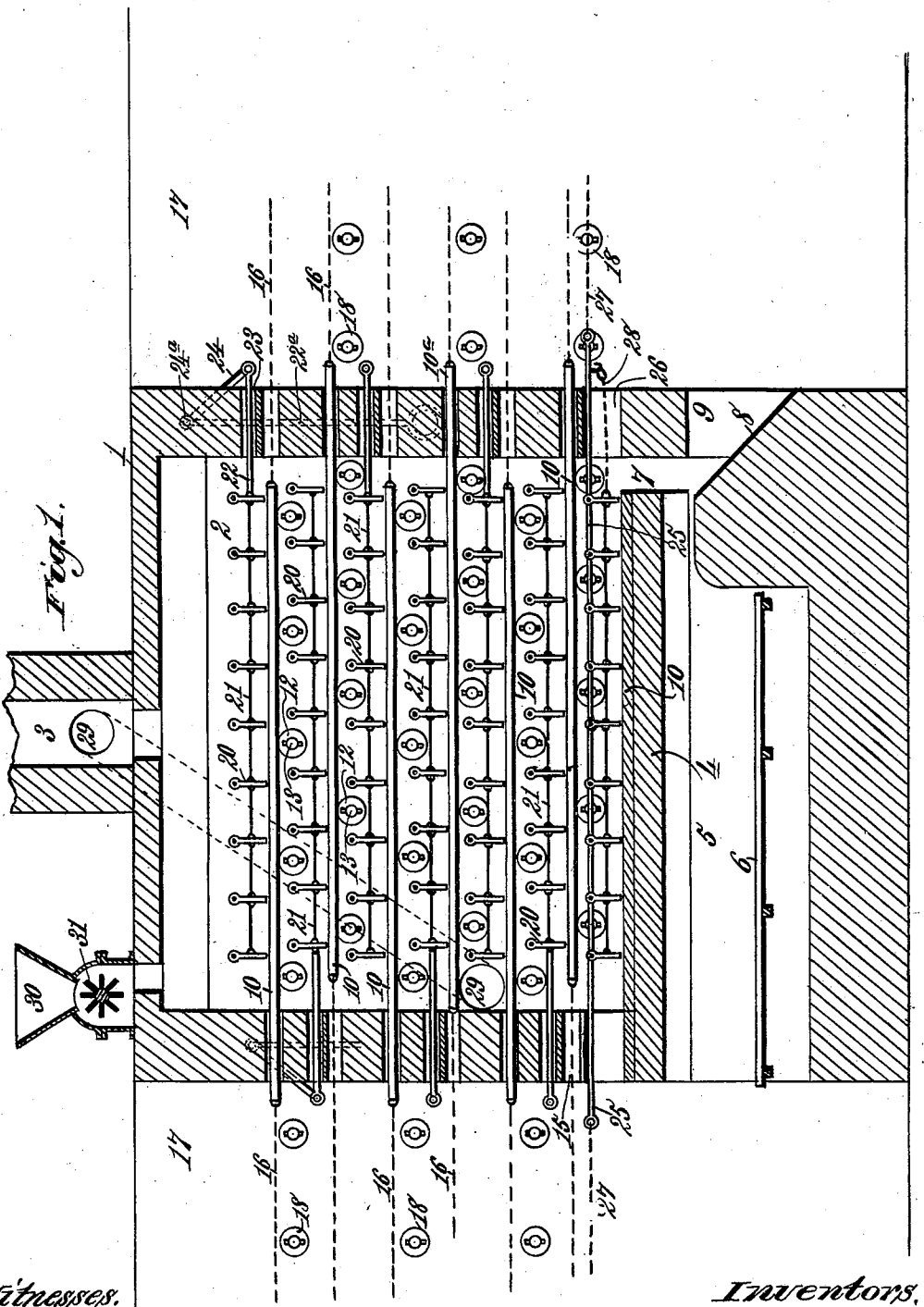
(No Model.) 3 Sheets—Sheet 1.

