No. 614,571. Patented Nov. 22, 1898.

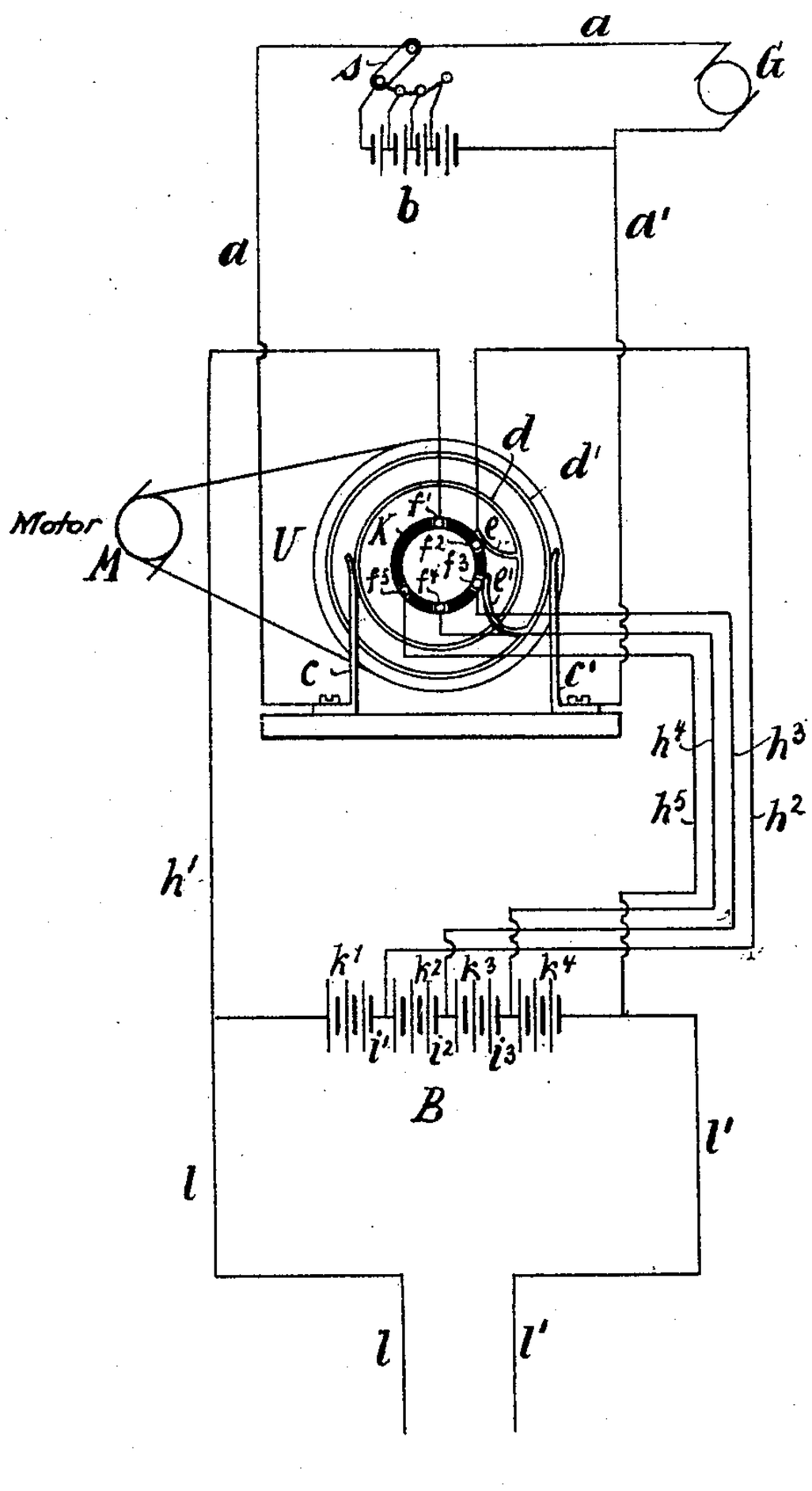
A. MÜLLER.

TRANSFORMER SYSTEM AND APPARATUS.

(Application filed July 30, 1897.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.



