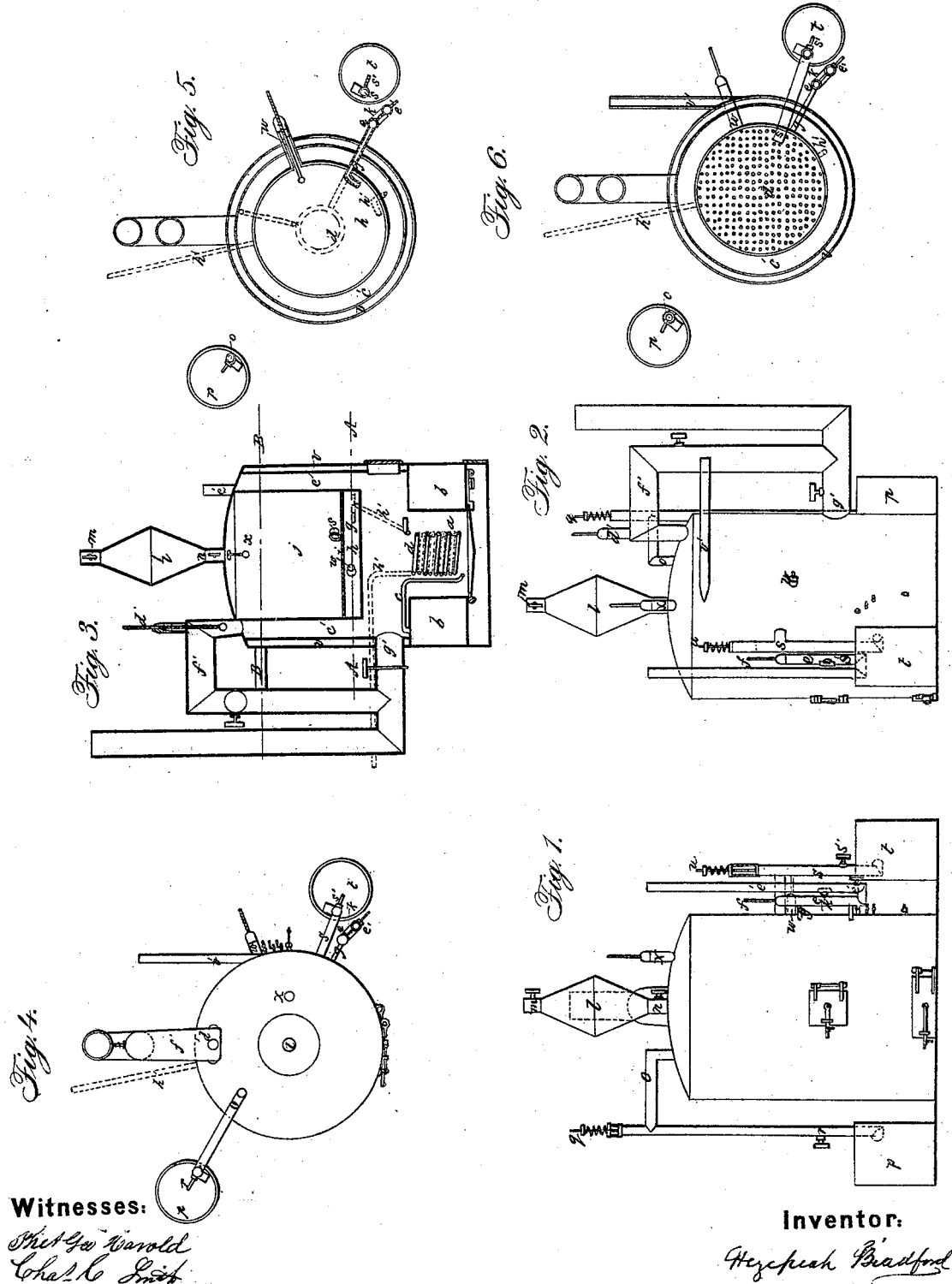


H. BRADFORD.
Roasting Ores.

No. 46,520.

Patented Feb. 21, 1865.



Witnesses:

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HEZEKIAH BRADFORD, OF NEW YORK, N. Y., ASSIGNOR TO HORATIO BOGART,
OF SAME PLACE.

IMPROVEMENT IN ROASTING AND DESULPHURIZING ORE.