L. PELATAN & F. CLERICI.

PROCESS OF AND APPARATUS FOR DESULFURIZING ORES.

No. 531,004. Patented Dec. 18, 1894.

Fig. 1.



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(No Model.) 3 Sheets—Sheet 2.

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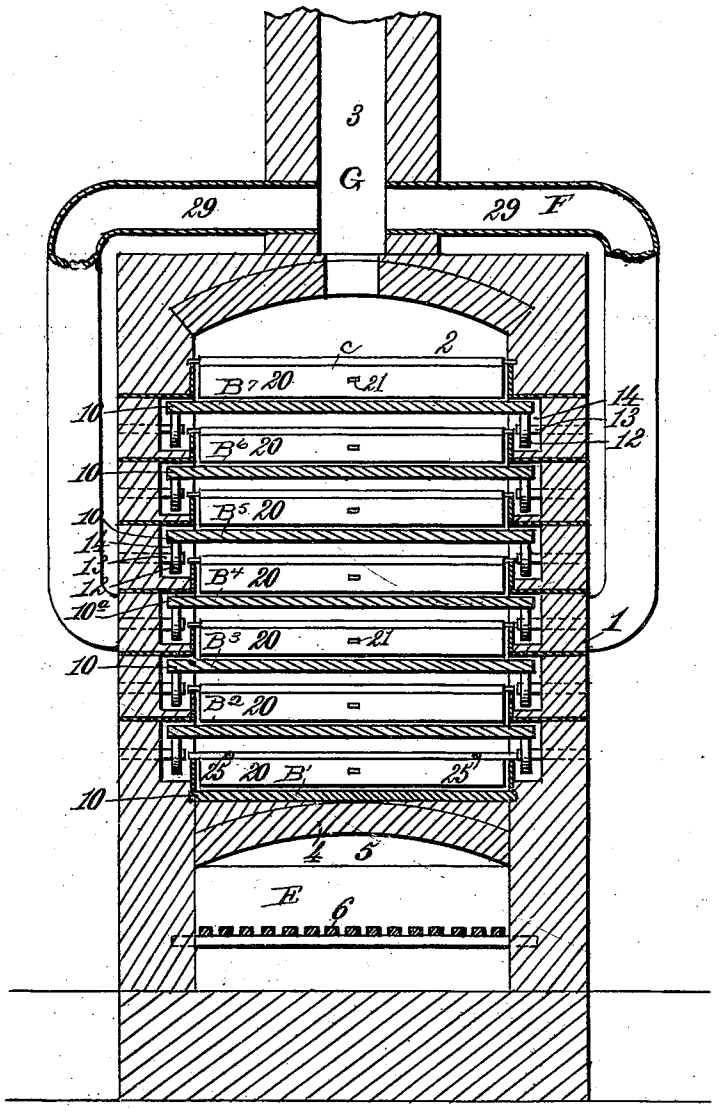
PROCESS OF AND APPARATUS FOR DESULFURIZING ORES.

No. 531,004. Patented Dec. 18, 1894.

Fig. 2.



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(No Model.) 3 Sheets—Sheet 3.

L. PELATAN & F. CLERICI.

PROCESS OF AND APPARATUS FOR DESULFURIZING ORES.

