(No Model.)

D. TOMMASI & C. THERYC.

SECONDARY BATTERY.

No. 454,091. Patented June 16, 1891.

Fig. 1.

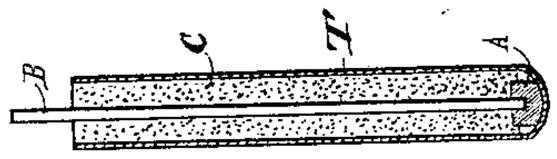


Fig. 1a.

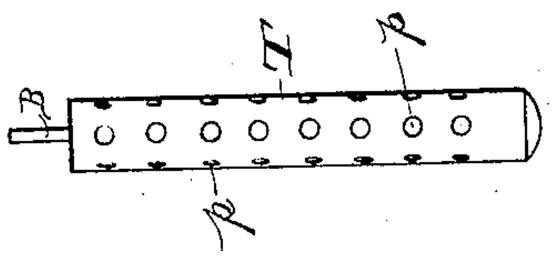


Fig. 1b.

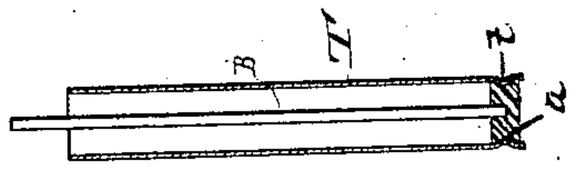


Fig. 2.

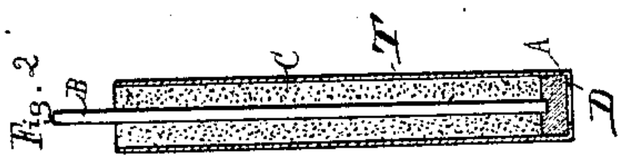


Fig. 3.

Fig. 4.

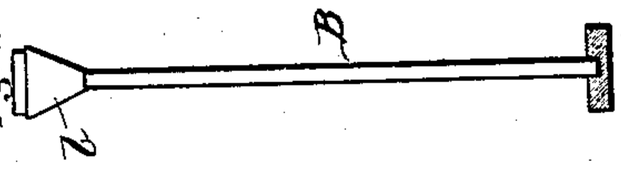


Fig. 5.

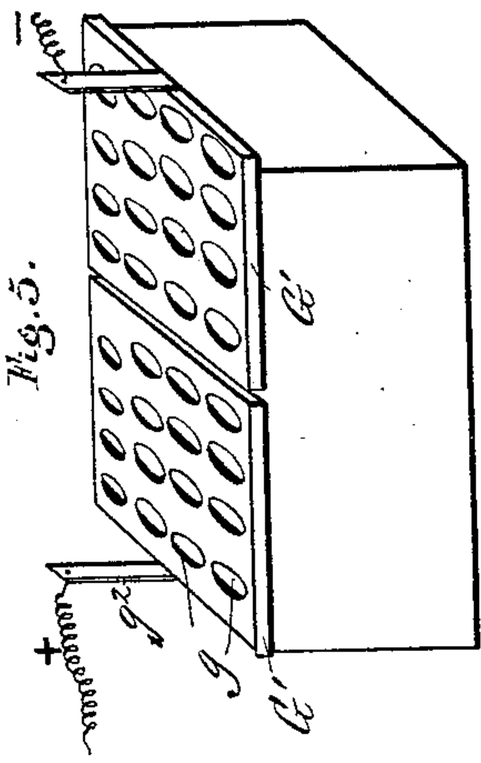


Fig. 6.

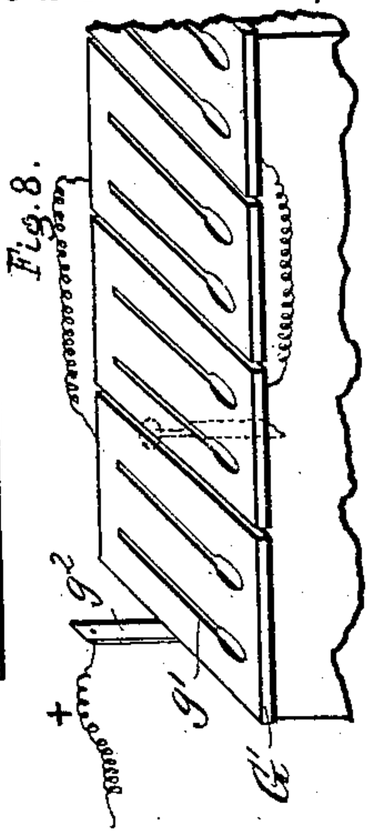


Fig. 7.

