No. 711,537. Patented Oct. 21, 1902.

F. SEDGWICK.

STORAGE BATTERY.

Application filed Aug. 2, 1902.

(No Model.) 2 Sheets—Sheet 1.

Fig. 2

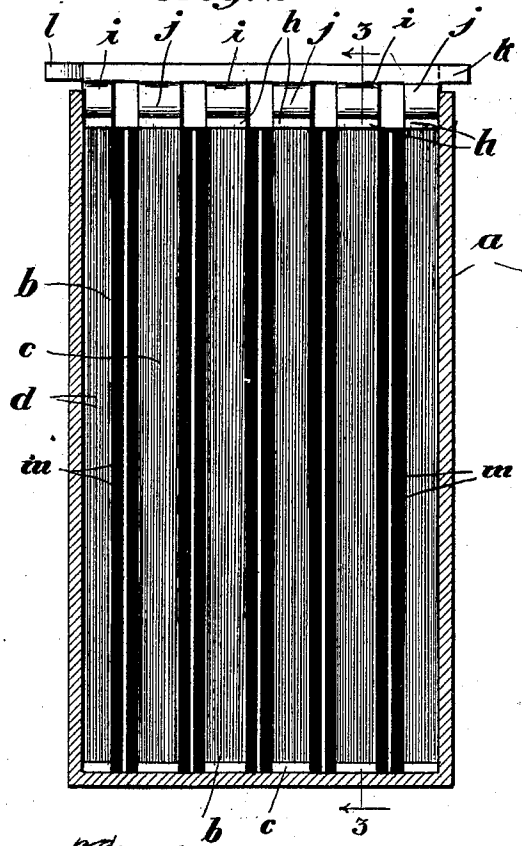


Fig. 3

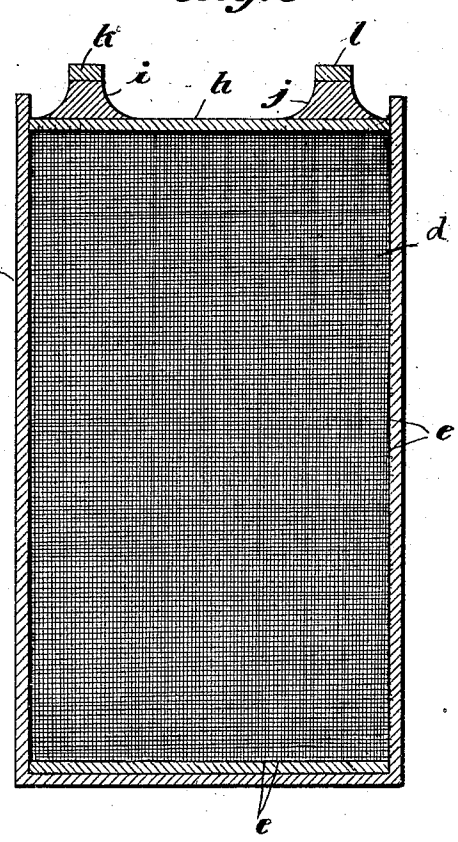
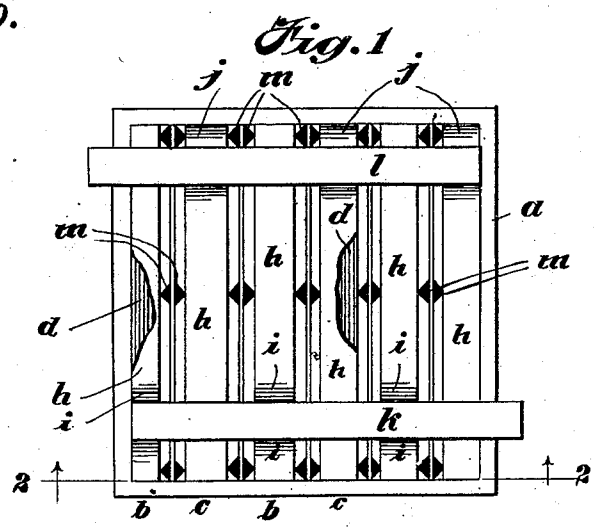


Fig. 10.

