April 17, 1956 F. H. ROCKWELL 2,742,420

ELECTROLYTIC CELL

Filed May 3, 1952 3 Sheets-Sheet 1

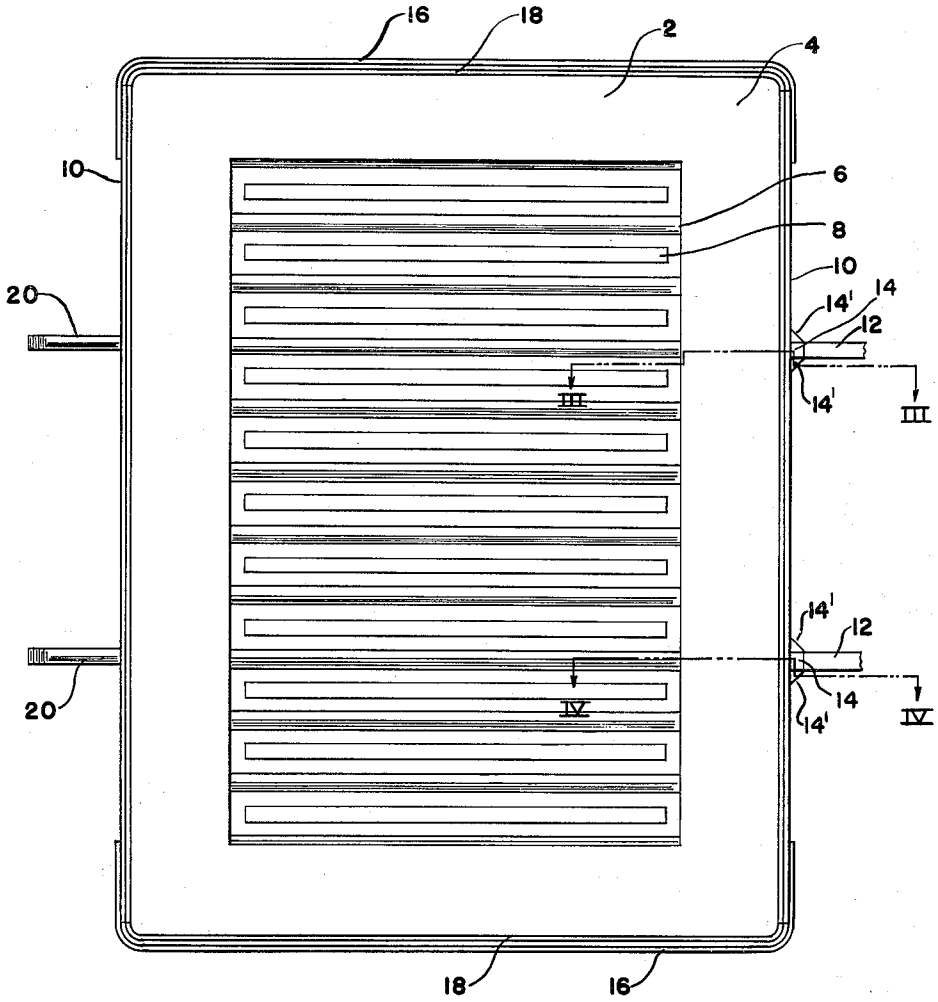


FIG. I

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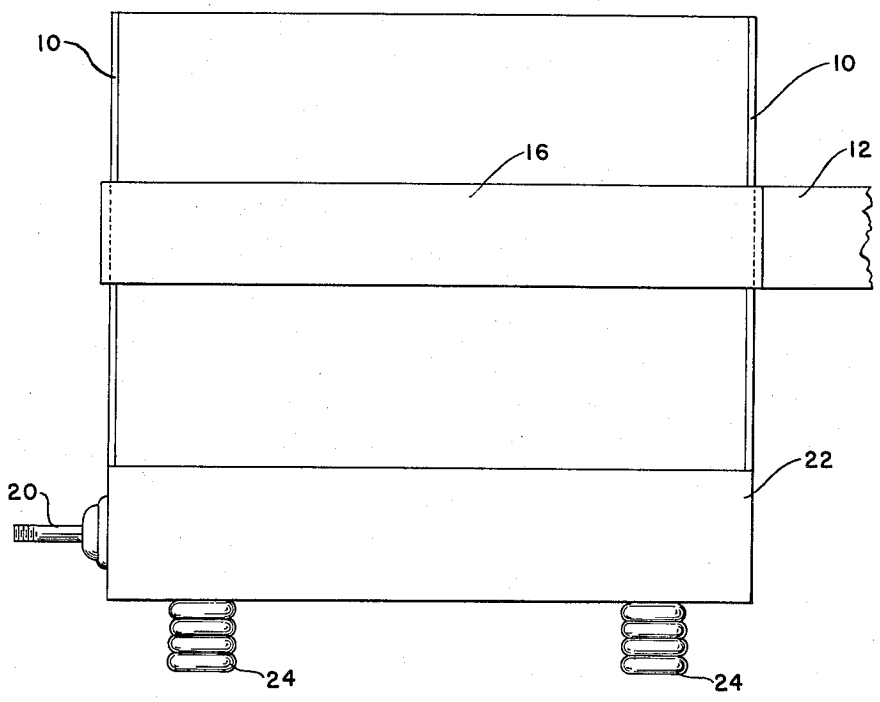


