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ELECTRICAL PROTECTIVE SYSTEM

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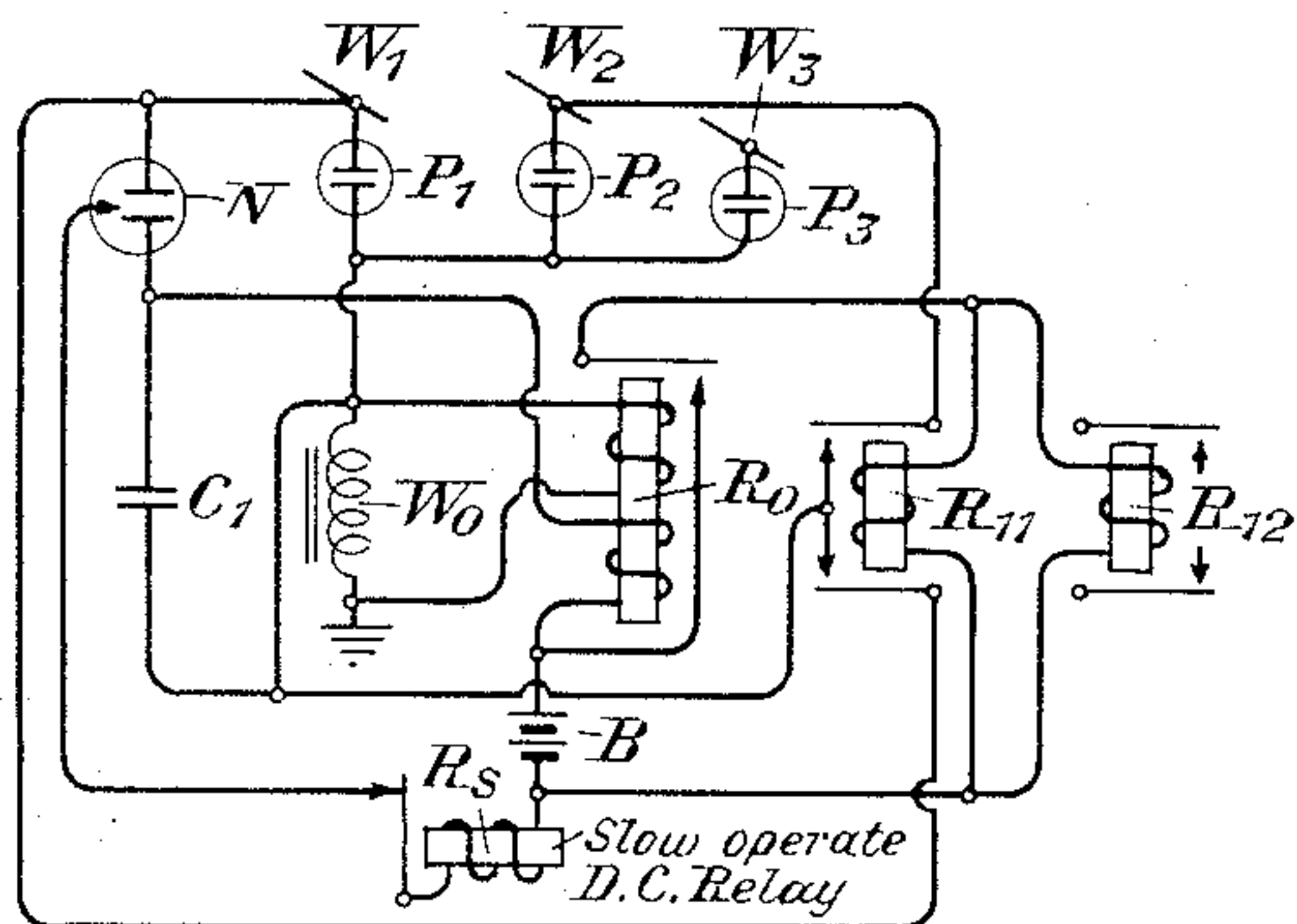


