2 Sheets—Sheet 1.

J. COLLOM.

ROASTING FURNACE FOR ORES.

No. 106,553. Patented Aug. 23, 1870.

Fig 1.

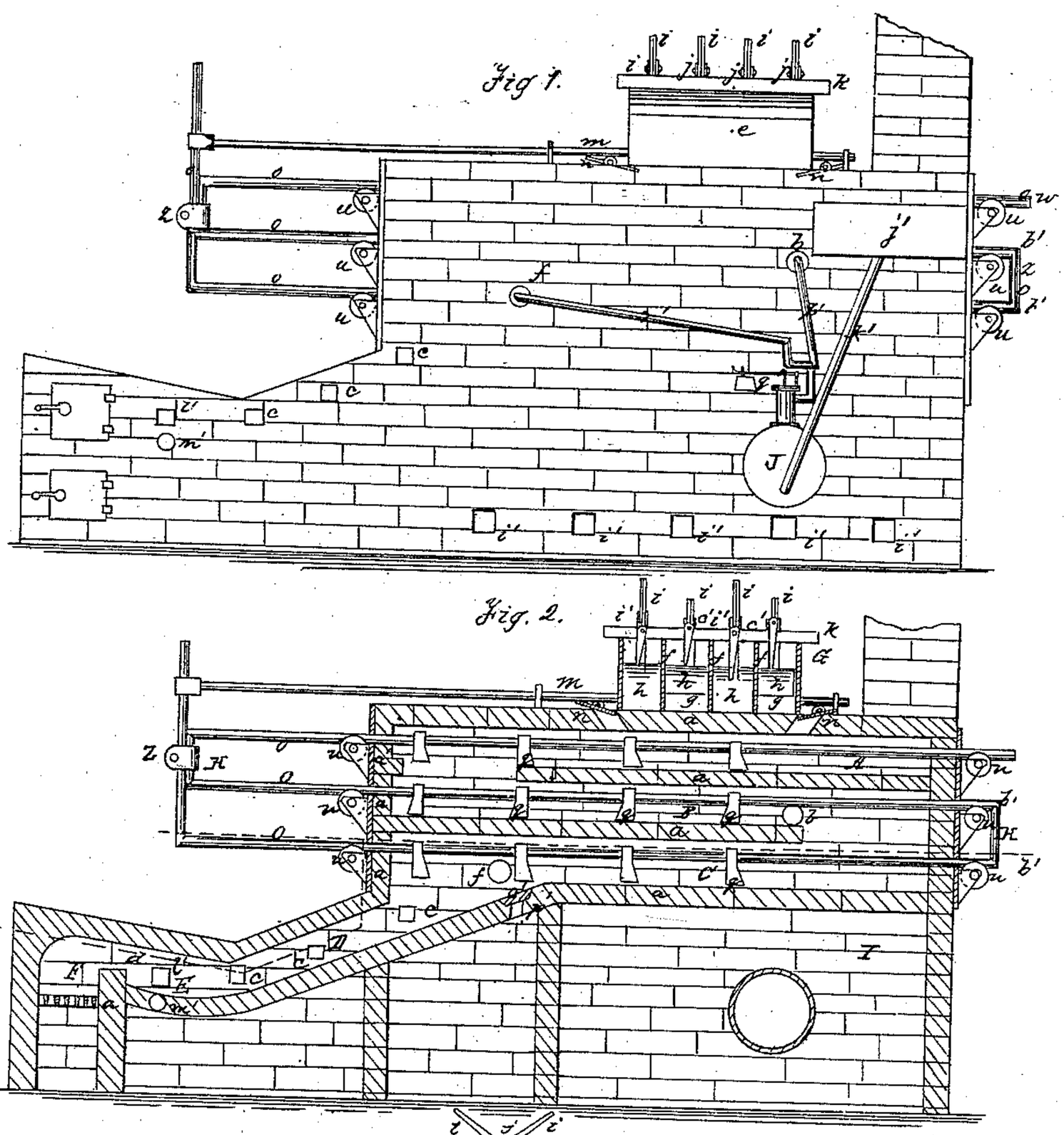
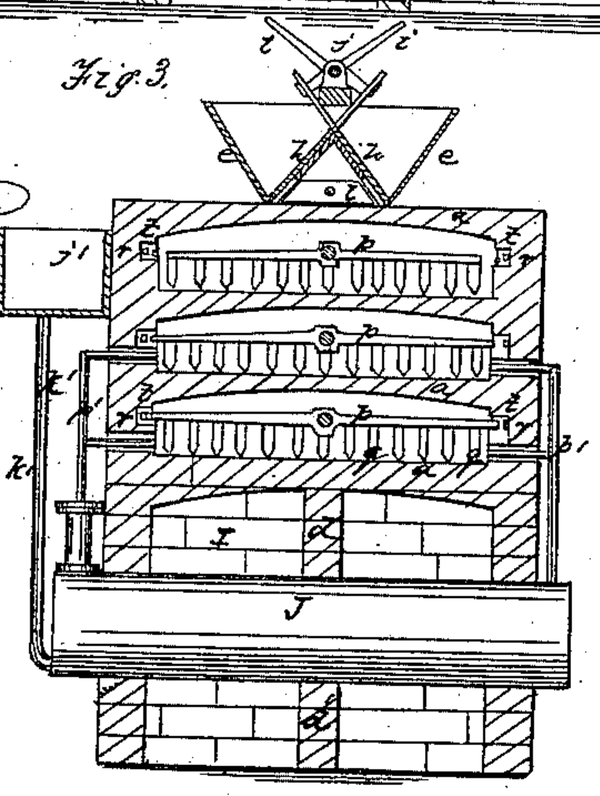


