W. H. CLARKE.

SYSTEM OF ELECTRICAL DISTRIBUTION.

APPLICATION FILED JUNE 15, 1907.

966,526. Patented Aug. 9, 1910.

Fig. 1.

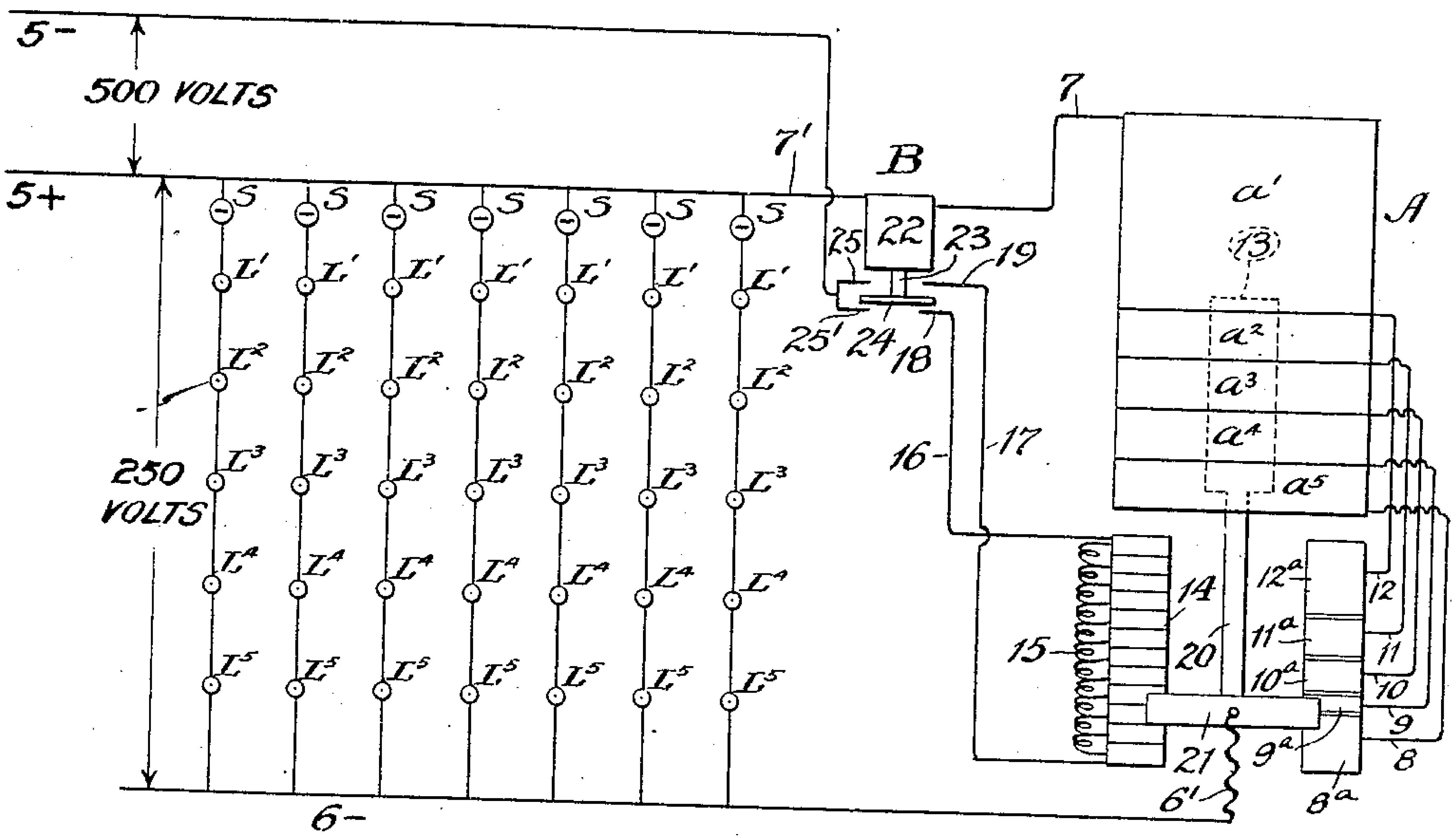
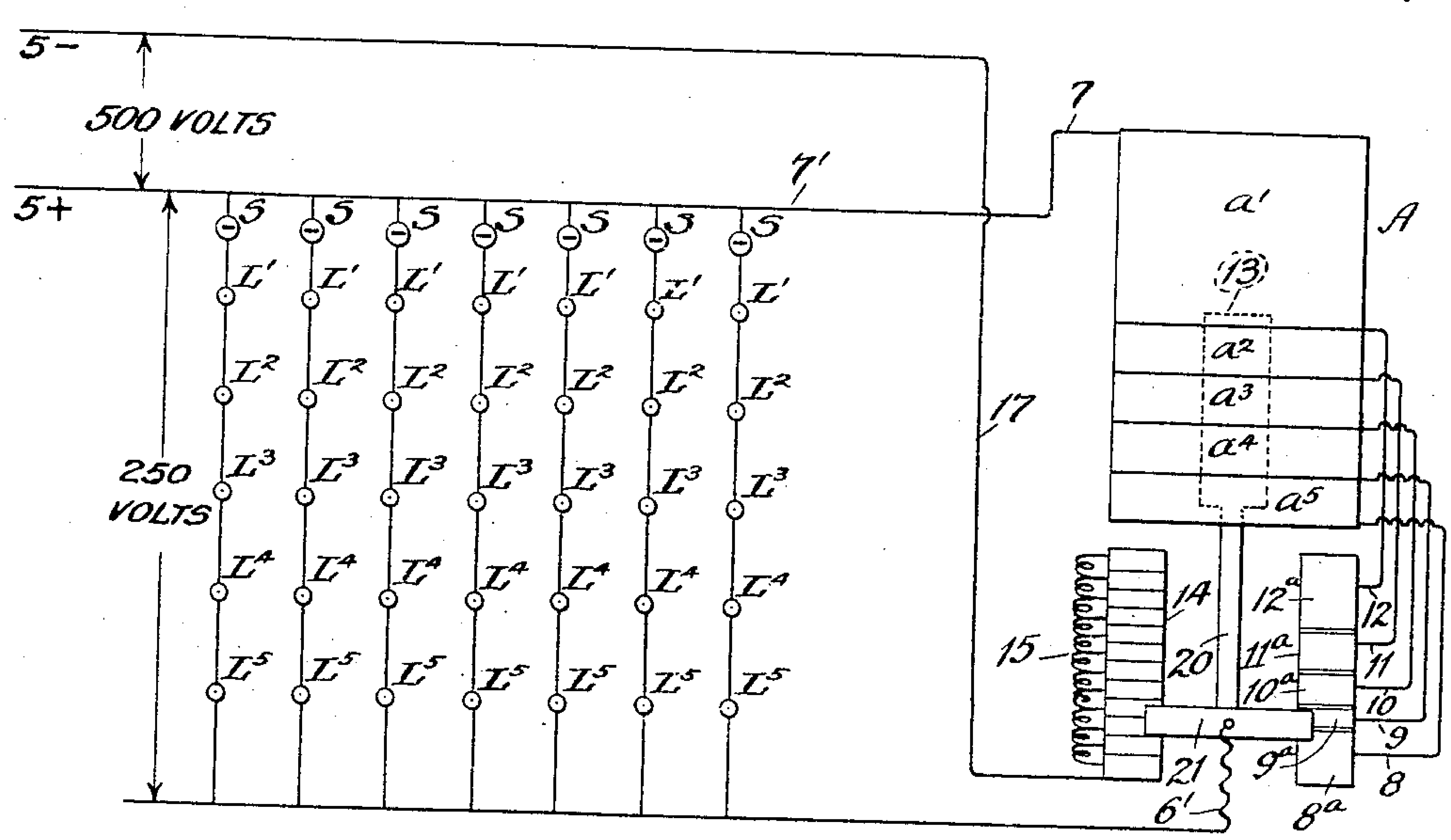


Fig. 2.



