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(54) **A wholly fabricated electrochemical cell.**

(57) The invention is a method for making an electrolytic unit having

a substantially planar electric current transmission element comprising a generally planar support portion (17), a peripheral flange portion (16), and

a plurality of bosses (18) (18a) projecting outwardly from each side of the support portion;

said flange portion (16) is constructed of at least one section and has an internal surface which sealably receives all external peripheral edges of the support portion;

said method comprising the steps of:

attaching in any sequential order:

(a) a plurality of bosses (18) (18a) to the support portion;

(b) at least one section of the flange portion (16) to the peripheral edges of the support portion; and

(c) a plurality of liner sections (26) (26a) to at least a portion of the bosses on at least one side of the support portion.

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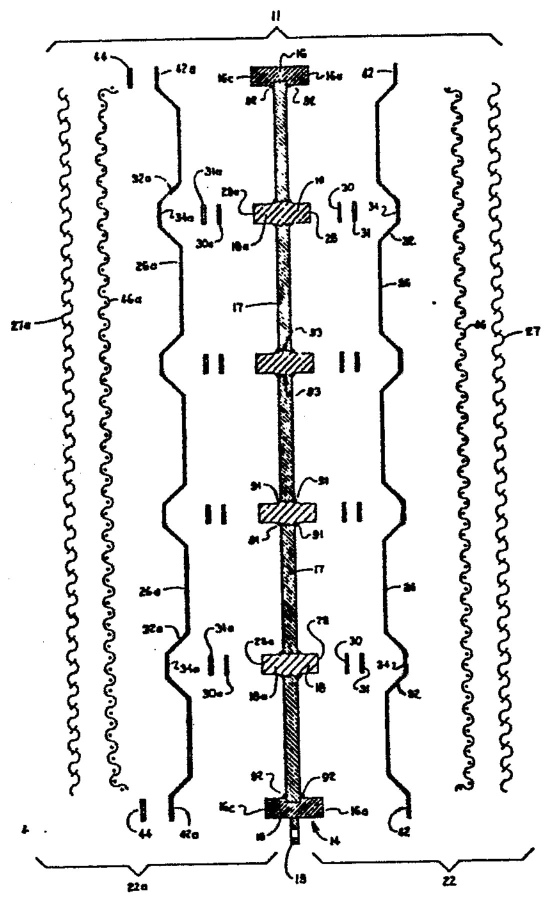

FIG.2

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A WHOLLY FABRICATED ELECTROCHEMICAL CELL

The present invention relates to an electrolytic unit wholly fabricated from a plurality of parts assembled in a unique way. A plurality of such units positioned in operable combination are particularly useful in the production of chlorine and caustic.

As used herein "electrolytic cell" means an assembly which at least includes an anode in an anode compartment and a cathode in a cathode compartment, wherein the anode compartment and the cathode compartment are separated by an ion exchange active substantially hydraulically impermeable membrane.

"Electrolytic unit" means an assembly which at least includes two electrode components separated by a planar support portion. The electrode components in an electrolytic unit may be oppositely charged, as is the case in a bipolar unit, or similarly charged, as is the case of a monopolar unit. Thus, monopolar units could be either anode or cathode units.

"Electrode component" means an electrode or an element associated with an electrode such as a current distributor grid or current collector. The component may be in the form of a wire mesh, woven wire, punched plate, metal sponge, expanded metal, perforated or unperforated metal sheet, flat or corrugated lattice work, spaced metal strips or rods, or other forms known to those skilled in the art.

Chlorine and caustic are large volume, basic chemicals which are most frequently produced electrolytically from an aqueous solution of an alkali metal chloride in electrolytic cells. Recently, a variety of technological advances have occurred to minimize the gap between the anode and the cathode of an electrolytic cell to minimize the electrical resistance of the electrolytic cell, thus allowing the electrolytic cell to operate more efficiently. Advances include such things as dimensionally stable anodes, ion exchange membranes, depolarized electrodes, zero gap cell configurations, and solid polymer electrolyte membranes.

There are two major types of electrolytic cells commonly used for the production of chlorine and caustic, i.e., monopolar and bipolar cells.

A bipolar cell consists of several electrochemical units in a series, in which each unit, except the two end or terminal units, acts as an anode on one side and a cathode on the opposing side. Electrolytic units are sealably separated by an ion exchange active membrane, thereby forming an electrolytic cell, or series of electrolytic cells. Electrical energy is introduced into a terminal cell at one end of a series of bipolar cells, passes through the series of cells, and is removed from the terminal cell at the other end of the cell series. An alkali metal halide solution is fed into the anode compartment(s) where a halogen gas is generated at the anode. Alkali metal ions are selectively transported through the ion exchange active membrane(s) into the cathode compartment(s) where alkali metal hydroxides are formed.

Monopolar electrolytic cells comprise at least two terminal cells and a plurality of anode units and cathode units alternately positioned therebetween. The monopolar units are separated by an ion exchange active membrane, thus forming a plurality of monopolar cells. Each unit is equipped with an inlet, through which electrolyte may be fed to the unit, and with at least one outlet, through which liquids and gases may be removed from the unit. Each unit is electrically connected to a power supply. Power is fed to one monopolar unit and is removed from an adjacent unit.

To take advantage of the new technological advances, a variety of electrolytic unit designs have been proposed. However, many of these are quite complicated and require the use of expensive materials. An uncomplicated electrolytic unit employing readily available, inexpensive materials would be highly desirable. It is the object of this invention to provide such an electrolytic unit which can be used either as a monopolar or a bipolar unit.

The invention is a method for making an electrolytic unit having

a substantially planar electric current transmission element comprising a generally planar support portion, a peripheral flange portion and;

a plurality of bosses projecting outward from each side of the support portion;

said flange portion is constructed of at least one section and has an internal surface which sealably receives all external peripheral edges of the support portion;

said method comprising the steps of:

attaching in any sequential order:

(a) a plurality of bosses to at least one side of the support portion;

(b) at least one section of the flange portion to the peripheral edges of the support portion; and

(c) a plurality of liner sections to at least a portion of the bosses on at least one side of the support portion.

