2 Sheets—Sheet 1.

J. J. NAPIER & J. M. THOMPSON.

Ore Roasting Furnace.

No. 234,798. **Patented Nov. 23, 1880.**

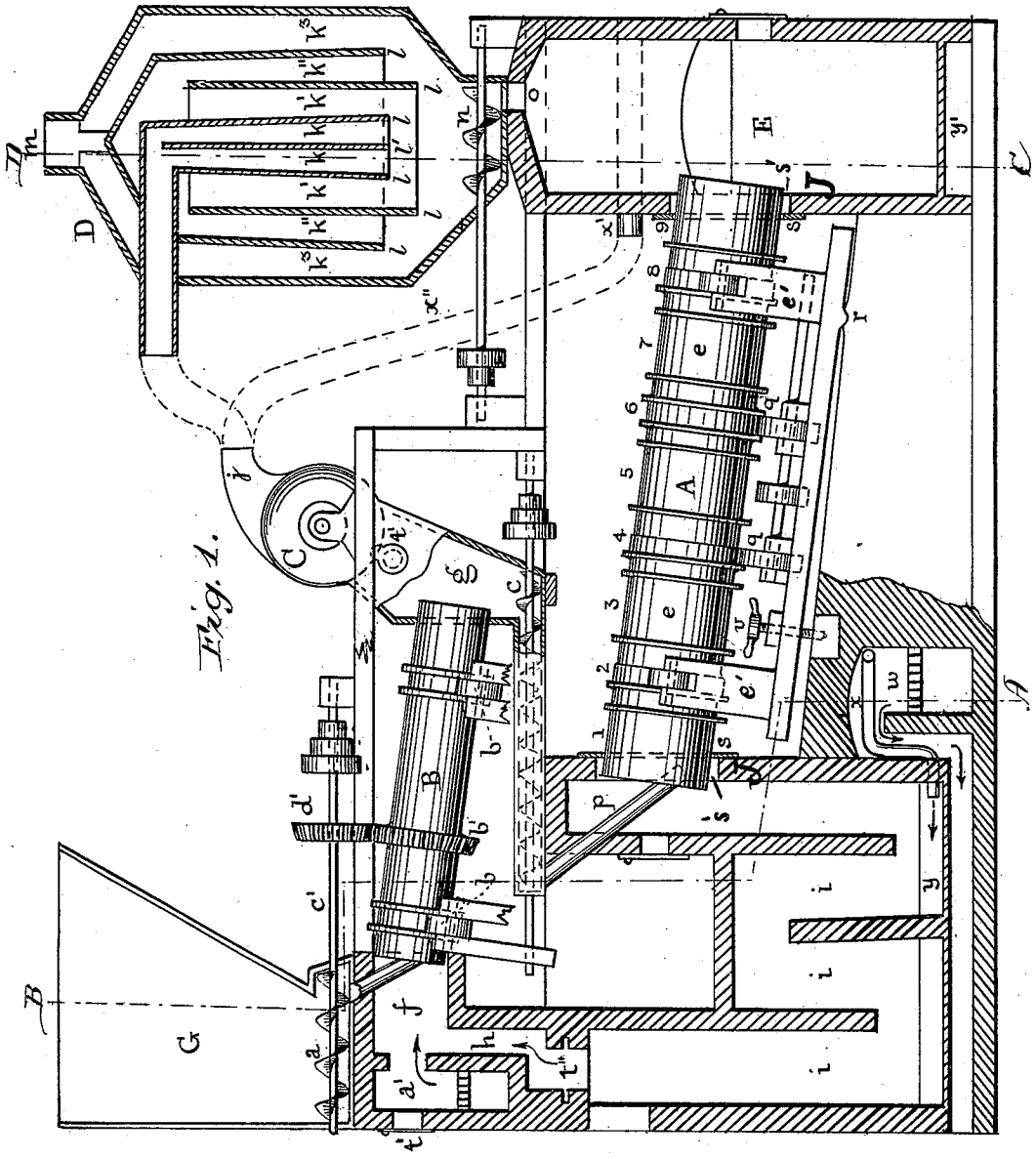


Fig. 1.

Witnesses.

H. Monteverde.

T. L. Osborn

Inventors.