FIG. II

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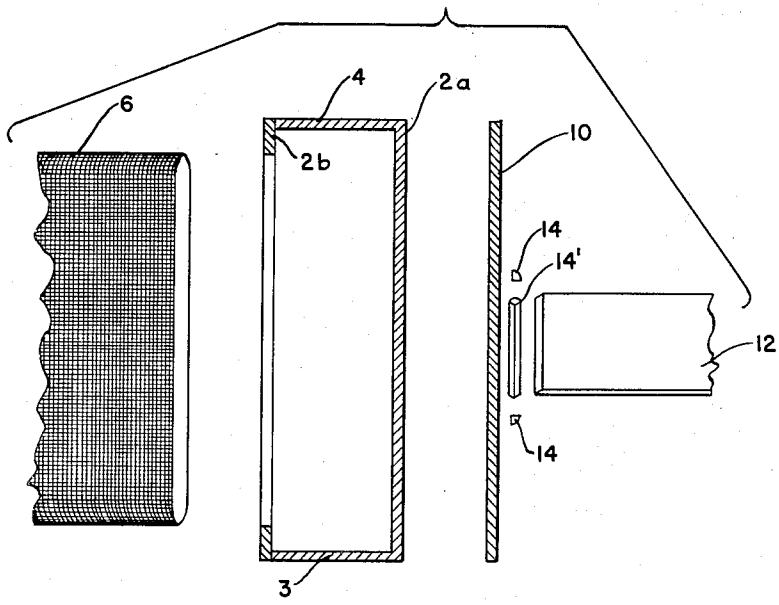


FIG. III

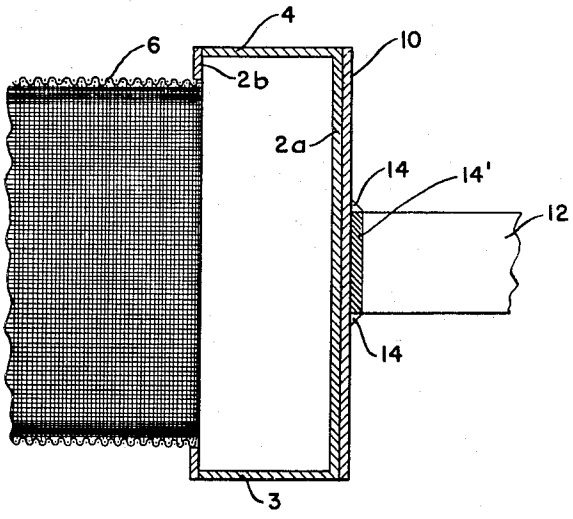


FIG. IV

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2,742,420

ELECTROLYTIC CELL

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Application May 3, 1952, Serial No. 285,906

4 Claims. (Cl. 204—266)

This invention relates to alkali-chlorine cells for the electrolysis of alkali metal chloride brines, and more particularly relates to alkali-chlorine cells having rows of permeable-diaphragm-covered, hollow, foraminous, metallic cathodes and rows of carbon anodes juxtaposed alternately within a containing vessel, and still more particularly relates to an improved cathode assembly structure for such cells.