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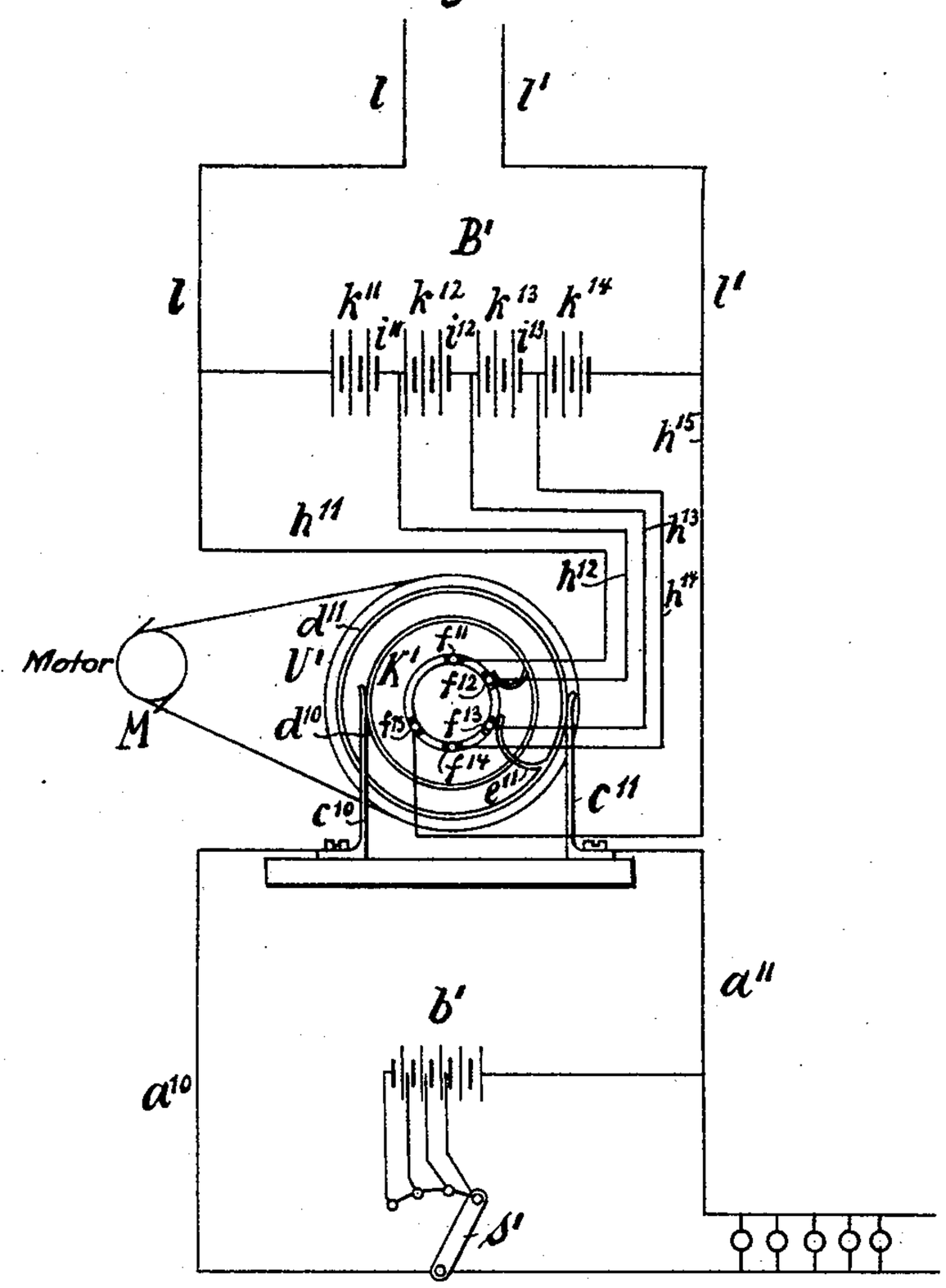
(No Model.) 3 Sheets—Sheet 2.

Fig. 2.



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(No Model.) 3 Sheets—Sheet 3.

Fig. 3.

