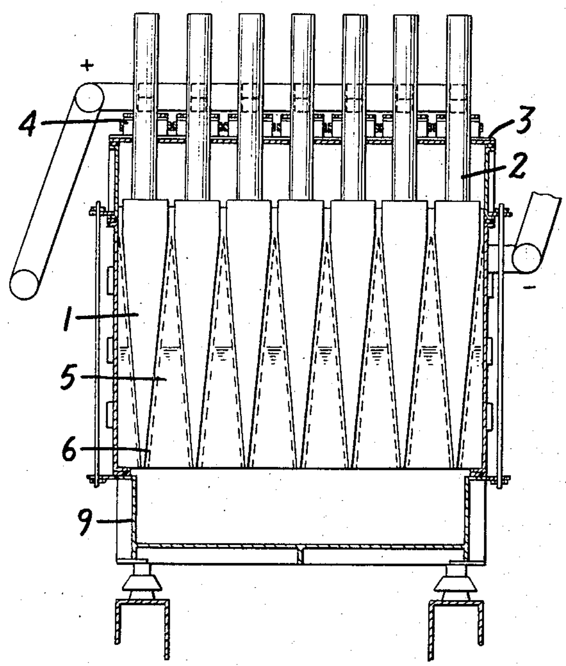
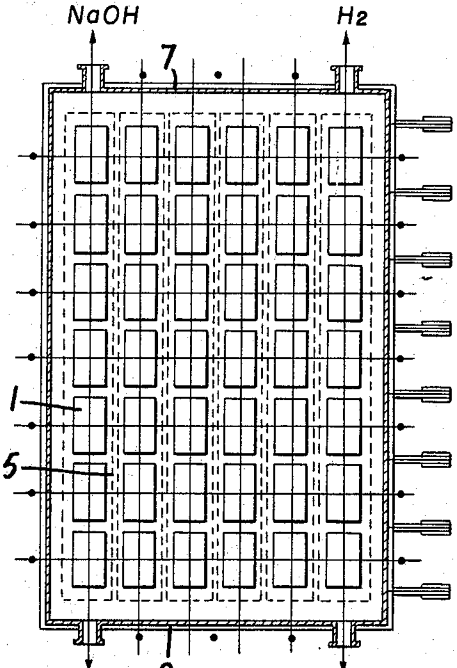