James J. Napier

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2 Sheets—Sheet 2.

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Fig. 2.

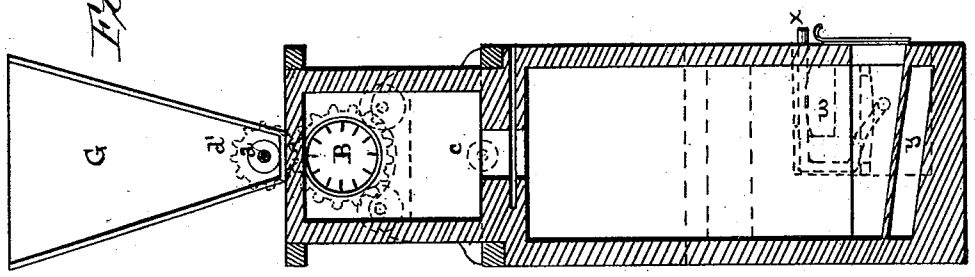
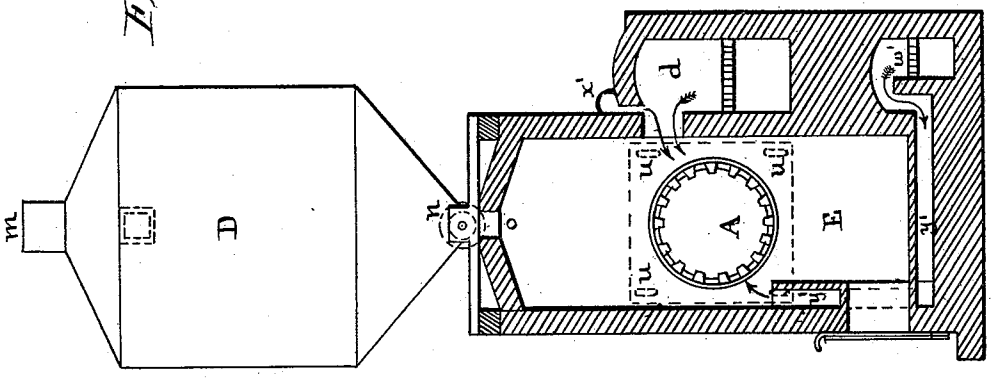


Fig. 3.



Witnesses.

F. Hollowverde.

C. C. Osborn

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UNITED STATES PATENT OFFICE.

JAMES J. NAPIER AND JAMES M. THOMPSON, OF SAN FRANCISCO, CAL.

ORE-ROASTING FURNACE.

SPECIFICATION forming part of Letters Patent No. 234,798, dated November 23, 1880.

Application filed October 10, 1878.

To all whom it may concern:

Be it known that we, JAMES J. NAPIER and JAMES M. THOMPSON, both of the city and county of San Francisco, and State of California, have invented a new and useful Improvement in Ore-Roasting Furnaces, of which the following is a specification.

Our invention relates to all ore-roasting furnaces in which the ores are exposed to the action of the draft, and more especially to that class of furnaces which act in a continuous manner, and in which, in order to increase the heat on the ore, it is introduced into the cooler end, or part of the furnace which is the farthest from the fire-box, and is dropped or showered and progressed through the furnace in a direction opposite to the draft and deposited in the ore-chamber at the hotter end next the fire-box.

In this description of furnaces there is always a considerable percentage of the finer particles of the ore carried back by the draft and prevented by it from falling or passing through the furnace, and which is carried out and deposited in dust-precipitating chambers, through which the draft is caused to pass before reaching the chimney or smoke-stack, and this ore consequently cannot be roasted in the main furnace.

Different devices or methods have been used or tried to roast these finer particles, the only ones employed with any degree of success to our knowledge being those in which an auxiliary fire is provided which connects with the flue leading from the furnace, and to which the finer particles are exposed and more or less imperfectly roasted.

Another method, consisting in locating the fire-box at and passing the fire into the upper or ore-receiving end of the furnace, so that all the ore will pass through the furnace in the same direction with the draft, has been several times patented in different devices; but this method has failed in every instance where tested, on account of the ores being exposed to too great heat at the first and too little heat at the last part of the process.

