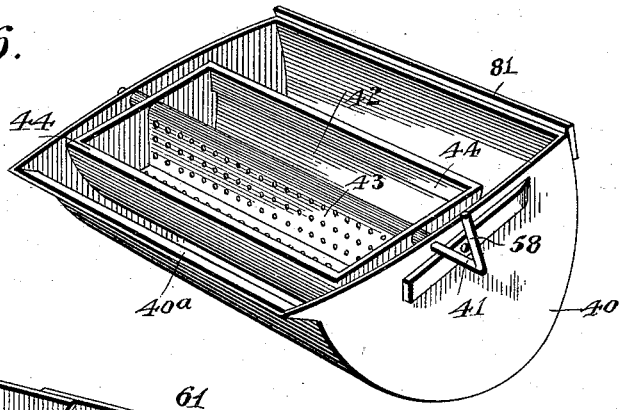


Fig. 7.

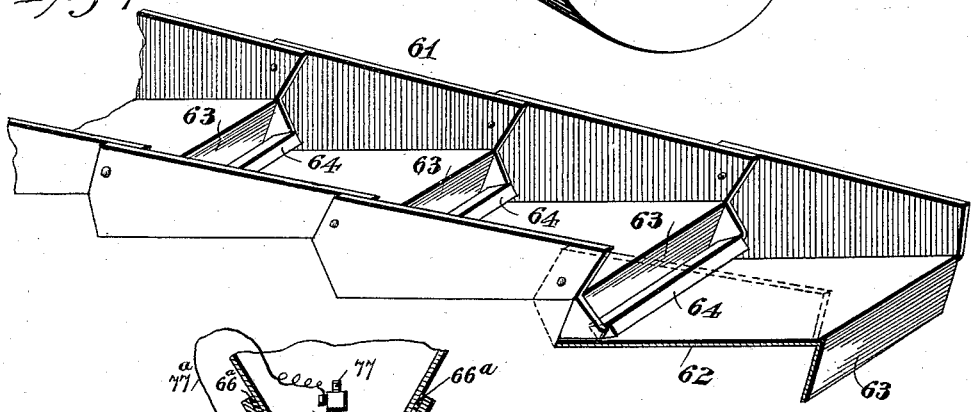


Fig. 9.

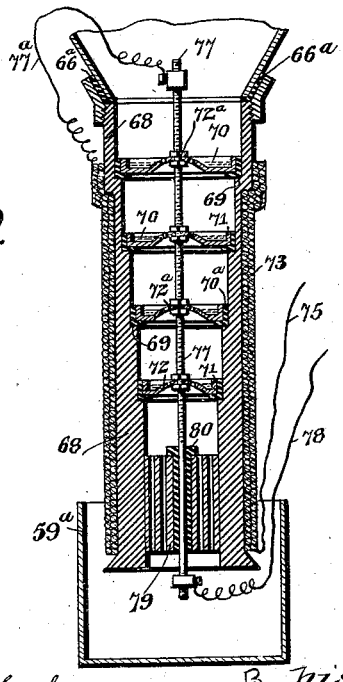
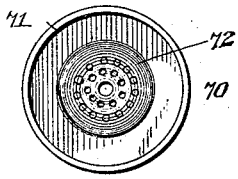


Fig. 10.



Witnesses

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UNITED STATES PATENT OFFICE.

GODFREY H. CLINE, OF JERSEY SHORE, PENNSYLVANIA.

ORE SEPARATOR AND AMALGAMATOR.

SPECIFICATION forming part of Letters Patent No. 648,549, dated May 1, 1900.

Application filed April 16, 1898. Serial No. 677,859. (No model.)

To all whom it may concern:

Be it known that I, GODFREY H. CLINE, a citizen of the United States, residing at Jersey Shore, in the county of Lycoming and State of Pennsylvania, have invented a new and useful Ore Separator and Amalgamator, of which the following is a specification.

My invention relates to improvements in ore separators and amalgamators especially designed for the treatment of precious metals in the gold-bearing regions of the north; and one object of the invention is to provide an apparatus by which the frozen gold-bearing earth may be disintegrated by the action of heat and is washed mechanically to separate in part the desirable particles of ore from the sand, gravel, and dirt.

A further object of the invention is to subject the solution of dirt and water which bears the "flake" and exceedingly-small particles of gold to the action of amalgam in a number of different devices with a view to the collection in a manner to involve a minimum loss and waste not only of the gold, but of the water in washing the ore-bearing dirt.

A further object of the invention is to provide an endless chain of amalgamators adapted to convey the solution from the sluice-box to the sluiceway and to sweep close to the path of a heating-furnace, whereby the mercury contained in the endless chain of amalgamators is exposed to heat, which obviates solidification of the mercury under the exceedingly-low temperature prevailing at the north, and the mercury is kept at a temperature which promotes or increases its affinity for the collection of the precious metal, while at the same time it is not subject to volatilization, or slightly so.

Having thus outlined briefly the nature of my improvements, the invention consists in the novel combination of elements and in the construction and arrangement of parts, which will be hereinafter fully described and claimed.

To enable others to understand the invention, I have illustrated the preferred embodiment thereof in the accompanying drawings, forming a part of this specification, and in which—

Figure 1 is a perspective view of an ore separator and amalgamator constructed in accordance with my invention. Fig. 2 is a vertical longitudinal sectional elevation on the plane indicated by the dotted line 2 2 of Fig. 3. Fig. 3 is a vertical transverse sectional elevation on the plane indicated by the dotted line 3 3 of Fig. 2. Figs. 4 and 5 are enlarged detail views illustrating the operation of discharging from the amalgamator-buckets to the rotary amalgamator-boxes and from said boxes to the sluiceway. Fig. 6 is a detail perspective view of one of the scoop-buckets with a swinging amalgamator-bucket therein. Fig. 7 is an enlarged detail view of a part of the riffle in the sluiceway and illustrating a number of amalgamator-plates in said riffle. Fig. 8 is a detail horizontal sectional view through one of the rotary hoppers or boxes, showing the amalgamator-drum therein. Fig. 9 is an enlarged vertical sectional view through the electric collector between the spout or funnel of the sluiceway and the sluice-box. Fig. 10 is a plan view of one of the collecting disks or cups used in the electric collector shown by Fig. 9. Fig. 11 is a detail view through the spout, showing the amalgamator-cup therein. Fig. 12 is a sectional view on the line 12 12 of Fig. 3, showing one of the vertically-adjustable bearings for the upper driving-shaft and the guides for the bearings.

