2 Sheets—Sheet 1.

D. J. O'HARRA.

Furnace for Roasting Ores.

No. 207,890. **Patented Sept. 10, 1878.**

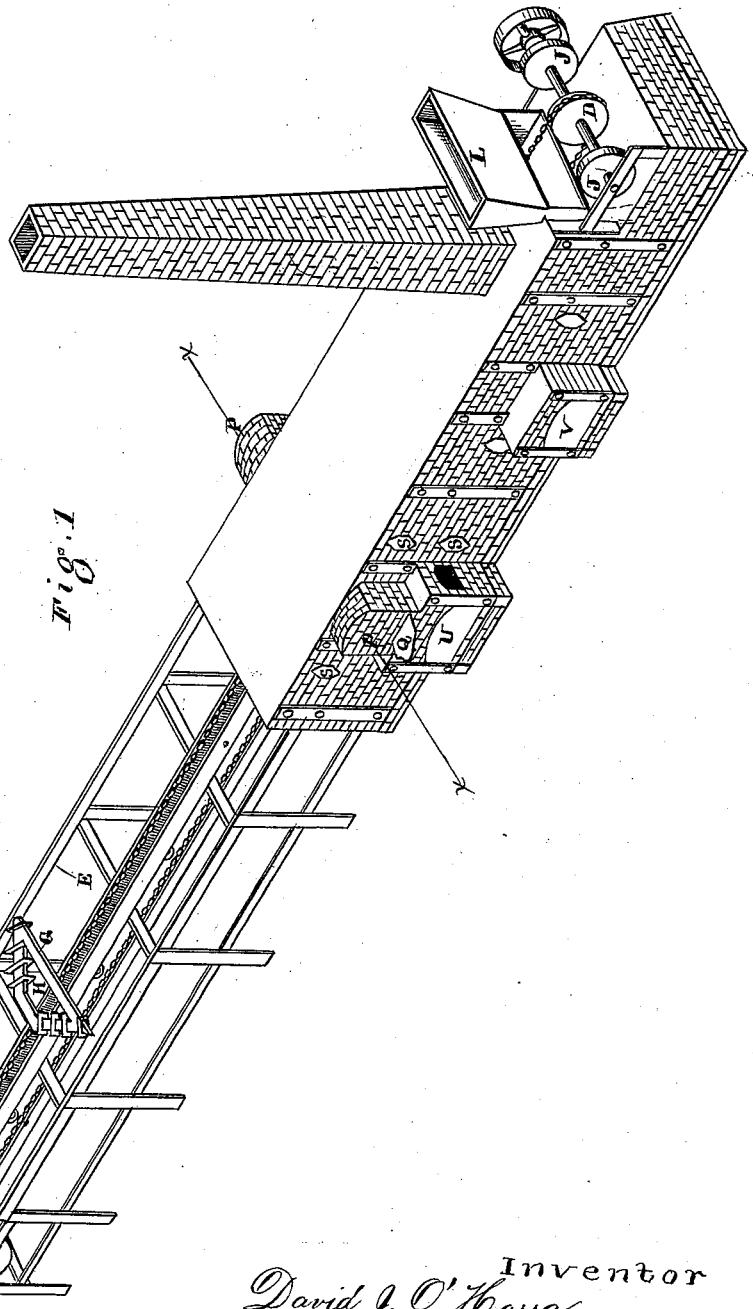

Fig. 1.

Witnesses

Geo. H. Strong

Frank A. Brooks

Inventor

David J. O'Harra

by Dewey & Co.

