No. 700,137. Patented May 13, 1902.

T. A. EDISON.

REVERSIBLE GALVANIC BATTERY.

(Application filed Mar. 5, 1901.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1

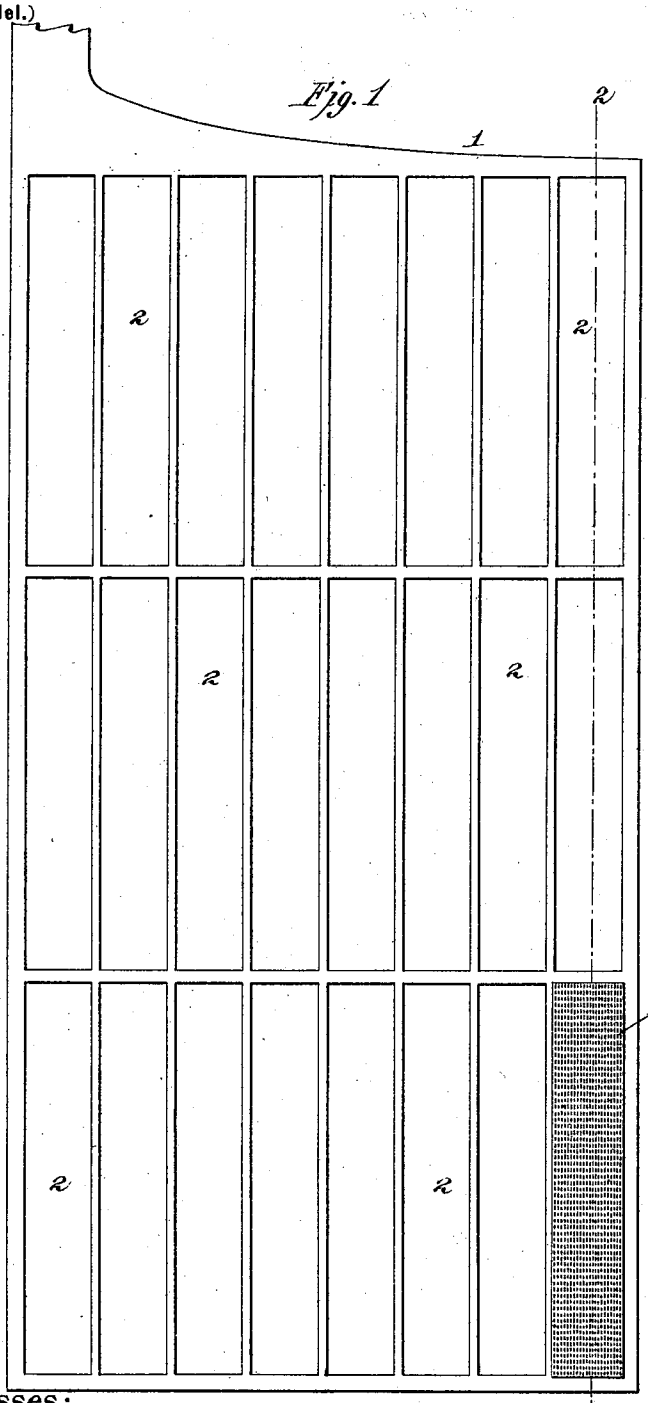
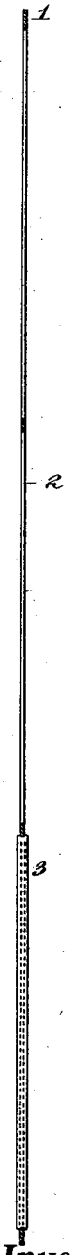


Fig. 2



Witnesses:

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(No Model.) 3 Sheets—Sheet 2.

