July 4, 1950 R. K. LAWSON ET AL 2,514,283

ELECTROLYSIS OF LIGHT METALS

Filed Sept. 16, 1944

Fig. 1.

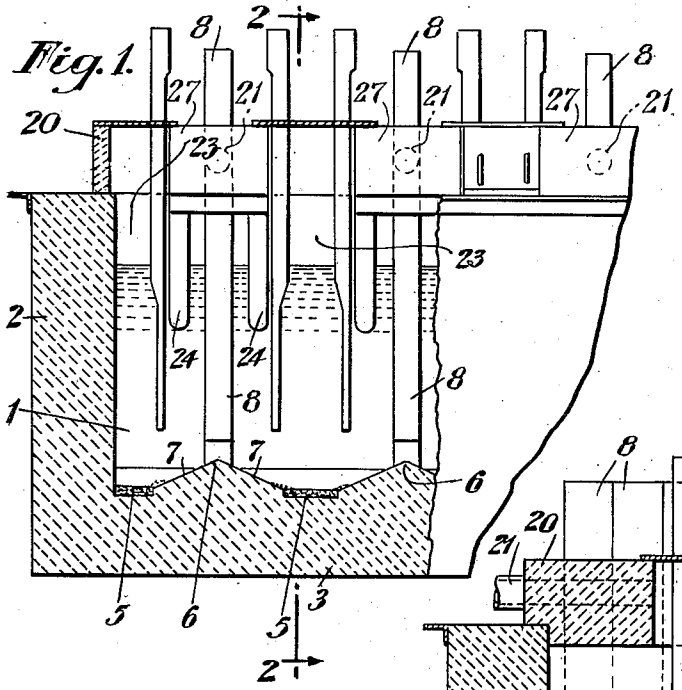


Fig. 2.

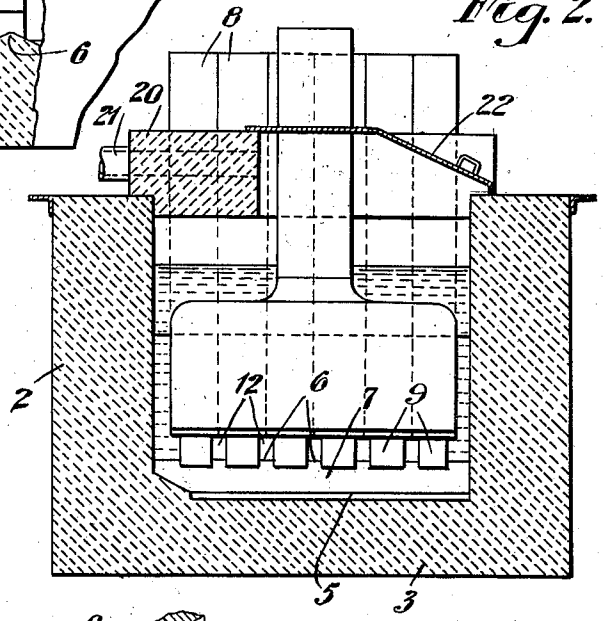
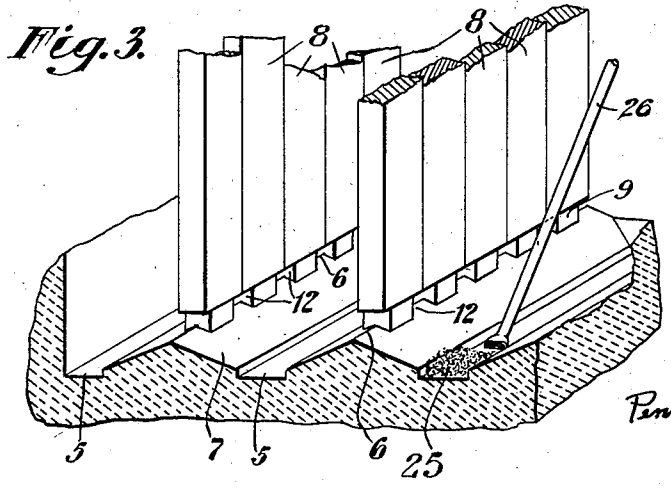


Fig. 3.