The invention also includes a method for making an electrolytic unit by assemblying an electric current transmission element having at least three parts, i.e. a frame-like flange portion, bosses, and a planar support portion. Opposing sides of the so formed transmission element may be flattened prior to, during, or after complete assembly of the parts. A side liner is then applied to at least a portion of at least one side of the assembled transmission element.

The invention can be better understood by reference to the drawings illustrating the invention and wherein like reference numerals refer to like parts in the different drawing figures, and wherein:

Figure 1 is an exploded, partially broken away perspective view of one embodiment of the electrolytic unit of the present invention;

Figure 2 is an exploded, sectional side view of one embodiment of the electrolytic unit shown in Figure 1;

Figure 3 is a cross-sectional side view of a plurality of electrolytic units positioned in operable combination, forming a series of electrolytic cells;

Figure 4 is a cross-sectional side view of an electrolytic unit having a side liner made from a plurality of components.

With particular reference to Figures 1 to 3, the present invention employs an electric current transmission element 14, hereinafter referred to as ECTE, as one component of an unlined electrolytic unit 10 or lined electrolytic unit 11. Preferably, the ECTE comprises a generally planar support portion 17 which has sufficient structural integrity to provide a support for a plurality of bosses 18 and 18A, a frame-like flange portion 16, and liners 26 or 26A, if liners are used. The ECTE is substantially more massive and more rigid than the liner 26 or 26A and any electrode components 36, 36A, 46, or 46A normally used in electrolytic cells.

The ECTE may be made from a variety of materials which meet the requirements outlined above. Preferably, however, the material is selected from ferrous metals such as iron, cast iron, ductile iron, steel, and stainless steel, and nickel, aluminum, copper, magnesium, lead, alloys of each and alloys thereof.

Preferably, the ECTE is constructed from ferrous metals whose primary constituent is iron. More preferably, the ECTE is constructed from low carbon steel or ductile iron because of their low cost and ready availability. Ductile iron has more dimensional stability as it cools after casting. Low carbon steel is more weldable.

In those cases where the electrolytic unit 10 or 11 is used as a bipolar electrolytic unit, the bosses 18 and 18A should be sufficiently conductive to transmit electrical energy through its mass, or portions of its mass, in a direction perpendicular to the planar support portion 17. The electrical conduction occurs through the bosses 18 and 18A, rather than through the mass of the planar support portion 17 except in the case where the bosses 18 and 18A are offset, then the planar support portion 17 must be sufficiently conductive to transmit electrical energy through its mass, or portions of its mass.

In those cases where the electrolytic unit 10 or 11 is used as a monopolar electrolytic unit, the ECTE preferably is sufficiently conductive to transmit electrical energy throughout substantially its entire mass. This allows an electrical connection from a power source to be connected to its flange portion 16 or to a point on the planar support portion 17 itself and distribute the electrical energy to the various points of an electrode component in electrical contact with the planar support portion.

Regardless of whether the ECTE is used as a monopolar or as a bipolar unit, it is possible to construct the ECTE from materials that are readily available, and generally inexpensive without having to be overly concerned with the resistivity of the material. This is possible because of the large mass and cross sectional area of the ECTE which is sufficiently large in cross-sectional area to minimize its electrical resistance. The fact that the ECTE has a large cross--sectional area allows the use of materials having a higher resistivity than could be used in configurations of the prior art. Thus, ferrous metals such as iron, steel, ductile iron and cast iron are perfectly suitable for use in the present invention. More specifically, metals having a resistivity as high or higher than copper may be economically used to form the ECTE. More economically, metals having a resistivity greater than about 10 micro-ohms-cm may be used. Most economically, metals having resistivities as high as, or higher, than about 50 micro-ohms-cm may be used.

When the electrolytic unit 10 or 11 of the present invention is used as a monopolar unit, the planar support portion 17 of ECTE 14 may have one or more lined passageways connecting opposite sides thereof. The passageways allow electrolyte or gases to pass from one side of the planar support portion 17 to the other side. Such passageways should occupy no more than about 60 volume percent of the total volume of the planar support portion 17. The openings allow less metal to be used in forming the planar support portion, thus making the cell more economical. In addition, openings can be spaced to direct electric current to certain portions of the cell.

A plurality of bosses 18 and 18A are attached to opposite sides of the planar support portion 17. These bosses project a predetermined distance outwardly from the planar support portion 17 into an area that will ultimately become an electrolyte compartment. The bosses are capable of being electrically connected either directly to an electrode 36, 36A, 46, or 46A, or indirectly to the electrode through a side liner. Preferably the ends of the bosses 18 and 18A lie in the same geometrical plane, respectively, and are substantially solid. They may, however, contain internal voids, as a result of casting.

The bosses 18 and 18A may be positioned in a back-to-back relationship with each other across the planar support portion 17. Optionally, they may be offset from each other across the support portion 17. They may be positioned in a variety of other cross sectional configurations from each other.

The bosses 18 and 18A may be made from the same metals as the metal used for the support portion 17. Optionally, the bosses may be made from a metal different from that used to construct the support portion 17. Preferably, the bosses are made from ferrous metals such as iron, cast iron, ductile iron, steel, stainless steel, or from nickel, aluminum, copper, magnesium, lead, alloys of each and alloys thereof. More preferably, the bosses are constructed from ductile iron or low carbon steel because of its stability, low cost and ready availability.

The bosses 18 and 18A are preferably spaced apart in a fashion so that they can rigidly support any electrode components 36, 36A, 46, or 46A desired for use in the electrolytic cell. The distance between the bosses on each side of the support portion 17 will generally depend upon the electrical resistivity of the particular electrode element used. For thinner and/or highly resistive electrode elements, the spacing of the bosses will be less, thus providing a more dense multiplicity of points for electrical contact. For thicker and/or less resistive electrode components the spacing of the bosses may be greater. Normally the spacing between the bosses is within 5 to 30 centimeters although smaller or larger spacings may be used depending on overall design considerations.