Fig. 3

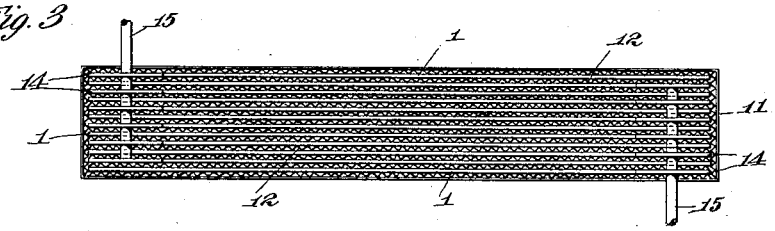


Fig. 4

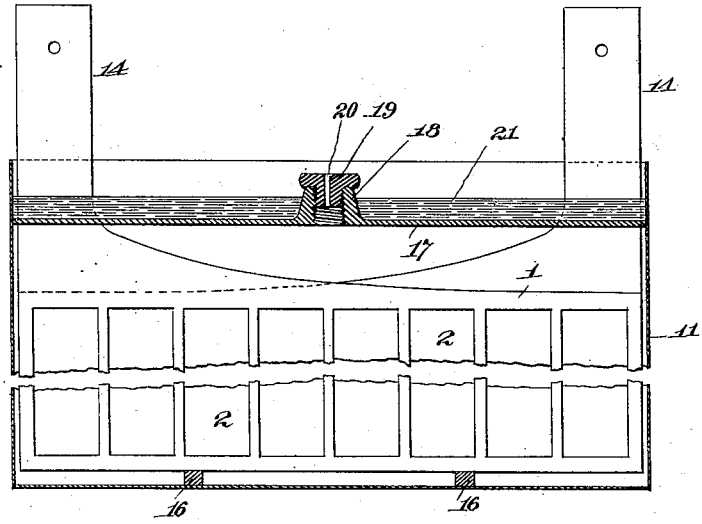


Fig. 5

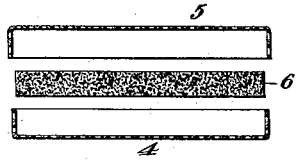


Fig. 6

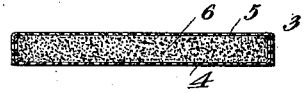


Fig. 7

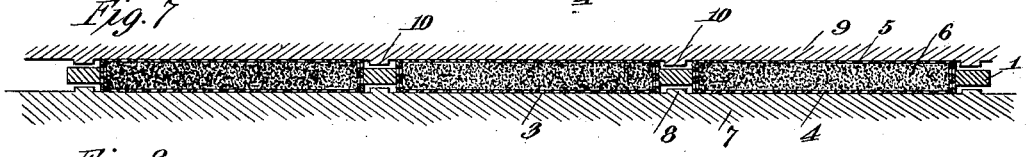


Fig. 8

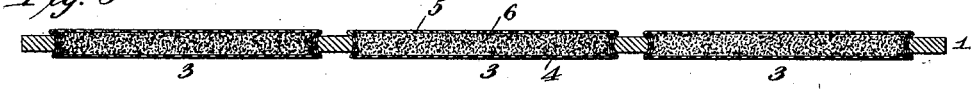
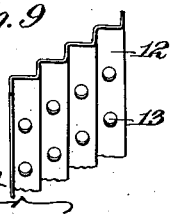


Fig. 9



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REVERSIBLE GALVANIC BATTERY.

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(No Model.) 3 Sheets—Sheet 3.

