

F. J. TONE.
PROCESS OF REDUCING ORES.
APPLICATION FILED APR. 11, 1906.

921,183.

Patented May 11, 1909.

Fig. 1.

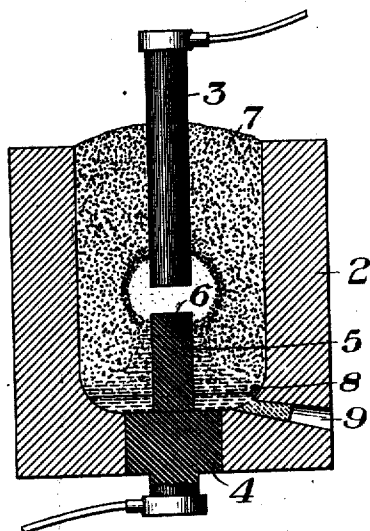
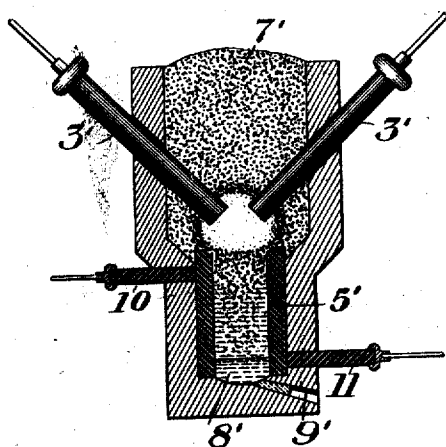


Fig. 2.



WITNESSES

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FRANK J. TONE, OF NIAGARA FALLS, NEW YORK.

PROCESS OF REDUCING ORES.

No. 921,183.

Specification of Letters Patent.

Patented May 11, 1909.

Application filed April 11, 1906. Serial No. 311,039.

To all whom it may concern:

Be it known that I, FRANK J. TONE, of Niagara Falls, Niagara county, New York, have invented a new and useful Process of Reducing Ores, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a sectional side elevation showing one form of apparatus for carrying out my method; and Fig. 2 is a similar view showing another form of the apparatus.

My invention relates to the reducing or smelting of ores in an electric furnace; especially, the reduction of refractory ores.

The invention is designed to assist in the reduction of the material, and facilitate the removal from the zone of the arc.

To that end, the invention consists broadly in causing the products to descend from the reaction zone of the arc along an electrically heated resistance conductor. The products may be either wholly reduced or partially reduced by the arc before they descend along the supplemental conductor.

In the drawings, referring to the form of Fig. 1, 2 represents a refractory receptacle within which depends the upper electrode 3, constituting one terminal of the electric furnace. In a hole in the bottom of the receptacle is placed the carbon base-block 4 which constitutes the other terminal. On the central part of this base-block rests a resistance conductor 5, which in this form consists of a column of carbon or other conductive refractory material, which is so formed as to give resistance to the passage of the current and therefore heat the product of the furnace as it descends from the zone of reaction. The upper end 6 of the resistance conductor 5 constitutes the lower electrode of the arc, which is maintained between the lower end of the upper electrode 3 and the top of the resistance conductor. The charge 7, which preferably consists of ore or a compound containing the material to be reduced, together with a reducing agent, preferably fills the furnace and surrounds the upper electrode, so that the arc is completely inclosed in the mass of charge. As reduction progresses, the reduced products descend along the heated resistance conductor into the receiving space 8 in the lower end of the cavity from which they may be tapped at intervals through the tap hole 9.

The electric circuit which maintains the arc may constitute the same circuit or a different circuit from that used to heat the resistance conductor. Thus, in Fig. 2, I show a furnace in which two electric circuits are employed. In this form the resistance conductor 5' consists of a cylinder or tube of carbon, or other refractory conductive material, having connections 10 and 11 to a source of electric current by which it is heated. In this form, I have shown the upper electrodes 3' as projecting through holes in the sides of the furnace. The charge 7' fills the furnace as before, being introduced at the top; and after it passes through the zone of reduction formed by the arc the products descend within the heated resistance tube to the receiving space 8' in the bottom of the furnace cavity. From this receiving space they may be tapped out at intervals through the tap hole 9'.

