2 Sheets--Sheet 1.

C. WIEGAND.

Separating Gold from other Metals.

No. 168,695.

Patented Oct. 11, 1875.

Fig. 1

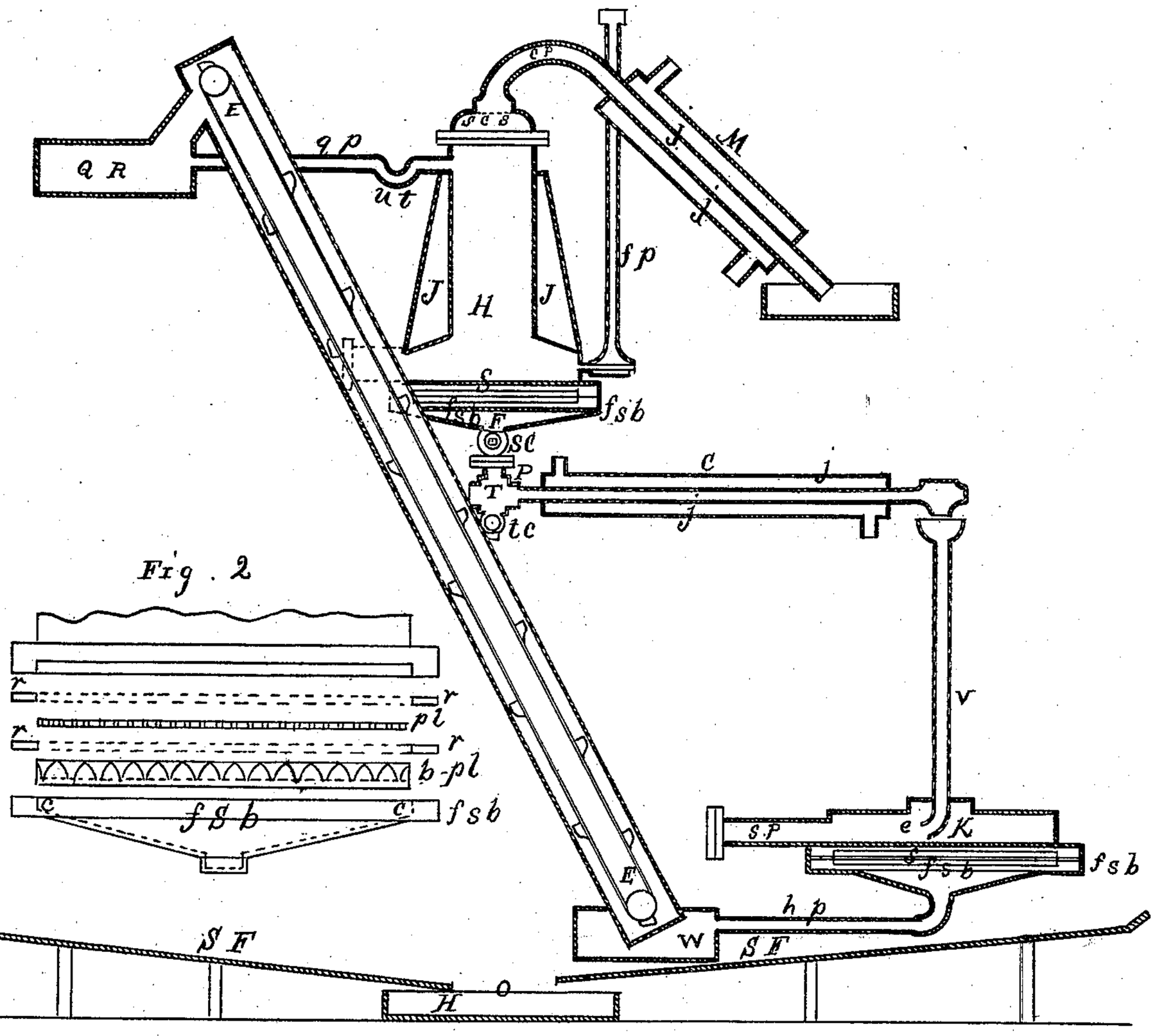


Fig. 2

Witnesses
John D Boone
C. McRichardson

Inventor
Conrad Wiegand
by Dewey & Co
Attys

N. PETERS, PHOTO-LITHOGRAPHER, WASHINGTON, D. C.

2 Sheets--Sheet 2.

C. WIEGAND.

Separating Gold from other Metals.

