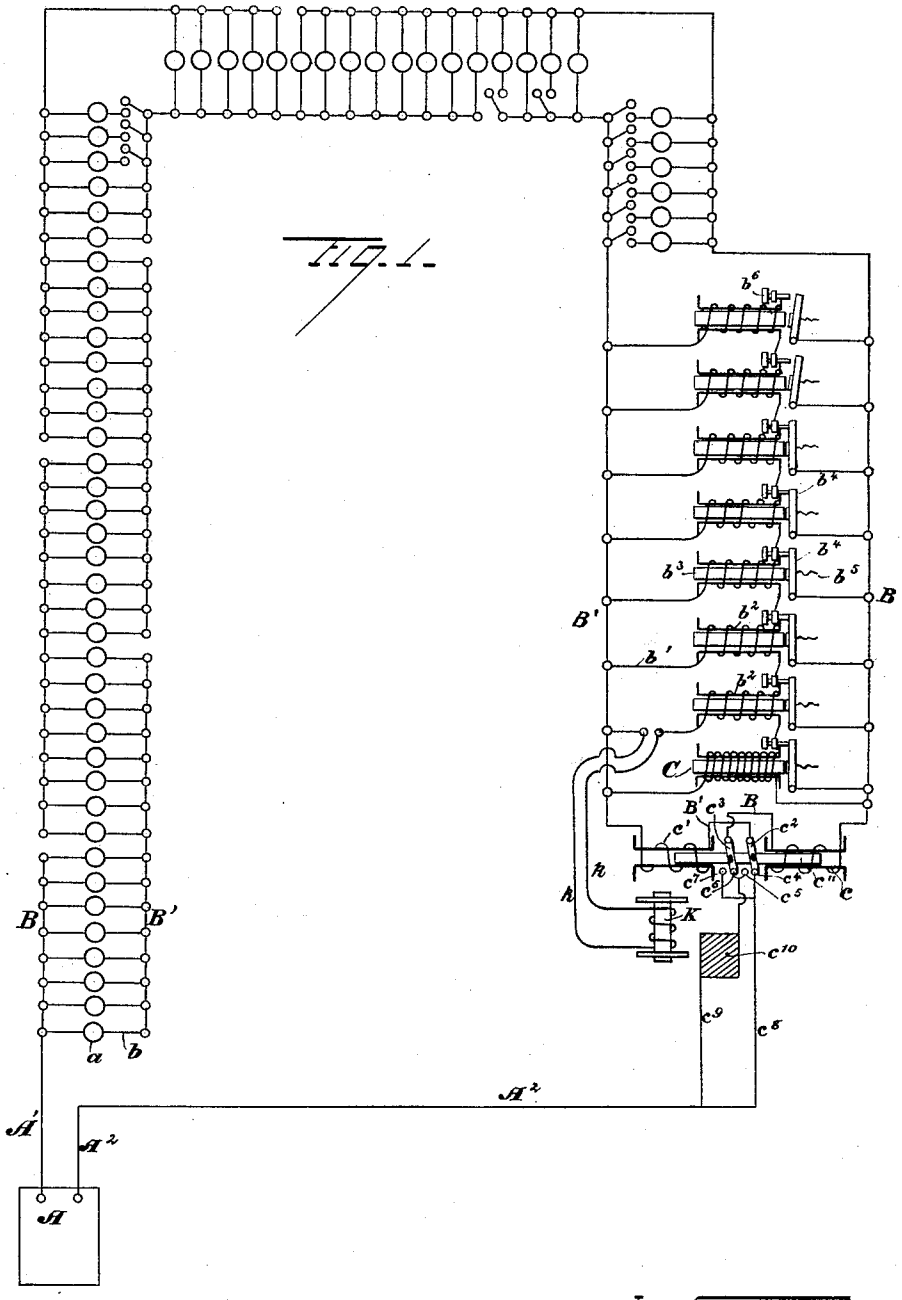
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H. P. BROWN.

SYSTEM FOR OPERATING INCANDESCENT LAMPS.

No. 325,391. Patented Sept. 1, 1885.



