J. P. CROUCH & J. ETCHELLS.

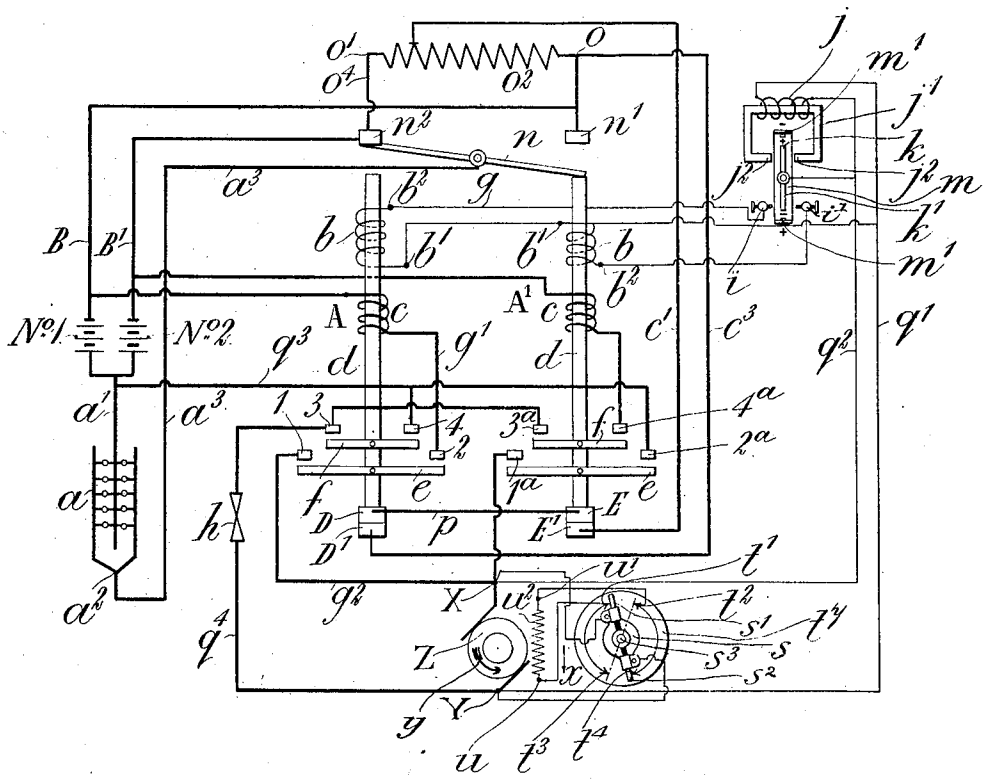
TRAIN LIGHTING SYSTEM.

APPLICATION FILED NOV. 27, 1909.

1,001,358. Patented Aug. 22, 1911.

4 SHEETS—SHEET 1.

Fig. 1.



Witnesses.
C. R. Wright, Jr.
V. A. Clagett.

Inventors.
J. P. Crouch
J. Etchells
by Hubert E. Pack
Atty.

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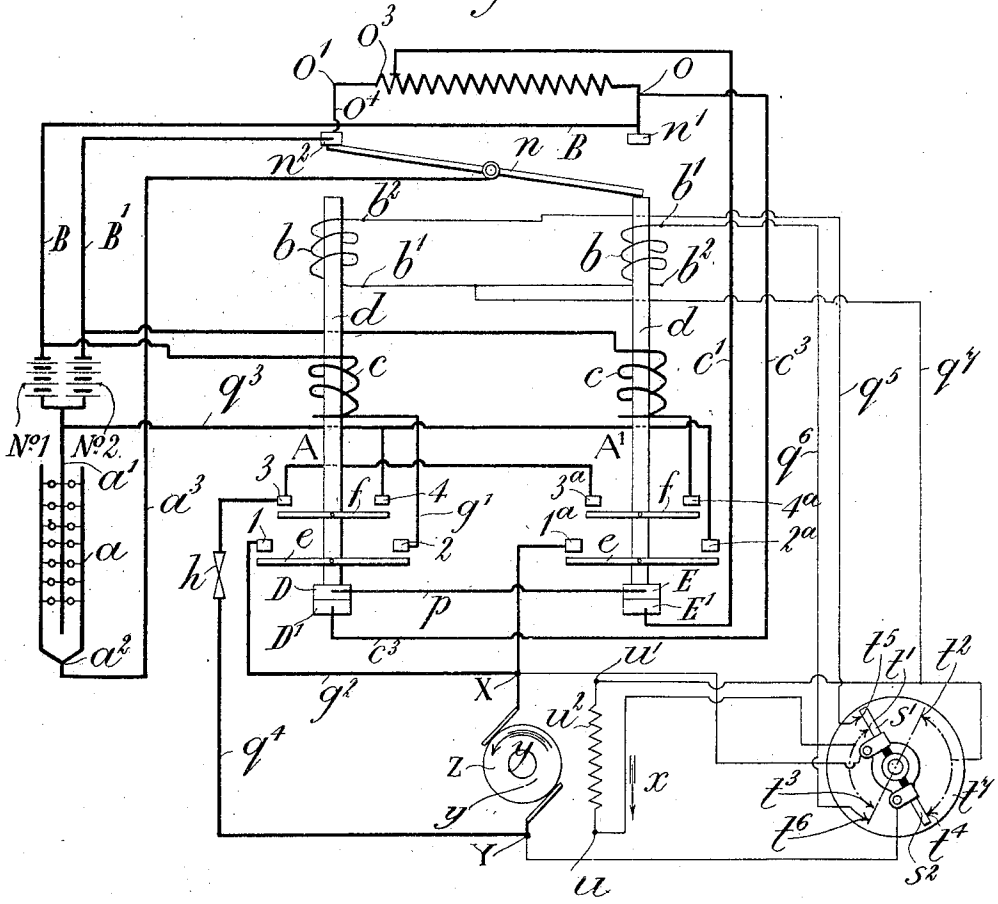
4 SHEETS—SHEET 2.