No. 168,695.

Patented Oct. 11, 1875.

Fig. 3.

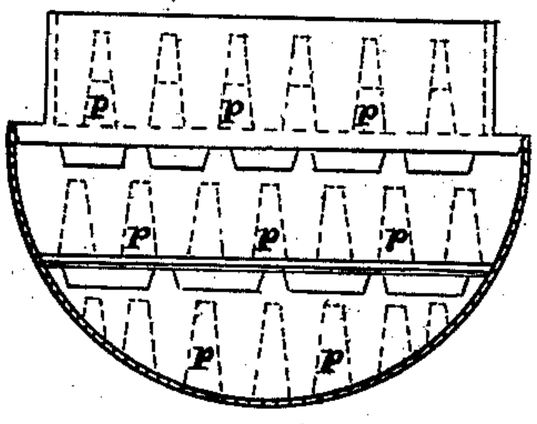


Fig. 4.

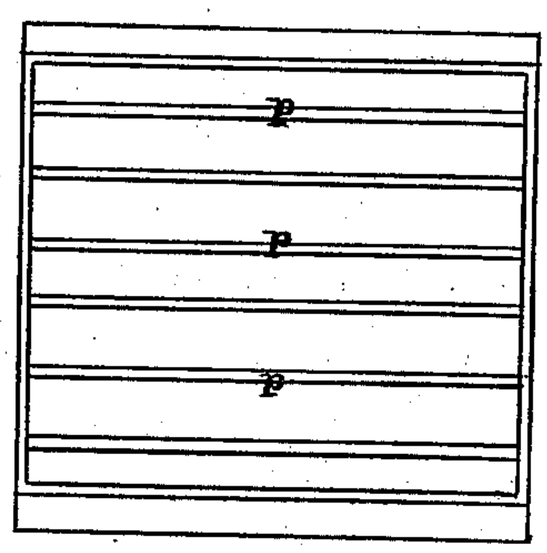


Fig. 5

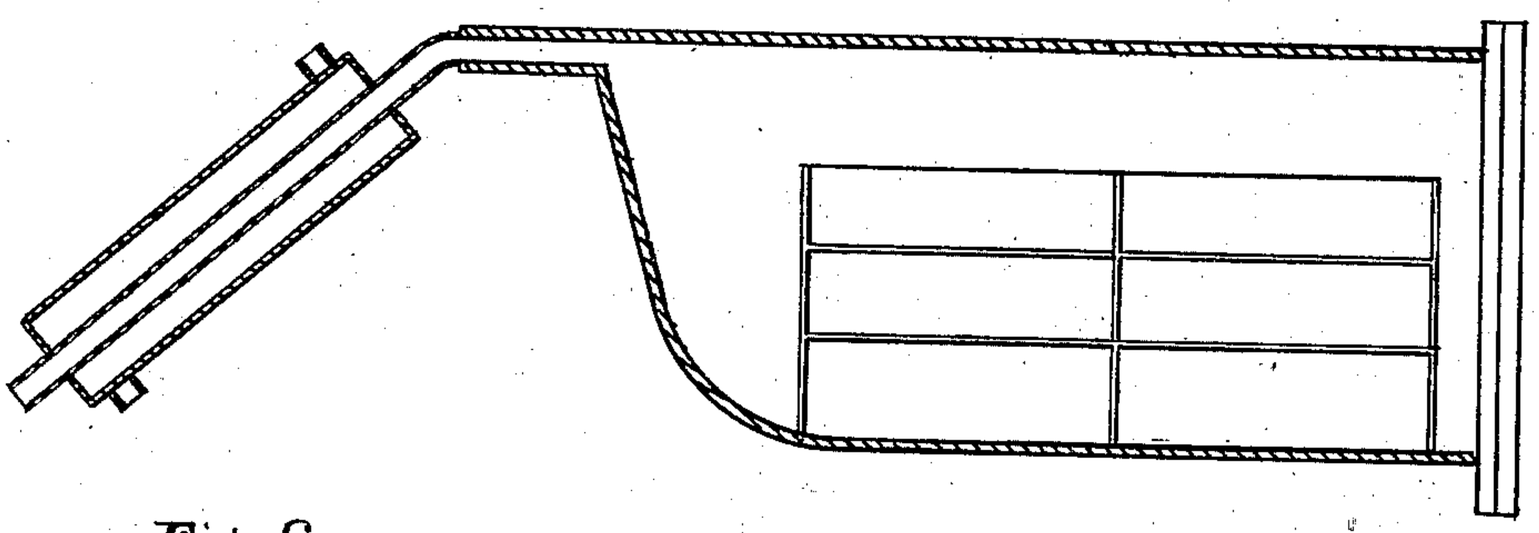


Fig. 6.