FIG. 1a

FIG. 1c



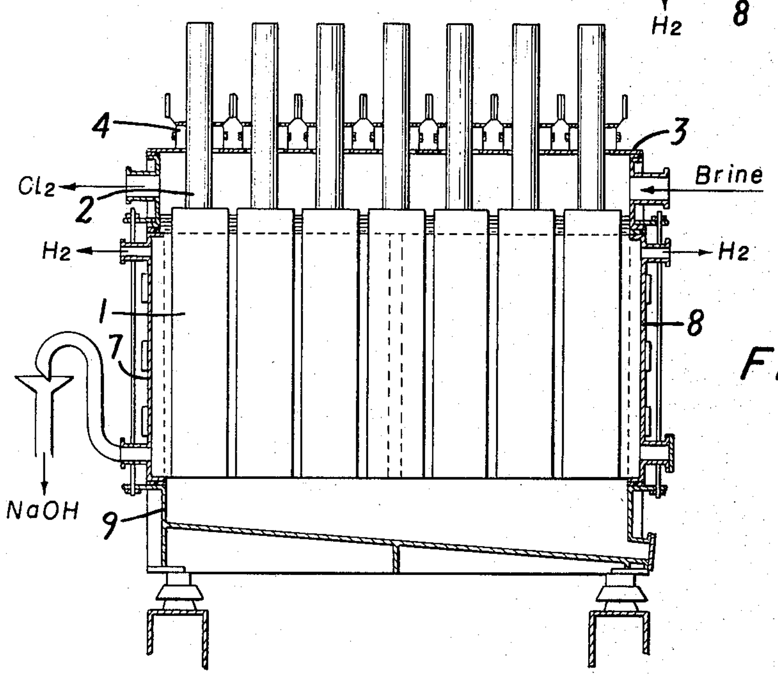


FIG. 1b

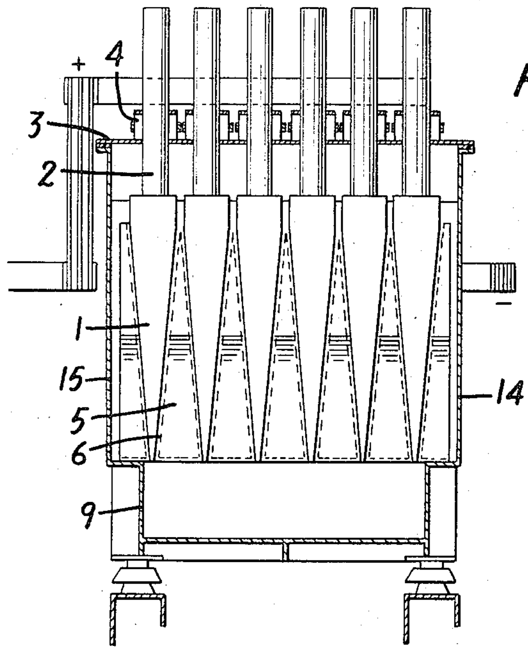


FIG. 2a

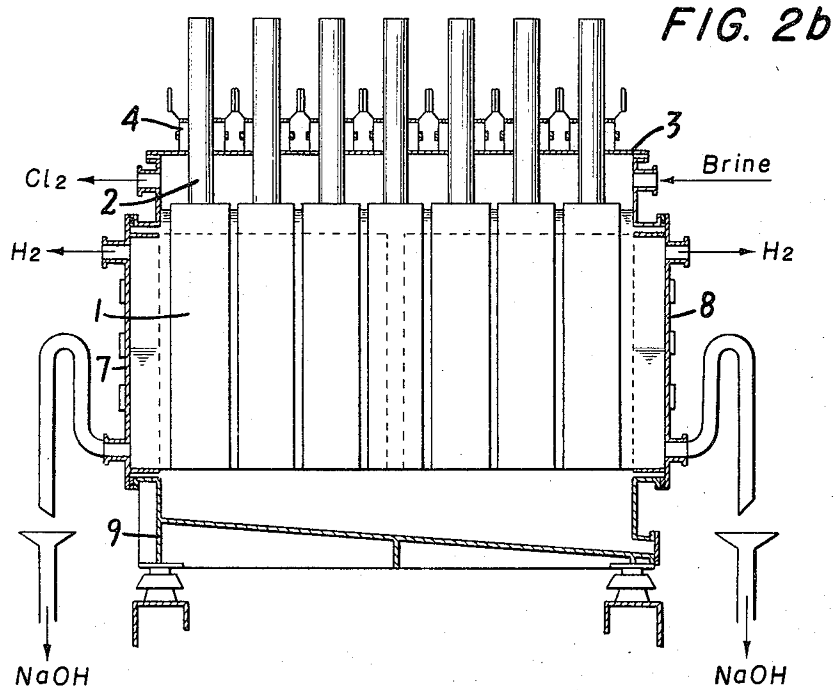


FIG. 2b

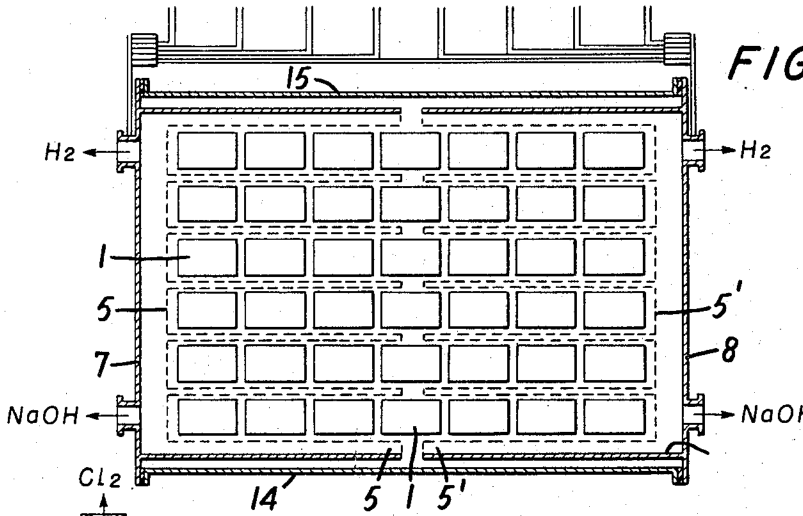


FIG. 2c

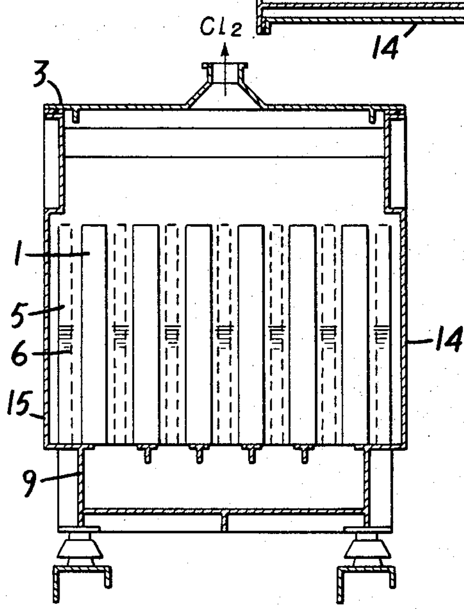


FIG. 3a

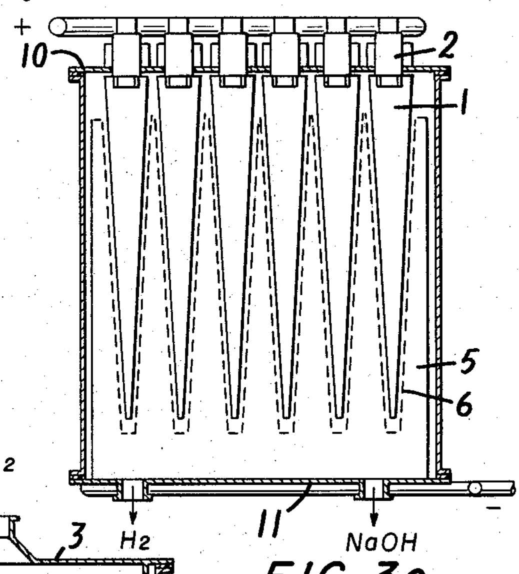


FIG. 3c

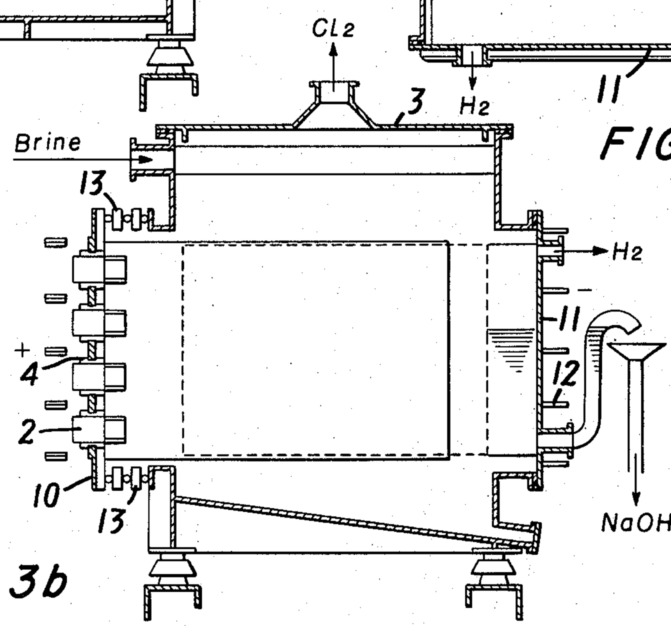


FIG. 3b

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3,375,184

ELECTROLYTIC CELL WITH CONTROLLABLE MULTIPLE ELECTRODES

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5 Claims. (Cl. 204—225)

The invention is concerned with an electrolytic cell of the type which comprises a succession of vertical electrodes in which graphite anodes alternate with cathodes carrying a diaphragm; in particular, it is concerned with an arrangement of the anodes and cathodes which permits the increasing distance between the electrodes, caused by the wear of the anodes, to be compensated without interrupting the electrolysis.

The use of diaphragms arranged in cells for the electrolysis of aqueous solutions of alkali metal halides, especially sodium chloride, has been known for a long time. It permits the construction of essentially cubic cells operating at low voltage and high amperage, due to the increase in the number of anodes and cathodes and to their arrangement in a compact group.