Fig. 2.



Witnesses
C. R. Wright, Jr.
V. A. Chappell

Inventors
J. P. Crouch
J. Etchells
by Hubert E. Paclp.
Atty.

J. P. CROUCH & J. ETCHELLS.

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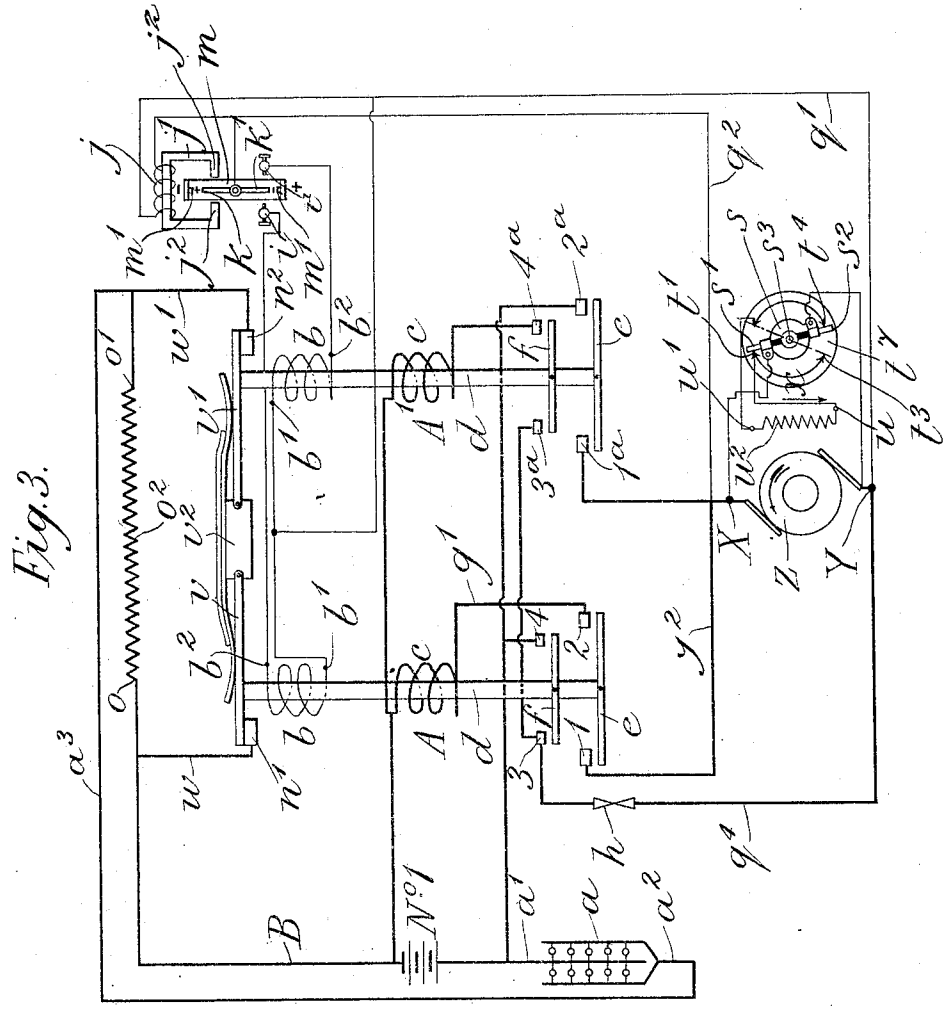
4 SHEETS—SHEET 3.

