

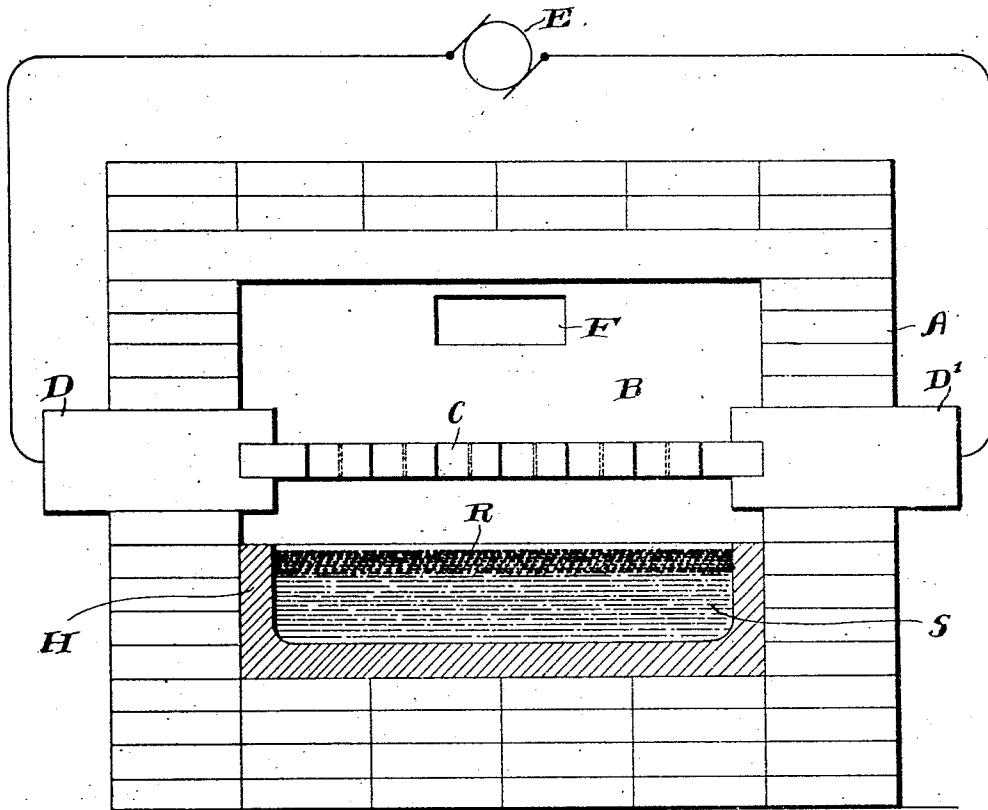
J. THOMSON.

METHOD OF ELIMINATING CARBON DIOXID AND OXYGEN IN ELECTRIC SMELTING FURNACES.

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1,308,879.

Patented July 8, 1919.



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METHOD OF ELIMINATING CARBON DIOXID AND OXYGEN IN ELECTRIC SMELTING-FURNACES.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, JOHN THOMSON, a citizen of the United States, and a resident of the borough of Manhattan, city of New York, County and State of New York, have invented certain new and useful Improvements in Methods of Eliminating Carbon Dioxid and Oxygen in Electric Smelting-Furnaces, of which the following is a specification, reference being made to the accompanying drawing, forming a part thereof.

This invention relates to metallurgy and more particularly to the use of electric furnaces for smelting or distilling zinc ores or concentrates thereof.

The single figure of the drawing is a sectional view of a furnace as when fully charged; and is a semi-diagrammatic illustration which is employed to show a preferred manner of carrying the method into useful effect rather than to denote precise details of construction.

The type of electric furnace required to utilize this method is one in which a carbon thermal element—such as a resistor or an arc—imparts its heat by radiation to an underlying charge.

In essence, the furnace, as here depicted, is comprised in a brick casing, A, having a chamber, B, with a zig-zag resistor, C, interpolated between and suspended by suitable terminals, as D, D', energized from a source of power, as E.

If, for example, the furnace is to be used for smelting roasted zinc concentrates, according to the classical formula $ZnO + C = Zn + CO$, the zinc being distilled in the form of fume, then the resistor-chamber would needs be provided with a throat, as F, leading to a suitable means for condensation, not deemed necessary of being here illustrated. So, too, an open retort H, disposed beneath the resistor, would be necessary, which contains the charge; and this retort, when exhausted, is preferably capable of being removed and substituted by a duplicate re-charged member.

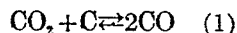
One of the gravest difficulties met with in zinc-smelting is the presence of CO_2 ; which has the pernicious effect of forming ZnO , or "blue-powder", or a combination of both, and to the extent thereof, whatever it may be, minimizing the quantity of zinc that may be condensed in the form of liquid metal. Another grave difficulty resulting from the

presence of CO_2 in electric furnaces is its attack on such portions thereof as may best be made from amorphous or graphitized carbon.

The foregoing controlling objections are obviated by the practice of this method; which consists in placing upon the top of the charge, preferably prior to its insertion in the furnace, a distinct and relatively thin layer of broken or granular carbon and maintaining it at a temperature of about or above $1,100^\circ C$.

In view of the state of the art, it may seem like a supererogative statement that the use of carbon for the elimination of CO_2 in the presence of zinc-fume has hitherto been proposed; but in such instances, or as have been shown in patents issued to others as well as the present applicant, the carbon has been employed as a curtain or porous septum in, or at, or near to, the condenser.