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SYSTEM OF ELECTRICAL DISTRIBUTION.

966,526. Specification of Letters Patent. **Patented Aug. 9, 1910.**

Application filed June 15, 1907. Serial No. 379,213.

To all whom it may concern:

Be it known that I, WILLIAM H. CLARKE, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Systems of Electrical Distribution, of which the following is a specification.

My invention relates to improvements in systems of electrical distribution.

One of the objects of my invention is to provide a system of electrical distribution wherein the difference of potential between the respective terminals of translating devices, arranged in multiple-arc relation, or in multiple-series relation in a subsidiary circuit may be maintained substantially constant, while in the main circuit the difference of potential is widely varied.

Another object of my invention is to provide a system of electrical distribution, wherein the results produced by the tendency to momentary variation of the difference of potential in the subsidiary circuit serves to effect means to establish and maintain practically constant and stable the difference of potential in such subsidiary circuit before such variation serves to materially affect the translating devices contained in said subsidiary circuit.

Other objects of my invention will become apparent to those persons who are skilled in the art from the description hereinafter contained, taken in conjunction with the drawing, wherein,

Figure 1 is a diagrammatic representation of the circuits and the regulating means, and, Fig. 2 is a modified view showing the system without the automatic switch for reversing the terminals of the resistance coils with respect to one of the mains of the circuit.

My system of electrical distribution is especially desirable and advantageous in connection with the illumination of electrically propelled cars from the circuit from which current is taken to operate the motors that propel the cars. In many instances incandescent lamps have heretofore been placed in series in strings of five or more and such strings are connected across the mains of such circuits in multiple-series at which points the maximum difference of potential is declared. Under such conditions the lamps manifest every change in potential by frequent disagreeable and undesirable variations in the illuminating intensities and qualities. It sometimes happens that a lamp in one or more strings, in cars so wired in multiple-series, "blows" or burns out, thus shutting off the current from such string or strings, in which event the entire number of lamps are liable to burn out in rapid succession. Especially is this the case when a current controlling governor is used in series with the entire group of lamps. My invention is designed to overcome these difficulties by controlling and maintaining substantially constant the difference of potential of a subsidiary circuit, which I provide, and in which the incandescent lamps may be placed independent of any variation of the difference of potential that may occur in the main circuit from time to time, without directly controlling the strength of the current that may be at any time flowing through said circuit. In other words, my device is not a current controller.

The main line terminals between which the maximum potential is declared are indicated by 5+ and 5—. The lamps are placed in a subsidiary circuit comprising terminal mains 5+ and 6—. The differences of potential may be caused to vary greatly between mains 5+ and 5— but the difference of potential of the subsidiary circuit, which is less than the lowest operative difference of potential ever existing between main 5+ and 5—, and in which the lamps are placed, is maintained substantially constant by means of a potential controlling device, which I will now proceed to describe.

A is a solenoid, wound in a number of sections, shown in the drawing to be composed of five sections, a^1, a^2, a^3, a^4 and a^5. When the circuit is complete from wire 7 to wire 8 all of the sections are in series relation. When the circuit is complete from wire 7 through the coil to wire 9 all of the sections are in circuit in series relation except section a^5, which is now not in circuit, and so on until all of the sections have been cut out of circuit except section a^1. The wires 8, 9, 10, 11 and 12 are connected to commutator sections 8^a, 9^a, 10^a, 11^a 12^a respectively. A solenoid core 13 is shown in dotted lines, as having been slightly lifted. A commutator 14 composed of many sections is properly connected to a series of resistance coils 15 comprising a rheostat. The terminal coils of the rheostat are connected by heavy wires 16 and 17 to contacts 18 and 19 respectively of an automatic reversing switch B. The core 13 of the coil A is provided with a stem 20 to which a double ended collecting brush or bar 21 is attached. This brush is designed to be freely moved over the commutators, on either side of the stem, by means of the core 13 and to make good electrical contact with the several sections thereof whenever the core 13 is raised and lowered.