Other plans or constructions designed for protecting the ore entirely from the draft, so that all the particles can be passed through the furnace from its cooler to its hotter end, have been attempted or patented, and still other attempts have been made to so construct a furnace as to cause all the particles of the ore to be progressed in the same direction, while they are at the same time exposed to the draft and the heat being increased on the same; but owing to difficulties, principally in the mechanical construction, these different devices have failed to operate in an effective manner.

The object of our invention is to provide a method of operation and means for roasting or reducing these finer particles of the ore held in suspension and carried by the draft more thoroughly and economically than has been heretofore done, or than it is possible to do by any of the other methods known to us.

The invention consists in separating from the coarser, in any suitable or effective manner, the finer portion of the ore, that would in any given furnace be carried out of it, or prevented by the draft from passing through it, and in feeding this finer portion into the end of the furnace into which the draft and products of combustion enter, and at the same time feeding the coarser portion into the opposite or cooler end and passing it through the furnace in the opposite direction from the draft and that in which the finer particles are carried.

It also consists in constructing the bottom and sides of the ore-chamber with a flue-space around them, and providing a fire-place which connects with said flue-space in such a manner as to cause the heat and products of combustion from the fire-place, after first passing around the bottom and side of the ore-chamber and heating the ore within it to any further degree required, to then pass over the ore and into and through the main roasting-furnace with the heat and products of combustion from the main fire-box, and aid in the roasting of the ores within the roasting-furnace; and it further consists in constructing the bottoms of the dust-chambers, on which are deposited the fine ore-particles which are carried out of the furnace with the draft and products of combustion, with a flue space or spaces underneath them, and in providing a fire-place to connect with said flue-spaces in such a manner as to cause the heat and products of combustion from it to pass through

them directly into the smoke-stack, and thus keep the bottoms of the dust-chambers constantly heated to any degree necessary for the still further reduction of the fine particles of the ore which are carried by the draft and deposited on them, and at the same time not to mingle with the ore or to interfere with its precipitation on the bottoms of the dust-chambers.

In the accompanying drawings, in which similar letters of reference indicate like parts, Figure 1, Sheet 1, is a vertical longitudinal section of a device embodying our invention as applied to a continuous feeding and discharging rotating cylinder furnace. Fig. 2, Sheet 2, is a cross-section of the same through the line A B of Fig. 1; and Fig. 3, Sheet 2, is a cross-section of the same through the line C D of Fig. 1.

The ore to be roasted is regularly and continuously fed from the ore-hopper G by the screw-conveyer *a* into the upper end of the revolving inclined cylinder B, having projections on its interior surface for showering and progressing the ore through it. This separating-cylinder B is mounted upon anti-friction bearing-wheels *b b*, and is rotated by means of the cog-gear *b'*, secured to its outside, and the pinion *d'* on the shaft *c'*. Each of the ends of this cylinder B projects into circular openings in the sides of the boxes or chambers *f g*, which fit as closely as possible around the ends of the cylinder, and yet allow its free revolution. The box *f* at the upper end of the cylinder and the dust-chambers *i i* are connected by a flue, *h*, provided with a valve, *t''*, for regulating the draft through it. This flue *h* and the chambers *i i* serve as a smoke-stack, through which the smoke and finer particles of ore not precipitated in the dust-chambers and the products of combustion from the roasting-furnace A pass and again enter the separating-cylinder B, being aided in their passage therein by draft of exterior air through the valved opening *t'*.

The box *g*, at the opposite or lower end of the cylinder B, connects with an ordinary exhaust-fan or suction-blower, *c*.

The exit or discharge pipe *j* of the suction-blower leads into the upper end of the central passages, *k k*, in the center of the dust chamber or precipitator D. The precipitator D can be made either circular or rectangular in form, and is divided by the partitions *l l* (which are secured in position around each other) into any number of passages or divisions, *k' k''*, which connect at their upper and lower ends with each other, and the outer one of which, k^3, connects with the exit or opening *m* at the top. These passages or divisions *k k' k''* are also subdivided into any desired number of parts by the narrow partitions *l'*. In this manner the central divisions, *k k*, are gradually enlarged from their upper ends, connecting with the pipe *j* until they connect at their lower ends with the passages *k' k'*, which are also gradually enlarged until they connect at their upper ends with the passages *k'' k''*, and so on to the passages or divisions, k^3 k^3, next the sides of the precipitator, which at their top are then contracted and lead into the exit *m* at the top. The lower end of the precipitator D is extended some distance below the partitions to form an ore hopper or space, and contracted by sloping its sides toward each other, and the screw-conveyer *n* in its bottom connects with the opening *o* in the top of the ore-chamber E.