Witnesses

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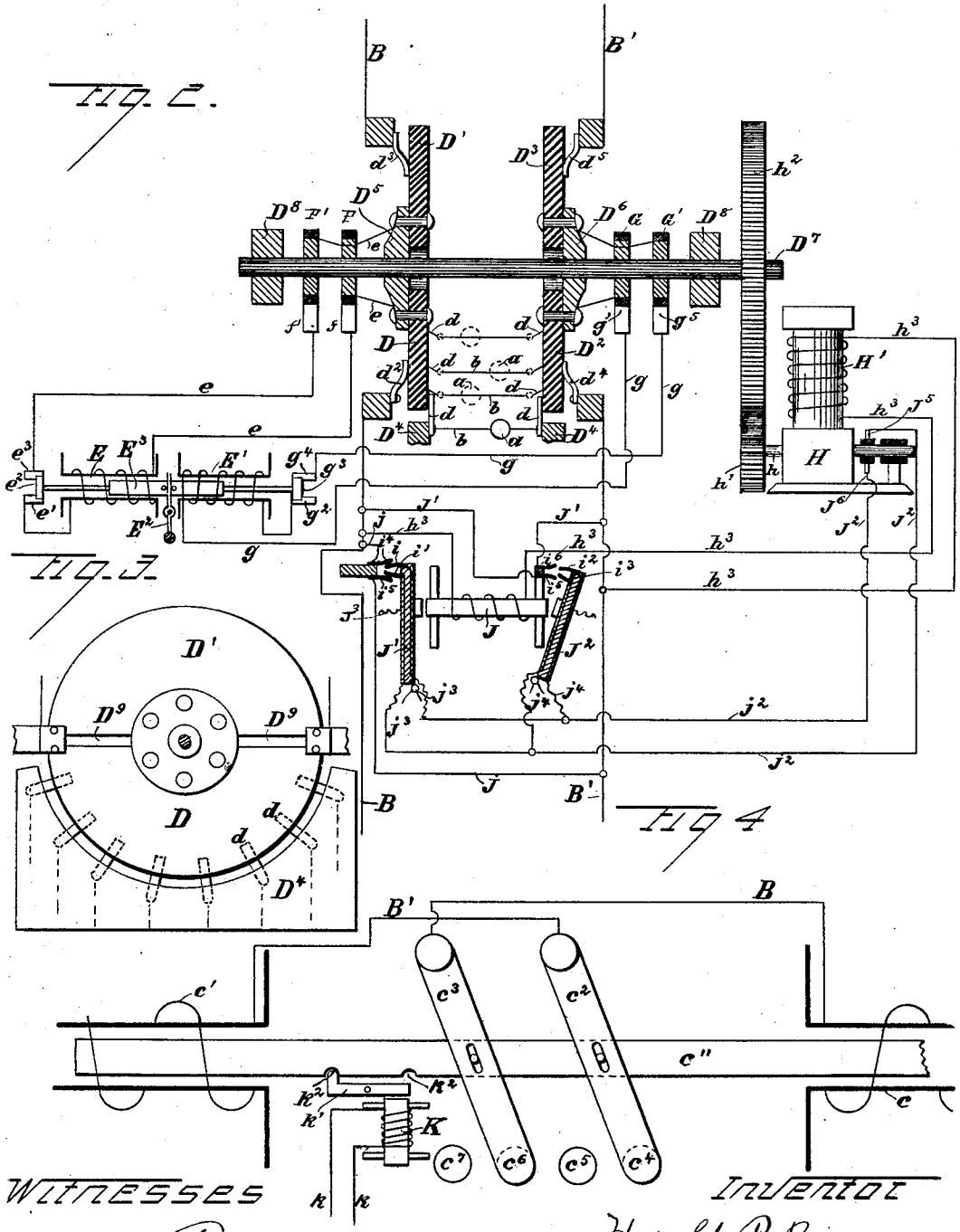
N. PETERS, Photo-Lithographer, Washington, D. C.

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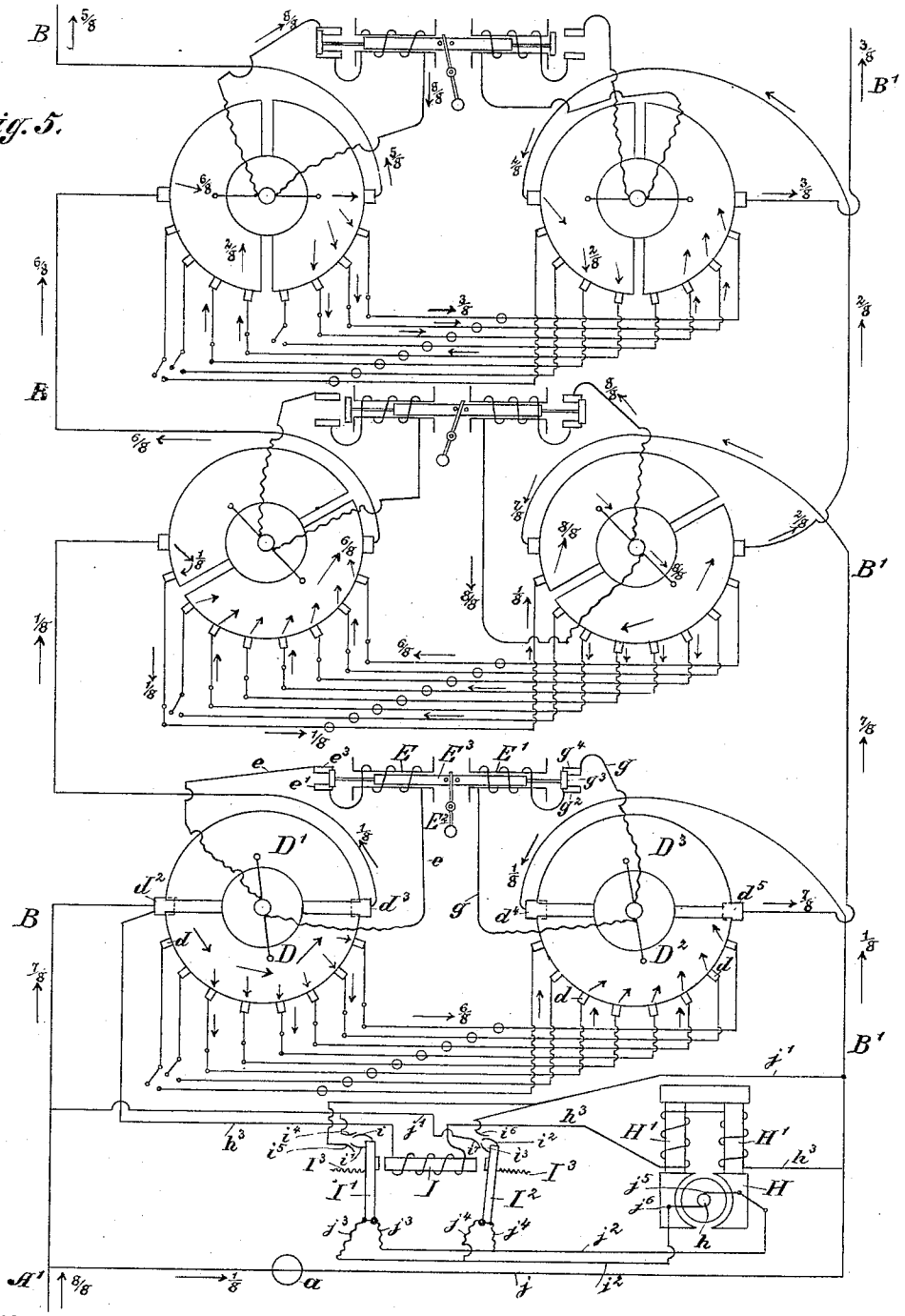
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Fig. 5.



