Jan. 13, 1959

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COMPOSITE ANODE ASSEMBLY FOR USE IN ELECTROLYTIC CELLS

2,868,712

Filed June 2, 1954

2 Sheets-Sheet 1

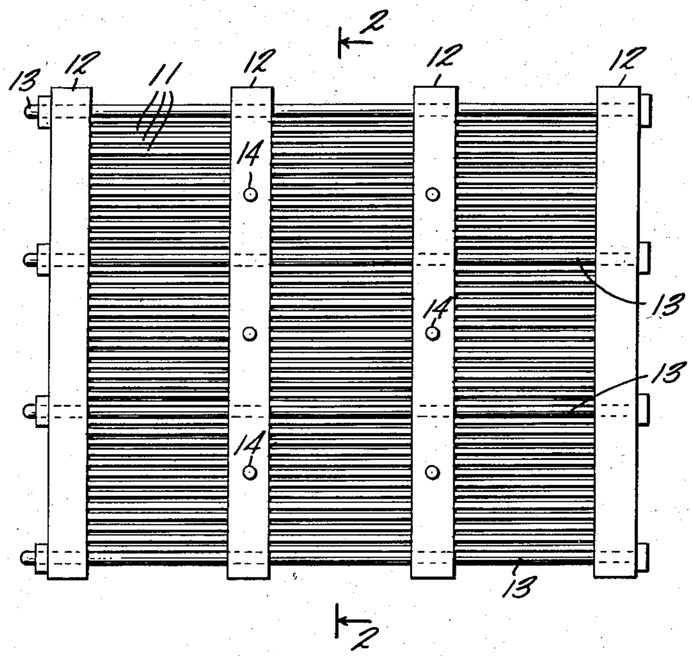

FIG. 1.

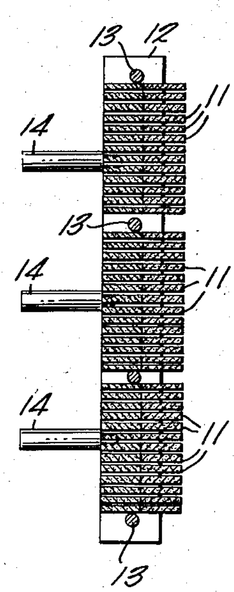

FIG. 2.

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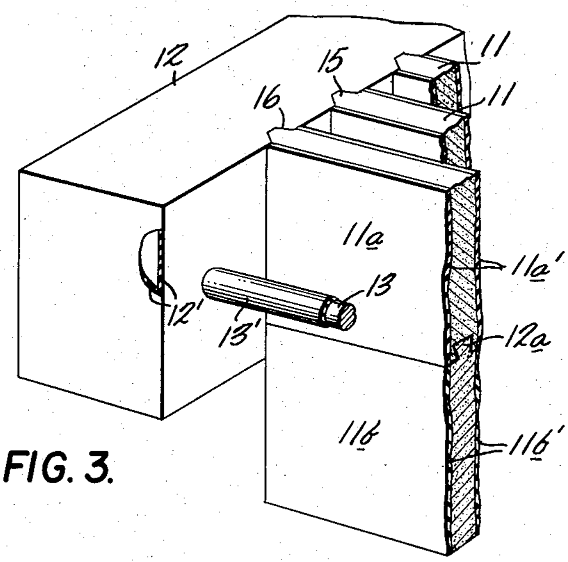

FIG. 3.

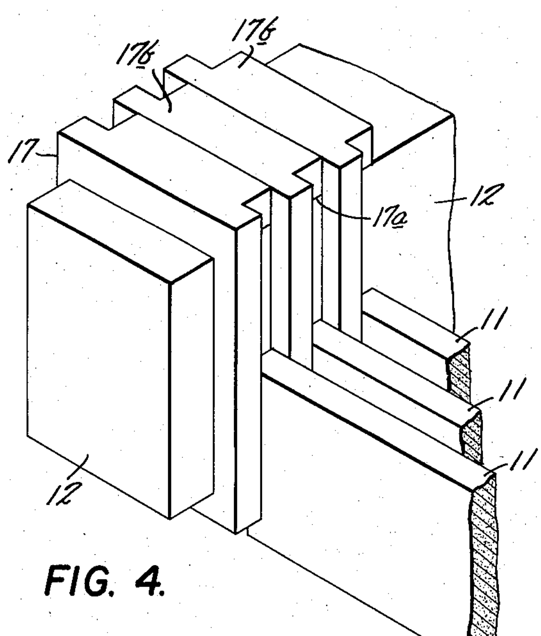

FIG. 4.