Fig. 2.

Fig. 3.



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2 Sheets—Sheet 2.

J. COLLOM.

ROASTING FURNACE FOR ORES.

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Fig. 4.

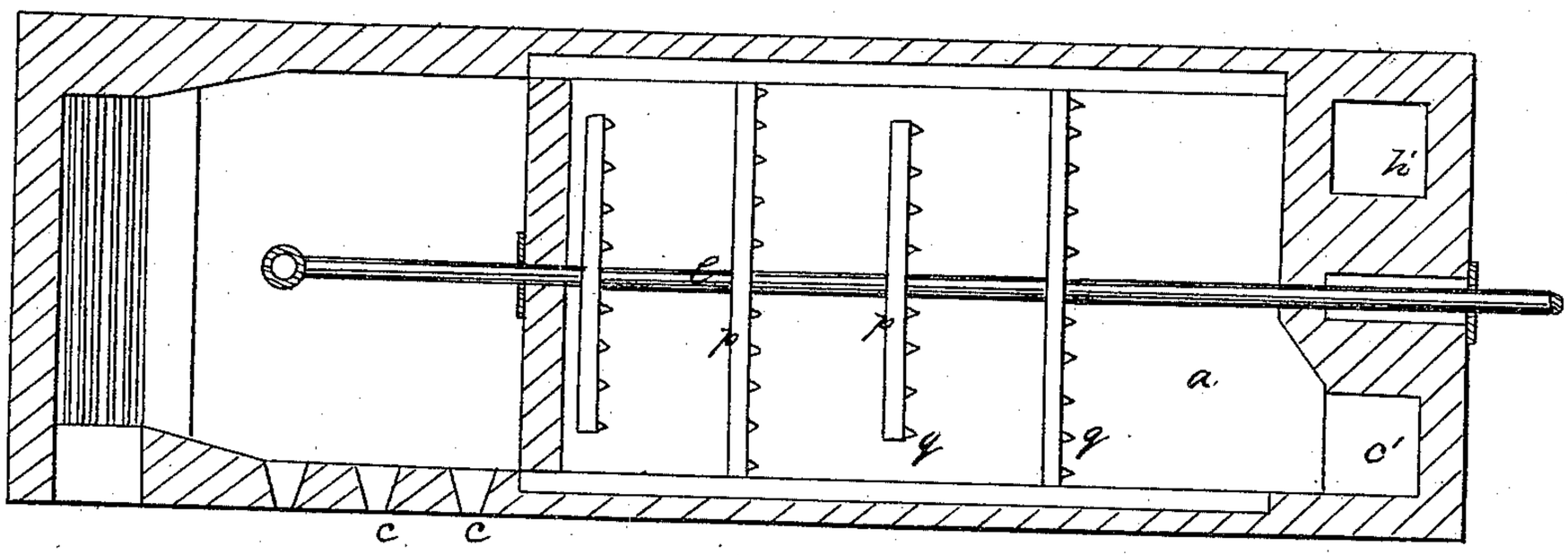


Fig. 5.

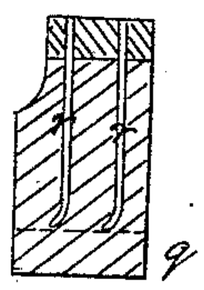


Fig. 6.

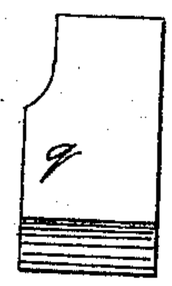


Fig. 7.

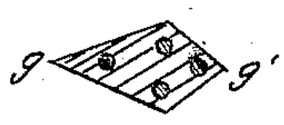
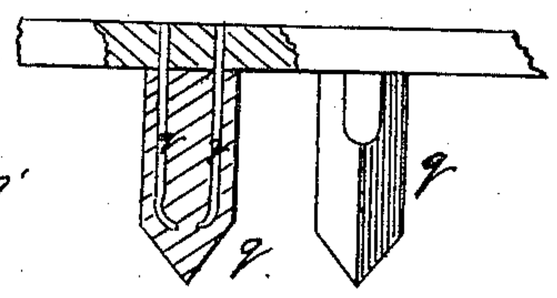


Fig. 8. Fig. 9.



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UNITED STATES PATENT OFFICE.

JOHN COLLOM, OF EMPIRE CITY, COLORADO TERRITORY.

IMPROVEMENT IN ROASTING-FURNACES FOR ORES.

Specification forming part of Letters Patent No. **106,553**, dated August 23, 1870; antedated August 15, 1870.

To all whom it may concern:

Be it known that I, JOHN COLLOM, of Empire City, in the county of Clear Creek, Colorado Territory, have invented a new and useful Improvement in Metallurgic Furnaces; and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable others skilled in the art to make and use the same, reference being had to the accompanying drawings, forming part of this specification.

The nature of my invention relates to improvements in furnaces, whereby the perfect desulphurizing, oxidizing, chloridizing, and smelting of metallic ores and metallurgical products are effected in larger quantities and at less cost for manual labor, fuel, tools, and repairs of furnace than has hitherto been the case.

In the accompanying drawings, Figure 1 represents a side elevation of a furnace provided with my improvements. Fig. 2 represents a longitudinal sectional elevation of the same. Fig. 3 represents a transverse sectional elevation. Fig. 4 represents a horizontal section. Figs. 5 to 9 represent details.

Similar letters of reference indicate corresponding parts.

The general arrangements of the furnace consist of three desulphurizing, oxidizing, and chloridizing chambers, A, B, and C, an inclined reaction-bed, D, a smelting-bed, E, fire-place F, mixing and feeding apparatus G, stirring-machine H, condensing-chamber I, and a steam-generating apparatus, J.

