APPARATUS FOR PROTECTING THE ANODES OF AN ELECTROLYTIC CELL AGAINST SHORT CIRCUITING

Filed Oct. 23, 1968

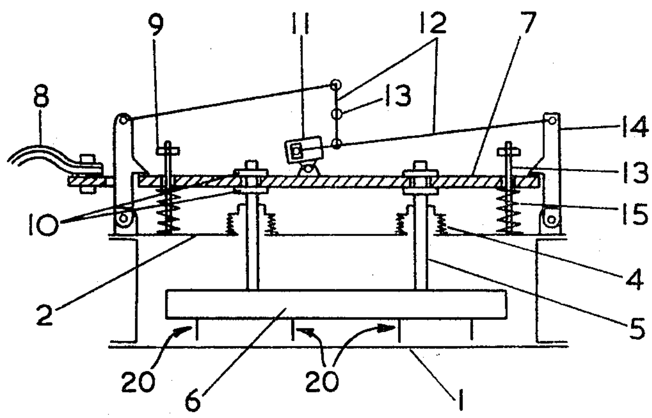

Fig. 1

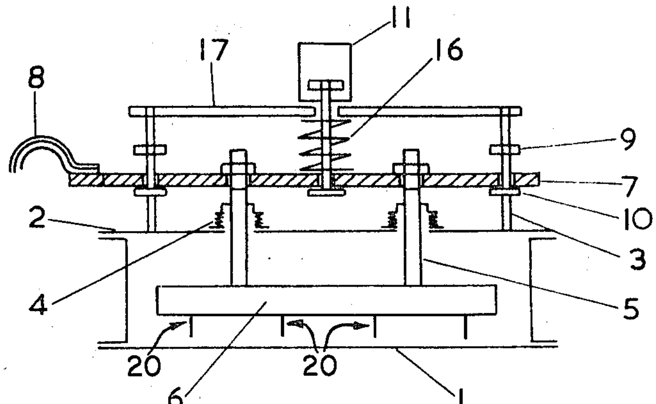

Fig. 2

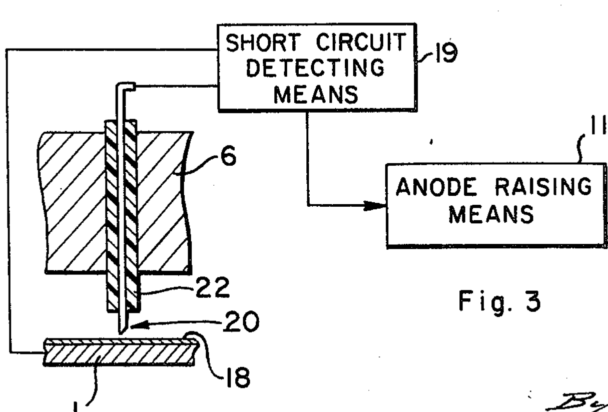

Fig. 3

INVENTOR
ROBERT SCHOBERLE

By Cushman, Darby & Cushman
ATTORNEYS

United States Patent Office

3,598,714

Patented Aug. 10, 1971

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3,598,714

APPARATUS FOR PROTECTING THE ANODES OF AN ELECTROLYTIC CELL AGAINST SHORT CIRCUITING

Robert Schoberle, Roermond, Netherlands, assignor to Solvay et Cie, Brussels, Belgium

Filed Oct. 23, 1968, Ser. No. 770,045
Claims priority, application Belgium, Oct. 31, 1967, 50,297, Patent 705,921; Nov. 23, 1967, 51,167, Patent 706,879
Int. Cl. C22d *1/04;* B01k *3/00*
U.S. Cl. 204—219 5 Claims

ABSTRACT OF THE DISCLOSURE

The anodes of a mercury cell are protected from short-circuiting by quickly raising the anodes from the mercury cathode under the impulse of a short-circuiting detector comprising conducting probes projecting from the anodes and which come into contact with the mercury before the anodes themselves.

The present invention relates to a method and an apparatus which prevents short-circuits between electrodes in a cell with a flowing mercury cathode for the electrolysis of aqueous solutions of alkali metal halides, without interrupting the electrolysis at any of the anodes of the cell.

With the object of reducing the ohmic resistance of the brine and, consequently, the consumption of electrical energy, the anodes are disposed as close as possible to the mercury cathode. In present-day cells, the distance between electrodes varies in general from 0.5 to 5.0 mm.; sometimes it is negative, that is the anodes are lowered several tenths of a millimetre beneath the normal level of the mercury surface, which enables very low electrolytic voltages to be used provided that the current density is high enough.

With such anode-cathode gaps short-circuits between electrodes are inevitably produced through accidental contacts between the anodic assembly and the mercury cathode. These contacts are particularly unfortunate in cells with anodes of titanium coated with metal or with noble metal compounds, because the coating and the support suffer serious damage.

These short-circuits can result from various causes:

presence of impurities (for example thick mercury) on the surface of the liquid cathode

unsuitable adjustment of the gap between anodes and cathode alteration in the depth of the mercury layer as a result of variations in the feed rate

undulation of the mercury surface as a result of irregular working of the mercury pump

momentary or permanent reduction in the current strength in the case of immersed anodes (anode-cathode gap negative)

breaking of an anode, this danger being however very slight in the case of metallic anodes.