Fig. 1



Witnesses:
J. B. Weir
Herman M. Krueger

Inventor:
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Fig. 4

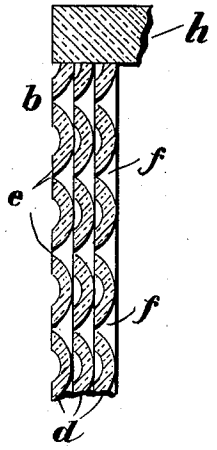


Fig. 9

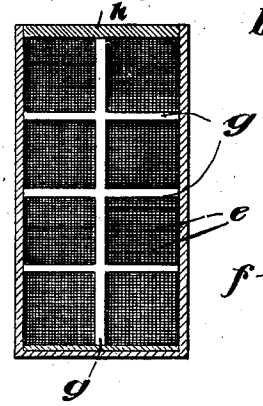


Fig. 5

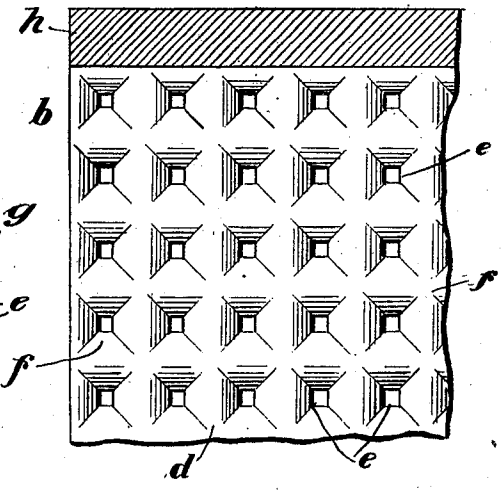


Fig. 6

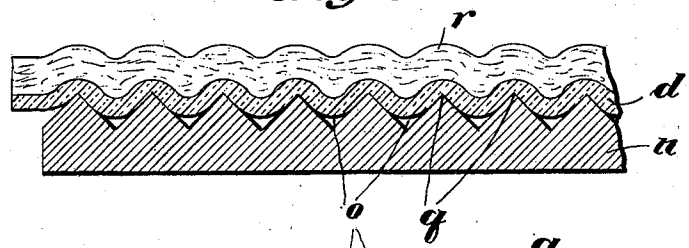


Fig. 7

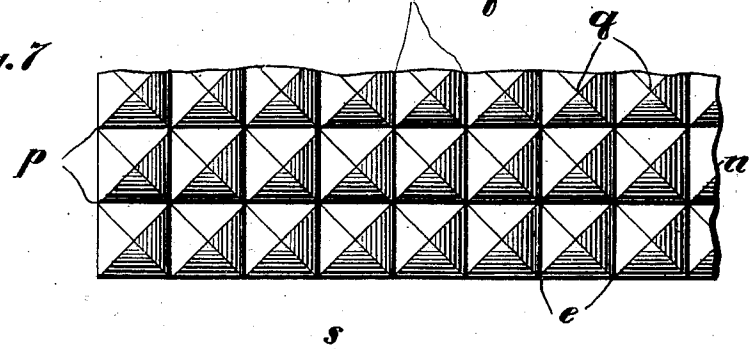
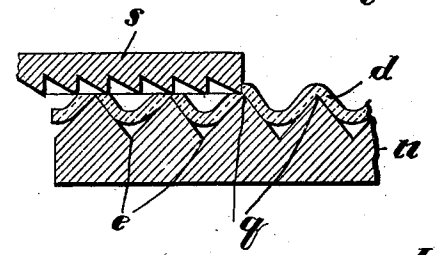


Fig. 8



Witnesses:

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Herman M. Krueger.

Inventor:

Frederick Sedgwick,

By David H. Fletcher

his Atty.

UNITED STATES PATENT OFFICE.

FREDERICK SEDGWICK, OF CHICAGO, ILLINOIS, ASSIGNOR TO INTERNATIONAL BATTERY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

STORAGE BATTERY.

SPECIFICATION forming part of Letters Patent No. 711,537, dated October 21, 1902.

Application filed August 2, 1902. Serial No. 118,167. (No model.)

To all whom it may concern:

Be it known that I, FREDERICK SEDGWICK, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Storage Batteries, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification, in which corresponding letters of reference in the different figures indicate like parts.