The chambers are formed by the sides and ends of the furnace and the four arches *a*, *a*, *a*, and *a*, which have each an open space at one end, but on alternate sides of the furnace. These may be built of common brick when it is not intended to melt refractory ores in the fusing-bed. On each side the chambers are provided with holes *b b* to introduce air, steam, chlorine and other gases, and to examine the charge. The reaction-bed D is built of fire-brick or other suitable material, and on its side has doors *c c c* to allow working the charge. The melting-bed is also built of fire-brick, and its peculiar construction and its relation to the fire-place F has for its object the production of the greatest heat immediately behind the bridge *d*.

The mixing and feeding apparatus G consists of a W-shaped box, *e*, divided by the partitions *f f* into several compartments, each provided with an aperture, *g*, and a valve, *h*, to be raised and lowered by the handles *i i*, which latter are supported by the check-bolts *j j*, secured to the beam K, a scraper, *l*, worked by means of the rod *m*, and the valves *n n*. The arrangement is such that the scraper will rake certain regulated quantities of each kind of ore contained in the separate compartments.

The stirring-machine H consists of the pipes O O O, which may be ordinary gas-pipe, or round, square, or oblong iron tubes. In wide furnaces more than one tube to carry and cool the rakes in each chamber would be required.

The rakes *p p* may be of cast or wrought iron, and provided with the flukes *q q*, made of clay or other fire and sulphur proof material, and attached to the rake-beams by the rods *r r*, slightly bent at their lower end to firmly hold the clay. The ends of the flukes are pointed to prevent the ore from accumulating under them, and their section above the taper is represented in Fig. 7. Figs. 5 and 6 show the side and longitudinal section, and Figs. 8 and 9 end and transverse section, of the flukes.

The angle *s* is made more acute than *s'*, for the purpose of causing the ore to pass slowly in the direction of *s'*. The obtuse angle *s'* being set toward the fire-place F in the chambers A and C and toward the chimney in chamber B, the ore will pass through the furnace, as desired. The rakes are of two lengths, and the flukes of the longer ones set so as to pass between and fill up the grooves made by those of the shorter. The ends of the longer rakes enter the metallic guides *t t*, by which they are kept in their proper position, and the tubes O *o o* are supported by the rollers *u u*.

For the purpose of cooling the tubes and rakes a stream of water (or air when water cannot be had) enters the pipes O at *v* and escapes at *w*, from whence, when necessary, it is conveyed into a tank. (Not shown.) The water will be conveyed to the pipes at *v*, and from them at *w*, by flexible hose; and the guides *t t*, which are hollow, are cooled by water entering at *x x*.

The stirring-machine has a reciprocating motion, which may be imparted to it by any suitable application of power at *z* and *z*, and the length of its stroke is equal to twice the distance from center to center of the rakes, so that

the set of grooves made by the one in the ore may be filled by the other, and thus be constantly exposing a new surface of the ore to the influence of the heat and gases. The ends *a' a' a'* of the roasting-chambers A, B, and C are temporarily closed by brick after the stirring-machine has been set in its place, and can be opened by the removal of the brick when the rakes need to be withdrawn for repairs. The pipes are put together by suitable connections, so that they may be separated at the angles *b' b'* to be withdrawn when necessary.

From the chamber **A** the gases pass down the flue *c'* into the condensing chamber I, divided by the partition *d'*, where, owing to their diminished velocity and temperature, they deposit much of the fine ore and volatilized metals—lead, silver, and gold—which they bear. From the condensing-chamber the gases escape into the air through the chimney *h'*, and the deposited dust is drawn out through the holes *i' i' i' i'*.

The steam-generating apparatus J, placed in the condensing-chamber and heated by the gases, is for the purpose of generating steam to be introduced into the roasting-chambers to facilitate the removal of the sulphur and the oxidation and chlorination of the ores and to regulate the temperature. Steam having a pressure of three or four pounds per square inch is very suitable for this purpose, and the boiler holding steam of this density may be supplied with water already hot from the tank *j* and through the pipe *k'*, thus avoiding the expense and labor of providing a feed-pump and economizing a part of the heat held by the water used in cooling the stirring-machine.