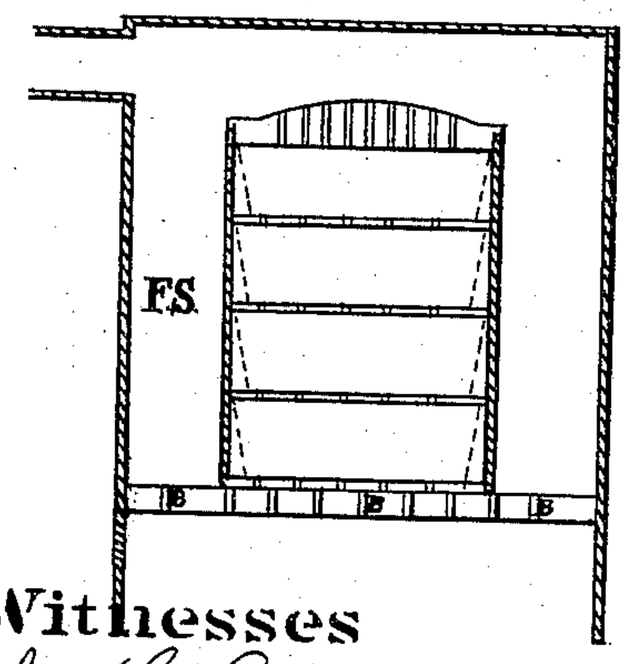


Fig. 7.

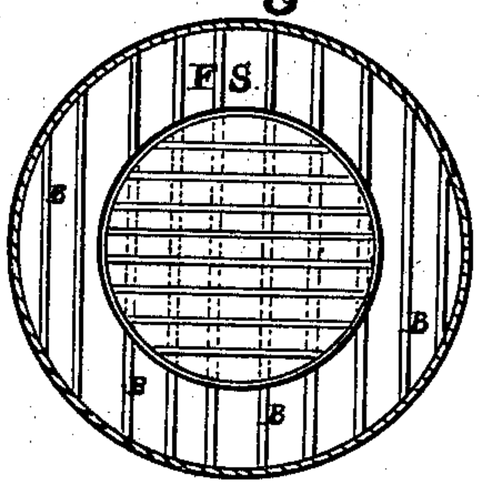
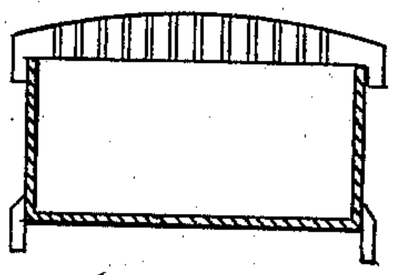


Fig. 8.



Witnesses

John L Boone

C. M. Richardson

Inventor

Conrad Wiegand

by Dewey & Co

his Attys

N. PETERS, PHOTO-LITHOGRAPHER, WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

CONRAD WIEGAND, OF VIRGINIA CITY, NEVADA.

IMPROVEMENT IN SEPARATING GOLD FROM OTHER METALS.

Specification forming part of Letters Patent No. **168,695**, dated October 11, 1875; application filed July 9, 1874.

To all whom it may concern:

Be it known that I, CONRAD WIEGAND, of Virginia City, Storey county, Nevada, have invented an Improved Method of Refining Base Gold, or separating other metals therefrom, as also the apparatus adapted thereto.

The following description will enable others skilled in the art to which it most nearly appertains to understand and use the same.