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UNITED STATES PATENT OFFICE.

HAROLD P. BROWN, OF CHICAGO, ILLINOIS.

SYSTEM FOR OPERATING INCANDESCENT LAMPS.

SPECIFICATION forming part of Letters Patent No. 325,391, dated September 1, 1885.

Application filed February 13, 1885. (No model.)

To all whom it may concern:

Be it known that I, HAROLD P. BROWN, a citizen of the United States, residing in Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Systems for Operating Incandescent Lamps, of which the following is a specification.

Heretofore incandescent lamps have ordinarily been operated in parallel from a quantity current; but this method requires very large and expensive conductors, and the current can even then be carried only a very limited distance. Incandescent lamps have heretofore, however, also been operated by a high-tension current, which of course can be carried long distances by comparatively small and inexpensive conductors, the lamps being arranged in multiple—that is to say, the lamps being in parallel prearranged groups—while the separate groups themselves are in "series." Under this latter system, whenever any one or more of the lamps in each group is not in use, its resistance must be replaced by suitable devices, as otherwise the remaining lamps in use in each group would receive more than their proper share of the current and be speedily destroyed. As much electric energy is therefore required to operate one lamp in each group as to operate them all, and this system is consequently not well adapted to lighting economically from a single main circuit a number of dwelling-houses and other buildings in a city wherein all the lamps are not generally required to be in use at once.

I overcome this difficulty or objection—and herein my invention primarily consists—by arranging all the lamps in automatically-adjustable groups, so that, whatever number of lamps may happen to be in use at one time, they will always be automatically divided into such number of groups as their number will form, the groups themselves being arranged in series, and the fraction of a group, if any, being left over at the end near the return-terminal of the main-wire circuit. The resistance of the remaining lamps in such fractional group is compensated for by means of a shunt-circuit having an automatically-variable resistance to correspond to the number of lamps in such fractional group, or by means of a group of resistance-coils, one or more of which are put in parallel with the lamps of the fractional group, as may be required. As some of the lamps are extinguished or additional ones lighted the groups are instantly and automatically rearranged. The lamps are all arranged in the usual manner on cross-wires extending between the two parallel legs or conductors of the main circuit. Each time the number of the groups in the series changes by the lighting or extinguishment of some of the lamps the connection of the return-terminal leading to the generator shifts from one of the two legs or conductors between which the lamps are arranged to the other—that is to say, when there is an odd number of groups, counting the fractional group, if any, the return-terminal is connected to one of the two parallel conductors, and when there is an even number of groups in the series it is connected to the other parallel conductor. By thus shifting the terminal from one parallel conductor to the other as an additional group is added or taken away the current is forced to pass through all the groups in series.

In the accompanying drawings, which form a part of this specification, and in which similar letters of reference indicate like parts, Figure 1 is a diagram view of an arrangement of circuits partially embodying my invention and showing the lamps arranged in multiple arc or parallel groups between the two legs or conductors of the main-wire circuit, the solenoid and switch for shifting the return-terminal of the main circuit to one leg or other of the parallel conductor, and the variable resistance to compensate for the remaining lamps of a fractional group. In this figure, for sake of clearness, the device for shifting the lamps from one group to another, the motor for operating the same, and also the switch and its operating-solenoid for breaking connection in one leg or the other of the parallel conductor between the separate groups, are omitted. Fig. 2 is a diagram view showing the device and its motor for shifting the lamps from one group to another, the relay or controlling-magnet for putting said motor in operation, and the switch and its operating-solenoid for automatically grouping the lamps or breaking connection in one leg or the other of the parallel conductor, so as to divide the

