

# UNITED STATES PATENT OFFICE.

CHARLES V. THIERRY, OF PARIS, FRANCE.

## METALLURGY OF ZINC.

1,030,349.

Specification of Letters Patent.

Patented June 25, 1912.

No Drawing.

Application filed October 6, 1911. Serial No. 653,248.

*To all whom it may concern:*

Be it known that I, CHARLES V. THIERRY, a citizen of the Republic of France, and a resident of the city of Paris, in said Republic of France, have invented certain new and useful Improvements in the Metallurgy of Zinc, of which the following is a specification.

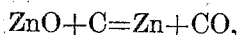
This invention relates to the metallurgy of zinc and has for its object the utilization of certain materials, appropriately proportioned, acted upon by electrically produced heat, whereby in a practical sense, all of the charged materials will be evolved and pass from the reaction chamber in the form of fumes, gases or vapors.

Many efforts have been made to substitute the electrical furnace for the old extraneously fuel-fired retort system. Several of these efforts have been more or less successful; but it is a fact, well known to those skilled in the art, that whatever may have been the ore and the reagent employed it has usually been necessary to fluidify the residue (which generally requires the addition of a flux for the gangues) in order to withdraw it from the reaction chamber. Such residues and slags require special refractory material to resist attack and erosion resulting in interruptions of the work and expensive renewals. Moreover, steam, carbonic acid, sulfurous acid, etc., are generally given off with harmful effects to one or more of the various materials employed, or to phases of the operation as for instance, the condensing portion of the process.

Pure oxid of zinc is a substance usually in the form of powder containing 80.34 parts of zinc and 19.66 parts of oxygen by weight, chemically combined, but commercial oxid of zinc also contains certain impurities, the nature and proportion of which depend upon the method by which the oxid of zinc has been artificially produced.

The basis of this process is the treatment of ordinary commercial zinc oxid, namely an oxid which as above set forth is not chemically pure or even of a high degree of purity.

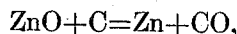
It is particularly observed that the symbolic formula of the classical reaction,



only represents an abstract theoretical process; as a matter of fact, in practice, ore and coke or coal of variable constituent elements

are employed instead of, strictly pure oxid of zinc and carbon. Theoretically the products resulting from the reactions (according to the formula) should be only in vapor form, that is gaseous products. But in the practical realization hitherto (using ore and coke or coal) one obtains in addition to the fumes and gases a residue which may be more or less solid, sticky, pasty or liquid and which may also be impregnated with gaseous impurities and unevolved portions of the metals in the ore.

My invention consists in charging, intermittently or continuously, a suitable electric furnace with ordinary commercial or commercial oxid of zinc and with carbon in the form of coal or coke, as for instance in the actual proportions corresponding to the theoretical formula,



whereby the contents of the furnace chamber react equally one on the other and the two products of the reaction (Zn and CO) pass off automatically as and when and at the rate produced, and in a gaseous form. As a consequence of this there is no residue and the operation may be carried on practically continuously and indefinitely. Incidentally, the reaction may proceed with all the rapidity with which heat units can be furnished and the metallic reduction is essentially complete and changed to a form in which the products resulting therefrom are easily recoverable. In other words, the ideal conditions for the utilization of the electric furnace are thus realized for the recovery of the metals in the materials treated.

To obtain absolutely perfect results would require the employment of a chemically pure oxid of zinc and carbon. But such is not essential, nor practically nor commercially realizable. Moreover the degree of commercial purity which is readily obtainable in current practice yields entirely satisfactory results. Water, hydro-carbons, carbonic acid and other impurities capable of being vaporized can be removed by a preliminary heating; hence, the remaining impurities then contained in oxid of zinc and carbon, as ordinarily obtainable generally and practically consist of sulfur, silica, lime, ash and similar products less easily vaporized and eliminated; but these elements are in amounts which are negligible, and they do

not sensibly interfere with the new technical effects already stated. At the most, it may be necessary to manually remove from the reaction chamber such sintered ash-slag as  
 5 may have accumulated from a run of long duration, that is, of weeks or even months. The removal of the sintered slag can therefore be made at a time when the process is not being carried out.

10 The employment of, in the commercial sense, "pure" oxid of zinc and carbon, in approximately the exact proportions necessary to produce a complete chemical reaction when thermally acted upon, effects  
 15 several advantages of controlling importance. For example the mass of the charge is a minimum, and correspondingly so is the quantity of electrical energy required; the condensation of zinc fumes to the metallic  
 20 state is much simplified, in that there is a less volume of pernicious gases to be dealt with; moreover the absence of residue permits the use of a more uniform and a lower temperature than would otherwise be possible. In  
 25 fact, these conditions make it possible to use ordinary fire-bricks for the furnace avoiding the necessary employment of tamped furnace chamber linings and various combinations of expensive refractories, such as magnesia, silica, chrome, carborundum,  
 30 etc.

Should oxid of lead, or oxid of cadmium, be contained in the oxid of zinc, it matters little since these oxids are also reduced by  
 35 the carbon. In such instances, the cadmium passes off in the form of a vapor; but the lead may be partially or wholly distilled or partially retained as liquid metal on the furnace hearth, from whence it can readily  
 40 be tapped off.