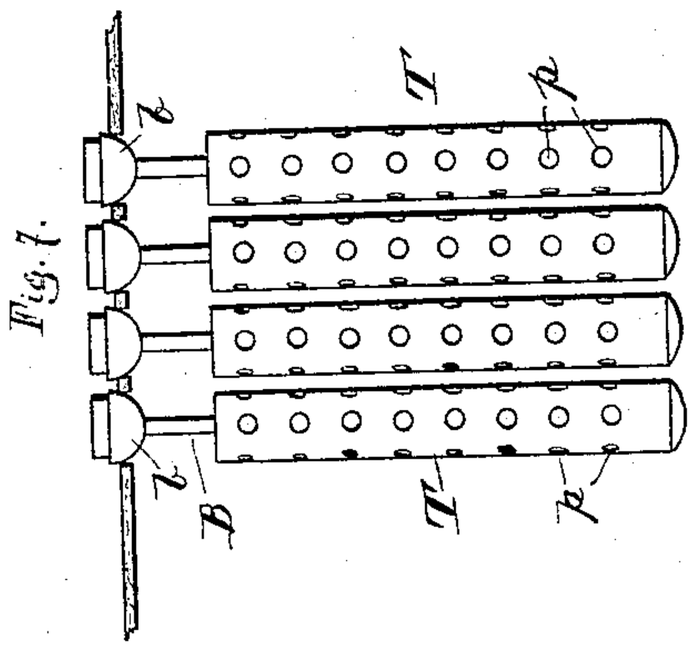
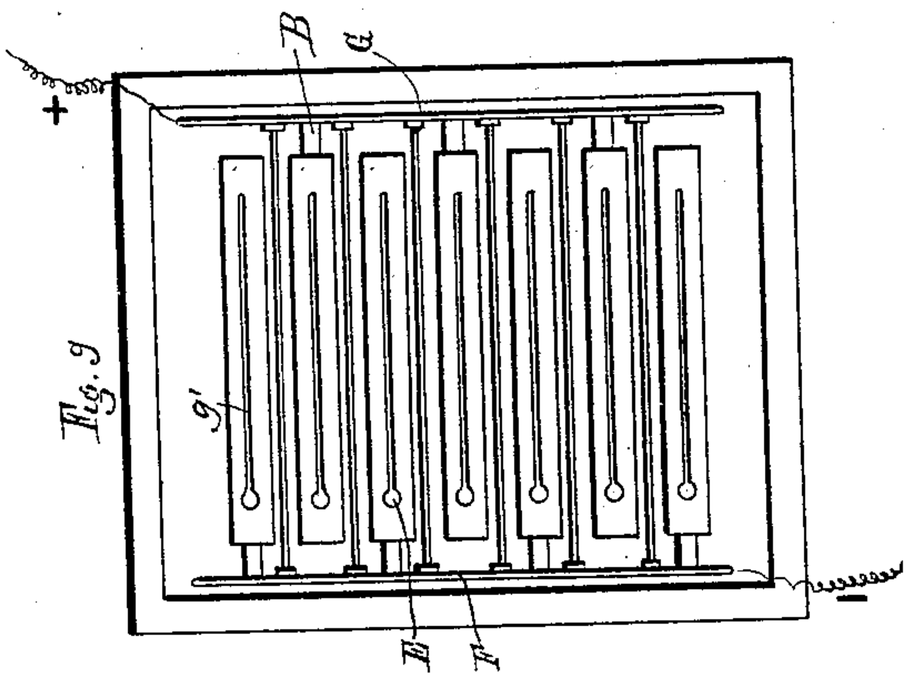


Fig. 8.

Fig. 9



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UNITED STATES PATENT OFFICE.

DONATO TOMMASI, OF PARIS, AND CHARLES THERYC, OF MARSEILLES, FRANCE.

SECONDARY BATTERY.

SPECIFICATION forming part of Letters Patent No. 454,091, dated June 16, 1891.

Application filed November 10, 1890. Serial No. 370,989. (No model.)

To all whom it may concern:

Be it known that we, DONATO TOMMASI, a subject of the King of Italy, residing in Paris, France, and CHARLES THERYC, a citizen of the Republic of France, residing in Marseilles, France, have invented certain new and useful Improvements in Electrical Storage-Batteries, of which the following is a specification.

