Specification of Edward Budd and William Morgan : furnaces for the reduction of copper and other ores."

Contributors

Budd, Edward.
Morgan, William.

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A.D. 1843 . . . . . N° 9999.

SPECIFICATION

OF

EDWARD BUDD AND WILLIAM MORGAN.

FURNACES FOR THE REDUCTION OF COPPER AND OTHER ORES.

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1855.

A.D. 1843 . . . . . N° 9999.

Furnaces for the Reduction of Copper and other Ores.

BUDD & MORGAN'S SPECIFICATION.

TO ALL TO WHOM THESE PRESENTS SHALL COME, we, EDWARD BUDD, of Haford Copper Works, near the Town of Swansea, in the County of Glamorgan, Copper Merchant, and WILLIAM MORGAN, of the same Place, Refiner of Copper, send greeting.

WHEREAS Her present most Excellent Majesty Queen Victoria, by Her Royal Letters Patent under the Great Seal of Great Britain, bearing date at Westminster, the Twenty-eighth day of December, in the seventh year of Her reign, did, for Herself, Her heirs and successors, give and grant unto us, the said Edward Budd and William Morgan, Her especial license, full power, sole privilege and authority, that we, the said Edward Budd and William Morgan, our exors, admors, and assigns, or such others as we, the said Edward Budd and William Morgan, our exors, admors, or assigns, should at any time agree with, and no others, from time to time and at all times during the term of years therein expressed, should and lawfully might make, use, exercise, and vend, within England, Wales, and the Town of Berwick-upon-Tweed, our Invention of "IMPROVEMENTS IN THE TREATING OR REDUCING OF COPPER ORES, AND IN THE CONSTRUCTION OF FURNACES FOR HEATING SUCH ORES, PART OF WHICH IMPROVEMENTS ARE APPLICABLE TO OTHER ORES;" in which said Letters Patent is contained a proviso that we, the said Edward Budd and William Morgan, or one of us, shall cause a particular description of the nature of our said Invention, and in what manner the same is to be performed, to be inrolled in Her said Majesty's High Court of Chancery within six calendar months next and immediately after the date of the said in part recited Letters Patent, as in and by the same, reference being thereunto had, will more fully and at large appear.

NOW KNOW YE, that in compliance with the said proviso, we, the said Edward Budd and William Morgan, do hereby declare that the nature of our said Invention, and the manner which the same is to be performed, are fully described and ascertained in and by the following statement thereof, reference being had to the Drawings hereunto annexed, and to the figures and letters marked thereon (that is to say):—

In order that our Invention may be fully understood, we will shortly state the means now resorted to when treating copper ore, and then describe the improvements which constitute the Invention secured by the present Letters Patent.

Copper ores for the most part consist of sulphuret of copper, combined with a large proportion of iron, various other metals in small proportions, and earthy matter in which silica generally predominates, and the processes adopted for the reduction of copper ores are adapted to the treatment of sulphurets of copper; and copper ores, consisting of copper in other states of combination, such as carbonates and oxides, are generally mixed in the furnace with sulphurets for the purpose of their reduction. Copper ores are commonly subjected to the following processes:—The ore is placed in a reverberatory furnace called a calciner, where it is exposed to the action of a moderate degree of heat, not sufficient for fusion, but sufficient for the volatilazation of a portion of the sulphur. The result of this process is, that a considerable portion of the surphur is driven off, and oxygen, derived from the atmospheric air, takes its place chiefly in combination with the iron. The next process is that of melting. This operation is performed in a reverberatory furnace, in which a great heat is applied, as is well understood. The effect of this process is, that the calcined ore being melted, the silica and other earthy matter, with the oxide of iron, form a slag, and, being lighter than the metallic part of the ore, floats on the surface, and is skimmed off by the workmen with a tool called a rabble. The metallic part is then tapped or run off either into water which granulates it, or into beds of sand forming pigs of metal. When tapped into sand, and thereby formed into pigs, the pigs are subjected to another melting, as is well understood, in a similar furnace; a surface of slag is again skimmed off, and the metal is tapped into water and granulated. We prefer, however, the plan of tapping at once into water, and granulating the metal at the first melting. The granulated metal thus obtained is subjected to a process of calcination similar to that adopted in the first instance with the ore, the result being a further liberation of sulphur, and a further combination of oxygen with the iron, and also to a certain extent with the copper; and when the process is continued for a long period, a certain portion of copper also assumes the