Like numerals of reference denote like and corresponding parts in each of the several figures of the drawings.

1 designates the sluice-box or primary tank of my apparatus. This sluice-box is of comparatively-large size to contain a proper amount of water and ore, and said sluice-box is constructed of metal, preferably, with a central curved depression 2 in the bottom thereof. At one end of the sluice-box is provided a heating-furnace 3, which may be built as a part of the sluice-box or constructed separately therefrom, and this heating-furnace is adapted to furnish the heat by which the frozen gold-bearing earth is disintegrated, the water in the sluice-box maintained at a proper temperature to melt ice or snow for supplying water to the sluice-box necessary to the operation of washing the ore, and of furnishing the heat for cooking or culinary purposes. My apparatus is designed to be located in a building or structure, and as the water is kept

at a temperature of about 100° and as the furnace 3 is also located within the building the temperature of the building is kept at the proper point to promote the comfort of the occupants of the building.

The furnace 3 discharges its heat to the flues 4 and 5, which are arranged horizontally at opposite sides of the sluice box or tank 1, and said side flues lead to and discharge into a hot-air chamber of an ore-disintegrating box 6. For culinary purposes the top 7 of the furnace 3 is provided with lid-holes 8, and over part of the furnace-top is provided a warming-oven 9.

10 designates a water-tank which is situated over one end of the sluice-box 1 and adjacent to the heating-furnace 3, and this tank is thus subjected to a part of the waste heat from the furnace, whereby snow and ice which may be placed in said tank are designed to be melted by the heat from the furnace. Said water-tank discharges to the sluick-box 1 through an outlet 11, in which is provided a valve 12, that is controlled automatically by a float 13, which is placed in the sluice-box 1 and by its buoyancy is adapted to float on the water therein. The float controls the valve 12 in a manner to automatically maintain the desired supply of water in the sluice-box necessary to the proper washing of the ore, as will presently appear, and any decrease in the quantity of water in the sluice-box permits the float to descend a certain distance for the purpose of opening the valve 12 and permitting water to flow from the tank 10 through the outlet 11 and past the valve 12 to the sluice-box 1.

The heat and products of combustion are permitted to escape from the furnace 3 through the side flues 4 and 5, and as the heat passes through the flues it parts with a certain proportion of its caloric and maintains the water in the sluice-box at a proper temperature. This escape of the heat through the flues 4 and 5 is controlled by a damper-rod 14, which extends entirely across the sluice-box and through the side flues 4 and 5, and this damper-rod carries the dampers 15, which are arranged to operate in the flues 4 and 5 for the purpose of closing the latter more or less, according as it is desired to cut off the flow of heat from the furnace to the hot-air chamber 6. The damper-rod is provided with a suitable handle by which it may be adjusted to regulate the position of the dampers in the flues 4 and 5.

The hot-air chamber 6 is situated at the end of the sluice-box opposite to the furnace and said chamber is provided with a suitable door 6a. Within this chamber is supported a horizontal earth-grate 16, which is arranged on a plane below the door-opening, and said grate is of substantial construction to make it sustain the weight of the load of gold-bearing dirt which is supplied to said chamber. The grate consists, preferably, of a series of bars bound together in parallel relation to provide large openings or spaces through which the dirt may pass after it has been softened or disintegrated by the action of heat from the furnace. The dirt as it passes through the grate 16 lodges upon the washing-screens 17, which are supported in the sluice-box at one end thereof and immediately below the hot-air chamber 6. I preferably employ two of these washing-screens arranged one below the other and in positions to be subjected to the action of the water, which is agitated by the movements of elevator-buckets adapted to traverse the sluice-box, and these screens are thus exposed within the sluice-box for the agitated water therein to wash the dirt and fine particles of ore from the screens and permit the same to accumulate in the bottom of the sluice-box. The grate in the hot-air chamber retains the gravel and any large nuggets of gold, which may be conveniently removed from the chamber 6 previous to placing a fresh quantity of earth therein for treatment by the apparatus, and any particles of gold and small gravel which may pass through the grate 16 are caught and retained by the washing-screen 17, access to which is obtainable during the "clean-out" operation, which takes place at suitable intervals.

From the lower compartment 19 of the apparatus leads a stack 18, which extends through the chamber 6, and into this compartment 19 discharges the side flues 4 and 5. The passage of the products of combustion through the stack 18 is controlled by the damper 20, the stem or rod of which passes through the chamber 6, so as to be readily accessible from the outside of the apparatus for adjusting said damper 20 without opening the door of the hot-air chamber.

In my apparatus I employ a sluiceway which is elevated a considerable distance above the sluice box or tank 1, and the mixture of water and dirt which contains the flake gold and the exceedingly-small particles which are practically imperceptible to the naked eye is carried from the sluice-box to the sluiceway by an endless elevator. The elevator has its buckets constructed to sweep close to the curved depression 2 in the bottom of the sluice-box, and with each elevator-bucket is combined an amalgamator-bucket which is adapted to contain a suitable amalgam for the collection and retention of the fine particles of gold during the ascent of the bucket from the sluice-box to the sluiceway.

As a further element of the apparatus I have combined with the endless amalgamating-elevator a pair of rotary amalgamator-boxes, to which the contents of the elevator and amalgamator buckets are delivered prior to the delivery of the solution to the sluiceway, in which the mixture is furthermore subjected to the action of amalgam prior to its delivery to an electric ore-collector, which constitutes the final device for treating the mixture prior to its return back to the sluice-box.

