Dec. 5, 1961 J. L. GUILLOT 3,011,964

DIAPHRAGM STRUCTURE FOR ELECTROLYSIS CELLS

Filed Sept. 29, 1958

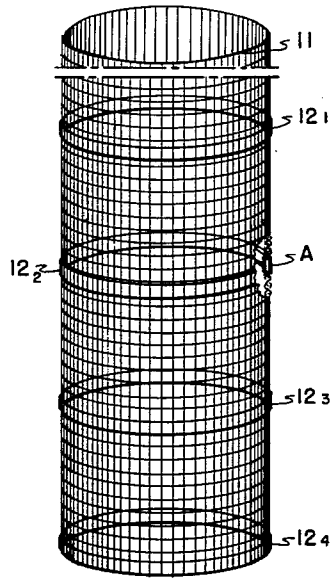


FIGURE 1

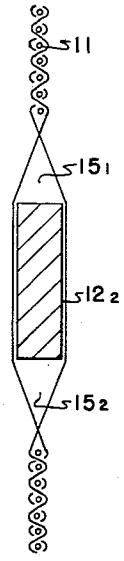


FIGURE 2

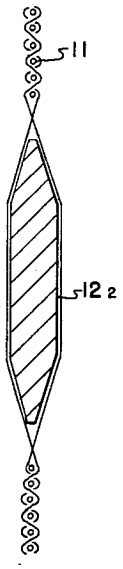


FIGURE 3

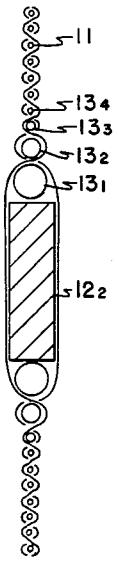


FIGURE 4

United States Patent Office 3,011,964 Patented Dec. 5, 1961

3,011,964
DIAPHRAGM STRUCTURE FOR ELECTROLYSIS CELLS

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Filed Sept. 29, 1958, Ser. No. 764,029
4 Claims. (Cl. 204—295)

This invention relates to improvements in an electrolysis cell of the type used for the production of chlorine and sodium by the electrolysis of molten sodium chloride. More particularly, the invention relates to improvements in diaphragms of the type used in cells of the Downs type.

The manufacture of sodium is carried out in an electrolysis cell of the Downs type, U.S. Patent 1,501,756. The Downs cell is characterized by a centrally positioned, bottom mounted vertical graphite anode and a surrounding steel cathode of cylindrical shape. These electrodes define a relatively narrow annular space within which electrolysis occurs. In recent years a new type of cell has emerged which includes a plurality of anodes and cathodes within the confines of the walls of a single cell though it is essentially the same type of cell. Briefly, the cell includes a housing which contains a plurality of anodes, each of which is surrounded by a cylindrical cathode. In the annular space between an anode and the surrounding internal surface of the cathode is positioned a wire gauze or diaphragm supported from above by a collector. The collector provides an outlet port for removal of the gaseous chlorine and an annular inverted channel for manifolding and removal of the sodium metal. The collector is supported by a frame which in turn is attached to and is supported by the cell housing.

The characteristic of the cell is the formation of sodium and chlorine in the annular space between an anode and a cathode, and into which space is positioned the diaphragm. The diaphragm partitions the annular spaces between each of the anodes and cathodes into two concentric and contiguous compartments. The diaphragm, being porous, permits the free passage of ions therethrough but but lessens molecular diffusion and therefore also lessens recombination of the anions and cations.

The fused electrolyte or bath employed is sodium chloride which includes substantial quantities of calcium chloride. The calcium chloride is present in sufficient quantities to provide a reasonably low melting point for the fused mixture. Preliminary separation means prevent the actual removal of substantial amounts of calcium metal from the cell and therefore prevents the production of appreciable amounts of calcium metal. During electrolysis metallic calcium and various accumulations of impurities are formed. These include oxides, carbon, silicon, silica compounds and heavy metals, derived from the electrolyte from oxidation of metals and from the materials used in the construction and operation of the cell. It is generally believed that these impurities come into close proximity to the electrodes and the diaphragms, and tend to form deposits. These deposits form conducting paths of lower resistance than the electrolyte. Thus, "bridges" are often formed across from the diaphragm to the cathode. This phenomenon, termed "calcium-bridging" often produces a current within the diaphragm itself and as a result of the short circuiting holes are often burned therein. This phenomenon, it is suspected, permits recombination of the sodium and chlorine atoms which produces lowered current efficiency and greatly shortens the life of the diaphragms. The life period of the diaphragms, generally very short, has necessitated many wasted hours spent in partially dismantling the cell to replace the diaphragms. Such dismantling, in addition to being inherently expensive, also

results in reducing the production capacity of a plant.

