UNITED STATES PATENT OFFICE.

GEORGE O. SEWARD, OF NIAGARA FALLS, NEW YORK, ASSIGNOR TO AMERICAN MAGNESIUM CORPORATION, OF NIAGARA FALLS, NEW YORK, A CORPORATION OF NEW YORK.

PROCESS OF ELECTRODEPOSITING MAGNESIUM.

1,310,450. Specification of Letters Patent. Patented July 22, 1919.

No Drawing. Application filed November 19, 1917. Serial No. 202,821.

To all whom it may concern:

Be it known that I, GEORGE O. SEWARD, a citizen of the United States, residing at Niagara Falls, in the county of Niagara and State of New York, have invented certain new and useful Improvements in Processes of Electrodepositing Magnesium, of which the following is a specification.

This invention relates to the electrolytic production of metallic magnesium, the object of the invention being to provide a novel process of electrodepositing magnesium.

In a prior United States Patent No. 880,489, patented February 25, 1908, to Franz von Kugelgen and George O. Seward, there is described and claimed an electrolytic process of producing magnesium or alloys thereof, according to which magnesium oxid is added to a molten bath containing magnesium fluorid and a fluorid of a metal or metals electropositive to magnesium. My present invention relates to operations of the above general character, modified in such manner as to secure improved efficiency of operation and an increased yield of metal.

The electrolyte which I use is preferably of the general nature set forth in my prior Patent No. 880,489; that is to say, it comprises magnesium fluorid, a fluorid of a metal or metals electropositive to magnesium, as sodium or potassium, and one or more salts acting to increase the specific gravity of the bath and to reduce its melting-point, barium fluorid being preferred. In the present case the density of the bath is an important consideration, for reasons hereinafter explained.

The electrolysis may be carried out in apparatus of the type illustrated in United States Letters Patent No. 864,928, patented September 3, 1907 to George O. Seward and Franz von Kugelgen, said apparatus comprising essentially a cast-iron container having means for cooling the base, one or more carbon anodes dipping or depending into the bath, and a cathode or cathodes, usually of cast iron, projecting upwardly through the base into the molten electrolyte and terminating in an edge or point in order to facilitate the upward flow and detachment of the molten magnesium. The bath solidifies to a greater or lesser extent adjacent the cooled portions of the container, a central pool or portion remaining fluid under the operating conditions.

In this construction the anodes are preferably located somewhat above but out of vertical alinement with the cathode or cathodes. Directly above the latter I provide means, for example a cooling coil as shown in the above-mentioned patent, for chilling the surface of the bath to a degree sufficient to form a local crust of solidified electrolyte, sufficient to shield the floating magnesium from the atmosphere but easily broken through when the metal is to be removed. It is found in practice that in operating in this manner the floating molten metal may be ladled or otherwise removed from the highly heated bath without material loss by burning. Other suitable forms of collecting device may be used instead of that above described.

In practising the present invention, a layer of magnesia or magnesium carbonate of considerable depth is maintained upon the surface of the bath, into which it has but little tendency to sink by reason of the high specific gravity of the electrolyte. This layer serves not only to retain the heat, but also serves as a primary source or raw material for the production of magnesium, the magnesium oxid either dissolving progressively in the bath and undergoing electrolysis therein, or uniting with fluorin liberated by the current and hence restoring the magnesium fluorid content of the bath. In case magnesium carbonate is used it is eventually converted into magnesium oxid by calcination *in situ*. Either magnesium oxid or magnesium carbonate is effective to protect the anodes, which are otherwise subject to rapid attack at or near the surface of the bath.

In the operation of the cell the current conditions are so maintained as to keep a central pool or body of the electrolyte in a molten condition, and to deposit metallic magnesium at the cathode at a temperature materially above its melting-point. A bath temperature of about 900° to 1000° C. is found satisfactory in practice. The amount of current required to maintain this condition will depend of course upon the size of the apparatus, the radiation therefrom, and many other factors, but in general a current density approximating 400 amperes per

square foot of cathode surface has been found suitable.

A representative bath may comprise by weight—

Magnesium fluorid	55 parts
Sodium fluorid	5 parts
Barium fluorid	40 parts

A bath so constituted will have a specific gravity of about 4.10, this figure referring to a determination made upon cooled (solidified) samples. The specific gravity at the operating temperature will of course be somewhat lower but should be sufficient to accomplish certain definite purposes as mentioned below.

It is important that the specific gravity of the bath should be sufficiently high to cause the magnesium deposited upon the cathode to flow freely and rapidly to the surface; and also to prevent the magnesium oxid, which is present in great excess of the proportion which is soluble in the bath, from sinking too rapidly or in excessive proportions to the bottom, where it would overlie the cathode or portions thereof. At the same time, it is desirable that the bath should carry suspended and distributed therethrough a sufficient quantity of magnesium oxid to prevent evolution of fluorin at the anodes and to insure prompt and substantially quantitative regeneration of the bath. For these purposes the specific gravity of the bath, determined as above, should preferably be at least 3.5, and in practice usually approximates or even somewhat exceeds 4.

I claim:—

1. A process of electrodepositing magnesium, which consists in passing an electric current through a molten bath including magnesium fluorid, said bath carrying magnesium oxid in substantial excess of the proportion soluble therein, and having a specific gravity approximating 4.0.

2. A process of electrodepositing magnesium, which consists in passing an electric current through a molten bath including fluorids of magnesium, sodium and barium, said bath carrying magnesium oxid in substantial excess of the proportion soluble therein, and having a specific gravity approximating 4.0.

3. A process of electrodepositing magnesium, which consists in passing an electric current through a molten bath including magnesium fluorid, said bath carrying magnesium oxid in substantial excess of the proportion soluble therein and being of sufficient density to prevent rapid subsidence of the undissolved portions, and withdrawing magnesium in the molten state from the upper portion of the bath.

4. A process of electrodepositing magnesium, which consists in passing an electric current through a molten bath including magnesium fluorid, said bath carrying magnesium oxid in substantial excess of the proportion soluble therein and having a specific gravity in excess of 3.0, and withdrawing magnesium in the molten state from the upper portion of the bath.

5. A process of electrodepositing magnesium, which consists in passing an electric current through a molten bath including magnesium fluorid, said bath carrying magnesium oxid in substantial excess of the proportion soluble therein and having a specific gravity approximating 4.0, and withdrawing magnesium in the molten state from the upper portion of the bath.

6. A process of electrodepositing magnesium, which consists in passing an electric current through a molten bath including fluorids of magnesium, sodium and barium, said bath carrying magnesium oxid in substantial excess of the proportion soluble therein and having a specific gravity approximating 4.0, and withdrawing magnesium in the molten state from the upper portion of the bath.

In testimony whereof I affix my signature.

GEORGE O. SEWARD.