Fig. 3.



Witnesses.
C. R. Wright, Jr.
V. G. Cadwell.

Inventors.
J. P. Crouch
J. Etchells
by Hubert E. Peck
Atty

J. P. CROUCH & J. ETCHELLS.

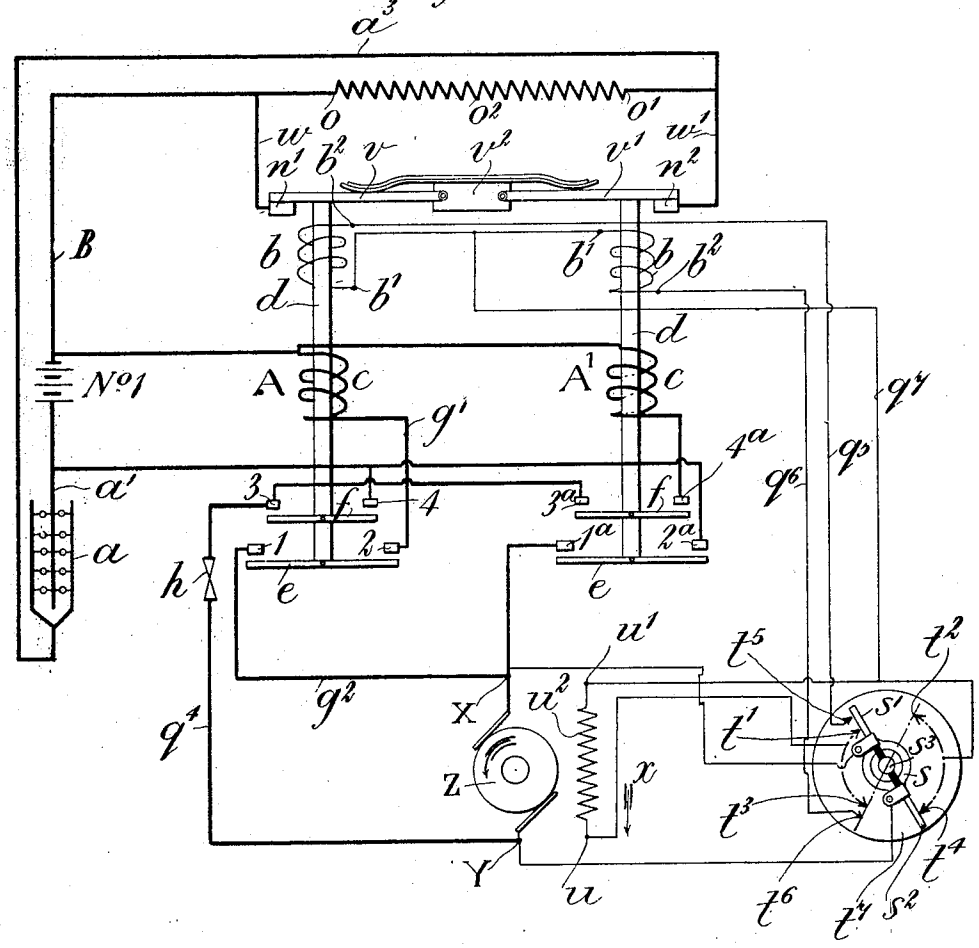
TRAIN LIGHTING SYSTEM.

APPLICATION FILED NOV. 27, 1909.

1,001,358. **Patented Aug. 22, 1911.**

4 SHEETS—SHEET 4.

Fig. 4.



Witnesses
C. R. Wright, Jr.
V. A. Claglett.

Inventors
J. P. Crouch
J. Etchells
by Hubert E. Pack
Atty.

UNITED STATES PATENT OFFICE.

JOHN PEACHEY CROUCH, OF NEWTON HEATH, AND JAMES ETCHELLS, OF MOSTON, MANCHESTER, ENGLAND.

TRAIN-LIGHTING SYSTEM.

1,001,358. Specification of Letters Patent. Patented Aug. 22, 1911.

Application filed November 27, 1909. Serial No. 530,212.