shape of sulphate of copper; this is produced by an oxidation of sulphur and an oxidation of copper, and a combination of the two. The metal thus calcined is melted in a similar furnace, and by a similar process to that adopted for the melting of the calcined ore, but a longer time is generally occupied in the melting. A slag is skimmed off the surface, and the metal is tapped into water or beds of sand. The melting process is repeated if the metal has not reached the requisite degree of fineness, and occasionally the calcination is repeated. When the metal has been brought to the state known in the trade as white metal or pimpled copper, it is again melted in a reverberatory furnace called a roaster, similar in construction with the melting furnaces employed in the former meltings, with this difference, that a current of cold air is generally admitted, and passed over the surface of the charge during certain periods of the melting, when it can be done without reducing the temperature too low to ensure the melting. This current of cold air is generally admitted through an aperture in the corner of the furnace or at the top, and the object of its admission is the oxidation of the remaining sulphur, and of foreign metals which may be mixed with the copper, so as to purify the copper. The sulphur goes off, and the foreign metals and earths form a slag on the surface, and are skimmed off; a portion of the copper is also oxydised in this process, and is skimmed off as part of the slag. The metal, which is very nearly pure copper, say from ninety to ninety-five per cent., is then tapped into sand and run into the shape of pigs. We have thus given a general outline of the processes adopted for the smelting of copper ores. These processes by different manufacturers differ slightly in the details, and there are variations in the processes, as are well known, when it is desired to produce copper of different qualities. The process which remains is that of refining, which is conducted in a reverberatory melting furnace of similar construction with those used in the former processes, and the object is to complete the purification of the copper, and to render it in a condition to be applied to the purposes of manufacture. In the processes usually adopted at present the atmospheric air finds its way into the calcining furnaces through the holes in the doors of the furnaces and by other openings, and enters cold into the furnace; a portion also finds its way through the fireplaces by means of the draught being too rapid to allow of the entire consumption of the air passing through over the fuel. In the roaster the air is admitted cold through the apertures before described. A considerable portion of the heat produced by the fires is therefore taken up in raising the temperature of the atmospheric air to the degree necessary for its combination with the sulphur, iron, and other metals.

The first part of our Patent consists in the use of air heated by suit-

able means before it comes over the ore under process, instead of cold air, in all the processes above mentioned, where oxidation of the charge in the furnace is desired.

The second part consists of treating copper ore in a peculiar construction of furnace, by which the air may be heated without any extra consumption of fuel, and which is attended with the advantage of preserving furnace by keeping it cool.

We will now proceed to describe the furnaces usually adopted for the processes before described. They will be better understood, and may be constructed by any competent workman accustomed to the building of copper furnaces, by reference to the accompanying Drawings.

The ore and metal calcining furnaces are of the description usually called reverberatory. They are usually from fourteen to sixteen feet square in the clear in the interior, having a fire-place at the back usually about three feet in height by five feet in breadth, opening at the upper part into the furnace over a wall of brick, which separates the fuel from the furnace, and which is about two feet six inches high from the bottom of the furnace, and about two feet wide, which is called the "bridge."

Figure 1 shews a sectional plan, and Figure 2 a sectional elevation, of a calcining furnace, shewing the mode of admitting heated air into the calcining furnace according to our Invention, which is by a number of flues, each about five inches square, at the back of the fire-place, and separated from it by a partition of fire brick about nine inches thick, having their external openings at the bottom of the brickwork, leading upward to the top of the furnace, and being carried forwards over the roof of the fire-place as far as the bridge, into which it is let down through the sides of the furnace. A flue passes through the bridge about nine inches high by four and a half wide, having two sets of openings, one set at the top of the bridge about five inches from its front surface, being each about four inches long by one inch wide, having under them other openings sloping forwards and downwards to allow of the passage into the calciner of ashes, or any solid matter coming over from the fire, and which without such precaution would fill up the flue and render it useless, the other set being situated in the inner surface of the bridge, about nine inches from the bottom of the calciner, and being each about four inches wide by three inches deep, for supplying heated air for the oxidation of the ores or metals. The object of the first-mentioned set of flues which enter at the top of the bridge is, to supply a sufficient quantity of heated atmospheric air to complete the combustion of the gases evolved from the fuel as they pass over the bridge into the furnace, on their way to the chimney or stack which

