No. 892,212. PATENTED JUNE 30, 1908.

F. M. BECKET.

ELECTRIC FURNACE METHOD.

APPLICATION FILED JAN. 8, 1908.

Fig. 1.

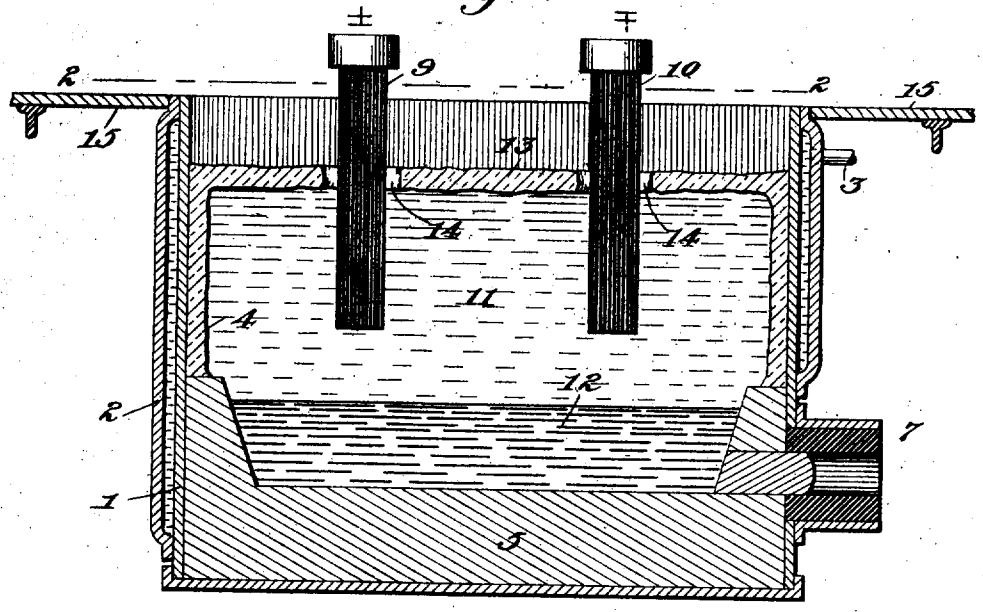
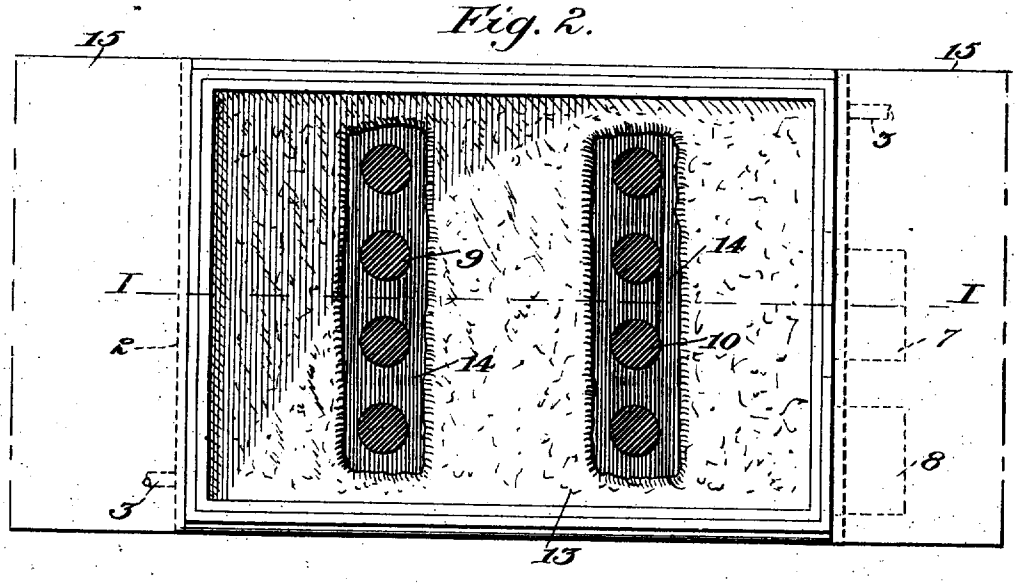


Fig. 2.



Witnesses:
C. H. Potter.
N. P. Leonard.

Inventor:
Frederick M. Becket,
by Byrnes & Townsend,
Att'ys.

UNITED STATES PATENT OFFICE.

FREDERICK M. BECKET, OF NIAGARA FALLS, NEW YORK, ASSIGNOR TO ELECTRO METALLURGICAL COMPANY, A CORPORATION OF WEST VIRGINIA.

ELECTRIC-FURNACE METHOD.

No. 892,212. Specification of Letters Patent. Patented June 30, 1908

Application filed January 8, 1908. Serial No. 409,859.

To all whom it may concern:

Be it known that I, FREDERICK M. BECKET, a subject of the King of Great Britain, residing at Niagara Falls, in the county of Niagara and State of New York, have invented certain new and useful Improvements in Electric-Furnace Methods, of which the following is a specification.