lamps on each side of the break into different groups. This figure also shows the arrangement of circuits and connections of these different parts or devices with the two legs of the conductor, between which the lamps are arranged. Fig. 3 is a side elevation of the device for shifting lamps from one group to another, said device consisting, as shown, of two semicircular insulated disks in each leg of the parallel conductor, with which the lamps are connected by suitable brushes or contact-pieces. These two insulated half-disks in each leg, it will be seen from Fig. 2, are connected together through a switch. If a break occurs at this switch, the lamps connected with one of these half-disks will be in a different group from those connected with the other half-disk; and it is obvious that by turning the half-disks a lamp or lamps may be shifted from one group to the other. Fig. 4 is a detail view of the switch and its operating-solenoid, which shifts the return-terminal of the main circuit to one leg or the other, according as the total number of groups in the series is odd or even. Fig. 5 is a diagram view illustrating the arrangement of circuits and showing three groups of lamps, with the two semi-disks in each leg of the parallel conductor extended flat, so that the arrangement of circuits and operation can be more clearly seen. In this figure it will be observed that though three groups are shown, the motor and its controlling-magnet are shown only for the lower group, the same for the other two groups being omitted for lack of space. These parts and their connections are the same for each group. In this figure it will be observed that only a portion of the lamps in each of the three groups are in use, the switches of two of the lamps being open in the lower group, one in the middle group, and three in the upper group, and the semi-disks are shown turned in different positions, and with a break at the switch connecting the two semi-disks of the middle group (in the left-hand leg) and with a break between the two right semi-disks of the upper group, so as to properly divide into groups all the lamps which happen to be in use. I have also marked on this figure the fraction of the current on each leg of the conductor at different points and indicated its direction by arrows.

As will be seen from the drawings, the cross-wires for the lamps of each group or separate building are connected to an electro-motive circuit making and breaking device operated by the currents passing through the two legs of the parallel conductor between which the lamps are arranged, and which serve to automatically divide or arrange the lamps into the required groups by breaking connection on one or the other leg of the parallel conductor at the proper place. When an additional lamp is lighted in any group, this electro-motive device operates to put the last lamp of such group into the next succeeding group, thus causing a like change in each of the following groups. When a lamp in any group is extinguished, this electro-motive circuit making and breaking device operates to put the first lamp in the succeeding group into the preceding group.

My invention also consists in the novel devices, combinations, and arrangement of mechanisms I have devised for practicing or carrying out my improved system or method.

In the drawings, A may represent a dynamo-machine, or other generator; A′, one terminal of the main circuit, and A^2 the return-terminal of the same. B and B′ are the two legs of the parallel conductor between which the incandescent lamps or other translating devices *a* are arranged on suitable cross-wires, *b*.

In the drawings I have represented for convenience the lamps as being arranged in groups of eight. It will, however, be understood, that the number of lamps in each parallel group may be varied according to the energy of the current generated. Ordinarily I deem it preferable to use a current of sufficient power to operate twenty lamps in a parallel group.

Between the parallel conductors B and B′ at the end thereof, or near the return-terminal, I arrange in parallel on cross-wires *b*′, like the lamps, a number of resistance-coils, b^2, corresponding to the number of lamps in the group, and also a high-resistance electro magnet C, the coil of which remains permanently in circuit. Each of the resistance-coils b^2 has a core, b^3, and an armature-lever, b^4, provided with a spring, b^5. The armature-lever b^4 of the high-resistance magnet C and its contact-piece b^6 are in circuit with the cross-wires *b*′ of the first or lower resistance-coil, b^2, and the armature-lever b^4 and contact-piece b^6 of the first resistance-coil b^2 are in circuit with the next succeeding resistance-coil, and so on. The spring b^5 of each succeeding armature-lever, is slightly stronger than its preceding one, so that the last resistance-coil will always be cut out first, as the last armature-lever will be pulled back first when the current falls below its normal strength. Whenever the number of lamps lighted forms only a fraction of a group or one or more groups and a fraction of a group over, one or more of the resistance-coils b^2 are put in parallel with the lamps of such fractional group to compensate for the resistance of the remaining or unlighted lamps of the fractional group. When one of the lamps is extinguished, the amount of current passing through the resistance-coils is increased, thus causing the last resistance-coil to pull up its armature and put the next resistance-coil in the group. When an additional lamp is lighted, the current through the resistance-coils is diminished and the last armature-lever is pulled back, thus cutting out the last resistance-coil. As the coil of the high-tension electro-magnet C remains always in circuit, it will always be in position to operate the armature-lever b^4

and put the first resistance coil in circuit whenever required.

The legs B B′ of the parallel conductor are each connected to the return-terminal A^2 through the coils c c' of a double solenoid and switch-lever c^2 c^3, contact-pieces c^4 c^5 c^6 c^7, and branch wires c^8 c^9. One of the branch wires, c^8, offers a free course for the current, but the other, c^9, has a very high resistance, c^{10}, therein, so that only a very small fraction of the current can take this course. The switch-levers c^2 c^3 are operated by the movable core c^{11} of the double solenoid to shift the connection of the return-terminal through the branch wire c^8 from one leg to the other whenever the total number of groups is changed by the lighting or extinguishment of some of the lamps. To accomplish this result, the core of the solenoid is adjusted so as to move to the right or left, according as nearly the whole of the current is on one or the other leg of the parallel conductor, and consequently passing through one or the other coil of the double solenoid.