The bosses may be conveniently welded or bonded to the support portion 17 or they may be screwed into the support portion 17 as shown by reference number 93. Either way, it is desirable to make the attachment such that the electrical contact between the support portion 17 and the bosses is maximized. In the case of an unlined electrolytic unit 10 or in the case where only one liner is used it is preferable that the bosses are welded, even though they are screwed into or bonded to the support portion 17. In the case of a lined electrolytic unit 11, it is preferable that the bosses not be welded, but could contain a tack weld.

The bosses have a flat surface 28 and 28A which is machined prior to, during, or after assembly of the unit. These surfaces are adapted to be attached to a liner or to an electrode component by means of intermediate coupons (30, 30A, 31 or 31A).

Surrounding the peripheral edges of the support portion 17 is a frame-like flange portion 16. It is a window frame-like structure having a thickness greater than, or at least equal to, the thickness of a boss-containing barrier portion 17. Preferably the flange portion 16 extends further from the plane of the support portion 17 than do the ends of the bosses 18 and 18A. This provides a space for electrode components 36, 36A, 46, or 46A that will be present when the electrolytic unit 10 or 11 of the present invention are stacked adjacent to each other in operable combination. Preferably the thickness of the flange portion is at least about 2 to 6 times greater than the thickness of the support portion. More preferably, the peripheral flange portion is about 60 to 70 mm thick when the planar support portion 17 is about 20 to 25 mm thick.

The flange portion 16 may be made from a variety of materials which meet the requirements outlined above. The materials may be metals and may be the same or different from the metals used to form the support portion 17. If the metals are different, preferably, the different metals are weldably compatible. Otherwise an intermediate metal, weldably compatible with both metals, may be positioned between the two metals. Preferably the metals are selected from ferrous metals such as iron, grey iron and malleable iron, ductile iron, steel, stainless steel, or from nickel, aluminum, copper, molybdenum, magnesium, lead, alloys of each of these metals and alloys thereof. Most preferably, the peripheral flange portion 16 is constructed from ductile iron because of its stability, low cost and ready availability.

If the planar support portion is made of a ferrous metal, the flange portion can be made of copper or any one of the other metals that can be suitably employed for the support portion.

Optionally, the flange portion can be made of a synthetic resinous material. Without intending to be limited by the specific synthetic resinous materials hereinafter delineated, examples of such suitable materials include polyethylene; polypropylene; polyvinylchloride; chlorinated polyvinyl chloride; acrylonitrile, polystyrene, polysulfone, styrene acrylonitrile, butadiene and styrene copolymers; epoxy; vinyl esters; polyesters; and fluoroplastics and copolymers thereof. It is preferred that a resinous material such as polypropylene be used for the flange portion since it produces a shape with adequate structural integrity at elevated temperatures, is readily available, and is relatively inexpensive with respect to other suitable resinous materials.

The flange portion 16 may be a single, unitary picture frame-type structure, or it may be a plurality of pieces joined together from more than one structural piece to form a complete frame-type structure around the peripheral edges of the planar support portion 17. The flange portion provides sealing surfaces 16A and 16C which lie in approximately the same plane as do the flat ends 28, 28A of the bosses 18 and 18A after they have been attached to the support portion 17. If the flange portion is composed of separate pieces, they may be attached to the support portion 17 before or after the bosses are attached to the support portion. The support portion 17 and bosses may be flattened (machined) before or after the flange portion is attached to the support portion, if needed.

If the electrolytic unit is to be used as a bipolar unit, the flange portion 16 need not be made from an electrically conductive material, because it will not need to conduct electricity. However, if the electrolytic unit is to be used as a monopolar unit, the peripheral flange portion is preferably electrically conductive. The flange portion provides a convenient means to transmit electrical energy into and out of the electrolytic units 10 and 11 which are present in an operating series of units. Less preferably, the flange portion is made from an electrically non-conductive material and provided with passageways which pass through it to provide a pathway for conductors to pass through the flange portion to conduct electrical energy into and out of the electrolytic unit.

The flange portion 16, if not formed as one piece body with the support portion 17, is preferably firmly attached to the support portion. A firm attachment assures the dimensional stability of the electrolytic unit and maintains the desired gap between electrode components of adjoining units. Preferably, the flange portion is attached to the support portion by welding.

When the electrolytic unit is to be used as a bipolar unit, and the unit is not lined, it is particularly important to sealably weld the flange portion to the support portion to prevent the flow of fluids from one side of the support portion to the other side.

When a plurality of electrolytic units 10, 11 are assembled in operable combination, an ion exchange active membrane 27 and 27A is positioned between adjoining electrolytic units 10, 11. A membrane is used between either bipolar or monopolar electrolytic units. In either case, the membrane separates one electrode compartment from an adjacent electrode compartment.

The membrane 27 and 27A suitable for use with the present invention may contain a variety of ion exchange active sites. For example, they may contain sulfonic or carboxylic acid ion exchange active sites. Optionally, the membrane may be a bi-layer membrane and have one type of ion exchange active sites in the other layer. The membrane may be reinforced to impair deforming during electrolysis or it may be unreinforced to maximize the electrical conductivity through the membrane. Ion exchange active membranes suitable for use with electrolytic cells of the present invention are well-known in the art.

Other elements which may be used in conjunction with the present invention include assemblies for zero gap configurations or solid polymer electrolyte membranes. Also, the units of the present invention may be adapted for a gas chamber for use in conjunction with a gas-consuming electrode, sometimes called a depolarized electrode. The gas chamber is required in addition to the liquid electrolyte compartments. A variety of cell elements which may be used in the present invention are disclosed in, for example, U.S. Patent Nos. 4,457,823; 4,457,815; 4,444,623; 4,340,452; 4,444,641; 4,444,639; 4,457,822; and 4,448,662.