For supporting the endless amalgamating-

elevator I employ a vertical frame 21, which supports all of the operating parts of said elevator and also furnishes the support for the sluiceway. This vertical frame straddles the sluice-box, and it consists of pairs of uprights 22 and 23, the cap-pieces 24, the tie-bars 25, and the base-pieces 26. The uprights 22 and 23 of the vertical frame are situated on opposite sides of the sluice-box, and they are rigidly fastened at their lower ends to the base-pieces 26, which in turn are fastened to the floor of the building in which the apparatus is located. The tie-bars 25 are rigidly fastened to the pairs of uprights on opposite sides and in substantially the horizontal plane of the upper edges of the sluice-box 1, and on these tie-bars 25 are rigidly secured the shaft-bearings 27, located at the middle portion of said tie-bars. These bearings 27 are on opposite sides of the sluice-box, and in said bearings is journaled the lower idler-shaft 28 of the endless elevator.

The cap-pieces 24 of the vertical frame are rigidly joined to the upper ends of the pairs of uprights 22 23, and in said cap-pieces are mounted and supported the bearings 29, which sustain the upper driving-shaft 31 of said endless elevator. The bearings 29 are vertically adjustable in the cap-pieces 24, and this vertical adjustment of the bearings is affected by means of the adjusting-screws 30, which find threaded bearings in the cap-pieces 24 and operate against the bearings 29, whereby the latter may be adjusted to take up the slack in the endless chains forming a part of the elevator between the sluice-box and the sluiceway. To maintain the vertically-adjustable bearings 29 against tilting and keep the shaft 31 in proper alinement with the shaft 28, vertical guide rods or bolts 30^a are fastened to the cap-pieces 24 and pass loosely through the bearings 29, whereby said bearings are slidably fitted to the guide bolts or rods.

The elevated driving-shaft 31 of the endless conveyer is extended at its ends beyond its bearings 29 to receive the power devices by which the shaft may be driven for imparting slow traveling motion to the endless elevator. I prefer to employ manually-operated devices for driving the shaft 31, and in the preferred embodiment of the invention a power-wheel 32 is rigidly fastened to one end of the shaft 31. This power-wheel is provided with a series of hand-spokes 33, and to the other end of the shaft is secured a ratchet 35, with which engages a pawl 36, as indicated by Figs. 1 and 3. This pawl is loosely hung on one of the cap-pieces 24 of the upright frame, and said pawl-and-ratchet devices prevent the shaft 31 from turning in a backward direction, thus causing the conveyer or elevator to always travel in a direction to carry up the solution from the sluice-box to the sluiceway.

The endless elevator or conveyer consists of a pair of endless link chains 37, sprocket-pinions 38, rigidly fastened on the shaft 31, and idler sprocket-wheels 39, fixed to the idler-shaft 28. The sprocket wheels and pinions are arranged in pairs in vertical alinement with each other, and the two pairs are properly spaced apart on the shafts 28 and 31 to receive the pair of endless link chains. The sprocket-wheels 39 are of larger diameter than the sprocket-pinions, so as to spread the lower end of the endless conveyer and give to the scoop-buckets a wide range of movement in the sluice box or tank 1. At suitable intervals on the pair of endless chains 37 is rigidly fixed a series of scoop-buckets 40, any suitable number of which may be employed. These scoop-buckets are open at one side and provided with curved bottoms, and each bucket has one end of its bottom extended in an inclined direction to provide a lip 40^a. The bucket is attached, at or near the middle of its ends, to an adjacent pair of links of the two chains, and each bucket is rigidly fastened to said links, so as to assume an upright position on the ascending side of the endless elevator and to be inverted on the descending side of the elevator, whereby the buckets are adapted to sweep close to the bottom of the sluice-box and take up the load as it travels around the idler sprocket-wheels 39 and through the sluice-box 1. With each scoop-bucket which is rigidly attached to a pair of links on the parallel endless chains is combined a loosely-hung amalgamator-bucket which is normally housed or contained within the scoop-bucket and is adapted to tilt or oscillate independently of the traveling movement of the scoop-bucket. Said amalgamator-bucket 42 is carried by a horizontal rod 41, which is suitably supported in the end walls of the scoop-bucket 40, and the amalgamator-bucket 42 is provided at its side edges with retaining-flanges 44, which are doubled or bent over upon the bottom of the bucket and serve to catch the amalgam or mercury when the amalgamator-bucket is tilted in the act of discharging the mixture therefrom at the upper end of the endless elevator. Each of the series of hinge-rods 41 for the series of loosely-hung amalgamator-buckets is extended at one end beyond the scoop-bucket with which its amalgamator-bucket is associated, and said extended end of the hinge-rod 41 is provided with a crank-arm 58, which is adapted to impinge against a fixed detent 57, supported on an arch 56 in the path of the crank-arms 58 of the series of rods 41 for the amalgamator-buckets which are housed or contained within the series of scoop-buckets on the chains of the endless elevator, whereby as the elevator travels slowly the scoop and amalgamator buckets are successively brought to positions where the crank-arms 58 of their hinge-rods 41 ride against the detent 57 for the purpose of tilting or inverting the amalgamator-buckets one after the other to discharge the mixture therein into rotary amalgamator-boxes

presently described. Each of the amalgamator-buckets 42 is adapted to contain a limited quantity of free mercury or amalgam, and within said bucket is arranged a collector-plate 43, the surface of which is coated with amalgam. This collector-plate in each amalgamator-bucket is loosely hung on the hinge-rod 41 of the bucket, and its inner edge is flanged or enlarged to provide a foot 43^a. This collector-plate is suspended centrally within the amalgamator-bucket, and both surfaces of the plate and the foot thereof are coated with a thin film of mercury or amalgam, whereby an enlarged area of the collecting-surface is provided within the amalgamator-bucket for collecting and retaining the flake and small particles of gold which may be contained in the mixture of water and dirt which is carried by the sluice-box through the sluiceway.

