April 16, 1974 G. L. BERGERON 3,804,739
ELECTROLYTIC CELL INCLUDING ARRAYS OF TUBULAR ANODE
AND DIAPHRAGM COVERED TUBULAR CATHODE MEMBERS
Filed March 5, 1973

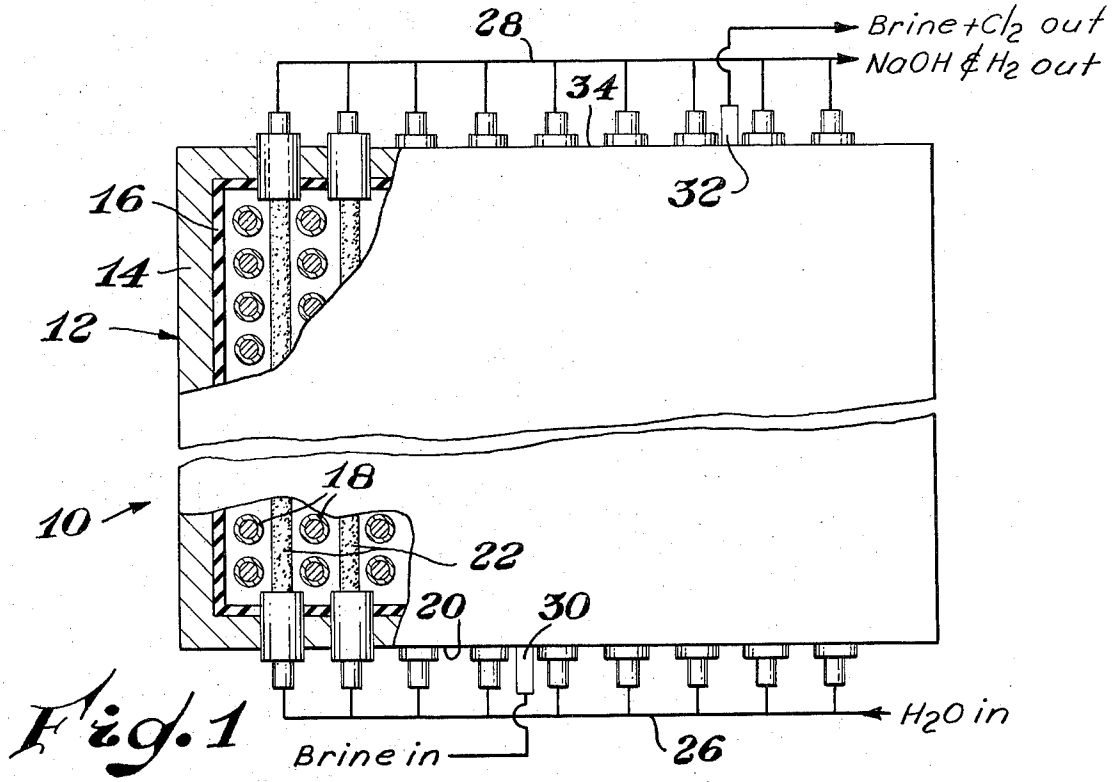



Fig. 1

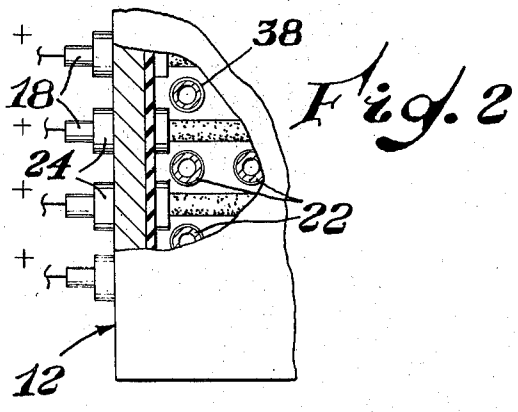



Fig. 2

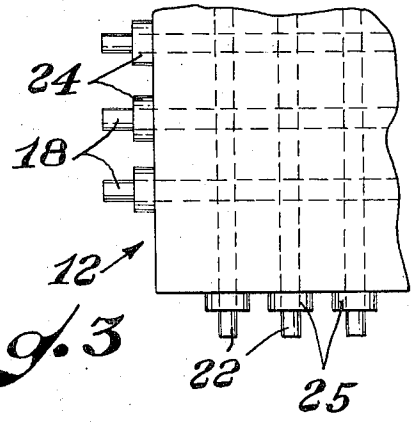



Fig. 3

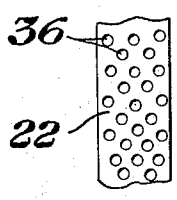



Fig. 4

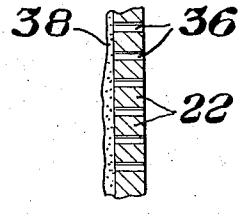



Fig. 5

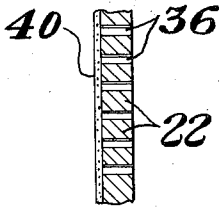



Fig. 6

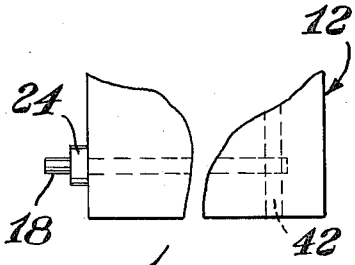



Fig. 7

United States Patent Office 3,804,739 Patented Apr. 16, 1974



3,804,739

# ELECTROLYTIC CELL INCLUDING ARRAYS OF TUBULAR ANODE AND DIAPHRAGM COVERED TUBULAR CATHODE MEMBERS

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Int. Cl. B01k 3/10
U.S. Cl. 204—266 9 Claims