The amount of heat to be absorbed by the water and steam may be regulated by partially covering the upper part of the boiler with sand supported by an iron frame, and the pressure of the steam in the boiler may be regulated by the safety-valve *q'*.

This furnace is designed especially to treat ores of lead, copper, silver, and gold, but may be used for other purposes. The great length of the three roasting-chambers, together with that of the reaction and melting beds and their relative position, constitutes an important feature. It enables the maintenance of a high temperature in the melting and reacting beds and a moderate heat in the upper chambers, and consequently the subjection of the ore to a gradually-increasing temperature from the time it enters the furnace until it is withdrawn therefrom. By this means the chemical reactions necessary to the reduction of most kinds of ore may be going on in different part of the furnace simultaneously, but successively, as the ore passes through the furnace and is exposed to the various degrees of heat, so that the fusible sulphides of antimony, silver, lead, copper, and iron may be safely roasted in the chambers, while their oxides and sulphates are being treated at a high heat in the reacting and smelting beds. By this arrangement the roasting and smelting of metals can be carried on continuously in the same furnace by the same fire, and with my complete mode of mixing, feeding, and stirring the ore, at the very smallest cost for labor, fuel, tools, and repairs. The said mode of stirring the ore by flukes of the shape represented is very thorough, as the ore on the top of the ridges falls to the bottom of the grooves, and is next pressed outward, and finally rises to the surface again, thus causing all the ore to pass repeatedly from the surface to the bottom of the layers. The arrangement of one chamber above another tends to economize heat, as that which passes through the roof of one chamber is taken up by the ore above it; and much of the valuable metals volatilized in the melting-bed will be condensed in passing over the cold ore in the upper chamber. The melting-bed, on account of the high heat prevailing there, will require to be repaired occasionally, which may be done without disturbing the rest of the furnace.

The following are some of the ways in which this furnace may be used in treating different kinds of ores.

Galena should be roasted in the chambers, so as on reaching the head of the reaction-bed most of the lead should be converted into oxide and sulphate, then the increased temperature would cause the oxide and sulphate to react upon each other and upon the undecomposed sulphide, producing sulphurous acid, metallic lead, and a slag containing oxide of lead. The latter should be reduced to metallic lead by throwing into the furnace and mixing with the ore a suitable quantity of charcoal. In carrying out this mode of smelting it is essential that the oxidation in the chambers should be carried so far that after the reactions have taken place oxide, and not sulphide, of lead should remain in the slag, as the former can readily be reduced by charcoal, while the latter would require to be reroasted, or to be reduced by metallic iron. All ores while on the reaction and smelting beds would need to be stirred with a hand-rake through the holes or working doors *c c c*.

In treating lead ores associated with a siliicious gangue, the roasting in the chambers would be continued until nearly all the galena had been changed into sulphate and oxide of lead; then on the reaction-bed the high temperature there prevailing would cause the silica present to react upon the sulphate and oxide, resulting in the dislodgment of sulphuric acid and the formation of silicate of lead, together with the silicates of lime, baryta, and iron, when such bases occur in the ore.

The silicate of lead may be treated in the melting-bed with charcoal and metallic iron, giving as a product metallic lead and silicate of iron and an impoverished slag, all of which may then be drawn off into a suitable receptacle. Or, when circumstances are favorable, the partially-fused silicates may be drawn from

the furnace, allowed to cool, broken into fragments, and smelted, with iron or iron ore, in a cupola-furnace.

As it is important that as much as possible of the sulphuric acid should be expelled before the mass becomes fused, it is intended by a judicious regulation of the fire, and admission of air and steam through the holes at the head of the inclined hearth, to cause the commencement of the reactions at the upper end of the bed, that they may be continued until the mass reaches the melting-bed and there becomes fused.

The various kinds of ores, matts, &c., of which the charge had to be compounded, on being put into the compartments of the mixing and feeding apparatus, could, by a proper attention to the valves *h h*, be intimately mixed in the exact proportions desired, and fed into the furnace with a regularity and precision unattainable by manual labor; and the rate at which the ores pass through the furnace can be nicely governed by a proper regulation of the speed of the stirring-machine, and by the depth of the ore in the furnace.