The object of my invention is to so construct a storage battery as to enable the usual grids or supporting-frames with their superfluous bulk and weight to be dispensed with and to provide for the ready escape of gases from the electrodes while presenting a maximum surface for exposure to electrolytic action with a minimum weight and bulk of active material.

To these ends my invention consists in forming the respective electrodes from a multiplicity of exceedingly thin juxtaposed sheets, films, or parallel layers of lead-foil, each film or layer having minute punctures therein of such number and such fine comminution as distinguished from mere holes or perforations and so closely assembled as that when the films are juxtaposed either in separate sheets or as a continuous roll they may form a cellular mass, thereby imparting to the electrode the characteristics of a fine sponge or lamp-wick, so that it may not only be capable of absorbing the electrolyte by capillary action and permitting a free circulation thereof, as well as the ready escape of any gases formed, but will also present a maximum surface to be acted upon by the electrolyte, all of which is hereinafter more particularly described, and definitely pointed out in the claims.

In the drawings, Figure 1 is a plan view of a secondary battery embodying the features of my invention. Fig. 2 is a vertical sectional view thereof, taken upon the line 2 2, Fig. 1, viewed in the direction of the arrows there shown. Fig. 3 is a vertical sectional view taken upon the line 3 3, Fig. 2, viewed in the direction of the arrow there shown. Fig. 4 is a vertical sectional view, very greatly magnified, of a portion of one of my improved electrodes. Fig. 5 is a face view thereof. Fig. 6 is a sectional view of a die greatly magnified, showing one of the lead films superimposed thereon, together with a yielding material for compressing the same against the die. Fig. 7 is a magnified face view of a portion of the forming-die. Fig. 8 is a magnified sectional view of a die with the lead film compressed against it and a planing-tool for planing the surface to form the perforations. Fig. 9 is a sectional view similar to the view shown in Fig. 3, showing a modification in the construction of the films or layers of which the electrode is composed; and Fig. 10 is a diagrammatic end view of a modified form of electrode.

Referring to the drawings, *a* represents a receptacle of vulcanite, glass, or other suitable material and of the usual construction for the reception of an electrolyte. Within said receptacle is placed positive and negative electrodes *b c*, said electrodes being arranged alternately with respect to each other, as shown, each consisting of a series of thin sheets *d*, of lead-foil, said sheets being provided throughout all or the greater portion of the surface thereof with minute perforations *e* and preferably, also, with slight indentations *f*, Figs. 4 and 5, the shape of which is immaterial.

The sheets or films *d* of each electrode are soldered at the top to a lead binding-strip *h*, to which are attached lugs *i* for the positive and like lugs *j* for the negative electrodes. To the positive lugs I attach a metal strip *k* and to the negative lugs a like strip *l*, which serve as terminals for the opposite electrodes.

Between the several electrodes I insert narrow strips *m*, of vulcanite or other non-conducting material, to serve as separators and to prevent short-circuiting of the electrodes.

As stated, the elements composing the electrodes are composed of thin films of lead-foil. While these may obviously vary in thickness, I prefer that they should be very thin and would recommend the use of sheets of about two thousandths of an inch in thickness. It is essential in order to obtain the best results

that the perforations or punctures therein should not only be exceedingly minute, but that they should be as numerous and closely assembled as possible. Moreover, I prefer to roughen the surface by means of minute grooves or indentations, preferably the latter, so that when the films are assembled they may form a cellular mass, through which a free and uniform circulation of the electrolyte may be induced by capillary attraction. One method of and means for producing the indentations may be described as follows:

A steel die *n*, Figs. 6, 7, and 8, is provided with fine longitudinal and transverse grooves *o p*, between which are projections having minute raised points *q*. The film of lead-foil *d* is laid flatwise upon the face of the die, and a piece of yielding material *r*, Fig. 6, preferably of leather, is placed over said foil. Pressure is then exerted against the leather either by pounding the surface or by placing the same within a suitable press, which causes the foil to become indented within the grooves in the manner shown in Fig. 6. The surface of the foil is then preferably removed by means of a plane, file, or other suitable tool *s*, Fig. 8, down to the point *q* of the die. The result is that a uniform and regular series of minute perforations *e* are formed, corresponding in number and position to the projecting points of the die. The die should be made very fine, with not less than about sixty grooves to the inch, and preferably more. Such a die would give about thirty-six hundred perforations for each square inch of surface of the lead-foil, and in view of the corresponding indentations in the foil it is obvious that the assembled foils would represent a wick-like cellular mass, through which a uniform and complete circulation of the electrolyte would obtain, as stated.