is placed on the opposite side or end of the furnace, whereby a higher temperature is obtained with the ordinary consumption of fuel, and the injurious influence of the carbonaceous gases on the calcining process is neutralized, thus allowing the heated air introduced by the other set of holes immediately above the ores or metals under process to have its full influence in effecting their oxydation. The same object may be obtained by admitting the air through two sets of flues having their external openings at the back part of the bridge, (which goes perpendicularly to the ground, and forms the back of the ash-pit,) in the ashpit, about three feet below the grate bars, which openings are about five inches square, each one set of flues having their internal openings at the top of a shield or arch of brick attached to the top of the bridge in the inner side, and extending inwards over the bottom of the furnace about fifteen inches. These openings into the furnaces are about five inches by one inch, and are situated about five inches from the front of the shield; each flue or external opening supplies air to two or more of these internal openings. To prevent the filling up of these flues by ashes or solid matter coming over from the fire-place, there is placed under each of them an inverted funnel-shaped opening through the whole depth of the shield; the other set of flues have their internal openings in the furnace, four inches wide by three inches in depth, or thereabouts, and enter the furnace on the inner surface of the bridge below the shield or arch, about nine inches above the flat bottom of the calciner, and supply heated air for the oxidation of the ores or metals. If the quantity of air admitted by the first-mentioned set of flues is greater than is required for, or is not consumed in, the combustion of the gases evolved from the fuel, of course the surplus passes into the furnace, and acts upon the ores or metals in the same way as the air admitted by the second-mentioned set of flues. Both sets of flues are conducted through the brickwork of the bridge (being separated from the fire-place by a partition of fire brick about seven inches thick) to the top of the bridge, where they enter into two separate chambers, the one of which chambers supplies heated air to the first-mentioned set of flues, which crosses the top of the bridge and the shield or arch, for the combustion of the gases evolved from the fuel, and the other supplying heated air to the second-mentioned set of flues for the oxydation of the ores or metals in the furnace, the last-mentioned set of flues simply crossing the top of the bridge, and thence descending to within nine inches of the bottom of the furnace, where they enter the furnace, both sets of chambers being at the same elevation, and both being covered with fire bricks. The quantity of air admitted is regulated by an iron or other plate suspended before the external openings in the

ash-pit, the supply of air being increased or diminished by the elevation or depression of this plate. There are various other methods through which heated air may be admitted to the furnaces through the sides of the furnaces, as well as through the bridge. The object must be in all cases to expose as large a surface of flues as possible to the action of the heat of the fire-place or furnace. In applying heated air to the roaster furnace shewn at Figures 3, 4, 5, and 6, the apparatus for the admission of the heated air consists of two or more sets of flues at the back of the fire-place, each flue or opening being about five inches square, which are carried forward over the roof of the fire-place, one set being introduced into the furnace over the bridge, and infringing on the flame and carbonaceous gases, and the other set being conducted down the side of the furnace into a flue about twenty-four inches high near the bridge, and tapering to nine inches high at its termination near the fore part of the furnace, and about six inches wide, running the whole length of the side of the furnace opposite to where the stack or chimney may be placed, and separated from the interior of the furnace by a partition of fire brick about four inches and a half thick, and having six or more apertures entering into the furnace along the side thereof, by which means a number of currents of heated air are made to pass over the surface of the metal contained in the furnace. The application of heated air has been found of great benefit in the first and second, and in all the calcination furnaces, and in the roaster furnaces, and, in fact, everywhere were oxydation of the charge is the object of the process. We have been particular in describing the exact means which we have found to answer best; but there are various other parts of the furnace through which the air might be heated. The dimensions of the flues and other parts which we have given, are those which we employ, but the dimensions may be varied. A competent workman will understand the management of a furnace, and he will regulate the quantity of heated air admitted, and the time of admission, according to the heat of the furnace, which, as heretofore, when admitting cold air, must depend on the judgment of the workman. If the heat of the furnace is sufficient to allow it, we believe that the more air he admits from the beginning to the end of the process, the better and quicker will the operations be performed. It will readily be understood, that the above furnaces, with the use of heated air, are applicabe for the calcining of zinc ore or black jack, and to all ores of whatever description which require to be subjected to the process of roasting or calcining; and a workman acquainted with the necessary treatment of black jack or other ores, will readily calcine the same in such furnaces.