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COMPOSITE ANODE ASSEMBLY FOR USE IN ELECTROLYTIC CELLS

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Application June 2, 1954, Serial No. 433,880

Claims priority, application Belgium June 4, 1953

9 Claims. (Cl. 204—288)

This invention relates to graphite anodes for electrolytic cells.

In current practice anodes are formed of graphite plates of which one of the major surfaces constitutes the anodic surface proper and of a current supply means which serves at the same time to support the anode opposite the cathode. Usually the connection between the current supply means and the anode plates is made in the actual body of the anode plate either by threading or by pressure fastening.

Wear of the anode plates gradually diminishes the plate thickness and there is a minimum thickness below which one cannot go without incurring the risk that the anode plate will break and thus bring about short circuits in the cells in operation. This minimum is determined first of all by the depth of the cavity that is cut into the body of the plate for the connection with the current lead. In practice, to prevent breaking of the plates which have become brittle by wear and to prevent splinters from short circuiting the cells when in operation, it is necessary to throw away the plates before the wear has reached the level of the cavity.

Thus a plate which, when new, has a thickness of 75 mm. must be replaced when, by reason of wear, its thickness has decreased to 15 mm., the loss of graphite amounting thus to 20 percent of the graphite originally used.

B. I. O. S. Final Report No. 846 describes a type of graphite anode in which the anode plates have, on their working surface, deep grooves which are cut into the mass of the plates. At the bottom of these grooves are provided holes which pass throughout the thickness of the anode, and the ducts thus defined are used to remove the anodic products of electrolysis and to ensure replenishment of the electrolyte. The manufacture of anodes of this type leads to a serious loss of graphite even before the anodes are put into service. Furthermore such anodes still contain after wear a considerable quantity of graphite which has to be thrown away as in the first mentioned case.

One object of the invention is to avoid all loss of graphite by making it possible to use graphite anodes until the graphite of the same has been completely used up.

According to the invention, an anode arrangement for the electrolysis of solutions in electrolytic cells, e. g. of the flowing cathode type, comprises a series of flat graphite elements arranged perpendicularly to the cathode of the cells and spaced so as to facilitate the removal of the anodic products of the electrolysis and the replenishment of the electrolyte, and each of these elements comprises a plurality of thin graphite plates, assembled together in edge to edge, abutting relationship, the assembly of plates being removably supported so as to permit, when the plate facing the cathode is partly used up, the extension of the assembly by the addition of a new plate at the side of the assembly opposite that of the partly used plate and the displacement of the plates towards the cathode in order that the partly used plate may be completely used up.

In a preferred embodiment the graphite plates which

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are assembled in edge to edge abutting relationship as mentioned are held in graphite blocks which are provided with the current supply means and with which the plates engage at their two side edges, the whole forming a unit to which rigidity is conferred by tie bars which are resistant to the action of the products of electrolysis.

In addition to the complete using up of the graphite, a further object of the invention is to protect against erosion the surfaces of the parts which do not participate in the electrolysis.

According to the invention this object is achieved by covering these parts by means of a protective material which is resistant to erosion, such as polyvinyl chloride or polyethylene in particular. The protective material that is applied to the anode plates is such however that it disintegrates and disappears automatically when entering the actual zone of electrolysis proper in order that the active surface of the anodes may be freed of said material to an extent and at a rate corresponding to the rate at which the anode is used up. A suitable material for this purpose is polyvinyl chloride containing pulverized graphite distributed in it.

It is also contemplated according to the invention that elements formed of protective material be used to cover the graphite blocks which support the anode plates and to ensure the correct spacing of said plates. Such protective elements are advantageously in the form of rings which match the shape of the blocks and which are strung thereon, but which are shaped to permit contact of the blocks with the plates between which the rings serve as spacers.

The invention is illustrated by way of example in the accompanying drawings in which:

Figure 1 is a plan of an anode assembly according to the invention,

Figure 2 is a transverse section along line II—II of Figure 1,

Figure 3 is a fragmentary view on an enlarged scale showing in perspective one way in which connection between the series of anode plates and their support blocks may be effected.