The dust chamber or precipitator D is preferably made of sheet-iron or other suitable metal, as it would be difficult and expensive to construct it or to place and secure it in its position over or higher than the furnace if made of brick or stone, of which dust-precipitating chambers have been heretofore made, and also the lower part of only two of its sides could be inclined toward each other, so as to make its bottom V or trough shaped, instead of hopper-shaped, as shown in the drawings.

The upper part or top of the ore-chamber E, into which the lower end of the roasting-cylinder enters or projects, is raised to any requisite height, so as to give greater heated space for the finer portion of the ores which is fed into it to pass through, and consequently to expose them for a greater length of time to the heat and flames and gases. A screw-conveyer, *c*, also connects at the bottom of the box *g* with the feed-pipe *p*, which projects into the upper end of the inclined revolving cylinder roasting-furnace A. The upper end of this roasting-cylinder A connects with the dust-precipitating chambers *i i*, and the cylinder is constructed in sections, which are fitted and bolted to each other in the usual manner. We also mount the timbers which support the cylinder on the pivot *r*, and provide the plates *s s*, which fit around the ends of the cylinder, with slots *u u*, through which the bolts pass which secure them to the walls J J of the ore-chambers, and over the perpendicularly-elongated holes *s' s'* in the walls J J, through which the ends of the cylinder project, so that the inclination of the cylinder can be easily changed, when necessary, by loosening the nuts of the bolts which secure the plates *s s* and turning the screw *v* in either direction, as required.

The bottoms of the dust-chambers *i i* are made horizontal, or nearly so, and constructed with flue space or spaces *y* under them, which connect with the fire-place *w*; and a pipe, X, which passes through the fire-place *w* into the dust-chambers *i i*, is also provided, to supply heated air to the ore which is deposited on the bottoms of the dust-chambers *i i*. The bottom of the ore-chamber E is also constructed with a flue-space under it, and a fire-place, *w'*, provided and connected so that the heat and products of combustion from it will pass through the flue-space *y'* under the bottom and up the side of the ore-chamber E and into the cylinder A, and thus, while keeping the

ore in the ore-chamber E up to the proper heat for its better reduction or chloridization after being discharged from the cylinder, will also aid in the roasting of the ore in the cylinder.

A furnace, *a'*, is also provided to connect with the box or chamber *f*, so that when desired the ore, while being separated, can also be more thoroughly dried or partially roasted and all volatile matter expelled, that it may be desirable and more practicable to save or condense at a low heat, or that, if not expelled, would interfere with the roasting. These volatile matters or fumes, after passing through the precipitator D and being freed from the fine ore-particles and products of combustion or soot, (which more or less obstruct the process of condensation by depositing on the sides of the condensers,) can then be passed from the exit-pipe *m* of the precipitator D into condensers and be condensed.

When it is desired to chloridize the ore the requisite amount of salt is mixed with it before it is introduced into the furnace. It is generally preferred to mix the salt with the ore before crushing, as a more perfect admixture is thereby effected, and in all such cases our process will effect a saving of salt, for in the process of crushing a much greater proportion of it than of the ore, or than is necessary for its chloridization, is made fine and light enough to be carried back by the draft, and the excess is therefore wasted; but in our process, by which the finer as well as the coarser portion of the ore is passed through the furnace, this excess of salt is decomposed in the furnace and aids in the chloridization of the coarser portion of the ore, as well as the chloridization of the finer portion, with which it enters the furnace.