Having regard to the above difficulties, it is accordingly an object of the present invention to provide a new and improved diaphragm. Specifically, it is an object of the present invention to provide a new and improved diaphragm capable of more extended operation than is possible with diaphragms existing heretofore. It is also an object of the present invention to provide a diaphragm, defined hereinafter, which is much less expensive to fabricate. Another object is to provide a diaphragm which has no sharp irregular surfaces. Yet another object of the present invention is to provide a diaphragm, several embodiments of which are hereinafter described, which permits a more smooth flow pattern for the movement of the liquids and gases through the cell. Other objects will appear hereinafter.

The apparatus is capable of assuming several forms, which will be readily understood from the detailed description below and the accompanying figures. The figures illustrate several of the embodiments of the apparatus, all having the basic elements as above described. The figures include FIGURE 1 which is an isometric view of a complete diaphragm or diaphragm assembly. FIGURE 2 presents a cross sectional view of a reinforcing band taken from cut-out A of FIGURE 1. FIGURE 3 shows a cross sectional view of a preferred type of reinforcing band which provides tapered edges. FIGURE 4 illustrates an equivalent of the preferred embodiment of FIGURE 3.

The apparatus of the present invention constitutes a new and novel type of foraminous metal diaphragm of cylindrical shape for use in fused salt electrolysis cells The diaphragm is formed of a wire gauze having a plurality of parallel reinforcing bands, spaced at intervals, which are woven into the said wire gauze Each of the said reinforcing bands are of a width equivalent to the width normally occupied by a plurality of gause wires running in the same direction The said bands are substantially transverse to the axis of the cylindrical diaphragm. The key and novel feature of the invention is the fact that the reinforcing bands are woven into the wire fabric or gauze. This constitutes a real advantage over previous types of diaphragm assemblies by providing greater overall current efficiencies and for longer periods of operation. By longer periods of operation is meant simply that the diaphragms can operate for longer periods of time before replacement is necessary. The reasons for this advantage are not entirely clear but it is believed that, at least partially, it results from the elimination of irregular surface areas on the diaphragm surfaces.

Fortuitously, another advantage has resulted from the above discovery. The past method of fabricating the diaphragms left much to be desired. The diaphragms were fabricated as follows: Wire gauze was received in large rolls from the manufacturer and was unrolled and cut into appropriate lengths. The cut edges were then "crimped" and stapled together to form a cylindrical shape. To provide rigidity, which is essential for operational use, steel hoops were formed and passed over the outside of the cylindrical shaped wire gauze. The hoops were then spaced at intervals, and stapled thereto. The time consumed by this method of fabrication was enormous and, of course, very costly. In the method by which the apparatus of the present invention is fabricated, the reinforcing bands are merely woven into the gauze wire on the loom during manufacture. The gauze is then cut into appropriate lengths and the ends of the reinforcing bands spot welded together. No stapling is required.

A preferred embodiment of the invention contemplates providing reinforcing bands having a cross sectional configuration which provides tapered edges. An equivalent

of this embodiment is to provide at least one wire adjacent the reinforcing band edges of smaller diameter than the thickness thereof and of greater cross sectional diameter than the gauze wires running in the same direction. Preferably there will be provided a plurality of gauge wires of non-uniform diameters beginning from a point adjacent the edges of the reinforcing bands, and of smaller cross sectional diameters than the thickness of said bands, and which progressively decrease in cross sectional diameter in a direction away from said edges until the cross sectional diameter becomes the same as the other gauze wires running in the same direction. One purpose of these preferred embodiments is to restrict the size of the larger apertures created adjacent the locations where the reinforcing bands are woven into the gauze so that they are no larger than the ordinary gauze openings. It will also be generally understood that the summation of the widths of the total number of reinforcing bands used shall be of no greater linear dimension than about 10 to 15 percent of the total length of the diaphragm assembly.

Referring to FIGURE 1, an isometric view is shown of a complete diaphragm or diaphragm assembly. The diaphragm assembly includes a wire gauze **11** formed into open end cylindrical shape and having a plurality, in this instance four, of parallel reinforcing bands 12_1, 12_2, 12_3, 12_4 woven into the said wire gauze **11**. Each of the said reinforcing bands **12** are spaced at intervals, and are substantially transverse to the axis of the cylindrical diaphragm assembly. In this embodiment the gauze wires **11** are all substantially of uniform diameter and form a mesh size of generally from about 20 to about 30. A preferred mesh size is about 26 (U.S. Standard).

FIGURE 2 shows a cut-out section A of FIGURE 1. The figure shows an enlarged view of the reinforcing band 12_2, which has a rectangular cross section, woven into the wire gauze **11**. The rectangular cross section of the reinforcing band 12_2 woven into the wire gauze **11** results in apertures 15_1, 15_2 of increased size adjacent its location of passage. FIGURES 3 and 4 show preferred embodiments which maintain uniformity of gauze wire openings. Specifically, FIGURE 3 shows a preferred embodiment of the reinforcing band **12**, the cross sectional configuration of which provides tapered edges. FIGURE 4 shows again a reinforcing band **12** with rectangular cross section as in FIGURE 2 but provides gauze wires 13_1, 13_2, 13_3, 13_4 of decreasing cross sectional diameters adjacent to the edges of the reinforcing band **12**. These create a "tapered effect" thus producing screen openings or apertures of uniform dimensions.

