2 Sheets—Sheet 1.

Z. A. WILLARD.

PROCESS AND APPARATUS FOR TREATING ORES.

No. 186,654. Patented Jan. 23, 1877.

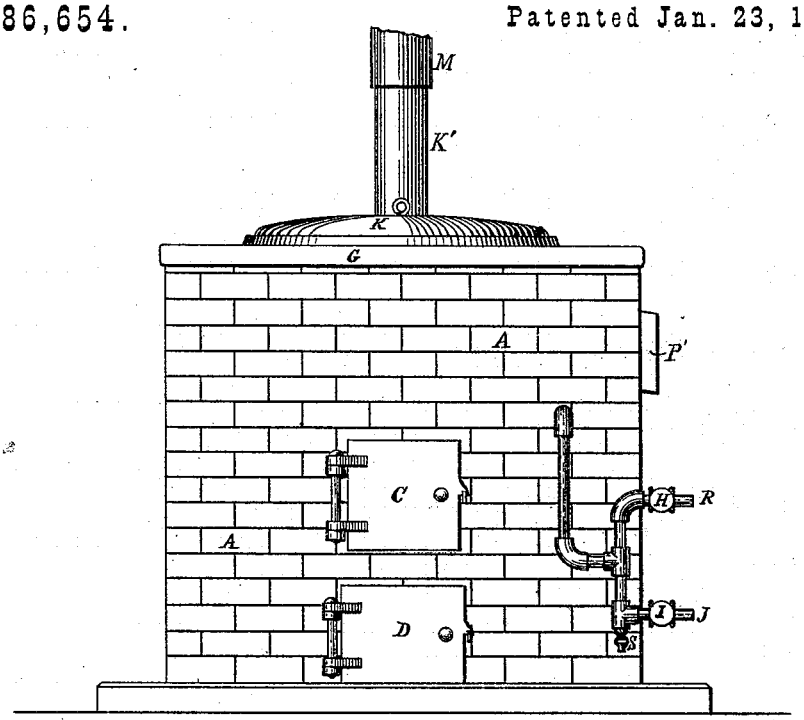

FIG. 1.

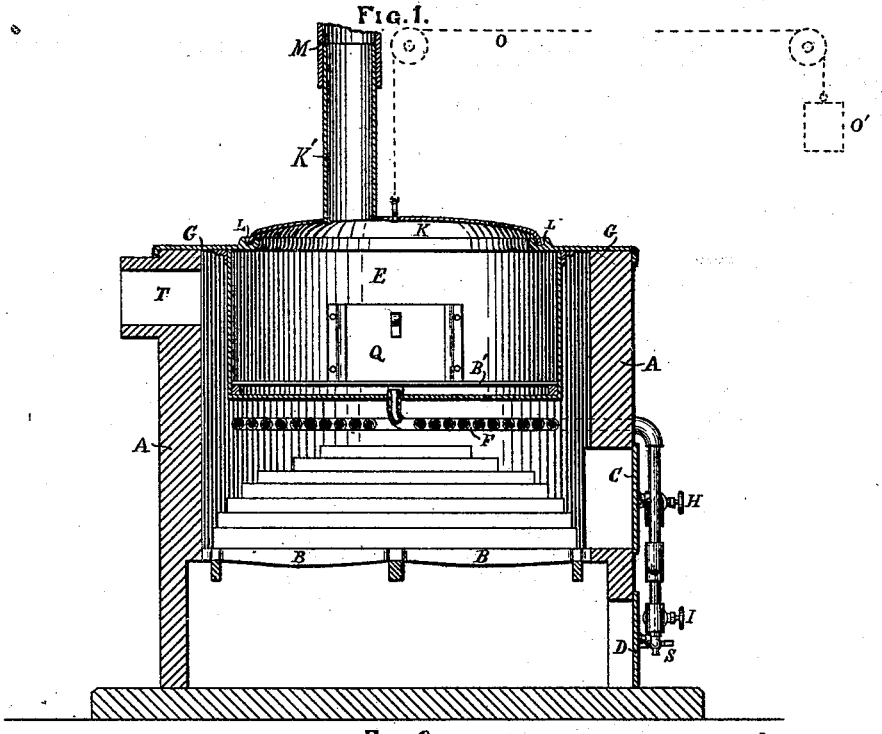

FIG. 2.

WITNESSES.

J. Robbins.
Jno. C. Hibbard

INVENTOR.

Z. A. Willard.

2 Sheets—Sheet 2.

Z. A. WILLARD.

PROCESS AND APPARATUS FOR TREATING ORES.

No. 186,654. Patented Jan. 23, 1877.