Fig. 1

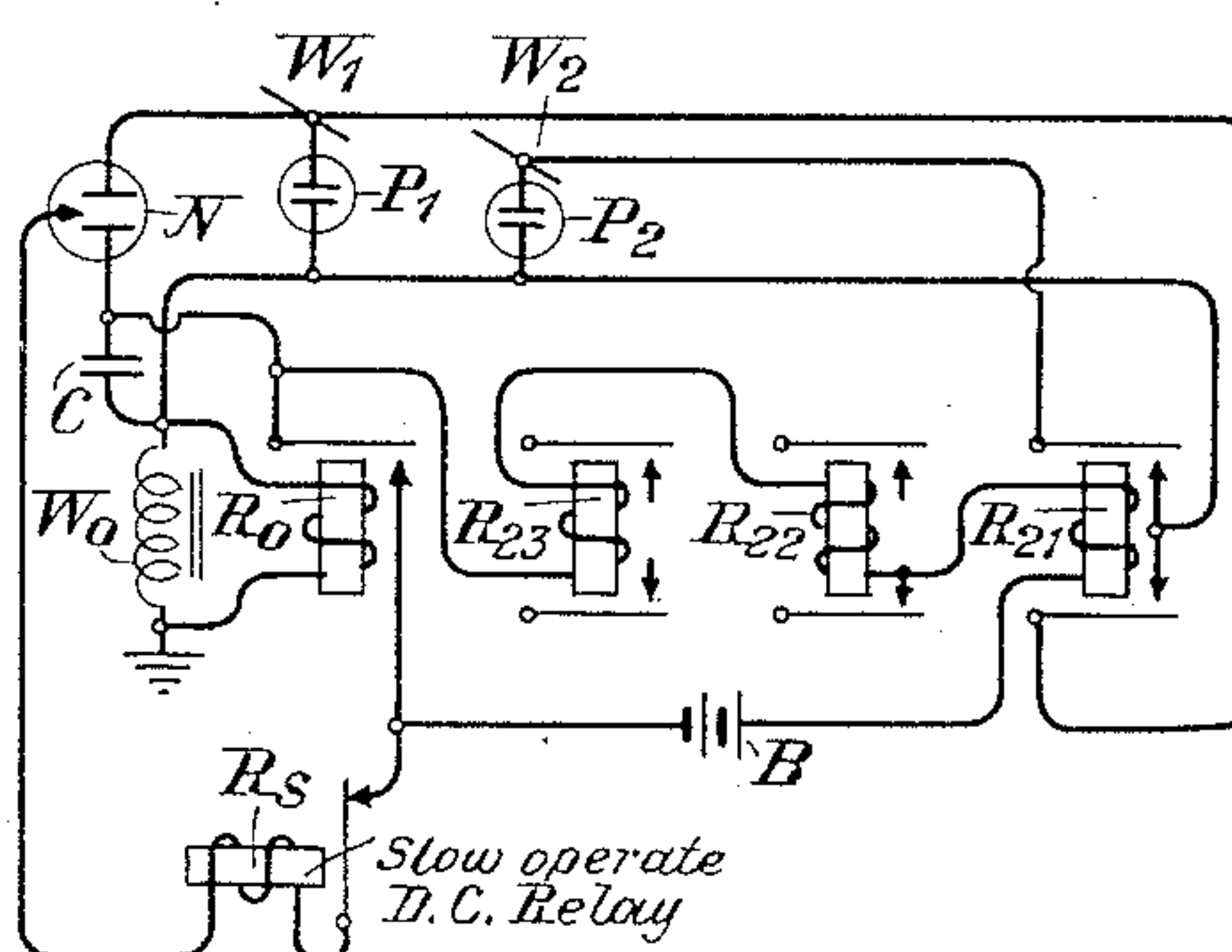


Fig. 2

