No. 670,648. Patented Mar. 26, 1901.

J. T. STOREY.

ELEMENT FOR SECONDARY BATTERIES.

(Application filed June 25, 1900.)

(No Model.)

FIG. 1

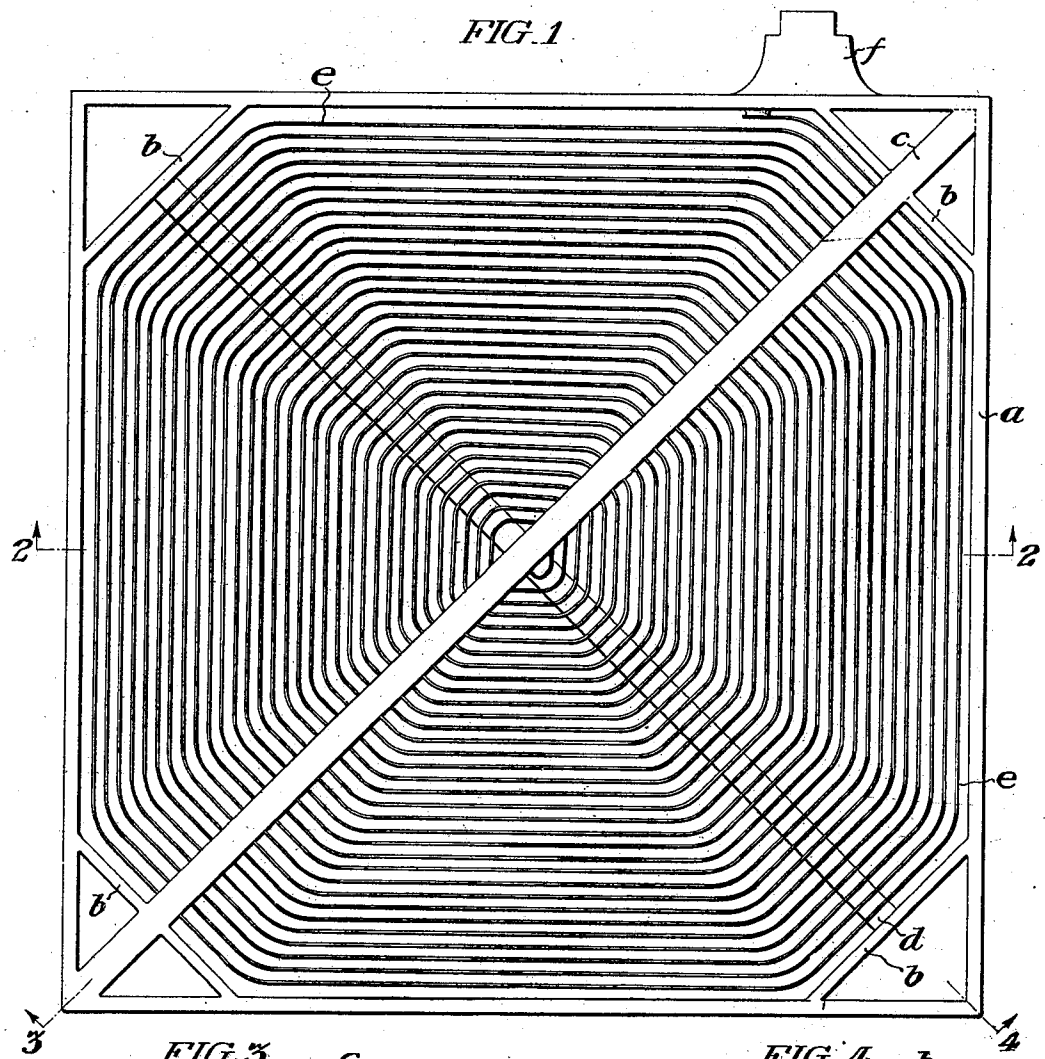

FIG. 3

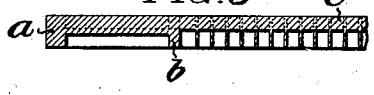

FIG. 4.

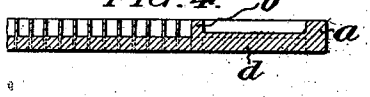

FIG. 2.

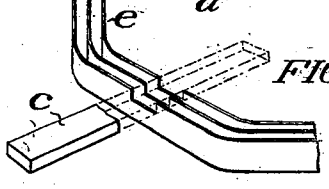

FIG. 5.

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UNITED STATES PATENT OFFICE.

JOHN T. STOREY, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR OF TWO-THIRDS TO HENRY B. GROSS AND CLAUDE S. JARVIS, OF SAME PLACE.

ELEMENT FOR SECONDARY BATTERIES.

SPECIFICATION forming part of Letters Patent No. 670,648, dated March 26, 1901.

Application filed June 25, 1900. Serial No. 21,426. (No model.)

To all whom it may concern:

Be it known that I, JOHN T. STOREY, a citizen of the United States, residing in the city and county of Philadelphia, in the State of Pennsylvania, have invented certain new and useful Improvements in Elements for Secondary Batteries, of which the following is a specification.