The main feature of this electrical storage-battery is that its electrodes are made in the shape of tubes instead of being formed of plates. An arrangement of such tubes is illustrated in the accompanying drawings.

Figure 1 is a vertical section of our improved electrode, and Fig. 1^a an elevation thereof. Fig. 1^b is a view similar to Fig. 1, showing a different mode of securing the plate A within the tube; Fig. 2, a like view showing a different form of insulating-plate; Fig. 3, a detail elevation of the connecting-rod B, showing the same provided with a semi-spherical head *b;* Fig. 4, a like view showing the rod provided with a conical head. Fig. 5 is a perspective view of the box or case containing the electrodes. Fig. 6 represents in elevation a series of the electrodes having conical heads connected together; Fig. 7, a like view of the electrodes having semi-spherical heads connected together; Fig. 8, a perspective view of a portion of the case, showing a different construction of closing-plates therefor; Fig. 9, a plan view of an accumulator, showing a different mode of connecting the electrodes.

Each electrode consists of a perforated tube T, preferably of lead, Fig. 1, closed at one end and provided at this closed end with a small insulating-plate A, of ebonite or other suitable material, and also with a central connecting-rod B.

The tubular electrode may be constituted by a suitable length of pipe, such as can be purchased ready-made, which pipe is then perforated with small holes P. The ebonite washer, through the center of which passes the lead rod, forms the bottom of the tube, resting upon a ledge or narrow turned-in edge D thereof. If desired, the other end of the tube may also be closed by an insulating-disk, which is equally traversed by the said rod. The filling material C occupies the space left between the rod and the inner wall of the tube, Figs. 1 and 2.

The storage-battery is divided by means of perforated plates or by strips of insulating material G into two or more compartments containing alternately positive and negative electrodes. Each of these compartments is closed by a plate G′, of metal or insulating material, which is covered with a thin plate or sheet of lead, provided either with holes *g* of a somewhat larger section than the tubes, for the insertion of the electrodes, or with slits *g′*, adapted to retain the latter in position. The spherical, Fig. 3, conical, Fig. 4, or pyramidal heads *b* of the electrode-rods should be wide enough to touch the edges of the perforations or the sides of the slits to make contact therewith. The closing-plates of the compartments are connected together, so as to form two or more series, (if two, one positive and the other negative,) each provided with a metal plate g^2 or a binding-post, to which the corresponding conductor is attached, Figs. 5 and 8.

The tubes forming the sheathing of the electrodes may be of round, oval, polygonal, or other section, and they may or may not be provided with a bottom integral therewith or fitted to their walls. These tubes can be manufactured by drawing, casting, molding, or in any other desired manner, or they may, instead of being perforated, be otherwise made porous, and instead of being made of lead they may be made of other metal, such as aluminium, platina, brass, and the like, or of ceramic or mineral substances, such as sandstone, porcelain, coal, asbestus, pulps, pastes, textile fabric, such as linen, paper, parchment, or any other suitable material. The perforations in them may be drilled, punched, or equivalently formed, or they may be formed in the initial casting, molding, or other process. Their section may be either variable or constant, and their sides at right angles or otherwise to the surface of the tubes. If necessary, the sheathing of these electrodes may be formed by a grating, wire-gauze, or net-work coated or plated with metal. The rods may be molded, cast, or drawn, or produced by a combination of these processes, or otherwise. They may be of circular or other

section and have smooth, grooved, milled, or other surfaces. Both the whole and the different parts of each electrode may be straight or otherwise and be arranged in a vertical or other suitable position. The case, rack, or frame of the storage-battery may be in the shape of a parallelopiped, a cylinder, or it may be of other form, and it may be made of wood, ebonite, sandstone, glass, or other suitable material. The insulating-plates of the electrodes and the parttitions and lids of the accumulators may also be constructed of ebonite or other suitable material. The metal of the electrodes and of the accumulator may either wholly or partly consist of lead, an alloy of lead, and antimony or other suitable metal or alloy. The electrodes are arranged either in straight lines or in quincuncial squares or in series of any suitable number of rows, and they may in each series, without inconvenience, be in contact with each other, either directly or otherwise.