To all whom it may concern:

Be it known that we, JOHN PEACHEY CROUCH and JAMES ETCHELLS, subjects of the King of Great Britain and Ireland, residing, respectively, at Newton Heath, in the county of Lancaster, England, and Moston, Manchester, in the county of Lancaster, England, have invented Improvements in Train-Lighting Systems, of which the following is a specification.

This invention relates to train lighting and equivalent electric systems (herein included in the term train lighting systems), adapted to be supplied with secondary battery current and current from a reversible dynamo, which latter is adapted to charge the battery, and it has for its object to provide an arrangement embodying a main switch for each direction of rotation of the dynamo and means responsive to reversal of rotation of such dynamo for bringing the main switches into alternative use.

In the accompanying illustrative drawings, Figures 1 to 4 inclusive show diagrammatically various arrangements of switch apparatus embodying the invention. Fig. 1 shows an arrangement suitable for use with a shunt wound dynamo and two secondary batteries. Fig 2 shows a modified arrangement wherein a mechanically operated circuit controlling device is used. Figs. 3 and 4 show arrangements in which a single battery is used.

In the example shown in Fig. 1, the two secondary batteries No. 1 and No. 2 have one of their poles connected to one end of the lighting circuit a by a conductor a^1 and their other poles connected to two separate supply mains B, B^1 respectively. The electro-magnetic switch apparatus is constructed with two independent switches A and A^1 each of which comprises a shunt solenoid b, a series solenoid c, and a magnetic core d common to the two solenoids and carrying two movable switch contacts e, f that are insulated from each other and are adapted to respectively bear against two pairs of fixed insulated contacts viz. 1—2 and 3—4 in the case of switch A and 1^a—2^a and 3^a—4^a in the case of switch A^1, when the circuit of the shunt solenoid b of the corresponding switch is closed by a reversing switch hereinafter described to actuate the core d and close the main switch. One of the fixed contacts, say 1, against which the movable switch contact e of switch A bears, when the said switch is closed, is suitably connected, as by a conductor g^2, to one pole X of the dynamo Z, and the other contact, say 2, of the pair is connected, as by conductor g^1, to one end of the corresponding series solenoid c, the other end of which is connected to the supply main B. One of the fixed contacts, say 3, of the second pair of fixed contacts of switch A against which contact f bears, is connected to the second pole Y of the dynamo Z through a fuse h and a conductor q^4, and the second contact, say 4, of the second pair of contacts is connected by a conductor q^3 to that end of the lighting circuit a to which the conductor a^1 is connected. The corresponding fixed contacts 1^a, 2^a, 3^a and 4^a of the second main switch, viz. A^1, are arranged similarly to contacts 1, 2, 3, and 4 but while 1^a and 3^a are connected up like 1 and 3, contact 2^a is connected up like contact 4, and contact 4^a is connected to one end of the series solenoid c of such switch the other end of which is connected to the second supply main B^1.

One end b^1 of the shunt solenoid b of each of the main switches A, A^1 is connected to the second pole Y of the dynamo through a conductor q^1, the other ends b^2 of the two shunt solenoids being separately connected to two insulated stationary contacts i, i^1 of a reversing switch. This reversing switch comprises an electro-magnet j the winding of which is connected in shunt across the poles X Y of the dynamo Z through the conductors q^1 q^2. The core j^1 of the magnet has inwardly and oppositely arranged polar extensions j^2 between which is mounted to oscillate one arm k of a pivoted polarized armature the other arm k^1 of which is mounted to oscillate between the two stationary, and it may be adjustable, contacts i, i^1. The armature is connected to pole X of the dynamo through the conductor q^2. In order that the electro-magnet j shall not operate the armature k k^1 until a predetermined voltage, say one or two volts, exists between the poles of the dynamo, the armature may be normally held in its mid-position by and between two oppositely and axially arranged poles m^1 of a magnet, for example a permanent

magnet m, that act to restrain movement, or effective movement, of the armature until the electro-magnet is energized to a predetermined degree, corresponding to the predetermined voltage of the dynamo just mentioned.

The second end a^2 of the lighting circuit a is connected through a conductor a^2 to the movable member or contact of a supplementary reversing switch, made, for example, in the form of a pivoted two armed switch blade n adapted to alternately engage two fixed contacts n^1, n^2, the two arms of the movable blade n being arranged above the respective cores d of the two electro-magnetic switches A, A^1, so as to be operated in one or other direction thereby. The two fixed contacts n^1, n^2 are respectively connected to the supply mains B, B^1 and also to the opposite terminals o, o^1 of a resistance device o^2 which, when the dynamo is connected to either main B B^1, is in series with the lighting circuit a. The movable cores d of the two switches A, A^1 also carry the insulated movable members D, E of two additional switches D D^1 and E E^1. The members D and E are electrically connected together by a conductor o and the insulated stationary members D^1, E^1 are respectively connected through conductors c^3 and c^1 to the stationary contacts n^1 and n^2 of the supplementary reversing switch, the switch member E^1 being connected to the contact n^2 through a portion o^3 of the resistance o^2 and a conductor o^4.