Another, the third part of our Invention, consists of a novel construction of calcining furnace. The nature of the calcining furnaces at present generally adopted has been explained above. Our novel construction of calcining furnace, shewn at Figures 7, 8, 9, 10, and 11, consists of a double furnace, both being heated by the same fire. The fire-place opens into the upper chamber or furnace; the flame, passing over the bridge as in the ordinary calcining furnace before described, enters into and passes through the said upper chamber or furnace, and conveying itself through four openings made in the front part of the furnace, enters the lower chamber or furnace, and passes backwards in the direction of the fire-place to two flues situated under the bridge of the upper calciner, and which are connected with a stack or chimney at the back of the fire-place; by this means the draught passes over the surface of the charge contained in both chambers or furnaces. The bottom of the lower calcining furnace is similar to that of calcining furnaces of the ordinary construction. The flat bottom of the upper chamber or furnace rests on two arches, supported in the centre by a wall about two feet in height, running the whole length of the furnace from the bridge to the front, and resting upon the lower bottom, and having in it a series of arched openings to give the workman the command with the rabble of the whole of the bottom from one side of the calciner. The bottom of the upper chamber or furnace is pierced with thirty-six holes, to allow of the withdrawal of the surfaces of the charge from time to time into the lower chamber when these surfaces have been calcined to a sufficient extent in the upper chamber. The charge thus withdrawn is allowed to remain in the lower chamber in the shape in which it falls through the holes or openings, that is, in a sort of cone under each opening; successive portions of the charge are withdrawn from the upper chamber with the ordinary rabble in this manner until the whole of the charge is deposited in the lower chamber, when a fresh charge is placed in the upper chamber in the ordinary manner. The calcined ore or metal is allowed to remain and accumulate in the lower chamber until the quantity becomes inconvenient, when it is withdrawn as in the ordinary calciner. The holes in the bottom of the upper chamber, through which the charge is withdrawn into the lower chamber, are about six inches square, and are closed by twelve dampers working into grooves formed in the bottom, six being on each side of the furnace. These dampers are made of two bars of wrought iron, placed six inches apart, and joined by welding at the top and bottom, on which are rivetted three plates of iron one-fourth of an inch thick and seven inches square, so fixed as to come immediately under the holes when the damper is pushed into the groove. By withdrawing the damper

seven inches, the three holes are at once opened. The advantage of this calcining furnace is, that by means of its two chambers it exposes a larger surface of metal or ore to the action of the air and fire than can be obtained in the ordinary calcining furnace, and for a longer period, thus ensuring a more perfect and more rapid oxydation of the charge, and tending to create a greater or lesser of sulphate of copper, which is an advantage in the subsequent process of melting. The heated air can be applied to it by the means already described, merely making such changes in the position and direction of the flues as the peculiar construction of the furnace renders necessary, and heated air may be applied with advantage to both chambers.

Another, the fourth part of our Invention, consists of a new mode of constructing the bottoms of copper melting and roasting furnaces, as shown at Figures 3, 4, and 5. The mode of forming the bottoms of these furnaces heretofore and at present adopted is to build a foundation arch of brick or other suitable material running longitudinally underneath the furnace; a flat platform of masonry is then made on this arch of the size of the interior of the furnace, and on this platform is placed a layer of sand of about a foot in thickness, which, after being properly calcined, is melted and set, after which a second layer of sand about three inches in thickness is added, and is treated in a similar way, when again a third layer of about five inches in thickness is added and melted, making altogether a thickness of twenty inches of sand. The sand employed is the common silicious sea sand, but should be free from salt water. From want of a proper means of cooling the under part of this mass of melted sand, and the consequent intense heat produced at a great depth below the surface, these sand bottoms have always been found to abstract and absorb a very large quantity of copper metal from the charges treated in the furnaces, and considerable expence is incurred in breaking up these bottoms when the furnace has become worn out, and a considerable amount of capital is uselessly and unproductively occupied. To remedy this evil the plan we have adopted is to excavate under the whole area of the furnace to the depth of four to five feet; around the sides of this excavation a wall is raised about five feet high, on which a number of plates of iron cast in the form of the interior of the furnace, and about one inch in thickness, are placed across the excavation, and are supported by pillars of brickwork, two being placed under each plate. The joints between the plates are closed, either with clay or by having thin strips of sheet iron placed over them, to prevent the sand which is afterwards placed on the plates from running through. A layer of sand of about fifteen inches in thickness is placed on the iron plate, and is calcined and melted in the ordinary manner; to this layer another of about five inches