Fig. 10

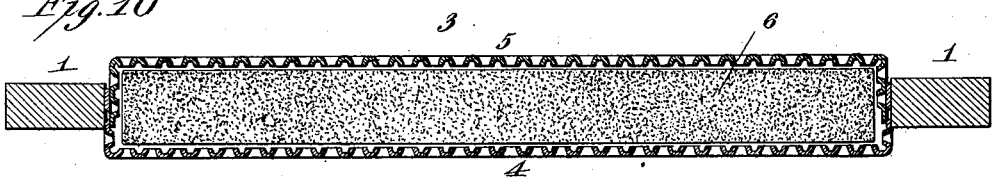


Fig. 11

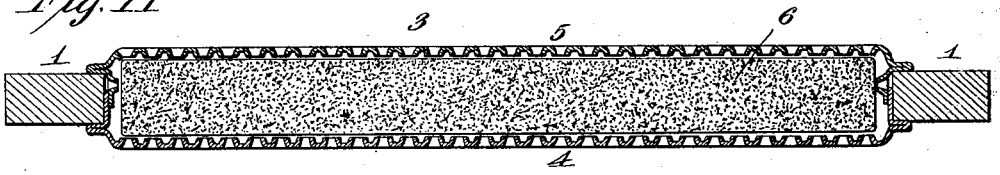


Fig. 12

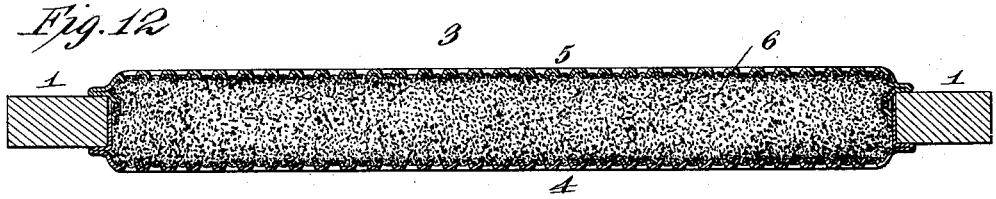


Fig. 13

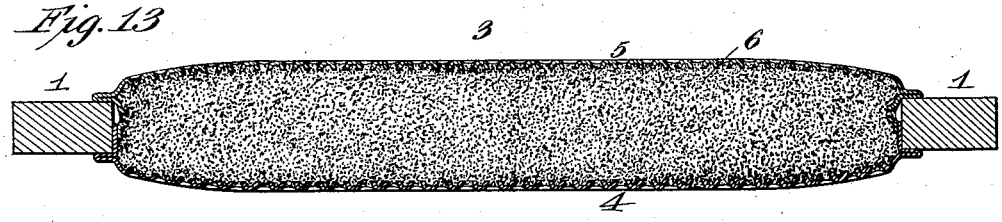
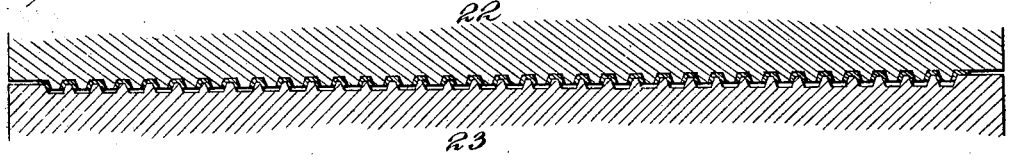


Fig. 14



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UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY, ASSIGNOR TO EDISON STORAGE BATTERY COMPANY, A CORPORATION OF NEW JERSEY.

REVERSIBLE GALVANIC BATTERY.

SPECIFICATION forming part of Letters Patent No. 700,137, dated May 13, 1902.

Application filed March 5, 1901. Serial No. 49,935. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Reversible Galvanic Batteries, (Case No. 1,054,) of which the following is a specification.

My present invention relates to improvements in reversible galvanic batteries; and my objects generally are to provide for the economical manufacture of the battery as a whole and to secure lightness, compactness, and strength in the completed article.

In carrying my invention into effect I make use of a thin grid or plate which is unaffected by the electrolyte and which is provided with a plurality of openings therein, preferably rectangular in form, arranged in horizontal rows quite closely together, and I carry the active material of the plate within perforated cups or pockets, which in turn are securely fastened in said openings. Preferably each cup or pocket which carries the active material is made of two sections, one engaging within the other and which after being introduced within the proper receptacle of the plate or grid are subjected to pressure, so as to be firmly compressed together and at the same time to be intimately locked in position, as I shall describe. At the same time the engaging pressure acts to compress the mass of active material to intimately engage it with the metal of the cups or pockets and within the perforations therein, so as to be effectively acted upon by the electrolyte during charging and discharging operations and also to make good contact between the active material and the metal.