The arrangement is such that assuming the core d of the main switch A to have been last operated and that the dynamo Z is at rest, or rotating at a speed below the speed corresponding to the required working voltage, the two main switches A, A^1 will be in the open position shown, so that the pole X of the dynamo will be disconnected from the supply mains B, B^1 and lighting circuit a, the supplementary reversing switch n, n^1 n^2 will be in a position to connect through the conductor o^3, the lighting circuit a to the supply main B^1 so that such circuit can receive current from battery No. 2, and the two resistance switches D D^1 and E E^1 will be closed. Battery No. 1, which will have been the last charged, will be connected in parallel with the other battery No. 2 and in series with the lighting circuit a, through the part o^3 of the resistance o^2, by way of the main B, contact n^1, terminal o conductor c^3, switch D, D^1, conductor p, switch E, E^1, conductor c^1, resistance portion o^3, terminal o^1, conductor o^4, contact n^2, switch blade n and conductor a^3. Upon then closing the lighting circuit a through any of the lamps therein, current will be supplied from both batteries acting in parallel. If the main switch A^1 was the last operated and is open, it will be battery No. 2 that will be placed in parallel with battery No. 1 through the part o^3 of the resistance o^2, under like conditions of working.

Upon the dynamo being rotated, in one direction, and producing a voltage of say one or two volts, the electromagnet j of the main reversing switch will act through the armature k k^1 to connect the shunt solenoid b of switch A across the poles of the dynamo by way of terminal b^2, conductor g, contact i, armature k, k^1 and conductor q^2 to the pole X and by way of terminal b^1 of the shunt solenoid b of switch A, terminal b^1 of the shunt solenoid b of switch A^1 and conductor q^1 to the pole Y of the dynamo. Upon the dynamo Z running at a speed to generate the required working voltage, the said shunt solenoid b will immediately act to close switch A and connect pole X of the dynamo to the supply main B and open the corresponding resistance switch D D^1, so that the dynamo will then act to supply current through the corresponding series solenoid c to battery No. 1 and to the lighting circuit a through the main B and resistance o^2, the circuit of both being completed through the switch A and fuse h to the second pole Y of the dynamo. The first of these circuits is by way of pole X, conductor q^2, contacts 1, e, 2, series solenoid c, main B, battery No. 1, conductor a^1, conductor q^3, contacts 4, f, 3, fuse h and conductor q^4 to pole Y, and the second of the circuits is by way of pole X, conductor q^2, contacts 1, e, 2, series solenoid c, main B, contact n^1, terminal o, resistance o^2, terminal o^1, conductor o^4, contacts n^2, n, conductor a^3, lighting circuit a, conductor a^1, conductor q^3 and so on as in the first circuit to the pole Y of the dynamo. At this time battery No. 2 supplies current through the supplementary reversing switch, by way of main B^1, contact n^2, switch blade n and conductor a^3, direct to the lighting circuit a, such battery then acting as the regulating battery. Upon the voltage of the dynamo falling below the required working voltage, the action of the shunt and series solenoids b, c, of switch A will become weakened to such an extent as to permit the switch to open and disconnect the dynamo from the battery and lighting circuits and connect the two batteries in parallel with each other and in series with the lighting circuit as already described. When the dynamo is rotated in the reverse direction, the armature current will be reversed in direction and the poles X and Y will reverse their polarity. The main reversing switch i—k^1 will now act in the reverse manner to connect the shunt solenoid b of switch A^1 across the poles X Y of the dynamo Z and thereby cause this switch to close and connect pole Y of the dynamo

