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ELECTROLYSIS METHOD AND APPARATUS EMPLOYING A NOVEL DIAPHRAGM

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Fig. 1

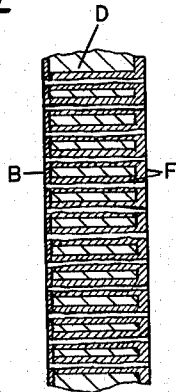
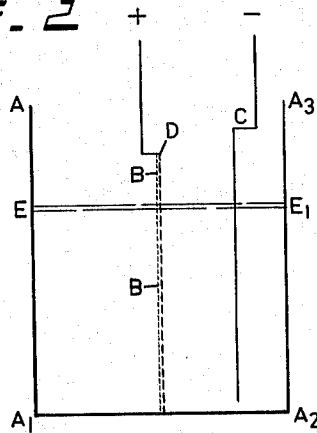


Fig. 2



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Original application Oct. 22, 1959, Ser. No. 848,037, now Patent No. 3,098,802, dated July 23, 1963. Divided and this application Nov. 13, 1962, Ser. No. 236,787 Claims priority, application Netherlands, Oct. 29, 1958, 232,721

3 Claims. (Cl. 204—1)

This application is a division of my copending application, Serial No. 848,037, filed October 22, 1959, now Patent No. 3,098,802.

This invention relates to a diaphragm for use in carrying out electrolysis.

As is known such diaphragms are for the purpose of keeping portions of an electrolyte substantially separated so that products formed during the electrolysis are kept separate from each other so as to prevent undesirable reactions, although the diaphragm is ion-permeable to allow the ions to pass through it unhindered.

Usually porous materials of inorganic or organic nature are used for such diaphragms. The diaphragms of the first mentioned type which, for example, consist of asbestos, fritted glass, earthenware, etc., must be rather thick if they are to have sufficient mechanical strength. As a result the diaphragm will have a large ohmic resistance and the potential drop across the diaphragm is considerable. This results, inter alia, in large losses in current and undesirable reactions. Organic materials, such as cellophane, parchment, canvas, etc., are occasionally used as diaphragm, but the drawback of using these materials is that they have little chemical resistance and little mechanical strength. Furthermore a perforated diaphragm of noble metal has been proposed, which is chemically resistant and which in a thin form has sufficient mechanical strength, but a great disadvantage is that the diaphragm is charged by induction and a discharge of ions and other secondary reactions will take place in the electrolysis cell at a place where this is undesirable.

The present invention is based on the insight that electrolysis diaphragms may advantageously be manufactured from a porous metal, the surface of which can easily be provided with a layer insulating the subjacent metal from the passage of current therethrough and which layer is inert and non conducting with respect to the electrolyte. Such a layer will hereinafter be called a "barrier layer."

According to the invention a diaphragm is provided for use in electrolysis in which it is desired to keep two portions of electrolyte substantially separated yet allow ions to migrate to the electrodes and in which the electrolyte is a non-fluoride containing electrolyte, said diaphragm comprising a plate of a metal selected from the group consisting of titanium and alloys consisting essentially of titanium, said diaphragm having pores therethrough substantially perpendicular to the faces of said plate, and said plate having a coating of a noble metal on one side thereof and having a barrier layer of titanium dioxide on the uncoated parts thereof.

For carrying out the electrolysis this diaphragm has the side thereof which is coated with the noble metal connected to the positive pole of the source of current. The diaphragm then at the same time performs the function of an anode.

The invention will now be described with reference to the accompanying drawing in which:

FIG. 1 is a schematic representation of an enlarged cross section through the diaphragm;

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FIG. 2 is a schematic representation of a manner of mounting the diaphragm in an electrolysis apparatus.

As seen in FIGURE 1 the diaphragm D consists of a porous plate of titanium which on one side is provided with a thin layer B of noble metal or an alloy of noble metals, e.g., platinum, rhodium or iridium, so that the diaphragm is conductive at said side and on the other side a barrier layer F of titanium dioxide.

The metal core of the diaphragm according to the invention may be manufactured in a manner known per se, e.g., by sintering metal powder, by etching a metal plate, by mechanically perforating a plate etc. Thus it is possible to provide a plate of titanium with a thickness of 1/20 mm. on either side with a layer of wax, whereupon the layer of wax is mechanically removed in a great number of places, the bared metal being etched through and through with a hydrogen fluoride solution. After the layer of wax has been completely removed the plate of titanium may at one side be provided with a layer of noble metal in a conventional manner if desired. This is accomplished by electroplating a noble metal such as platinum or rhodium on a titanium base in a conventional manner. The thus plated core may then be heated or otherwise treated to cause the plating to adhere more closely to the titanium base.