45 and 46 designate rotary amalgamator-boxes which are fixed to the driving-shaft 31 of the endless elevator and are adapted to work in the intervals between the series of spaced buckets on the endless chains of the elevator. These amalgamator-boxes are rigidly fastened to the shaft 31 to rotate therewith, and they are arranged on opposite sides of said shaft, so that as one amalgamator-box is discharging into the sluiceway the other amalgamator-box is receiving the contents of one scoop and amalgamator bucket. Each amalgamator-box is of closed metallic construction and within the same is provided a screen or grate 47, and the end edges of the bottom of each box are bent or doubled to form the retaining-flanges 48. One side of the amalgamator-box is open to receive a fixed section 49 of a cover, said fixed section of the cover being detachably secured in any suitable way to the end walls of the amalgamator-box. The movable section 50 of the cover is hinged to the fixed section 49, and said hinged section is normally held in a closed position across the amalgamator-box by an impelling or pressure spring 51, which acts against the hinged cover-section and tightly closes the amalgamator-box against the escape accidentally of its contents during the semirevolution of the amalgamator-box with the shaft 31. The hinged section of the cover is provided with an extended arm 50^a, which is adapted to sweep against a bridge 55, which is fixed to the sluiceway in the path of the arms on the hinged cover-sections of the amalgamator-boxes. Within each amalgamator-box is an amalgator-cylinder 52, which is rigidly attached to the fixed section of the cover thereof, and each amalgamating-cylinder is provided interiorly with annular flanges 52^a, that are adapted to retain the free mercury or amalgam against escape and loss during the rotation of the amalgamator-box with the shaft and the outlet of water from said amalgamator-box. The flanges 52^a of the amalgamating-cylinder within each amalgamating-box retain the free mercury which is placed in said cylinder, and any mercury which may escape from the cylinder is caught or retained by the retaining-flanges 48 of the amalgamator-box when the latter lies below the shaft 31 and the hinged cover-section is opened, as shown by Fig. 4, thus reducing to a minimum or wholly overcoming any tendency of the mercury to escape. The joint between the hinged and fixed sections of the cover to each amalgamator-box is closed by a flexible strip 50^b, and this flexible strip may be extended across the hinged section of the cover to provide a packing between the free edges of the hinged section 50 and the wall of the amalgamator-box. The grate or screen 47 within the amalgamator-box provides a compartment which is normally open to enable the contents of the scoop and the amalgamator-buckets to be dumped into the amalgamator-box, and the mixture thus deposited in the compartment passes through the screen and thence into the chamber of the amalgamator-box, whereby the mixture is subjected to the action of the mercury contained within the cylinder of the amalgamator-box. In the practical service of the apparatus the endless elevator is moved intermittently at suitable intervals, and in operating the structure the driving-shaft 31 is given a half-turn, thus changing the position of the amalgamator-boxes before the shaft comes to a period of rest, and provision is thus made for the proper collection of the gold in the mixture by giving the amalgam an opportunity to act on the gold.

The sluiceway 53 is arranged in a horizontal or slightly-inclined position below the upper discharge end of the endless elevator and so as to lie close to the path of travel of the amalgamator-boxes. This sluiceway is tapered or widened from its receiving end to its outer discharge end, which projects beyond one side of the vertical frame and the sluice-box. The sluiceway is supported on the vertical frame by means of the bridges 54, which are clamped to the uprights 22 and 23 of the vertical frame, and on this sluiceway is fixed a trip-bar 55, which is in the path of the arms on the hinged cover-sections of the rotary amalgamator-boxes for the purpose of opening the covers to said boxes as they sweep across the sluiceway, and thus permit the mixture in the boxes to be deposited on the sluiceway. Within this sluiceway is secured a removable screen 65, which is suitably supported in place over the riffles 61, and to the outer end of the sluiceway is connected a return-funnel 59 and a spout or chute 59^a, which lead from the sluiceway back to the sluice box or tank. If desired, this return-funnel 59 and the spout or chute 59^a may discharge to the lower of the washing-screens 17, or said spout may discharge directly to the sluice-box at any suitable point.

The riffles 61 are of peculiar construction and are arranged in the lower part of the sluiceway. The riffles have a series of in-

clined bottoms 62, forming a series of falls 63, which constitute the pockets or cups adapted to contain the free mercury by which the flake and free gold are collected from the mixture as it traverses the sluiceway. The inclined bottom 62 of each riffle rises from one fall 63 to the adjacent fall, and each bottom is so arranged that its delivery end terminates on a horizontal plane about half-way of the preceding fall. This arrangement of the riffle-bottoms provides for the proper flow of the mixture through the sluiceway and permits the solution to accumulate in the riffles momentarily for the action of the amalgam or mercury on the free gold contained in the mixture. To increase the surface of the amalgamator within the pockets of the riffles, a series of amalgamator-plates 64 are provided in the pockets, and each plate is fixed to the riffle in any suitable way to occupy a position closely adjacent to one of the falls 63, whereby the plate 64 is exposed to the action of the free mercury contained within the pocket or cup, and it intercepts the gold in the mixture of water and earth as the latter travels over the bottom and falls of the riffles.

It will be observed that the amalgamator-plates 64 are of an angular shape in cross-section to present a maximum resistance to the flow of the liquid, and said plates are also supported entirely out of contact with the riffle-plates to permit the mixture to freely flow over and under the same, and thereby be exposed to the amalgamating action of all surfaces of the said angular plates, which may more properly be termed "bars."

In the bottom of the sluiceway within its open discharge end is arranged a removable screen 66, which lies below the screen 65 over the riffles, the last-named screen serving to discharge from the sluiceway any gravel, dirt, or refuse which may be carried by the elevator from the sluice-box to the sluiceway.