Specification forming part of Letters Patent No. **46,520**, dated February 21, 1865; antedated
February 16, 1865.

To all whom it may concern:

Be it known that I, HEZEKIAH BRADFORD, of the city and State of New York, have invented a new and useful Process for Roasting, Desulphurizing, or Removing the Volatile Ingredients of Metallic Ores; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, making part of this specification, in which—

Figure 1 is a front elevation; Fig. 2, an elevation of the right-hand side. Fig. 3 is a vertical section. Fig. 4 is a top view. Fig. 5 is a horizontal section taken at the line A A of Fig. 3, and Fig. 6 is a horizontal section taken at the line B B of Fig. 3.

The same letters indicate like parts in all the figures.

My said invention relates to a process for roasting, desulphurizing, and removing the volatile ingredients of metallic ores; and it consists in subjecting the finely-pulverized ore, while contained in a chamber, to numerous jets of superheated steam or heated atmospheric air, or both commingled and forced through the charge so as to agitate the mass of pulverized ore, and thus act upon all the particles thereof, and facilitate the chemical action and liberation and discharge of the volatile matter or matters therefrom. I retain the fine particles of ore that pass away with the heated air, gas, or steam, by passing the same through water, thus saving the particles that would otherwise be lost; and when the ore-chamber is to be partially or entirely emptied it is accomplished by opening a pipe that leads to a vessel of water, said particles being blown off by the pressure in the ore-chamber.

Having thus stated the characteristic features of my said process, I will now describe the form of apparatus in which I prefer to work my said process, although I do not wish to be understood as limiting myself to the use thereof, as other suitable apparatus may be substituted.

In the accompanying drawings, *a* represents a fire-pot of any suitable form, preferring the cylindrical with a grate and ash-pit of any suitable construction. This fire-pot is surrounded by a boiler, *b*, provided with the usu-

al appendages of gage-cocks, feed-pipe, safety-valve, &c. The form of this boiler and its location may be variously changed. From the upper part or steam-chamber of this boiler there is a pipe, *c*, which extends down nearly to the bottom of the fire-chamber *a*, and is then carried up in the form of a coil, *d*, and is thence carried out and discharged into the lower end of a vertical tube, *e*. The steam generated in the boiler *b* passes through the pipe *c* and through the coil *d* thereof, where it is superheated, and in this condition is discharged into the said tube *e*.

Within the tube *e* a thermometer, *f*, is suspended to indicate the temperature of the superheated steam as it passes through this tube to the place where it is to be used. The upper end of the tube *e* is provided with a discharge-pipe, *g*, which extends inward to the inner periphery of a horizontal pressure-chamber, *h*, and there it is bent in the direction of a tangent, so that the superheated steam, in entering the said chamber, shall have a whirling motion in the said chamber and under the perforated bottom *i* of the ore receiver or chamber *j*.

In the tube *e*, before described, there is a throttle or other equivalent valve, *k*, for shutting off or regulating the flow of superheated steam through it. If desired, the said tube *e* may be provided with a blow-off pipe and cock, as at *e'*, for the discharge of steam, if it should become too highly heated.

The ore to be desulphurized is to be properly pulverized and charged into the ore-receiver *j*, and on the bottom thereof, which is perforated in any suitable manner with numerous fine holes. I prefer to make the perforations two hundred and fifty-six to the square inch; but this may be greatly varied. The pulverized ore is charged into the ore-chamber *j* through the charging-tube *l*, at the top provided with two cocks, *m n*—one near the upper and the other near the lower end—so that they can be alternately opened and closed to prevent the steam and fine particles of ore within the ore-chamber *j* from escaping during the operation of charging. The superheated steam being discharged in the pressure-chamber *h* under the perforated bottom of

the ore-chamber *j* through a tangent pipe or nozzle, gives it a whirling motion, which spreads it under the entire area of the perforated bottom, that it may pass up through all the perforations with equal or nearly equal pressure—a result which could not be obtained if the steam were directed by a nozzle against any one part of the perforated bottom. The numerous fine jets of superheated steam thus passing through the said perforated bottom *i* act on all the particles of ore, agitating the whole mass and causing an action analogous to ebullition. In this way the superheated steam is brought in contact with every particle of ore, however finely it may be pulverized, without the necessity of using mechanical stirrers, which are liable to derangement, require power to operate them, and, as proved by experience, have failed to effect that intermingling of the superheated steam and pulverized ore so essential to the operation of desulphurization.