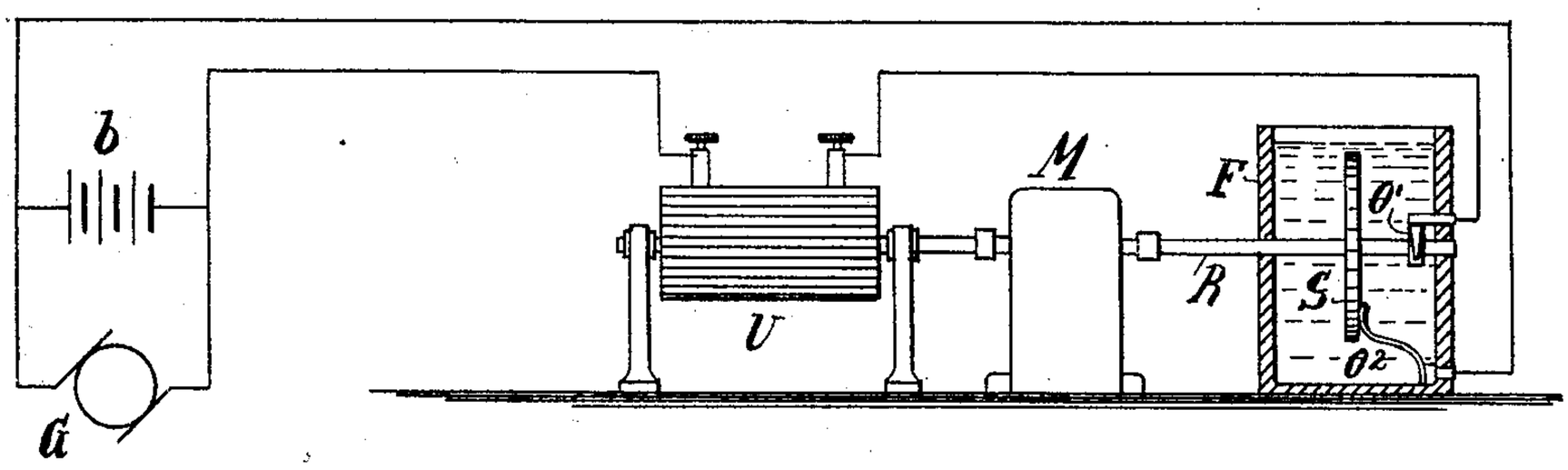
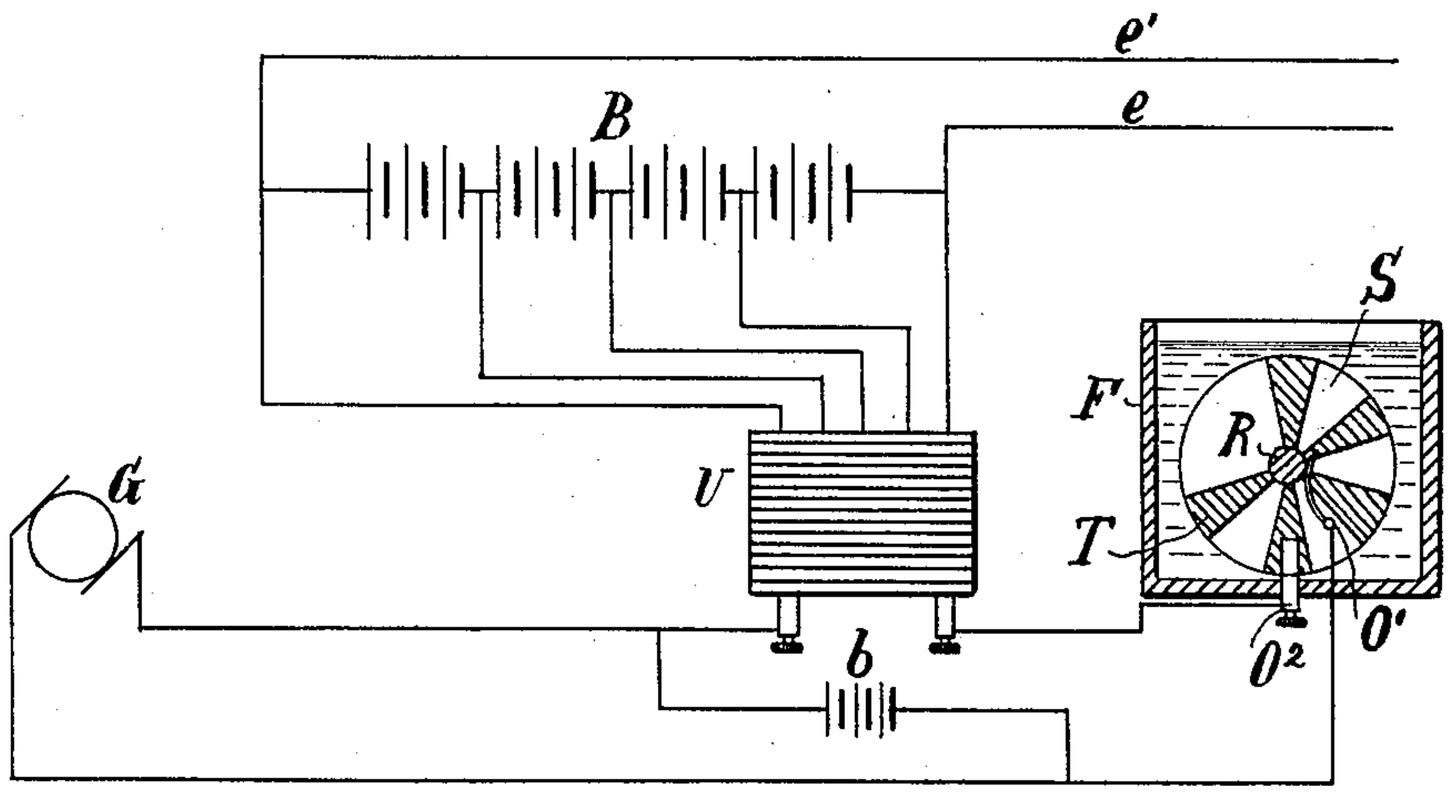