The upper end of the return-funnel 59 is enlarged or flared to enable it to properly join the sluiceway below the screen 66 therein, and within this funnel is provided a series (two or more) of amalgamator-cups 67, each of which has an arched perforated dome 67^a, which permits the mixture of water and earth to pass through the cup and retains mercury within the cup for the small particles of gold to amalgamate therewith as the mixture passes through the funnel.

The lowermost series of openings in the dome of each amalgam-cup lies in a horizontal plane above the bottom of the cup, so that a proper quantity of mercury will be retained within the cup and prevented from escaping through the openings in the arched dome, as shown by Fig. 11.

Between the return-chute 59^a and the funnel 59 is arranged an electromagnetic collector 68, having an interior series of amalgamator-cups. This electromagnetic collector consists of a tubular soft-metal core 68, erected between the funnel 59 and the chute 59^a, and the tubular core is electrically insulated at 68^a from metallic connection with the funnel 59. The interior of this tubular core 68 is recessed to provide a series of annular seats 69, shown preferably as of decreasing size and concentric with each other through the length of the core 68, and on these seats are fitted a series of spaced cups 70, one of which is shown in plan by Fig. 10. These cups are arranged one below the other in vertical series through the length of the tubular core, and they are insulated from said core by the insulations 70^a, fitted between the annular seats 69 and the edges of the cups. Each cup is of metal with a raised flange 71 and an arched center or dome 72, which forms a recess or chamber 71^a, adapted to contain mercury, with which the metal held in suspension in the mixture will amalgamate, and the raised or arched dome of each cup is perforated centrally, as at 72^a, to permit the mixture to pass through the same. The tubular core 68 of the electromagnetic collector is wound externally with a helix of insulated wire 73, to which is connected one of the conductors of an electric circuit 75, energized from a suitable source of electrical energy, as by a battery 76, and the other end of this wire helix is connected by a wire 77^a with a conductor stem or spindle 77, by which the return connection of the circuit is completed back to the battery through the conductor 78. This conductor stem or spindle passes axially through the tubular core and the perforated domes of the cups 70, and the stem and cups are metallically united together. The lower end of the tubular core 68 has a perforated foot 79, which forms a support for the axial conductor-stem, and the stem and foot of the core are electrically insulated from each other by an insulating-bushing 80. The lower end of the stem protrudes below the foot, and to it is attached the return-conductor 78, which leads back to the battery, and thus the circuit is completed through the helix of the core and the stem. The current from the source of electrical energy passing through the helix 73, which surrounds the hollow metallic core 68, necessarily energizes the helix and converts the device into an electromagnet. Hence when the current is passed through the helix the metallic core 68 is magnetized and presents all of the characteristics of a magnet having the usual poles of opposite polarity. It has already been explained that the hollow or tubular core 68 is recessed to provide a series of annular seats 69 of a decreasing diameter, but concentrically arranged to provide for the support of the vertical series of different-sized amalgam-cups 70, which are arranged inside of the said hollow or tubular core. It will now be observed in connection with this construction that the core is of a tapering diameter, so that there is a gradual reduction of the thickness of the metal toward the top. On account of this gradual reduction of the thickness of the shell

or wall of the core toward its upper end the intensity of the magnetism is increased in inverse proportion to the decrease of the cross-sectional area of the core, so that at the upper pole a field of greater intensity is produced. The diamagnetic effect of this field on the gold particles, combined with the effect of the downward movement of such particles, cutting the lines of force and generating currents in themselves, tend to cause a strong repellent action, which serves to repel the particles from the pole. This repellent action has been found to appreciably retard the diamagnetic particles to such an extent as to facilitate the same being caught and retained by the mercury in the amalgam-cups. A series of these cups is employed to insure the collection of a maximum amount of metal.

In connection with the operation of the electrical magnetic collector it has also been found that by including the stem 77 in the electrical circuit, which stem has a metallic connection with the several amalgam-cups, there will be an appreciable effect of the electric current upon the mercury to assist in maintaining the same bright and active.