## ABSTRACT OF THE DISCLOSURE

The invention is a novel electrolytic cell assembly using tubular electrodes which allow greater production per unit of cell volume than do conventional electrolytic cells. Dimensionally stable anodes are used. The tubular cathodes adapt readily to the use of ion exchange diaphragms. The anodes and cathodes may be disposed parallel to or at an angle with respect to each other.

## BACKGROUND OF THE INVENTION

This invention relates to electrolytic cells and particularly diaphragm type electrolytic cells which are adapted for use in the production of chlorine and caustic soda.

Conventional diaphragm types of electrolytic cells generally use plate type graphite anodes and metal screen pocket type cathodes having a flocculated asbestos diaphragm deposited thereon.

The cathode configuration of such cells makes difficult the use of so-called ion exchange diaphragms with such cells. However, the use of such diaphragms permits the cell output of caustic soda to be of higher concentration than in conventional diaphragm type electrolytic cells.

In addition, anode wear is a problem in conventional chlorine-caustic electrolytic cells.

In addition, it is desirable to operate chlorine-caustic electrolytic cells at high current densities per unit of electrode area in order to reduce the capital construction cost per unit of cell capacity.

Accordingly, a principal object of this invention is to provide an improved diaphragm type electrolytic cell which is well adapted for caustic-chlorine production.

Another object of this invention is to provide an improved diaphragm type electrolytic cell which utilizes dimensionally stable anodes.

A further object of this invention is to provide an improved diaphragm type electrolytic cell in which the diaphragm comprises an ion exchange material.

An additional object of this invention is to provide an improved diaphragm type electrolytic cell which has high output capacity per unit of electrode area.

## STATEMENT OF INVENTION

In accordance with this invention there is provided an electrolytic cell assembly utilizing rod-like anodes and cathodes, the cathodes being hollow, having perforated or foraminous walls and being spaced adjacent to one or more anodes. Each cathode electrode has a diaphragm structure adjacent to its outer surface, the diaphragm being at least porous to ions. The anodes are usually titanium tubes having a ruthenium coating on the outer surface thereof. The interior of the anode tubes are filled with a metal such as magnesium, for example, to provide improved current carrying capacity in the anode structure.

The anodes and cathodes may be either parallel with respect to each other or angularly disposed with respect to each other.

The electrodes are disposed in a housing such as a rubber lined steel box, for example, with brine entering the bottom of the housing and chlorine and brine being taken from the top of the cell. Caustic soda solution and hydrogen are removed through the hollow cathode electrode tubes.



## BRIEF DESCRIPTION OF THE DRAWING

The invention, as well as additional objects and advantages thereof, will best be understood when the following detailed description is read in connection with the accompanying drawings, in which:

FIG. 1 is a simplified side elevational view, partly broken away and in section, of an electrolytic cell in accordance with this invention;

FIG. 2 is a simplified fragmentary view of an electrolytic cell in accordance with this invention showing vertically disposed cathode elements in section;

FIG. 3 is a fragmentary end view of a cell in accordance with this invention, showing a crossed arrangement of anodes and cathode members;

FIG. 4 is a fragmentary side elevational view of a perforated cathode tube element;

FIG. 5 is a fragmentary sectional view of a cathode tube element having a flocculated diaphragm carried thereon;

FIG. 6 is a fragmentary sectional view of a cathode tube element having an ion permeable diaphragm carried thereon; and

FIG. 7 is a fragmentary view of a cell in accordance with this invention showing internal support of an anode or cathode element within the cell housing.

## DETAILED DESCRIPTION OF THE DRAWINGS

Referring to the drawings, and particularly to FIGS. 1–4, there is shown an electrolytic cell, indicated generally by the numeral **10**, comprising a box-like covered housing **12** having a steel outer wall and cover parts and a lining **16** of rubber, for example.

An array of rod-like anode members **18** are disposed generally parallel with the bottom **20** of the cell housing.

An array of vertically disposed tubular cathode members **22** are interspersed between each row of anode members **18**.

Each of the anode members **18** and each of the cathode members **22** extends through an electrically insulating sealing gasket **24, 25** respectively, in the wall of the huosing **12**.