Fig. 4.



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UNITED STATES PATENT OFFICE.

ADOLPH MÜLLER, OF HAGEN, GERMANY.

TRANSFORMER SYSTEM AND APPARATUS.

SPECIFICATION forming part of Letters Patent No. 614,571, dated November 22, 1898.

Application filed July 30, 1897. Serial No. 646,546. (No model.)

To all whom it may concern:

Be it known that I, ADOLPH MÜLLER, a subject of the German Emperor, and a resident of Hagen, Germany, have invented certain new and useful Improvements in and Relating to Transformer Systems and Apparatus; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters of reference marked thereon, which form a part of this specification.

My invention has relation to transformer systems and apparatus, and more particularly to that class in which the transformation is effected by means of storage-battery systems.

In the transformation of direct currents of a given potential into currents of different potential the groups of cells of the storage battery in the transformation of currents of a high into currents of a lower potential or tension have been charged in series and discharged in parallel, the reverse being done in the transformation of currents of low tension into currents of a higher tension where the groups of cells of the storage battery are charged in parallel and discharged in series. In such systems a continuous operation becomes possible only when two absolutely independent groups of cells of full capacity are used and alternately charged and discharged. This, however, is a very costly arrangement. In order to avoid this disadvantage, a commutator has been used adapted to electrically connect the individual groups of a single series of storage-battery cells in series or uninterrupted succession with the charging or discharging circuit, as described, for instance, in Letters Patent of the United States, Nos. 565,740 and 565,741, to F. D'A. Goold, dated August 11, 1896. In the systems shown and described in said Letters Patent it has been the aim to avoid the current interruptions necessarily resulting from unavoidable circuit changing by making the commutator-brushes wider than the insulation between two commutator-contacts. It is obvious that such an arrangement results in the short-circuiting of individual battery-cell groups through the commutator-brushes and the unavoidable destruction of the latter, so that such a system is not available for practical purposes. If, on the other hand, as is the case at a certain point in the transforming systems referred to, the insulation between the commutator-contacts is made so wide that the brushes will not extend over them, a complete current interruption accompanied by strong sparking inevitably follows, which likewise precludes the practical use of such systems.