The operation may be described as follows: The fire is first started in the furnace, and the products of combustion pass through the side flues to the compartment 19 and thence to the hot-air chamber 6. Snow or ice is placed in the tank 10, and it is melted by the heat from the furnace. The water is permitted to flow from the tank into the sluice-box until a suitable quantity has accumulated therein to raise the float 13 and close the valve 12, which operates to shut off the further flow of water from the tank to the sluice-box. A proper quantity of gold-bearing dirt is placed in the chamber 6, and the heat in the chamber disintegrates the dirt, which passes through the grate 16 and lodges upon the washing-screens 17, which are immersed in the water contained within the sluice-box. The apparatus is now in condition for operation, and the operator or operators give to the shaft 31 a sufficient number of turns to elevate the buckets through the medium of the endless chains. As the first loaded bucket approaches the shaft 31 the scoop-bucket turns over the upper sprockets and presents itself to the compartment of one of the amalgamator-boxes, and as this scoop-bucket is inverted the trip-arm of the tiltable amalgamator-bucket rides against the detent, thus turning the amalgamator-bucket in the reverse direction to the travel of the scoop-bucket, and discharges its contents, except the particles of gold which may adhere to the free mercury and the collector-plate, into the scoop-bucket and the amalgamator-box, the scoop-bucket serving to catch any drip which may have a tendency to escape from the amalgamator-bucket when it is tilted. The apparatus is now allowed to remain at rest for a suitable time, so that the collectors in the series of buckets on the ascending side of the elevator will have an opportunity to collect the gold in the solution and also permit the mercury within the amalgamator-box to likewise collect the gold in the solution contained therein. At the termination of this interval of rest the operators again give a semiturn to the shaft 31, so as to move the elevator a certain distance and present another bucket to the empty amalgamator-box, and during this half-turn of the shaft 31 the filled amalgamator-box is moved to a position immediately above the riffle, whereby the arm on the hinged cover of the amalgamator-box contacts with the trip-bridge 55 for the purpose of opening the amalgamator-box and discharging the mixture thereof into the sluiceway. In the continued operation of the apparatus the buckets discharge their contents in successive order to the amalgamator-boxes, which receive alternately from the buckets and discharge in like manner to the sluiceway, and as the elevator is operated intermittently or at suitable intervals the amalgamators in the tiltable buckets and the amalgamator-boxes have an opportunity to collect the gold in the mixture contained therein. The mixture as it traverses the riffle of the sluiceway is exposed to the action of the free mercury and the amalgamator-plates in the pockets or cups of the riffle, thus collecting in a measure the gold which may be contained in the mixture which passes through the sluiceway, and the mixture is then discharged to the return-funnel 59, and the electromagnetic collector serves to retain any particles of gold which may remain in the mixture. The water, earth, and gold which may escape therewith are returned to the tank, so that in the final clean-up, which may take place at proper intervals, the gold accumulated in the various receptacles and in the sluice-box may be removed. As the endless elevator is operated only at intervals the attendant is able at the periods of rest to inspect the amalgamator-boxes, the riffle, and the buckets of the endless elevator. During the operation of the apparatus the fire in the furnace is maintained continuously; but it is subject to control by the dampers. The water from the tank is supplied at intervals to the sluice-box to keep the proper quantity in the latter, and the gold-bearing earth may be supplied at proper intervals to the hot-air chamber 6. It is to be understood that it is necessary to resupply the tank at intervals with water on account of the loss by evaporation, as well as by waste, which may be incident to the action of the elevator-buckets in being filled and discharged, and in the event of an excess of water filling the sluice-box on account of accumulation of the water from the thawed earth the surplus water may be conveniently disposed of by providing the sluice-box in one side thereof with a suitable overflow-opening 100, as shown in Fig. 2 of the drawings. One of the important features of my apparatus resides in the location of the washing-

screens in the sluice-box, through which sweeps the buckets of the endless elevator. As the buckets traverse the sluice-box they agitate the water therein, and the impulse imparted to the water causes it to break across the washing-screens, thereby separating the gold in a measure from the dirt and sweeping the dirt into the sluice-box, where it is held in suspension in the water, to be carried with the latter by the buckets to the sluiceway. All the parts of the apparatus are accessible to the operator for the purpose of removing the mercury and the metal which may be collected by the grate in the hot-air chamber and the washing-screens. The grate 16 and the screens 17 are preferably fitted in the chamber 6 and the sluice-box in a removable manner.

I prefer to provide the collector-plates 43 within the tiltable amalgamator-buckets with transverse perforations which permit the solution to flow through the plate and enable the plate to collect the gold in suspension in the solution to the best advantage.

While I have described the shaft 31 as having a single power-wheel, I do not limit myself to this particular means for rotating the shaft 31, as it is evident that power-wheels may be attached to both ends of the shaft and each wheel provided at intervals with suitable hand-grasps by which the operators are able to turn the shaft with convenience. The furnace provides convenient means by which the occupants of the building may cook their food or perform other culinary duties, and as the apparatus is located in the building and the water is kept at a temperature sufficient to overcome any tendency to freeze the building is warmed by heat from the apparatus. It will be understood, however, that the separator and amalgamator may be placed in the drift from whence the gold-bearing dirt is taken.

In my apparatus the rotary amalgamator boxes and the buckets are arranged to work in unison and to give the parts sufficient clearance to obviate interference one with the other in discharging from the elevator to the amalgamator-boxes. The bottoms of the amalgamator-boxes and the elevator-buckets are curved, as shown by the drawings, and the elevator-buckets are spaced apart at proper intervals on the endless chains to leave spaces between themselves for the play of the amalgamator-boxes. The curved bottoms of the buckets and boxes allow the parts to approach each other and turn or rotate in close relation without interference while the discharge from the elevator-buckets is in progress, and the water and dirt are discharged from the lip of the elevator-bucket into the amalgamator-boxes with minimum loss of the mixture by drippage.

While I have shown and described each amalgamator-box as equipped with devices for the collection of flake and particles of gold which are held in suspension by the menstruum or solution, I do not strictly limit myself to the employment of such amalgamator or collecting devices. Hence they may be omitted from the rotary boxes which thus serve the purpose of hoppers for the discharge of the mixture from the elevator-buckets to the sluiceway with minimum loss or drippage of the mixture. It will be observed that the rotary boxes, or, as they may be termed, the "rotary hoppers," rotate in close relation to the elevator-buckets as the latter are carried around the overhead driving-shaft, and the buckets are designed to discharge to the rotary boxes or hoppers and the latter in turn deliver to the sluiceway without permitting perceptible waste or loss of the mixture from the hopper to the sluiceway.

One important feature attendant upon the discharge from the elevator-buckets to the rotary boxes or hoppers is the tilting of the amalgamator-boxes in a reverse direction to the movement of the scoop-bucket as the latter travels with the chains around the sprocket-wheels on the driving-shaft. By reference to Figs. 4 and 5 it will be noted that as each scoop-bucket is carried with the chains over the sprocket-pinions and assumes its dumping position to discharge the rotary hopper or box the tiltable amalgamator-bucket is turned by a detent in a reverse direction to the turning movement of the scoop-bucket, and thus the mixture in the tiltable bucket is discharged into the scoop-bucket, so as to flush the latter and effectually carry off any residue in the scoop-bucket and deposit the mixture and residue in the rotary box or hopper.

The utility of this apparatus is apparent when it is considered that water is produced by melting ice, snow, and frozen earth by heat from the furnace without waiting through a long winter and consuming fuel for domestic service until the direct heat of a short summer thaws the pay-dirt and puts it in a condition for panning. By the employment of this apparatus the long winter season enables the miners to secure employment and effect economy in the use of fuel.