Each hollow cathode member has a liquid pervious wall part within the housing **12**, usually of perforated construction (see FIG. 4, particularly). The bottom of each cathode member **22** is coupled to a water inlet header **26** and at its top to a hydrogen and caustic soda solution output header **28** when an ion exchange type diaphragm (as shown in FIG. 6) is used.

If a flocculated diaphragm (as shown in FIG. 5) is used, the header **26** would be used as a caustic soda solution withdrawal header (a suitable trap, not shown, being used to maintain the liquid level in the cathode tubes).

While the anode arrays are shown as being horizontally disposed and the cathode arrays are illustrated as being vertically disposed, the arrays of the anode and cathodes may be paralled to each other. Unless an ion exchange diaphragm is used, however, the arrays of cathodes would then be vertically disposed.

One practical reason for maintaining the anode and cathode electrodes disposed at right angles to each other is that it is easier to make connections from the electrodes to the buss bars supplying power to the cell.

In the cell shown in FIG. 1, brine is introduced through the inlet **30** and brine and chlorine are withdrawn through the header **32** at the top **34** of the cell.

As mentioned previously, FIG. 4 illustrates a cathode rod having a series of bores or perforations **36** extending through its walls.

In FIG. 5, a diaphragm of flocculated material such as asbestos is shown on the outer surface of a cathode tube **22**.

In FIG. 6, a diaphragm comprising a sleeve of ion exchange material **40** is shown on the outer surface of a cathode tube **22**.

In many situations, it is desirable to have the electrode members extend through opposing walls of the cell housing (to apply powder to each end). FIG. 7, however, illustrates a cell situation wherein the electrode **18** extends through only one wall of the cell housing and is supported internally of the housing by a support element **42**.

In the cathode tubes, commonly made of so-called iron pipe or tube, the perforations in one cell have been .109 inch in diameter spaced on diagonally disposed 5/32 inch centers.

An ion exchange material which may be used as the diaphragm is polysulfonated tetrafluoroethylene.

The dimensionally stable anode tubes may be made of titanium with a ruthenium oxide coating on their outer surface and with the interior of the anode tube filled with magnesium to provide better electrical conductivity.

The anode and cathode electrodes in one cell were spaced apart one-half inch rather than the one-quarter inch spacing of conventional diaphragm type chlorine caustic soda cells. Instead of the expected voltage penalty one would expect because of the increased IR drop, a small reduction in cell voltage occurred. Such a voltage education is evidence to indicate depolarization resulting from the cell design and cell geometry—an unexpected result.

## Operation

The electrolytic cell of this invention operates generally as do conventional chlorine-caustic soda diaphragm type electrolytic cells. The anode members are connected to the positive terminal and the cathode electrodes are connected to the negative terminal of a direct current power source. A suitable feed brine is flowed through the cell. Chlorine is released at the anode and is withdrawn at the top of the cell. Caustic soda and hydrogen are released at the cathode and are withd rawn from the hallow interior of those electrode members.

What is claimed is:

**1.** A diaphragm type electrolytic cell for use in the production of chlorine and caustic soda, comprising, within an enclosed housing, including a top, bottom and sides, an array of tubular dimensionally stable anodes and an array of hollow tubular liquid permeable walled cathode members, each of said cathode members having a porous diaphragm along and covering its outer surface within said housing, said anodes and cathode members being disposed adjacent to each other, means for introducing brine to said housing, means for withdrawing chlorine and brine from the top part of said housing, and means for withdrawing hydrogen and caustic soda from the interior of said hollow tubular cathode members.



**2.** Apparatus in accordance with claim **1**, wherein said anodes are made of titanium tubes whose outer surface is coated with ruthenium oxide and whose interior is filled with a magnesium alloy.

**3.** Apparatus in accordance with claim **1**, wherein said diaphragm is an ion permeable element.

**4.** Apparatus in accordance with claim **1**, wherein said diaphragm is a flocculated diaphragm.

**5.** Apparatus in accordance with claim **1**, wherein said anodes and cathode members are angularly disposed with respect to each other.

**6.** Apparatus in accordance with claim **1**, wherein said cathode members are more or less vertically disposed.

**7.** Apparatus in accordance with claim **1**, wherein said means for withdrawing hydrogen and caustic soda includes water circulating through said cathode members.

**8.** Apparatus in accordance with claim **1**, wherein said anodes and cathodes extend through at least one side of said housing.

**9.** Apparatus in accordance with claim **1**, wherein said arrays of anode and arrays of cathode members each extend through opposed sides of said housing.

**References Cited**

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JOHN H. MACK, Primary Examiner

W. I. SOLOMON, Assistant Examiner

U.S. Cl. X.R.

204—257, 258, 263, 283

PO-1050
(5/69)

# UNITED STATES PATENT OFFICE
# CERTIFICATE OF CORRECTION

Patent No. 3,804,739 Dated April 16, 1974

Inventor(s) Grafton L. Bergeron

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 29, delete "education" and insert --reduction--.

Column 3, line 41, delete "hallow" and insert --hollow--.

Signed and sealed this 3rd day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents