H. W. Adams.

Dry Amalgamator.

No. 45,214. Patented Nov. 29, 1864.

Fig. 1

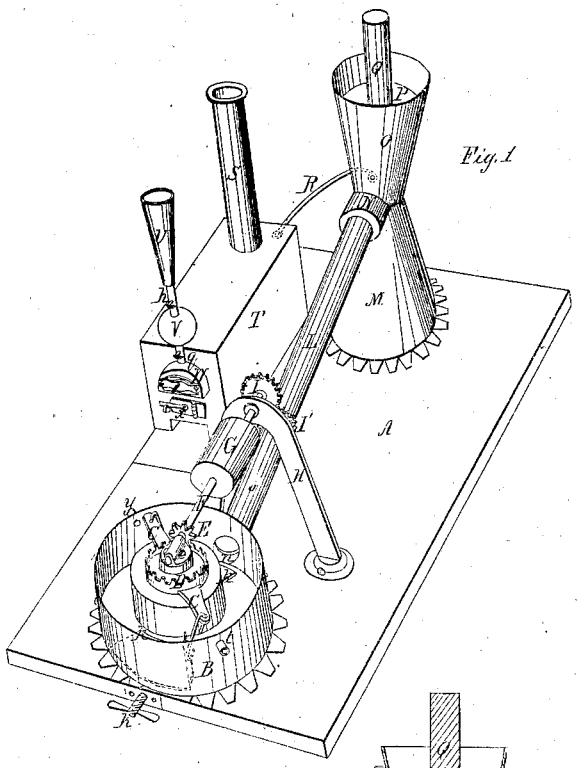


Fig. 2

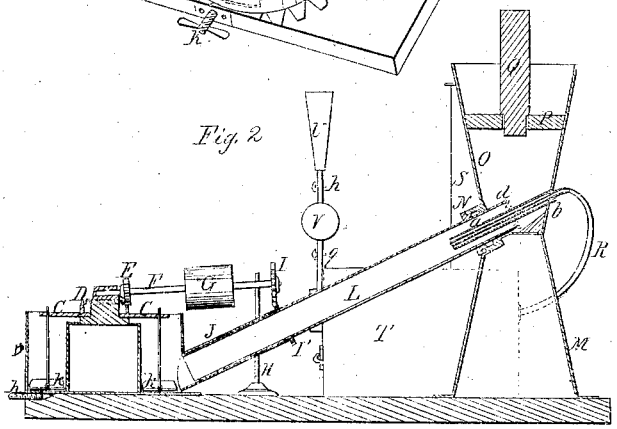
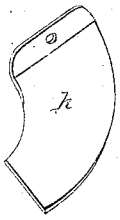


Fig. 3



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UNITED STATES PATENT OFFICE.

HENRY W. ADAMS, OF NEW YORK, N. Y.

IMPROVED APPARATUS FOR AMALGAMATING GOLD AND SILVER.

Specification forming part of Letters Patent No. 45,214, dated November 29, 1864.

To all whom it may concern:

Be it known that I, HENRY W. ADAMS, of the city, county, and State of New York, have invented new and useful Improvements in Amalgamating Gold and Silver; and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable others skilled in the art to make and use the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a perspective view of an apparatus by which I have chosen to illustrate my invention. Fig. 2 is a view showing a portion of the apparatus in section and another portion in elevation, and Fig. 3 is a detailed view of one of the drags K of the mill B.

Similar letters of reference indicate like parts.

The nature of my invention consists in the construction and arrangement of certain mechanical devices for utilizing the process of amalgamating gold and silver by means of the distilled vapor of quicksilver.

To comprehend more fully the novelty and importance of this invention it is necessary to set forth in a concise manner the chief obstacles to be overcome in the process of amalgamating gold and silver by the use of mercury in a liquid state, the much greater efficiency of the distilled vapor of this metal to meet and overcome these hitherto insuperable difficulties, and the admirable adaption of my mechanical arrangement for rendering available this new and useful method of amalgamation.

Four formidable difficulties oppose and hinder the extraction of the precious metals from most kinds of quartz or metalliferous rock.

First. The admixture of many foreign substances with the gold and silver—such as sulphur, iron, copper, arsenic, antimony, and other similar bodies existing in the form of sulphurets or pyrites—by which the precious metals are coated over and effectually protected from the slightest touch of the quicksilver.

Second. The dull or dirty surfaces of the precious particles when released from the rock by the process of pulverization, by which an interposing film or base matter effectually prevents their contact and union with the mercury. It is well known to many, and it may be easily demonstrated to all, that quicksilver in a liquid state cannot amalgamate with any metal unless the surface of that metal at the point of contact be clean and bright.

Third. Much of the gold and silver exists in the quartz in an extremely comminuted state, forming an impalpable powder or flour too infinitesimally fine to be seen by the naked eye, and scarcely discernible by the most powerful microscope. The molecules of this metalliferous flour are vastly too light to repose in agitated water, but are unavoidably floated away in the process of washing out the refuse quartz from the amalgam and consequently lost.

Fourth. The utter impossibility of mixing liquid quicksilver with any considerable body of pulverized quartz so intimately as to touch every particle of the gold and silver. The mechanical difficulties are very great by reason of their specific gravities, and also their respective mobilities. Hence it must be obvious that the enveloping coatings of foreign substances, bodies, and the dirty or dull surfaces of the precious particles when properly liberated from the quartz by grinding, by which conditions contact with the mercury is hindered, and also the running away with the water of large quantities of the finest dust of the precious metals, and the difficulty of mixing intimately any considerable quantities of pulverized quartz with liquid mercury, so that every particle of the gold and silver shall be touched by it, must of necessity render the present process of amalgamating the precious metals very imperfect and unsatisfactory.

The most experienced miners universally admit a very great loss. How much this loss is no one really knows, inasmuch as no one can tell how much fine gold and silver he loses by the action of running water in washing it away; but all concede that from one-tenth to three-fourths of the whole amount, in one way and another, is totally lost. The difference in the loss arises from the difference in the amount of foreign substances in the rock that hinder effectual amalgamation and in the different amounts of fine metal carried off by the action of water in the process of elutriation.

From the concurrent testimony of practical miners, and from divers experiments and comparisons made with my process in connection

with the old method on the same ores, I do not doubt that the losses more frequently amount to one half the original quantity contained in the quartz than any percentage less.

Many efforts have been made to overcome these difficulties by attempting to prepare the quartz by preliminary processes more thoroughly for amalgamation. Supposing that fire would easily decompose the stubborn sulphurets and pyrites and lay bare the hidden metal for an easy and magical process of amalgamation with mercury, they have resorted with high hopes to various methods of calcination. Although this mode of treating refractory and composite ores may prepare them for finer pulverization, and may, in some cases, cause them to yield with quicksilver a larger percentage of gold and silver, yet new difficulties are extemporized by this process without fully curing the old ones.

Nearly all the native sulphurets of the metals exist in the rock in the form of bisulphurets. Heat easily drives off the first equivalent of sulphur and produces proto-sulphurets, (which are very refractory and inseparable, except at a very high heat maintained for a long time,) together with oxides, sulphates, and other binary compounds, whose plastic energy in a nascent state creates impenetrable films and coatings which crystallize on cooling and protect from amalgamation much of the precious metal. The process of desulphurization by heat, as now usually practiced, besides being defective in the above respects, cannot fail also to sweep away the fine flour of gold and silver in the pulverized rock by the strong draft of the furnace, sulphurous flames, and gases through the chimney into the air.

It is an infallible law, well known to chemists, that heat increases chemical affinities, and that those affinities can take place only at insensible distances from each other—that is, upon absolute contact. Hence, thorough amalgamation with liquid quicksilver necessarily requires that all the particles of gold and silver contained in the metalliferous quartz should be eliminated from every protecting envelope and exposed with clean and bright surfaces to the interblending mercury. Without this perfect contact of every particle, molecule, or separate atom of the precious metal with quicksilver no amalgamation can possibly take place, consequently the use of mercury in a liquid state, even though the quartz be calcined, can never exhaust the rock of its gold and silver, simply because it cannot come in contact with it. This just conclusion both the analytical chemist, fresh from his crucible, his process of amalgamation, and his elutriation, and the practical miner, searching in vain for anything like the amount of gold and silver in his amalgam, which he has reason to believe is in his quartz, will readily acknowledge. Only the coarser particles, whose specific gravity is too great to be held in suspension or carried away by agitated or running water, and whose surfaces are without films of alloy, dirt, or dullness, are ever amalgamated by this defective process; but can these well-known and universally admitted difficulties be remedied by the use of the distilled vapor of mercury, instead of the liquid metal? From many practical experiments and demonstrations I can answer this question with the utmost confidence in the affirmative.