While it is not essential that the charge of oxid of zinc and carbon shall be intimately mixed, this is nevertheless deemed preferable; as also, while not essential it  
 45 is preferable that the carbon be crushed so as to pass through a rather fine mesh screen. However it is quite feasible to feed the oxid and the carbon separately to the furnace, say in layers, and the oxid, especially may  
 50 be considerably preheated before being reacted upon in the electric furnace, thereby minimizing the amount of electric energy required for producing the reaction.

It goes without saying that the zinc  
 55 vapors may be condensed or precipitated to the form of metal or in the form of "blue powder" or, even, to a very refined oxid of zinc, which in any of the instances mentioned presupposes the use of appropriate  
 60 means, even as in the ordinary manner hitherto employed.

The realization of this method while confined to an electric furnace is not limited to any particular type of such furnace. This  
 65 may be constructed according to the register,

to the induction, to the arc, or to a combination of the resistor and of the arc principles. But, up to the present time, preference is accorded to electric furnaces in which the  
 resistance system of heat development is  
 70 employed. Suffice to say, in this connection, that the temperature of the furnace should be capable of complete control and the construction such as to exclude air from the interior of the charge.

75 I am aware that oxid of zinc has been employed in the classical fuel-fired retort process, carbon being the reagent; but the purpose thereof has been for the partial enrichment of natural ores or concentrates.  
 80

In the new process in which the electric furnace is utilized, large charges may be acted upon and the heat units pass directly without intervening obstruction, into the material, whereas in the old process the  
 85 calories must be forced through the walls of retorts and also through and to the center of the contained charge. Heretofore, the universal practice among zinc smelters has been to add a considerable excess of carbon  
 90 that is more than is necessary to liberate or displace the zinc in the ore. Then in using the prior classical process there is the necessity for roasting sulfid ores; which, in practice, cannot be carried far enough to  
 95 entirely eliminate the sulfur, entailing losses in the reduction and other difficulties in conducting the operations. Hence under the old processes the reaction is long, irregular and incomplete; and a large excess of pernicious gases is evolved which greatly increases the difficulty of condensation.  
 100

The condensation of zinc vapors into metallic zinc, upon a commercial scale, is one of the most delicate and perplexing problems known to metallurgy, and the rapidity and completeness with which this can be done largely constitutes the limiting factor as to the capacity of the electric furnace unit. This problem has been solved by my  
 110 process, and by my process there is produced a product containing zinc vapors which can be delivered to a condenser (whatever its type or detail) with a minimum quantity of entrained gases.  
 115

The production, primarily, of oxid of zinc of ordinary commercial quality is simple and comparatively inexpensive, either by fuel-fired or electric furnaces, according to circumstances. Therefore the method here-  
 120 in disclosed permits of the utilization of blends of complex ores (oxids or sulfids) without mechanical concentration, and of slimes and ore-dumps which have hitherto been regarded as practically valueless.  
 125 Moreover the use of this system does not require high-class labor.

What I claim as my invention is:—

1. In metallurgy, the method which consists in reducing, by electrically developed  
 130

heat, a commercially pure metallic oxid mixed with a commercially pure carbon in such relative proportions that the reaction will completely convert them into the forms of fumes, gases, vapors and an ashy or sintered residue, the volatilized substances continuously escaping as and when produced.

2. In metallurgy, the method which consists of maintaining in an electric furnace, from which air is excluded from the reducing zone, a composite charge composed of commercial metallic oxids and carbon, the said elements being electrically heated and the nature of the oxid being such that, when subjected to an adequate temperature in the presence of carbon, it will volatilize; the oxid and the carbon being charged in such relative proportions that the reaction will convert the entire charge to the forms of fumes, gases, vapors and a relatively small proportion of ashy or sintered residue, said volatilized products continuously escaping from the reaction chamber as and when produced.

3. In metallurgy, the method of reducing commercially pure zinc oxid which consists in heating the same, mixed with a commercially pure carbonaceous material, in an electric furnace from whose reducing zone air is excluded, the materials being in such proportions as will effect, when heated to or above the temperature of reaction, their complete conversion into fumes, gases, vapors, and an inert ashy or sintered residue, the volatilized products being continuously evacuated as and when produced.

4. In metallurgy, the method of reducing

commercial zinc oxid which consists in heating the same, mixed with commercially pure coke or coal, in an electric furnace from whose reducing zone air is excluded, the materials being in such proportions as will effect, when heated to or above the temperature of reaction, their complete conversion into fumes, gases, vapors and an inert ashy or sintered residue, the volatilized products being continuously evacuated as and when produced.

5. In the metallurgy of zinc the method which is comprised in progressively charging an electric furnace with oxid of zinc of commercial purity and carbon and heating the mixture of said oxid and carbon in the furnace to produce zinc fumes and withdrawing zinc fumes as and when produced, the carbon and oxid of zinc being in such proportion that substantially the entire charge will be changed into gaseous form.

6. In the metallurgy of zinc the method which is comprised in progressively charging an electric furnace with oxid of zinc of commercial purity and carbon and continuously heating the mixture of said oxid and carbon in the furnace to continuously produce zinc fumes and withdrawing zinc fumes as and when produced, the carbon and oxid of zinc being in such proportion that substantially the entire charge will be changed into gaseous form.

This specification signed and witnessed this 12th day of September A. D., 1911.

CHARLES V. THIERRY.

Signed in the presence of—

CLAUDIUS LUSSEN,

H. C. COXE.