Such short-circuits if they are not removed promptly, can have, besides their unfortunate influence on the current efficiency of the cells, serious consequences such as destruction of the anode and its current lead and deformation or even perforation of the base-plate by excessive local overheating.

It is therefore of the first importance to detect rapidly threats of short-circuits and to avoid them in order to ensure economic operation of electrolytic cells with flowing mercury cathodes and particularly when anodes of titanium coated with precious metal, their alloys or oxides are employed.

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In cells with a mercury cathode and graphite anodes, the protection is generally ensured by one of the following methods:

(1)(a) Detection of a short-circuit by any appropriate means, for example by measuring the cell-voltage by means of a contact voltmeter which starts an alarm signal as soon as the voltage attains the lower fixed limit;

(b) Taking the cell off load by external short-circuiting so as not to stop all the cells belonging to the same electrical series;

(c) Possibly, in case of a local short-circuit, locating and manually raising the short-circuited anode.

(2) Automatic disconnection of the short-circuited anode by melting of a fusible member installed in the current lead.

Although technically there is no objection to the use of this latter method of protection for cells with titanium anodes, it has a great disadvantage from the economic point of view because the fusible member necessarily forms a resistance to the passage of electric current in the current lead.

As far as external short-circuiting of the entire cell is concerned, it presents serious disadvantages for cells with metallic anodes, especially those based on titanium. It is generally achieved by connection of the anodic assembly of the cell to be protected to that of one of the neighbouring cells, or again by connection of its cathode to that of a neighbouring cell. In both cases the cell is short-circuited on itself and the amalgam present is rapidly decomposed with liberation of hydrogen from the anodes. Their coating, which generally consists of at least one metal of the platinum group or its oxide optionally mixed or alloyed with other metals or compounds, always offers a certain porosity which allows the atomic hydrogen formed to react with the metal underneath (titanium, tantalum, zirconium, niobium or their alloys) to form a hydride whose poor resistance to corrosion renders the anode useless.

In the case of cells with titanium or similar anodes, taking the cell off load as called for by the alarm signal must thus be accomplished without external short-circuiting of this cell on itself in order to avoid violent decomposition of the amalgam with liberation of hydrogen at the anodes. This can be done, for example, by connecting the anodic assembly of one cell to that of a neighbouring cell and at the same time disconnecting the cathode of the cell taken off load. To render this method of disconnection automatic would require a significant capital outlay on copper bars and movable contacts, the number of the latter being double that for a simple external short-circuiting of the cell. Moreover, whether the cells are on or off load, the electrolytic current must always pass through a number of switch contacts corresponding to the number of cells in the series. These contacts inevitably offer a certain resistance which moreover has a tendency to increase in a corrosive atmosphere and are hence responsible for a continual loss of energy, particularly high in automore loose.

In short, in the classical methods of protection described above, the anode concerned, the anode group, or even the whole cell is always taken off load, that is all electrolysis is interrupted until the defective element is put back in place and in circuit.

The present invention avoids all these disadvantages. It relates to the automatic protection of the anodes of a cell with a flowing mercury cathode in a group of similar cells connected in series, against the effects of a short-circuit due to contact with the mercury cathode while keeping all the anodes of the cell under electrolytic tension, i.e. without disconnecting any of them.

This protection is achieved by rapidly removing from the cathode, the anode or the group of anodes which is threatened with short-circuit, so as to increase substantially the anode-cathode gap, under the impulse of a short-circuit detector.

Generally, in horizontal cells a rapid displacement of the anode by 5 to 15 mm. is desirable.

The present invention also relates to an apparatus for effecting the displacement of one or more anodes before the short-circuit occurs between electrodes which comprises a bus-bar supporting the anode or group anodes, a flexible connection for leading current to said bus-bar, at least one electrically conducting probe protruding from the base of the anode plate, integral therewith and electrically insulated therefrom, short-circuit detector means electrically connected external to the cell between said probes and the cell base plate and means responsive to said detector means for raising the bus-bar so as to withdraw the anodes away from the cathode.

Two embodiments of this apparatus are described below with reference to the attached drawings in which the references common to the figures relate to the same constituent parts.

FIG. 1 is a schematic vertical sectional view of a horizontal cell;

FIG. 2 is a similar view of a modified form of cell; and

FIG. 3 is a schematic fragmentary view, on an enlarged scale of a portion of a cell.

1 represents the base-plate of the cell on which the mercury film **18** is flowing and **2** its cover which supports the substantially vertical threaded rods **3** and which is provided with sealing means **4** (bellows, membranes etc.) allowing the sliding of current leads rods **5** which support the anode **6** substantially parallel to the plane of the mercury. The rods **5** can be at least partially of titanium or a similar metal.