When the two active materials of the battery are both of such form that they can be carried in cups or pockets, as explained, secured in position within openings formed in grids or plates, the grids or plates carrying the active materials are alternately arranged in a suitable supporting-cell, made, preferably, of sheet metal, and are insulated mechanically and electrically from each other, preferably by means of thin corrugated sheets of hard rubber, thereby producing a very light and rigid construction, after which an insulating-cover is applied to each cell, the electrolyte being then introduced, and finally a viscid insulating material is preferably flowed over the cover, so as to make the cell absolutely water-tight, except for the usual gas-vent therein. If, however, the battery is of the type wherein only one of the active elements is in a pulverized form suitable for being received in a perforated pocket or cup, the other element being, for example, a plate on which a metal from the electrolyte is deposited electrolytically—as, for instance, in reversible batteries using an alkaline-zincate electrolyte—the plates or grids carrying the active material in the perforated pockets or cups can be alternately arranged with respect to the other electrodes in an inclosing case, being separated therefrom by corrugated hard-rubber partitions, as explained, and the case being provided with a water-tight cover having the usual air-vent therein.

In an application for patent filed March 1, 1901, No. 49,453, I describe an improved reversible galvanic battery employing for one of its elements finely-divided iron mixed with foliated graphite and for the depolarizing element a mixture of such graphite and nickel or cobalt oxid, and since by such a combination I am enabled to produce a battery having the greatest capacity per unit of weight of any combination with which I am familiar I prefer to employ my present improvements therewith, and I shall describe the several elements as being composed of materials suitable for use in this special combination. When, however, the improvements are used in connection with other elements, the material will be suitably varied to meet the special conditions.

In order that the invention may be better understood, attention is directed to the accompanying drawings, forming part of this specification, and in which—

Figure 1 is a front elevation showing the grid or plate as being provided with twenty-four openings or perforations therein, one of which is equipped with a perforated cup or pocket containing the active material; Fig. 2, a section on the line 2 2 of Fig. 1; Fig. 3,

a plan showing a cell provided with twelve grids or plates, the cover being removed; Fig. 4, a vertical section of a complete cell; Fig. 5, a detailed section, on an enlarged scale, showing the two sections of one of the perforated cups or pockets with the block of active material between them; Fig. 6, a corresponding view of the same parts assembled together; Fig. 7, an enlarged cross-section illustrating a part of the grid with three pockets in place on the press ready to have pressure applied thereto; Fig. 8, a similar section of the grid and pockets after the pressure has been applied; Fig. 9, an enlarged perspective view of a portion of one of the corrugated insulating-partitions; Fig. 10, a similar view, on a still larger scale, illustrating a pocket having perforations therein formed by rolling the metal sheet between male and female die-rolls and showing the active material therein of less thickness than that of the pocket; Fig. 11, a corresponding view illustrating a modified way of holding the pockets in place by compressing the edges only; Fig. 12, a corresponding view showing the active material swollen into engagement with the pocket-walls by absorption of the electrolyte; Fig. 13, a corresponding view showing the active material further increased in bulk during charging, bulging the pocket-walls outwardly; and Fig. 14, an enlarged section showing the male and female die-rolls working upon a plate.

In all of the above views corresponding parts are represented by the same numerals of reference.

1 represents the grids or plates, having openings 2 2 therein, the latter being preferably rectangular in shape, as shown. When the plate or grid is to be used with a battery employing an alkaline electrolyte, it may be made of nickel throughout, but is preferably made of hardened sheet-steel carefully nickel-plated, so as to be unaffected by the electrolyte in the presence of the current. The active material is carried in a series of perforated cups or pockets 3, secured rigidly in place within the openings 2. Each pocket is made of nickel or nickel-plated iron or steel, having perforated walls throughout, so that the active material can be properly acted upon by the electrolyte. Preferably the cups or pockets are made of thin hardened sheet-steel, which is first perforated, cleaned, and finally carefully nickel-plated. Each cup or pocket is made of two sections 4 5, stamped to size, so that the former will fit within the latter, as shown in Fig. 6. The active material is molded into blocks, as shown at 6, to fit within the smaller section 4 of each pocket. When the active material is of a non-conducting character at any or all the time, it is intimately mixed with the desired proportion of flake or foliated graphite moistened with an alkaline solution and molded under slight pressure into blocks of the desired form.

