

UNITED STATES PATENT OFFICE.

PARKER C. CHOATE, OF NEW YORK, N. Y., ASSIGNOR TO THE ELECTRICAL ZINC COMPANY, OF NEW JERSEY.

ART OF PRODUCING METALLIC ZINC.

SPECIFICATION forming part of Letters Patent No. 512,361, dated January 9, 1894.

Application filed January 21, 1892, Serial No. 418,865. (No specimens.)

To all whom it may concern:

Be it known that I, PARKER C. CHOATE, a citizen of the United States, residing in the city of New York, in the county and State of New York, have invented certain new and useful Improvements in the Art of Producing Metallic Zinc, (Case No. 5,) of which the following is a specification.

My invention relates generally to the production of metallic zinc from its ores and the object of my improvements is to provide an electrolytic solution of zinc from which a commercially pure metallic zinc may be obtained by means of electrolysis.

While in my process any of the ores of zinc may be utilized in preparing such a solution, it is more especially valuable when employed in connection with that large class of ores known as "blendous" or "complex" which contain besides zinc numerous other metals such as gold, silver, iron, lead, arsenic, antimony, bismuth, cadmium, &c., in varying proportions, and which, on account of the difficulty of working them economically have heretofore been discarded at the mines in great quantities as waste products. In working such ores for the extraction of metals other than zinc as heretofore practiced there has been a loss of the zinc except when utilized as a pigment, and at the same time its presence causes heavy losses of the other metals of value such as gold, silver, &c. Although in many cases these ores are very rich in zinc, which is often the most valuable constituent, all attempts to treat them for the extraction of that metal commercially have failed even at the expense of the sacrifice of the other constituents of value. Thus the ordinary method of producing metallic zinc from the ore by distillation is entirely inapplicable to these "complex" ores, since so many other metals are distilled with the zinc and enter as impurities into the metallic product that it is entirely unfit for the commercial uses to which metallic zinc is applied. Although numerous attempts have been made to that end no method has been heretofore devised by means of which it has been possible to continuously produce pure metallic zinc on a profitable commercial scale, by electrolytic deposition.

The difficulty in utilizing electrolysis as a means of producing pure metallic zinc is primarily due to the fact that zinc is electro-positive to many of the metals which are present with it in the ore and so much so that it will deposit upon itself or precipitate most of these metals from an acid solution in which they are present. Consequently if such metals are allowed to be present in the bath in solution with the zinc they will be deposited with it and appear as impurities in the product. It is evident therefore that before the deposition of pure zinc from an electrolytic solution can be begun the solution must be free from all those substances which would be deposited before or along with the zinc.

Attempts have heretofore been made to purify impure solutions of zinc by removing the metals other than zinc therefrom by the use of chemical precipitants. The precipitation of other metals from a solution in which they are present with zinc, so as to obtain a pure solution of zinc is, however, extremely difficult, even as a laboratory experiment, and has proven utterly impracticable on a commercial scale.

While it might appear that an impure solution of zinc could be readily brought to the requisite degree of purity, at the expense of the loss of a small quantity of impure zinc, by passing an electric current through the solution, until all the depositable impurities were deposited out, this is not in fact the case, since in depositing zinc and other metals from solutions of their salts, free acid quickly appears in the bath through the action of the current upon the solution, which, unless neutralized or annulled, re-dissolves the deposited metals from the cathode as fast as they are deposited thereon thus keeping a percentage of them always in the solution. This difficulty cannot be obviated by annulling the free acid with the zinc ores since in so doing the impurities contained in the ore would continually enter the solution taking the place of those deposited or precipitated out by the current. By my invention I overcome all these difficulties and produce an electrolytic solution of zinc free from depositable impurities, using the electric current as the purifying agent since the condition in which I take

the zinc wherewith to neutralize the acid set free in the bath during the process of purification enables me to do so without introducing additional soluble impurities into the bath.

From the point of view of my process only those substances which would enter into solution with the zinc in a zinc electrolyte and be deposited therefrom before or along with the zinc by the electric current under the conditions used, are regarded as impurities. To the end therefore of obtaining a commercially pure metallic zinc my invention consists in producing a pure electrolytic solution of zinc by passing an electric current through an impure solution of zinc salts to deposit and precipitate out the depositable impurities and neutralizing the free acid liberated in the bath with an oxidized zinc fume freed from its soluble depositable impurities.