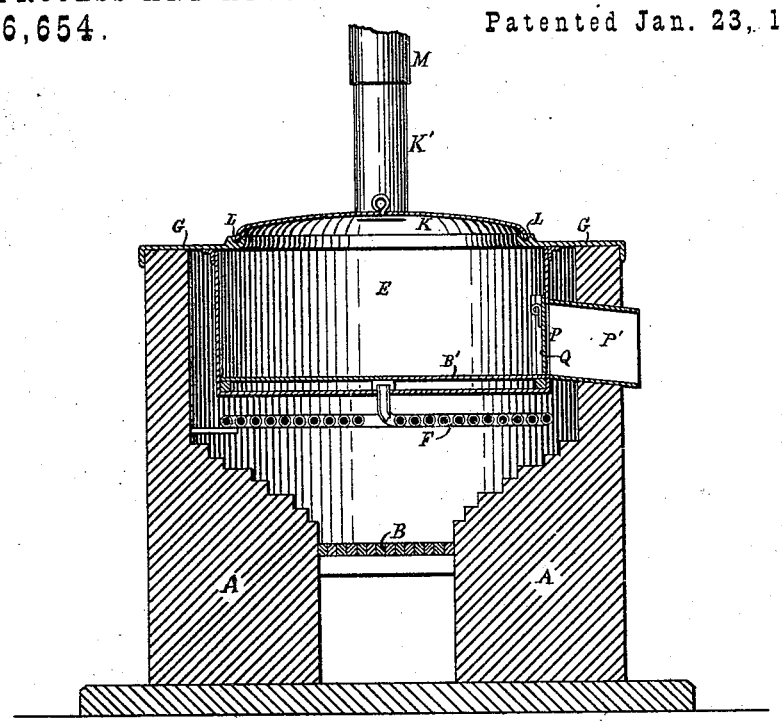

FIG. 4.

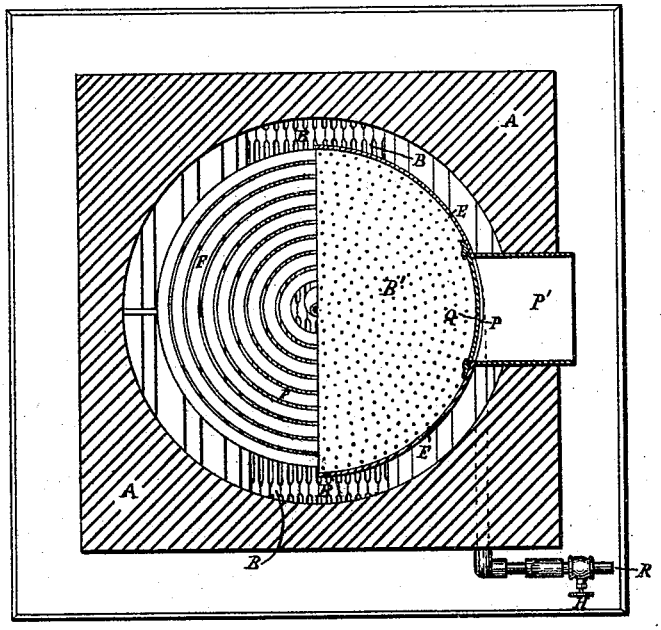

FIG. 3.

WITNESSES.

J. Robbins.
Wm. C. Hibbard

INVENTOR.

W. A. Willard.

UNITED STATES PATENT OFFICE.

ZABDIEL A. WILLARD, OF BOSTON, MASSACHUSETTS.

IMPROVEMENT IN PROCESSES AND APPARATUS FOR TREATING ORES.

Specification forming part of Letters Patent No. **186,654**, dated January 23, 1877; application filed July 27, 1876.

To all whom it may concern:

Be it known that I, ZABDIEL A. WILLARD, of Boston, in the county of Suffolk and State of Massachusetts, have invented an Improved Process and Apparatus for Treating Ores, of which the following is a specification:

My invention is mainly for the purpose of desulphurizing the ores of metals, or for expelling from minerals such matters as may be volatilized by heat and chemical reaction.

The nature of my new process and the several operations which constitute it, may, perhaps, be best understood by the practical metallurgist from a description of the apparatus used, and from a description of the operations performed in connection with it.

Before subjecting the minerals to treatment by this process, the ore is reduced to a fine powder, and any usual means may be used to concentrate the ore and separate from it the barren matters that may be associated with it, to avoid the expense of their treatment.

The apparatus for carrying on this process is substantially represented in one form in the accompanying drawings, in which—

Figure 1 is an elevation of the furnace. Fig. 2 is a vertical section through the center of the same. Fig. 3 is a horizontal section, part above and part below the bottom of the retort. Fig. 4 is a vertical section at a right angle to Fig. 2.