In the classical cells of this type, the anodic graphite plates are mounted vertically in the base by means of a layer of lead which secures the electrical connections and is covered with a cement layer and an asphalt layer.

This method of mounting the anodes presents certain disadvantages some of which are not negligible:

At the temperature of the electrolysis, the asphalt layer undergoes a softening which may result in its displacement.

This asphalt layer may give rise to the formation of halogenated (chlorinated) organic compounds which contaminate the halogen (chlorine) generated at the anodes.

If the protective layers break, the lead of the base is attacked by the halogen (chlorine) formed at the anode and passes into the cathodic liquor in the form of plumbite.

It is impossible to replace an anode which breaks, for some reason or other, in the course of the electrolysis.

Since the anodic plates are sealed in the base, it is not possible to compensate, during the electrolysis, for the increase in the distance between the electrodes, which is due to the graphite being used upon its whole active surface. This distance which is initially about 10 mm. may reach 25 mm. It is known (Hayder and Springemann: Chloralkalielektrolyse, Chem. Tech., December 1956, pages 702–704, "Wirtschaftliche Überlegungen zum Problem Hg- oder D-Verfahren bei der Chloralkalielektrolyse") that an increase in the distance between anode and cathode of 10 mm. corresponds to an increase in the electrolysis potential of about 20 mv. for a current density of 100 a./m.^{2}. In practice, this increase in potential is even higher, since the anodic surface is not worn off uniformly and presents rough spots which give rise to a halogen (chlorine) over-potential.

The present invention permits these advantages to be obviated.

The object of the invention is an electrolytic cells with diaphragm comprising a succession of alternating anodes and cathodes, characterised in that the electrodes have the shape of alternately reversed wedges, the anodes and the cathodes having the same wedge angle, and that each anode fits in between two adjacent cathodes in the free space left between the latter, the distance between the parallel surfaces of the electrodes being determined by the height of one series of electrodes of the same sign relative to the height of the intercalated electrodes of opposite sign.

In particular, the cell forming the object of the present invention is intended for the electrolysis of aqueous solutions of sodium chloride.

It is known that in the course of this electrolysis the life of the graphite anodes is generally four times that of the diaphragm. In the course of one operating cycle of the cell, the diaphragm will thus have to be renewed three times. The device according to the invention makes it possible to exchange at every renewal of this kind any anode which may be broken for some reason and, if desired, to straighten the anodic surface by means of a suitable apparatus.

The accompanying drawings illustrate diagrammatically, by way of example, three forms of execution of the device of the present invention.

The FIGURES I*a*, II*a*, III*a* show cross-sections of three cells according to the invention; the FIGURES I*b*, II*b*, III*b* and I*c*, II*c*, III*c*, respectively, show cross-sections and horizontal sections of the corresponding cells. The preferred devices are those illustrated by FIGURES II and III.

In the cells shown in the FIGURES I*a*, I*b*, I*c* and II*a*, II*b*, II*c*, the wedge-shaped graphite anodes **1** are suspended with their thin ends downwards, the lower edge being horizontal, by means of a rod **2** conducting the current and sliding in the lid **3** of the cell, by means of a device **4** which is known as such and enables the distance between the electrodes to be regulated during the electrolysis.

Such a device can consist of a graphite rang such as the one described in Belgian Patent Specification No. 457,712.

The sets of anodes **1** are interposed between the cathodes **5** so as to be placed in the free spaces left between the latter. The cathodes **5**, preferably made of metal, carry the diaphragm **6**. They are also wedge-shaped, but their thin ends are directed upwards, the upper edge being horizontal.

In the cell shown in FIGURES I*a*, I*b*, I*c*, the cathodes **5** are arranged in a cathode assembly which rests on the base **9** of the cell and supports the lid **3**.

The cell illustrated by the FIGURES II*a*, II*b*, II*c* differs from the first in that the cathode assembly is devised as a drawer mounted in the frame of the cell which enables the cathodes to slide in parallel to the edges of the wedges in the space left free between the anodes. Preferably the cathode assembly is constituted by partial drawers. These are formed by the lateral walls **7** and **8** and the cathodes **5** and **5'** and they slide in the frame of the cell between the two other lateral walls **14** and **15**.

When the two partial assembles (**5**) (**5'**) are in their place in the interior of the cell, they constitute an assembly similar to the single casing of the cell shown in FIGURES I*a*, I*b*, I*c*.