Liners 26 or 26A are preferably formed with a minimum of stresses in them to minimize warpage. Avoiding these stresses in the liner may be accomplished by hot forming the liner in a press at an elevated temperature of from 482°C to 704°C. Both the liner metal and the metal press are heated to this elevated temperature before pressing the liner into the desired shape. The liner is held in the heated press and cooled under a programmed cycle to prevent formation of stresses in it as it cools to room temperature.

Liners 26 or 26A suitable for use in chlor-alkali cathode compartments are preferably selected from ferrous metals, nickel, stainless steel, chromium, monel and alloys thereof. Liners suitable for use in chlor-alkali anode compartments are preferably selected from titanium, vanadium, tantalum, columbium, hafnium, zirconium, and alloys thereof.

To assure the maximum physical and electrical contact between the liner and the bosses, it is preferred for the liner to be welded to the flat ends 28, 28A of the bosses 18 and 18A Optionally, the liner can be welded not only at the flat ends of the bosses, but at various other places where the two contact each other. Capacitor discharge welding is a preferred welding technique to be used to weld the liner to the bosses.

For fluid sealing purposes between the membrane 27 or 27A, and sealing surfaces 16A or 16C, provided on the flange portion 16, it is preferred that the liners 26 or 26A are formed in the shape of a pan with an off-set lip 42 or 42A extending around its periphery. Lip 42 and 42A fits flush against the sealing surfaces 16A or 16C. A peripheral portion of membrane 27 or 27A fits flush against liner lip 42, and a peripheral gasket 44 fits flush against the other side of the peripheral portion of the membrane 27 or 27A. In a series of electrolytic units, the gasket 44 fits flush against the lip 42A of the liner 26A and flush against the sealing surface 16C when there is no liner.

If the liners 26 and 26A are made of titanium and ECTE 14 is made of a ferrous metal, they may be connected by resistance welding or capacitor discharge welding. Resistance or capacitor discharge welding is accomplished indirectly by welding the liners to the flat ends 28 and 28A of the bosses 18 and 18A through metal intermediates, preferably vanadium wafers 30 or 30A. Vanadium is a metal which is weldably compatible with titanium and ferrous metals. Weldably compatible means that one weldable metal will form a ductile solid solution with another weldable metal upon the welding of the two metals together. Titanium and ferrous metals are not normally compatible with vanadium. Hence, vanadium wafers 30 and 30A are used as an intermediate between the ferrous metal bosses and the titanium liners 26 and 26A to accomplish the welding of them together to form an electrical connection between the liners and ECTE 14 as well as to form a mechanical support means for the ECTE to supporting liners 26 and 26A.

Preferably, a second metal intermediate or wafer 31 and 31A is used and placed between wafer 30 and 30A and the liner 26 and 26A. The second wafer is preferable because when only one wafer is used, it has been discovered that the corrosive materials contacting the liner during operation of the cell to produce chlorine and caustic seem to permeate into the titanium-vanadium weld and corrode the weld. The corrosive materials also permeate into the body of the ECTE and corrode it. Rather than use a thicker liner, it is much more economical to insert a second wafer 31 and 31A of a sufficient thickness to minimize the possibility of the corrosive materials permeating into the ECTE.

To introduce reactants into the electrolytic cells formed when a plurality of electrolytic units 10 and 11 are stacked in operable combination, a plurality of nozzles (not shown) are preferably present in each electrolytic unit. Although a variety of designs and configurations may be used, a preferred design is as follows. A plurality of metal nozzles are formed, for example by investment casting. The nozzle casting is then machined to the desired size. A number of slots are machined into each flange portion 16 at a plurality of desired locations to receive the nozzles. The slots are of a size to correspond to the thickness of the nozzle to be inserted into the slot, to assure a seal when the elements of the electrolytic cell are ultimately assembled. If a liner 26 or 26A is used, it is cut to fit around the nozzle. The nozzle is preferably attached to the liner 26 or 26A, for example, by welding. The liner nozzle combination is then placed into the electrolytic unit 10 or 11 and the caps 32, 32a of the liners are then welded to the bosses 18 and 18A.

When a plurality of electrolytic units 10 or 11 are assembled adjacent to each other, gaskets 44 are preferably positioned between the units. The gaskets serve three main functions: sealing, electrical insulation and setting the electrode gap. There are a variety of suitable gasket 44 materials that may be used, such as, for example, rubber gaskets. Although only one gasket 44 is shown, the invention encompasses the use of gaskets on both sides of membrane 27 or 27A.

Adjacent to ECTE 14, or the liner 26 or 26A, if liners are used, is an electrode component 36, 36A, 46, or 46A which may be attached or pressed against the liner or the ECTE. Preferably, the electrode component is coextensive with the support portion 17 and does not extend into the flange portion 16 area. Otherwise, it would be difficult to seal adjacent electrolytic units when they are placed in operable combination.

Electrode components are preferably foraminous structures which are substantially flat and may be made of a sheet of expanded metal perforated plate, punched plate or woven metallic wire. Optionally, the electrode components may be current collectors which contact an electrode or they may be electrodes. Electrodes may optionally have a catalytically active coating on their surface. The electrode components may be welded to the bosses or to the liner, if a liner is used. Preferably, the electrode components are welded because the electrical contact is better.

Other electrode components which may be used in conjunction with the present invention include current collectors, spacers, mattresses and other elements known to those skilled in the art. Special elements or assemblies for zero gap configurations or solid polymer electrolyte membranes may be used. Also, the electrolytic units of the present invention may be adapted for a gas chamber for use in conjunction with a gas-consuming electrode, sometimes called a depolarized electrode. The gas chamber is required in addition to the liquid electrolyte compartments. A variety of electrode elements which may be used in the present invention are well known to those skilled in the art and are disclosed in, for example, U.S. Patent Nos. 4,457,823; 4,457,815; 4,444,623; 4,340,452; 4,444,641; 4,444,639; 4,457,822; and 4,448,662.