During the operation the steam, after acting on the ore, escapes through a pipe, *o*, at top, and this pipe extends down and discharges into a tub of water, *p*, and as very fine particles of ore are liable to be carried off with the steam, and it is important to save such fine particles, particularly when operating on ores containing gold or silver, the lower end of this pipe is tangential to the periphery of the tub *p*, so as to give the water in the tub a whirling motion, which will cause the steam to be diffused in the water, and, if inserted deep enough, insure its condensation and the deposit in the water of all the fine particles of ore carried over by the steam. These finer or lighter particles may not be fully desulphurized. As many will be carried over during the first stage of the process, they may, after a sufficient quantity is collected, form a separate charge to be treated in the ore-chamber. In this case the necessary agitation or ebullition will be produced with much less steam, not enough to carry over the fine particles again. This pipe *o* is provided at top with a spring-valve, *q*, opening inward to prevent the water in the tub from being forced up into the ore-chamber *j*, if by accident the steam should be suddenly condensed within the apparatus, and this pipe is provided with a stop-cock, *r*, to shut off the escape of steam through this pipe, taking care to open the cock *s'* in the pipe *s* at the same time when it becomes necessary to discharge the ore from the chamber after it has been desulphurized or when it is desired to examine specimens during the progress of the process.

At or near the perforated bottom of the ore-chamber *j* is a discharge-pipe, *s*, the lower end of which extends into a vat, *t*, containing water, the discharge end of the pipe being bent tangential, or nearly so, to the inner periphery of the said water-vat *t*, so as to give the water in the vat a whirling motion. This pipe is also provided with a stop-cock, *s'*, and with

a spring-valve, *u*, opening inward to prevent the contents of the vat from being carried up into the ore-chamber by an accidental condensation of the steam within the apparatus. By closing the stop-cock *r* of the escape-pipe *o* and opening the stop-cock *s'* of the discharge-pipes, the whole force of the steam will be caused to act on the pulverized ore, to force it out through the said pipe *s* and the tangential nozzle into the vat *t*. This nozzle is to be sufficiently below the surface of the water in the vat to insure the condensation of the steam, whereby all the particles of ore be will retained in the water, and the sulphates that may have been formed during the process of desulphurization will be dissolved, and thus in the case of gold or silver ores prepare them for the purpose of amalgamation. The same means may be resorted to during the operation to obtain samples of the ore for examination to determine when the charge is desulphurized. The ore-chamber *j* is surrounded by a casing, *v*, which I prefer to make double, the better to retain the heat, and said casing may be employed as a means of regulating the temperature of the space *c'* by introducing hot or cold air by the pipe *v'* by any suitable blower, and allowing the said air to pass out of the case or jacket *v* and through any suitable opening.

As it is important in desulphurizing ores to work at given temperatures, in addition to the thermometer *f* in the tube *e*, through which the superheated steam passes to the inside of the chamber *h*, I have another thermometer, *w*, fitted in a tube that extends from the pressure-chamber *h* through the casing *v*, (see Fig. 5,) the thermometer extending from the inside of the chamber *h*, under the perforated bottom of the ore-chamber *j*. In this way the temperature of the steam when it enters the ore-chamber *j* can be observed at all times, that the attendant may increase or decrease the temperature by varying the supply of superheated steam.

On the top of the ore-chamber *j* is another thermometer, *x*, inserted through the top, to enable the operator to ascertain the temperature of the inside of the said ore-chamber *j*. As it is desirable that no condensation, either of steam or vapor, shall be allowed to take place in the ore-chamber *j*, the said chamber is surrounded by a casing, *v*, which I prefer to make double, the better to retain the heat, and, if necessary, this casing may be extended over the top of the chamber; but in that case tubes will have to be fitted in the casing to admit the thermometer *x*, the smoke-pipe *f'*, and the discharge-pipe *o*.