The advantage of this second method of execution is that it permits the two cathodic partial assemblies to be removed for renewal of the diaphragms and straightening of the anode surfaces, without necessitating the removal of the lid carrying the anodes. The latter is only removed when all the anodes have to be replaced.

The two cells described above enable the distance between electrodes of opposite sign to be kept constant by regulating the height of the anodes in the cells. This operation can be performed every time the cells are opened for replacing the diaphragms, or even during the electrolysis by using an apparatus measuring the amperage of each anode individually. Moreover, all the disadvantages inherent in the use of layers of lead and asphalt are clearly removed.

A third method of putting the invention into practice is illustrated by the FIGURES III*a*, III*b*, III*c*. According to this variant, the electrodes are arranged with their thin edges vertical; the anodes are fixed in an anodic assembly and the cathodes in a cathodic assembly. The anodic and cathodic assemblies are mounted in the frame of the cell in the manner of drawers and the relative depth of the drawers makes it possible to regulate the distance between the electrodes. Moreover, the cases can be removed for inspection and maintenance of the cell.

Since the lid **3** does not support any electrode, its removal is infinitely more convenient. The electrodes of opposite sign are fixed to the two opposed lateral walls **10** and **11** of the cell by the surfaces opposite their thin ends, possibly by means of rods **2**, **12** conducting the current. The walls **10** and **11** and the electrodes **1** and **5** together form the anodic and cathodic assemblies, which slide between the two other lateral walls **14** and **15**.

The electrolysis tank comprises two lateral apertures through which pass the anodic assembly (**1** and **10**) and the cathodic assembly (**5** and **15**), which fit one into the other. A set of suitable cross-bars **13** enables the anodic case to be introduced more or less deeply into the cell, thereby regulating the distance between the anodes and cathodes.

This third method of execution permits the regulation of the anode-cathode distance and the renewal of the diaphragm, the replacement of a broken anode or the straightening of the anodic surfaces; these operations are easily carried out without having to remove the lid of the cell.

It is apparent that the three embodiments described above are not limitative; the figures are given by way of example only and any other modified form based on bringing the anodes and cathodes nearer together can be adapted without departing from the scope of the invention.

It is conceivable, for example, that in the cells shown in FIGURES I*a*, I*b*, I*c* and II*a*, II*b*, II*c* the anodes are not supported by the lid itself, but by a perforated partition arranged horizontally between the cathodic assembly of assemblies and the lid. This perforated partition would not hinder the passage of the chlorine and of the brine and it would enable the length of the rods supporting the anodes to be noticeably reduced.

I claim:

1. Electrolytic cell with diaphragm comprising a succession of alternating anodes and cathodes, characterised in that the electrodes are in the form of alternately reversed wedges, the anodes and cathodes having the same wedge angle, and that every anode fits in the free space left between two adjacent cathodes, the distance between the parallel surfaces of the electrodes being determined by the height of one series of electrodes of the same sign relative to that of the electrodes of opposite sign.

2. Device according to claim **1**, characterised in that the anodes are suspended, the thin ends being downwards and the lower edges horizontal, by rods conducting the current and sliding in the lid of the cell, by means of a device which permits a vertical displacement of the anodes during the electrolysis, whereas the cathodes are fixed to the lateral walls of the cell, their thin ends being upwards and the upper edges horizontal, parallel with the thin ends of the anodes, thus forming a cathodic assembly.

3. Cell according to claim **2**, characterised in that the cathodic assembly is in the form of a drawer mounted in the frame of the cell, thus enabling the cathodes to slide in parallel with the edges of the wedges in the space left free between the anodes.

4. Cell according to claim **3**, characterised in that the cathodic assembly is formed by two partial drawers which can be removed on opposite sides of the cell.

5. Cell according to claim **1**, characterised in that the electrodes are arranged with vertical thin ends and that the anodes are fixed in an anodic assembly and the cathodes in a cathodic assembly, the anodic and cathodic assemblies being mounted in the frame of the cell in the manner of drawers, the relative depth of the drawers enabling the distance between the electrodes to be regulated and the assemblies being capable of removal for inspection and maintenance of the cell.

References Cited

UNITED STATES PATENTS

682,155	9/1901	Tatro et al.	204—225
2,392,868	1/1946	Stuart	204—252

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