The electrodes 36, 36A, 46, or 46A preferably have their edges rolled inwardly toward the ECTE and away from the ion exchange active membrane 27 and 27A. This is done to prevent the sometimes jagged edges of these electrode components from contacting the ion exchange active membrane and tearing it.

The electrolytic unit 10 and 11 may be prepared in a variety of ways using a variety of elements. Each of the basic elements used in making the electrolytic units of the present invention, i.e. the planar support portion 17; the frame-like flange portion 16, and the bosses 18 and 18A may be composed of a plurality of pieces. For example, the support portion 17 may be constructed of a plurality of pieces joined together. Likewise, the flange portion 16 may be constructed of a plurality of pieces joined together. Similarly, the bosses 18 and 18A may be single piece units that pass through the support portion 17 or they may be partial units which do not pass through the support portion 17, but are merely attached to one surface or opposite surfaces thereof.

The basic elements may be assembled by first attaching the bosses to the support portion 17 and then attaching the flange portion 16, to the periphery of the support portion 17. In another sequence, the flange portion 16, is first attached to the support portion 17 and then the bosses are attached.

To assure that the electrolytic unit 10 or 11 is as planar as possible, it is optional to flatten or plane the surfaces of the assembled, or partially assembled, electrolytic units. The electrolytic unit may be flattened at any one, or more, of the various steps of assembly of the electrolytic unit. For example, it may be flattened:

after all of the bosses have been attached to one side of the support portion 17;

after only a portion of the bosses have been attached to the support portion 17;

after all or a portion of the bosses have been attached to the support portion 17 but before the flange portion 16 has been attached; or

after all the bosses and the flange portion 16 has been attached.

The electrolytic unit of the present invention may be flattened using a variety of techniques well known to those skilled in the art, such as abrasive belt grinding, and mechanical milling. Preferably, the electrolytic unit is sufficiently flattened such that when two units are mated with each other in operable combination, the number of leaks is minimized. For use in chlor-alkali electrochemical cells, it is most preferred for the electrolytic unit 10 or 11 to have a flatness deviation of less than about 0.4 mm throughout its entire mass.

Attaching the bosses 18 and 18A to the support portion 17 of ECTE 14 may be done using a variety of techniques. For example, the support portion 17 may be cast as a solid unit and later have holes drilled and tapped through the thickness, or partially through the thickness of the support portion. The bosses can be threaded and then screwed into the holes in the support portion 17 from both sides. Optionally, the bosses can be threaded through half their length and then threaded half-way through the support portion 17. Preferably, the ends of the bosses are machine flattened before they are attached to the support portion 17.

Another way for attaching the bosses is by welding. Preferably, the bosses and the support portion 17 are made from metals that are weldably compatible. If the two metals are not weldably compatible, an intermediate metal, weldably compatible with both metals may be inserted between the two metals. Preferably, the bosses are welded slowly so the warpage of the barrier portion 17 caused by the heat of the welding is minimized.

If desired, a liner 26 or 26A may be positioned over only the area of the electrolytic unit which will be contacted with a corrosive environment. Optionally, the flange portion 16 of the ECTE may also be lined, even though the flange portion may not be exposed to a corrosive environment. Optionally, a liner may be positioned on only one side of the ECTE or on both sides of the ECTE. The liner may be constructed of a single, unitary piece or, it may be constructed of a plurality of pieces bonded together (as shown in Figure 4). It should, however, be of a thickness sufficient to be substantially completely hydraulically impermeable.

The liner 26 or 26A may be coextensive with the support portion 17 of the ECTE, or it may be coextensive with the entire length and width of the ECTE, including the peripheral flange portion 16.

When a plurality of electrolytic units are assembled adjacent to each other, gaskets 44 are preferably positioned between the adjacent units. Gaskets serve three main functions: 1) sealing, 2) electrical insulation, and 3) setting and maintaining the electrode gap. There are a variety of suitable gasket 44 materials that may be suitably used, such as, for example, ethylene-propylenediene terpolymer, chlorinated polyethylene, polytetrafluoroethylene, perfluoroalkoxy resin.

Preferably, the electrodes 36, 36A, 46 or 46A are coextensive with the support portion 17 and do not extend over the peripheral flange portion 16. Otherwise, it would be difficult to seal adjacent electrolytic units when they are placed in operable combination.

A particularly suitable way for fabricating the ECTE of the present invention is by using a flat workpiece upon which to support the ECTE which previously had holes drilled and tapped in its support portion to receive the bosses. A plurality of bosses are cut to equal length and each boss is provided with a threaded portion in the mid portion thereof. The unthreaded end portions are of differing diameters. One end portion is smaller in diameter than the other portion and has a diameter which is smaller than the diameter of the hole drilled in the support portion. The smaller end portion of a boss is passed through the hole and until the threaded portion of the boss contacts the threaded portion of the hole. The bosses are threaded into the threaded holes in the support portion until they touch the flat workpiece. In this manner, it is easy to make sure that all of the bosses extend the same length from the barrier portion.

Example 1

A 122 cm x 244 cm bipolar, flat plate fileter press-type ion exchange membrane cell was constructed as follows.

A 122 cm x 244 cm steel plate, 1.27 cm thick was drilled and tapped so it had 116, 25 mm holes in it, in a square pattern. The steel plate was used as the support portion of the ECTE and had welded around its periphery a 19 mm thick, 70 mm wide low carbon steel picture frame-type flange portion.