D D′ and D^2 D^3 are the two pairs of insulated revolving half-disks forming part of the two legs of the parallel conductor, and to which the cross-wires b of each group of lamps or the lamps of each building are connected through the contact-strips d. These contact-strips for each group are all arranged on a little less than a semi-circle, on the insulator-pieces D^4 D^4, so that by revolving the disks all of the lamps may be arranged between the disks D D^2 or D′ D^3, or part between the former and part between the latter, as may be required in adjusting or dividing into groups the total number of lamps in the electric circuit. These revolving semi-disks are secured to the insulating-plates D^5 D^6, mounted on the shaft D^7, which is journaled in suitable bearings D^8 on the frame. Connection is made by the contact strips or brushes d^2 d^3 between the leg B of the parallel conductor and the half-disks D D′, and by the brushes d^4 d^5 between the leg B′ and the half-disks D^2 D^3. Connection is made between the half-disks D D′ through a wire, e, leading from half-disk D to insulated ring F, brush f, coil E of a double solenoid, contact-piece e', switch e^2, contact-piece e^3, brush f', insulated ring F′, and thence back to half-disk D′. The connection between the half-disks D^2 D^3 is made in the same manner through a wire, g, leading from half-disk D^2 through insulated ring G, brush g', other coil E′ of the double solenoid, contact g^2, switch g^3, contact g^4, brush g^5, insulated ring G′, and thence back to half-disk D^3. The double solenoid is so adjusted by means of a spring or weighted lever, E^2, that its core E^3, which operates the switch or contact-pieces e^2 and g^3, will remain stationary in its middle position when a greater fraction of the current than that required for one lamp is on each leg of the parallel conductor and passing through the coils E E′ of the solenoid; but whenever a less fraction of the current is passing through one of its coils the core will be thereby pulled toward the coil of the solenoid having the greater share of the current, and thus cause the switch e^2 or g^3 to break connection at e' e^3 or at g^2 g^4, and thus divide the lamps connected between the half-disks D D^2 and those connected between the half-disks D′ D^3 into different groups. The function and purpose of the double solenoid E E′ E^3 and the switches e^2 g^3 operated thereby, it will thus be seen, is to automatically group the lamps or make a division between groups by breaking connection on one leg or the other of the parallel conductor, as may be required.

The half-disks D D′ D^2 D^3 are revolved backward or forward to increase or diminish the number of lamps in the group, as may be required from time to time as lamps are lighted or extinguished, by means of a small electric motor, H, the driving-shaft h, of which is provided with a gear, h', that meshes with a gear, h^2, on the revolving disk-shaft D^7. The field-magnet H′ of this motor is connected with the two legs B B′ of the parallel conductor by a cross-wire, h^3, that extends from one leg to the other, like the lamp-wires, and it remains constantly in circuit. On this same cross-wire h^3, in series with the field of the motor, is also an electro-magnet, I, provided with armature-levers J′ J^2—one at each end of its core—each of which is provided with two insulated contact-pieces, i i' and i^2 i^3. The contact-pieces i i' register with two corresponding insulated contact-pieces, i^4 i^5, connected by the cross-wire j with the legs B B′ of the parallel conductor, and the contact-pieces i^2 i^3 register with the contact-pieces i^6 i^7, which connect through the cross-wire j' extending between the legs B′ B. The circuit-wire j^2 of the motor-armature is connected through the wires j^3 j^4, with the contact-pieces on each of the levers J′ J^2. The spring J^3 of the armature-lever I′ is of such tension as to pull the lever back when the magnet J falls below its normal force—that is to say, when too many lamps are in the group—and thus make connection between the contacts i and i^4 and between i' and i^5, thereby putting the armature of the motor in circuit, the current passing in the direction necessary to cause the motor to revolve the half-disks D D′ D^2 D^3 backward or in the direction to shift the last lamp in the group into the next succeeding group. When the lamps in the group are two few, the force of the magnet J will be increased above its normal condition, thus pulling up the lever J^2 and putting the armature of the motor in circuit; but this time the current will pass in the opposite direction through the motor-armature—that is to say, in at the upper brush, j^5, and out at the lower brush, j^6—and thus revolve the armature-shaft in the opposite direction from before and turn the disks D D′ D^2 D^3 forward instead of backward, and move the first lamp of the succeeding into the preceding group.

The contact strips or brushes d^2 d^3 d^4 d^5 are

made wider than the space or insulation between the half-disks D D′ and D^2 D^3, so that as the half-disks revolve there may be no break when the brushes are opposite the space D^9 between the half-disks; and by this arrangement when the half-disks stand in the position shown in Fig. 3 the solenoid E E′ will be short-circuited, thus allowing the weighted lever E^2 to restore the core E^3 to its middle position, and several contact-connections are thereby also avoided. The brushes or strips *d* are made narrower than the space D^9, so that they cannot be in contact with both half-disks D and D′ at the same time.