The vapor of quicksilver at a distilling heat, which is 662° Fahrenheit, is a much more efficient and potential agent. Some of its more available properties for amalgamating purposes are:

First. Its affinity for gold and silver is immensely intensified.

Second. Its power to interpenetrate dull, dirty, or alloyed and coated surfaces is instantaneous and irresistible. This may be easily tested by any one in the following manner: Take a piece of zinc or other metal whose surface is so dirty that liquid quicksilver will roll over it freely without the least tendency to amalgamate with it. Now, expose the same soiled surface to the vapor only for an instant, and the effect is like breathing on a polished plate of metal on a frosty morning. The vapor penetrates through the dirt and whitens the metal beneath it in a moment.

Third. It is easily conveyed in continuous streams like steam into a rotating or oscillating cylinder, in which metalliferous and pulverulent quartz is tumbled round and intermingled instantly with the whole mass, condensing in contact with every particle of the cold ore and precious metal in fine dewy atoms and effecting a perfect amalgamation, even through their interpenetrated films and coatings of every molecule of the precious dust.

Fourth. It does this in such a rotating or oscillating cylinder through which pulverized quartz is passing in a dry state out of contact with water, and seizes instantly the finest flour of the gold and silver stirred up in clouds of revolving dust, amalgamates with them and so increases their specific gravity that as the mass is gradually discharged from the lower end of the revolving cylinder and sealed beneath water, the amalgam settles to the bottom, instead of floating off with the muddy water.

Fifth. By supplying such a cylinder continuously with fresh vapor from a still, and with ground quartz, in a powder as nearly impalpable as possible, through a hopper, the process of amalgamation becomes continuous and at least ten times as rapid as the old method and thoroughly exhaustive of every particle of the precious metal.

Both the theory and practice of this novel and useful process are based upon scientific principles and natural laws which can never fail, when employed with mechanical fidelity, to produce the most satisfactory results. The important question which now arises is: What is the simplest, cheapest, and best mechanical device for utilizing this process? After re

peated trials with various kinds of carefully-constructed machines with a view to arrive as nearly to perfection as possible, the following arrangement is believed to combine the greatest simplicity, economy, portability, rapidity of working, and certainty of action of any, all things considered, that can be devised.

A represents any suitable flooring or platform for supporting the operating mechanism.

B is intended to represent an arastra, with its sweeps C and drags K, to which rotation is given by means of a crown-wheel, D, and a pinion, E, or by means of bevel-wheels. The pinion E is secured to a horizontal shaft, F, which is journaled at one end in a bearing arising from the center of the arastra, and near its other end in a standard, H. The inner end of the shaft carries a mitered pinion, I, which engages a miter wheel, I′, set upon the inclined cylinder L. This inclined cylinder is hollow, and it extends from the opening *n* in the lower part of the arastra through the stuffing-box N in the lower part of a hopper, O. A sleeve, J, rigidly secured to the arastra in or around the opening *n*, receives that part of the cylinder which lies below the gear-wheel I′, and forms a bearing or socket within which that end of the cylinder revolves. The hopper O is sustained upon a suitable standard or foundation, M. The stuffing box N, formed in it to receive the upper end of the cylinder, may be constructed in any way known to the mechanic art. The bottom of the hopper is adapted to permit the rotation of the cylinder whose end is slitted so as to form leaves *d*, which are bent so as to flare outward, as is clearly shown in Fig. 2. The hopper has a diaphragm, P, at a suitable height up its sides, which diaphragm is perforated in its center. A plug, Q, closes the perforation when desired.