Figure 4 is another view similar to Figure 3 but showing one way in which the support and current supply blocks may be protected against the effects of electrolysis.

Referring to the drawings, and more particularly to Figs. 1, 2 and 3, there is shown an anode assembly embodying features of the present invention. The assembly comprises a plurality of anode elements arranged in parallel groups and mounted in support blocks held in position by tie bars. The anode elements are indicated at **11**; each element comprises vertically adjacent anode plates **11**a and **11**b. The support blocks are indicated at **12** and the tie bars at **13**. In the embodiment shown, the anodes are arranged in nine groups with the plates in parallel relationship, leaving a regular spacing between them. Blocks **12** carry metallic current supply means **14** which are adapted to be connected to suitable feeders (not shown) which carry the electrolysis current. In order to reduce contact resistance between the anode elements **11** and their support blocks **12** the side ends of the anode plates may be provided with projections **15** which engage with corresponding grooves **16** cut into the blocks. These grooves and projections are preferably cut perpendicular to the plane of the active anodic surface (Figure 3) since this arrangement is more readily carried into effect.

The support blocks are designed preferably to hold at least two anode plates which are connected to each other in edge-abutting relationship along their edge faces which are parallel to the active face of the arrangement, that is to say parallel to the face opposite to that which carries the current supply means **14**. The anode plates are provided on the faces parallel to their active surface with assembly means which ensure simultaneously mechanical and electrical connection. This assembly of the plates can be carried out by known means (not shown), for example by mortise and tenon joints, dovetails, lugs, etc. Anode elements are thus obtained which comprise at least two anode plates **11***a* and **11***b* connected in edge-abutting relationship.

An arrangement is thus formed in which the anode plates extend in a direction away from the active electrolytic zone; the advantage and the purpose of this arrangement will appear from the operation of the anodes described below.

During electrolysis the anode plates are used up, as known, at their faces nearer to the cathode of the electrolytic cell, that it to say each plate **11***b* will wear down at the edge face opposite to that which is in contact with the corresponding plate **11***a*. The distance between the anode and the cathode is maintained, at the rate and to the extent at which the anode is used up, by displacement of the anode assembly in known manner towards the cathode. When the anode has been used up to such an extent that its active surface is nearly in the plane defined by the outer surfaces of the support blocks which are opposite to the surfaces which carry the current supply means, the anode assembly is displaced away from the cathode, and new anode plates are mounted on the old ones at the side opposite the partly used plates. The tie bars **13** are then loosened and the plates that have thus been assembled are shifted in the direction of their active surface without removing the worn plate. The tie bars are thereafter tightened and the distance of the anode to the cathode of the cell is re-adjusted. As the plate that has been partly used up is assembled edge to edge with the following plate it may be completely used up without any loss of graphite in the course of electrolysis.

As already stated it is also an object of the invention to protect against erosion the surfaces of the assembly which do not directly take part in the electrolysis.

To this end the graphite plates **11** are covered laterally with a protective coating of polyvinyl chloride, for example. It is necessary that the material which protects the graphite disintegrates when it penetrates into the zone of electrolysis proper. Under these conditions, the protective coating or cover disappears at the rate and to the extent that the active surface of the anode is used up. By way of example the lateral surfaces of the plates may be protected by covering them with a thin sheet of polyvinyl chloride containing pulverised graphite distributed in the sheet.

The current supply and support blocks **12** are also covered with a layer of protective material on the surface which is not in contact with the anode plates. This protective layer, for instance, may be formed by a coating or an enamel, or the blocks may be covered by means of a layer of, for example, polyvinyl chloride or polyethylene, which layer may be formed of a single piece or may consist of annular elements.

Finally the metal rods which feed the electric current to the blocks are protected against corrosion by tubular sleeves (not shown) made of a protective material.

In accordance with a particular manner of protecting the anode supporting blocks, especially suitable when the contact grooves and projections, by which said blocks and the anode plates are connected together, are arranged in the manner shown in Figure 3, the protection means for the blocks may be used simultaneously for the spacing of the anode elements. To this end (see Figure 4) frames **17** of an insulating material such as polyethylene are used. The aperture of such frames corresponds to the maximum dimensions of the transverse section of the current supply blocks **12**, two opposing sides of said frames being grooved at **17***a* to permit contact between the anode plates **11** and the block **12**, while the two other surfaces **17***b* form a continuous surface with the corresponding surfaces of the adjacent frames and thus ensure protection of the surfaces of said blocks which are not in contact with the anode plates.