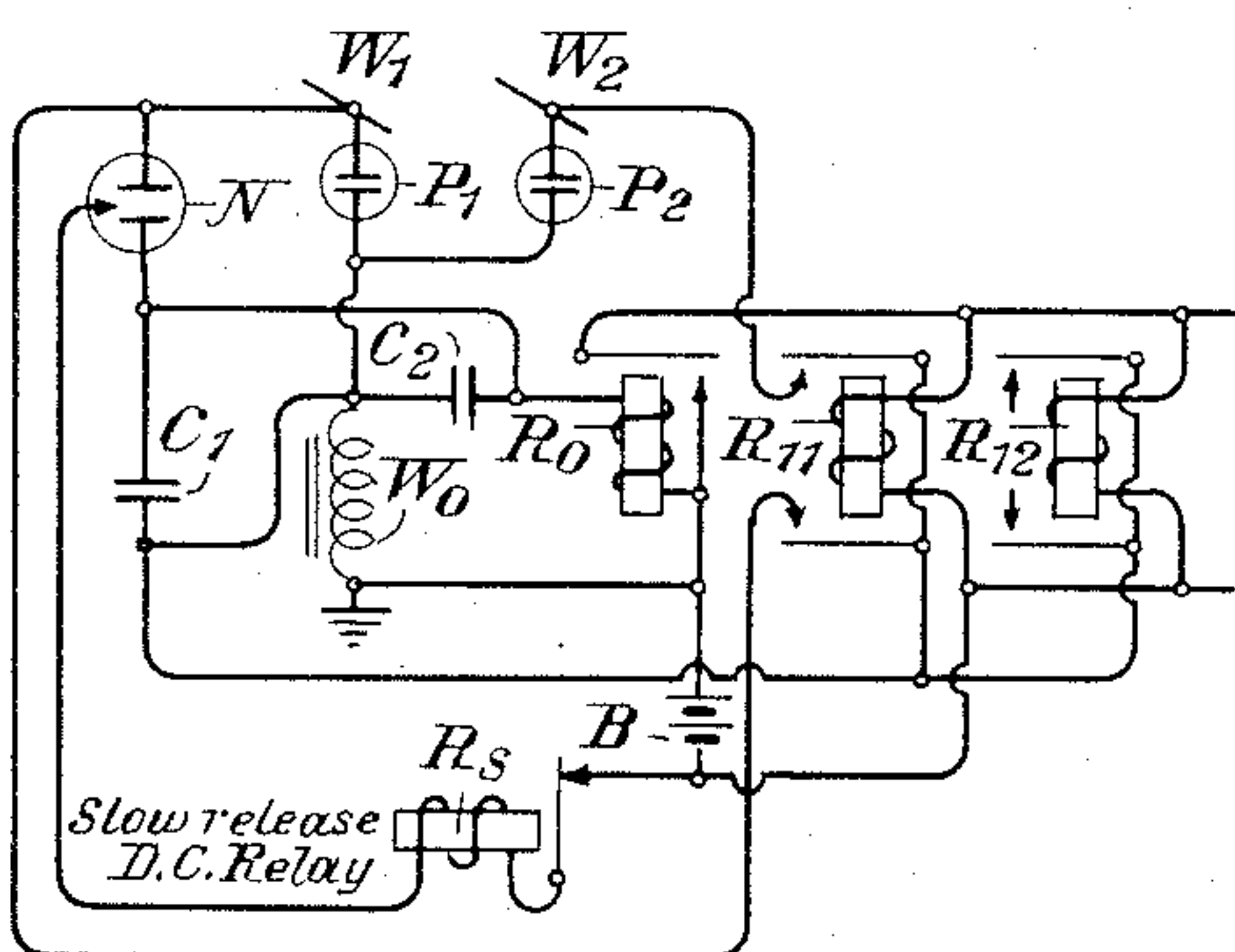


Fig. 3