INVENTORS,
ROBERT K. LAWSON
WALTER O. McCLINTOCK
HENRY R. HENDRICKSON
FRANK W. WOODMAN

BY
Pennie, Davis, Marvin & Edmonds
ATTORNEYS

Patented July 4, 1950 2,514,283

UNITED STATES PATENT OFFICE

2,514,283

ELECTROLYSIS OF LIGHT METALS

Robert K. Lawson, Walter O. McClintock and Henry R. Hendrickson, Henderson, and Frank W. Woodman, Boulder City, Nev., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Navy

Application September 16, 1944, Serial No. 554,348

1 Claim. (Cl. 204—245)

1

This invention relates to the electrolysis of fused salt electrolytes, and has for its object the provision of an improved method and apparatus for the production of a light metal from a fused salt bath. The invention is especially concerned with the separation and removal of sludge accumulations from fused electrolytes used in the production of such light metals as calcium, magnesium, sodium, potassium and alloys thereof from their salts. The invention provides means for the collection of the sludge in the bottom of the cell together with means for removing the sludge without interfering with the operation of the cell.

During electrolysis to produce light metals such as calcium, magnesium, sodium, potassium and alloys thereof, sludges are formed in the bottom of the electrolytic cell through the accumulation of oxides, nitrides, carbon, silica, silica compounds and heavy metals derived from the electrolyte from oxidation of metals and from the materials used in the construction and operation of the cell. If this sludge is allowed to accumulate to any great extent, it will seriously interfere with the desired operation of the cell.

Such accumulations are especially objectionable under the anodes of an electrolytic cell in that they may form "secondary electrodes" which cause light metals to be produced where they will be acted on by anode products and so converted to the original salt form; or anode products may be formed where they react with the metal to cause its loss, thus reducing the efficiency of electrolytic production. In addition, when the sludge comes into close promixity to the electrodes, conducting paths of lower resistance than the electrolyte may form and bridge across from anode to cathode, thus short-circuiting the cell and sometimes causing complete shutdown.

It has been proposed to construct a cell with a metal shell which serves as a cathode and which forms a vessel around the anodes to hold electrolyte and in which sludge may accumulate and to remove periodically the accumulation of sediment by means of dippers applied through the top entrances of the cell. In this case, since anode products are usually of a gaseous and very obnoxious nature, the tools must be applied through a cathode compartment or an inactive closed-off zone in the cell to prevent injury to workmen.

In the electrolytic production of magnesium in a ceramic lined cell having separate cathode and anode compartments, it has also been proposed to apply periodically a scraper-like tool

2

through a top entrance to the cell and rake the accumulation of sediment from under the anodes into the cathode compartment and then to scoop it up with dipper-shaped tools and remove it through the top opening of the cell. This method of handling the cell sediment is laborious and necessitates expenditure of considerable time under unpleasant working conditions.

In any case, the sediment must be picked up from the bottom of the cell by passing a tool down through the electrolyte and then the sediment must be raised up through the body of the electrolyte in order to remove it from the cell. The electrolyte washes some of the sediment from the employed tool and the sediment is even more objectionable in the electrolyte than at the cell bottom, since it causes interferences with desired cell action and efficiency, as is well known to those skilled in the art.

We have discovered a method whereby these difficulties due to accumulation of sediment in the bottom of said electrolytic cells may be largely overcome and the removal of the sediment may be effected more simply with a minimum disturbance to the cell operation and with a great reduction in the labor required.

Carbon anodes depending from the top of the cell frequently have a short operating life due to corrosive attack at the surface of the electrolytic bath. This attack soon weakens the anode structure and causes them to break apart and fall to the bottom of the cell. The practice of supporting the anodes at the bottom has been heretofore impractical because of difficulties due to sludge accumulations in proximity to the electrodes. Such accumulations cause bridging with consequent short-circuiting and cause erosion such as pitting of the electrodes and their supports. It is very difficult to prevent a permanent deposition of sediment between and surrounding the supports and such deposition is further aggravated by the pits and other eroded spaces on said supports. In these considerations it must be remembered that the distance from the bottom of the electrodes to the bottom of the ceramic-lined cell is limited.

We have discovered that the angle of repose of settling sediment or mixture of sediment and molten electrolyte in such cells is sometimes as small as 15 degrees from the horizontal plane of the cell bottom, and is seldom greater than 30 degrees from said plane and its exact magnitude depends on the relative properties of the electrolyte and the sediment. Hence we have found it is advantageous to use a cell bottom having a high

portion or ridge preferably under one or more anodes and having the cell bottom slope toward a lower portion under the cathode or cathodes. For example, a satisfactory cell bottom comprises alternate ridges and troughs, wherein the top of the ridges lies under the anode and slopes downwardly at an angle between 15° and 25° so that the troughs are formed under the cathodes or between two adjacent cathodes, where two or more cathodes are employed in a cathode compartment. The sediment then collects in a trough which can be reached readily through the top entrance of the cathode compartment and no sediment collects in an inaccessible or other part of said cell which is difficult to reach. When the sediment first collects, it is sufficiently fluid, in admixture with the melt, that it may be pumped from the cell. A pump intake can be put into the trough through the cathode compartment of the cell, while said cell is operating, and the intake of the instrument may be moved along the length of the trough so that the sediment is removed without contamination of the electrolytic bath.