The barrier layer may be provided in simple manner, e.g., by anodic oxidation. The barrier layer thus obtained may still be strengthened by heating in an oxygen containing atmosphere. The heating may be from 400 to 800° C. for periods up to 6 hours, and a barrier layer of about .001 mm. thickness is formed.

As seen in FIG. 2, the diaphragm D with the layer B of noble metal thereon is positioned on the opposite side of the diaphragm D from cathode C and connected to the positive side of the source of current, so that the side of the diaphragm coated with noble metal B serves as an anode in the electrolysis apparatus AA₁A₂A₃. As a result thereof the distance of the anode to the cathode C is reduced by, e.g., 50%, so that a high increase in useful effect is obtained.

Because the voltage supplied to the diaphragm the resistance of it decreases by 10-40% and the pores may be larger than in conventional diaphragms.

Its function as a diaphragm is maintained because during the galvanic deposition of or the chemical coating with a layer of noble metal the precipitate does not penetrate into the pores of the core metal, so that the core metal is only provided with a layer of noble metal around the openings of the pores. In such a diaphragm the titanium core metal will conduct the current in the longitudinal direction of the diaphragm (which length amounts to, e.g., 40 cm.) whereas the deposited noble metal conducts current only in the direction of its thickness, which thickness amounts to e.g., 1/1000 mm.

It has been found that in carrying out an electrolysis by means of a diaphragm according to the invention a considerable saving in the power consumption is obtained.

The diaphragm according to the invention inter alia has the following advantages. It is chemically resistant and its mechanical strength is of such a nature, that the thickness of the diaphragm need only amount to a fraction of one millimeter. As result the pores are substantially rectilinear so that the resistance to current flow therethrough is decreased, in contradistinction to, e.g., a diaphragm of asbestos which has no rectilinear pores so that the current which passes therethrough must traverse a long path and the resistance is increased. In addition the diaphragm according to the invention admits of being easily worked and of being given the desired shape.

The invention is not limited to a diaphragm of titanium. Also other metals forming a barrier layer resistant in the

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electrolyte used may be used according to the invention.

I claim:

1. A method of carrying out electrolysis in which it is desired to keep two portions of the electrolyte substantially separated yet allow ions to migrate to the electrodes, comprising the steps of placing an ion permeable, electrolyte substantially impermeable diaphragm of a metal selected from the group consisting of titanium and alloys consisting essentially of titanium, said diaphragm having pores therethrough and having a coating of a noble metal on one side thereof and having a barrier layer of titanium oxide on the uncoated parts of said diaphragm, at a point spaced from a cathode in an electrolysis apparatus with the other side of said diaphragm toward said cathode, placing a non-fluoride containing electrolyte on opposite sides of the diaphragm, and passing a current from said diaphragm coating as an anode to the cathode through the electrolyte portions and the diaphragm, said diaphragm keeping the two portions of the electrolyte substantially separate and allowing passage of ions through said pores when said diaphragm coating is connected as an anode.

2. An apparatus for carrying out electrolysis in which it is desired to keep two portions of the electrolyte substantially separated yet allow ions to migrate to the electrodes, comprising an ion permeable, electrolyte substantially impermeable diaphragm of a metal selected from the group consisting of titanium and alloys consisting essentially of titanium, said diaphragm having pores therethrough and having a coating of a noble metal on one side thereof and having a barrier layer of titanium oxide on the uncoated parts of said diaphragm, a cathode

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spaced from the uncoated side of said diaphragm, a container for electrolyte in which said diaphragm and cathode are mounted, and current supply means connected to said diaphragm and to said cathode for passing current from said diaphragm to said cathode, said diaphragm coating acting as an anode, said diaphragm keeping the two portions of the electrolyte substantially separate and allowing passage of ions through said pores when said diaphragm coating is connected as an anode.

3. A diaphragm for use in electrolysis in which it is desired to keep two portions of electrolyte substantially separated yet allow ions to migrate to the electrodes and in which the electrolyte is a non-fluoride containing electrolyte, said diaphragm comprising a plate of a metal selected from the group consisting of titanium and alloys consisting essentially of titanium, said diaphragm having pores therethrough extending substantially perpendicular to the faces of said plate, and said plate having a coating of a noble metal on one side thereof and having a barrier layer of titanium dioxide on the uncoated parts thereof.

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