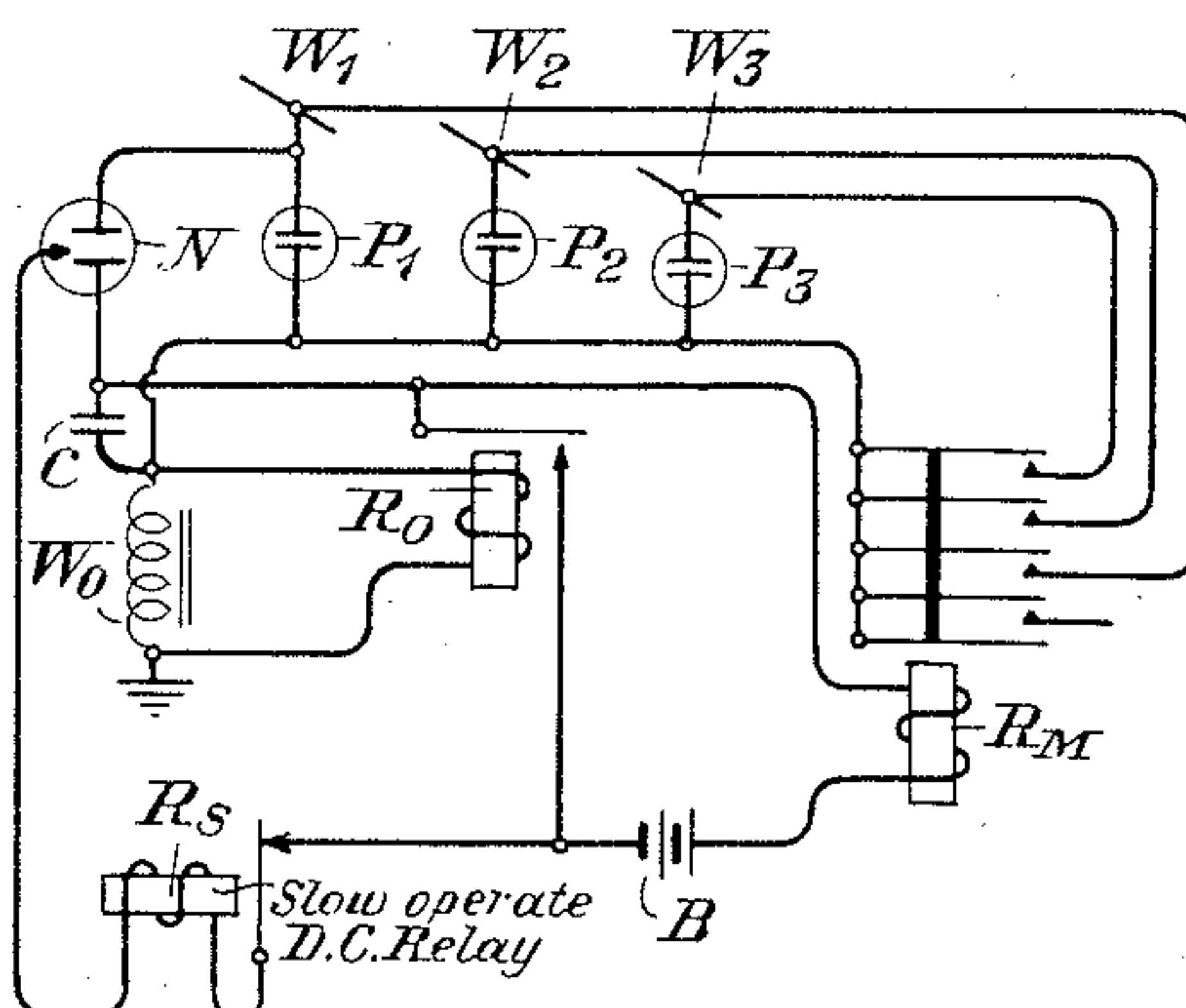
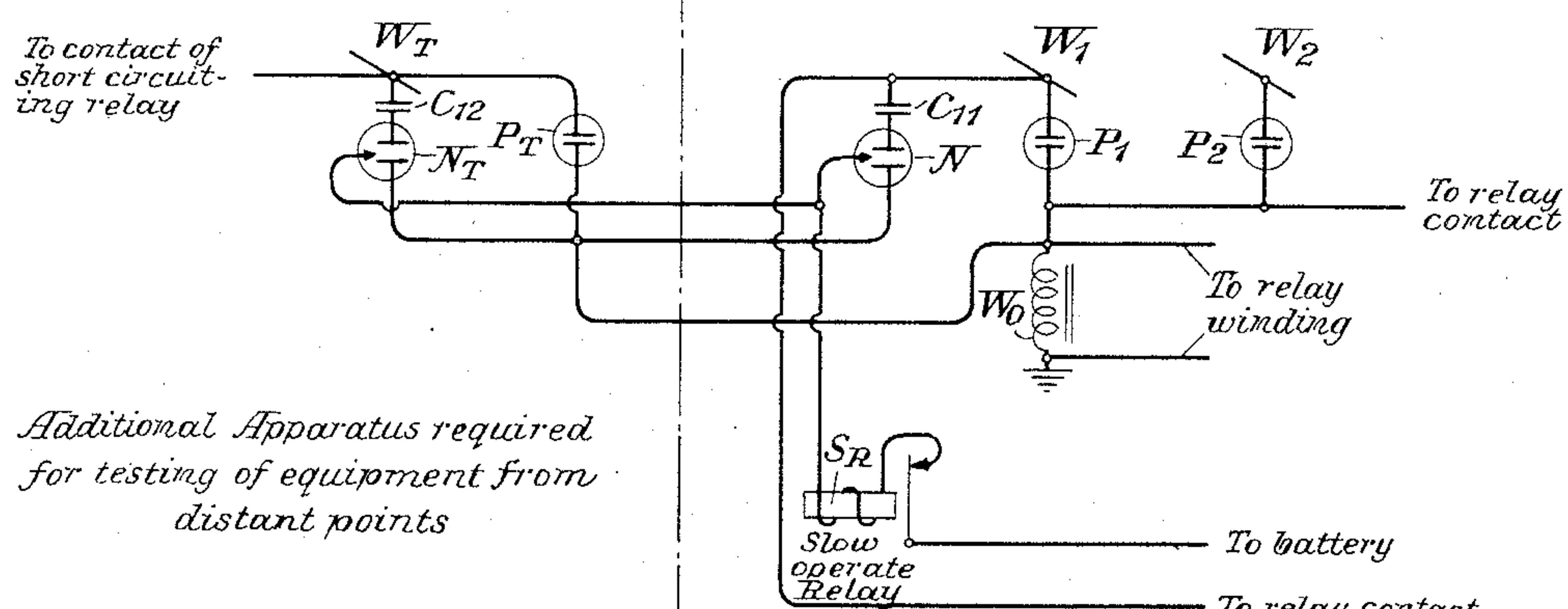