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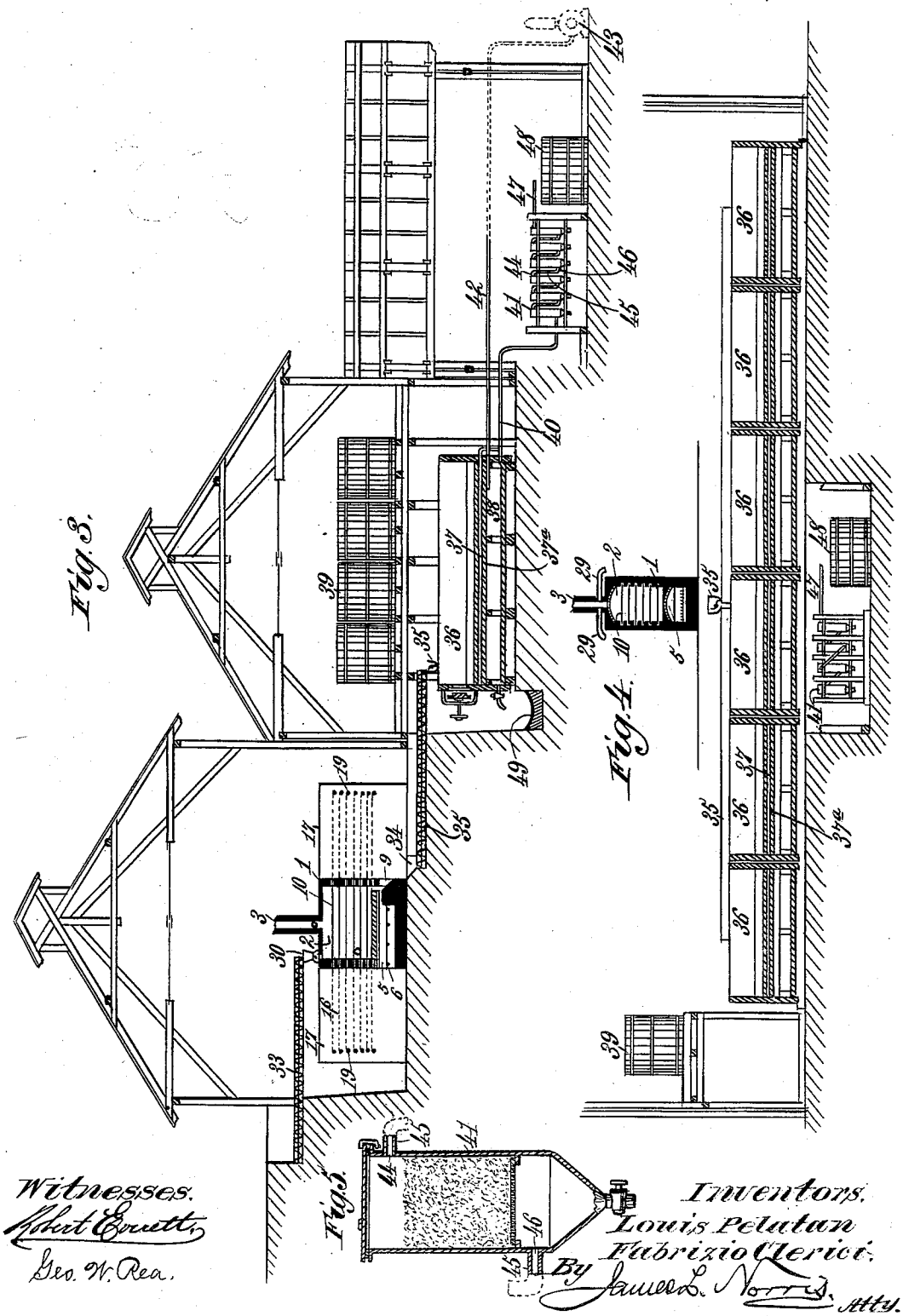

Fig. 3.

Fig. 4.

Fig. 5.

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UNITED STATES PATENT OFFICE.

LOUIS PELATAN, OF PARIS, FRANCE, AND FABRIZIO CLERICI, OF MILAN ITALY.

PROCESS OF AND APPARATUS FOR DESULFURIZING ORES.

SPECIFICATION forming part of Letters Patent No. 531,004, dated December 18, 1894.

Application filed August 28 1894. Serial No. 521,552. (No model.)

To all whom it may concern:

Be it known that we, LOUIS PELATAN, a citizen of the Republic of France, residing at Paris, France, and FABRIZIO CLERICI, a subject of the King of Italy, residing at Milan, Italy, have invented new and useful Improvements in Processes of and Apparatus for Desulfurizing Ores, &c., of which the following is a specification.

