No. 626,798. Patented June 13, 1899.

E. J. WADE.

ELECTRICAL SWITCH.

(Application filed Dec. 17, 1898.)

(No Model.) 2 Sheets—Sheet 1.

FIG. 1.

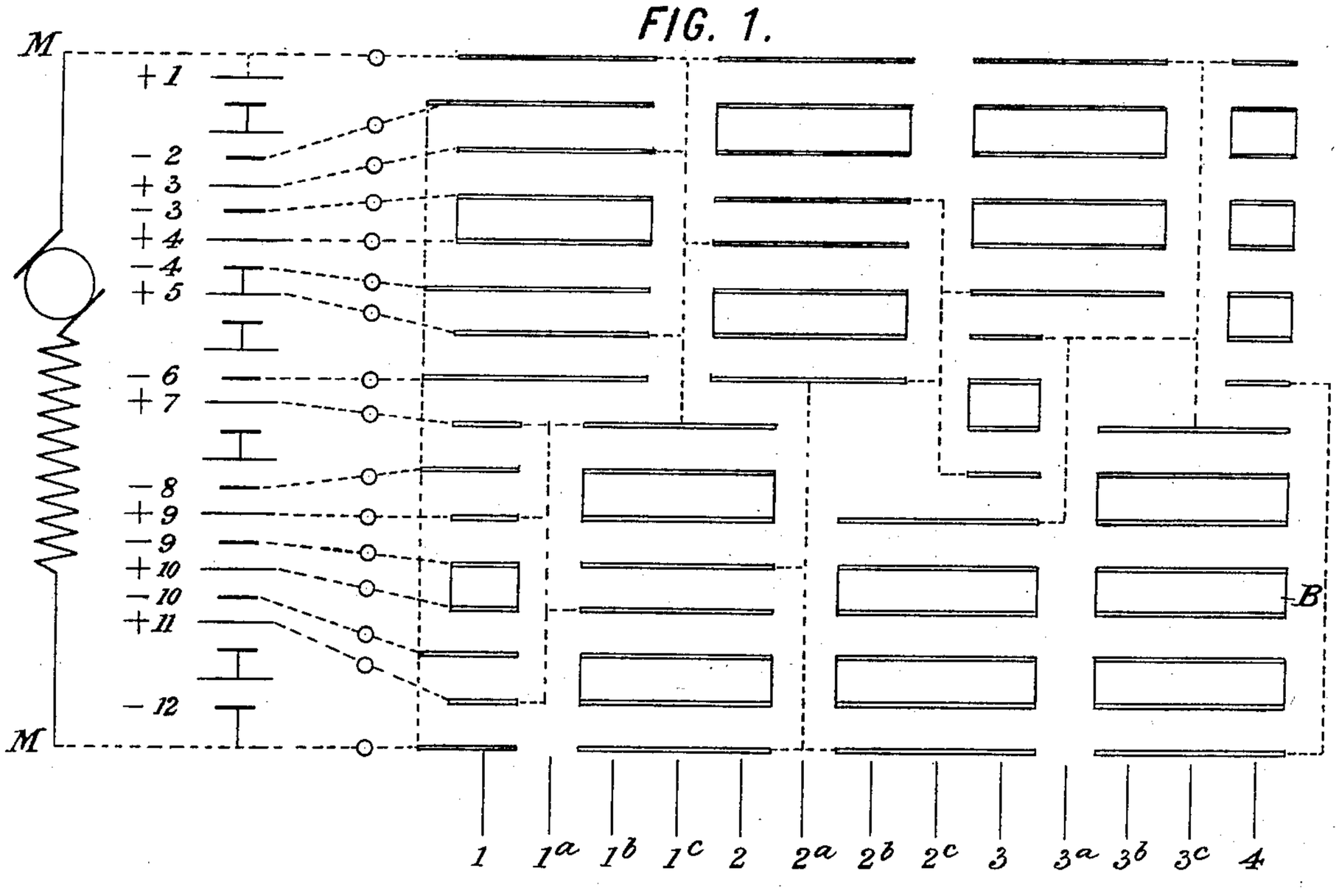
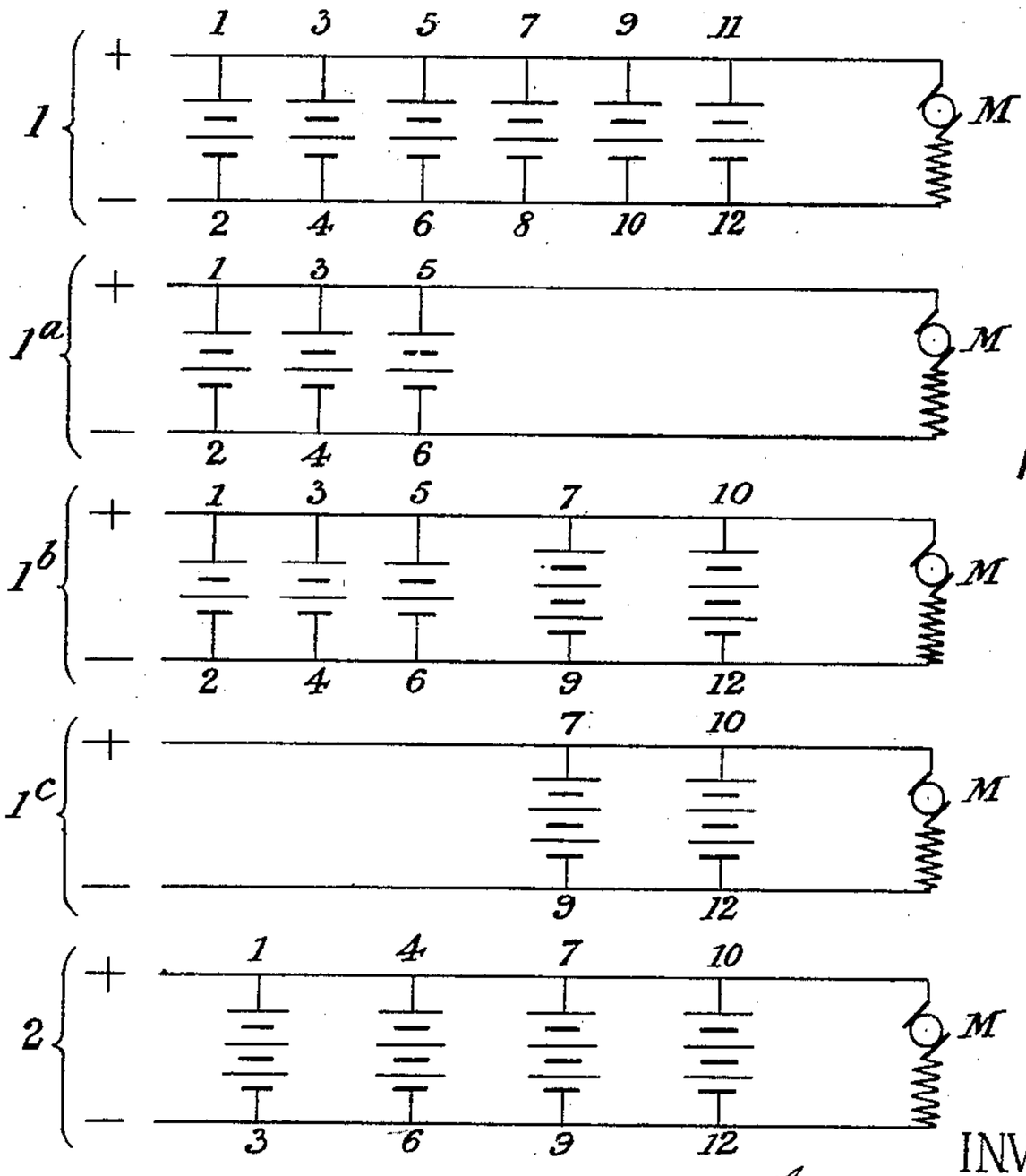


FIG. 4.