The automatic switch B is composed of a solenoid coil 22, in series with coil A and connected to the main 5+ by wire 7′. A responsive core 23 carries a cross bar 24 on its lower end arranged to make electrical connection with stationary contacts 18 and 19 and contacts 25 and 25′. The latter contacts are joined together and are connected with the main line 5—. When the armature 23 is raised electric circuit is completed between contacts 19 and 25 through contact bar 24, and when the armature is down in its normal position, as when coil 22 is deenergized, the electric circuit is complete between contacts 18 and 25′ through the bar 24.

The lamps for illuminating the car are shown in seven strings, there being five in a string; L^1, L^2, L^3, L^4 L^5, indicate the lamps in the strings.

S is a switch, of which there is one in each string, by means of which all of the lamps in a particular string may be extinguished.

The use and operation of my system is as follows: One of the prime objects to be attained is to maintain the difference of potential between the terminals of the several strings of lamps as nearly uniform as possible so as to prevent the disagreeable and frequent change of intensity of light of the lamps. It therefore becomes necessary to arrange the lamps, to be properly operated, at a difference of potential in the subsidiary circuit below which, in practice, the voltage never goes in the main circuit. For the purpose of explanation I will assume arbitrary values. Suppose that the system is installed in a car having an electric propelling motor taking current from a circuit of 500 volts, and that it is desirable to wire the car for 35, 50 volt, eight candle power lamps, each string of lamps would require one half ampere to properly light the lamps, or 3½ amperes for the seven strings of lamps. Therefore, 3½ amperes would pass between wires 5+ and 6— at 250 volts difference of potential, and 3½ amperes would pass from wire 5+ and wire 5— at 500 volts difference of potential, 250 volts difference of potential being taken up, so to speak, in the rheostat coils 15. Under such conditions the system would show its lowest relative efficiency. Let us again assume that the loss on the main line had for the time reduced the voltage to 300 volts. Then under such conditions 3½ amperes would pass through the lamps from wire 5+ to 6—, and then 250 volts would still be maintained therebetween, but there would be 50 volts lost in the rheostat resistance owing to the difference between the voltage in the main circuit (300 volts) and that of the subsidiary circuit (250 volts) and under all other conditions of variations in the main circuit the controller will operate to maintain the voltage across the terminals of the strings of lamps at a practically constant value and the lamps will continue to burn without variation of light. Normally one end of contact bar 21 rests on commutator section 8^a retaining all of coil A in circuit. The other end of the bar rests on the lower commutator section of the rheostat, thereby placing all of the resistance coils, 15, in circuit. Contact brush or bar 24 normally closes circuit between contacts 18 and 25′. When the circuits are completely deënergized these are the positions of the parts. When the circuit is closed through the system the current will flow from main wire 5+ through the lamps L^1, L^5, inclusive, to wire 6—, through flexible wire 6′ to contact bar 21, through all of the resistance coils 15, through wire 16 to contact 18, over bar 24 to contact 25′ to wire 5—, completing the circuit through the rheostat and the lamps in series. The branch circuit from wire 5+ is over wire 7′ through coil 22, over wire 7, through sections a^1, a^2, a^3, a^4 and a^5 of coil A, through wire 8 to section 8^a of the commutator, through bar 21 and the resistance coils 15 to main line wire 5—. It will be seen that coil A is in parallel circuit with lamps L^1–L^5 and that it is affected by the same variations in difference of potential. At or just before coil 22 is energized the circuit is completed through the lamps and all of the resistance 15 and the difference of potential, for this reason, under the conditions mentioned cannot exceed 250 volts. The armature 13 of the coil A will begin to rise and cut out some resistance, but almost immediately armature 23 of coil 22 is lifted until connection is made between contacts 19 and 25, thus reversing the direction of current through resistance 15, then armature 13 is further drawn up until sufficient resistance 15, all of that below the bar 21, is cut in series with the lamps to compensate for the difference in the voltage of the main circuit and the 250 volts, that of the subsidiary circuit. Should the voltage of the main circuit be 500 then the cross bar 21 would rest on the commutator 14 near its top and on commutator contact 12^a and all or nearly all of the resistance 15 would be included in circuit with the lamps, and all of the sections of coil A except section a^1 would be cut out. Should the voltage between the wires 5+ and 5— fall to a point just slightly above 250 volts, then, under such conditions, the armature 13 would fall until nearly all of the resistance 15 would be cut out of circuit, and any variation of voltage in the main circuit between the limits mentioned, would operate to cause the magnet A to place the contact bar 21 at such point on the rheostat commutator as to insert or cut out the proper amount of resistance to correspond with the variation of voltage in the main circuit. When the voltage in the subsidiary circuit tends to vary, or before its effect can become apparent upon the eye by a manifestation of change of intensity of light, on account of the persistence of vision, the magnet A has felt the change and has effected an adjustment sufficient to compensate for the variation. The magnet coils a^1–a^5 of the controller A, being in the subsidiary circuit with the lamps L^1–L^5, are responsive to any change of potential that may affect said circuit and operates by the movement of its core to maintain the difference of potential in said circuit constant.