Copper pyrites and other sulphureted copper ores should be roasted in the chambers and reach the head of the reaction-bed as soon as only sufficient sulphur remained to draw all the copper into a matt, and enough iron oxidized to form a fusible slag with the silica present, and then, on being exposed to the heat of the reaction-bed, the silica would combine with the oxide of iron, and the copper with the sulphur, and on reaching the higher heat of the melting-bed the perfectly-fused matters would separate into a substratum of sulphides or matt, and a superstratum of silicates or slag. The latter would be drawn out at the door *l'* and cast away as useless, and the matt run out through the hole *m'* into a tank of water, to be granulated, and afterward returned to the furnace, to undergo a similar roasting and smelting to remove the remaining sulphur, iron, and other impurities. In working ores of this class, the introduction of steam through the holes *b b* would facilitate the removal of sulphur and oxidation of metals.

Silver ores may be treated in this furnace by being mixed with the silicious lead ores, and roasted and smelted, as has already been described, the silver concentrated in the lead and afterward separated by cupellation; by being mixed with copper and iron pyrites the silver concentrated in a matt and separated therefrom by a process of liquation, amalgamation, or precipitation; or by a chlorination roasting preparatory to amalgamation. In roasting for amalgamation the silver ore, pyrites, and salt would be put into the compartments of the mixing and feeding machine, and mixed and fed into the furnace in the usual way, roasted under a moderate heat in the chambers A and B, and then under the higher temperature of chamber C, to cause a reaction of the sulphuric acid of the metallic sulphates upon the sodium of the salt, resulting in an evolution of the chlorine, which would immediately combine with the silver, forming a chloride of silver readily decomposed by iron and taken up by mercury in the process of amalgamation.

In treating silver ores containing only a small quantity of base-metal sulphides—such as zinc, copper, lead, antimony, &c.—the chlorination of the silver and the decomposition of the sulphates would be thoroughly accomplished on reaching the head of the reaction-bed, and would not need to pass through the reaction-bed, but would be discharged through the aperture *n'* by the removal of the brick stopper *o*; but when the ore abounds in base-metal sulphides the latter part of the roasting should be effected under the higher heat of the reaction-bed, in order to decompose the sulphates and chlorides of zinc, copper, lead, &c., as these remaining in the ore would seriously interfere with the amalgamation. The decomposition of the base-metal sulphates and chlorides will be greatly facilitated and the use of salt economized by allowing a suitable quantity of steam to pass into the furnace from the boiler J through the pipes *p' p'*.

Gold ores, whether sulphurous or quartzose, can be successively treated in this furnace by being mixed, roasted, and smelted with silicious lead ores or with sulphureted copper ores, as already mentioned.

Auriferous iron pyrites could be partially roasted in the chambers and then melted in the fusion-bed, by which the gold would be concentrated in an iron matt, from which it could be readily separated by being melted with lead ores, or by an amalgamation, or a precipitation process; or the sulphurous ores could be well roasted in the chambers and then in the reaction-bed to decompose the sulphates of iron and copper, and then be withdrawn from the furnace to be treated by the amalgamation or chlorination process.

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

1. The combination of the inclined reaction-bed D and melting-hearth with a mechanical roasting-furnace, all arranged as and for the purpose specified.

2. The combination of scraper, scraper-rod, and regulating-valves, each constructed and operated as described.

3. The improved stirring-rakes *p p*, having tapering flukes *q q* thereon to prevent an accumulation of the roasting ore beneath them, and having angles *s s'*, of different acuteness, so that when reciprocated they will stir the ore at each half-stroke and cause it to pass slowly in the direction of the larger angle.

4. As an improvement in metallic furnace-rakes, the construction of the flukes *q*, in the manner shown and described.

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