The cups or pockets being assembled together and each receiving one of the blocks of the active material or of the active material mixed with graphite, the cups or pockets containing one of the active materials are all inserted within the openings 2 of the desired grid or plate and the parts which are thus assembled are placed on the bed 7 of a suitable press, said bed being provided with ribs 8, which are arranged in line with the ribs of the grids or plates between the perforations. The movable member 9 of the press is provided with corresponding ribs 10, and said movable member is forced downward under a very heavy pressure—say that of one hundred atmospheres—to flatten each cup or pocket and cause its outer edges to be crimped or burred over around the edges of each of the perforations, as shown in Fig. 8, whereby the cups or pockets will be held firmly in position while at the same time the active material will be subjected to pressure and will intimately engage the walls and perforations of the cup or pocket in which it may be contained. The grids or plates having been thus formed are alternately arranged in a suitable cell or box 11, which with a battery using an alkaline electrolyte is also made, preferably, of sheet iron or steel carefully nickel-plated on its interior. The several grids or plates are insulated mechanically and electrically from each other and from the walls of the cell by partitions 12, (see Fig. 9,) made, preferably, of thin hard rubber, corrugated, as shown, and provided with perforations 13 therein to permit conduction between the plates and circulation of the electrolyte. Each grid is provided with the usual ear or lug 14, which on the negative plates is at one side and on the positive plates at the other, and these ears or lugs are connected together by conductors 15 in the usual way. Preferably the metal of the grid 1 above the upper line of perforated pockets is made of a gradually-increasing vertical width toward the lug or ear 14 in order that the current-carrying capacity of the metal of the grid may substantially correspond with the discharge from the pockets to the respective conductors. In this way I am enabled to employ a minimum amount of metal in the construction of the grids. At their bottoms the plates are supported on blocks 16, made of electrically-insulated material not affected by the electrolyte—as, for instance, hard rubber. After the plates have been thus assembled in the cell a cover 17, made, preferably, of hard rubber, is inserted in place within the cell, said cover being formed at its edges with slits through which the lugs or ears 14 extend and having a threaded nipple 18 at its center through which the electrolyte may be introduced. This nipple is provided with a cap 19, having the usual gas-vent 20 therein. After the cover has been placed in position and the electrolyte introduced a suitable thick viscid insulating material is flowed over the cover to form a layer 21 thereon, which quickly hardens, seals

up any interstices around the lugs or ears 14, and makes the cover entirely water-tight. This insulating material may be, for example, any thick varnish, shellac, gum, rubber solution, or analogous material.

When my improvements are employed with an active material, like oxid of nickel or cobalt, which swells or increases in bulk by absorption of the electrolyte and by oxidation or absorption of oxygen (as the case may be) during charging, the construction of pockets or cups above described may be used, the elastic character of the pocket-walls keeping them always in intimate contact with the active material, however the latter may expand or diminish in bulk. Preferably, however, for such an active material the modified arrangement illustrated in Figs. 10 to 13, inclusive, is used. In the first place, I show the perforations as being formed by a rolling operation—as, for instance, between male and female die-rolls 22 and 23, respectively, whereby the cups may be manufactured very economically, and by leaving the burs extending inwardly to project into the mass of active material the extent of contact surface will be very largely increased. Obviously the perforations may be made in other ways—as, for example, by punching—or they may be rolled, as explained, and the burs ground off. Referring now particularly to the modification under consideration, when the sections of the cups are assembled the block 6 of active material is made of somewhat smaller dimensions than the internal dimensions of the cups, as shown in Fig. 10. Pressure is now applied only to the edges of the cup, so as to crimp said edges around the openings in the plate or grid, as shown in Fig. 11. When now the grids or plates are immersed in the electrolyte, the active material by absorption will swell slightly, so as to completely fill each of the cups and put the walls thereof under slight stress, as shown in Fig. 12. During the charging operation the oxidation of the oxid or the absorption of oxygen, whichever may be the effect, results in an increase in the bulk of the active material, causing the walls of each cup to bulge outwardly, as shown in Fig. 13. During the discharging operation the reduction of the oxid to a lower state of oxidation or other effect results in a contraction of the bulk of the active material; but owing to the elastic nature of the pocket-walls the latter will be always kept in intimate contact with the active material. In other words, with the modification under consideration the active material and the cups, respectively, change from the dimensions shown in Fig. 12 to the dimensions shown in Fig. 13 during the charging operation and reversely during the discharging operation.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is as follows:

1. A grid or plate for alkaline reversible galvanic batteries, the immersed surface of which is unaffected by the alkaline solution and having a series of openings therein, a receptacle secured in each opening and having a surface which is unattacked by the alkaline solution, both of the exposed walls of each receptacle being elastic and having numerous perforations permitting the passage of the solution therethrough, and an active material tightly packed in each receptacle, whereby the elastic walls of the latter will maintain continuous pressure with the active material, substantially as and for the purposes set forth.

2. A grid or plate for alkaline reversible galvanic batteries, the immersed surface of which is unaffected by the alkaline solution and having a series of openings therein, a receptacle made of telescoping sections secured in each opening and having a surface which is unattacked by the alkaline solution, both of the exposed walls of each receptacle being elastic and having numerous perforations permitting the passage of the solution therethrough, and an active material tightly packed in each receptacle, whereby the elastic walls of the latter will maintain continuous pressure with the active material, substantially as and for the purposes set forth.

3. A grid or plate for a reversible galvanic battery having a plurality of openings therein, a perforated cup or pocket the edges of which are crimped around the edges of each of the openings, and an active material in said cup or pocket, substantially as set forth.

4. A grid or plate for a reversible galvanic battery having a plurality of openings therein, a sectional perforated cup or pocket the edges of which are crimped around the edges of each of the openings, and an active material in said cup or pocket, substantially as set forth.

5. A grid or plate for a reversible galvanic battery having a plurality of openings therein, a perforated cup or pocket made of elastic metal and secured in place within each of said openings, and a coherent block of active material within each cup or pocket and maintained under pressure therein, substantially as set forth.

6. A grid or plate for a reversible galvanic battery having a plurality of openings therein, a perforated cup or pocket made of telescoping sections secured in place within each of said openings, and a coherent block of active material within each cup or pocket and maintained under pressure therein, substantially as set forth.

7. A plate or grid for a reversible galvanic battery employing an alkaline electrolyte and presenting an immersed surface of nickel, said plate having a series of openings therein, and a perforated cup or pocket within each of said openings and containing the active material, said cup or pocket being made of highly-elastic sheet metal having a nickel surface and of telescoping sections, substantially as set forth.

8. A plate or grid for a reversible galvanic cell employing an alkaline electrolyte, made of iron nickel-plated having a series of openings therein, and a perforated cup or pocket secured within each of said openings and containing the active material, said cup or pocket being made of nickel-plated sheet-steel and of telescoping sections, substantially as set forth.

9. A grid or plate for a reversible galvanic battery having a plurality of openings therein, a perforated cup or pocket the edges only of which are crimped around the edges of each of the openings and the chamber of the cup or pocket being of less thickness at its marginal portions than at its other portions, and an active material in said cup or pocket, substantially as set forth.

10. A grid or plate for a reversible galvanic battery having a plurality of openings therein, a sectional perforated cup or pocket the edges only of which are crimped around the edges of each of the openings and the chamber of the cup or pocket being of less thickness at its marginal portions than at its other portions, and an active material in said cup or pocket, substantially as set forth.

11. As a new manufacture, a metallic cup or pocket made of telescoping sections having perforated walls, each perforation being surrounded by a bur of displaced metal which extends inwardly, and an active material within said cup or pocket, substantially as set forth.

This specification signed and witnessed this 23d day of February, 1901.

THOMAS A. EDISON.

Witnesses:
FRANK L. DYER,
JNO. R. TAYLOR.