Fig. 4



Additional Apparatus required
for testing of equipment from
distant points

Apparatus as shown in Figures 1 to 4.

Fig. 5

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ELECTRICAL PROTECTIVE SYSTEM

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10 Claims. (Cl. 179—78)

This invention relates to electrical protective systems. More particularly, this invention relates to arrangements for simultaneously grounding a plurality of circuits when induced voltages above a fixed and predetermined value become impressed thereon. Still more particularly, this invention relates to arrangements for testing the apparatus employed in carrying out the principles of this invention.

Pairs of protector blocks each having an air gap which breaks down at a predetermined potential have been used in the telephone art for the protection of each of a number of telephone circuits from high voltages set up therein by one or more sources extraneous to the circuits themselves. In these arrangements, a resistor or saturating reactor is interposed in the ground connection of each pair of protector blocks or in the common ground connection of all of the protector blocks. This resistor or reactor, as the case may be, is designed to carry all of the operating current transmitted through one or all of the protector blocks associated therewith.

In these arrangements, apparatus is connected or otherwise coupled to the resistor or saturating reactor and this apparatus is caused to operate in response to a potential which becomes impressed between the terminals of the resistor or saturating reactor. Upon the operation of the aforementioned apparatus, circuits are established for simultaneously grounding all of the associated protector blocks, the grounding circuit generally including the resistor or saturating reactor.