As an illustration of the effectiveness with which the apparatus accomplishes the objectives of the invention, a number of diaphragms of the type shown by reference to the figures are used in a fused sodium chloride electrolysis cell of the type having four vertically aligned bottom mounted anodes, each with a surrounding cathode. The cell is operated at a temperature of 600° C. for an extended period of time. Fresh sodium chloride is added in an equivalent amount to the chlorine gas and sodium metal produced. The diaphragms are found to provide a considerably higher overall average current efficiency for a much longer period of time than the older type of diaphragms. Therefore, the diaphragms need not be replaced as often as older types of diaphragms and consequently the frequency of dismantling the cell to replace diaphragms is reduced. Greater production is realized.

As previously mentioned, several variations may be made in the apparatus without departing from the spirit and scope of the invention. As already mentioned, the essence of the invention is the provision of a diaphragm assembly wherein the reinforcing bands are woven into the wire gauze or fabric in a direction which is substantially transverse to the longitude or axis of the diaphragm assembly. The bands are each spaced apart and substantially parallel one with respect to the other. The reinforcing bands are employed for the sole purpose of imparting rigidity to the whole assembly and therefore the exact dimensions or the exact number employed is not critical. The importance of providing a rigid structure is readily understood when it is realized that the whole diaphragm assembly is about four feet in length and approximately eighteen inches in diameter. In addition to operational use within the cell the diaphragms must be handled manually in large quantities. Generally, it is preferable to employ about four of these reinforcing bands in a diaphragm assembly to impart sufficient rigidity. As stated, the width of the reinforcing bands is not critical but generally the cumulative width of all the band used in an assembly should occupy no more than about 10 to 15 percent of the total length of the cylindrical diaphragm assembly. Reinforcing bands of about 1/16 inch in thickness and about ½ inch in width are a convenient size. Obviously, however, the greater the number of reinforcing bands used in an assembly, the greater will be the reduction of the opening through which the ions of chlorine and sodium can pass. One method of compensating for the width occupied by the reinforcing bands is to provide a fewer number of gauze wires running in the same direction as the said bands than the number of gauze wires in a direction perpendicular thereto.

As was illustrated by reference to FIGURES 2, 3 and 4, the cross sectional configuration of the reinforcing bands may vary considerably. Generally it can be said that a "streamlined configuration" is preferred. As was illustrated, this configuration can be produced in a variety of ways. This configuration is preferred for two fundamental reasons viz., a lesser "bulge" or irregular surface is created on the face of the diaphragm assembly and also apertures of substantially increased size are not produced in the adjacent area wherein the reinforcing bands pass through the wire gauze.

The materials of construction of the diaphragm assembly are the same as would be employed in conventional type diaphragm assemblies in similar use. Essentially all that is required is that the material be capable of withstanding the high temperature and that it be inert to the fused bath. Generally, it is preferred that the reinforcing bands and the gauze wires be made of iron or steel.

What is claimed is:

1. A foraminous metal diaphragm for location within an annular electrolysis zone of a fused salt electrolysis cell comprising a cylindrical wire gauze structure having a plurality of circular spaced-apart parallel reinforcing bands woven into the wire gauze, each of the said bands having a width equivalent to the width normally occupied by a plurality of gauze wires running in the same direction, the bands being substantially transverse to the axis of the cylindrical diaphragm.

2. A foraminous metal diaphragm for location within an annular electrolysis zone of a fused salt electrolysis cell comprising a cylindrical wire gauze structure having a plurality of circular spaced-apart parallel reinforcing bands woven into the said wire gauze, each of the said bands having a width equivalent to the width normally occupied by a plurality of gauze wires running in the same direction, the bands being substantially transverse to the axis of the cylindrical diaphragm, and each of said bands having a cross sectional configuration which provides tapered edges.

3. The apparatus of claim 1 further defined in that the total width of the summation of the reinforcing bands used in a diaphragm assembly is of no greater linear dimension than about 15 percent of the total length of the diaphragm assembly.

4. A foraminous metal diaphragm for location within an annular electrolysis zone of a fused salt electrolysis cell comprising a cylindrical wire gauze having a plurality of spaced apart parallel reinforcing bands woven into the said wire gauze, each of the said bands having a width

equivalent to the width normally occupied by a plurality of gauze wires running in the same direction, the bands being substantially transverse to the axis of the cylindrical diaphragm, and each having gauze wires of decreasing cross sectional diameter immediately adjacent the edges thereof whereby the size of the openings in the gauze produced by the passage of the reinforcing bands therethrough are substantially reduced.

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