Between the ore-chamber *j* and the casing *v* is the space *c'*, through which the products of combustion of the fire-pot *a* pass around the ore-chamber *j*, and if the casing *v* is extended over the said chamber, this space *c'* must also be extended, so that the products of combustion may surround the entire sides and top of the chamber *j* and pass off through the smoke-pipe *f'*, if desired. There is also another

passage for the products of combustion through the smoke-pipe *g'*. Each smoke-pipe has a damper, which will enable the operator to control the heat around the ore-chamber at pleasure, and, if desired, in addition to the thermometer *d'* in smoke-pipe *f'* other thermometers may be inserted through tubes fitted in the casing *v* into the space *c'* at any desired point to ascertain the temperature in the space *c'* around the chamber. If heated air be used instead of superheated steam as the volatilizing agent, all that is necessary to be done is to force air into the boiler instead of water, and the air thus forced in by any suitable blower will become sufficiently heated, and will operate mechanically on the ore to agitate it just as the superheated steam above described; but if it is desired to introduce both superheated steam and heated air jointly, said air may be supplied by a suitable blower and passed through a coil of pipes, (shown by dotted lines at *h'*.) Thence the heated air passes into the pressure-chamber *h* and receives a whirling motion similar to that of the steam by being discharged from a nozzle bent in a direction tangential to the inner periphery of said pressure-chamber *h*. If preferred, however, the said coil of pipe may be dispensed with and the air heated in any desirable manner before it is forced into the pressure-chamber *h*.

If desired, an apparatus similar to the pipes *ee'*, with their cocks and thermometers, may be employed to regulate the temperature of air passing into the chamber *h*. When air or air commingled with steam is used as the desulphurizing agent, it should, in passing out of the tangential nozzles of the pipes *o* and *s* into the water-vats *t* and *p*, be discharged in fine stream through a perforated plate, or its equivalent, in order that the water may come in contact with and detain the particles of ore discharged with the air from the ore-chamber *j*. The finely-pulverized ore should be dry when it is charged into the ore-chamber *j*, and sufficiently heated to prevent the condensation of the steam among the particles, otherwise said particles might adhere together, and not be equally exposed during the process to the action of the desulphurizing agent.

Before charging the ore-chamber I prefer that the entire apparatus be heated to a temperature a little above 212° Fahrenheit, and that the superheated steam or heated air, or both, should be supplied to the pressure-chamber *h* with force enough to blow out any particles of ore or other substances that may have lodged in or become entangled in the perforated holes in the bottom *i* of the chamber *j*. After these perforated holes are all cleared out, a sufficient and constant force of air or steam, or both commingled, should be kept up during the charging of the chamber, and during the whole process, and until the

chamber *j* is finally discharged, to keep the whole mass of ore in constant agitation or ebullition, and keep open the perforated holes and prevent the fine particles of ore from falling through the perforated holes into the pressure-chamber *h*. During the process the temperature should be gradually increased until the sulphur is entirely driven off; but the temperature should never be increased so fast as to melt the particles of sulphur, or cause the particles of ore to adhere to each other, or adhere to the perforated bottom, and the temperature of the space *c'* around the chamber *j* should be maintained as nearly as possible the same as that of the air or steam, or both, in the pressure-chamber *h*, in order that the particles of ore in the chamber *j* may all be exposed to a corresponding temperature.

In ores containing a large proportion of sulphur that is easily separated, it is preferable, first, to introduce heated air, and as the operation progresses, to supply superheated steam to commingle with the air in the pressure-chamber *h*, increasing gradually the proportion of steam and diminishing the supply of air in such a manner that the last portion of the operation may be performed by the superheated steam alone.

The escape heat from the apparatus may be employed in drying and heating the ore previous to its being charged into the ore-chamber *j*, and said ore should be screened in any suitable manner, to prevent the introduction of any pieces larger than one-half or one-third the size of the perforations in the perforated bottom *i* of the ore-chamber *j*, otherwise the holes may get stopped by the wedging of one or more pieces of ore that may remain in the chamber and fall into the perforated holes after the operation is completed and the current of air or steam stopped.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The process, substantially as herein described, of treating metallic ores in a finely divided or pulverized state in a chamber with jets of superheated steam or heated air, or both, jointly forced through the charge, substantially as and for purposes specified.

2. Retaining the fine particles of ore that pass off from the ore-chamber with the steam, air, or gases, by passing the same into or through water, substantially as set forth.

3. Discharging the finely-pulverized ore from the ore-chamber through a pipe into a vessel or reservoir of water by the pressure of the air, gas, or steam, substantially as set forth.

In witness whereof I have hereunto set my signature this 3d day of August, 1864.

HEZEKIAH BRADFORD.

Witnesses:

THOS. GEO. HAROLD,
CHAS. H. SMITH.