In German Patent No. 50,056 an arrangement is shown and described which, although designed for different purposes, performs in a certain measure the function of a direct-current transformer. In this arrangement the complete interruption of the charging-current is avoided by means of a shunt-circuit perpetually included in said charging-circuit, which shunt-circuit may consist either of a wire resistance or a storage battery. In the latter case the battery referred to, like any one of the groups of storage batteries to be charged, would have to be cut out of the charging-circuit and replaced by another. This would render still more complicated the already complicated circuit-changing appliances necessary to the cutting out of the charging-circuit the individual groups of battery-cells to be charged, because it would be absolutely necessary for the purpose of charging a group of cells to cut out four of them. Irrespective of this disadvantage direct currents of low tension alone can be transformed. Hence this system is also not available for practical purposes.

Broadly speaking, my invention has for its object the transformation of direct currents of a given tension into like currents of a different tension, and, specifically speaking, the invention has for its object the transformation of direct currents by means of storage batteries, the transmission of such currents over long distances through conductors of small cross-sectional area, and at a distant point the retransformation of the high-tension current to a current of a tension suitable for consumption for the different practical purposes.

The invention has for its further object the transformation of direct currents of any

given tension into currents of the tension of a current produced by another source for supporting the latter.

In accordance with my invention the transformation is effected without interruption of the supply or charging or the consumption or discharging circuits or currents, and this without any possibility of producing short circuits through the circuit-changing or commutator brushes. Furthermore, according to my invention I am enabled to regulate the current tension in the most simple manner in accordance with the current consumption without resorting to other means than well-known forms of circuit-changing appliances. This I attain by perpetually including, not only in the high-tension circuit, (as according to the United States Patents cited hereinbefore,) but also in the low-tension circuit, a storage battery whose cells are arranged in groups and whose tension is equal to that of said charging-circuit and to the tension of a group of cells of the storage battery in the high-tension circuit. This battery does not in any manner partake in commutation of the cell groups of the high-tension battery, but is designed to equalize the differences of potential brought about by current interruptions due to that commutation.

That my invention may be fully understood I will describe the same in detail, reference being had to the accompanying drawings, in which—

Figures 1 and 2 are diagrammatic views of circuits and appliances for transforming direct currents of low tension into like currents of higher tension, and vice versa, respectively. Figs. 3 and 4 are like views illustrating the combination of a spark catcher or arrester and extinguisher, with circuits and appliances for transforming direct currents of very high tension into like currents of lower tension.

Referring to Fig. 1, G indicates a generator of electricity, as a dynamo, included in a low-tension current-charging circuit $a\ a'$, in which is also permanently included a storage battery b, whose cells are arranged in groups connected in series, a switch s being provided whereby the number of groups of cells in circuit may be varied in accordance with the tension of the current supplied by the dynamo. In the discharging-circuit l and l' is permanently included a storage battery B, whose cells are also arranged in groups and connected in multiple series, the tension of each group of cells being equal to that of the battery b or to the tension of a definite number of groups of cells of said battery b. In these two circuits are interposed the circuit-changing appliances—namely, a commutator comprising a suitable support, to which are secured two contact-springs c and c', constituting one of the terminals of the charging-circuit a and a'. The commutator further comprises two synchronously revoluble contact-rings d and d', set in motion by any suitable motor, as an electric motor M. The terminal springs c and c' have bearing on the periphery of said rings d and d', respectively, and each of said rings is provided with a brush (lettered e and e', respectively) that have bearing upon a fixed commutator-cylinder K. The commutator-cylinder K has a series of contact-segments, the number of which is greater by one than the number of storage-battery cell groups, in the case under consideration, five, (indicated by f', f^2, f^3, f^4, and f^5,) of which f' and f^5 are connected by wires h' and h^5 to opposite poles of the terminal or end groups of cells of storage battery B, while the contacts $f^2\ f^3\ f^4$ are connected by wires $h^2\ h^3\ h^4$ with the serial connections i', i^2, and i^3, respectively, between the groups of cells of said battery B.

It will readily be seen that in the arrangement described any desired number of groups of cells of battery B, corresponding to a given multiple of the tension of the charging-current, can be discharged.