The filling material of the electrode is introduced into them either in the condition of a powder or as a paste, to which state it may have previously been reduced by being mixed with water acidulated or not with glycerine, or with a suitably-proportioned mixture of acidulated water and glycerine. The acid to be used in preference is sulphuric acid or phosphoric acid. In the positive electrodes the filling material is litharge, or minium, or peroxide of lead, or spongy lead, or any other insoluble compound of lead or any other metal. For the negative cells the material to be used is spongy lead, either electrolytic or not, litharge, sulphite of lead or any other insoluble compound of lead, or any other metal, which may or may not be mixed with ground carbon or grains of lead.

The liquid employed in the accumulator is water mixed with sulphuric or phosphoric acid.

Fig. 2 illustrates the simplest form of our electrode.

In Fig. 1[b] the plate A is provided with a circumferential groove *a*, into which fits the projection *t* near the lower end of the tube T, thus firmly securing said plate and the rod B in position. This rod B, made of any suitable metal or alloy, is supported in position by its head surmounting it.

When it is desired to fit the electrode in position, the rod is so adjusted as to occupy its center and engage the recess of the insulating-washer, in which position it is held while the filling material is being introduced. When the latter is in the state of a powder, the electrode is dipped into a liquid which serves as an agglomerating agent, and when sufficiently soaked it is withdrawn and allowed to dry. The power of adhesion of the different parts then enables the electrode to be suspended by the rod, as shown in Figs. 6 and 7. If desired, the rod may be screwed into the washer, in order to give increased strength to the whole structure.

Fig. 9 is a top view of an accumulator wherein a series of slots *g'* are provided for the insertion of the electrodes. The said electrodes are introduced into them one by one in succession through button-hole-shaped openings E, terminating each slot. The electrode-supports are connected alternately to a conductor F, one of which is arranged on either side of the case, as is clearly shown in the figure, each series of electrodes being separated from the adjacent series by means of an ebonite partition G.

The advantages resulting from the before-mentioned improvements may be summed up as follows:

First. The operative portion permanently remains in its initial position, which does away with the loss and expense involved by the use of storage-batteries consisting of plates by reason of the latter being liable to decomposition and decay.

Second. The molecular surface of the electrode is considerably increased, which results in a proportioned augmentation of the capacity of the accumulator.

Third. The electrodes are perfectly independent of each other and may be removed and replaced singly, as required, without causing any interruption in the operation of the battery.

Fourth. The use of solder is avoided, and thereby a cause of rapid deterioration and of great difficulty in the use of the storage-battery removed.

Fifth. The number of binding-posts is considerably reduced, and consequently a great economy is realized in the cost of fitting and keeping in repair these parts and much annoyance is avoided.

Sixth. Owing to the use of phosphoric acid certain injurious reactions are less to be apprehended. Hence electrodes are more rapidly charged and discharged and the working power of the apparatus in a given time increased.

Seventh. The charging of the electrodes is further accelerated, owing to the extensive surface of contact.

Eighth. The electrodes may be formed and charged outside of the apparatus in which they are intended to act.

Ninth. The formation of sparks hitherto caused by the opening of the circuit, which was necessary whenever the accumulators had to be replaced or exchanged, is here avoided, as in this improved storage-battery the electrodes only need be replaced, so that the general portion of the battery is not disturbed.

The practical advantages consequent upon the features above stated are as follows: (*a*) reduction of space for a given capacity; (*b*) a considerable diminution of the number of accumulators required for each plant; (*c*) an increased durability of the apparatus; (*d*) considerable reduction of price and of the cost of keeping the apparatus in repair; (*e*) a material simplification of the various operations

and manipulations necessitated by the use of the apparatus; (*f*) and, lastly, a notable economy realized in the cost of transport and storage of the apparatus.

We claim—

1. In an electric battery, an electrode made in tubular form and provided at one of its ends with an insulating plate or disk and a suspending and conducting rod secured at one end to said plate, as described.

2. In an electric battery, an electrode made in tubular form and provided at one of its ends with an insulating plate or disk and a suspending and conducting rod secured at one end to said plate and provided at its opposite end with a head or enlargement, for the purpose specified.

3. In an electric battery, the combination, with a box or case provided with closing-plates and a series of openings in said plates, of a series of tubular electrodes arranged within said case, each provided at one end with an insulating plate or disk, suspending and conducting rods connected with said plates or disks and provided with heads adapted to make contact with and be supported by the edges of said openings, and suitable binding-posts or contact-strips connected with said plates, as and for the purpose specified.

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