It should be borne in mind that in dealing with zinc-fume and the gases of carbon the following reversible reaction takes place:



At the smelting temperature, the reaction is from left to right, that is in the presence of carbon any CO_2 which may be present combines with the carbon to form CO and at about or between 1,000 to 1,100 degrees centigrade the gas will be altogether CO ; but if the temperature falls therefrom the reaction is reversed, forming CO_2 , and at the lower ranges of temperature the procedure will be according to this equation:



The consequence is that it is nearly always difficult if not impracticable to maintain carbon at such a temperature, when in or contiguous to the condenser, as will be adequate to produce the desired result. In fact it has variously been proposed to separately heat such carbon-screens; which, while effective as to the elimination of the pernicious gas, has the contingent objectionable result of super-heating the zinc-fume immediately prior to its entry into the condenser.

Moreover, CO_2 is generated at a much lower temperature than CO , or at the latter's initial temperature of active reaction with ZnO , wherefore the furnace chamber and the condenser become more or less pre-filled with an oxidizing atmosphere.

These difficulties and objections are wholly obviated, in a practical sense, by the simple expedient of applying directly upon the top of the charge S a relatively thin layer of granular carbon R. This top dressing of carbon is virtually a filter-bed, through which all of the ascending volatilized fume, vapor or gases generated in and ascending from the charge must percolate.

When feasible to do so, the filter-carbon should preferably be pre-heated; consequently, when the charged retort is placed in the furnace, the resistor, or whatever substitute therefor may be used, quickly raises the temperature of this carbon to a state of incipient incandescence both before CO_2 is evolved and also before the reaction begins. Hence, from start to finish, the filter-carbon will be uniformly maintained at a higher temperature than that of the charge.

The calories imparted to the filter-carbon are not lost in that they are transferred by conduction to the charge.

As the reaction proceeds and the depth of the charge diminishes, the filter-carbon follows down whereby it continues to most effectively "trap" CO_2 , irrespective of when it may be developed, and convert it into CO. And the same observations apply to such oxygen as may be entrained or combined in the charge. Then, as the zinc-fume mingles only with perfectly "clean" CO, the gases may be progressively cooled as they flow toward the condenser whereat all of the zinc can be condensed to liquid metal. Moreover, in these circumstances, such portions of the furnace as may best be constructed of carboniferous materials are completely immune from destructive attack and will endure indefinitely.

It is true that, when the reaction begins, a certain minimum amount of the filter-carbon, in direct contact with the charge, is lost by reduction; but this consumption ceases when a thin interposed layer of residuum is produced and the only further diminution will be that due to the reaction with up-flowing CO_2 , or O, or hydrous vapors.

Nor does the addition of this filter-carbon involve extra expense; for it thus becomes feasible to at least correspondingly diminish the amount of reaction-carbon mixed with the concentrate. Or, to otherwise state the case, instead of having an excess of carbon mixed with the ZnO, serving to increase the production of CO_2 , it is placed upon the top of the charge where it acts to convert the pernicious gas into one that is benign.

While the within described mode of applying the filter-carbon to an ore charge is regarded as preferable, such need not necessarily be adhered to; as, for example, it may be stoked-in, through openings in the furnace-walls, or be sifted-in through tubes or

ports in the cover or roof. Nor need the employment of this method be restricted to the $\text{ZnO}+\text{C}$ reaction, in that a layer of filter-carbon may be advantageously utilized on a charge of ZnS when reduced by a metallic reagent; but, in such instance, the principal function of the carbon would be to protect the resistor from "air-burning", due to the liberation of oxygen from the gangue.

What I claim is:

1. In an electric smelting furnace provided with a thermal element formed of carbon whose energy is radiated to an underlying charge, the method of protecting the said thermal element from the erosive attack of CO_2 and O, or either of them, which consists in covering the said charge with a layer of filter-carbon and maintaining it at a temperature of about or above eleven hundred degrees centigrade.

2. In an electric smelting furnace provided with a carbon thermal element whose heat is transmitted by radiation to an underlying reacting charge composed of $\text{ZnO}+\text{C}$, the method of converting, at the source of generation, CO_2 into CO which consists in covering the said charge with a layer of filter-carbon and maintaining it at a temperature of about or above eleven hundred degrees centigrade.

3. In an electric smelting furnace provided with a carbon thermal element whose heat is transmitted by radiation to an underlying charge in which CO_2 and O, or either of them, may be evolved and whose presence would be pernicious, the method of converting them into benign gases which consists in covering the charge with a layer of filter-carbon and maintaining it at a temperature of about or above eleven hundred degrees centigrade.

4. In an electric smelting furnace provided with a carbon thermal element whose heat is transmitted by radiation to an underlying charge in which CO_2 and O, or either of them, may be evolved with pernicious effect, the method of rendering the said gases non-oxidizable which consists in applying to the top of the charge, prior to its introduction in the furnace, a layer of filter-carbon which is thereafter acted upon by the thermal element and maintained at a temperature higher than the charge.

5. In the treating of metals in a furnace having an electrical thermal element, the method which comprises employing the thermal element to heat the metal sufficiently to drive off fume of the metal and protecting the thermal element against the action of gases such as CO_2 or O, passing off or mixed with the fume, by filter-carbon located between the metal being treated and the thermal element.

6. In the treating of metal in an electric

furnace having a thermal element comprising carbon as an essential part thereof, the method which comprises employing the thermal element to heat a charge of the metal sufficiently to drive off metal fume and protecting the thermal element against the action of CO_2 or O by a layer of filter-carbon which is on said charge, said layer of filter-carbon being located so that the heat sup-

plied from the thermal element to the metal to be converted into fume must pass through said layer.

This specification signed and witnessed this 13th day of September, A. D. 1918.

JOHN THOMSON.

Signed in the presence of—

RALPH M. THOMSON,

H. O. WEED.