Viewed separately, the steps properly involved or desirable are, first, the conversion of all the amalgamable metals into one mercurial or amalgamated mass. Second, the removal of silver from the amalgam by a process for which Patent No. 145,265 was issued to me December 2, 1873, and reissued as 5,934 June 23, 1874. Apart from the fact that this second step is a process complete in itself, having another object in view, (the production of refined silver,) the removal of the silver from the mixed amalgams, to the extent which is easily practicable by the said method, constitutes a helpful and important part of this gold-refining process; for if not removed its presence would prove a serious impediment to (if not frustration of) the later steps of the process, as is practically found to be the case in the process patented as No. 48,438. Third, the production of a highly porous or spongiform state of the base metals, throughout which the gold to be refined has been diffused by amalgamation. The object in view for obtaining the base metals in this form is to favor their oxidation by roasting, adapted appliances for which are hereinafter described; and the aim of oxidation itself is to prepare the base metals for the next vital step. The production of once amalgamated base metals in the spongiform state, and easily fitted for roasting, is attainable by retorting the silver-denuded amalgam in described specially-adapted retort-cups. Fourth, solution of the base-metal oxides in dilute sulphuric acid, preferably after grinding or pulverizing the already roasted lumps of base metal, either with or without a preliminary additional roasting. Fifth, digestion of the residue or subsidence of the dissolving-vats in hot, strong sulphuric acid, or in warm dilute nitric acid, or in warm dilute nitro-sulphuric acid, (or successively by two or more of these acids) for the purpose of removing any portions of the base metals which failed to dissolve in the original dilute sulphuric acid. Sixth, washing with water to dilute and remove adhering acid. Seventh, melting either with or without refining fluxes.

My invention consists in a process for refining metals, involving a series of consecutive steps, and machinery for carrying them out, as hereinafter more fully described and claimed.

The silver-separating apparatus consists, chiefly, of a heater, (furnished with a strainer,) a cooler, a collector, a mechanism adapted to lifting quicksilver, a fume-condenser adjusted to the above apparatus for precautionary purposes, and an inclined table or floor shedding to a tank for receiving and saving any leakages or drippings of quicksilver or amalgam which may fall. The retorting, roasting, and dissolving apparatus, besides furnaces, tanks, and vats commonly used, and, without description, well understood by refiners and manufacturing chemists, embraces retort-cups of special construction, and original stationary roasting boxes or pans, so contrived that heating them externally in an ordinary cylindrical furnace, without any application of mechanical power, causes an oxidizing circulation of air within them, while a reducing contact of fuel or flame with their contents is excluded.

Figure 1, in diagram herewith, represents a general view of the silver-separating apparatus and trap-floor, with their several parts connected with or adjusted to each other. Fig. 2 represents the supports and fastenings of the strainers in the heater and in a collector of similar construction. Figs. 3 and 4 represent a sectional edge and top view of the special retort-cups already alluded to. Fig. 5 represents a sectional side view of a cylindrical retort, (with condenser attached,) in which two tiers of retort-cups are represented in position. Figs. 6 and 7 represent a sectional side and top view of a roasting-furnace, with a tier of stationary roasting-boxes within. Fig. 8 represents a sectional side view of one of the special roasting-boxes already referred to.

In Fig. 1, S F is an inclined table or floor, which may either descend from two or more sides to a central opening, O; or, if desired, it

may incline only in one direction to a side or edge. Beneath the opening O (or beneath the lateral edge) a tank or vessel, A, is represented. This tank and inclined table, in combination, constitute a quicksilver-trap for catching any dripping from above. Over or above this trap the entire silver-separating and quicksilver-lifting apparatus is constructed, so that any drip or leakage therefrom must be shed to the tank and saved.

H is the heater, located at a height above the inclined table S F sufficient to permit a cooler, C, and collector K, or its described substitute, and well W, being adjusted below and between it and the inclined table or shedding-floor S F. From the collector K the cold strained quicksilver is conducted into the well or tank W, whence it feeds to a pump, or is scooped up by the bucket of the elevator E, and is lifted to the quicksilver-reservoir Q R. Located near the upper end of the heater H a pipe, *q p*, connects this reservoir with the upper end of the heater, as shown. A U-shaped trap, *u t*, forms part of this pipe, and is designed to prevent mercurial fumes escaping from the heater into the air. The heater H is an upright vessel whose sides are impervious to quicksilver, and, preferably, made of iron. It is surrounded with a heating-jacket, J J. The upper end of this heater may be connected with a condenser, M, by a condensing-pipe, *c p*, through which any mercurial fumes generated in the heater can pass, and being condensed, when not conducted elsewhere, their escape into the air which operatives breathe is prevented.

The lower end of the heater may be enlarged to form a chamber of any desired shape or size. Its enlargement increases the straining-surface without reducing the pressure; but all such enlargement may be dispensed with and speed attained by increasing the height of the heater.