The substantially horizontal copper bar **7** conducts the current to the anode rods **5** which it supports; it is fed by a flexible connection **8** (for example a copper leaf) which connects it to the base-plate of the preceding cell in the series. The adjusting nuts **9** limit the upward movement of the bar **7**, thus determining the raised position of the anode, while the anode-cathode-gap adjusting nuts **10** fix the normal operating position of the anode. It is desirable to be able to adjust the movement of the bar **7** between 5 and 15 mm. and accordingly the height of raising the anode **6** which is integral with it. A pneumatic cylinder **11** releases the ascending movement of the anode under the impulse of a signal arising from the short-circuit detecting apparatus **19** (FIG. 3). The approach of a short-circuit is detected for each anode by means of one or more probes **20** projecting slightly from the active surface of the anode and connected to the apparatus for detecting a short circuit.

The probe **20** is carried by the anode plate through which it passes, but is electrically-insulated from the latter. Advantageously, the probe **20** consists of a titanium wire whose protruding end is platinised, and the probe/anode electrical insulation is ensured by a "Teflon" sheath **22** around the probe except at the platinised end.

When the anode/cathode separation becomes too small, one or more of the anode probes **20** makes contact with the mercury **18** so that the short circuit detecting means **19** causes removal of the anode before the latter makes contact with the liquid cathode, thus completely avoiding short-circuit between the electrodes.

The detecting means **19** may be activated by utilising the electrolysis current, by a contact voltmeter connected between the probes and the base-plate of the cell (which carries the flowing mercury cathode), or by recourse to an external source of low-strength current of which one pole is connected to the conducting base-plate and the other to the probe or to the group of probes which are connected in parellel. In the last case, the anode movement or the alarm signal will be activated by a contact ammeter connected in the circuit, for example between the probe and the current source, or again by a contact voltmeter or a relay tapped across the circuit and shunted by the probe.

The use of the probes according to the invention not only avoids untimely short-circuits during electrolysis, but also fixes a reference point when adjusting the anodes.

In FIG. 1, the pneumatic cylinder **11**, through an arrangement of linkages **12** pivoted about the fixed pin **13**, moves the latches **14** which release the bar **7**. The springs **15** rapidly extend, thus throwing the bar upwards as far as the limit-nuts **9**.

In FIG. 2, on the contrary, the spring **16** is not compressed when the anode is in its normal operating position. In the event of a short-circuit, the pneumatic cylinder **11** raises instantaneously the bar **7** (and the anode **6** which is suspended from it), at the same time compressing the spring **16**. Here the cylinder **11** does not rest on the bar **7**, as in FIG. 1, but in fact on a support **17** which rests on the screwed rods **3**.

It is understood of course that the above descriptions only constitute particular ways of arranging the apparatus claimed, provided by way of example and not limiting. The pneumatic cylinder **11** for example can be replaced by a solenoid or any other suitable moving means. Likewise, the sealing devices represented by **4** could also consist of washers or pressed-packing.

The method of claimed presents the following known advantages over prior art methods:

Since the prevention of a short-circuit is not achieved by cutting off the current nor by external short-circuiting, it does not ipso facto entail the interruption of electrolysis at the anode or anodes protected. This continues, but with reduced intensity, until the initial inter-electrode gap is re-established, which can be done by simple manual control.

The electrolysis can be effected at a lower voltage because the anodes-cathodes gap can be distinctly smaller than in cells not provided with the protection apparatus claimed.

In fact, there is more ready acceptance of the risk of a dangerously close approach of the anode to the cathode when means are installed to prevent a short-circuit to continue the electrolysis at the protected anodes.

What is claimed is:

1. In an electrolytic cell having at least one anode disposed above a base plate over which a mercury electrode flows, a vertically movable bus-bar supporting the anode, and a flexible electrical connection for leading current to said bus-bar, the improvement which protects the anode against a short circuit arising from contact thereof with the cathode, said improvement comprising: at least one electrically conducting probe protruding downwardly from the anode so as to be engageable with the cathode before contact between the anode and cathode occurs, said probe being carried by the anode and electrically insulated therefrom; short circuit detector means electrically connected external to the cell between the probe and the cell base plate for detecting a short circuit between the probe and the cathode; and means responsive to the detector means for raising the bus-bar to thereby withdraw the anode away from the cathode.

2. Apparatus according to claim **1**, characterised in that each of said probes consists of at least one titanium wire covered with "Teflon" except at the protruding end, which is platinised.

3. Apparatus according to claim **1**, characterised in that the short-circuit detector means comprises a contact voltmeter, connected between the said probe and the conducting base-plate of the cell and means for maintaining the voltmeter under electrolysis voltage when there is no short-circuit between any one cell and the cell cathode.

4. Apparatus according to claim **1**, characterised in that the short-circuit detector means comprises a contact ammeter connected in series with an auxiliary source of current between the said probes and the conducting base-plate of the cell.

5. Apparatus according to claim **1**, characterised in that the short-circuit detector means comprises a contact voltmeter or a relay shunted across an auxiliary source of current connected in an external circuit between the said probes and the said conducting base-plate.

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JOHN H. MACK, Primary Examiner

D. R. VALENTINE, Assistant Examiner

U.S. Cl. X.R.

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