Attys

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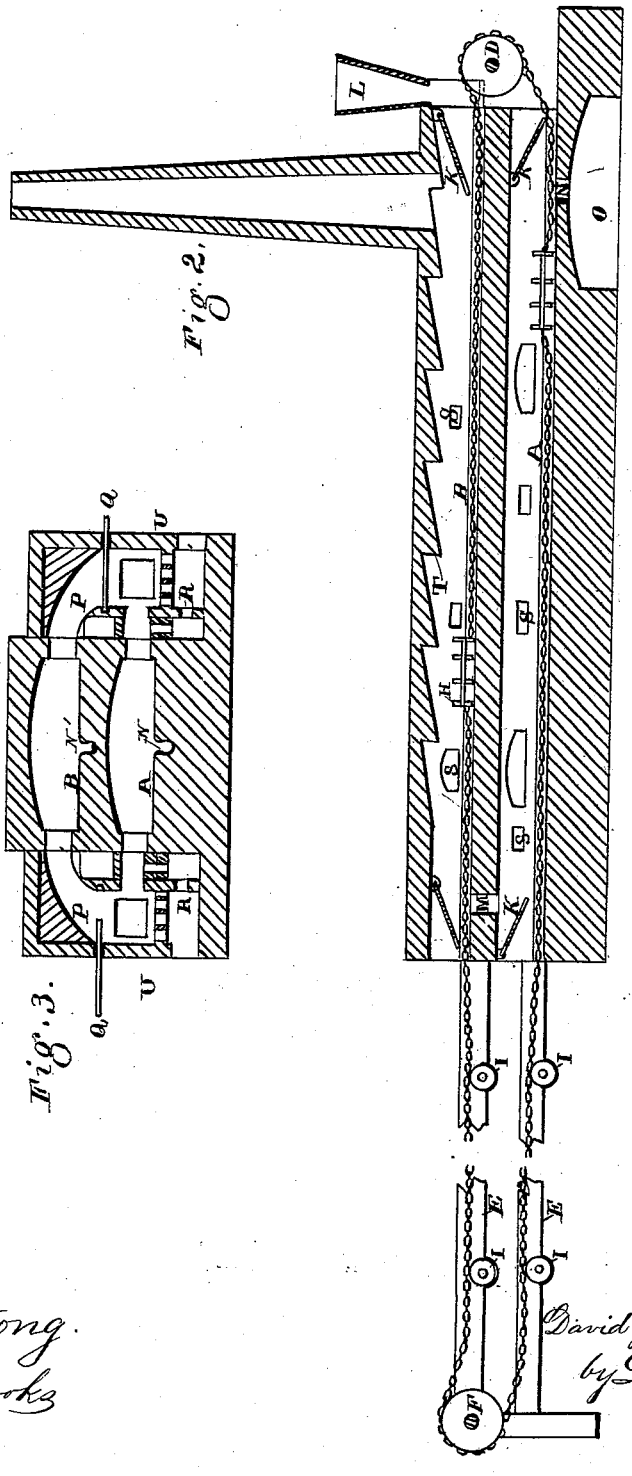

Fig. 2.

Fig. 3.

Witnesses

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attys

UNITED STATES PATENT OFFICE.

DAVID J. O'HARRA, OF RENO, NEVADA, ASSIGNOR OF ONE-HALF HIS RIGHT TO J. F. FERGUSON.

IMPROVEMENT IN FURNACES FOR ROASTING ORES.

Specification forming part of Letters Patent No. **207,890**, dated September 10, 1878; application filed April 10, 1878.

To all whom it may concern:

Be it known that I, DAVID J. O'HARRA, of Reno, county of Washoe, and State of Nevada, have invented a Desulphurizing and Chloridizing Furnace; and I do hereby declare the following to be a full, clear, and exact description thereof, reference being had to the accompanying drawings.

My invention relates to that class of horizontal furnaces intended for desulphurizing and chloridizing ores, and introduces certain improvements in the furnace for which Letters Patent were granted to myself and Clark B. Thompson on the 6th day of August, 1867, and of which I am now sole owner.

My improvements consist in constructing the furnace with two longitudinal compartments, so as to form two hearths, one above the other, with connecting passage between them, on the upper one of which the desulphurization of the ore is accomplished, and on the lower the chloridization.