Our invention relates to a certain novel process and apparatus for desulphurizing and dead-roasting refractory ores and extracting the precious metals from the same.

In the reduction of refractory ores of gold and silver, it has been found practically impossible, by the processes heretofore employed, to roast ores containing more than thirty per cent. of sulphur and desulphurize them in one and the same furnace to a point where only a trace of sulphur remains. Concentrates, or pyrites, roasted in a furnace without fire, will contain, when the process has been completed, not less than two per cent. of sulphur, which is too large a percentage to permit of obtaining good results by chlorination. If fire is applied, in the furnace in which said ores have been roasted, for the purpose of driving off the two per cent. of sulphur remaining in the concentrates, or pyrites, it is practically impossible to avoid heating the same so suddenly that they will bake into hard lumps, instead of burning, thereby rendering a perfect oxidation roasting impracticable.

It has been found necessary, in chlorination works, in treating concentrates of pyrites, to employ two separate furnaces, one for roasting the ore to a point where not more than about two per cent. of sulphur remains, and a second and separate furnace for driving off this remainder by dead-roasting. The increased extent and cost of the plant, due to the necessity of having this additional furnace, and the greater time and labor required in carrying out the process of treatment, is a serious item in the expense of operating the plant. It is the purpose of our invention to remove this difficulty, to simplify the construction and reduce the cost of the plant, or reduction-works, and diminish the expense of recovering the precious metals from their refractory ores.

It is our purpose, to this end, to provide a novel method, or process, of roasting refractory ores of the precious metals to the point of practical desulphurization at one and the same continuous operation.

It is our further purpose to provide a novel form of furnace for practicing said method, or process; and, finally, our invention also aims at the provision of an improved apparatus whereby the processes of desulphurizing, chlorinating, and separating, or precipitating, the precious metals from their chloride solutions, may be continuously and automatically carried on, with a large resulting gain in economy of time, labor, and expense, and an increased yield of the precious metals.

To enable those skilled in the art to which our invention pertains to fully understand and practice our novel process and to make and use the apparatus devised by us, we will proceed to describe said process and apparatus in detail, reference being had, for this purpose, to the accompanying drawings, in which—

Figure 1, is a vertical, longitudinal section, showing our novel desulphurizing furnace. Fig. 2, is a transverse section of the same, taken in the line 2—2, Fig. 1. Fig. 3, is a sectional elevation, showing a complete plant, or reduction-works, for desulphurizing and dead-roasting, chlorinating, and precipitating the precious metals from their refractory ores, in accordance with our invention. Fig. 4, is a sectional view of the same, the line of section being at right angles with that in Fig. 3. Fig. 5 is a detail section showing one of the precipitating and collecting vessels.

The reference-numeral 1, in said drawings, indicates a furnace, which is constructed of suitable masonry, and inclosed upon four sides and the top. The structure contains a chamber 2, which is preferably of greater length than width, and from the central part of the top rises a chimney 3. The bottom of the chamber 2 consists of a floor 4, arched on its lower face to form the top of a fire-chamber 5, having a suitable grate 6, and

adapted to the consumption of either coal, or wood. The floor 4 terminates, at one end, at a little distance from the end wall of the furnace, thereby forming an opening 7, which overhangs an outlet-chute 8, for a purpose presently to be explained. The chute 8 is formed by inclining the outer face of the end-wall of the fire-chamber, the inclined surface being caused to traverse an opening 9 in the end wall of the furnace structure.