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(No Model.) 2 Sheets—Sheet 2.

FIG. 2.

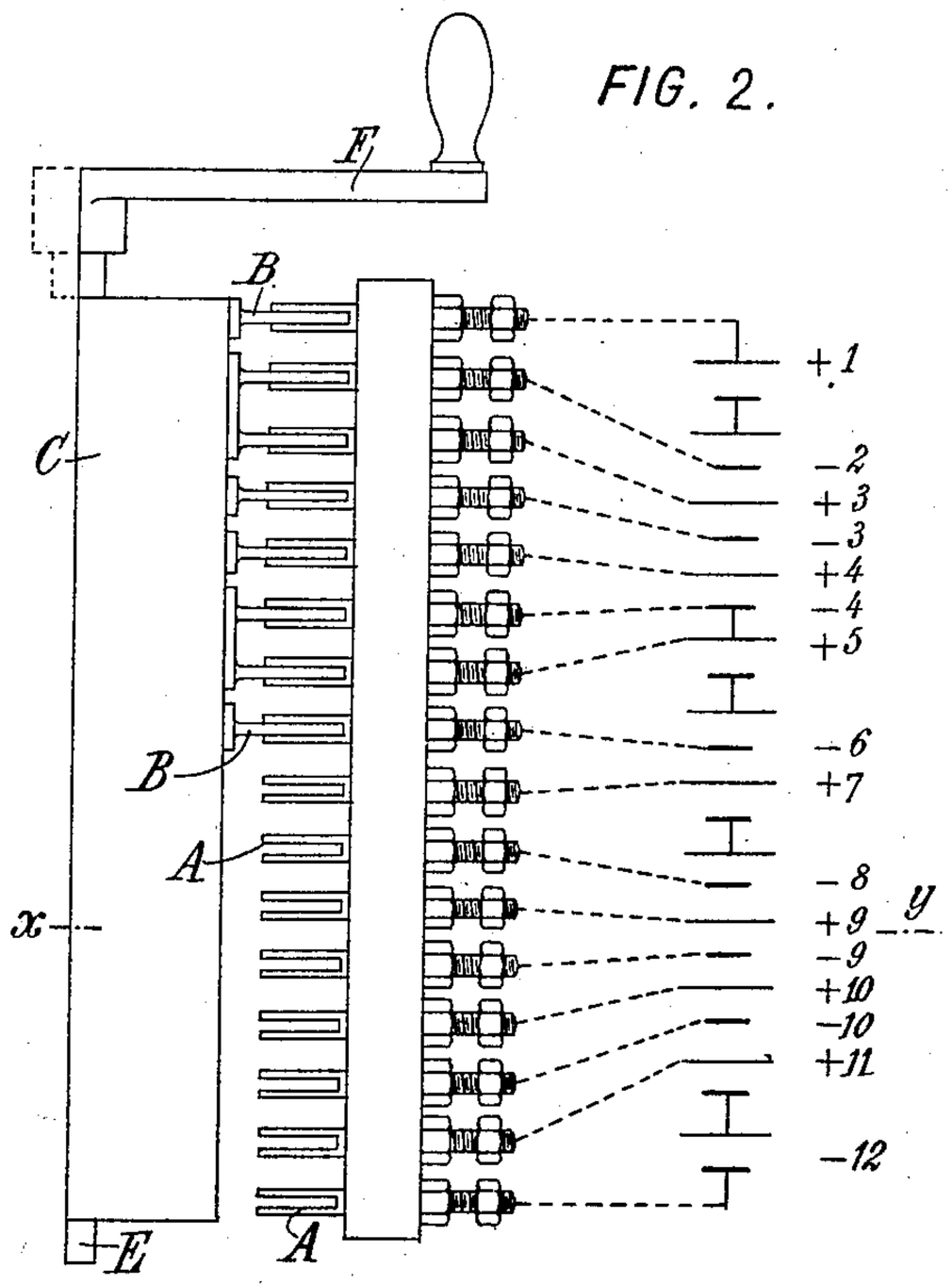
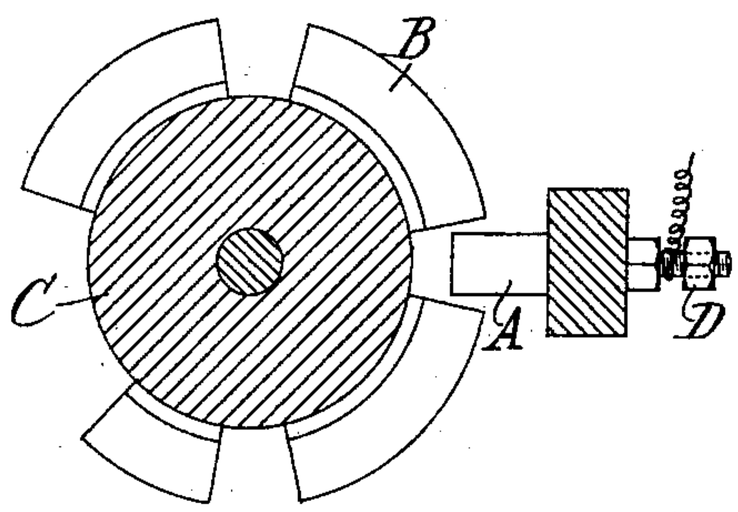


