W. J. TAYLOR.

Calcining Kilns.

No. 166,159. Patented July 27, 1875.

FIG. I.

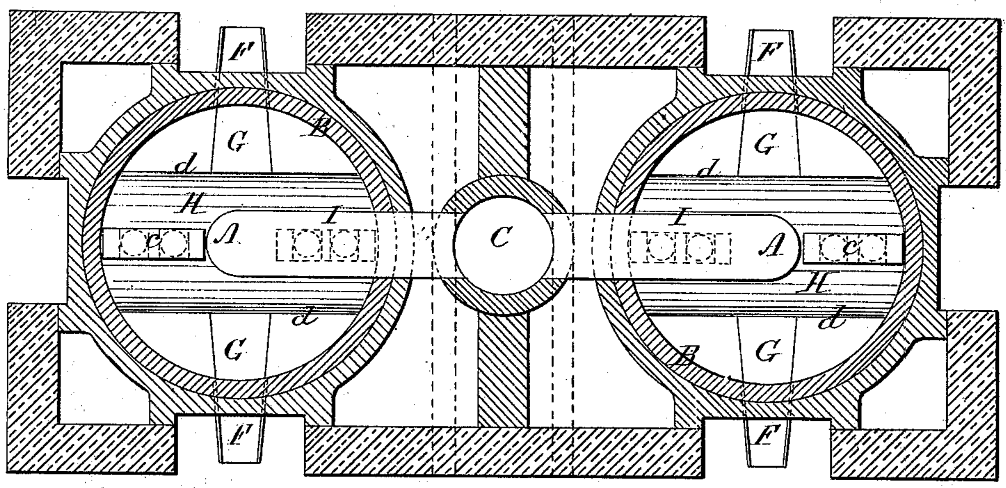
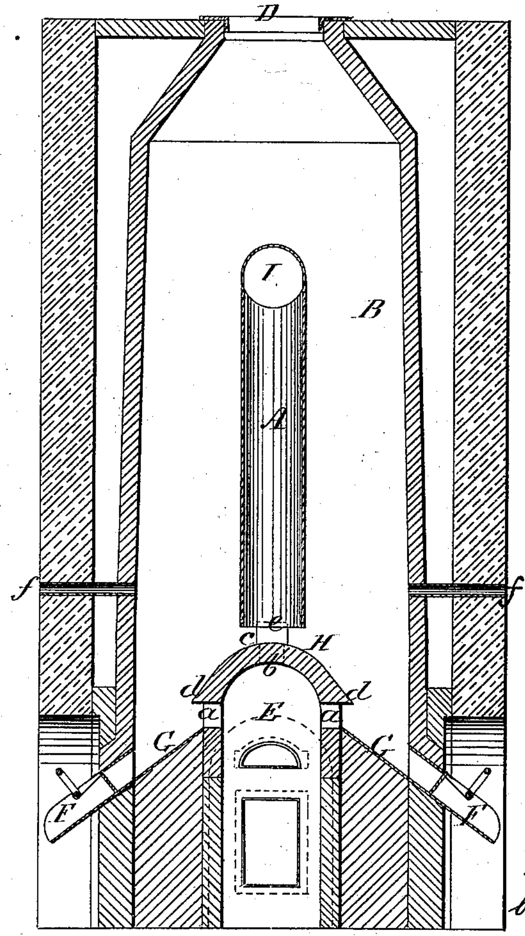


FIG. II.



WITNESSES

John E. Laing.

J. H. Rutherford

INVENTOR

William J. Taylor

by Johnson and Johnson

his Attys.