through the corresponding series solenoid c to supply main B^1, operate the supplementary reversing switch n, n^1 n^2 so as to connect main B^1 to the lighting circuit through the resistance o^2 and open the corresponding resistance switch E E^1 when the dynamo is generating the required working voltage. The dynamo will then supply current to the main B^1 and charge battery No. 2 and supply current to the lighting circuit through the resistance o^2. The circuit in this case is from pole Y, conductor q^4, fuse h, contact 3 of switch A, contacts 3^a, f, 4^a and series solenoid c of switch A^1 to main B^1, the circuit of battery No. 2 being completed through conductors a^1 and q^3, and contacts 2^a, e and 1^a of switch A^1 to pole X of the dynamo, and the lighting circuit being completed through main B^1, contact n^2, conductor o^4, terminal o^1, resistance o^2, terminal o, contact n^1, switch lever n, conductor a^3, lighting circuit a, conductor a^1 to conductor q^3 and thence through the contacts 2^a, e and 1^a of switch A^1 to the pole X. At this time battery No. 1 will be connected direct to the lighting circuit a through main B, contact n^1 and switch blade n and act as the regulating battery, and the resistance switch E E^1 will be open. The switch A^1 will act in the manner hereinbefore described with reference to switch A to disconnect the dynamo from battery No. 2 and the lighting circuit a when the voltage of the dynamo falls below the required working voltage.

The insulated movable contacts e, f of each main switch A, A^1 may, as shown, be pivoted to the corresponding solenoid core d in order to afford an adjustable bearing contact.

The field winding u^2 of the dynamo is connected as a shunt to the poles X and Y of the dynamo Z through a mechanically operated reversing switch, comprising, for example, a movable holder s carrying two insulated and diametrically arranged movable contact brushes s^1, s^2 which are respectively connected to the poles X and Y of the dynamo. The said brushes are arranged to work between four stationary spring blade contacts t^1 to t^4. Two of these contacts, viz. t^1 t^2, are arranged at the upper part of a fixed disk or support t^7 and at opposite sides of the upper movable contact brush s^1 and are respectively connected to the opposite terminals u u^1 of the shunt field winding u^2 of the dynamo. Two more of the fixed contacts, viz. t^3 t^4, are similarly arranged and connected up at the lower part of the disk or support t^7 and at opposite sides of the lower movable contact brush s^2. Contacts t^1 and t^3 are electrically connected together, as also are contacts t^2 and t^4.

The movable contact holder s may be mounted on the armature shaft s^3 so that it can be turned therewith to a limited extent, by friction; or instead of being moved by friction, it may be connected to the rocking brush holder of the dynamo so as to be moved therewith, when the position thereof is reversed, by any convenient means, upon reversal in the direction of running of the dynamo. By the arrangement described the polarity of the field of the dynamo will be maintained constant in whichever direction the armature of the dynamo be rotated. Thus, when the parts are in the position shown, assuming poles X Y to be respectively positive and negative, current will flow from pole X to brush s and contact t^1 and thence in the direction of the arrow x to the terminal u, field winding u^2, terminal u^1 connected terminals t^2 t^4 to brush s^2 and thence to the pole Y of the dynamo. Upon the motion of the dynamo being reversed, the position of the brushes s^1 s^2 will also be reversed and current will then flow from the pole Y, now the positive pole, to brush s^2 and connected contacts t^3 t^1 thence in the same direction as before through the terminal u, field winding u^2 and terminal u^1 to terminal t^2 and thence through the brush s^1 to the now negative pole X of the dynamo.

Fig. 2 shows a modified arrangement wherein the electro-magnetic reversing switch i—k^1 of Fig. 1 is replaced by a mechanically operated circuit controlling device or reversing switch. Such switch is shown combined with the mechanical reversing switch used in Fig. 1 for the field winding u^2, for which purpose such switch is provided with two additional contacts t^5 t^6. Of these additional contacts, t^5 is arranged adjacent to the upper fixed contact t^1 and connected by a conductor q^5 to terminal b^2 of the shunt winding b of switch A, while the other t^6 is arranged adjacent to the lower fixed contact t^3 and on the same side of a vertical line, passing through the axis of the armature shaft s^3, as the contact t^5, and is connected by a conductor q^6 to terminal b^1 of the shunt winding b of switch A^1. Terminal b^1 of the shunt coil b of switch A and terminal b^2 of the shunt coil b of switch A^1 are connected by a conductor q^7 to the connected contacts t^2 t^4. As will be seen the arrangement is such that when the armature of the dynamo Z is turned in the direction of the arrows y, the shunt winding b of switch A is connected through the conductors q^5, q^7 across the poles X Y of the dynamo, as shown, and when the armature is turned in the opposite direction the position of the movable contact brushes s^1, s^2 will be reversed so as to open the circuit of the said shunt winding b and connect the shunt winding b of switch A^1 across the poles Y X of the dynamo through the conductors q^6 q^7.