While I prefer to employ the method described in making the perforations, the result may be accomplished by merely pressing the sheet against the face of the die, so as to cause the punctures to be made by the points. This, however, should be done with care and accuracy in order to insure uniformity throughout the sheet.

In view of the great number and minuteness of the perforations it is necessary in order to avoid trapping air between the sheets that they should be wet when assembled; otherwise the circulation of the electrolyt- may be more or less impeded, unless the electrode be gradually introduced into the liquid, so as to permit it to absorb the latter by capillary action.

In Fig. 9 I have shown a modification of said invention, in which the layers forming the electrode are provided with plain portions or unperforated bands or zones *g* for the purpose of better conveying the current from the perforated portions to the terminals or for reducing the resistance of the electrodes.

While I prefer to use a multiplicity of juxtaposed films, as described, it is obvious that a continuous film perforated and indented, as described, may be formed in a round or flat roll without departing from the principle involved, which is the formation of a cellular structure made up of finely-perforated layers. A diagrammatic view of such a structure is shown in Fig. 10, in which *s* indicates the film arranged in a flattened roll.

I am aware that electrodes for storage batteries have been constructed consisting of a series of assembled corrugated lead plates having holes or openings therein, the corrugations of one plate being at an angle to those of the adjacent plate, so as to "prevent nesting or coinciding and preserve an even and constant groove-space between and a fixed and permanent bracing of the layers in relation to each other." Such a construction while obviously permitting a circulation of the electrolyte necessarily implies the use of comparatively thick plates in order to have a "bracing" action, with relatively large spaces between the corrugations of adjacent plates in which capillary action could not take place.

I am the first, as I believe, to construct an electrode composed of thin films or layers of lead-foil, continuous or otherwise, having perforations therein so numerous and so closely comminuted as not only to induce capillary action, like a wick or sponge, but presenting to the electrolyte the largest possible surface of active material. In such a construction, the perforations being so minute and so closely assembled and each being of necessity accompanied by a slight surrounding indentation of the metal, "nesting" could not occur, inasmuch as it would be practically impossible to produce registration between the minute projections upon a given film and the corresponding indentations upon the adjacent one. The result, therefore, would be a mechanically-constructed sponge or cellular absorbent mass capable of permitting a free circulation, allowing the gases to escape as fast as formed, and presenting a maximum surface of active material, while materially reducing the weight and bulk of the battery in proportion to its capacity and efficiency.

Having thus described my invention, I claim—

1. An electrode for storage batteries composed of juxtaposed film-like layers of lead-foil, each layer having minute, closely-comminuted perforations therein sufficiently numerous and minute to produce in the assembled whole a cellular mass capable of capillary action.

2. A secondary battery composed of electrodes consisting respectively of film-like layers of lead-foil each having minute closely-comminuted perforations therein together with tiny indentations or projections whereby the combined layers may form a cellular mass capable of inducing capillary action.

3. An accumulator-electrode consisting of juxtaposed layers of film-like lead-foil, each

layer being provided with minute, closely-assembled projections having minute perforations at the apices thereof, the fineness and multiplicity of said perforations and projections being such as to form a cellular mass capable of inducing capillary action, said layers being joined to a common terminal.

4. An accumulator-electrode, in which is combined with a common terminal, a plurality of juxtaposed layers of lead-foil having minute perforations throughout the greater portion of the surface thereof and non-perforated zones, spaces or paths, whereby the resistance of the electrode may be reduced.

5. The combination in a storage battery of opposite electrodes, each composed of a plurality of juxtaposed layers of lead-foil, each layer having minute perforations throughout the greater portion of the surface thereof, and non-perforated zones, spaces or paths for the reduction of internal resistance.

In testimony whereof I have signed this specification, in the presence of two subscribing witnesses, this 31st day of July, 1902.

FREDERICK SEDGWICK.

Witnesses:

D. H. FLETCHER,

CHARLES L. HINE.