A plurality of 25 mm threaded steel rods were screwed firmly into each of the 116 holes. On the side destined to become the anode side, a vanadium wafer was positioned over the end of each rod and a titanium cap was then placed over the rod and vanadium water. The cap was welded to each of the 116 rods, through the vanadium wafer. On the side destined to become the cathode side, a nickel cap was placed over and welded to each of the 116 rods. Since nickel can be relatively easily welded to steel, no intermediate wafer was needed on the cathode side. The vanadium wafer was about 0.13 mm thick. The cap was about 0.9 mm thick.

For corrosion protection, the anode compartment was lined with a 0.9 mm thick titanium liner which was made of a flat titanium sheet welded to a

U-shaped titanium side cover on all four peripheral sides. The titanium liner had 116 holes concentric to the holes on the support portion for fitting over the connector rods. The titanium liner was welded to the titanium cap on the connector.

The cathode compartment was lined with a 1.5 mm thick nickel liner which was made of a flat nickel sheet welded to a U-shaped nickel side cover on the peripheral sides. The nickel liner also had 116 holes concentric to the holes on the support portion for fitting over the connector rods. The nickel liner was welded around each nickel cap.

The anode was a 1.6 mm thick, 40 percent open, expanded titanium mesh with a diamond pattern of 0.65 mm (SWD) x 1.3 mm (LWD). The anode was resistance welded to the titanium caps on top of connectors on the anode side.

The cathode was made of nickel mesh of the same specifications as the titanium mesh. The cathode was resistance welded to nickel caps on top of connectors on the cathode side.

A 13 mm diameter titanium pipe was welded to the titanium liner through a hole at the bottom left of the anode compartment for the brine inlet. Another 19 mm diameter pipe was welded to the titanium liner through a hole at the top right of the anode compartment for the brine and chlorine gas outlet. Similarly, nickel pipes were welded to the cathode compartment for a catholyte inlet and outlet.

The cell was built so that the anode mesh receded about 0.4 mm below the titanium side gasket flange and the cathode mesh receded about 0.9 mm below the nickel side gasket flange. With an expanded polytetrafluoroethylene gasket of about 1.3 mm compressed thickness between the membrane and the cathode gasket flange and no gasket between the membrane and the anode gasket flange, the nominal inter-electrode gap was about 2.5 mm.

The distance between the planes of the ends of the bosses was 65.4 mm for this bipolar cell, which may be called the support portion thickness. The overall cell unit thickness, from the outside of the nickel electrode component to the outside of the titanium anode component, was 71.1 mm. Thus, the cell element thickness was 92 percent of the total unit thickness.

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WE CLAIM:

1. A method for making an electrolytic unit having

a substantially planar electric current transmission element comprising a generally planar support portion, a peripheral flange portion and;

a plurality of bosses projecting outward from each side of the support portion;

said flange portion is constructed of at least one section and has an internal surface which sealably receives all external peripheral edges of the support portion;

said method comprising the steps of:

attaching in any sequential order:

(a) a plurality of bosses to at least one side of the support portion;

(b) at least one section of the flange portion to the peripheral edges of the support portion; and

(c) a plurality of liner sections to at least a portion of the bosses on at least one side of the support portion.

2. The method of Claim 1 including the step of attaching at least one section of the flange portion to the support portion by welding.

3. The method of Claim 1 or 2 including the step of attaching all of the bosses prior to flattening the unit.

4. The method of Claim 1, 2 or 3 including the step of flattening the at least partially assembled unit.

5. The method of any one of the preceding claims including the step of constructing the support portion, at least a section of the flange portion, and the bosses from metals selected from ferrous metals, nickel, aluminum, copper, magnesium, lead, alloys of each and alloys thereof.

6. The method of any one of Claims 1 to 4, including the step of constructing the support portion and the bosses from a castable metal selected from ferrous metals, nickel, aluminum copper, magnesium, lead, alloys of each and alloys thereof, and wherein at least a section of the flange portion is made of a synthetic resinous material and attached to a peripheral edge of said support portion.

7. The method of any one of the preceding claims, including the step of constructing the flange portion of a thickness at least about two times greater than the thickness of the support portion.

8. The method of any one of the preceding claims including the step of covering both of the boss-containing sides of the support portion with a liner.

9. The method of any one of the preceding claims including the step of selecting the liner from a ferrous metal, nickel, chromium, titanium, vanadium, tantalum, columbium, hafnium, zirconium, and alloys thereof.

10. The method of any one of the preceding claims, including the step of attaching at least one electrode component to the liner(s), and attaching an electrical connection means to a portion of the support portion co-extensive with the electrode component.

11. The method of any one of Claims 1 to 9, including the step of attaching an electrical connection means to the flange portion.