As shown in Fig. 5, six lamps are represented as being in use or operation between the two lower half-disks, D D^2, and none between the two half-disks D′ D^3 of this lower group or set. One lamp *a*, or it may be a fixed resistance equal to one lamp, is shown below the six lamps of this lower set. In the middle set one lamp is shown in use between the upper pair of half-disks, D′ D^3, and six lamps in use between the two lower half-disks, D D^2. In the top set two lamps are in use between the left-hand half-disks, and three between the right-hand half-disks. Nineteen lamps in all are thus represented in use, forming two complete groups of eight lamps each, and a fractional group of three lamps. The course of the current is as follows: One-eighth of it passes from B to B′ through the lower lamp or resistance *a;* six-eighths of it passes from the half-disk D to the half-disk D^2 through the six lamps of the lower set; and one-eighth of it passes from the half-disk D′ to the half-disk D^3 of the middle set through the first or bottom lamp of that set, thus making eight lamps in the group between which the current has divided. The current then passes back again from B′ to B, six-eighths of it through the six lamps of the middle set, which connect with the lower half-disks D^2 D thereof, and two-eighths of it through the two lamps which connect with the two left-hand half-disks D^3 D′ of the upper set, thus making the eight lamps of the second complete group. The division between the first and second groups is made by the full current passing from the half-disk D^3 of the middle set, to the half-disk D^2 of said set through the right-hand coil, E′, of the double solenoid, thus pulling the core to the right and breaking connection at the switch between the half-disks D D′ of the middle set. In the same way the division between the second and third groups is made on the right-hand side, or in the leg B′, by connection being broken between the half-disks D^2 D^3 of the upper set by reason of the full current passing from the half-disk D of the upper set to the half-disk D′ of said set through the left-hand coil, E, of the double solenoid.

In order to hold the four-point switch in position and prevent the core c^{11} of the double solenoid from moving, except at the proper time—that is to say, not until after the number of groups have been changed by the group dividing or adjusting mechanism, before described—I provide a little electro-magnet, K, the coil of which is connected by the wire *k* with the cross-wire *b′* of the first resistance-coil b^2. This magnet has a pivoted armature-lever, *k′*, that engages in notches k^2 in the core of the solenoid whenever the current is passing through the cross-wire *b′*, but which drops away the moment the current through the coil b^2 of the first resistance-coil ceases, as it does every time the fractional group is completed or the number of groups in the entire circuit is changed. As soon as this armature-lever *k′* drops away the core of the solenoid moves to the other side, and thus shifts the switch-levers so as to connect the return-terminal with the other leg of the parallel conductor, as hereinbefore described.

It will thus be seen, according to my invention, a lamp is automatically shifted from one group to the adjoining group in front or rear when required, by means of the two revolving semicircular disks in or forming part of each of the two legs of the parallel conductor. These two revolving semi-disks in each leg are insulated from each other, the connection between the two being through a switch or a contact maker and breaker, so that when required the two half-disks may be automatically arranged in the same group or in adjoining groups. The lamps or their cross-wires for each group or building are all connected with these two pairs of revolving half-disks in the two legs of the parallel conductor by suitable brushes or contact-strips pressing against the disks, all the strips being arranged on a little less than half the circumference of the two semi-disks, so that by revolving the semi-disks all the lamps may be connected with one or the other semi-disk or part with each, as may be required. Whenever the two semi-disks are in different or adjoining groups, by revolving them one way or the other it will be seen lamps may be shifted or changed from one group to the other, as may be required to maintain the proper number of lamps in the preceding group. When the two half-disks are both in the same group, their revolution of course makes no change in the grouping of the lamps.

The half-disks are revolved in either direction by means of a small electric motor, the field of which is connected with a cross-wire extending between the two legs of the parallel conductor, like the lamp-wires, and which remains constantly in circuit. A high-resistance electro-magnet is also arranged on this cross-wire, so that only a small fraction of the current will pass through the field-magnet of the motor. The armature-magnet of the motor is also connected with a cross-wire extending between the two legs of the parallel conductor; but the ends of this cross-wire are connected with the opposite legs of the parallel conductor, through two switch-levers, so that the direction of the current through the armature of the motor may be one way or the other, accord-

ing as the connection is made through one of these switch-levers or the other, and the armature-circuit is broken when connection is made through neither one of these switch-levers. These switch-levers are operated by the high-resistance electro-magnet in circuit with the field of the motor. One of these switch-levers is drawn up by said magnet so as to make connection or complete the circuit through the armature of the motor when there are too few lamps in the group, and therefore more than the normal amount of current passing through said magnet, and thus cause the motor to turn the half-disks forward or in the direction necessary to increase the number of lamps in the group. On the other hand, when there are too many lamps in the group, the current passing through this high-resistance magnet falls below its normal amount, thus causing the other switch-lever to drop away from its normal position, make connection, and complete the circuit, so that the current will pass in the opposite direction through the armature of the motor, and thus revolve the half-disks backward, or in the direction necessary to diminish the number of lamps in the group. When the proper number of lamps in the group is again attained, the normal amount of current is flowing through the high-resistance magnet, and both of these switch-levers occupy the position to break the circuit through the armature of the motor, so that the motor-shaft and the revolving half-disks driven by it remain stationary.

Connection is made between the two half-disks on each leg of the parallel conductor through a wire connected with one coil of a double solenoid, the core of which operates a switch or contact-piece, through which also the current passes, and which breaks connection on one or the other leg of the parallel conductor, as may be required, to divide the lamps into the necessary groups. This double solenoid is so adjusted that when there is a less fraction of the current than that necessary to operate one lamp on one leg of the parallel conductor and passing through one coil of the solenoid, and a greater fraction of the current than that necessary to operate all the lamps but one of the group on the other leg of the parallel conductor and passing through the other coil of the solenoid, that the core of said solenoid will be pulled to one side, and thus break connection between the revolving half-disks on that leg of the parallel conductor having the small fraction of the current, and thereby make a division between groups at such point. When the current passing along each leg of the parallel conductor is a greater fraction than that required for one lamp, the core of the double solenoid remains in its middle position, so that there is no break between the two half-disks on each leg of the parallel conductor.