The object of this invention is to provide an economical and efficient electric heating method which possesses special advantages as applied to the production of metals or alloys, and more particularly the refractory metals as chromium, molybdenum, tungsten, vanadium or the like and their alloys with iron, nickel, etc., by continuous or semi-continuous operation. In such cases it is desirable that the electrodes, or such of these as depend into the bath and are adjustable therein, should be easily accessible for adjustment, renewal or repair, and it is further desirable that the surface of the bath should be accessible for supplying the charge as required, stoking the same, and manipulating the furnace to maintain fairly constant current conditions. These requirements render it desirable to perform the operation in uncovered or partially uncovered furnaces, but this has heretofore involved serious losses of heat by radiation from the surface of the molten bath.

I have now discovered that by a proper adjustment of certain conditions or factors hereinafter described it is possible to conduct electric furnace operations involving either the production of metals or alloys or the refining of the same in presence of a molten bath, while maintaining upon the surface of the bath a solid crust of sufficient thickness to materially reduce the loss of heat by radiation, thus conserving the heat of the furnace and increasing the efficiency of the operation. By properly proportioning the cross-sectional area of the depending electrodes to the current employed, these may be so heated as to prevent the crust from forming over the portions of the bath immediately adjacent the electrodes, thus providing openings or apertures in the crust which permit the charge to be supplied or stoked and also provide for the escape of gases or volatile reduction products. Moreover the electrodes are readily adjustable in the openings thus provided in the crust.

The essential conditions of operation comprise an adjustment between the current density or heat development in the molten bath or slag and the composition or fusibility of this bath, these factors being so related that the temperature of the upper portion of the bath in contact with the atmosphere will permit the formation of the crust described. In this crust apertures, located at any desired point or points, may be provided and kept open by any desired means, as by local heating or by simple manual methods, preferably however these apertures are maintained by local heating applied through some or all of the working electrodes as above described.

In carrying out the method under the last named conditions, the proper operating conditions involve a correlation or adjustment between several factors, principally the heat development in the bath, the heat development in the electrode or electrodes, and the fusibility of the molten bath or slag; and the proper conditions for any specific operation may be readily attained by varying one or all of these several factors.

For a full understanding of the invention reference is made to the accompanying drawings wherein

Figure 1 is a vertical longitudinal section on line 1—1 of Fig. 2 of a simple form of continuous furnace for carrying the invention into effect, and Fig. 2 is a horizontal section on line 2—2 of Fig. 1.

In said drawings 1 represents a metallic vessel or furnace, having its side walls protected by a water-jacket 2 provided with pipe connections 3 for the circulation of a cooling medium as water, the cooling resulting in a lateral protective coating 4 of the solidified constituents of the bath. The hearth of the furnace may consist of magnesite 5, or of carbon or other refractory material.

7, 8 represent the taps for metal and slag respectively, through which the molten reaction products may be withdrawn from time to time.

9, 10 are electrodes, illustrated as of carbon or graphite, depending into the bath and adjustable therein.

11 represents the molten bath or slag, and 12 the molten metallic product accumulating beneath the same.

13 indicates a crust composed of the solidified constituents of the bath and covering the

same with the exception of openings or apertures 14 surrounding the electrodes.

15 represents the working floors, conveniently arranged at the level of the top of the vessel.

The electrodes may be of any shape and of any desired number. As illustrated they are arranged in two series of four electrodes each, the electrodes 9 being of common polarity and of opposite polarity with respect to the electrodes 10. Either alternating or direct current may be used. While I have described a form of furnace having depending electrodes of opposite polarity the invention is not restricted thereto but may be applied to a form of furnace wherein the current passes through a molten bath between a single electrode or group of electrodes of common polarity and the walls or hearth of the furnace or the metallic product therein.

In the production of refractory metals or their ferro-alloys according to this method I provide a bath containing an ore or compound of the refractory metal, a source of the alloying metal if desired, and a reducing agent, adding if necessary an acid or basic flux adapted to yield with the constituents of the ore or the reaction products a bath or slag having the proper degree of fusibility to permit the formation of a crust while yet providing within the bath the temperature conditions necessary for the reduction. The composition of the bath will of course depend entirely upon the ore and reducing agent used and the temperature at which the reduction occurs, but is readily determined for any specific conditions.

The method is applicable for use with various reducing agents, such as carbon, calcium carbid, silicon carbid, silicon and ferro-silicon.

I claim:

1. The electric furnace method which consists in passing an electric current through a molten bath while maintaining at the surface thereof a heat-retaining crust of the solidified constituents of the bath, and providing apertures in said crust for supplying the charge and permitting the escape of volatile reaction products.

2. The electric furnace method which consists in passing an electric current from a depending electrode through a molten bath while maintaining at the surface thereof a heat-retaining crust of the solidified constituents of the bath, and providing apertures in said crust around said electrode for supplying the charge and permitting the escape of volatile reaction products.

3. The electric furnace method which consists in passing an electric current between depending electrodes of opposite polarity through a molten bath while maintaining at the surface thereof a heat-retaining crust of the solidified constituents of the bath, and providing apertures in said crust around said electrodes for supplying the charge and permitting the escape of volatile reaction products.

4. The continuous electric smelting method which consists in passing an electric current through a molten bath containing a compound of a refractory metal and a reducing agent, while maintaining at the surface of said bath a heat-retaining crust of the solidified constituents of the bath, providing apertures in said crust for supplying the charge and permitting the escape of volatile reaction products, supplying additional portions of the charge to the bath as required and withdrawing the molten reaction products from time to time.

In testimony whereof, I affix my signature in presence of two witnesses.

FREDERICK M. BECKET.

Witnesses:
J. N. DEINHARDT,
D. BURGESS.