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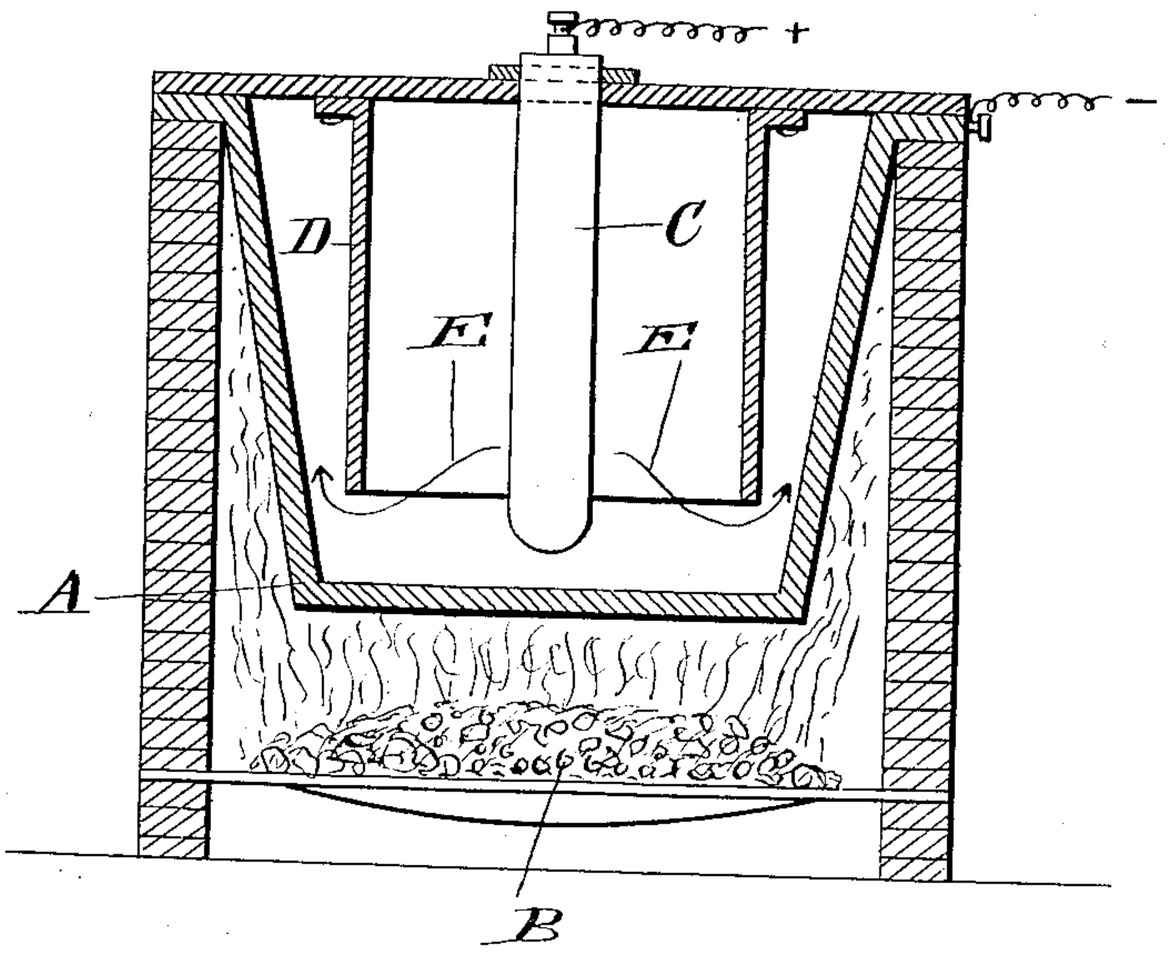
PATENTED MAR. 28, 1905.

J. A. LYONS & E. C. BROADWELL.

PRODUCTION OF BORON BY ELECTROLYSIS.

APPLICATION FILED SEPT. 16, 1903.



Witnesses

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UNITED STATES PATENT OFFICE.

JOHN A. LYONS AND EDWARD C. BROADWELL, OF CHICAGO, ILLINOIS.

PRODUCTION OF BORON BY ELECTROLYSIS.

SPECIFICATION forming part of Letters Patent No. 785,962, dated March 28, 1905.

Application filed September 16, 1903. Serial No. 173,387.

To all whom it may concern:

Be it known that we, JOHN A. LYONS and EDWARD C. BROADWELL, citizens of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in the Production of Boron by Electrolysis, of which the following is a specification.

Our invention relates to electrolysis of metals; and the object of our invention is the production by such process of boron or metallic borids in conjunction with highly electropositive metals, such as potassium, sodium, manganese, chromium, molybdenum, tungsten, uranium, and vanadium.