Any usual or suitable mode may be adopted for obtaining the zinc oxide to be used in my process. As an example of one well known method, the ore may be first crushed and then when it contains an excess of sulphur, it may be roasted at a moderate temperature not sufficiently high to volatilize the zinc in order to drive off the excess of sulphur. The partially desulphurized ore may then be mixed with carbonaceous fuel, such as coal screenings, and roasted in a furnace into which air is admitted beneath its grate at a temperature high enough to volatilize the zinc until the zinc contained in the ore is driven off. The volatilized zinc and other volatilized bodies may then be caught and collected in a bag room in the ordinary manner. The resulting product will be substantially pure oxide of zinc in the shape of a fine powder known as "fume" mixed with such lead as was contained in the ore and which is volatilized with the zinc. There may also frequently occur with the zinc and lead fume, as condensed products, other volatilizable oxides which may have been present in the ore in their metallic form such as the oxides of antimony, arsenic, bismuth, cadmium, &c. These substances are all volatilizable at a lower temperature than zinc and lead. Hence when they occur in appreciable quantities I dispose of them by subjecting the fume to a moderate roast at a temperature of from 500° to 800° Fahrenheit in any well known form of muffle furnace, thereby driving them off, care being taken not to apply sufficient heat to revolatilize any of the zinc or lead contents. By means of this roast the fume is purified from its more volatile constituents, thereby easily eliminating all those soluble depositable impurities which would otherwise enter into solution with the zinc when the fume is used to neutralize the free acid in the electrolytic bath.

Other metals which may have been contained in the ore, such as iron, gold, silver, copper, nickel, &c., are not primarily driven off with the zinc and lead but remain in the

furnace in the form of cinder or slag and may afterward be smelted out and recovered in the usual manner.

I do not confine myself to the above described mode of producing or purifying the zinc oxide, as this may be done in any suitable way, it being only necessary to my invention that I should have for use in my process an oxide of zinc which has been properly purified from its lighter soluble impurities.

The impure zinc solution to be treated for the production of the pure electrolyte may be one primarily prepared in any convenient or usual manner, as by treating a zinc ore or the impure "flue product" from a zinc volatilizing furnace with a solvent of the zinc constituent.

The impure solution is placed in a tank or vat and current from a suitable source of electricity, as a dynamo electric machine is passed through it. The density of the current applied in purifying the solution must be at least equal to and should preferably be somewhat greater than that of the current which it may be desired to apply afterward in the deposition of pure metallic zinc.

On the application of the current some of the depositable impurities in the bath will be deposited upon the cathode while the others through the action of the current and of the secondary reactions which will take place will be thrown down as precipitates in the bath.

In order to prevent the redissolving of the deposited and precipitated impurities, the free acid liberated in the bath by the action of the current is neutralized by means of the oxidized zinc fume above described. For this purpose the fume may be introduced directly into the bath in sufficient quantities to keep the solution neutral, or the freed acid, which will rise to the top of the bath may be continuously drawn off into a separate tank and after being neutralized with the fume be returned to the depositing tank. In case the zinc solvent used in making up the solution be also a solvent of lead, which will be the only impurity associated with zinc in the fume, enough sulphuric acid should be introduced into the bath, when lead is present in the fume, to render it insoluble. With this precaution any desired solvent of zinc may be used in making up the solution. The application of the current to the solution should be continued until all the depositable impurities are deposited or precipitated when the precipitates may be allowed to settle and the clear solution to be drawn off ready for use. In this manner, since by the use of the oxidized zinc fume the free acid liberated in the bath may be neutralized without introducing additional impurities. I am able to produce from a very impure solution of zinc a neutral zinc electrolyte of such nature that it will yield upon electrolysis a commercially pure metallic zinc. The zinc may be deposited from such a solution by means of electrolysis using an insoluble an-

ode, as one of carbon, and a cathode of suitable material such as zinc or copper, and the process may be rendered continuous by maintaining and regenerating the solution by neutralizing or annulling the free acid liberated in the bath with an oxidized zinc fume free from its soluble depositable impurities such as is hereinbefore described. I do not however claim herein the method of doing this as I have made it the subject of another application for Letters Patent filed of even date herewith.

The advantages of my invention will be readily apparent to those skilled in the art since by means of it the most impure ores of zinc, which have hitherto been discarded as waste products can be utilized in the production of a zinc electrolyte free from all depositable impurities from which a commercially pure metallic zinc can be obtained.

What I claim as new, and desire to secure by Letters Patent, is—

1. The hereinbefore described process of producing from an impure solution of zinc salts, a zinc electrolyte free from depositable impurities, which consists in subjecting the

solution to the action of an electric current to precipitate and deposit the depositable impurities and neutralizing the acid set free in the bath with an oxidized zinc fume freed from its more volatile soluble constituents, substantially as set forth.

2. The hereinbefore described method of producing from an impure solution of zinc salts a zinc electrolyte free from depositable impurities which consists in subjecting the solution to the action of an electric current to precipitate and deposit the depositable impurities and at the same time preventing the re-solution of such impurities in the solution by neutralizing the acid set free in the bath with a neutralizing agent which is free from any depositable impurities soluble in the solvent element of the bath, substantially as set forth.

In testimony whereof I have hereunto subscribed my name this 16th day of January, A. D. 1892.

PARKER C. CHOATE.

Witnesses:

BENJAMIN BARKER, Jr.,
CLARKSON A. COLLINS.