2 Sheets--Sheet 2.

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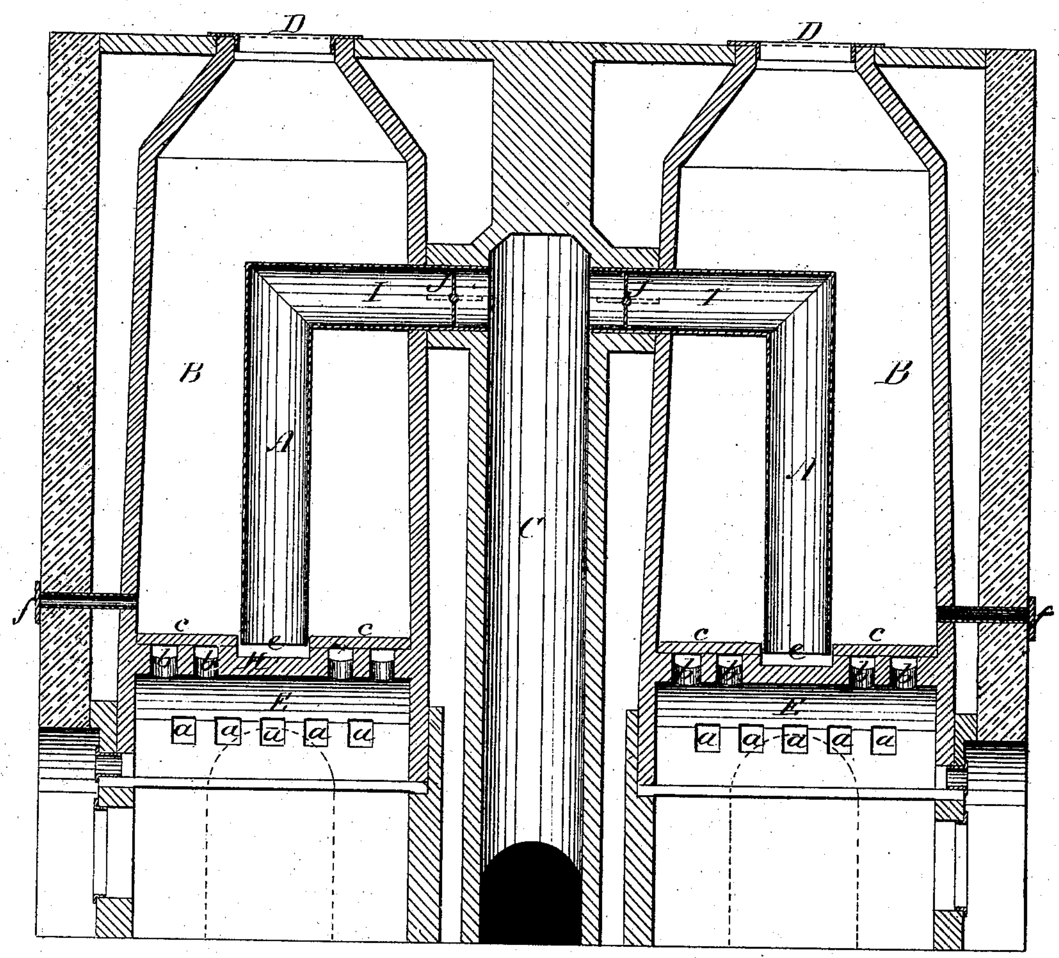
FIG. III.



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UNITED STATES PATENT OFFICE.

WILLIAM J. TAYLOR, OF HIGH BRIDGE, NEW JERSEY.

IMPROVEMENT IN CALCINING-KILNS.

Specification forming part of Letters Patent No. **166,159**, dated July 27, 1875; application filed June 14, 1875.

To all whom it may concern:

Be it known that I, WILLIAM J. TAYLOR, of High Bridge, in the county of Hunterdon and State of New Jersey, have invented certain new and useful Improvements in Calcining-Kilns; 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 which it pertains to make and use the same, reference being had to the accompanying drawing, and to the letters of reference marked thereon, which form a part of this specification.

My improved kiln for roasting ores is more especially adapted for treating magnetic oxides of iron ($FeOFe_2O_3$) for the purpose of oxidizing whatever sulphur they may contain into sulphurous-acid gas (SO_2) and also oxidizing the protoxide (FeO) into sesquioxide (Fe_2O_3) as far as possible.