At any convenient place on the flooring I locate a furnace, T, which is supplied with fuel by means of a door, *x*. The products of combustion escape through its pipe S. A retort, W, is secured within the walls of the furnace over its fire chamber in any suitable manner. This retort is to be used for the vaporization of quicksilver, and it is charged from time to time by means of the bulb V and hopper U in the following manner: The quantity of quicksilver to be introduced into the retort being placed in the hopper U, and the stop cock in the connecting-tube *q* being closed, the operator proceeds by opening the stop-cock in the pipe *p*, thereby allowing the charge to pass into the bulb V. The stop-cock *p* is then closed and the cock *q* opened, when the charge is allowed to pass into the retort, the stop-cock *q* being then immediately closed. The retort is thus charged while in operation, without allowing the escape of any of the vapor therefrom. A worm, R, connected with the retort, is passed into and through the lower part of the hopper O, and thence into the upper part of the cylinder L, terminating at a considerable distance within the same. It is surrounded throughout its whole course within the cylinder L and the hopper O by a jacket, *a*, secured tightly in the side of the hopper, and having a stuffing-box, *b*, where it receives the worm R. The jacket *a* is intended to prevent the condensation of the vapor of the quicksilver within the worm, and it is therefore to be of any good non conducting material. The jacket *a* and worm R are to be supported within the cylinder at about its center by means of stays or brackets. (Not shown.) The drags or skids K are formed like that shown in Fig. 3, and serve the same office as in the common arastra used by gold and silver miners, together with the office of separating from the pulverized mass and collecting the fine particles of the condensed vapor of quicksilver. The arastra is supplied with a constant supply of water through the induction-pipe *y*, and it has on its opposite side an eduction-pipe, *t*, to set a little lower than the pipe *y*. The lower discharge opening at its bottom is closed by means of the plug *h*.

It is not absolutely necessary that the connection of the cylinder with the hopper O be through a stuffing-box, N, but it may be passed through an open joint without impeding the successful operation of the parts by inclosing the cylinder at its upper end within a box, which may receive the escaping contents of the hopper O. The accumulation of the escaping matter will then rise and form a packing about the joint of the cylinder, and thus prevent any escape therefrom of the mercury.

The operation of the parts is as follows: The retort W, being charged with quicksilver, and the hopper O being filled with pulverized metalliferous rock and earth through the diaphragm P, and the plug Q inserted in its openings, rotary motion is given to the cylinder by means of the pulley G, when the bent or flaring leaves formed upon the upper end of the cylinder whose rotation upon its axis will cause the ore to be constantly turned and tossed over as it descends within it. The quicksilver is to be simultaneously vaporized and permitted to pass the worm R and be discharged into the midst of the whirling mass of pulverized matter in the cylinder, by contact with which it becomes condensed and amalgamates with the precious metals present. The arastra will be set in operation at the same time through the rotation of the shaft F. The water therein, being kept at the level of the pipe *t*, will flow up the discharging-end of the cylinder and around it in the pipe J, to a point equal to the height of the pipe *t*, and thus the whirling mass within it will be delivered into the sealing water before it is finally discharged upon the bottom of the arastra, the water setting back into the rotating cylinder and around it in the pipe J, acting as a packing and condenser of the vapor of the quicksilver. When it is so discharged the drags begin to operate upon it in the way peculiar to that well-known machine, the light-

er bodies of matter being carried off with the water discharged through the pipe *t*, and the heavier bodies being retained under the action of the drags until removed through the pipe *t*, the lower discharge-opening, or otherwise. The operation is perfected under the action of the arastra, whose mode of action is highly favorable to the separation of the amalgam from the refuse matter present, and to the collection of the free quicksilver to be used over again.

I have shown a rotating cylinder as the medium of conveying the pulverized ore from the hopper O to the arastra, but I propose also to use an oscillating cylinder or conduit, under a plan of action substantially like that shown in other respects, the object of the oscillations being to convey the pulverized matter through the cylinder and keep it in constant motion, so as perfectly to expose every particle thereof to the action of the vapor of the quicksilver delivered in its midst.

It will be perceived that the upper end of the conveyer L rotates or moves in the mass of pulverized ore which fills the hopper O, and that being constantly immersed therein, the vaporized quicksilver cannot escape upward through the conveyer. By this arrangement of the parts and this mode of action, the receiving end of the conveyer is in effect packed against the emission of the vapor through it, and the packing is effected by, or in other words the packing consists of, the pulverized ore into which the vapor is discharged at a lower point of the conveyer. In order to make this packing still more efficient the hopper O is arranged with its perforated diaphragm P and plug Q, by means of which the workmen are enabled to first fill that part of the hopper which lies above the diaphragm, and then by withdrawing the plug the pulverized ore and earth are passed by their own gravity into the closed part of the hopper below. The plug is then replaced, and the upper part of the hopper again filled for another supply, and so continuously while the machine is kept in operation.