Of course it will be understood that instead of revolving the contact-rings d and d' about the commutator-cylinder K the latter may be revolved. In the position of the commutator, brushes, and contact-rings shown in Fig. 1 current from dynamo G flows by wire a to spring c, ring d, brush e, contact f^2, wire h^2, group of cells k^2 of battery B, which is thereby charged, wire h^3, contact f^3, brush e', ring d', spring c', and wire a' back to opposite pole of dynamo G. During this operation the storage battery b remains unaffected provided the potential or tension of its charge is equal to that existing in the charging-circuit—*i. e.*, equal to that of the charging-current. In general the tension of battery b will be higher than that of the group of storage-cells being charged, so that the supply-current is supported or in a measure reinforced by said battery b. As the brushes $e\ e'$ move out of contact with $f^2\ f^3$ and into contact with $f^3\ f^4$ cell group k^2 is cut out of the supply-circuit and cell group k^3 included in said circuit, current flowing from G, via a to $c\ d\ e\ f^3\ h^3\ k^3\ h^4\ f^4\ e'\ d'\ c'\ a'$ back to G, cell group k^3 being charged, and in a similar manner cell groups k^4 and k' will be charged by the further rotation of the contact-rings d and d'. It will, however, be observed that owing to the interposition of battery b in the charging-circuit the latter is not interrupted during the successive cutting out of the cell groups of battery B, but remains closed through said battery b, thereby charging the latter, while the tension, as above stated, can be regulated by means of the switch s. Inasmuch as the cell groups of battery B are connected in series in the discharge-circuit l and l' the tension of the discharge-current will be greater than that of the supply-current, as is well understood, and in proportion to the number of cell groups in said storage battery B. The transformation of direct currents of high tension into like currents of a lower ten-

sion takes place in precisely a similar manner, whether such high-tension currents are derived directly from a generator or from a high-tension discharge-circuit supplied by transformation from a low-tension charging-circuit. It is obvious that by means of the appliances shown in Fig. 1 the high-tension currents obtained by the transformation of low-tension currents may be transmitted to a distant point and there retransformed into current of low tension for consumption, this being presumed to be the case in the diagram shown in Fig. 2, to which reference is now made. In this arrangement the high-tension or discharging circuit $l\ l'$ becomes, of course, the charging-circuit and has permanently included therein the high-tension storage battery B', the four groups of cells of which are connected in multiple series. The low-tension or charging circuit $a\ a'$, Fig. 1, becomes the discharging-circuit $a^{10}\ a^{11}$, Fig. 2, and includes the storage battery b', the connections between the batteries and circuit-changing appliances being exactly as described in respect of Fig. 1. The battery B' is uninterruptedly charged and maintains the charging-circuit constantly closed, and as the groups of cells $k^{11}\ k^{12}\ k^{13}\ k^{14}$ of said battery are connected in multiple series with the discharge-circuit through the contacts $f^{11}\ f^{12}\ f^{13}\ f^{14}\ f^{15}$ of the circuit-changing appliances and the connections h^{11}, i^{11}, h^{12}, i^{12}, h^{13}, i^{13}, h^{14}, and h^{15}, said groups of cells are discharged serially into the discharging-circuit a^{10} and a^{11}, that includes the battery b', which also maintains said circuit constantly closed, while the tension in said circuit can be regulated by means of the switch s', as described in respect of Fig. 1. It will thus be seen that a current of comparatively low tension, such as is readily generated by a direct-current dynamo, can be transformed into a current whose tension may reach thousands of volts and transmitted to a great distance, to be there retransformed into a current of lower tension suitable for consumption.

Although the circuit-changing appliances shown and described are of a simple and very practicable nature, yet their construction and arrangement may be varied in many ways without departing from the nature of my invention.

In the application of my system to existing installations should the given tension not be directly divisible into a higher tension, or vice versa, it will be advisable to find the highest possible common divisor that will divide the tensions without remainder and then divide both high and low tension storage batteries into groups of cells in such manner that the tension of each of said groups of the high-tension battery will be equal to the tension of a group of cells of the low-tension battery. The circuit-changing appliances will then be so organized as to connect at equal intervals of time cell groups of equal dimensions of the primary and secondary batteries.