Figs. 3 and 4 are diagrams showing modified arrangements in which a single battery, say No. 1, is used. In each of such arrangements the switches A, A^1 may be constructed and arranged substantially as hereinbefore described, the series windings c of both switches being arranged to supply current to the single main B which is connected to one pole of the battery, as before, and to one terminal o of the resistance device o^2, the other terminal o^1 of which is connected to one end of the lighting circuit a through the conductor a^3. The supplementary reversing switch hereinbefore described may, in this case, be replaced by a double switch comprising two spring loaded movable contact arms v v^1 pivoted to a stationary metallic support v^2, each of the contact arms being adapted to engage a fixed contact n^1 or n^2. The fixed contact n^1 above the coil b of switch A is connected by a conductor w to terminal o of the resistance o^2, while the other fixed contact n^2 is connected by a conductor w^1 to the other terminal o^1 of the resistance o^2 so that when both of the switch arms v v^1 are closed against the fixed contacts n^1 n^2 the resistance o^2 is short circuited. The shunt solenoids b of the two switches may be connected across the poles of the dynamo in either of the ways hereinbefore described, that is to say, either by an electromagnetic reversing switch i—k^1, as shown in Fig. 3, or by a mechanical reversing switch as shown in Fig. 4. The resistance switches D D^1 and E E^1 hereinbefore described with reference to Figs. 1 and 2 are, in this case, omitted. As will be seen, the arrangement is such that when either switch A or switch A^1 is operated and main B thereby connected to the dynamo, the corresponding contact arm v or v^1 of the double switch is operated to open the short circuit, w, n^1, v, v^2, v^1, n^2, w^1 of the resistance o^2, so that the lamp circuit a is then completed through the main B and the resistance o^2, to the conductor a^3. When the dynamo is disconnected from the said main B, both contact arms v v^1 of the double switch are in the closed position shown so as to short circuit the resistance o^2 and connect the battery to the lighting circuit direct through the main B, terminal o, conductor w, switch n^1, v, v^2, v^1, n^2 and conductor w^1 to conductor a^3. The contact arms v v^1 of the double switch instead of being spring loaded, as shown, may be otherwise arranged to be opened and closed by movement of the cores d of the main switches A A^1 below them.

The details of construction can be variously modified.

What we claim is:—

1. An electric distribution system, comprising a reversible dynamo, a battery, and a consumption circuit alternatively supplied from such dynamo and battery, a main switch corresponding to each direction of rotation of the dynamo having series and shunt operating windings, and means responsive to reversal of rotation of the dynamo for bringing one shunt winding into circuit for one direction of rotation of the dynamo and the other for the opposite direction of rotation.

2. An electric distribution system, comprising a reversible dynamo, a battery, and a consumption circuit alternatively supplied from such dynamo and battery, a main switch corresponding to each direction of rotation of the dynamo, having series and shunt operating windings, and means responsive both to voltage variation of the dynamo and to its direction of rotation adapted to bring the shunt winding of one or other of the switches into operation to connect the dynamo with the consumption circuit.

3. An electric distribution system, comprising a reversible dynamo, a mechanically operated reversing switch for reversing the connection of the field magnet winding of the dynamo with change in direction of running of the armature, a battery adapted to be charged by the dynamo, a consumption circuit adapted to be supplied by the dynamo and battery alternatively, two main switches, each having a shunt and a series operating winding, adapted to remain open and disconnect the dynamo from the consumption circuit until a predetermined armature speed is attained, and means for alternatively connecting the shunt operating windings in circuit to close one or other switch in accordance with the direction of running of the dynamo.

4. In an electric distribution system, the combination with a reversible dynamo, two batteries and a consumption circuit, of a mechanically operated reversing switch for reversing the connection of the field magnet winding of the dynamo, two main switches each having a shunt and a series operating winding, alternatively adapted to connect the dynamo with the consumption circuit depending upon the direction of running of the dynamo, means responsive to the direction of running of the dynamo for alternatively connecting the shunt windings of the switches to the dynamo, and a supplementary switch alternatively operated by the main switches for alternatively connecting the batteries to the consumption circuit.

5. In an electric distribution system, the combination with a reversible dynamo, two batteries and a consumption circuit, of a mechanically operated reversing switch for reversing the connection of the field magnet winding of the dynamo, two main switches, each having a shunt and a series operating

winding, alternatively adapted to connect the dynamo with the consumption circuit depending upon the direction of running of the dynamo, means responsive to the direction of running of the dynamo and to the speed of the dynamo armature for alternatively connecting the shunt windings of the switches to the dynamo, and a supplementary switch alternatively operated by the main switches for alternatively connecting the batteries to the consumption circuit.