My invention aims to provide an element for a secondary battery which shall be inexpensive in its first cost, highly efficient in operation, and the parts composing which shall in their assemblage be combined in such compact form as to exist within a very small compass without detriment to their strength and durability.

In the accompanying drawings I show and herein I describe a good form of a convenient embodiment of my invention, the particular subject-matter claimed as novel being hereinafter definitely specified.

In the accompanying drawings,

Figure 1 is a view in side or face elevation of an element embodying my invention.

Figure 2 is a transverse section of the same on the line 2—2 of Figure 1.

Figure 3 is a fragmentary section on the line 3 of Figure 1.

Figure 4 is a fragmentary section on the line 4 of Figure 1.

Figure 5 is a fragmentary view in perspective of parts of several convolutions of the coil and of a confining bar engaged therewith.

Similar letters of reference indicate corresponding parts.

a is a frame, or inclosing structure, preferably, as shown, of rectangular plan, of any preferred dimensions, the frame bars composing which are, however, of the least possible thickness consistent with securing the requisite degree of strength. The frame is strengthened by the presence of corner pieces, *b*, which fill the angular spaces at the junctions of the frame members, each corner piece consisting, in the form shown, of a short corner bar, as I term it, and a web filling the triangular space inclosed between said bar and the adjacent frame members. The side faces of the corner bars are flush with the side faces of the frame members.

c d are a pair of confining bars, preferably each of about or slightly less than half the thickness of the frame members, said confining bars being disposed respectively upon the opposite sides of the frame and each so arranged in the completed element that its exterior face is flush with corresponding side faces of the frame members and corner bars. The said confining bars are, as shown in the drawing, preferably arranged to extend diagonally with respect to the frame, and perpendicularly with respect to each other, the ends of the bars being located at the respective corners of the frame.

e is a coil of tape formed preferably of pure lead of width substantially equal to the thickness of the frame members, the coil being of such diameter and proportions as to fill the space bounded by the frame members and the corner pieces. This coil, which is so arranged that its successive convolutions or layers are separated from each other by slight interspaces, may be conveniently formed with the required interspaces by rolling together the lead tape and a film of paper or other material which is subsequently removed.

The tape, however, remains in an approximately spiral arrangement, although its curves may, in the manipulation of the coil in the formation of the grooves and its insertion in the frame, become somewhat flattened, as illustrated.

The coil when mounted in the frame, is preferably secured in position by being engaged or interlocked, so to speak, with the confining bars, in the manner illustrated in the drawings. This is conveniently effected by providing or constructing said coil as to each of its side faces with a diametric "confining bar" recess or groove, cut through all the successive convolutions of the coil and extending from rim to rim of the latter, said recesses or grooves being so situated that when the coil is mounted in the frame they coincide with the confining bars and take over or receive the same.

The frame, with its confining bars, is preferably formed by casting the same, as an integral whole, of suitable metal or alloy. For convenience of insertion of the lead coil, I so cast the structure that the body and one end of the confining bar *c*,—for instance that end at the upper right hand corner in Figure 1,—are free from the other confining bar *d*, and

the adjacent corner piece, respectively. This may, of course, be readily done by expedients well known in the casting art.

To provide that the outer face of the free end of the confining bar *c* will, in the completed structure, be flush with the corresponding faces of the frame bars and corner bars, the said free end portion of the said confining bar is shaped to fit within a corresponding recess in the edge of the corner bar of the adjacent corner piece *b*, and the end of said confining bar *c* is shaped to an angle to fit within the junction of the adjacent frame bars, as shown in dotted lines in Figure 1.

When the frame structure is thus produced, the body and free end of said confining bar *c* may be bent upwardly and rearwardly away from the body of the structure (without disturbing its integral union with the diagonally opposite corner portion of the frame) to allow the placing of the coil within the inclosed eight sided space. The coil, with its two grooves already formed to match the respective confining bars, is thereupon laid in the space within the frame, with its lower groove taking over or receiving the confining bar *d*.

The confining bar *c* is then bent down into position within the groove formed in the second side or face of the coil, with its free end portion within the recess in the corner bar *b* and its tapered end fitting the angular corner at the junction of the adjacent frame bars, and said end is thereupon soldered to the corner piece and to the frame bars. The two confining bars are also preferably soldered together at their junction. Also the coil is preferably secured by solder to the confining bars wherever its convolutions cross said bars.

In the element or plate thus formed are present a coil or mass of lead tape, an inclosing structure which surrounds said coil, and confining bars which extend perpendicularly to each other across the respective faces of the coil and secure said coil and its individual convolutions securely in position, each convolution of the coil being, as is manifest, supported by engagement with the confining bars, at four points in its circumference. The supporting frame, while thus securely retaining the coil in position, does not add to the thickness of the element as a whole, the thickness of the element being precisely that of the breadth of the lead tape, which represents, so to speak, the acting member of the element and there is thus no waste of space in the battery cells by reason of lateral space being occupied by the supporting frame, but on the contrary, the total lateral cell space occupied is precisely the same as would be taken up by the coils alone, were no frame necessary or employed. Hence the maximum of efficiency in the minimum of space is attained.