12. An article produced by the method of any one of the preceding claims.

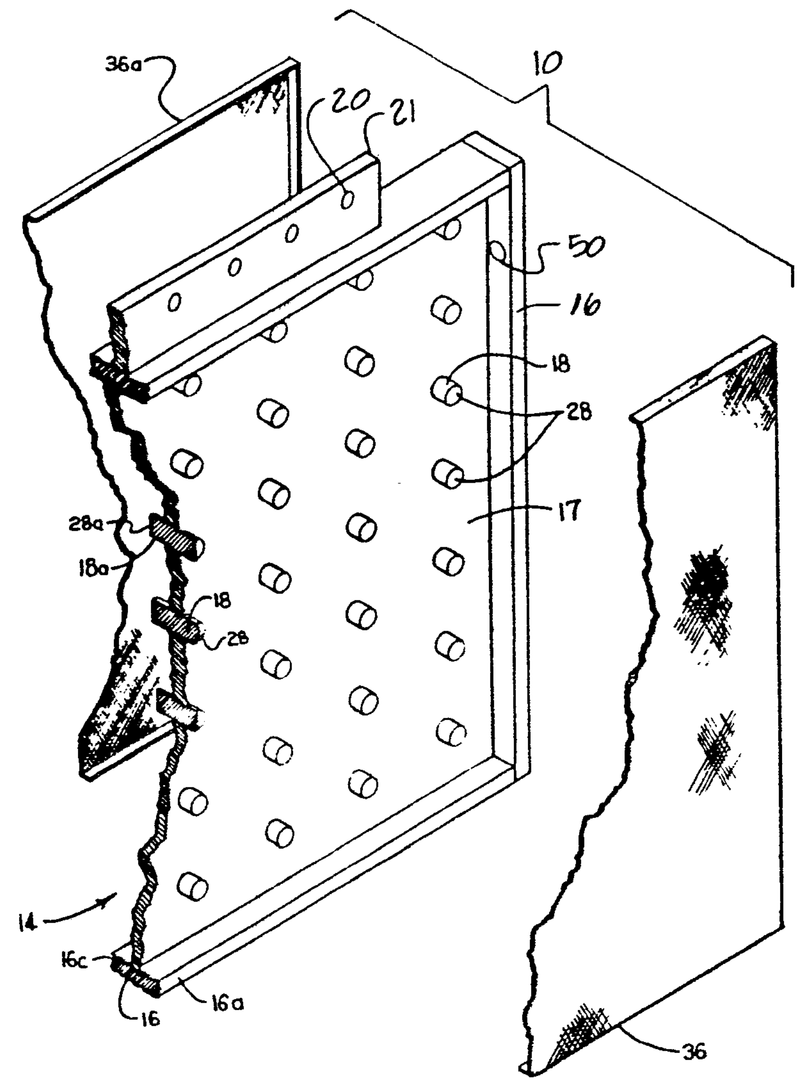

FIG.1

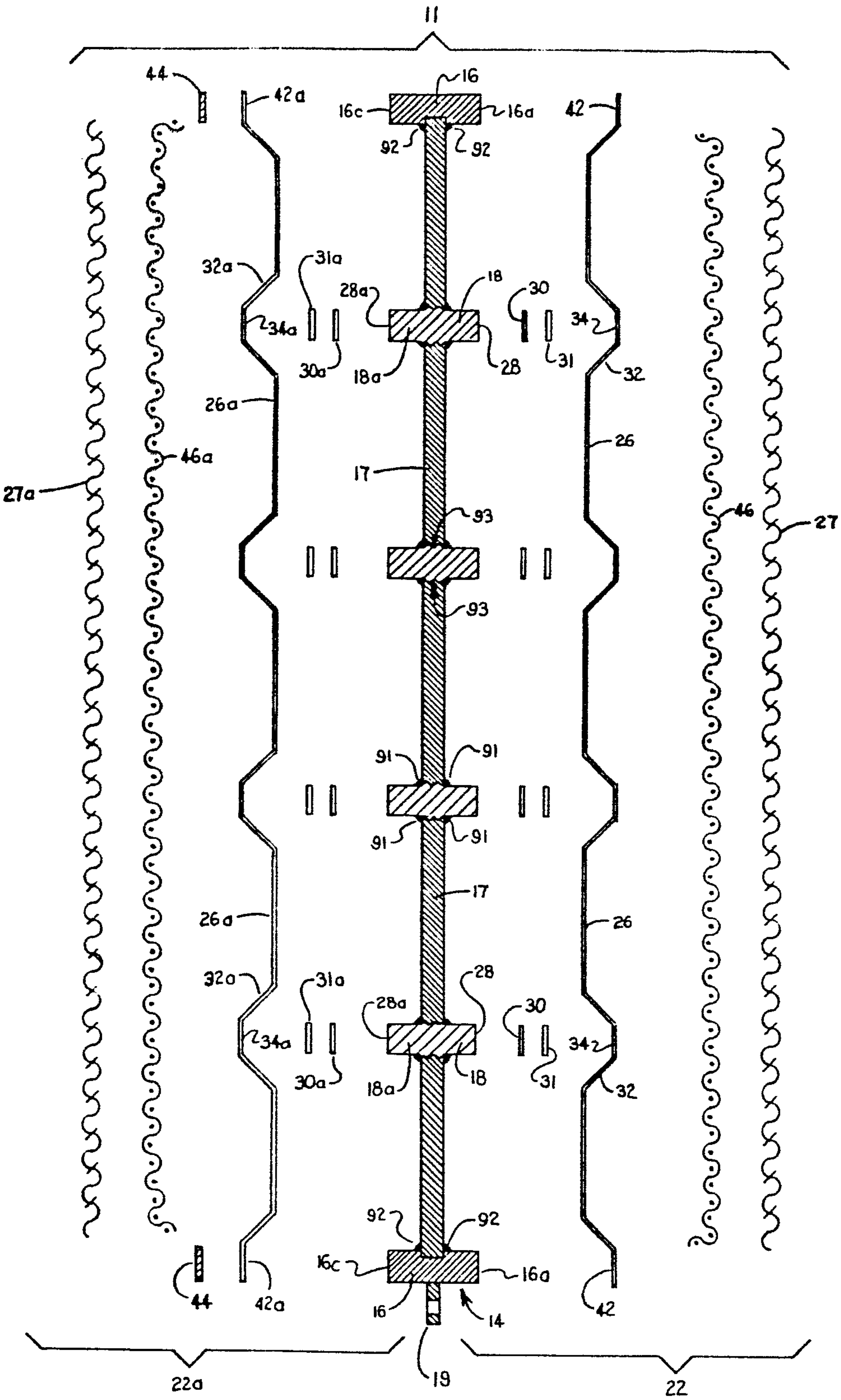
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FIG.2