6. In an electric distribution system, the combination with a reversible dynamo, two batteries and a consumption circuit, of a mechanically operated reversing switch for reversing the connection of the field winding of the dynamo, two main switches, each having a shunt and a series operating winding, alternatively adapted to connect the dynamo with the consumption circuit depending upon the direction of running of the dynamo, means responsive to the direction of running of the dynamo for alternatively connecting the shunt windings of the switches to the dynamo, a supplementary switch alternatively operated by the main switches for alternatively connecting the batteries directly to the consumption circuit, a resistance in permanent connection across stationary contacts of the supplementary switch, conductors leading respectively from one end of the resistance and from a point intermediate of its length, and resistance switches opening with closure of the main switches and closing with opening thereof to complete the circuit between said conductors at two points, so that when the supplementary switch directly connects one battery to the consumption circuit and both main switches are open both resistance switches connect the remaining battery in parallel with the other battery and in series with the consumption circuit through part of the resistance.

7. In an electric distribution system, the combination with a reversible dynamo two batteries and a consumption circuit, of a mechanically operated reversing switch for reversing the connection of the field winding of the dynamo, two main switches, each having a shunt and a series operating winding, alternatively adapted to connect the dynamo with the consumption circuit depending upon the direction of running of the dynamo, means responsive to the direction of running of the dynamo and to its speed of rotation for alternatively connecting the shunt windings of the switches to the dynamo, a supplementary switch alternatively operated by the main switches for alternatively connecting the batteries directly to the consumption circuit, a resistance in permanent connection across stationary contacts of the supplementary switch, conductors leading respectively from one end of the resistance and from a point intermediate of its length, and resistance switches opening with closure of the main switches and closing with opening thereof to complete the circuit between said conductors at two points, so that when the supplementary switch directly connects one battery to the consumption circuit and both main switches are open both resistance switches connect the remaining battery in parallel with the other battery and in series with the consumption circuit through part of the resistance.

8. An electric distributing system comprising a reversible dynamo, means for reversing the connections of the field winding of the dynamo with change in direction of running of the dynamo, a battery adapted to be charged by the dynamo, a consumption circuit adapted to be supplied by the dynamo and battery alternatively, two main switches, each having a shunt and a series operating winding, adapted to remain open and disconnect the dynamo from the consumption circuit and battery until a predetermined armature speed is attained, means for alternatively connecting the shunt operating windings in circuit to close one or other switch in accordance with the direction of running of the dynamo, a supplementary switch alternatively operated by the main switches for connecting the battery to the consumption circuit, and a resistance connected across the stationary contacts of said supplementary switch and arranged to be inserted in series with the dynamo and lighting circuit when the dynamo is supplying current to said circuit.

9. In an electric distribution system, the combination with a reversible dynamo and means for reversing the connections of the field magnet winding of the dynamo with change in direction of running of the dynamo, of two batteries, a consumption circuit connected at one end to one pole of each battery, a supplementary switch comprising two fixed contacts and a movable contact, two electric supply mains connected respectively to the other poles of the batteries and to the two fixed contacts of the supplementary switch, a conductor between the other end of said consumption circuit and the movable contact of the supplementary switch, two main switches, each having a shunt and a series operating winding, alternatively adapted to connect the dynamo to one or other of said supply mains depending upon the direction of running of the dynamo, said main switches being also adapted to alternatively operate the movable contact of the supplementary switch, means responsive to the direction of running of the dynamo for alternatively connecting the shunt windings of the main switches to the dynamo, a resistance con-

nected across the stationary contacts of said supplementary switch, two conductors leading one from one end of the resistance and the other from an intermediate point between the ends of said resistance, and two resistance switches controlled by the main switches and arranged to connect said conductors together when the main switches are open and to disconnect them when either of the main switches is closed.

10. An electric distribution system, comprising a reversible dynamo, a battery, and a consumption circuit alternatively supplied from such dynamo and battery, a main switch corresponding to each direction of rotation of the dynamo having series and shunt operating windings, and an electro-magnetic switch responsive to reversal of rotation of the dynamo for bringing one shunt winding into circuit for one direction of rotation of the dynamo and the other for the opposite direction of rotation, said electro-magnetic switch having its winding connected across the terminals of said dynamo and its armature adapted to close the circuit of one or other of said shunt windings according to the direction in which it is moved, and means arranged to prevent movement of said armature in either direction until a predetermined voltage has been set up by said dynamo.

Signed at London England this 19th day of November 1909.

JOHN PEACHEY CROUCH.
JAMES ETCHELLS.

Witnesses:
HERBERT D. JAMISON,
R. WESTACOTT.