I have shown in the drawings the variable resistance as consisting of the coils b^2, arranged in parallel between the legs B B', like the lamps, as this is a convenient way of compensating for the resistance of the remaining lamps of the fractional group, if any; but this variable resistance may be otherwise arranged.

It should also be observed that while the revolving half-disks D D' D^2 D^3 constitute the most improved form of my invention, still other movable contact-pieces for shifting lamps from one group to another—as, for example, sliding contact-pieces—may be employed; and though the contact-pieces D D' D^2 D^3 have for convenience been called in this specification "half-disks," it will of course be understood that these contact-pieces when made in the form of disks may be a greater or less part of a disk than one-half. Nor is my invention limited to any particular kind of switches or electro-motive devices. A small electric motor I, however, deem to be much the more convenient way of operating the contact-pieces D D' D^2 D^3.

I claim—

1. The combination, with a main circuit having two legs or conductors, of a number of incandescent lamps or other translating devices arranged between said legs in a series of adjustable or shifting groups, as contradistinguished from fixed or prearranged groups, so that the number of groups may change from time to time according to the number of lamps actually in use, substantially as specified.

2. A main circuit having two legs or conductors, a number of incandescent lamps arranged in groups between them, an electro-motive device actuated by the current passing on said legs, and a switch operated thereby to break connection on one of said legs when the fraction of the current thereon falls below that required for one lamp in the group, and thus automatically divide the lamps into groups, substantially as specified.

3. The combination of a main circuit having two legs or conductors with a number of incandescent lamps arranged in groups between them, an electro-motive device actuated by the current passing on said legs, a switch operated thereby to break connection on one of said legs when the fraction of the current thereon falls below that required for one lamp, and a variable resistance to compensate for the resistance of the remaining lamps of a fractional group, substantially as specified.

4. The combination, with a main circuit having two legs or conductors, of a number of incandescent lamps or other translating devices arrranged between said legs in a series of adjustable or shifting groups, as contradistinguished from fixed or prearranged groups, so that the number of groups may change from time to time according to the number of lamps actually in use, and a switch for shifting the return-terminal of said main circuit from one of said legs to the other when the number of groups is changed, substantially as specified.

5. The combination of a main circuit hav-

ing two legs or conductors with a number of incandescent lamps arranged in groups between them, and an electro-motive device actuated by the current passing on said legs, a switch operated thereby to break connection on one of said legs, when the fraction of the current thereon falls below that required for one lamp, and a switch for shifting the return-terminal of the main circuit from one of said legs or conductors to the other when the number of groups is changed, substantially as specified.

6. The combination of a main circuit having two legs or conductors with a number of incandescent lamps arranged in groups between them, an electro-motive device actuated by the current passing on said legs, a switch operated thereby to break connection on one of said legs when the fraction of the current thereon falls below that required for one lamp, and a variable resistance to compensate for the resistance of the remaining lamps of a fractional group, and a switch for shifting the return-terminal from one of said legs to the other, substantially as specified.

7. The combination, with a main circuit having two legs or conductors, of a number of incandescent lamps or other translating devices arranged between said legs in a series of automatically adjustable or shifting groups, as contradistinguished from fixed or prearranged groups, so that the number of groups may change from time to time according to the number of lamps actually in use, a switch for shifting the return-terminal from one of said legs to the other when the number of group is changed, and an electro-motive device actuated by the current on said legs for operating said switch, substantially as specified.

8. The combination of a main circuit having two legs or conductors with a number of incandescent lamps arranged in groups between them, an electro-motive device actuated by the current passing on said legs, a switch operated thereby to break connection on one of said legs when the fraction of the current thereon falls below that required for one lamp, and a variable resistance to compensate for the resistance of the remaining lamps of a fractional group, and a switch for shifting the return-terminal from one of said legs to the other, and an electro-motive device actuated by the current on said legs for operating said switch, substantially as specified.

9. The combination of a main circuit having two legs or conductors with incandescent lamps arranged in groups between them, said lamps being connected to said legs through movable contact-pieces or disks, so that by moving said contact-pieces or disks lamps may be shifted from one group to another, substantially as specified.

10. The combination of a main circuit having two legs or conductors with a number of incandescent lamps arranged in groups between them, a pair of revolving half-disks in each of said legs or conductors, brushes connecting lamps with said disks, a switch to make or break connection between the two half-disks in each leg or conductor, and an electric motor to revolve said half-disks to shift lamps from one group to the other, substantially as specified.

11. The combination, with two parallel conductors, of two or more groups of incandescent lamps arranged between them, and means for shifting the lamps or their connections from one group to the other, substantially as specified.

12. The combination, with two conductors, of two or more groups of incandescent lamps, and movable contact-pieces to which a number of lamps are connected, and an electro-motive device for moving said contact-pieces to shift the lamps from one group to another, as may be required, substantially as specified.

13. The combination, with a main circuit having two legs or conductors, of two or more groups of incandescent lamps arranged between them, means for shifting the lamps or their connections from one group to another, automatic electric switches to make or break connection in each of said legs or conductors, and an automatic electric switch to shift the connection of the return-terminal from one of said legs or conductors to the other when the number of groups is changed, substantially as specified.