It will be noticed that commutator sections 9^a, 10^a, 11^a and 12^a are gradually increased in length accordingly as they are situated near the coil. The lower section 8^a, the section upon which bar 21 normally rests, being somewhat longer. The object of this arrangement is to retain the corresponding section a^1–a^5 of the coil A in circuit only within certain prescribed limits, corresponding to the strength of the field in which the core is at the time located, so as to quickly secure a suitable adjustment of the core in its various positions. As the field of force of the solenoid through which the core 13 passes varies, the commutator sections are also varied, thereby producing a more uniform "pull" upon the core and causing it to remain in the position it has last assumed until a variation, sufficient to cause it to be moved to a new position has occurred.

It is well known that when the core of an ordinary air-path solenoid is raised by the magnetic effect in obedience to the energizing solenoid, the attraction or strength of "pull" is not uniform at all points throughout the extent of the movement or excursion of the core. In the drawing the core 13 is shown in a position slightly above that in which it exerts the strongest pull (without consideration of the effect of cutting out the coil sections). If, as in the ordinary solenoid, the core be raised further, the pull will become weaker, or it will require more current to maintain the uniform strength of pull, and so on until the core could not be moved any higher by current of infinite strength, as when it arrives at approximately the center of the coil. In the present invention it is desirable to move the core a less relative distance at the beginning of the excursion so that it will not be necessary to materially increase the strength of the current and at the same time to have the core occupy positions of stable equilibrium. To this end I provide a sectional solenoid and a commutator having sections of variable lengths; the first section being shorter so that the imposed travel of the core becomes progressively longer as the core is raised and the commutator brushes pass over the commutator sections of gradually increasing length. When the core moves the commutator brush over the first section its relative travel is less than when moved over the second section, and so on. Positions of stable equilibrium of the core are thus established immediately after the sections are respectively cut out. The result is that the core will remain in given positions until the electro-motive-force of the circuit has again been materially increased or decreased, as the case may be, sufficient to initiate movement of the core to another section.

Fig. 2 shows the system without the reversing switch, the operation in every respect being the same as that of Fig. 1 with this exception. In the wiring system, without the automatic reversing switch, the lamps may be subjected to the entire voltage of the main circuit for an almost imperceptible period of time, which, however, would be of such short duration as to produce no material effect.