In cases where the salt is mixed with the ore before it is crushed and separated, and it should be desired to still further increase the proportion of salt in the finer portion of the ore which is to be passed through the furnace with the draft, the additional amount required must, before mixing it, be pulverized fine enough to be also carried by the draft; and in cases where the salt is not mixed with the ore until after its separation all that portion of the salt which is to be mixed with the finer portion of the ore must also be pulverized sufficiently fine to be carried by the draft; and in the chloridization of most ores a more thorough chloridization can be effected by feeding an increased proportion or percentage of the finely-pulverized salt into the furnace with the draft and products of combustion, (than is even contained in the finer portion of the ore,) as an increased amount of the chlorine necessary for the chloridization is thereby evolved and carried by the draft into the hotter end of the furnace, where the ore is in the proper condition to form chlorides.

Instead of separating the finer particles before passing the ore into the furnace, either by the means herein described or in any other manner, the ore can be fed into the furnace from the ore-hopper G, and the finer particles, which would then be carried back by the draft, can be precipitated in the dust-chambers *i i*, and at comparatively long periods or intervals of time, or when a certain amount is accumulated, be fed in a comparatively short time into the pipe X', or into the opening *o* in the top of the ore-chamber E, while at the same time the regular feeding of the ore from the ore-hopper G into the furnace is continued, and that portion of these finer particles which is not carried down and deposited in the ore-chamber E, after passing through the furnace and being a second time deposited in the dust-chambers, would then be roasted, and can then be removed to permit the precipitation of another quantity or charge; but this method of separating or treating the finer particles is objectionable on several accounts, and more especially for the reason that during the short time they are being passed into the furnace and roasted the finer particles of the ore, which are at the same time being fed from the hopper G into the upper end of the furnace, are carried back by the draft and deposited without being roasted at all, or but very imperfectly, and we therefore prefer the method herein described of separating the finer and lighter particles from the coarser before passing the ore into the furnace.

The operation of our device as applied to a continuously-acting roasting-furnace shown in the drawings is as follows: The ore, after being passed from the battery or crusher into the ore-hopper G, is regularly fed by the screw-conveyer *a* into the revolving separating-cylinder B, and is, by the rotation and inclination of the cylinder and the projections within it, kept constantly showering and regularly progressed through it, while at the same time the ore is acted upon by the current of air or draft produced by the suction-blower C, and the coarser ore-particles are deposited in the ore box or hopper *g* at the lower end of the cylinder B, and fed by means of the conveyer *c* into the upper end of the roasting-cylinder, and are progressed downward through it and deposited in the ore-chamber E, while at the same time the finer ore-particles are carried by the draft into the precipitator D and collected at its bottom, and fed by the screw-conveyer *n* through the opening *o* into the top of the ore-chamber E, where they are exposed to the heat from the fire-box *d*, as well as to the heat and action of the gases which are constantly being evolved from the roasted ore accumulated in the lower part of the ore-chamber E, and that portion of it which is not carried down and deposited in the ore-chamber E is carried by the draft from the fire-box *d* upward through the furnace or roasting-cylinder and precipitated on the floors of the dust-chambers *i i*, and exposed, when necessary, to the further reducing action of the

ore in the ore-chamber E up to the proper heat for its better reduction or chloridization after being discharged from the cylinder, will also aid in the roasting of the ore in the cylinder.

A furnace, *a'*, is also provided to connect with the box or chamber *f*, so that when desired the ore, while being separated, can also be more thoroughly dried or partially roasted and all volatile matter expelled, that it may be desirable and more practicable to save or condense at a low heat, or that, if not expelled, would interfere with the roasting. These volatile matters or fumes, after passing through the precipitator D and being freed from the fine ore-particles and products of combustion or soot, (which more or less obstruct the process of condensation by depositing on the sides of the condensers,) can then be passed from the exit-pipe *m* of the precipitator D into

by the means herein described or in any other manner, the ore can be fed into the furnace from the ore-hopper G, and the finer particles, which would then be carried back by the draft, can be precipitated in the dust-chambers *i i*, and at comparatively long periods or intervals of time, or when a certain amount is accumulated, be fed in a comparatively short time into the pipe X', or into the opening *o* in the top of the ore-chamber E, while at the same time the regular feeding of the ore from the ore-hopper G into the furnace is continued, and that portion of these finer particles which is not carried down and deposited in the ore-chamber E, after passing through the furnace and being a second time deposited in the dust-chambers, would then be roasted, and can then be removed to permit the precipitation of another quantity or charge; but this method of separating or treating the finer particles is ob-

ried back by the draft, and in then passing this portion into the furnace with the draft and products of combustion, while treating the residue or coarser portion in the same furnace in the usual manner, substantially as and for the purpose specified.