A is the brick-work of the furnace. B is the grate. C is the fire-door. D is the ash-pit door. E is the retort, which, by preference, is made of wrought-iron plate riveted. It is about five feet, more or less, in diameter, and about two feet deep in the clear, and will contain a charge of about two tons of ore. It is suspended from the under side of the plate G, which rests upon the top of the brick-work and forms the top of the furnace. The retort extends downward within the furnace to within about two feet from the grate, depending upon the kind of fuel used. At say two inches from the bottom of the retort is placed a perforated plate, B′, which is filled with small holes, say, one-sixteenth of an inch in diameter, or less, and an inch, more or less, apart, and said plate is supported in the retort sufficiently to carry the whole charge of ore that is treated, leaving a free open space below it, into which is admitted a current of hot air, or air and steam, as will be described. The top of the retort is covered in part by the plate G, to which the retort is attached, and the opening through which is covered by the hood or cover K, which is raised up out of the way when it is necessary to empty or charge the retort, which hood is provided with a large upright pipe, K′, to conduct away the fumes that may be produced in the retort during the operation. The lower edge of the hood K rests in the trough or channel L formed around the opening through the top plate G, which is partly filled with dry sand or powdered treated ore, which closes the joint of the cover sufficiently to carry off the fumes produced in the retort through the pipe K. The pipe K′ extends upward about six feet, and enters an exterior pipe, M, which is a little larger in diameter than the pipe K′, and in which said pipe K′ slides telescope fashion. The pipe M leads to a chimney or to the open air. Or, in case it should be desired to save any of the volatile products of the operation, this pipe would be led to suitable condensing or depositing chambers; but these form no part of the present process.

The cover K and pipe K′ are counterpoised by a weight, O′, and chain O, which work over pulleys placed above, by which the cover K can be raised up out of the way of the workman in emptying or charging the retort. P is an opening through the side of the retort, even at the bottom with the top of the perforated plate B′, through which opening the contents of the retort are removed. This opening is provided with a spout, P′, which extends outside of the wall of the furnace, as shown, and at the inside of the retort is provided with a sliding door, Q, which closes it. F is a coil of wrought-iron pipe, which is coiled spirally in a plane with its convolutions close together, and placed but a little distance from the bottom of the retort, and the exterior diameter of the coil is about the same as that of the retort. The inner end of this coiled pipe is inserted into the bottom of the retort at the center, and projects about an inch above the bottom, and the outer end of this pipe is extended outward through the wall of the furnace, and is connected with a blowing-

machine of some kind by the pipe R that will drive a current of air under pressure through the mass of ore above the perforated plate B′ in the retort, which current is controlled by the stop-valve H. To this pipe also, exterior to the furnace, is attached a smaller steam-pipe, J, which connects with a steam-boiler, and the flow of steam through this pipe is controlled by the stop-valve I. By this arrangement a mixture of air and steam in any desired proportion can be forced into the lower part of the retort, and diffused through the mass of ore upon the perforated plate B′ under the control of the workman, both as to its volume and mixture; and by this means the rate of combustion of the sulphur can be so regulated by increasing or diminishing the proportion of steam to the air-current, that the slagging of the sulphuret can be entirely prevented. S is a pet-cock to carry away the condensed water produced from the steam, and prevent it from flowing into the heating-coil F and producing an explosion. T is a flue, which leads from the upper part of the furnace to a chimney, and suitable fire-doors are fitted to the brick-work in the usual manner.

With an apparatus thus constructed I will now describe the process of desulphurizing a sulphuret of iron or copper, or other base metal, charged more or less with the precious metals—such, for instance, as the gold ores of Colorado. The ore is to be reduced to a fine powder that will pass through a sieve of about forty to fifty mesh, or finer, and should contain, say, twenty-five per cent. of neutral matter, such as quartz, alumina, &c. If the ore is clear sulphuret, about twenty to twenty-five per cent. of some neutral or inert mineral should be mixed with it to prevent the sulphuret from slagging or running together. The pulverized ore is then mixed with about its bulk of pitch-pine saw-dust, uniformly incorporated with the mass, when the whole is moistened with salt water, by preference sea-water, or water of the same saltness, but not made so wet as to drip. This use of salt water I do not regard as indispensable, as the process of desulphurization may be carried on without it; but it is better done with it, as the action of the chlorine, or soda, or both, supplied by the salt, serves to render the gold eliminated by the process bright and clean, and in good condition for amalgamation, if that method is employed for saving the precious metals. This moistened mass is placed in the retort just described upon the perforated plate B′, first strewing some sawdust or fine shavings upon it, to prevent the powdered ore from falling through the holes in the plate.