For clarity the grooves and projections which increase the contact area of the graphite, are not shown on Figure 4. The ends of the current supply blocks are protected by caps (not shown) made from a similar insulating material and attached to the graphite in known manner, for instance by means of screws made from a material that resists corrosion.

It must be understood that the invention is not limited to the forms and details of execution which have been described and shown by way of example and various modifications may be carried out without departing from its scope.

I claim:

1. A composite anode assembly for use in an electrolytic cell adapted to be positioned opposite the cathode of the cell comprising, in combination, a plurality of thin rectangular graphite plates each having a first elongated end edge face forming the active anodic surface of the plate and adapted to be disposed opposite the cathode of the cell in face to face spaced parallel relationship therewith, side edge portions merging with each end of said end edge face at right angles thereto, and a second elongated end edge face on the portion of the plate remote from said first end edge face, a carrier frame formed from a plurality of spaced parallel bars engaging the side edge portions of said rectangular graphite plates at right angles thereto with the plates in parallel spaced-apart relationship, and adjustably tightenable tie rods interconnecting the parallel bars to hold the interposed graphite plates removably in said spaced-apart parallel relationship, said plates being slidable relatively to said bars upon loosening of said tie rods, the portion of each plate provided with said first end edge face projecting beyond the assembled parallel bars with said end edge faces of all of said plates lying substantially in a common plane adapted to be disposed in parallel relationship with respect to said cathode when the anode assembly is mounted in the electrolytic cell, each plate being formed from at least two plate elements lying in a common plane in edge-abutting relationship with the second end edge face of the element providing the active anodic surface in engagement with the second end edge face of the adjacent element while both elements have their side edge portions in engagement with said parallel bars, means holding the plate elements of each plate in removable interengaged relationship, and the elements of each plate being movable in their respective planes relatively to the parallel bars in the direction of said active anodic surface as the plate element providing the active anodic surface is consumed, and said bars being adapted to accommodate a fresh plate element in coplanar relationship with the plate elements of each plate as the plate progresses in the direction of said active anodic surface, the fresh plate element being adapted to be placed in edge-abutting relationship and removably interengaged with the end edge face of the plate element of each plate most remote from said anodic surface.

2. A composite anode assembly as defined in claim 1, wherein the surfaces of said plates are coated with erosion-resistant material.

3. A composite anode assembly as defined in claim 1, wherein the surfaces of said plates are coated with a composition comprising polyvinylchloride and pulverized graphite.

4. A composite anode assembly as defined in claim 1, wherein said bars are formed from graphite.

5. A composite anode assembly as defined in claim 1, wherein said bars are formed from graphite coated with an erosion-resistant material.

6. A composite anode assembly as defined in claim 1, wherein said tie rods are made of metal and coated with a corrosion-resistant material.

7. A composite anode assembly for use in an electrolytic cell adapted to be positioned opposite the cathode of the cell comprising, in combination, a plurality of thin rectangular graphite plates each having a first elongated end edge face forming the active anodic surface of the plate and adapted to be disposed opposite the cathode of the cell in face to face spaced parallel relationship therewith, side edge portions merging with each end of said end edge face at right angles thereto, and a second elongated end edge face on the portion of the plate remote from said first end edge face, a carrier frame formed from a plurality of spaced parallel graphite bars engaging the side edge portions of said rectangular graphite plates at right angles thereto with the plates in parallel spaced-apart relationship, said bars being formed with means for guiding said plates in said assembly, and adjustably tightenable tie rods interconnecting the parallel bars to hold the interposed graphite plates removably in said spaced-apart parallel relationship, said plates being slidable relatively to said bars upon loosening of said tie rods, the portion of each plate provided with said first end edge face projecting beyond the assembled parallel bars with said end edge faces of all of said plates lying substantially in a common plane adapted to be disposed in parallel relationship with respect to said cathode when the anode assembly is mounted in the electrolytic cell, each plate being formed from at least two plate elements lying in a common plane in edge-abutting relationship with the second end edge face of the element providing the active anodic surface in engagement with the second end edge face of the adjacent element while both elements have their side edge portions in engagement with said parallel bars, means holding the plate elements of each plate in removable interengaged relationship, and the elements of each plate being movable in their respective planes relatively to the parallel bars in the direction of said active anodic surface as the plate element providing the active anodic surface is consumed, and said bars being adapted to accommodate a fresh plate element in co-planar relationship with the plate elements of each plate as the plate progresses in the direction of said active anodic surface, the fresh plate element being adapted to be placed in edge-abutting relationship and removably interengaged with the end edge face of the plate element of each plate most remote from said anodic surface.