In Fig. 1 of the drawing a chamber is represented by flaring the lower end of the heater, to which there is shown attached a funnel-shaped bottom, *f s b*, (see Figs. 1 and 2,) as also a spout, *sp*, closed with a gate, through which spout the contents of the heater may be removed without disturbing the strainer. Between the funnel-shaped bottom and the lower end of the heater a strainer is secured by the two rubber rings *r r* being pressed against the edges of the strainer, one ring being above and the other below it. The drilled plate *pl*, in Fig. 2, is covered with wire-cloth, and supports the middle of the strainer, while its own support is a heavier bed-plate, *b pl*, fitting in a cavity, *c c*, of the funnel-shaped bottom. The strainer itself may be made of punched iron or steel, (screen,) or of woven iron or steel wire; or it may be hair-cloth, duck, muslin, skin, or felt, and is to be laid on top of the above-described supports, so that bolting the heater-flange to the flange of the funnel-shaped bottom will make a quicksilver-tight joint, and compel the quicksilver to pass through the strainer. A short depending pipe, P, furnished with a stop-cock, *s c*, connects the lower part of the heater with the cooler, and provision is also made by a small try-cock, *t c*, for sampling the mercurial filtrate as it strains from the heater. Though other forms for a cooler are admissible, that represented in Fig. 1 is a nearly horizontal pipe, T, surrounded by a cold-water jacket, J J. The lower end of this pipe opens over and discharges into the collector, which is simply a straining apparatus. That marked K in Fig. 1 is a vessel furnished, like the heater, with a closed spout, *sp*, a strainer, *s*, and a funnel-shaped bottom, *f s b*. This strainer, however, may be made in any desirable form—for instance, in the form of a pair of canvas hose hanging from the trough over necessary receiving-vessels, and supplied with stop cocks, which enable the operator to empty and cleanse one hose of collected amalgam while the other is collecting more. A horizontal pipe, *h p*, conveys the strained-out quicksilver from the collector (or collecting-hose) to the tank or well W.

In Fig. 1 there is shown an endless band, bearing scoops or buckets. The band passes over two pulleys. The lower pulley causes the scoops to dip into the well W. The upper pulley empties the dipped-up quicksilver into the reservoir Q R. Instead of this elevator an iron pump may be used for lifting the quicksilver, by attaching springs to the valves, designed to overcome the levity of iron when immersed in quicksilver.

The form of retort is not important. In Fig. 5 it is represented as cylindrical. The characteristic feature of the retort-cups which are adapted to it is, that each cup is furnished with numerous parallel ribs, *p p*, Figs. 3 and 4, which mold the amalgam (while retorting) into thin slabs or bars. The slabs can readily be broken into small pieces without materially impairing the porousness of the retorted amalgam.

Fig. 6 represents a common upright furnace, with ordinary grate-bars. On these bars shallow roasting boxes or pans are set, in whose bottoms are apertures, through which air may rise from the ash-pit of the furnace when the roasting-boxes are heated. The bottom of each box or pan is so formed as to serve the purpose of a cover to any similar box on which it may be placed. The broken pieces of retorted amalgam being put into these boxes, they are piled one on the other, and a grating or perforated lid is laid on the top pan.

When a fire is built around the tier of pans or boxes, heat is communicated to the boxes and their contents, though fuel and flame are kept from reducing contact with the base metals, and oxidation is accomplished by the continuous circulation of air through the porous mass. An ordinary mill, (or battery furnished with a screen,) which needs no description, is sufficient to pulverize the roasted metal cold, when it is ready for acid treatment.

Having thus sufficiently described my apparatus and utensils, it remains to show their use in carrying on the process herein set forth, and to claim in form what I deem my invention, and entitled under the law to protection in.

In my apparatus for carrying on the quicksilver-leaching portion of the process herein described, I use a pump of novel construction, which will be made the subject of another patent, and in which springs are applied to the valves to overcome their levity when submerged in quicksilver.