FIG. 3.



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UNITED STATES PATENT OFFICE.

EDWARD JOHN WADE, OF LONDON, ENGLAND.

ELECTRICAL SWITCH.

SPECIFICATION forming part of Letters Patent No. 626,798, dated June 13, 1899.

Application filed December 17, 1898. Serial No. 699,546. (No model.)

To all whom it may concern:

Be it known that I, EDWARD JOHN WADE, of London, England, have invented certain new and useful Improvements in and Connected with Electrical Switches, of which the following is a specification.

This invention relates to improvements in those classes of electrical switches which are used for coupling up storage-cells or other sources of electromotive force in various combinations of series and parallel, more especially with the object of controlling and varying the electromotive force applied to electric motors for traction and other purposes. These switches as now constructed have certain disadvantages. In order to avoid short-circuiting the cells, one combination has to be broken up before making another and the motor-circuit has also to be broken and remade with each change of electromotive force. The result is that the switch-contacts are rapidly destroyed by the sparking that ensues and the speed of the motor can only be varied in intermittent steps instead of rising and falling in a continuous manner. For example, suppose twelve cells or sets of cells are used and it is desired that they can be coupled up at will in six parallels of two each, or in four parallels of three each, or in three parallels of four each, or in two parallels of six each. Numbering the cells or sets of cells from 1 to 12, these four working combinations may be represented as follows:

$$+\left\{\begin{matrix}1,\ 2\\3,\ 4\\5,\ 6\\7,\ 8\\9,10\\11,12\end{matrix}\right\}- \quad +\left\{\begin{matrix}1,\ 2,\ 3\\4,\ 5,\ 6\\7,\ 8,\ 9\\10,11,12\end{matrix}\right\}- \quad +\left\{\begin{matrix}1,\ 2,\ 3,\ 4\\5,\ 6,\ 7,\ 8\\9,10,11,12\end{matrix}\right\}- \quad +\left\{\begin{matrix}1,2,3,\ 4,\ 5,\ 6\\7,8,9,10,11,12\end{matrix}\right\}-$$
(1) (2) (3) (4)

No two of these combinations can be in circuit at the same time without short-circuiting some of the cells, and therefore in passing from one to another a distinct gap or break has to be provided between each.