These and other novel features of the invention will be better understood after considering the following discussion taken in conjunction with the accompanying drawings, in which:

Fig. 1 is an elevational view, partly in section, of an electrolytic cell embodying the invention;

Fig. 2 is a sectional view along line 2—2 of Fig. 1, and

Fig. 3 is an isometric view of a portion of the cell bottom and supported anodes.

The electrolytic cell illustrated in the drawings comprises a refractory lined container 1 having sides 2 and a bottom 3 for confining a bath of fused electrolyte, for example, a salt mixture containing magnesium chloride as a constituent. The floor of the cell has alternate troughs 5 and ridges 6 with the sides 7 of the ridges sloping downward at an angle of from 15° to 30° from the horizontal to the troughs. The tops of the ridges lie beneath the anodes 8 (usually of segmented graphite) and the anode supports 9 rest on the ridges.

One of the important features of the invention is the additional function which the ridges perform in supporting the anodes. These supports eliminate the strains resulting from supporting the anodes from above. The spaces 12 between the supports permit a fairly free circulation of the electrolyte under the anodes. Whereas a plurality of spaced anode supports are shown, one or more longer supports may be utilized, space being provided at the ends of supports and sides of anodes for circulation of electrolyte.

The cell of the invention may be provided with any suitable cover. The cover 20 over the cathode has a hinged door 22 which gives access to the cathode compartment 23. A cover 27 connected to a pipe 21 for the removal of anode gas covers the anode compartment. As is customary in cells of this type, the spaces between the cathode and anode are provided with partitions 24 usually formed of refractory materials to separate the anode and cathode compartments.

In operation, sediment falls to the bottom of the cell and settles down the slopes 7 forming layers 25 in the troughs 5, said layers being below the electrical transfer path and below any major path of motion caused by electrical and thermal action between electrodes. At specified time intervals, usually of several days interim, a pump intake 26 (Fig. 3) is lowered through the open

cathode compartment 23 into trough 5, suction is applied and the intake dredge pipe 26 is caused to move along the trough 5 from end to end, whereby the sludge 25 containing the sediment is pumped out of the cell without causing the remainder of the electrolyte to become contaminated. In this manner, a fused-bath cell can be cleansed in a few minutes as compared to the much longer period previously required. Further advantages accrue from this method of cleaning in that no separate inactive working compartment is required in the cell and no interference is caused to the normal operation of the electrolytic cell.

Cathode compartment is defined as that region lying in the vicinity of the cathode from which anode products are excluded. The term "light metal" is defined as those metals which float on the electrolyte from which they are produced by electrolysis.

We claim:

In a cell for the electrolysis of fused salt baths in the production of a light metal comprising a refractory container for confining the fused bath and a plurality of spaced rows of anodes in the container, and cathodes disposed between the said rows of anodes, a plurality of ridges formed on the bottom of the container, each of said ridges having downwardly sloping plane sides meeting at an angle in a linear apex of said ridge, said linear apex of each of said ridges being disposed beneath a said row of anodes and lying substantially in the central vertical plane of said row of anodes, a plurality of troughs at the bottom of said container one at either side of said ridges, the sloping plane sides of said ridges forming a part of said troughs and being inclined at an angle to the horizontal of approximately 15° to 30°, said troughs forming the bottom of cathode compartments with the said cathodes being disposed in said cathode compartments laterally offset from vertical alignment with the bottoms of said troughs to provide access to the bottoms of said troughs for the removal of sludge therefrom through the upper part of said cathode compartments.

ROBERT K. LAWSON.
WALTER O. McCLINTOCK.
HENRY R. HENDRICKSON.
FRANK W. WOODMAN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
476,914	Bernard	June 14, 1892
778,270	Roberts	Dec. 27, 1904
1,214,808	McNitt	Feb. 6, 1917
1,311,231	Jacobs	July 29, 1919
1,534,316	Hoopes	Apr. 21, 1925
1,562,090	Hoopes	Nov. 17, 1925
1,951,836	Obiedoff	Mar. 20, 1934
2,073,631	Gilbert	Mar. 16, 1937
2,216,167	Fisher	Oct. 1, 1940
2,421,209	Lindner	May 27, 1947

FOREIGN PATENTS

Number	Country	Date
351,542	Great Britain	June 29, 1931
152,160	Austria	Jan. 10, 1938
36,452	Norway	Jan. 2, 1923