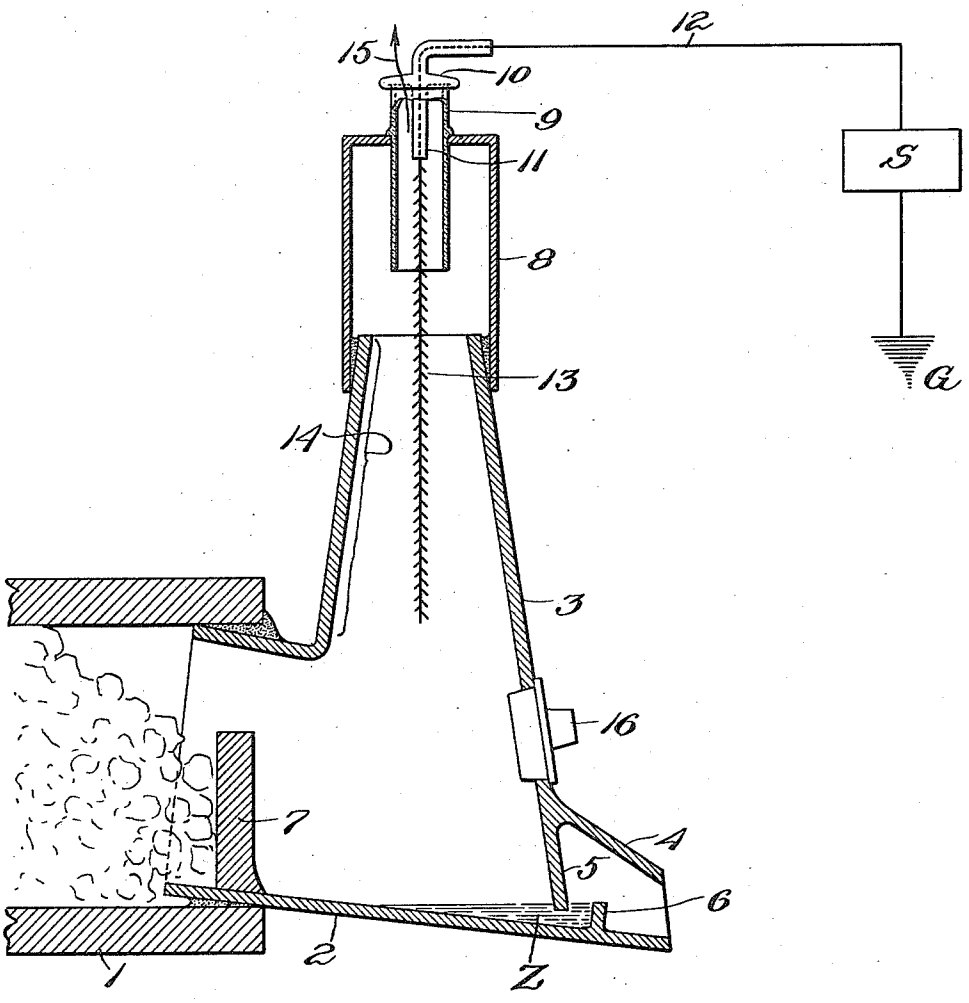
H. S. KIMBALL.

METALLURGY.

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1,189,830. Patented July 4, 1916.



Witnesses:
Josephine A. Ryan
Charles D. Woodbury

Inventor:
Henry Sturgis Kimball
by Pruett Roberts Cushman
Attys.

UNITED STATES PATENT OFFICE.

HENRY SWIFT KIMBALL, OF ST. LOUIS, MISSOURI, ASSIGNOR TO AMERICAN ZINC LEAD & SMELTING COMPANY, OF BOSTON, MASSACHUSETTS, A CORPORATION OF MAINE.

METALLURGY.

1,189,830. Specification of Letters Patent. Patented July 4, 1916.

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To all whom it may concern:

Be it known that I, HENRY SWIFT KIMBALL, a citizen of the United States, and resident of the city of St. Louis and State of Missouri, have invented new and useful Improvements in Metallurgy, of which the following is a specification.