The object of the present invention is to provide means whereby the cells may be altered from one working combination to another without short-circuiting any of them, and yet at the same time without breaking the main circuit. For this purpose I introduce a number of intermediate combinations, through which the changes are effected, and I so arrange the contact-pieces that circuit is always made on one combination before it is broken on another. Three intermediate stages or combinations are provided between each of the working combinations. In passing from one of the latter to another the first stage is to cut out some of the parallels composing it, but leaving one or more of them in circuit to maintain the current. The second stage is to put back into the circuit in parallel with those still there part or all of the cells cut out, but grouped in series differently according to the new electromotive force it is desired to obtain. The third stage is to cut out the remainder of the cells of the old grouping, and the contacts then pass to the next working combination, when all the cells out of circuit are put back in parallel with those introduced at the second stage and in a similar series grouping.

According to my invention in the case of twelve cells hereinbefore cited the combinations from six parallels of two each to four parallels of three each would be

$$+\left\{\begin{matrix}1,\ 2\\3,\ 4\\5,\ 6\\7,\ 8\\9,10\\11,12\end{matrix}\right\}- \quad +\left\{\begin{matrix}1,2\\3,4\\5,6\end{matrix}\right\}- \quad +\left\{\begin{matrix}1,\ 2\\3,\ 4\\5,\ 6\\7,\ 8,\ 9\\10,11,12\end{matrix}\right\}- \quad +\left\{\begin{matrix}7,\ 8,\ 9\\10,11,12\end{matrix}\right\}- \quad +\left\{\begin{matrix}1,\ 2,\ 3\\4,\ 5,\ 6\\7,\ 8,\ 9\\10,11,12\end{matrix}\right\}-$$
(1) (1ª) (1ᵇ) (1ᶜ) (2)

and from four parallels of three each to three parallels of four each

$$+\left\{\begin{matrix}1,\ 2,\ 3\\4,\ 5,\ 6\\7,\ 8,\ 9\\10,11,12\end{matrix}\right\}- \quad +\left\{\begin{matrix}1,2,3\\4,5,6\end{matrix}\right\}- \quad +\left\{\begin{matrix}1,\ 2,\ 3\\4,\ 5,\ 6\\9,10,11,12\end{matrix}\right\}- \quad +9,10,11,12- \quad +\left\{\begin{matrix}1,\ 2,\ 3,\ 4\\5,\ 6,\ 7,\ 8\\9,10,11,12\end{matrix}\right\}-$$
(2) (2ª) (2ᵇ) (2ᶜ) (3)

and from three parallels of four each to two parallels of six each

$$+\left\{\begin{matrix}1,\ 2,\ 3,\ 4\\5,\ 6,\ 7,\ 8\\9,10,11,12\end{matrix}\right\}- \quad +1,2,3,4- \quad +\left\{\begin{matrix}1,\ 2,\ 3,\ 4\\7,8,9,10,11,12\end{matrix}\right\}- \quad +7,8,9,10,11,12- \quad +\left\{\begin{matrix}1,2,3,\ 4,\ 5,\ 6\\7,8,9,10,11,12\end{matrix}\right\}-$$
(3) (3ª) (3ᵇ) (3ᶜ) (4)

Throughout a whole series of combinations arranged in this way any two of them directly adjacent to each other may be in circuit at the same time without short-circuiting any of the cells, and the main circuit need never be broken. In each case the second of the intermediate combinations consists of unequal series of cells joined in parallel with each other, and there will therefore be a local current through the switch from the greater to the lesser series. For this reason the electromotive force in circuit must not be varied too abruptly; but, provided the two electromotive forces involved in any one change are not in a greater ratio than three to two, the currents through the local circuits will not be excessive. Moreover, as these local circuits are almost entirely free from self-induction the sparking that occurs on breaking them is practically negligible. If desired, the local currents may be still further reduced by arranging that when two or more series of unequal numbers of cells are in parallel with each other those containing the greater number of cells shall have a small resistance inserted in series with them, which shall be cut out by short-circuiting at the same time that the lesser series of cells are cut out.

When a change of electromotive force has to be effected which cannot be accomplished in the manner hereinbefore described—as, for instance, when doubling or halving the electromotive force by changing the storage-cells from two parallels to all in series, or vice versa—auxiliary resistances may be introduced into the circuit to diminish the sparking at these points.