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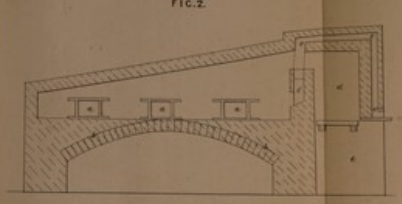
BUDD & MORGAN'S SPECIFICATION.

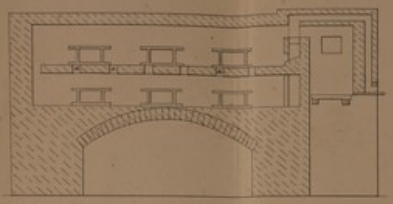
Longitudinal Section of Calcining Furnace with flues for the admission of heated air.

FIG. 2.



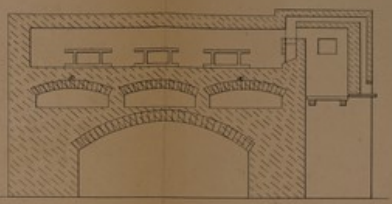
Longitudinal Section of Improved Calcining furnace with an upper and lower Chamber for the ore.

FIG. 7.



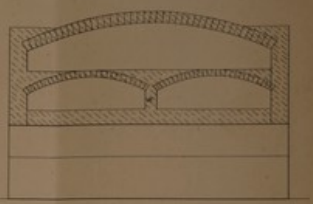
Longitudinal Section of Improved Calcining Furnace Showing the Arches in the partition wall x of the lower Chamber.

FIG. 9.



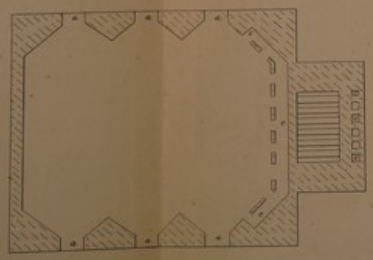
Transverse Section of Improved Calcining Furnace showing the Arches which support the floor of the upper Chamber.

FIG. 11.



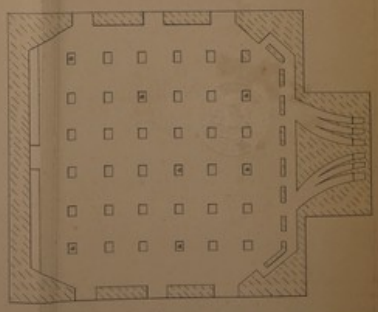
Sectional Plan of Calcining Furnace.

FIG. 1.



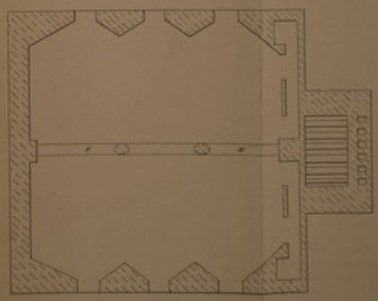
Sectional Plan of Improved Calcining Furnace Showing the floor of the upper Chamber.

FIG. 8.



Sectional Plan of Improved Calcining Furnace Showing the floor of the lower Chamber.

FIG. 10.



a. a. Doors through which the workman stirs the charge.
b. b. Arch which supports the furnace.
c. c. Flue entering at the back of the fire place for supplying the heated air.
d. Fire place.
e. Ash pit.

Reference to Figs. 7. 8. 9. 10 & 11.

a. a. Holes in the floor of the upper Chamber through which the ore or metal is drawn into the lower Chamber.

Note. The fire places and apparatus for heating the air in this furnace are managed in the same manner as in the roasting and common calcining furnace.

The enrolled drawing is colored.

