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ELECTROLYTIC APPARATUS.
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Fig. 1.

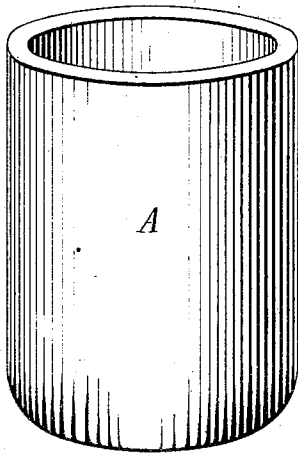


Fig. 2.

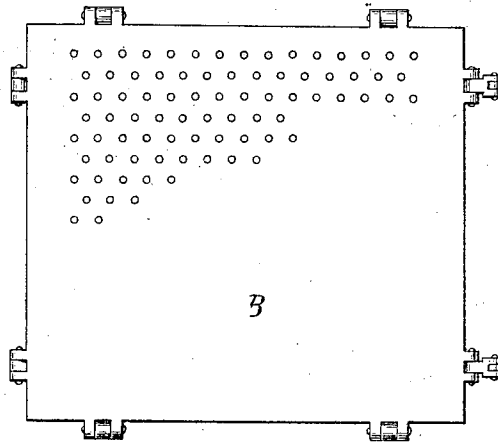
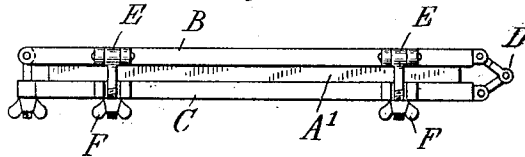


Fig. 3.



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ELECTROLYTIC APPARATUS.

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To all whom it may concern:

Be it known that I, ISAIAH L. ROBERTS, a citizen of the United States, residing at New York, in the county and State of New York, have invented certain new and useful Improvements in Electrolytic Apparatus, of which the following is a specification, reference being had to the drawings accompanying and forming a part of the same.

10 My invention relates to porous diaphragms for use in batteries and electrolytic cells. Heretofore such diaphragms have been made of various substances and in various ways, as for example, of clay 15 molded and then baked at a high temperature; of cements and various other mineral, vegetable and animal substances molded and baked; also of anthracite coal and other carbonaceous materials, the particles of same 20 being held between suitable mechanical supports, or cemented together. All these devices are more or less affected by the acids or alkalis with which they come in contact, while the anthracite diaphragms possess the 25 disadvantage of requiring the use of cement or mechanical supports to hold them in form. Efforts have been made to use a porous diaphragm of conducting carbon, but without success, for the reason that, being 30 conducting, the diaphragm will on closing the electrical circuit through it assume a polarity of its own, one side becoming positive and the other negative, thus setting up a double action in the battery or electrolytic 35 cell. I have therefore been led to devise my present invention, which has for its object the production of a porous diaphragm which is light and strong and which will be affected to a minimum degree, if at all, 40 by the liquid or liquids in which it is used; and also the provision of a simple and efficient apparatus in which such a diaphragm may be employed.

In carrying out the first part of my invention I take a sheet or vessel of wood, wood 45 pulp, paper, strawboard, or similar material, of the proper size for the purpose desired, and then char or partially carbonize the same, sufficiently to change the organic materials therein into a condition in which they 50 will not be attacked by the electrolyte, at the same time without rendering the diaphragm sufficiently conducting to set up double electrolytic action. For example, in 55 making a diaphragm in the form of a cup, I may take a block of wood and turn from

it a cup or vessel of the desired form and size, allowing of course for the usual shrinkage in the process of carbonization. The cup is then placed in a suitable oven and heated 60 very slowly, keeping the temperature as nearly as possible uniform throughout all parts of the vessel. The heating should be carried only to such a degree that the diaphragm will be charred without becoming 65 conducting to an appreciable extent. If the vessel is made from wood of a good quality, that is, of even grain, free from cracks, etc., it will retain its form very closely. Instead of making the vessel from wood, by turning 70 the same from a solid block, it may be formed by molding wood-pulp, or similar material, in a plastic state, or may be built up from sheets of them in any suitable manner. Such a vessel is then carbonized in the manner as 75 just described.

If the diaphragm is to be in the form of a flat plate or sheet, it should be prevented from warping or twisting in the process of carbonization, and for this purpose I use 80 a pair of plates of iron or other suitable material, between which the sheet is clamped during the baking, apertures being provided in the clamping plates to permit escape of the gases of decomposition. The extent to 85 which the diaphragms are to be heated without rendering them conducting varies, of course, with the materials used. Within certain limits, however, it is immaterial at what point the carbonization is stopped, since it 90 may be carried considerably beyond the point where the material becomes sufficiently resistant to the attack of acids or alkalis used or developed in the electrolyte or battery solution, without the diaphragm be- 95 coming sufficiently conducting to render it useless for the purpose intended. It is impossible, on account of the wide differences in the substances from which the diaphragms may be made, to give definite temperatures, 100 or degrees of carbonization, to which they may or should be subjected, but these facts may be readily ascertained for any particular kind of material by preliminary trial. Where the electrolyte is "watery", that is, 105 a liquid at ordinary temperatures, in contradistinction to a fused bath, the heat used to carbonize the diaphragm should be no higher than is necessary to decompose the organic matter to such a degree that it will not be 110 attacked by the gases produced in the electrolysis or by the substances in the solution.