The advantages of my invention result from the action of the electrically heated resistance conductor, along which the reduced or partly reduced products descend before being removed. The resistance conductor aids in completing the reduction of partially reduced material, also helps to agglomerate small fused masses and particles and facilitates their removal from the zone of the arc. I thus aid in preventing volatilization and absorption, or other loss of product.

The process is especially applicable to the reduction of elements which at the temperature of reduction are subject to losses by volatilization for example, silicon and aluminum. The products volatilized may be the ores, the reduced elements or secondary compounds formed in reduction. It is important in reducing such elements to avoid excessive localizing of heat and to remove the products from the zone of great heat as soon as they are formed. This is accomplished by the resistance conductor, which heats the products, and assists in keeping them in a fused condition facilitating their removal, and which also agglomerates separated particles and provides an easy path for descent to the receiving or collecting space.

Within the scope of my invention, many other forms of furnaces may be employed; also other forms of conductor electrodes, &c., may be employed without departing from my invention.

I claim:—

- 1 The method of reducing ores or compounds consisting in electrically heating the compound and the reducing agent within the reduction zone of an electric arc, to a temperature sufficient to reduce the compound, removing the reduced product by gravity away from the reduction zone, and electrically heating said products during such descent and removal, said heating being accomplished in a zone below and distinct from the reduction zone substantially as described.
2. The method of reducing ores or compounds consisting in electrically heating a charge of the compound and a reducing agent within the reduction zone of an electric arc to a temperature sufficient to reduce the compound, removing the products as they are formed therein by gravity along a resistance conductor, and electrically heating the products as they are thus removed from the reduction temperature of said zone, said heating being accomplished in a zone below and distinct from the reduction zone substantially as described.
3. The method of reducing ores or compounds consisting in maintaining a reduction zone by means of an electric arc, collecting the products at a point below and removed from the said reduction zone, causing the products to descend from the reduction zone to the collecting space as they are formed, and electrically heating the products during their removal and descent from the reduction zone to the collecting space, said heating being accomplished in a zone below and distinct from the reduction zone substantially as described.
4. The process of reducing refractory ores which consists in heating a charge of the compound and a reducing agent to a reducing temperature within the reaction zone of an electric arc furnace, removing the products as they are formed by causing them to descend out of the reaction zone along an electrically heated resistance conductor, the upper end of which constitutes the lower electrode of said arc furnace, and collecting the fused products in a lower receiving space, substantially as described.
5. The process of reducing compounds of elements which at the temperature of reduction are subject to losses by volatilization, which consists in heating a charge of the compound and a reducing agent in an electric arc furnace, keeping the maximum temperature of the charge at a point which will

substantially prevent volatilization losses, causing the products to descend from the reaction zone of the arc along an electrically heated resistance conductor, and collecting the fused product in a receiving space; substantially as described.

6. The process of reducing silicon compounds, which consists in heating a charge of the compound and a reducing agent in an electric arc furnace, keeping the maximum temperature of the charge at a point which will substantially prevent volatilization losses, causing the silicon to descend from the reaction zone of the arc along an electrically heated resistance conductor, and collecting the fused product in a receiving space; substantially as described.

7. The process of reducing silicon compounds, which consists in heating a charge of the compound and a reducing agent in an electric arc furnace, keeping the maximum temperature of the charge at a point which will substantially prevent volatilization losses, causing the silicon to descend from the reaction zone of the arc along an electrically heated vertical resistance column, the top of which constitutes the lower electrode of said arc furnace, and collecting the fused product in a receiving space; substantially as described.

8. The process of reducing refractory ores which consists in heating a charge of the compound and a reducing agent in an electric arc furnace, withdrawing the products from the region of the arc as they are formed and maintaining them in a fused state during such withdrawal by means of an electrically heated resistance conductor; substantially as described.

9. The method of reducing ores or compounds, consisting in heating a charge of the compound and a reducing agent in the reduction zone of an electric arc, collecting the resulting products in a receiving space distant from the reaction zone of the furnace, and interposing between the reaction zone and the receiving space an electrically-heated path along which the products travel said path being a heated zone distinct from the reduction zone; substantially as described.

In testimony whereof, I have hereunto set my hand.

FRANK J. TONE.

Witnesses:

ASHMEAD G. RODGERS,
A. D. KYSOR.