My invention can be carried out in various ways; but the method I prefer is to bring the terminals of the cells or sets of cells or other source of electromotive force to a row of fixed contact-pieces and to connect these together as required for the various combinations by means of annular contacts, which are arranged in suitable sets on the periphery of a cylindrical drum and can be brought into play one after the other as it is revolved. This form of the switch is illustrated in the accompanying drawings, in which—

Figure 1 is a developed plan of the drum, showing the arrangement of contact-pieces necessary to couple up the cells in the combinations hereinbefore referred to—that is to say, six, four, three, and two parallels—together with the intermediate combinations for passing from each one of these to the next. The position of each combination is indicated by figures which correspond to those already used. Fig. 2 is a lengthwise section through the drum (only one-half of which is shown) when the contacts required to give combination No. 2^a are engaged with the fixed contacts, and it also shows diagrammatically the connections between the cells and the fixed contacts. Fig. 3 is a cross-section through the drum on the line $x\ y$ of Fig. 2, and Fig. 4 is a diagram illustrating the successive coupling up of the battery-cells, which is effected by the controller in passing from the working combination 1 to the working combination 2, as hereinbefore described. It is typical of the changes passed through between any other of the working combinations herein referred to.

A A are a row of forked contact-pieces mounted on some non-conducting material or otherwise insulated from each other and provided with suitable means, such as threaded stems and nuts D, whereby the wires from the storage-cells may be connected to them. Against each terminal is marked which cell and which pole of the cell is connected to it, assuming that twelve cells are used, numbered consecutively from +1 at one end of the battery to −12 at the other.

C is the drum.

B B are annular contacts on the drum, which make connection by passing between the forks of the fixed contacts A A. The drum is mounted on an axis E and is fitted with a handle F, by which it can be rotated. M M represent the motor-circuit. Some of the contacts are simply bridge-pieces for connecting two adjacent terminals, while others have to couple up terminals at some distance from each other and must therefore be connected together as shown by the dotted lines.

The width of the fixed contacts must be such that they can never rest on more than two combinations at the same time, for if three adjacent combinations are bridged together short circuits will result.

The intermediate combinations are only intended to be in circuit momentarily when passing from one working combination to another, and any suitable device may be provided to indicate when this is effected or to prevent the switch being left continuously in a wrong position.

It is obvious that the form of switch shown in the drawings and the special combinations and number of cells can be varied, those hereinbefore described being given for purposes of illustration and example.

What I claim, and desire to secure by Letters Patent, is—

1. In electrical controller-switches, the method of passing from one parallel combination to another without breaking the motor or main circuit by first cutting out one or more of the parallels, then reintroducing in parallel the whole or a part of the cells cut out, but coupled up in a different series, then cutting out the remainder of the first parallels and finally reintroducing in parallel all the cells out of circuit grouped according to the new series, substantially as set forth.

2. In electrical controller-switches, a set of contact-pieces with which the terminals of the cells or sets of cells or other source of electromotive force are connected in combination with another set of contact-pieces, arranged to contact with said first-named set, the posi-

tions of said two sets relatively to each being variable at will, and the number and relative position of the contacts of said two sets being such that when one set is moved relatively to the other set in making a change from one working combination of cells to another working combination intermediate combinations or stages are produced and the new working combination obtained without short-circuiting any of the cells and without breaking the main circuit, substantially as set forth.

3. In electrical controller-switches, a set of contact-pieces with which the terminals of the cells or sets of cells or other source of electromotive force are connected in combination with another set of contact-pieces on a revoluble drum, and arranged to contact with said first-named set, the number and relative position of the contacts of said two sets being such that when one set is moved relatively to the other set in making a change from one working combination of cells to another working combination, intermediate combinations or stages are produced and the new working combination obtained without short-circuiting any of the cells and without breaking the main circuit, substantially as set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses:

EDWARD JOHN WADE.

Witnesses:

GEORGE C. BACON,

ROBERT M. SPEARPOINT.