14. The combination of a main circuit having two legs or conductors with a number of incandescent lamps arranged in groups between them, a pair of revolving half-disks in each of said legs or conductors, brushes connecting lamps with said disks, a switch to make or break connection between the two half-disks in each leg or conductor, and an electric motor to revolve said half-disks to shift lamps from one group to the other, and a switch to change the return-terminal from one of said legs to the other, substantially as specified.

15. The combination of main circuit A, having legs or conductors B B′, with lamps *a*, arranged in groups between them on cross-wires *b*, revolving half-disks D D′ D^2 D^3, double solenoid E E′, having its coils connected with said half-disks, switches e^2 and g^3, electric motor H, having its field H′ connected with said parallel conductors, electro-magnet I, having armature-levers I′ I^2, provided with switches adapted to make connection with the armature-magnet of said motor and pass the current in opposite directions through said armature-magnet, according as connection is made through one or the other of said levers I′ I^2, substantially as specified.

16. The combination of a main circuit, A, having legs or conductors B B′, with lamps *a*, arranged in groups between them on cross-wires *b*, revolving half-disks D D′ D^2 D^3, double solenoid E E′, having its coils connected with said disks, switches e^2 and g^3, electric motor H, having its field H′ connected with said parallel conductors, electro-magnet I, having

armature-levers I' I², provided with switches adapted to make connection with the armature-magnet of said motor and pass the current in opposite directions through said armature-magnet, according as connection is made through one or the other of said levers I' I², and a solenoid, *c c'*, switch c^2 c^3, substantially as specified.

17. The combination of a main circuit, A, having legs or conductors B B', with lamps *a*, arranged in groups between them on cross-wires *b*, revolving half-disks D D' D² D³, double solenoid E E', having its coils connected with said disks, switches e^2 and g^3, electric motor H, having its field H' connected with said parallel conductors, electro-magnet I, having armature-levers I' I², provided with switches adapted to make connection with the armature-magnet of said motor and pass the current in opposite directions through said armature-magnet, according as connection is made through one or the other of said levers I' I², and a solenoid, *c c'*, switch c^2 c^3, electro-magnet C, and resistance-coil b^2, having cores b^3, and switch-lever armatures b^4, substantially as specified.

18. The combination of a main circuit, A, having legs or conductors B B', with lamps *a*, arranged in groups between them on cross-wires *b*, revolving half-disks D D' D² D³, double solenoid E E', having its coils connected with said disks, switches e^2 and g^3, electric motor H, having its field H' connected with said parallel conductors, electro-magnet I, having armature-levers I' I², provided with switches adapted to make connection with the armature-magnet of said motor and pass the current in opposite directions through said armature-magnet, according as connection is made through one or the other of said levers I' I², and a solenoid, *c c'*, switch c^2 c^3, electro-magnet C, and resistance-coil b^2, having cores b^3 and switch-lever armatures b^4, and electro-magnet K, connected with the first resistance-coil, and having armature-lever *k*, engaging in notches in the movable core of said solenoid *c c'*, substantially as specified.

19. The combination of revolving half-disks D D' D² D³ with shaft D⁷, parallel conductors B B', and an electric motor, H, for revolving said shaft, substantially as specified.

20. The combination of revolving half-disks D D' D² D³ with shaft D⁷, parallel conductors B B', and an electric motor, H, for revolving said shaft, and an electro-magnet actuated by the current on said conductors B B' to reverse the direction of the current through said motor and turn said shaft in one direction or the other, as may be required, substantially as specified.

21. The combination of revolving half-disks D D' D² D³ with shaft D⁷, parallel conductors B B', and an electric motor, H, for revolving said shaft, an electro-magnet actuated by the current on said conductors B B' to reverse the direction of the current through said motor and turn said shaft in one direction or other, as may be required, and an electro-magnet, I, having armature-switch levers I' I² to start said motor in one direction or the other, according as the fraction of the current on one of said legs is greater or less than that required for one lamp, substantially as required.

22. The combination of parallel conductors B B', lamps *a*, half-disks D D' D² D³, solenoid E E', and switches operated thereby, motor H, electro-magnet I, having switch-levers I' I², substantially as specified.

23. The combination of parallel conductors B B', lamps *a*, half-disks D D' D² D³, solenoid E E', and switches operated thereby, motor H, electro-magnet I, having switch-levers I' I², resistance-coils b^2, and electro-magnet C, substantially as specified.

24. The combination of parallel conductors B B', lamps *a*, half-disks D D' D² D³, solenoid E E', and switches operated thereby, motor H, electro-magnet I, having switch-levers I' I², resistance-coils b^2, and electro-magnet C, and solenoid *c c'* and switches operated thereby, substantially as specified.

25. The combination of parallel conductors B B', lamps *a*, cross-wires *b*, revolving half-disks D D' D² D³, insulating-plates D⁵ D⁶, shaft D⁷, brushes *d* d^2 d^3 d^4 d^5, insulated rings F F' G G', brushes *f f' g g'*, and double solenoid E E' and switches operated thereby, substantially as specified.

26. The system or means of operating a number of incandescent lamps from a suitable source of electric energy, consisting in a main circuit having two parallel legs or conductors, a number of incandescent lamps connected between said conductors, means for opening the circuit in said conductors on alternate sides to arrange said lamps in a series of groups, and means for shifting lamps from one group to another, substantially as specified.

HAROLD P. BROWN.

Witnesses:
H. M. MUNDAY,
EDMUND ADCOCK.