2. In roasting ores, the herein-described method of roasting the finer ore-particles at the same time and in the same furnace in which the coarser portion is being roasted, which consists in separating the finer particles which are sufficiently light to be carried by the draft, and introducing them by the blast or draft into the fire-box or end of the furnace into which the draft and products of combustion enter, in the manner substantially as described.

3. In an ore-roasting furnace, the combination, with the ore-roasting cylinder A and roasting-chamber E, of a dust-precipitating chamber, D, with its bottom V or hopper shaped, situated above said roasting-chamber, connecting therewith by passage *o*, and provided with an ore-conveyer, *n*, all constructed and arranged as described and shown.

4. In an ore-roasting furnace, the combination, with the ore-roasting cylinder A, of an ore-separating cylinder, B, suction-blower C, precipitator D, ore-chamber E, dust-chambers *i i*, ore-conveyers *a c n*, and connecting-pipes *p j*, all constructed and arranged as described and shown.

5. In an ore-roasting furnace, in combination with the ore-roasting cylinder A and ore-chamber E, the precipitator D, of rectangular or circular form, containing the separate and gradually-enlarging passages *k k' k'' k'''*, formed by the partitions *l l'*, in the manner described, and having the V or hopper shaped ore space or receptacle in its lower end, for containing the particles of ore when precipitated therein, substantially as described, and for the purpose set forth.

6. In an ore-roasting furnace, the combination, with the ore-roasting cylinder A, of the ore-chamber E and fire-box *d* at its discharging end, dust-chambers *i i* at or near its upper or receiving end, ore-separating cylinder B, suction-blower C, precipitator D, ore-conveyers *a c n*, and pipes *p j*, or equivalent means of connection, all constructed and arranged as described, and for the purpose set forth.

7. In an ore-roasting furnace, the revolving ore-roasting cylinder A with its supporting timbers or frame *e e'*, adapted to be tilted, in combination with the sliding or adjustable wall-plates *s s* and the walls J J, having the elongated openings *s' s'*, in which the ends of the cylinder move and rotate, substantially as described, and for the purpose set forth.

8. In an ore-roasting furnace, the dust-chambers *i i*, arranged at or near the upper or receiving end of the roasting-cylinder A, and constructed with their bottoms level, or nearly so, in combination with the fire-box *w*, provided with flue *y*, which connects with and leads from said fire-box and under the bottoms of said dust-chambers to the smoke-stack, substantially as described, and for the purpose set forth.

9. In an ore-roasting furnace, the combination of the ore-roasting cylinder A with the ore pit or chamber E and the fire-box *w'*, provided with the flue *y'*, which connects with and leads from said fire-box under and around the bottom and sides of said ore-chamber and into the ore-roasting cylinder, substantially as described, and for the purpose set forth.

10. In an ore-roasting furnace, the combination, with the ore-roasting cylinder A, ore-chamber E, and dust-chambers *i i*, of the separating-cylinder B, fire-box *a'* at its upper end, suction-blower C at its opposite end, precipitator D, pipes *p j*, or equivalent means of connection, and ore-conveyers *a c n*, all constructed and arranged substantially as described and shown.

11. In an ore-roasting furnace, the combination, with ore-roasting cylinder A, of the ore-chamber E, fire-box *d*, and fire-place *w'*, with connecting-pipe *y'* at its discharging end, dust-chambers *i i* at or near its upper or receiving end, flue *h*, connecting such chambers with separating-cylinder B, draft-regulating valves *t' t''*, separating-cylinder B, suction-blower C, precipitator D, pipes *p j*, or equivalent means of connection, and ore-conveyers *a c n*, all constructed and arranged substantially as described and shown.

In testimony that we claim the foregoing we have hereunto set our hands this 26th day of August, 1878.

JAMES J. NAPIER.
JAMES M. THOMPSON.

Witnesses:
D. L. SMOOT,
T. L. SKINNER.