My invention relates to the metallurgy of metals which in the process of recovery pass from a gaseous to a liquid condition, and has for its object the promotion of condensation, or transition from the gaseous to the liquid condition of such metallic substances; *i. e.* metals of which the reduction temperature is higher than the boiling point of the metal.

As my invention is applicable to the metallurgy of zinc, it will be herein described in that connection.

The present usual method of smelting zinc ore for the metal, a method empirically determined and fixed by the practice of more than a century, involves the costly procedure of reduction of zinc oxid (obtained at present for the most part by roasting the natural sulfid ores) with carbonaceous material, in small isolated charges of about 100 pounds within clay retorts heated externally in a gas furnace, to about 1400 degrees centigrade. After the preliminary expulsion of water vapor and coal gas from the retort, the zinc is reduced by the carbon, and together with carbon monoxid, drifts from the retort into the condenser, which is a conical clay extension luted into the end of the retort. The difficulties of condensation of the zinc gas to metallic zinc, have been largely responsible for the present state of the art. Under the best conditions of condensation in the condenser, the yield of metallic zinc is high, running to 90% and over in commercial operation. But at certain stages in the reduction of a retort charge, or under ore conditions, temperature conditions, etc., which fall short of the empirically ascertained standard of practical perfection, the losses due to formation of "blue powder" and waste of zinc by escape and combustion, frequently reach a ruinously high percentage. The chief cause of loss is the formation of "blue powder," which to the best of present knowledge consists of extremely minute particles of zinc on the surface of which zinc oxid has formed, this oxid preventing the agglomeration of the small particles into larger drops of metallic zinc in the condenser. As it is very difficult to fuse this blue powder at practicable temperatures it is common practice to replace it in a retort together with a little reduction material and again reduce the zinc.

By the invention herein described, larger percentages of coherent metallic zinc are precipitated from retort gas than would otherwise be the case, and also metallic zinc can be condensed and recovered under conditions in which, by means of processes heretofore practised, only blue powder would result.

Generally speaking, this invention is characterized by electrical excitation of the region where a substance in gaseous condition or in gaseous solution, as for instance zinc, exists and is at or near the temperature of condensation, and the provocation or promotion of condensation of the substance to the liquid form by such electrical excitation. This effect is producible by the maintenance of an electrical field either with or without convective discharge, and to a greater or less extent may be produced by either unidirectional or alternating, stress in an electrical field. The net practical result of subjecting a zinc gas or vapor region to the influence of electrical field is: that the condensation of metallic zinc under the best smelting conditions, is slightly improved; the condensation of metallic zinc under inferior smelting conditions is very emphatically improved; and the electrical field, imposed upon conditions which otherwise would preclude the production of anything except blue powder, causes condensation of metallic zinc. An explanation of this practical result cannot be offered with any great degree of confidence, since we are doubtless dealing with inter-atomic relations. Probably one aspect of the action of the electrical field is analogous to the agglomerating action on water vapor of the electric discharge during electric storms. Another aspect of it is probably the production of an abnormal or artificial dew point, which would provoke condensation from an atmosphere only saturated with reference to the normal dew point. Obviously, either or both of the above actions would take place whether the electrical stress be direct or alternating. It seems reasonable to suppose that the agglomerating action of the electric field is due to a speeding up of the zinc mole-

cules or particles, so that they collide with each other more frequently than they otherwise would. Probably also, another effect, particularly in the case of direct current (or current in which one phase predominates) whether or not qualified by spray discharge, is to drive the particles of zinc mist together, locally increasing the density of the zinc mist after passing from the gaseous to the cloud stage, giving the particles increased opportunity for bombarding each other and the walls of the containing vessel. There may be still another effect; that the zinc particles are electrically charged and more or less dissociated at the high temperature involved, so that there is a true movement of ions in the gas; producing an effect analogous to that characteristic of electrolysis. But, whatever may be the ultimate scientific ascertainment of the behavior of the materials under electrical field conditions, demonstration on a commercial scale has shown that the maintenance of electrical field in the condensation zone of a zinc smelter condenser produces an improved and increased recovery of zinc and a proportionate diminution of deposited blue powder.