Within the chamber 2 is arranged a series of horizontal soles 10, formed of cast-iron and separated from each other by substantially equal intervals. These soles extend across the width of the chamber and are supported by rolls 12, which are journaled upon fixed axes 13, in recesses 14, in the side-walls of the furnace. The length of the soles 10 is somewhat in excess of the length of the chamber 2, and their ends lie in, or should the soles be moved horizontally on their rolls 12, are adapted to pass into openings 15 in the end-walls of the structure. The soles are moved in the manner referred to by means of chains 16, secured to their ends and passing through openings in the walls, the arrangement being such that the alternate soles shall move in the same direction. For example, if the upper sole 10 is drawn toward the left-hand, in Fig. 1, the sole next beneath it will be drawn toward the right; the third toward the left, and so on. As they emerge from the end-walls of the structure 1 they pass between parallel extension walls 17, on which are mounted supplemental supporting rolls 18. The chains 16 are operated by independent drums 19, or any other suitable form of device.

Immediately above each sole is arranged a series of hanging rakes 20, each rake consisting substantially of a plate of refractory material supported upon a horizontal axis, arranged transversely to the sole and at such a distance above it that the lower edge of the rake just clears the surface. All the rakes in each series are connected together by a rod, or other suitable connection 21, attached at one end to a bar 22 which passes through an opening 23 in the end-wall of the chamber 2 and is connected to an arm 24. This arm is pivotally mounted in such manner that it can swing, as the sole is drawn into the chamber 2, thereby allowing all the rakes 20 to assume an inclined position so that they can pass over any ore resting on the sole. On the other hand, when the sole is withdrawn from the chamber 2, the rakes will be held rigidly in vertical position and will sweep the surface of the sole. The bars 22 and arms 24 are, therefore, arranged alternately at opposite ends of the soles 10. The lowest series of rakes overhangs the sole resting upon the floor of the chamber 2, and as this sole is not moved the rakes are themselves made movable by means of a long rod 25, which passes at each end through an opening 26, large enough to allow the rakes to pass. Each end of said rod is connected to a chain 27, which is operated like one of the chains 16. A slender chain 28 is connected to one end of the rod over the outlet-chute 8, and to the connection 21, which communicates inclination to said rakes. By this arrangement the rakes are held in vertical position when moving toward the right, in Fig. 1, and will sweep the ore resting on the lower sole into the opening 7, by way of which it will descend to the outlet-chute 8. When moving toward the left hand, the rakes are free to swing into an inclined position and pass over whatever may be lying upon the sole.

By rigidly attaching a rod 22^a to the pivotal axis 24^a, which supports the arm 24, and allowing the rod to hang down outside the furnace, as seen in dotted lines in Fig. 1, the rod 21 may be drawn to a limited extent, out of the opening 23, causing the rakes 20 to assume an inclined position as heretofore described.

We have shown the chamber 2 provided with seven of the soles 10, as we regard this number as preferable, though we may use either more, or less. In use, the fourth sole, counting from the top, is of such length, or is so placed, as to extend from one end-wall of the chamber to the other as shown in Fig. 1. This sole is distinguished from the others by the reference-numeral 10^a. The other soles 10 are so placed as to provide an opening, at alternate points, between their ends and said end-walls. The products of combustion passing from the fire-box through the opening 7, at the end of the lower sole, flow between the latter and the sole next above, passing between its end and the other end wall, thence between the second and third soles and around the end of the latter, into the space between the third and fourth soles. After traversing the space between the latter, the hot products and gases enter pipes 29, which communicate with said space through the side-walls and thence pass upward and enter the lower part of the chimney 3. By this arrangement, no fire is allowed to enter the parallel spaces between the four upper soles.

The ore is supplied to the chamber by means of an automatic feeder, mounted on the top of the structure 1, at the end through which the upper sole 10 is drawn outward. The feeder consists of a hopper 30 having beneath its contracted throat an equalizing fan-wheel 31, by the rotation of which the pulverized ore is caused to pass through the inlet-opening 32 and enter the chamber 2 in a substantially uniform stream. The fan wheel 31 is driven at a constant speed by any suitable means.