It also consists in the use of an endless chain, carrying conveyers, in which are hoes or stirrers, which pass through both compartments, stirring up the ore and gradually conveying it from the feeding to the discharge opening. This chain passes some distance into the open air in its revolutions, so as to be cooled before again entering the furnace, thus preventing it from being destroyed by the heat. I also form certain openings in the sides of the furnace, by which the supply of oxygen may be regulated for ore more or less highly sulphureted.

Referring to the accompanying drawings, Figure 1 is a perspective view of the furnace. Fig. 2 is a longitudinal section. Fig. 3 is a cross-section on line *x x* of Fig. 1.

My furnace is constructed of the usual materials, and is made with two separate hearths, one for desulphurizing and the other for chloridizing the ore, both processes being performed at the one operation. The lower hearth, A, is a perfect plane, and is separated from the upper hearth, B, also a plane, by the longitudinal diaphragm or division C, which forms the roof of the lower furnace and the floor of the upper one.

At the end of the furnace, where the ore is fed and discharged, as hereinafter described, is a grooved pulley, D, mounted on a shaft, to which power may be applied, as shown. At the other end of the furnace is built an extension or frame-work, E, at the outer end of which is another pulley, F. Around these pulley D and F passes an endless chain, which passes completely through the furnace, going one way through the upper compartment and the other way through the lower as the grooved pulley D is rotated on its shaft by the steam-engine.

The pulleys carrying the endless chain move from left to right, so that the scrapers or conveyers on the chain move over the upper hearth from the opening through which the ore is fed, and then back through the lower compartment, thus admitting of the ore being fed and discharged at the same end of the furnace, as hereinafter described.

Attached to this endless chain, at proper distances apart, are conveyers or scrapers G, formed in a triangular shape, as shown. To the front bars of this triangle are fastened a number of hoes or stirrers, H, at such an angle that they will push the ore on the hearths from the center to the sides. On the next triangular scraper the hoes are set in an opposite direction, that they will scrape the ore from the outer part of the hearth to the center.

The hoes or plates in each alternate scraper are set at opposite angles, so that one set of plates covers up the furrows made by the preceding set, thus keeping the ore continually stirred, so that all portions are subjected to the action of the heat and chloridizing substances, and so that it may be thoroughly desulphurized and chloridized as it passes through the furnace. As each scraper with its set of plates or hoes passes through it moves the ore ahead, somewhat at the same time that it stirs it over.

In the center of the extension-frame E, between the center portions of the frame-work, are the pulleys or sheaves I, which take the weight of the endless chain as it passes out of the furnace. On the outer ends of the two shafts carrying the pulleys D and F, on which the endless chain revolves, are two pulleys, J, over which the scrapers carrying the plates pass. The peculiar triangular shape of these scrapers or conveyers admit of their passing over the pulleys without difficulty.

In the center of both upper and lower hearth

is a longitudinal groove, into which the endless chain may be dropped when the machinery of the furnace is stopped. In order to accomplish this the shaft carrying the pulley F on the extension is mounted on a carriage which admits of a forward and backward motion.

When the furnace is in operation the carriage carrying the shaft on which the pulley F is mounted is slid to the outer end of the frame or extension E and secured so as to tighten the chain. As the chain then passes in and out of the furnace in its rotation it becomes alternately heated and cooled, and it is not injured by the heat and sulphurous fumes.

When, however, the machinery is stopped while the furnace is still hot, that part of the chain within the furnace would be injured by the action of the heat and gases. By sliding the carriage carrying the shaft and pulley F back toward the furnace the chain is slackened and drops into the grooves in the hearth out of the way. At either end of both upper and lower hearths is hinged a door, K, having a groove at its lower edge, through which the chain passes. As each conveyer comes to the door it pushes the door up on its hinges out of the way, and when it has passed in the door drops to its seat again, the groove in the bottom allowing the chain to pass on. This door is intended to prevent there being too much open space at the ends of the compartments, which would affect the draft.