After having subjected the fine particles and flake-gold to the devices of the apparatus the mixture is returned to the sluice-box and fine particles or flakes return with it, and the liquid and the gold in suspension therein are in turn subjected to the same process for an indefinite number of times.

The apparatus may be used advantageously in drift-mines when there is an excessive supply of water without the employment of the furnace and heating appliances, or it may also be employed to good advantage in "bench-mining," where a scarcity of water exists, the water being supplied to the apparatus and used repeatedly in the washing of the pay-dirt. It is also evident that the apparatus may be used in other relations for mining purposes generally.

To reduce wear on the elevator-buckets to a minimum, the advancing edge of each bucket is preferably provided with a shoe 81, which

is removably attached to the said edge of the bucket and is readily renewable when worn by substituting a new shoe therefor.

During the operation of lifting the buckets, tilting the same to discharge to the amalgamator-boxes, and of the rotation of said amalgamator-boxes the free mercury therein is prevented from escaping by the retaining-flanges provided in said tiltable buckets and the rotary amalgamator-boxes, and thus any tendency of the mercury to escape accidentally is wholly obviated.

I am aware that changes in the form and proportion of parts and in the details of construction may be made by a skilled mechanic without departing from the spirit or sacrificing the advantages of my invention, and I therefore reserve the right to make such modifications as clearly fall within the scope of the invention.

Having thus described the invention, what I claim is—

1. In an ore separator and amalgamator, the combination of a sluice-box, an open-bottomed earth-receiving chamber arranged at one end of the sluice-box and communicating directly therewith, a furnace arranged at the end of the sluice-box opposite the earth-receiving chamber and having a flue connection with the latter, a washing-screen located within the open earth-receiving chamber and exposed directly to the water within the sluice-box, an elevated sluiceway, and a conveyer arranged to work in the sluice-box, and so propelled as to impart impulses to the water in a direction toward the screen for washing the contents of the latter, substantially as set forth.

2. An ore separator and amalgamator comprising a horizontal sluice-box, a dirt-chamber situated over the sluice-box, at one end thereof, and communicating directly therewith, a dirt-screen in said chamber, washing-screens situated in the dirt-chamber below the dirt-screen and accessible to the water in the sluice-box for exposure thereto, and an endless elevator arranged to sweep through the water in the sluice-box, in a plane at one side of the dirt-chamber, and propelled in a direction for its buckets to impart impulses to the water in a direction toward the dirt-chamber for washing the contents of the screens, substantially as described.

3. An ore separator and amalgamator comprising an elongated horizontal sluice-box, a furnace at one end thereof, a dirt-receiving chamber at the opposite end of the sluice-box and in a horizontal plane above the furnace, flues extending through the sluice-box and connecting the furnace to the dirt-chamber, washing-screens situated in the sluice-box in the vertical plane of the dirt-chamber and arranged to receive dirt directly therefrom, and an endless bucket elevator arranged in a vertical position between the furnace and dirt-chamber and adapted to sweep through the sluice-box in a direction to impart impulses to the water therein toward the dirt-chamber, for the purposes described, substantially as set forth.

4. An ore separator and amalgamator comprising a sluice-box, a furnace at one end thereof, a dirt-chamber at the opposite end of the sluice-box and communicating directly therewith, washing-screens located within said chamber and exposed directly to the water within the sluice-box, damper-controlled flues extending through the sluice-box at the sides thereof and connecting the furnace to the dirt-chamber, a damper-controlled uptake extending through the dirt-chamber and communicating with the furnace-flues, and an endless bucket elevator arranged in an upright position between the furnace and the dirt-chamber and operating in the sluice-box between the furnace-flues, substantially as described.

5. An ore separator and amalgamator comprising a tank, a furnace, a water-tank situated adjacent to the furnace and adapted to discharge to the sluice-tank, a float-controlled regulating-valve for the water-tank, a washing-screen within the sluice-tank, an elevated sluiceway, and a conveyer, substantially as described.

6. In an amalgamator, the combination with a sluice-box, of an endless elevator having a series of buckets each carrying a tiltable bucket provided with collecting devices, substantially as described.

7. In an amalgamator, the combination with a sluice-box, of an endless elevator having a series of scoop-buckets, tiltable buckets hung within the elevator-buckets, and an amalgamated plate suspended within each tiltable bucket for collecting metallic particles of ore in the water contained within said tiltable bucket, substantially as described.

8. In an amalgamator, the combination with a sluice-box, of an endless elevator having a series of scoop-buckets and amalgamator-buckets hung within the scoop-buckets and provided with retainers to prevent the escape of mercury when the buckets are tilted, substantially as described.

9. In an amalgamator, the combination with a sluice-box and a sluiceway, of an endless elevator and rotary amalgamator-boxes arranged to receive from the buckets of the endless elevator and to discharge to the sluiceway, substantially as described.

10. In an amalgamator, the combination with a sluice-box and a sluiceway, of an endless elevator carrying a series of tiltable buckets, and rotary amalgamator-boxes arranged to receive successively from the buckets of the endless elevator and to discharge alternately to the sluiceway, substantially as described.

11. In an amalgamator, the combination with a sluice-box and a sluiceway, of an endless elevator carrying a series of tiltable buckets, rotary amalgamator-boxes arranged to be projected in the path of the elevator-buck-

ets, means to tilt the elevator-buckets successively, and means to discharge from the amalgamator-boxes to the sluiceway, substantially as described.

12. In an amalgamator, the combination with a sluice-box and a sluiceway, of an endless elevator carrying a series of buckets containing suitable amalgamator devices, and rotary amalgamator-boxes to intercept the elevator-buckets and provided with amalgamator devices, the elevator being adapted for operation intermittently and the amalgamator-boxes discharging to the sluiceway, substantially as described.

13. In an amalgamator, the combination with a sluice-box, and an elevator having a series of buckets, of a shaft, amalgamator boxes or hoppers disposed on opposite sides of the shaft to rotate therewith and operating in the intervals between said elevator-buckets, each box or hopper provided with a flanged collecting-cylinder adapted to contain an amalgamating agent, substantially as described.