Practice has demonstrated that direct electric currents can be transformed into currents of any desired tension by my system without injurious sparking at the commutator, which in similar systems heretofore used has not been attained; but, as is well known, it is extremely difficult to effect the transformation of currents of very high tension without injurious sparking, and I provide means whereby the injurious effect is, if not absolutely avoided, at least greatly mitigated by so constructing the circuit-changing appliances that those parts immediately affected and liable to wear can be readily removed and others substituted. This I have shown in Figs. 3 and 4 by interposing in the high-tension circuit a spark catcher or arrester and extinguisher. As will be seen by an inspection of said figures of the drawings, the current from dynamo G for charging the high-tension battery B flows from the intermediate battery b through a spark-arrester and thence to the commutator U. This spark-arrester consists or may consist of an insulation-disk S, secured to the shaft R of the electric motor M and commutator U, said disk being provided with conductive contact-segments T, electrically connected with said shaft R, the circuit-terminals being connected to contact-springs O' O^2, the former trailing on shaft R and the latter on the face of disk S. The number and relative arrangement of the segments T correspond, of course, with the number and relative arrangement of the commutator-contacts, while the superficial arc of said segments T relatively to the superficial arc of the commutator-contacts is such that the circuit will be interrupted and closed at the spark-arrester a little before it is interrupted and closed at the commutator. Hence the sparking, if any, takes place at the spark-arrester instead of at the commutator. The conductive segments T, subjected to the influence of the sparking, can, however, be readily removed and replaced by others at a trifling cost, which is not the case with the commutator-contacts. In order to minimize the injurious effects of sparking, the disk S may be inclosed in a vessel F, filled with any suitable non-conductive extinguishing liquid, as distilled water or alcohol or the like. Like results may be obtained by magnetically or mechanically wiping the sparks, as by a blast of air, and instead of the disk S a cylinder can be used.

Having thus described my invention, what I claim as new therein, and desire to secure by Letters Patent, is—

1. The combination with two circuits for carrying currents of different tension, a commutator interposed therein, storage-cells in the high-tension circuit electrically connected in groups with said commutator and adapted to be charged in parallel and discharged in series when receiving current from, and charged in series and discharged in parallel when supplying current to the commutator;

of a storage battery always in circuit with the low-tension circuit and connected with the commutator, for the purpose set forth.

2. The combination with two circuits for carrying currents of different tension, a commutator interposed in said circuits, groups of storage-cells in the high-tension circuit connected with said commutator to be charged in parallel and discharged in series when receiving current from, and charged in series and discharged in parallel when supplying current to the commutator; of a storage battery always in circuit with the low-tension circuit and through the commutator successively with each group of storage-cells in the high-tension circuit, for the purpose set forth.

3. The combination with two circuits adapted to carry currents of different tension, a commutator interposed in said circuits, storage-cells in the high-tension circuit connected in groups to said commutator to be charged in parallel and discharged in series when receiving current from, and charged in series and discharged in parallel when supplying current to the commutator; of storage-cells always in circuit with the low-tension circuit and through the commutator successively with the several groups of cells in said high-tension circuit, for the purpose set forth.

4. The combination with two circuits adapted to carry currents of different density, a commutator interposed in said circuits, and storage-cells connected in groups with said commutator to be charged in parallel and discharged in series, and charged in series and discharged in parallel respectively when receiving current from or supplying current to the commutator; of storage-cells always in circuit with the low-tension circuit, and means for regulating the tension in said cells to that in a group of cells in the high-tension circuit, for the purpose set forth.

5. The combination with two circuits for carrying currents of different tension, a commutator interposed in said circuits, storage-cells always in circuit with the high-tension circuit, and connected in groups with said commutator to be charged in parallel and discharged in series, and to be charged in series and discharged in parallel respectively when receiving current from or supplying current to said commutator; of a storage battery always in circuit with the low-tension circuit and adapted to be connected, through said commutator, successively with the several groups of cells in the high-tension circuit, for the purpose set forth.

6. The combination with two circuits for carrying currents of different tension, a commutator interposed in said circuits, groups of storage-cells connected with the commutator to be charged in parallel and discharged in series, and to be charged in series and discharged in parallel respectively, when receiving current from or supplying current to said commutator; of a storage battery and a spark-arrester always in circuit with the low-tension circuit and connected through the commutator with the groups of storage-cells, substantially as and for the purpose set forth.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

ADOLPH MÜLLER.

Witnesses:
HENRY HASPER,
W. HAUPT.