The ore is fed into the hopper L and drops onto the upper hearth, B. The action of the plate H on the conveyers, actuated by the endless chain, gradually carries the one along this hearth to the other end of the furnace until it reaches the opening M, when it falls through the opening onto the lower hearth, A. Here the conveyers, having passed over the pulley F on the extension, are carried by the endless chain back over the lower hearth to the end of the furnace, where the ore was fed, and by the same action previously described carry the ore with them.

On the lower hearth, at the front end, is formed another opening, N, similar to the opening M on the upper hearth. The ore is carried along the lower hearth by the action of the conveyers or plates until it reaches this opening N, when it drops through the opening into the chamber O, from which it may be removed when cooled.

If considered necessary, the lower hearth may be extended and the opening N closed, and the same mechanical means may move the ore along the extension of the hearth in the open air and discharge it perfectly cooled. I provide four or more fire-places to my furnace, two on each side, and two of them, U, so arranged that the heat may be directed to either the upper or lower compartment, and the other two, V, to discharge the heat to the lower compartment alone, whence it will find its way by means of the opening M in the upper hearth to the upper compartment, and thence to the stack. On two of the firing-places, V, are placed the flues P, which are connected with the upper compartment, by drawing out the damper Q. The flame and heat, with its natural tendency to rise, will pass on up into the upper compartment. As soon as this upper compartment is thoroughly heated the fire-clay damper Q is pushed in and the flue P stopped. The heat from the fire will then pass over the bridge-wall to the lower hearth. After the upper part of the furnace is once heated, or starting up in the manner described, the heat from all the fires is then directed into the lower compartment first, passing up through the opening M to the upper compartment, and thence to the stack.

At each of the fire-places, just under the grates, and between them and the ash-floor in the sides of the furnace, are a number of small openings, R, passing through the bridge-wall that separates the fire-places from the hearths. These openings thus connect with the lower compartment and admit a large supply of oxygen to the flame of the fire as it passes from the fire-place over the bridge-wall, thus allowing all the carbon to be consumed and giving a better oxidizing flame than could be furnished by other means.

On both sides of the furnace at intervals, are a number of openings, S, into the upper and lower compartments, through which air may be admitted. These openings have doors so arranged as to regulate the size of the opening, so as to admit more or less air or to close the openings entirely if desired. The object of these openings is to admit an additional supply of oxygen to the ore to bring about the chemical changes necessary to desulphurize the ore. The supply of oxygen thus admitted also tends to increase the heat, so that the furnace consumes its own smoke, and no heat is lost.

On the arch of the upper compartment of the furnace are formed a series of jogs or projections, T, which act as bafflers or obstructions, which intercept the flying particles of ore carried onward by the draft, and precipitate them to the hearth B, where they are again mixed with the ore. By this means no particles of ore are carried out by the draft to the stack, for as they fall to the floor from the projections or jogs T the action of the conveyers and plates carries them along with the ore to the discharge-opening N, as previously described. The space between the roof and hearth of each compartment is quite small, so as to confine the heat close to the ore.

The operation of my furnace is as follows: The ore is fed continuously from the battery into the hopper L, through which it falls onto the upper hearth, B. The conveyers and plates or hoes, actuated by the endless chain, as previously described, stir the ore on the hearth over and over, keep it from caking or clogging, and gradually push it along over the hearth to the opening M, where it falls through to the lower hearth, A. As the ore is passed

along in the upper compartment it is thoroughly desulphurized by the heat furnished by the fires, as described, and by the combustion of the sulphur in the ore. This action is assisted by the oxygen in the supply of air admitted at intervals through the sides of the compartment by means of the openings S. For a chloridizing roasting, salt is mixed with the ore as it is fed into the hopper and becomes thoroughly intermingled with it by the stirring action of the plates or hoes. If there is any free silver in the ore, it gets the benefit of the chlorine vapors passing up from the lower hearth.