For example, chlorin gas will soon decompose such organic materials as wood, paper-board, strawboard, wood-pulp, etc., but if these are partially carbonized, as described, the substances which would unite with chlorin are decomposed or driven off in the baking, leaving the diaphragm in proper form and of sufficient strength to be used for the purpose intended.

For molten baths a cup diaphragm will generally be found more suitable, since it does not require the use of sealed joints in contact with the fused electrolyte; whereas flat diaphragms used to divide a tank into compartments requires the joint which its edges make with walls of the tank to be sealed, as for example, by means of asphaltum, paraffin, or similar material. The substances just mentioned melt at comparatively low temperatures, and hence could not withstand the heat of fused electrolytes, which usually are kept at higher temperatures than the melting point of asphaltum, paraffin, etc. On the other hand, a hollow diaphragm, as a cup or other vessel, may be plunged to the desired depth into the molten electrolyte while the seal at the top of the cup, in cases where a seal is desirable, remains out of contact with the bath and may be kept at a much lower temperature.

Referring now to the drawings for a more complete explanation of my invention: Figure 1 is a perspective view, showing a vessel or cup ready for carbonization. Fig. 2 is a plan view, showing a convenient clamping device for use in making flat plates or sheets. Fig. 3 is a side elevation of the clamping apparatus.

Referring now to Fig. 1, A indicates a vessel in the form of a cylindrical cup, made of turned wood, or molded or otherwise shaped, from any of the materials already mentioned, or their equivalents. It will of course be understood that the cylindrical form of the vessel shown is not an essential feature of the invention, since the diaphragm may be of any desired shape. As before described, the vessel is now partially carbonized, making it porous and unattackable by the substances in the electrolyte or battery solution, or by the gases evolved therefrom, but leaving it substantially non-conducting.

In Figs. 2 and 3 I have shown convenient clamping device for retaining a flat plate in shape during its process of carbonization. The apparatus shown consists of two plates of cast-iron, or other suitable material, indicated by B, C. These are fastened together at one side in a convenient manner, as for example by means of a knuckle joint D, which will permit sheets of different thicknesses to be firmly clamped. At the edges of the plates are suitable clamping devices, such as bolts E, pivoted to ears outstanding from the plates, and carrying at

their other ends nuts F, which may be screwed down upon ears projecting from the lower plate, thus clamping the sheet A firmly between the upper and lower members of the apparatus. Both plates are perforated throughout their surfaces, as indicated in Fig. 2, it being understood that the perforations cover substantially the entire extent of the plates. The purpose of the perforations is to provide free vent for the gases of decomposition during the carbonizing of the diaphragm. After the diaphragm-sheet has been locked in the clamp, it is placed in the oven and baked, being careful, as before, to raise the temperature very slowly and evenly so that the diaphragm will not be cracked by too rapid heating. As the carbonization progresses the diaphragm will shrink and become loose in the clamp, but if the heating is gradual and regular no splitting or cracking of the diaphragm will occur. The cooling should also be gradual, so as to produce no sudden strain thereon. When the process is completed, it will be found that the sheet of wood, pulp, strawboard, or other material, as the case may be, is transformed into a plate of the necessary porosity, and resembling charcoal in its appearance and consistency. The porosity of the diaphragm, in whatever form the same is made, depends, of course, upon the material used, a diaphragm of charred straw-board, pulp-board, etc., being more porous than one from a board or vessel of wood.

From the foregoing it will be seen that my invention provides diaphragms which are light, cheap, and strong, and withal substantially unaffected by the electrolytic acids or alkalies, etc. It will of course be understood that the method of making the diaphragms may be practiced in a variety of ways, so long as it involves the partial carbonization of a "woody" article to render it unattackable by the substances used or evolved in the electrolyte, without making the diaphragm conducting. By the term "woody" I mean not only wood itself, but also wood-pulp; likewise strawboard, papier mache, paper, and similar organic materials which when partially carbonized retain their form to a substantial degree without the necessity of using a "binder".

What I claim is:

1. The method of making porous diaphragms, which consists in forming of woody material an article of the desired shape, and then partially carbonizing the same throughout to a non-conducting point, as set forth.

2. The method of making porous diaphragms, which consists in forming an article of wood, and then partially carbonizing the same throughout to a non-conducting point, as set forth.

3. The method of making porous diaphragms, which consists in forming of woody material an article of the desired shape, then partially carbonizing the same throughout to a non-conducting point while retaining the same in substantially its original form, during the carbonization, as set forth.
4. The method of making porous diaphragms, which consists in forming of woody material an article of the desired shape, inclosing the same in a rigid holder of corresponding conformation, and subjecting the whole to heat to partially carbonize the article throughout to a non-conducting point, as set forth.

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