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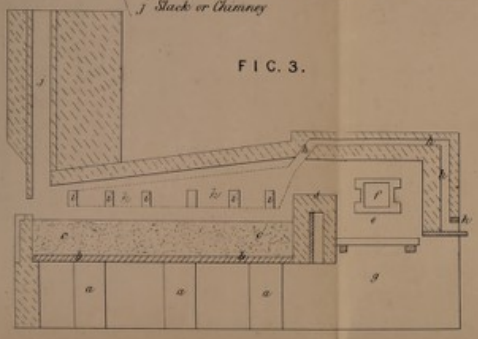
BUDD & MORGAN'S Specification.

Longitudinal Section of Roasting and Melting Furnace

Reference to Figs. 3. 4. 5 & 6

a. a. Pillars supporting the iron beams.
b. Cast iron bottom.
c. Sand Bottom formed thereon.
d. Bridge having concave plate and air hole within it.
e. Fire place.
f. Door for feeding the fire.
g. Ash pit.
h. Section of Flue for admission of air which passes along the side of Furnace.
i. Apperture opening from hot air Flue into Furnace.
j. Stack or Chimney.

FIG. 3.



Transverse Section

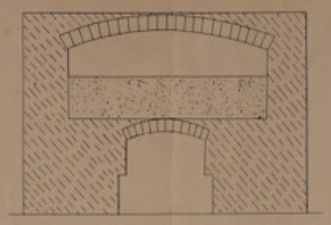
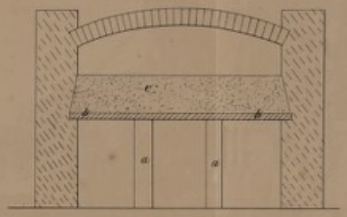
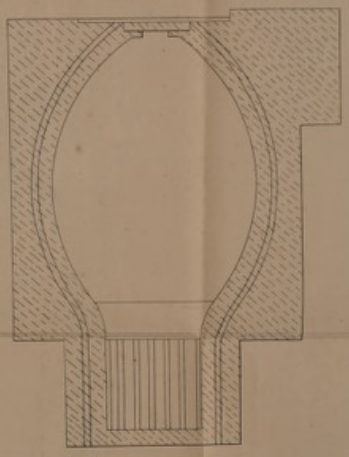


FIG. 5.

Transverse Section of Roasting and Melting Furnace

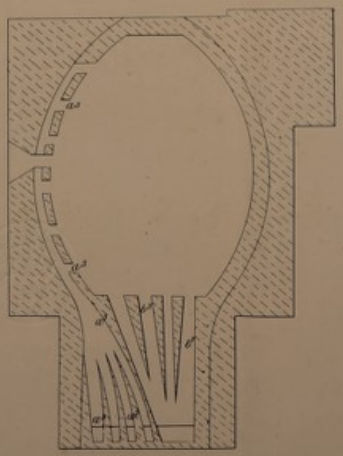


These Figures show two views of the Roasting and Melting Furnace now generally used.

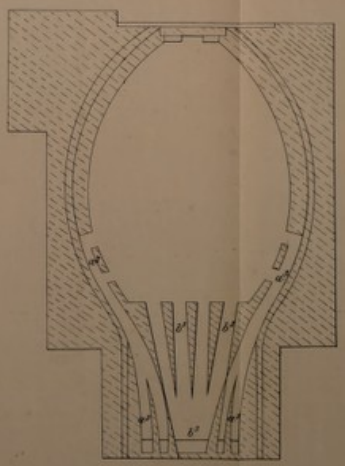


Sectional Plan of Roasting & Melting Furnace showing the mode in which the air is heated & enters the Flues.

FIG. 6.

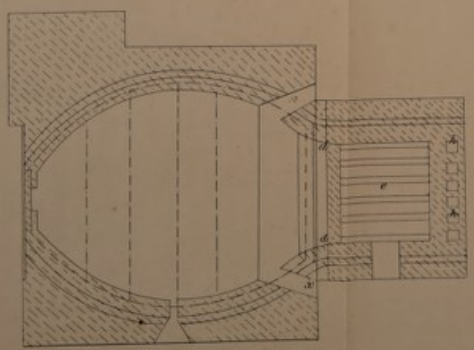


This figure shows the Plan of a Furnace similar to that shewn at Figs 3. 4. 5 & 6 except that the air is admitted into the Furnace on both sides & that there is no plug hole.