Now, when the ore falls through the opening M and onto the lower hearth, the fall will break any spongy lumps or masses that may have formed, and the ore is again stirred over and over, and carried slowly along through the flame and heat over the lower hearth by the action of the conveyers and plates toward the discharge-opening N. As the ore is moved along in contact with the fires opening into the lower compartment the salt gives up its chlorine by the action of the sulphurous gases rising from the decomposing metallic sulphates which have been generated, which action converts the metallic sulphate into chlorides with the simultaneous production of sulphate of soda.

The process is essentially the same as the well-known Freiberg process; but the mechanical devices applied to my furnace and the peculiarity of its construction enable me to thoroughly desulphurize and chloridize the ore to a higher percentage than other furnaces, and with less cost for fuel and labor. When the desulphurization has been accomplished and sulphuric acid ceases to be formed, with the old method, it has been necessary to increase the fires to complete the finishing calcination by decomposing the salt, so that the chlorine evolved will transform the metallic sulphates into chlorides.

By my method no increase of fires is necessary. The construction of the furnace is such that the heat is greatest just where it is needed—viz., at the point where the ore has been desulphurized—and when it is ready to receive the chlorine from the decomposing salt, in order to be thoroughly chloridized.

The ore, while on the upper hearth, is freed from its sulphur by the combustion of that substance by the heat afforded by the fires, and the combustion of the sulphur is assisted by the supply of oxygen admitted through the side openings, as described, which supply may be regulated so as to suit a class of ore more or less highly sulphureted. During all this time a certain amount of chlorine vapor is rising from the lower compartment and assisting in transforming any metallic silver into a chloride.

By the time the ore drops onto the lower hearth the metals have become sulphates, and here more heat is required, in order that these sulphates may decompose the salt, by the sulphur being liberated and uniting with the oxygen and hydrogen, forming sulphuric acid, which unites with the sodium and forms sulphate of soda, while the chlorine is set free and converts the metals into chlorides. The ore has become gradually more and more heated in its passage through the upper hearth, and by the time the extra heat is required, as stated, it comes immediately in front of the same fires which have during the whole process furnished the heat. As the ore passes along the lower hearth it reaches the last fire, where the intense heat will effectually cause the chemical changes described to occur, and the ore is dropped from the furnace thoroughly sulphurized and chloridized, having been stirred over and over in its passage through by the hoes, so that every particle of ore has been subjected to the action of the heat and chlorine vapors.

Ordinarily the ore will be from five to ten hours in passing through the furnace, according to its character. Only one man is required to attend the fires, no other attention being necessary, as the ore may be fed to the hopper from the battery by any mechanical means.

By the peculiar construction of this furnace I am enabled to feed and discharge the ore at the same end of the furnace. The battery and machinery being at this end of the furnace, the ore may be elevated and passed to the amalgamating appliances with very little trouble or expense of handling.

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

1. The horizontal furnace with two hearths, A B, one above the other, and the connecting-opening M, in combination with the endless chain carrying the stirrers G, moving longitudinally, whereby the ore on the lower hearth is conducted in a direction opposite to the ore on the upper hearth after passing through opening M, substantially as set forth.

2. The furnace having the hearths A and B, situated one above the other, and provided with the single endless chain and stirrers operating in both chambers, in combination with the extension-frame E and pulley F, substantially as shown, and for the purpose herein described.

3. The peculiarly-constructed scrapers and stirrers, consisting of the triangular frames G, with plates H secured to their angularly meeting sides, substantially as herein described.

4. The hearths A B, provided with the longitudinal grooves N N′ for containing the chain when its motion is stopped, as set forth.

In witness whereof I hereunto set my hand and seal.

DAVID J. O'HARRA. [L. S.]

Witnesses:

GEO. H. STRONG,

FRANK A. BROOKS.