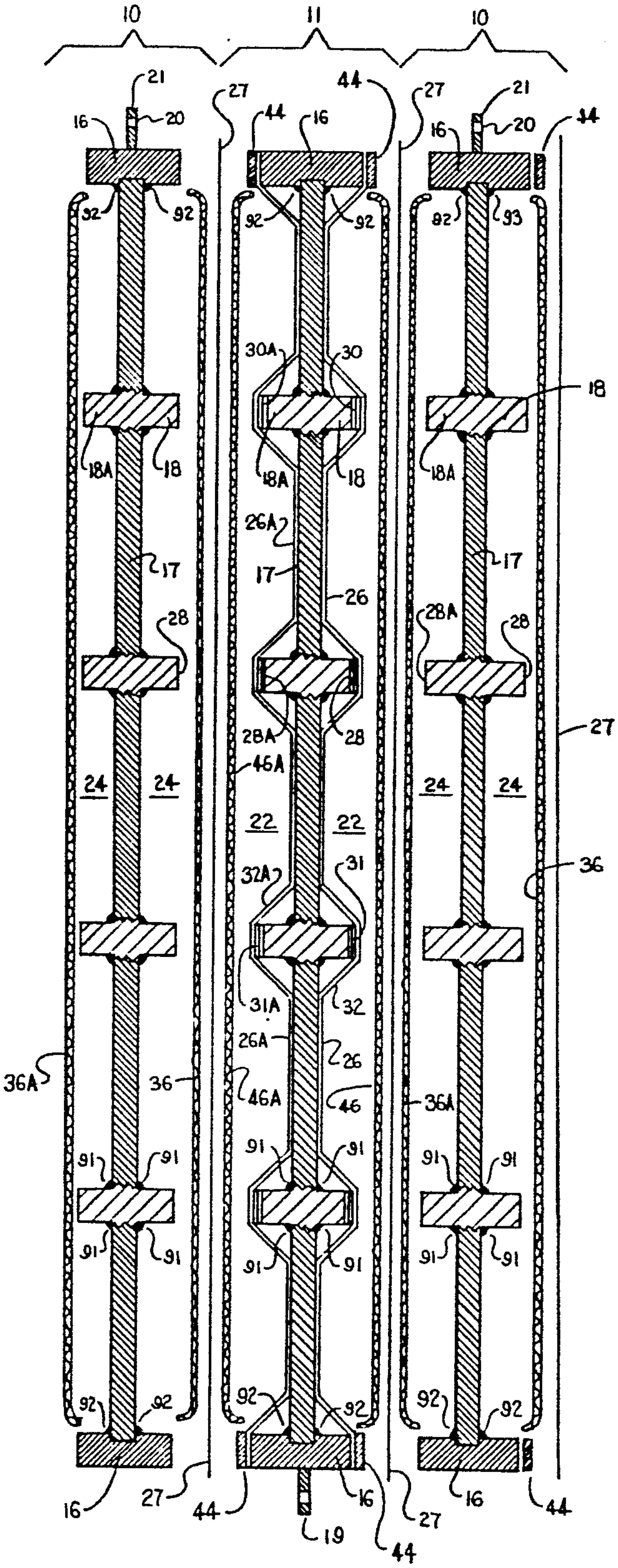
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FIG.3

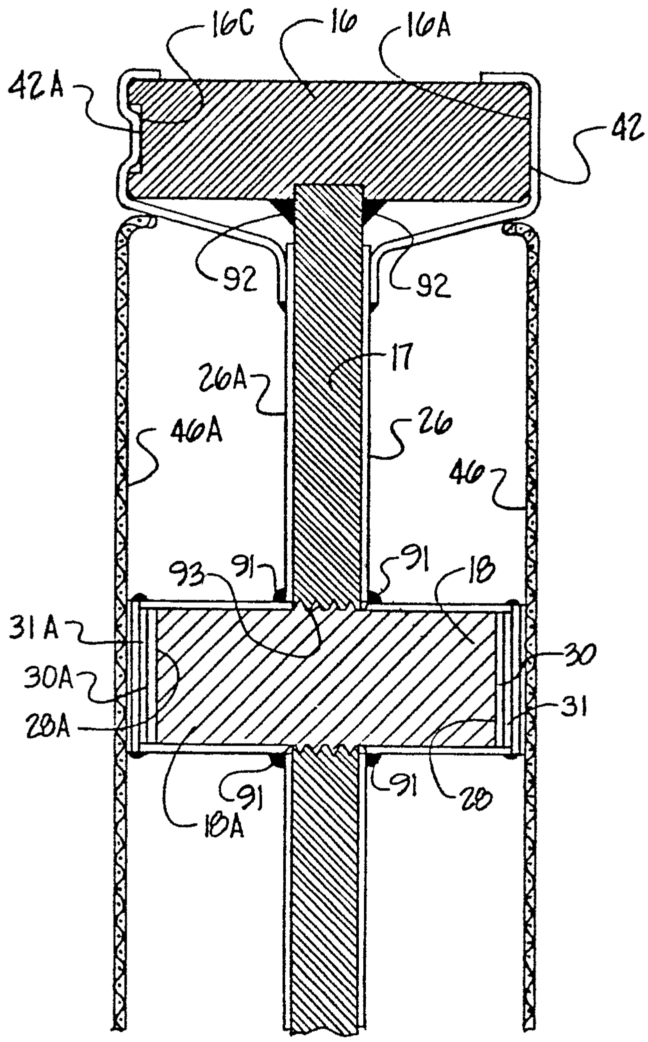
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FIG. 4

European Patent Office

EUROPEAN SEARCH REPORT

0185269

Application number

EP 85 11 5535

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl 4)
X,Y	EP-A-0 111 149 (ORONZIO DE NORA) * Page 19, lines 9-29; page 20, lines 1-19; figure 5 * ---	1,2,5, 7,9,12	C 25 B 9/04 C 25 B 9/00
Y	WO-A-8 403 523 (THE DOW CHEMICAL COMPANY) * Page 20, lines 19-33; pages 33-39, claims; figures 1-3 * ---	1,4,5, 7-12	
A	DE-A-2 600 345 (H.T. HYDROTECHNIK) * Page 7, lines 7-12; claims 1,2,6,8 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl 4)
			C 25 B 9

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	05-03-1986	GROSEILLER PH.A.

CATEGORY OF CITED DOCUMENTS

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E earlier patent document, but published on, or after the filing date
D document cited in the application
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