In alkali-chlorine cells of the type above-described for the electrolysis of sodium chlorine brine, there has been a trend toward design and operation of such cells at much higher current capacities than those formerly employed. With the increased current capacity, there is an increase in the capacity of the cell to produce chlorine and caustic soda. In the design of such cells for higher productivity, the solution to the problem of efficient current conduction and uniform current distribution to the cathodes, together with the solution of the problem of providing more adequate electrical connections between cells, has become increasingly more difficult to attain. Thus, in the design of such cells, the added current load might require the addition to the cathode structure of upwards of one-half to one inch thickness in the steel plate forming the outer wall of the cathode structure of the cell. Moreover, in such a cell it has been found difficult in practice to obtain a completely satisfactory and fully reliable bond, having low electrical resistance, between the copper bus bars ordinarily employed to carry the current from the anode of one cell to the cathode of the next cell in a series. This difficulty is brought about because of the fact that the melting point of the copper bus bar is so very much lower than that of the steel sheet or plate to which it is attached that a difficult and time-consuming welding or brazing technique is required. The material used in the weld or braze is of necessity an alloy having a low electrical conductivity as compared to copper.

One of the objects of the present invention is to provide an alkali-chlorine electrolytic cell of low electrical resistance, and capable of extraordinary efficiency at high electrical current throughput.

Another object is to provide an alkali-chlorine electrolytic cell in which more uniform current distribution to the cathode electrodes is effected than is obtained by means of conventional design of such cells.

Still another object of the invention is to provide an alkali-chlorine electrolytic cell in which the means provided for the more uniform distribution of current also affords means for more efficient electrical connections between the cells.

Pursuant to these objects, the present invention is directed to an electrolytic alkali-chlorine cell in which there is a cathode assembly including vertical, hollow, end chambers defined by current-carrying, liquid-retaining, ferrous-metal, inner and outer end walls, said chambers communicating with hollow, foraminous, ferrous-metal, vertically disposed, cathode electrodes extending horizontally from said inner end walls, said outer end walls having a copper veneer sheet bonded thereto and copper bus bars attached to said veneer sheet so as to be substantially integral therewith.

Referring now to the drawings, from which a better understanding of the present invention may be gained by those skilled in the art,

Fig. I is a top-plan view of an electrolytic cell for the electrolysis of sodium chloride brine, with the cover thereof removed and to show the arrangement of anodes, cathodes therein, and the copper veneer sheet attached to the cathode assembly;

Fig. II is a side elevation of the apparatus of Fig. I;

Fig. III is a partial vertical section in exploded form along the line III—III of Fig. I; and

Fig. IV is a partial vertical section along the line IV—IV of Fig. I to show the parts of Fig. III in assembled form.

In the cell structure, the cell can **2** comprises outer wall **2***a*, inner wall **2***b* (Fig. III), bottom portion **3** and top portion **4**. These walls, together with the bottom portion **3** and the top portion **4**, form the cathode chamber for the collection of the catholyte solution and cathode gas evolved in cathode tubes **6** during the operation of the cell. Anodes **8** are juxtaposed alternately with cathode tubes **6** within the cell chamber. A copper veneer sheet **10** (which may also be referred to as copper cladding for outer wall **2***a*) is suitably bonded directly to the outer wall **2***a* in such a manner as to insure as nearly as possible perfect electrical contact with the outer wall, the method employed in directly bonding the cladding metal to the base metal being well-understood in the art and forming no part of the present invention. Bus bars **12** are attached to the veneer sheet **10** by brazing or other suitable means which will insure that the bus bars **12** are substantially integral with the veneer sheet **10**. In Figs. III and IV particularly, slugs of copper **14**, **14'** are represented as the means by which bus bars **12** are brazed or welded to veneer sheet **10**.

It will be noted from the drawings that the copper veneer shet **10** is intended to cover substantially entirely the outer wall **2***a* of the cathode, but as will be appreciated by those skilled in the art, the veneer sheet **10** may also be bonded to the cathode structure in such a manner as to cover top portion **4** and bottom portion **3** of the cathode chamber over substantially the entire length of the cell. However, it is not necessary for the veneer sheet **10** to be continuous across the sides **18** of the cell since the sides of the cell are normally relatively electrically inactive and hence, side bus bars **16**, which are suitably out of direct electrical contact with the sides **18** of the cell, may be employed as the current-carrying means from the veneer sheet **10** covering the outer wall **2***a* of the cell can **2** to the equivalent sheet on the opposite outer wall of the cell. Bus connectors **20** are in electrical connection with anode structures, not shown, in the base **22** of an adjacent cell and are in no way, of course, connected to the cell can **2**, except by means of the solution in the cell during the operation thereof. Insulators **24** insulate the cell electrically from the ground or other support.