When the retort is charged full, the hood or cover K is lowered, so that its lower edge rests in the dry sand or treated powdered ore which is placed in the groove or channel L, which sufficiently closes the joint. As soon as the retort is properly heated up, the air from the blowing-machine is gradually let on by the air-cock H, and flows into the heating-coil F, by which the air is heated to, say, 500° or 600° Fahrenheit, and discharged into the space or chamber in the retort below the ore. The effect of the hot-blast is to heat up the mass of the ore uniformly, and dry out the moisture, and, as soon as the ore is hot enough, to ignite the sulphur in the ore. This burns slowly with its peculiar blue flame, and in turn ignites the sawdust, which thus supplies additional fuel to support the combustion or volatilization of the sulphur or other volatile matter in the ore. The carbon of the sawdust also aids in the decomposition of the water of the steam mixed with the air while within the mass of ore itself, and produces a set of interactions among the matters present by the sublimation and ignition of the sulphur, the destructive distillation and combustion of the sawdust, and the production of chlorine from the salt, which I am not able to explain, but which experiment has shown are very efficient in liberating the precious metals from their connection with the sulphurous and volatile matters with which they are associated. The destruction, also, of the sawdust within the mass of ore, leaves the latter porous and permeable throughout to the circulation of the current of hot air and steam through it, and enables them to lift out and carry away from the mass of ore all the vaporized matters as fast as they are liberated from the ore. This operation goes on until the combustion ceases of itself by the exhaustion of the combustible matters, when the operation is finished, and the retort is ready to be discharged and filled again. The time of treatment varies with the nature of the ore, say from five to eight hours.

Although I have especially designated pitch-pine sawdust as the kind of carbonaceous and hydrogenous material to be mixed with the ore to be treated, yet other similar materials may be used instead—such as other kinds of sawdust, or chips, leaves, peat, &c. The use of steam mixed with the hot air in this process enables the heat in the mass of ore to be so graduated as to prevent the slagging of the ore by the excessive combustion of the sulphur, which would interrupt the operation.

This use of a current of hot air and steam which is driven mechanically through the mass of ore made pervious to that current, enables the volatile products of the operation to be immediately removed and carried away with great facility, and also conveys the heat into all parts of the mass of ore at the same time, and carries on the work of desulphurization or volatilization within the mass itself, which enables the operation to be performed in a comparatively short time, and at a comparatively low temperature.

Although I have described the apparatus and the process of desulphurizing ores fully, and wish to claim it broadly as such, yet there are substantial and material subordinate parts

of the invention which I deem to be new, and which may be usefully employed in connection with other operations than those specifically described—as, for instance, the admixture of sawdust, or its equivalent, with the ore, whereby a combustible material, which serves as a portion of the fuel, is intimately incorporated with it, and imparts a porosity to the mass under treatment, which enables a diffused current of air and steam to be driven through it mechanically, to support the combustion of it and carry off the volatile matters produced, is an operation that may be used in metallurgy in other connections than that specifically mentioned, and be of great utility, and I therefore desire to claim it separately as a feature of my invention. And so of the use of the mixture of steam with the current of air which supports the combustion of the combustible matters within the mass of ore, to prevent slagging the sulphuret by reason of the intense combustion of the combustible matters. I deem this to be new, and desire to claim it separately as a part of my invention.

I do not confine myself to the particular construction of the apparatus herein represented, as the form may be considerably varied and still retain substantially the same mode of operation of the process; but

What I claim is—

1. The combination, with such vertical retort as is herein described, of the blast-conveyer pipe, formed in flat coil beneath the retort, whereby the bottom of the retort is shielded from the direct furnace-flame, substantially as described.

2. The herein-described process of desulphurizing ores, which consists in moistening a mixture of the pulverized ore and sawdust with salt-water, and then subjecting the mass to the action of a heated current of air and steam, the current being disseminated throughout the material, and its flow continued until desulphurization is completed, all substantially as herein shown and described.

3. The method herein described of preparing pulverized sulphuret ore or other mineral for treatment, by intimately incorporating therewith a suitable proportion of sawdust, or other similar combustible substance, and moistening the whole with salt-water, substantially as described.

4. The process of treating a mass of pulverized sulphuret ore, which consists in intimately incorporating with it sawdust, or similar carbonaceous matter, then passing through this mass a current of air and steam, the quantity of steam being regulated by the operator, whereby combustion is maintained within the retort, and by the presence of the steam the slagging of the sulphuret is prevented, substantially as described.

Z. A. WILLARD.

Witnesses:
J. ROBBINS,
WM. C. HIBBARD.