In order to a full understanding of what I aim to accomplish the following explanation is given: In general terms the roasting of ores is subjecting them to heat in the presence of atmospheric air. It is well known that a proper calcination of the ores before treatment in the blast-furnace greatly facilitates their reduction. The effect of heat is to reduce the affinity existing between the elements to be expelled and those remaining in the ore, and also to crack or split up the ore caused by the expansion of the same by heat, which renders the ore more open and porous. In accomplishing this under my invention, the chemical affinity of the sulphur is so much reduced by heating it that the oxygen of the air admitted overcomes this affinity by associating itself with the sulphur and forming sulphurous-acid gas. The higher the heat below the melting-point of the ore, and the more uniform the heat is throughout the ore, the more rapidly and uniformly will the sulphur be oxidized. In the portions of the ore having the least temperature the affinity between the sulphur and the iron will be greater than if it were heated as high as it can be without melting, and, consequently, such ore, even though it be exposed as long a time in such low temperature as that having the highest heat, will lose less sulphur, because the process of oxidation becomes slower in proportion to the decrease of temperature, on account of the affinity between the sulphur and the iron, which affinity decreases upon an increase of heat and increases by a decrease of heat. The objectionable contingency, namely, irregular heating of the ore, either heating some of the ore to fusion or else not heating enough, is to a greater or less degree unavoidable when ores are roasted with alternate layers of coal. The supply of air is also of as much importance in calcining ores as a proper heating, because an irregular distribution of the air will produce irregular results. The effect of the air is not to oxidize the sulphur only, but to also oxidize a part of the protoxide existing in all magnetites into sesquioxide of iron. The effect of this is similar to one of the effects of heating, namely, to making the ore more porous, for, as every equivalent of protoxide oxidized into sesquioxide increases in bulk, it will have an expansive effect, and, consequently, open up the ore, giving still further access to the sulphur in the interior of it. Porosity is not only a great advantage in the proper elimination of sulphur, but also the process of reduction of the ores in the blast-furnace. In the case of magnetic ores containing pyrites no suitable rapid process entirely under the control of the operator has, to my knowledge, been devised to successfully eliminate the sulphur, mainly on account of the difficulty of maintaining an oxidizing-atmosphere, together with the proper temperature, for a sufficient length of time.

It is absolutely necessary to maintain an oxidizing-atmosphere during the whole time the ore is subjected to the process of roasting, in order, first, that the sulphur will get sufficient oxygen to convert it into sulphurous-acid gas—otherwise it will sublime; and, second, that the protoxide will take up its other equivalent of oxygen as far as possible. Hence what is wanted in the process of calcination is an atmosphere exactly the reverse of what is obtained in the upper zone of a blast-furnace, which is deoxidizing instead of oxidizing. It has long been the custom to submit ores to heat in kilns, the heat being derived from the combustion of fuel mixed with the ore; but the difficulty of maintaining a free current of air for a supply of oxygen has made this process entirely unreliable, or not under proper control, and almost impracticable for useful results. This applies to any process where oxidation is necessary when the fuel is mixed with the ore, for if a free circulation of air is maintained the oxygen goes to the fuel, and keeps on adding to the temperature until the coal is all consumed, and if instead the temperature is regulated by the supply of air there is not enough oxygen to form sulphurous-acid gas, and the sulphur sublimes and settles in the ore again, or, in other words, is merely removed from one piece of ore to another. Hence it would appear to be impossible to remove any large proportion of sulphur from ore roasted in pipes or kilns when fuel is mixed through the ore only, and the only way to accomplish oxidation of both sulphur and ore successfully is to control both temperature and admission of air during the whole time of roasting. These conditions my invention fulfils in a very advantageous and satisfactory manner, with great economy in fuel, in connection with a uniform supply and distribution of air from near the top of the kiln, by means of an air-downtake at a point centrally above and in near proximity to the upper surface of the crown of a centrally-located combustion-chamber, so that the flame and gases passing upward into the calcining-chamber will meet the descending hot currents of air, which, issuing from the bottom of the downtake or air-supply pipe, enter and permeate the ore alike at the center and at the walls of the kiln, giving the heat and air a uniform travel and scope throughout the body of the ore from a point just above the top of the combustion-chamber. The outlet end of this downtake has such relation to the arched top of the fire and combustion chamber as to cause the ore resting thereon to leave spaces all round the outlet end of the down-take for the passage of the air therefrom, so that the ore will be uniformly exposed to its combined action. In addition to this the central pendent position of the air-supply pipe or downtake occupies space which would otherwise be occupied by ore; and as it is well known that the center of a kiln is always the hottest, and the point which the heat seeks in its upward travel, the occupation, therefore, of this central space by the air-supply pipe or downtake avoids this very serious disadvantage, and thereby becomes one of the chief elements whereby a uniform temperature and distribution of the heat and air are maintained throughout the body of the ore, and its calcination thereby rendered perfect. This centrally-depending pipe or downtake supplies the air from a point or source lower than the outlet, and for this purpose its upper end connects by a lateral branch with an uptake or branch open to the outer air, thus counteracting all tendency of an upward draft through the downtake from the interior of the ore-chamber, but producing and maintaining a constant suction of air, which is heated in its downward course into the ore-chamber, the roasting-ore space, and not the combustion-chamber, serving to heat the air in its passage into such ore-chamber. By this draft-tube or air-downtake through the center of the kiln several very important results are obtained, and among these the supply of air is heated by the hot ore surrounding the pipe or downtake. The heat is constantly being taken from the center and distributed to the circumference by the heated air, which, descending through the downtake, issues and rises through the ore-chamber, which is a very important matter, for without this air-downtake, when the proper temperature of the outside of the body of the ore is reached the heat in the center of a kiln would be too great; and, moreover, by this improvement I am enabled to greatly increase the size and capacity of a kiln.