In the drawing hereto annexed there is shown, in diagram, an apparatus suited to the performance of my process. This apparatus is not claimed herein, but forms the subject matter for another application for patent.

Referring to the drawing: 1 represents the end of a zinc smelting retort.

2 represents the condenser, luted into the end of the retort 1.

3 represents an upward extension of the condenser.

4 represents a spout from which metallic zinc (Z) may be tapped.

5 is a curtain formed at the head of spout 4.

6 is a dam in the spout 4, forming with the curtain 5 a trap, to be sealed by metallic zinc.

7 is a screen, built at the retort end of the condenser, to close all but the top of the inner end of the condenser.

8 is a cylindrical cowl, placed over the top of the conical extension 3, and preferably luted thereto.

9 is a tube through which the gases escape into the atmosphere, secured through the top of the cowl 8.

10 is a spider, to support the tube 11 centrally in the tube 9.

11 is a tube of refractory insulating material, preferably fused quartz, suspended centrally in the larger tube 9.

12 is a conductor, leading from the source of electric potential at S. The conductor 12 passes through tube 11, and out therefrom into the condenser cone 3, where, if desired, the condenser may be armed with sharp projections 13. The conductor which projects into the condenser cone should be made of metal which will persist unaltered under the conditions of operation. The alloy nichrome has been found quite suitable.

G represents the ground connection from the electrical source S.

S represents a source of electrical potential, which may be direct or alternating in character.

Z represents the pool of metallic zinc in the lower part of the condenser, trapping the same at 5, 6.

14 represents a region where, under electrical influence the zinc condenses in liquid form, to flow down the sides of the condenser toward the pool at Z.

15 shows the direction of efflux of carbon monoxid, which burns on escape into the air.

16 is a hand hole cover which may be removed to clean out the condenser.

The operation of the apparatus is as follows: Carbon monoxid and gaseous zinc, delivered from the charge in the retort 1, flow gently over the screen 7 and often through a mass of incandescent carbon in the mouth of the condenser back of the screen 7, into the condenser 2, 3, cooling as they flow toward the outlet through tube 9. Direct current—say—is supplied from the source S, the voltage delivered being fairly high, say—5000 to 6000 volts. The electric quantity, of course, is proportionately small. If the conditions before applying the electric current were such that zinc flame appeared at 15, it will be observed that the application of electric current is followed immediately by cessation of zinc flame. The condenser 2, 3 being grounded to all practical intents, the circuit is completed to ground. Zinc in liquid form, condenses at the zone 14, and runs in drops down the sides of the condenser 2, 3. The proportion of blue powder is reduced below what would result in the absence of the electric field, and metallic zinc is yielded, though the retort conditions are such that such zinc yield would be precluded were the electrical field not maintained.

An important, if not the chief, reason why it has proved impracticable heretofore to smelt zinc in furnaces of large capacity and by continuous processes, such as are suited to the reduction of other metals, is, that the conditions of reduction of zinc compel the use of temperatures at which zinc when reduced is a gas, and the metal, at the critical temperature of condensation, is hypersensitive to oxidation, and still at low density, is easily carried away by currents.

What I claim and desire to secure by Letters Patent is:

1. The method of promoting and insuring liquefaction by condensation of a metal from a gas thereof, which consists in subjecting

the metallic gas when at or near the temperature of condensation, to a field of electric stress, thereby accelerating the agglomeration of liquefying particles and preventing individual oxidation thereof.

2. The method of promoting and insuring liquefaction by condensation of zinc from the gas thereof, which consists in subjecting the zinc gas when at or near the temperature of condensation to a field of electric stress, thereby accelerating the agglomeration of liquefying particles and preventing the formation of blue powder.

3. The method of promoting and insuring liquefaction by condensation of zinc from the gas thereof, which consists in subjecting the zinc gas when at or near the temperature of condensation to a field of electric stress, characterized by convective discharge, thereby accelerating the agglomeration of liquefying particles and preventing the formation of blue powder.

Signed by me at St. Louis, Missouri, this twenty-first day of January, 1914.

HENRY SWIFT KIMBALL.

Witnesses:

ALBERT E. JENKINS,

A. K. MCDANIEL.