8. A composite anode assembly for use in an electrolytic cell adapted to be positioned opposite the cathode of the cell comprising, in combination, a plurality of thin rectangular graphite plates each having a first elongated end edge face forming the active anodic surface of the plate and adapted to be disposed opposite the cathode of the cell in face to face spaced parallel relationship therewith, side edge portions merging with each end of said end edge face at right angles thereto, and a second elongated end edge face on the portion of the plate remote from said first end edge face, a carrier frame formed from a plurality of spaced parallel graphite bars engaging the side edge portions of said rectangular graphite plates at right angles thereto with the plates in parallel spaced-apart relationship, said bars being formed with grooves for receiving and guiding the side edge portions of said plates, and adjustably tightenable tie rods interconnecting the parallel bars to hold the interposed graphite plates removably in said spaced-apart parallel relationship, said plates being slidable relatively to said bars upon loosening of said tie rods, the portion of each plate provided with said first end edge face projecting beyond the assembled parallel bars with said end edge faces of all of said plates lying substantially in a common plane adapted to be disposed in parallel relationship with respect to said cathode when the anode assembly is mounted in the electrolytic cell, each plate being formed from at least two plate elements lying in a common plane in edge-abutting relationship with the second end edge face of the element providing the active anodic surface in engagement with the second end edge face of the adjacent element while both elements have their side edge portions in engagement with said parallel bars, means holding the plate elements of each plate in removable interengaged relationship, and the elements of each plate being movable in their respective planes relatively to the parallel bars in the direction of said active anodic surface as the plate element providing the active anodic surface is consumed, and said bars being adapted to accommodate a fresh plate element in co-planar relationship with the plate elements of each plate as the plate progresses in the direction of said active anodic surface, the fresh plate element being adapted to be placed in edge-abutting relationship and removably interengaged with the end edge face of the plate element of each plate most remote from said anodic surface.

9. A composite anode assembly for use in an electrolytic cell adapted to be positioned opposite the cathode of the cell comprising, in combination, a plurality of thin rectangular graphite plates each having a first elongated end edge face forming the active anodic surface of the plate and adapted to be disposed opposite the cathode of the cell in face to face spaced parallel relationship therewith, side edge portions merging with each end of said end edge face at right angles thereto, and a second elongated end edge face on the portion of the plate remote from said first end edge face, a carrier frame formed from a plurality of spaced parallel graphite bars engaging the side edge portions of said rectangular graphite plates at right angles thereto with the plates in parallel spaced-apart relationship, the plates between each two bars lying in spaced parallel planes and being uniformly spaced from each other and said bars being provided with means for maintaining said spacing, and adjustably tightenable tie rods interconnecting the parallel bars to hold the interposed graphite plates removably in said spaced-apart parallel relationship, said plates being slidable relatively to said bars upon loosening of said tie rods, the portion of each plate provided with said first end edge face projecting beyond the assembled parallel bars with said end edge faces of all of said plates lying substantially in a common plane adapted to be disposed in parallel relationship with respect to said cathode when the anode assembly is mounted in the electrolytic cell, each plate being formed from at least two plate elements lying in a common plane in edge-abutting relationship with the second end edge face of the element providing the active anodic surface in engagement with the second end edge face of the adjacent element while both elements have their side edge portions in engagement with said parallel bars, means holding the plate elements of each plate in removable interengaged relationship, and the elements of each plate being movable in their respective planes relatively to the parallel bars in the direction of said active anodic surface as the plate element providing the active anodic surface is consumed, and said bars being adapted to accommodate a fresh plate element in co-planar relationship with the plate elements of each plate as the plate progresses in the direction of said active anodic surface, the fresh plate element being adapted to be placed in edge-abutting relationship and removably interengaged with the end edge face of the plate element of each plate most remote from said anodic surface.

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