The metals to be removed from the gold having been reduced with the gold to the form of an amalgam, the next step is to leach out, as far as practicable, the silver which may be associated with gold. To do so, charge the heater (preferably through the feed-pipe *f p*) with the base amalgam, (dissolved to fluidity in quicksilver,) applying heat to the heater, and turning on cold water into the cooling-jackets of the condenser and cooler, while motion is imparted to the pump or elevator. To a great extent the silver is automatically leached out from the base amalgam by the circulating heated quicksilver, and is caught in the collector, leaving in the heater only an amalgam of base metals and gold. When steam or hot air is injected into the heater, either for heating or for agitation, care must be taken to keep the jet exceedingly small, as also to adjust an upper straining-cloth, *s c s*, across the top of the heater, and below the mouth of the condensing-pipe *c p*, the intention of which is to prevent the quicksilver and amalgam being carried over mechanically into the condenser. The completion of the leaching is known by drawing off a sample of the filtrate as it strains from the heater. After cooling and straining it, if the silver is sufficiently leached out, only a trace of amalgam will be recovered from the sample. When the silver has been removed heat is to be withdrawn; but for the purpose of cooling the heater, besides other appliances, the pump or elevator may be continued in operation longer, after which—the excess of quicksilver having strained through—the gate of the heater-spout should be removed, and the amalgam taken out and retorted in the retort-cups, hereinbefore described, room being left in the cups for the swelling of the amalgam while retorting. The roasting of the retorted amalgam may be done in an ordinary reverberatory furnace, as in the Frieberg process; but it may be effected with less labor in an ordinary vertical furnace by the use of the roasting-boxes, hereinbefore described. If the retorted metal, prior to roasting in the roasting-boxes, is broken into sufficiently small pieces without injuring its porousness, and if the roasting heat is raised gradually and protracted long enough, the greater portion of the base metals will be oxidized and fitted for solution in weak sulphuric acid without a second roasting after pulverization. If the roasted lumps are then ground or pulverized solution is hastened, as is the case also when the acid is heated prior to introducing the roasted metal. A second skillful roasting of the pulverized material will insure complete, prompt solution of the base-metal oxides. The amount of acid employed should be but slightly in excess of the chemical requisite to form sulphates of the metals, and the dilution should be but a little more than is necessary for crystallization and warm aqueous solution. Further dilution (to prevent crystallization while subsidence of the unoxidized and insoluble portions is going on) can be provided for in special subsiding or settling vats, when there is not sufficient room in the dissolving-vat, or when time forbids its use for subsidence. The clear liquor having been drawn from the subsiding-vat, (a flexible siphon, the feeding end of which is attached to a float, is a good device for this purpose,) the settlings may be digested in hot strong sulphuric acid, or, at a moderate heat, in dilute nitric or nitro-sulphuric acid, or in two or more of these acids successively, in order to remove from mixture with the gold any soluble metal which may not have been fully taken up by the dilute acid first employed; or, if it is in any place more convenient to complete the process by a substitute for these last-named humid steps, or to employ the process to an extent which will produce only a partial refining of the gold, the subsidence may be melted with the use of ordinary refining fluxes, and preferably in sand crucibles; or it may be melted with simple cleansing fluxes in such crucibles as can be most conveniently obtained. But if the process, as already indicated, is employed in its completeness after the final acid treatment of the subsidence above named, the residue should be washed, and the gold produced will be found mintable, or, after melting and assaying, will be found salable.

I disclaim the process of oxidation by means of roasting-vessels revolving in a furnace or flame, to the interior of which vessels the air has access. I also disclaim the process of oxidizing lumps of retorted base amalgam by heating the same with access of air in boxes or pans generally.

Having thus described my process, utensils, and procedure, what I claim as my invention, and desire to secure by Letters Patent, is—

1. The process herein described for refining gold, consisting essentially of the following steps: First, the conversion of all amalgamable metals into one amalgamated mass; second, removing the silver therefrom, as hereinbefore specified; third, retorting the remainder, containing the gold, into a highly porous or spongiform mass; fourth, roasting the same with access of air; fifth, dissolving the base-metal oxides in dilute sulphuric acid; sixth, digesting the residuum in hot strong sulphuric acid, or in dilute nitric acid, or in weak nitro-sulphuric acid; seventh, washing

the remaining gold with water; eighth, melting.

2. The heater H, constructed with the strainer, as described, and with suitable supports for the same, substantially as set forth.

3. The collector K, constructed with a diaphragm, S′, composed of the plate *b p l*, wire-cloth *p l*, and cloth *r*, lying contiguous to each other, substantially as and for the purpose set forth.

4. In combination with the silver separating and lifting apparatus hereinbefore described, the quicksilver-trap consisting of the shedding floor or table S F and tank A, as set forth.

5. In combination with the heater H and the condenser M, the strainer *s c s*, as herein described.

In witness whereof I hereunto set my hand.

CONRAD WIEGAND.

Witnesses:
E. TERRA,
J. WALDSTEIN.