The manner of operating the desulphurizing furnace is as follows: The furnace being suitably charged with ore and the proper degree of heat being established, the ore lying upon the three lower soles 10 is roasted by the flames in conjunction with the oxygen of the air, which mingles with the products of combustion, the entrance of the air being

amply provided for by the openings 7, and 26. The ore lying upon the four upper soles, however, will be roasted, by the heat of its own combustion, the products of combustion being practically excluded from that portion of the chamber lying above the fourth sole from the bottom. The ore in this portion of the chamber 2 will be roasted to the point where all its sulphur, excepting one to three per cent. or thereabout, is driven off. When this result is obtained, the ore is transferred from the space above the sole 10^a, to the soles lying below it. This is accomplished by drawing the sole 10^a toward the right-hand of Fig. 1, the sole 10 next beneath it remaining in the position shown in said figure. The rakes 20, being rigidly held in vertical position, sweep the ore off the sole 10^a as the latter moves outward and spread it with substantial uniformity on the sole 10 beneath. The latter being, in turn, drawn out toward the left hand, spreads the ore it supports in a similar manner upon the sole beneath it, which being, in its turn, drawn out toward the right hand, deposits the ore on the sole resting on the floor of the chamber. It is removed from this sole by drawing the rakes out toward the right hand of Fig. 1, said rakes sweeping the ore off the surface into the opening 7, through which it passes to the outlet chute 8.

In operating the furnace, as the ore is fed in at the top, the mode of procedure is substantially as follows: The upper sole 10 being drawn out toward the left hand of Fig. 1, the ore is fed in by means of the hopper 30 and fan-wheel 31, the upper sole being, meantime, drawn inward by a uniform motion. The ore is thus spread with approximate uniformity on the surface of said upper sole, the rakes 20 being thrown into an inclined position, as the sole moves into the chamber, as shown in dotted lines. After remaining a suitable length of time, the upper sole is drawn out toward the left, thereby depositing the ore upon the next sole beneath. As the upper sole returns into the chamber, it receives a fresh charge of ore from the feeder. The second sole being now drawn out toward the right, the ore deposited on it is spread on the third sole, and the second being drawn into its normal position, receives, in due time, a second charge of ore from the upper sole in the same manner, and the third sole from the top receives its charge from the one next above in a similar way. It will be noted that, as the ore descends from one sole to the next below, it is subjected to an increased temperature. By the successive increments of heat to which it is subjected, in traversing the upper portion of the chamber 2, its sulphur is driven off, save only from one to three per cent. or thereabout, as already stated. Its treatment in passing successively to the fifth, sixth, and seventh soles, on each of which it is roasted in conjunction with air and fire, eliminates the remaining sulphur, or practically so.

It is evident that the furnace may be filled with ore on the four upper soles, including the sole 10^a and those above, before the process of roasting begins, and that the first operation, after the roasting has progressed to the proper point, will be to transfer the ore on the sole 10^a to the sole next below, then to shift the ore on the three soles next above 10^a one step downward a second charge being then fed to the upper sole. When all the soles are occupied, the ore is simply shifted from the sole on the floor of the chamber 2 to the outlet chute 8, then from each sole next above to the one below, in succession. This operation is performed at intervals of from ten to thirty minutes, according to the nature of the ore and the circumstances of each case. A quantity of ore may be transferred from the upper to the lower sole 10, in the manner described, in a very short time and a single workman can operate three such furnaces without excessive effort. Each furnace is capable of roasting from six to ten tons of ore per day, to practically complete desulphurization, the daily output varying according to the nature of the ore.