Some concept of the significance of the present invention in the design of alkali-chlorine cells may be gained from the following general considerations:

Preliminary design calculations show that end wall dimensions for a given cathode structure should be of the order of 85 inches by 30 inches; further calculations relative to structural strength show that the thickness of the copper cladding for the outer end walls of such cathodes may suitably be within the range of 15% to 35% of the thickness of the outer end walls and that the walls are suitably made 0.375 inch thick; coordination of economic factors with designed capacity of the cell dictate that 15% of the thickness of the end wall be copper cladding;

from these requirements and taking the resistivity of copper to be 1.724×10^{-6} ohm/cm.^{3}, and that of steel as 10^{-5} ohm/cm.^{3}, it is shown that the copper clad structure has a resistivity of 59% of a sheet of steel of equal area and thickness, that a steel plate having the same resistance as the copper clad structure would have a thickness of 0.65 inch, an increase of 1.7 over the copper clad structure. Also, it is shown, by taking the above weight-volume figures for steel and copper, that an outer end wall of steel 0.65 inch thick without cladding, and the copper clad end wall structure have a weight differential of about 185 pounds in favor of the clad structure, which differential amounts to about 41% of the weight of the thicker steel end wall.

Thus, cathode structures of alkali-chlorine cells employing the principles of the present invention are seen to be lighter in weight than an all steel cathode of comparable resistivity, and, by virtue of the copper to copper bonding between the bus and the cathode wall, to insure minimum electrical resistance at this point and to dispense completely with the disadvantage of bonding the copper bus to the steel cathode end wall.

While there have been described various embodiments of the invention, the apparatus described is not intended to be understood as limiting the scope of the invention as it is realized that changes therewithin are possible and it is further intended that each element recited in any of the following claims is to be understood as referring to all equivalent elements for accomplishing substantially the same or equivalent manner, it being intended to cover the invention broadly in whatever form its principle may be utilized.

What is claimed is:

1. In an electrolytic alkali-chlorine cell, a cathode assembly including end chambers defined by current-carrying liquid-retaining ferrous metal inner end walls and copper clad ferrous metal outer end walls, said chambers communicating with ferrous metal cathode electrodes extending from said inner end walls, said copper clad ferrous metal outer end walls having the copper cladding bonded uniformly and directly to the surface external to said chamber, and a copper bus bar attached to said copper cladding so as to provide a copper-to-copper bond and to be substantially integral therewith.

2. In an electrolytic alkali-chlorine cell, a cathode assembly including vertical hollow end chambers defined by current-carrying liquid-retaining ferrous metal inner end walls and copper clad ferrous metal outer end walls, said chambers communicating with hollow foraminous ferrous metal cathode electrodes extending horizontally from said inner end walls, said copper clad ferrous metal outer end walls having the copper veneer sheet bonded uniformly and directly to the surfaces external to said chambers, so as to provide direct copper-to-ferrous metal bonding and to insure as nearly as possible a perfect electrical contact, said veneer sheet being substantially coextensive with said outer end walls, and copper bus bars attached to said veneer sheet so as to provide a copper-to-copper bond and to be substantially integral therewith.

3. In an electrolytic alkali-chlorine cell, a cathode assembly including vertical hollow end chambers defined by current-carrying liquid-retaining ferrous metal inner end walls and copper clad ferrous metal outer end walls, the copper cladding being bonded uniformly and directly to the surfaces external to said chambers and substantially coextensive with said outer end walls, said chambers communicating with hollow foraminous ferrous metal cathode electrodes extending horizontally from said inner end walls, and copper bus bars attached to the copper cladding of said outer end walls so as to provide a copper-to-copper bond and to be substantially integral with said cladding.

4. In an electrolytic alkali-chlorine cell, a cathode assembly including a vertical hollow end chamber at each end of said cell, each of said chambers being defined by a current-carrying liquid-retaining ferrous metal inner end wall and current-carrying liquid-retaining ferrous metal channel sections forming the top, bottom, and outer end walls of said chambers, the outer surface of each of said outer end walls being copper clad and having the copper veneer sheet bonded uniformly and directly to the surfaces external to said chambers, so as to provide direct copper-to-ferrous metal bonding and insure as nearly as possible a perfect electrical contact, said veneer sheet covering substantially all of each of said outer end walls, copper bus bars attached to said veneer sheets so as to form a copper-to-copper bond and to be substantially integral therewith, said bus bars electrically connecting said veneer sheets outside the boundary walls of said cell, and hollow foraminous ferrous-metal cathode electrodes extending horizontally from one of said inner end walls to the other and communicating with said chambers by means of openings in said inner end walls.

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