In building kilns in pairs, for greater convenience and economy, the air-downtake of each kiln is supplied from a single flue or uptake, built in the wall from the base upward, which divides the kilns so that the heat of the contiguous walls serves to aid in heating the air supplied to both kilns. The flame and gases not only issue from the sides but from the top of the combustion-chamber on each side of the air-downtake, and for this purpose the crown-openings are provided with open arch-shields, and the side openings have guard-ledges or projecting eaves from the arch to prevent the ore running into the combustion-chamber. A fire and combustion chamber, located centrally within and near the base of the kiln, so as to form a part of the bottom thereof, is not new as a means for supplying the heat to the ore, and forming the discharge-sheds for the chutes or outlets; but the combination with such a centrally-located fire and combustion chamber with a central air-downtake, forms an invention which produces the best results in such a kiln.

In the accompanying drawings, Figure 1 represents a horizontal section of a double kiln embracing my invention, the air-downtakes and the combustion-chambers being shown in plan; Fig. 2 a vertical cross-section of one of the kilns, and Fig. 3 a sectional view of the double kiln, taken at right angles to Fig. 2.

In the construction of my kiln, for convenience and economy I build them in pairs, inclosed in rough stone masonry, and preferably of rectangular form, well bound together with either wooden or iron binders. This double form is of special advantage by reason of its cheapness of construction, and in connection therewith the air-downtake A for each kiln B is supplied from an intermediate flue or uptake, C, within and forming part of the wall which divides the two kilns, and by which the air is supplied to both kilns alike and at the same temperature, as the walls forming such air-uptake or supply-flue C are contiguous to the walls of the kilns and are thereby somewhat heated by the radiation from the double kilns. The kiln, however, may be built in single form and my invention be maintained intact. In such case, the air-uptake or supply-flue C may be built in one of the side walls, or arranged outside thereof, as may be deemed best. The chamber or chambers B, for holding the ores to be desulphurized, are built of fire-brick or any suitable material, with double walls, so as to leave intervening spaces, which are packed with loam or any other suitable material. The kilns are provided with charging-openings D at the top. At the base of the ore-chamber I construct the fire or combustion chamber E, with the necessary doors, grates, and fixtures. Proper chutes F connect, by inclined bottoms G, with the outside walls of the combustion-chamber, through which to draw off the roasted ore. The combustion chamber E is located centrally in the kiln, and its crown or arch H forms the dividing-ridge between the opposite chutes F, which are provided with suitable closing or stop doors. The combustion-chamber E is provided with a series of openings, *a*, on each side, just above the inclines G, for the chutes, through which the flame and gases escape into the ore-chamber.

In addition to these, similar openings *b* are made in the crown or arch H of said chamber, to allow the flame and gases to escape therefrom at this point, whereby I obtain a more uniform spread of the heat from the combustion-chamber throughout the base of the ore-chamber. These upper openings *b* are guarded by arched shields *c*, and the side openings *a* are protected by ledges or projecting eaves *d*, which form continuations of the crown-arch H, and thereby prevent the ore from running into the combustion-chamber at all these flame-openings. Combined with this centrally-arranged fire and combustion chamber E I employ a centrally-arranged air-downtake or supply-pipe, A, in such manner that the outlet *e* thereof is in near contiguity with the top surface of the crown or arch H of such fire-chamber, leaving only sufficient space between the two for the free outlet of the air which flows down said pipe. This pipe A, to perform its functions properly, and to conform to the dimensions of the kiln, should be about one-third of a square inch to about one cubic foot of the cubical contents of the kiln. This downtake A occupies the center of the kiln, and is maintained in such position by any suitable means. Its upper end is not open to the air, but is joined to a lateral branch, I, which, extending through the wall of the kiln, forms a junction with an uptake, C, which extends down to the base of the kiln and must open into the outer air at a much lower level than the downtake, in order thereby that the air-current will be maintained within, and through, said conduit and into the kiln when it rises through the ore. As stated, this uptake C can be either within the wall of a single kiln or outside thereof, and in a double kiln its position is between the kilns, and forms a part of the wall which separates them. In the combination of this element with a double kiln the uptake C should be of double the area of the downtakes A. In practice the junction of the uptake C with the downtake A should be at a point about one-third the distance from the top of the kiln; but this is immaterial and may be varied.

The down take or takes A being surrounded by the heated ore are thereby heated, and the air is, of course, also heated before it enters the ore-chambers, and, in this respect, takes no heat directly from the combustion-chamber.

The hot air is delivered directly upon the crown or arch H of the combustion-chamber, and is thereby deflected or turned aside from the central issue into the ore, and, meeting the flame and gases rising from the openings into the combustion-chamber, unites therewith, and rises through the mass of ore. The central location of this downtake A also prevents the heat taking an accumulating course in the center of the kiln, and thereby renders the heat more uniform, and places it under absolute control.

The quantity of inflowing air is regulated by dampers J, placed in the lateral branch or branches I connecting the down take or takes, and these are governed by damper-rods extending through the kiln wall or walls. The flow of air to support combustion in the fire-chamber is admitted through a suitable register in the door of the ash-pit.

A series of sight-holes, *f*, two or three inches in diameter, are inserted through the walls, in order that the state of the heat of the ore in the kiln may be ascertained at any time, and the combustion in the fire-chamber regulated accordingly.

If desirable to obtain the greatest economy and rapidity of working, enough fuel may be mixed with the ore when it is charged into the kiln to heat it to the proper temperature, and use the heat of the combustion-chamber only to maintain that temperature during the balance of the time occupied in oxidation. The ore should be broken into quite small pieces, and the very fine ore separated from it; otherwise it would take too long for oxidation to penetrate each piece, and the fine ore, if used, might clog the kiln. It will also be found desirable to draw the ore from the kiln as hot as possible, and cool it with a stream of water.

The rapid cooling of the surface of each piece has a tendency to burst the ore and make it still more porous. At the same time the water will assist to further oxidize the ore, and also to remove any sulphur that may remain by forming sulphureted hydrogen.

This kiln is adapted for the roasting of all ores, whether they be sulphurets, carbonates, or hydrates; for, although an oxidizing-atmosphere is not necessary for the latter, yet the carbonic acid (CO^2) and water ($H^2 O$) can be more readily and cheaply expelled by this kiln than any other known to me.

I claim—

1. The combination, with an ore-roasting kiln, of an air-downtake, A, depending centrally within the kiln-chamber, whereby the heated air will be discharged and diffused therefrom at a point above the combustion-chamber, substantially as herein set forth.

2. The combination, in an ore-roasting kiln, of a centrally-located air-downtake, A, with a centrally-located fire and combustion chamber, E, beneath said downtake and separated from it, whereby the air is delivered at a point centrally upon the crown or arch of the combustion-chamber, and diffused or turned aside uniformly into the ore-chamber.

3. The combination, in an ore-roasting kiln, of a centrally-located air-downtake, A, with a centrally-located fire and combustion chamber, E, provided with lateral and top flame and gas openings *a b*, whereby the upward-issuing flames of combustion are brought into immediate contact with the inflowing currents of heated air from the downtake, to more equally distribute both the heat and the air.

4. The air downtake A, depending centrally from near the top of the kiln, and combined with the uptake C, joining the upper end of the downtake by the branch I, and extending down outside of the kiln, whereby the cold air entering at the top is caused to descend through the entire length of the central hot pipe, as and for the purpose described.

5. The combination of two kilns B B for roasting ores with an air-downtake, A, centrally located in each, supplied by a single uptake, C, built in the dividing-wall of said kilns, substantially as herein set forth.

6. The combination, in a twin kiln for roasting ores, having centrally-located air-downtakes depending in each from or near the top, of the intermediate uptake C, having greater length and double the area of the combined downtakes, as and for the purpose set forth.

7. The combination, in a twin kiln for roasting ores, of the centrally-located fire and combustion chambers E in each, the centrally-located air-downtake A therein, and the intermediate air-uptake C, having the relation to each other and co-operating to produce the results herein stated.

In testimony that I claim the foregoing I have affixed my signature in presence of two witnesses.

WILLIAM J. TAYLOR.

Witnesses:
A. E. H. JOHNSON,
J. W. HAMILTON JOHNSON.