14. In an amalgamator, the combination with an endless elevator carrying a series of buckets, of a driving-shaft therefor, amalgamator-boxes carried by said shaft to rotate therewith and arranged to intercept the elevator-buckets successively as they travel around the shaft, and a sluiceway to which the amalgamator-boxes discharge alternately, substantially as described.

15. In an amalgamator, the combination with a shaft and an endless conveyer having a series of buckets, of amalgamator-boxes attached at intervals to the shaft and each containing a collector device and a spring-controlled cover, a sluiceway, and trip devices to open the amalgamator-boxes at intervals, substantially as described.

16. In an amalgamator, the combination with a shaft and an endless elevator having a series of buckets, of amalgamator-boxes each provided with a screen or grating, a collecting-cylinder, and a spring-controlled cover, a sluiceway to which the amalgamator-boxes are adapted to discharge, and a trip device in the path of the covers to the amalgamator-boxes, substantially as described.

17. In an amalgamator, the combination with an elevated sluiceway and a driving-shaft, of an endless elevator carrying a series of scoop-buckets, a series of tiltable buckets hung within the scoop-buckets and provided with collector devices, rotary amalgamator-boxes attached to said shaft and likewise provided with collector devices, a detent in the path of the tiltable buckets to discharge the contents thereof to the amalgamator-boxes, and trip devices in the path of the amalgamator-boxes to open the latter as they sweep across the sluiceway, substantially as described.

18. In an amalgamator, the combination with a sluice-box, of an endless elevator having a series of scoop-buckets, a series of collector-buckets hung within the scoop-buckets and each provided with retaining-flanges at the ends thereof, and a perforated amalgamated plate suspended within each collector-bucket to play between the flanges thereof, substantially as described.

19. In an amalgamator, the endless elevator having a series of buckets, the hinge-rods carried by said buckets, the tiltable buckets on the hinge-rods and provided with retainers to overcome any tendency of the mercury to escape, and the collector-plates suspended from the hinge-rod within the tiltable buckets, substantially as described.

20. In an ore separator and amalgamator, the combination of a sluice-box, an elevated sluiceway, a return-chute discharging into the sluice-box, and a tubular electromagnetic collector having its hollow core in communication with the chute and receiving the mixture from the sluiceway, said collector having a helix surrounding the core and a series of amalgam-cups within the latter, substantially as specified.

21. In an ore separator and amalgamator, the combination of a sluice-box, an elevated sluiceway having a return spout or chute to discharge to the sluice-box, an electric collector situated within said spout or chute and receiving from the sluiceway, the riffles in the sluiceway, an elevator, and a series of amalgamator devices between the sluice-box and the sluiceway, substantially as described.

22. In an ore separator and amalgamator, the combination of a sluice-box, an elevated sluiceway, a return spout or chute between the delivery end of the sluiceway and the sluice-box, the riffles within the sluiceway, an electric collector situated between the sluiceway and the return spout or chute, an endless elevator between the sluice-box and the sluiceway and carrying a series of amalgamator-buckets, and rotary amalgamator-boxes between the discharging-buckets of the elevator and the receiving end of the sluiceway, substantially as described.

23. In an amalgamator, the combination with rotary boxes or hoppers, of an endless bucket elevator provided with a series of tiltable auxiliary buckets within the primary elevator-buckets, and means for turning the tiltable buckets in a reverse direction to the elevator-buckets as the latter discharge their contents to the rotary boxes or hoppers, substantially as described.

24. In an amalgamator, the combination with an elevated sluiceway, of an endless elevator which travels over the sluiceway, a series of elevator-buckets provided with curved bottoms, and rotary hoppers or boxes also provided with curved bottoms and arranged to work in the intervals between the elevator-buckets; said rotary curved boxes or hoppers rotating in unison with the traveling movement of the curved elevator-buckets, and said boxes arranged to receive the contents of the elevator-buckets and dis-

charge the tailings to the sluiceway, substantially as described.

25. In an ore washer and amalgamator, an electromagnetic collector comprising a tubular core, a series of amalgam-cups situated within and insulated from said core, a helix surrounding the core, and an electric circuit which includes the helix and the amalgam-cups, substantially as described.

26. In an ore washer and amalgamator, an electromagnetic collector comprising a tubular core surrounded with a helix and formed with a conduit through which the tailings may circulate, a series of amalgam-cups situated within the core, a stem connected electrically to the cups, and an electric circuit including the helix and said stem, substantially as described.

27. In an ore washer and amalgamator, the combination with an electric circuit including a helix, a tubular core within the helix, a series of perforated amalgam-cups supported within the passage of the core and insulated electrically therefrom, and means for including the cups in the circuit, substantially as described.

28. In an ore washer and amalgamator, an electromagnetic collector comprising an electric circuit, a tubular core having a helix and provided with the internal seats, a series of amalgam-cups each having a perforated dome and fitted to the core-seats and insulated electrically therefrom, and an axial stem electrically connected to the amalgam-cups and included in the circuit, substantially as described.

29. In an ore washer and amalgamator, the combination with a sluice-box, and an elevated sluiceway, of the return-funnel communicating with the discharge end of the sluiceway and containing a series of mercury-cups, an electromagnetic collector having a tubular core which communicates with the funnel and is insulated therefrom, and a return chute or spout connected with the discharge end of the tubular collector-core and with the sluice-box, substantially as described.

30. In an apparatus of the class described, an electromagnetic collector, comprising a hollow metallic core of a tapering cross-section, with its wall reduced in thickness toward the upper end, a helix surrounding the core, and a series of different-sized amalgam-cups arranged within the core and insulated therefrom, substantially as specified.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

GODFREY H. CLINE.

Witnesses:

JOHN H. SIGGERS,

FRANCES PEYTON SMITH.