While I prefer to bend the mass of lead tape into an approximately spiral form as illustrated in the drawings and herein described, as productive of the maximum economy and efficiency, it is to be understood that my invention in its broadest aspect contemplates the bending, doubling, or folding, of the tape upon itself in non-spiral arrangements to form as in the spiral arrangement indicated compact masses in which the respective edges of the tape exist in substantially parallel planes.

The element may be treated and employed in any manner usual or desirable in the employment of such devices in batteries. Active material is to be, when desired, applied in the spaces between the convolutions of the tape The frame members, corner pieces, and confining bars may of course be made of any selected material. I prefer to construct them of lead and antimony. The element is of course to be provided with any usual lug or ear *f* for the attachment of the conductor.

Having thus described my invention, I claim—

1. In a battery element, in combination, a tape embodying openings formed in successive portions of its length, and bent upon itself to form a flat mass the respective faces of which are formed by the respective edges of the bent tape, and a frame in which the mass of tape is mounted, having a bar engaged in said openings, substantially as set forth.

2. In a battery element, in combination, a spiral or approximately spiral flat coil of tape formed of suitable metal and embodying a series of alined openings, and an inclosing frame having a bar entered in said alined openings, substantially as set forth.

3. In a battery element, in combination, a flat coil of tape formed of suitable metal and having a groove or recess formed in one of its faces, and a supporting frame having a confining bar arranged within said groove, substantially as set forth.

4. In a battery element, in combination, a flat coil of tape formed of suitable metal, an encompassing structure, said coil and structure being of approximately equal thickness, grooves formed in the opposite faces of the coil, and confining bars mounted in the grooves of said coil and the respective ends of which are secured to the encompassing structure, the outer faces of the confining bars being approximately flush with the side faces of the encompassing structure and coil, substantially as set forth.

5. In a battery element, in combination, a frame composed of frame bars arranged in quadrangular form, and of confining bars extending diagonally across in opposite directions, the outer faces of said confining bars being flush with the side faces of the frame bars, and a flat coil of tape formed of suitable metal mounted within said frame bars and between said confining bars, the convolutions of said coil embodying recesses or notches which receive said confining bars, substantially as set forth.

6. In a battery element, in combination, a

frame composed of frame bars arranged in quadrangular form, and of confining bars extending diagonally in opposite directions, the outer faces of said confining bars being flush with the side faces of the frame bars, and a flat coil of tape formed of suitable metal mounted within said frame bars and between said confining bars, the convolutions of said coil embodying recesses or notches which receive said confining bars, and the tape being of breadth corresponding to the thickness of the frame bars, substantially as set forth.

7. In a battery element, in combination, a frame having frame bars arranged in quadrangular form, diagonally arranged corner bars, of thickness corresponding to that of the frame bars, located at the junctions of said frame bars, and diagonally arranged confining bars intersecting the diagonally arranged corner bars, and a flat coil of tape of suitable metal mounted within the frame and between the confining bars and having recesses or notches formed in its convolutions which receive said confining bars, substantially as set forth.

8. In a battery element, in combination, quadrangularly arranged frame bars, corner pieces formed of diagonally arranged corner bars and triangular webs, diagonally arranged confining bars of thickness less than the thickness of the frame bars, extending from corner to corner of the frame on opposite sides thereof, and a flat coil of tape of suitable metal, mounted within the frame and between the confining bars, substantially as set forth.

9. In a battery element, in combination, a tape formed of suitable metal bent upon itself to form a flat mass the respective faces of which, formed by the respective edges of the bent tape, are parallel, a series of openings formed in said tape, and a frame in which the mass is mounted, of thickness corresponding to the breadth of the tape, and having a bar engaged in said openings, substantially as set forth.

10. In a battery element, in combination, a flat coil of tape formed of suitable metal and having a groove formed in one of its faces, and a supporting frame in which said flat coil is mounted, said frame being of thickness corresponding to the breadth of the tape, and having a confining bar mounted in said groove and secured to said frame, the exterior face of said bar being flush with the face of the coil and the face of the frame, substantially as set forth.

11. In a battery element, in combination, a quadrangular frame formed of frame members of common thickness provided with a pair of confining bars each of approximately half the thickness of the frame members and extending across the central space inclosed by said frame members, the respective exterior faces of the said confining bars being flush with the respective exterior faces of the frame members, and a flat mass of bent tape, supported within said frame and between said confining bars, said tape embodying recesses or grooves which receive said bars, substantially as set forth.

12. In a battery element, in combination, a quadrangular frame formed of frame members of common thickness, a pair of confining bars each of approximately half the thickness of the frame members and extended across the central space inclosed by said frame members, the exterior faces of said confining bars being flush with the respective exterior faces of the frame members,—corner pieces, consisting of corner bars and webs, arranged at the junctions of the frame members,—and a flat mass of bent tape, supported within said frame and between said confining bars, said tape embodying recesses or grooves which receive said bars, substantially as set forth.

In testimony that I claim the foregoing as my invention I have hereunto signed my name this 15th day of June, A. D. 1900.

JOHN T. STOREY.

In presence of—

F. NORMAN DIXON,

THOS. K. LANCASTER.