While we are aware that elemental boron has been attained by pure electrolysis, it has not to our knowledge been contemporaneously produced with the electropositive metals referred to. Our invention not only consists of such contemporaneous reduction, but also of a reduction in which additional heat is employed to keep the metallic bath fused.

The means employed in carrying out our invention are illustrated in the accompanying drawing, which is a vertical sectional view of an apparatus, the parts of which are designated by suitable letters of reference, although we desire to here state that our invention does not rest upon any one form of reduction apparatus.

In the apparatus shown, A is a crucible; B, an external source of heat; C, an internal positive electrode, (the crucible forming the negative;) D, an interior graphite partition, and E the course of current.

In carrying out our invention the borates of these metals, either basic or neutral, in such proportion as to give any suitable alloy or any amount if a single borate is electrolyzed and a single metal sought are while kept fused by an external heat of a temperature of, say, 1,100° centigrade submitted to an electric current in such manner that while we get electrolysis we have great heating effect at the carbon positive electrode by making its surface many times smaller than the area of the inner surface of the retaining-crucible, which acts as the negative electrode. Between the positive electrode and the negative electrode there is suspended a partition of graphite or other suitable infusible or incorrodible material, which partition reaches from the crucible cover to, say, one-half the distance to the bottom of crucible, and said partition is insulated electrically. During electrolysis the borates are decomposed in such way as to eliminate the metal upon the inner surface of the crucible and the hypothetical ion or radical B_4O_7 or B_2O_4 is deposited at the positive electrode, the carbon of which being kept to an incandescent heat by the current owing to its relatively small area reduces the B_2O_4 or B_4O_7 to boron, carbon-monoxid gas being evolved. The partition serves to keep the boron from floating over to the cathode.

It will be seen that in our process the boron is not produced by its electrolytic deposit upon the anode, but upon the electrolysis of the borate the anion, boric anhydrid—that is, the acid radical—brought to the anode with oxygen is produced, and then this is reduced chemically by the intensely-heated carbon of the anode.

By surrounding the carbon positive electrode with different metals their borids can be obtained. If a borid of any metal is to be produced, it can either be prepared by placing the metal around but not touching the carbon anode, or preferably the pure borate of the metal the borate of which is desired, or the pure borate of this metal fused with about an equal weight of the more fusible borate of a metal of more difficult reducibility, such as calcium borate, may be placed in the apparatus with the partition removed and then the bath electrolyzed, thus allowing the reduced boron to float over to the cathode deposit and corrode it to the borid of the deposited metal.

While we are aware elemental boron has been obtained by pure electrolysis, it has not been, to the best of our knowledge, contemporaneously with the highly electropositive metals, and, moreover, our process is a high-temperature chemical reduction by carbon in conjunction with an electrolytic effect.

The bath may be kept in a fused state by any suitable application of heat, the fire here shown being one form of means of accomplishing this end; but the electric current employed

may be sufficiently strong to maintain the state of fusion.

Having thus described our invention, what we claim is—

1. The process of subjecting a fused bath of the borates of electropositive metals to electrolytic action and subjecting the anion produced thereby to a reducing action at the anode which is maintained at an intense heat.

2. The process of producing boron from the borates of electropositive metals, consisting in subjecting a fused bath of said borates to electrolytic action establishing an incandescent heat at the anode and subjecting the electrolyzed anion to a reducing action at the anode.

3. The process of producing boron from the borates of electropositive metals which consists in subjecting the borate in a fused bath to electrolytic action between a cathode, and an anode reductive of boric anhydrid, with a relatively great current density at the anode, whereby an intense heat is generated at the anode and subjecting boric anhydrid brought to the anode to such heat whereby boron is produced.

4. The process of producing boron from the borates of the electropositive metals which consists in subjecting a fused bath of said borates to electrolytic action between a cathode and a carbon anode subjected to an intense heat.

5. The process of producing boron from the borates of the electropositive metals which consists in subjecting a fused bath of said borates to electrolytic action between a cathode, and an anode of reductive capacity, separated in such manner as to prevent the floating of the boron to the cathode and creating an auxiliary heat at the anode whereby the boron is produced from the anion brought there by the electrolytic action.

6. The process of producing boron which consists in subjecting a fused bath of the borate of an electropositive metal to electrolytic action between a cathode and a carbon anode, with a relatively great current density at the anode.

In testimony whereof we have signed our names to this specification, in the presence of two subscribing witnesses, this 7th day of September, 1903.

JOHN A. LYONS.
EDWARD C. BROADWELL.

Witnesses:
MATTHEW MURPHY,
LADIMIR MONDRY.