Sectional Plan of Roasting & Melting Furnace the dotted red lines shewing the iron plates which form the bottom.

FIG. 4.



x x Appertures for the admission of cold air to be used only when roasting.

a². *a.²* Flues by which the air is admitted at the back of the fire place & passes into the Furnace through the appertures at the side

b². *b.²* Flues by which the air is admitted & brought into contact with the flame of the fire place.

The enrolled drawing is colored

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is added, and is similarly treated, when the bottom is complete, and the furnace is ready for the first small charge of copper or metal, which is usually given to season the bottom. To keep the iron plates constantly cool, a flue communicating with the excavation under the furnace passes up the solid mass of masonry in the front corner of the furnace opposite the stack through which the rarefied air passes with great rapidity from beneath, by which means a current of cold air is constantly brought in contact with the external surface of the iron plates on which the bottom is supported. From the iron plates being thus kept constantly at a moderate temperature, the sand bottom placed on it absorbs only a very trifling quantity of the copper or copper metal composing the charge in the furnace, as it (the copper or metal) is cooled and solidified before it can reach the iron plates. The saving thereby occasioned in interest of capital and expence of breaking up the bottoms of furnaces is very great.

Having thus described the nature of our Invention, we would remark that we do not confine ourselves to the precise details herein described, so long as the peculiar character of either part of our Invention be retained; and we are aware that reverberatory furnaces suitable for other manufactures than copper have had heated air introduced at the bridges and other parts thereof; and we mention this circumstance in order to state that we do not claim the introduction of heated air into reverberatory furnaces generally, nor do we claim the so-constructing reverberatory furnaces as to heat air before passing into the same when uncombined with the process of oxydising copper ore or zinc ore; and we are also aware that reverberatory furnaces have before been made with cast iron bottoms when used in other processes than that of melting copper; and we are informed that a small experimental furnace for melting copper was, before the date of our Patent, made and used with an iron bottom, but without any provision for cooling the said iron bottom, which would be inapplicable to large furnaces used for practical purposes; and we mention these in order to say that we do not claim the use of iron bottoms to furnaces unless combined with the melting of copper, and so arranged as to allow of air or other fluid passing below to cool the same. And we would wish it to be understood that what we claim is,—

First, the application of air heated before it enters the furnace where copper or zinc ore is being calcined, or copper or copper metal is being roasted, by passing air near to or in contact with suitably arranged heated flues or ways.

Secondly, we claim calcining of copper or zinc ore and the roasting of copper or copper metal in reverberatory furnaces, so arranged as to have air introduced and heated by flues formed in the bridge, sides, or other parts of the furnace.

Thirdly, we claim the mode of constructing a calcining furnace whereby the same is divided into two compartments, the upper one being heated directly by the fire, and the lower one being heated by the heated products passing from the upper to the lower compartment.

And, fourthly, we claim the mode of constructing the bottoms of copper melting and roasting furnaces known as ore furnaces, metal furnaces, and roasters, in such manner that the under surfaces may be kept cool by air or other fluid.

In witness whereof, we, the said Edward Budd and William Morgan, have hereunto set our hands and seals, the Twenty-sixth day of June, in the year of our Lord One thousand eight hundred and forty-four.

EDWARD (L.S.) BUDD.
WILLIAM (L.S.) MORGAN.

Signed, sealed, and delivered by the within-named William Morgan, in the presence of

J. TREV. JENKIN, Sol^r,
Swansea.

JENKIN, Extra.

AND BE IT REMEMBERED, that on the Twenty-sixth day of June, in the year of our Lord 1844, the aforesaid William Morgan came before our said Lady the Queen in Her Chancery, and acknowledged the Specification aforesaid, and all and everything therein contained and specified, in form above written.

RICHARDS.

AND ALSO BE IT REMEMBERED, that on the Twenty-seventh day of June, in the year of our Lord 1844, the aforesaid Edward Budd came before our said Lady the Queen in Her Chancery, and acknowledged the Specification aforesaid, and all and everything therein contained and specified, in form above written. And also the Specification aforesaid was stamped according to the tenor of the Statute made for that purpose.

Enrolled the Twenty-eighth day of June, in the year of our Lord One thousand eight hundred and forty-four.

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