My invention will enable one to treat about one ton of pulverized matter each hour of its operation, and will require less than one gallon of quicksilver per ton of pulverized matter, although it will be safer to put the supply at one gallon to prevent imperfect amalgamation.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. Amalgamating gold and silver contained in pulverized earth, ores, tailings, or other metalliferous material by means of quicksilver brought in contact therewith in the condition of vapor, under a mode of operation substantially such as above set forth.

2. The discharge of the distilled vapor of quicksilver from a still and auriferous or argentiferous quartz or substances containing gold or silver in a pulverized state from a hopper into a rotating or oscillating and inclined cylinder or chamber, which is fed in a continuous stream with the said quartz or material from the said hopper by means of the rotating or oscillating motion of the said cylinder or chamber, substantially in the manner and for the purposes set forth.

3. The combination of the apparatus for supplying the retort with quicksilver with the retort, substantially in the manner and for the purpose specified.

4. The combination and connection of the retort and the revolving or oscillating cylinder and chamber by means of the worm R, through which the distilled vapor of mercury is discharged from the retort into the said revolving cylinder or chamber, in the manner and for the purpose herein named.

5. The stationary hopper O, in combination with the rotating or oscillating cylinder or chamber L, substantially in the manner and for the purpose mentioned.

6. The partition of said hopper O, with its aperture and plug Q, in combination with said hopper, in the manner and for the purpose described.

7. The stuffing-box N, in combination with the feeding-end of the rotating or oscillating cylinder or chamber through which it passes and in which it works, substantially in the manner and for the purposes set forth.

8. The surrounding jacket-pipe *a*, in combination with that part of the worm which passes through the hopper, in the method and for the object designated.

9. The mode of sealing the upper or feeding end of the rotating or oscillating cylinder or chamber by plunging it directly into the pulverized quartz or gold or silver bearing substance contained in the hopper and allowing it to revolve or oscillate, submerged in and surrounded by the said pulverulent matter, substantially in the manner and for the object specified.

10. The revolving or oscillating motion of the cylinder or chamber, the feeding end of which moves in the pulverized matter to be supplied to it, for agitating and drawing the said pulverized substance into and through the said cylinder or chamber in a continuous and equable stream, in the manner and for the purpose mentioned.

11. The widening and projecting outwardly of the feeding end of the rotating or oscillating chamber by means of arms, or their equivalents, to describe a larger circle than the said cylinder or chamber in its revolution or oscillation in the pulverized ore contained in the hopper to stir up and throw into the said cylinder or chamber the said pulverized auriferous or argentiferous substance, substantially in the manner described.

12. The combination of the receiving and elutriating pan with the discharging-cylinder, or its equivalent, whether moving or stationary, when the said cylinder or chamber, either revolving or stationary, is discharging into said pan gold or silver bearing quartz or ore in a pul-

verized state, which has been treated or amalgamated with the distilled vapor of quicksilver, and when at the same time the said pan is supplied with the grinding and mashing drags K, or any equivalent crushing device, by which apparatus the said pan becomes substantially an arastra, the scope of this claim being to claim the machine known as the arastra, and shown substantially in Fig. 1, in combination with any auriferous or argentiferous pulverized ore discharged from an amalgamator, in which it has been amalgamated with the distilled vapor of quicksilver to grind and mash and work over the said mass and separate from it the fine dewy particles of quicksilver condensed through it and collect them into a liquid state to be used over again, all substantially in the manner and for the purposes hereinbefore set forth.

13. The use of the drags *k* to grind the amalgamated mass and work out of it the fine particles of quicksilver disseminated through it when the said fine particles result from the condensation of the distilled vapor of that metal.

14. The use of the shaft and cog-wheels, or any equivalent device, by which the rotating shaft, when attached by a belt or its equivalent to the driving power, shall move both the rotating cylinder or chamber and the drags K, or their equivalents, substantially in the manner and for the purposes specified.

15. The use of a rotating or oscillating conveyer for turning over and exposing the ore to the vaporized quicksilver during its passage through it, substantially as above set forth.

16. Connecting the discharging end of the conveyer L at or near the bottom of the arastra, so that the water may reach up therein and around it in the jacket-pipe J, and act on the descending vapor of the quicksilver as a condenser in the revolving or oscillating conveyer, substantially as and for the purpose above described.

17. Making the joint which connects the conveyer with the arastra, and sustaining the lower end of the conveyer, by means of a pipe, J, extending from the arastra, which permits the rotation of the conveyer in water and prevents the escape of the vapor of quicksilver from its lower end, substantially as described.

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