We prefer to supply the automatic feeder of the furnace with concentrates, or dry, crushed pyrites, or other ores, by means of a spiral carrier 33, which discharges directly into the hopper 30, as shown in Fig. 3. The roasted ore, when discharged by way of the outlet chute 8, falls by its own gravity into a receiver 34, from which it is taken by spiral carriers 35 to a plurality of tanks or vats 36. These vats, which are duplicates one of another, have filtering layers 37 at bottom, formed of any suitable material, and below said filtering layers and the perforated false bottoms 37^a, on which they rest, are communicating chambers 38, which receive the filtered liquid. In a convenient position above the vats are arranged reservoirs 39, lined with lead, or other suitable material, and containing a chlorine solution, containing about one per cent. of free chlorine. When the tanks, or vats 36, are filled with roasted ore by the spiral carriers 35, they are closed by a cover which is applied with care, and the chlorine solution is allowed to run through the mass of roasted ore. The gold is dissolved thereby, or, to speak more accurately, is transformed into a chloride, which is readily soluble in water. This chloride solution is passed through the filtering material 37 into the communicating chambers 38, from which said solution is conveyed by a pipe 40 to a series of precipitating vessels 41, in which the precious metal, or metals, are eliminated. The passage of the chloride solution through the filtering material 37 may be expedited by means of atmospheric pressure a pipe 42 being arranged to connect the series of chambers 38 with a pump 43, by which the air is withdrawn from said chambers. The normal atmospheric pressure on the solution in the tanks, or vats 36, forces said solution through the filtering material, and, as the communicating

chambers 38 are tightly closed against all access, save through the filtering material 37, the pressure also serves to drive the filtered solution through the pipe 40 and the series of precipitating vessels 41.

As the chlorination process, by which the gold is transformed by chlorine gas, to a chloride which is soluble in water, does not differ substantially from that discovered by Plattner and now in general use, in the art to which our invention pertains, a detailed description of said process is not considered necessary.

The precipitating vessels 41, one of which is shown in detail in Fig. 5, contain chips, or particles of aluminium, or zinc, resting on perforated diaphragms near the lower ends of said vessels. The outlet 44 to each vessel is above the mass of aluminium or zinc particles, and they are connected in series, so to speak, by pipes 45 leading from said outlets to the inlets 46, which are below the perforated diaphragms. The pipe 40 enters the inlet of the first vessel 41, and a pipe 47 extends from the outlet of the last vessel over a tank 48, which receives the fluid after it has traversed the vessels 40.

The gold contained in the chloride of gold solution after passing through the filter, is precipitated by the aluminium particles or by the zinc and settles thereon in the form of a fine powder. Being detached by the continuous upward current, the precipitated particles work their way downward by their own gravity and collect in the lower ends of the vessels 41. As these vessels and the method of using the same are fully described in an application for Letters Patent filed by us on the 18th day of July, 1894, Serial No. 517,940, further description thereof in this specification is unnecessary.

In some cases it may be necessary to allow the chlorine to act upon the ore for a longer time than that occupied by the chlorine solution in percolating the mass of ore in the tanks, or vats 36, and for this purpose the connection between the tanks or vats 36 and the chambers 38 is closed and the chlorine solution is retained in the tanks as long as may be necessary. This treatment effects a considerable economy in the consumption of chlorine.

The tank 48 contains a mass of chips, turnings, or particles of aluminium, by which any small quantities or traces of gold still remaining in the solution after coming from the precipitating vessels 41, are collected and saved.

Should the ore contain free gold it may be obtained by allowing the tailings from the tanks 36 to run upon amalgamated copper plates 49.

After chlorination, the coarse gold which is not dissolved by the chlorine solution is so thoroughly cleansed by the action of said solution, that it can be caught and retained by the copper-amalgamated plates, upon which the tailings are discharged, as last described.

What we claim is—

1. The process herein described for desulphurizing refractory ores, said process consisting in arranging the ore in a series of quantities each of which is a step nearer the fire, roasting part of the whole number of quantities in direct contact with the fire, and simultaneously roasting the remaining number of quantities without access of fire and periodically advancing the whole series a step, whereby one of the separate quantities is discharged from and another is brought into the fire, while all the quantities in one part of the series are brought a step nearer the fire, substantially as described.