It is evident that if one or more of the switches S be turned so as to open the circuit, or circuits, of corresponding strings of lamps, or if such circuits be opened in any other manner, thus increasing the resistance of the subsidiary circuit in a corresponding degree, that the current flowing in the subsidiary circuit at any time will of course be inversely proportional to the resistance. Therefore, if the difference of potential of the subsidiary circuit is maintained constant the said circuit, for this reason may be said to be inherently self-regulating and only current to properly supply the lamps remaining in circuit will flow at any one time, and thus one or more strings of lamps may, at any time, be removed from the circuit without affecting the brilliancy and steadiness of those remaining in circuit.

Having thus described my invention, what I claim and desire to secure by Letters Patent, of the United States is:

1. In a system of electrical distribution, a main circuit and a subsidiary circuit, and means for maintaining a constant potential in said subsidiary circuit comprising a rheostat consisting of a series of sections, a solenoid consisting of a series of sections, a commutator for the resistance sections, a commutator for the solenoid sections, a core responsive to energization of the solenoid, a brush connected to said core for coöperation

with both of the commutators, and circuit connections whereby an increase of energization of the solenoid throws resistance in the subsidiary circuit and cuts out sections of the solenoid.

2. In a system of electrical distribution wherein the potential difference of the main circuit varies, a main circuit, a subsidiary circuit having a group of translating devices connected therein, a variable resistance in series with the group of translating devices, a sectional solenoid permanently connected in parallel circuit with the translating devices, and mechanical means whereby said solenoid automatically varies the resistance and coincidently the number of its coil sections in circuit according to the varying potential strength of the main circuit in parallel with the subsidiary circuit.

3. In a system of electrical distribution, a main circuit, a subsidiary circuit having translating devices connected therein in parallel relation, a variable resistance in series with the group of translating devices, a means for varying the resistance to include substantially all of the resistance in circuit when said circuit is first energized, and a means for reversing the direction of the current through said resistance after the circuit has been energized.

4. In a system of electrical distribution, a main circuit and a subsidiary circuit, translating devices in parallel in the subsidiary circuit, a variable resistance in series in the subsidiary circuit, a sectional solenoid structure for varying said resistance, and means for automatically varying the energized portion of the solenoid coincidently with variation of the resistance.

5. In a system of electrical distribution, a main circuit, a subsidiary circuit having translating devices in parallel relation, a resistance in series with said subsidiary circuit, a solenoid coil composed of a series of coil sections all of which are normally in said subsidiary circuit, parallel with said translating devices, a core for said solenoid, a commutator to which said sections are connected, and a brush secured to the core and associated with said commutator sections automatically to throw resistance in series with said translating devices and cut out sections of said solenoid.

6. In a system of electrical distribution, a main circuit, a subsidiary circuit having translating devices in parallel relation, a resistance provided with a sectional commutator, in series with said subsidiary circuit, a solenoid composed of a series of sections, a commutator to which said sections are connected in regular order, a solenoid core responsive to said solenoid coil, and a circuit controller connected to said core cutting said resistance into the circuit coincidently with cutting out the solenoid sections.

7. In a system of electrical distribution, a controller comprising a solenoid coil divided into a plurality of sections, a commutator having a series of sections decreasing in length in the order of their remoteness from the coil, said commutator sections and coil sections connected together respectively in the same order, a coacting commutator brush controlled by the core, for imparting current to said coil commutator, and a rheostat.

8. The combination of a solenoid composed of a plurality of sections, a core responsive to energization of the solenoid, a resistance composed of a plurality of sections, suitable means for varying the number of said resistance and solenoid sections to be included in circuit associated with the core for operation thereby, a circuit, suitable circuit connections whereby a constant potential is maintained in a portion of the circuit by operation of said solenoid, and electrical means responsive to a predetermined current for reversing the connection of the resistance with the circuit.

In testimony whereof I hereunto set my hand in the presence of two witnesses.

WILLIAM H. CLARKE.

In the presence of—
FORÉE BAIN,
MARY F. ALLEN.