2. The process described for desulphurizing refractory ores, said process consisting in arranging the ore in a series of separate quantities, separating several of said quantities from the remaining quantities, roasting the entire series simultaneously, part of the whole series with, and the other part without direct contact with the fire, and transferring the entire series step-by-step to bring the quantities in one part into and through the fire and out of the furnace, and to advance the quantities in the other part toward the fire and bring them successively into the first series, substantially as described.

3. The process described for the complete desulphurization of refractory ores by a single, continuous treatment, said process consisting in arranging the ore in separate quantities one above the other, roasting those quantities above a given point without access of fire, and those below said point in the presence of both air and fire, periodically transferring the several separate quantities of ore a step downward whereby they successively approach, enter, and ultimately pass through the fire and out of the furnace, and periodically supplying quantities of fresh ore at the top, substantially as described.

4. The process described, which consists in arranging separate quantities of ore one above another, roasting part of said quantities without contact with fire and the remainder with contact of both air and fire, transferring the separate quantities of ore periodically a step downward to bring them successively nearer to and into the fire, carrying the separate quantities of said ore through the fire and out of the same, transferring the roasted ore to a vat, flooding it with a chlorine solution, filtering, and finally precipitating the chlorides of gold by aluminium, substantially as described.

5. A furnace for desulphurizing refractory ores, said furnace having a series of horizontally movable soles arranged one above another over the fire-chamber of a furnace, a series of rakes arranged over each sole and pivotally connected to each other, below their

pivotal supports, and to a pivoted rod capable of swinging outwardly, one of said soles between the top and bottom being adapted to cut off the upward passage of air and products of combustion, and means for conducting the latter from the space beneath said sole to the chimney, substantially as described.

6. A furnace for desulphurizing refractory ores, the same comprising a series of soles arranged one above another in a closed chamber above the fire-chamber, one of said soles at or near the middle of the series being adapted to cut off the upward passage of air and products of combustion, means for drawing said soles out of and into said chamber independently; a series of rakes arranged over each sole and connected to each other and to an arm in such manner as to turn on pivotal supports when the soles are drawn into the chamber and to stand rigidly vertical when said sole is drawn out and external pipes connecting the space beneath the middle sole with the chimney, substantially as described.

7. In a furnace for desulphurizing refractory ores, the combination with a series of soles arranged one above another in a chamber over the fire-chamber, their edges resting on rolls mounted on fixed axes in recesses in the walls, of means for drawing said soles out of and into said chamber in opposite directions alternately, supplemental supporting rolls mounted on extension side-walls, rakes arranged over each sole and connected together and to a pivoted external arm, a series of movable rakes over a fixed sole at the bottom of the fire-chamber, an outlet chute and an automatic feeder for supporting ore at the top, one of the soles at or near the middle of the series being adapted to cut off the passage of air and products of combustion, and deflect the same into external passage, substantially as described.

8. The combination with a desulphurizing furnace having horizontally movable soles arranged in a vertical series in a chamber over the fire-chamber, of means for drawing said soles independently out of and into said chamber, external pipes connecting the chimney with the space beneath a sole at or near the middle of the series, a feeder, a chlorination tank having filtering material in its bottom and receiving the roasted ore from the furnace, and reservoirs containing a solution of chlorine arranged above the level of the tank, substantially as described.

9. The process described for recovering gold from its ores, the same consisting in arranging the ore in separate quantities removed, successively, a step farther from the fire, separating part of the whole number of quantities from the other part, roasting the whole series by a single fire simultaneously, one part with and the other part without direct access of fire, advancing the separate quantities periodically to bring them nearer to, into, through, and out of the fire, treating the roasted ore with a chlorine solution, filtering, precipitating the gold from the chloride solution by aluminium, and recovering the coarse gold present, in the tailings by amalgamation, substantially as described.

In testimony whereof we have hereunto set our hands and affixed our seals in presence of two subscribing witnesses.

LOUIS PELATAN. [L. S.]
FABRIZIO CLERICI. [L. S.]

Witnesses:
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