This invention represents a substantial improvement over the apparatus heretofore employed for simultaneously grounding a plurality of exposed lines or conductors. In this invention, a cold cathode gas filled tube is employed and it comprises three (or more) electrodes which are enclosed within an envelope filled with a gaseous medium preferably of the rare gas type. This gas filled tube may comprise two input electrodes and an anode which are spaced from each other by predetermined distances. The spacing of the input electrodes is such that when a sufficient potential becomes impressed across these electrodes, the gas within the tube will become sufficiently ionized to permit substantial current to flow therebetween. As a result of this current practically all of the gas within the tube will then become ionized and, consequently, the impedance between the anode electrode and either of the input (or cathode) electrodes will also become greatly reduced. It will thus be possible to trans-

mit current between the anode electrode and either of the input electrodes after the arc between said input electrodes has been formed. On the other hand, unless a glow is produced between the input electrodes, it will be virtually impossible to transmit any current between the anode electrode and either of the input electrodes. These are some of the features employed in carrying out the principles of this invention.

This invention will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing in which Figures 1 to 4 each represent arrangements for simultaneously grounding a plurality of exposed conductors, with each of which a gas filled tube of the type already referred to and a novel circuit are associated, and Fig. 5 shows an arrangement which may be applied to any of the arrangements illustrated in Figs. 1 to 4 for testing the protector equipment from a distant point.

Referring to Fig. 1 of the drawing, the reference characters W_1, W_2, W_3 , etc. represent a plurality of conductors which may be open-wire lines which may be exposed to inductive interference. The reference characters P_1, P_2, P_3 , etc. designate a plurality of protector blocks each of which may comprise a pair of carbon electrodes which are enclosed and retained within a porcelain holder so that these electrodes may be spaced from each other by fixed and predetermined distances. The upper terminal of each of these protector blocks P_1, P_2, P_3 , etc. is connected to one of the exposed conductors W_1, W_2, W_3 , etc. as shown, and the lower terminals of these protector blocks are connected to each other.

The conductor common to the lower terminals of the various protector blocks P_1, P_2, P_3 , etc. is connected to ground through a saturating choke coil transformer or relay designated W_0 . This choke coil or transformer or relay W_0 is connected to the upper winding of a two-winding relay designated R_0 . This relay R_0 may be of the alternating current type.

The reference character N designates a gas filled type of cold cathode tube having three electrodes, the input electrodes of which are represented by straight lines which are parallel to each other. One input electrode is connected to the conductor W_1 while the other input electrode is connected to the upper terminal of the coil W_0 through a condenser C_1 . The anode of the tube N is connected in series with the lower winding of the relay R_0 through a circuit which includes a source of potential designated B which may be,

for instance, of the dry-cell type, said circuit also including the winding of a slow-operating relay R_s as well as its armature and back contact, as shown.

5 The armature and contact of the relay R_0 are connected in a circuit which includes the source B and the windings of a plurality of relays designated R_{11} , R_{12} , etc., the windings of the latter relays being connected in parallel relationship.
 10 When the armature of the relay R_0 closes its contact, then the relays R_{11} , R_{12} , etc. will be operated and their armatures and contacts will provide circuits which shunt the various protection blocks. Thus, the lower armature and contact of the
 15 relay R_{11} will provide a circuit which shunts the protector block P_1 . The upper armature and contact of this relay will provide a circuit which shunts the protector block P_2 and similarly the armatures and contacts of relay R_{12} and of the
 20 other relays having their windings in parallel therewith will provide circuits for shunting additional protector blocks connected to other conductors (not shown).

When a potential exceeding a predetermined
 25 magnitude is impressed between the conductor W_1 and ground, if insufficient to break down the gap of the protector block P_1 , will cause the gas between the gap formed by the plates of the tube N to glow. This glow discharge will arise from
 30 the flow of current from the conductor W_1 through the circuit formed by the plates of the tube N , the condenser C_1 and the coil W_0 to ground. Condenser C_1 is optional and is included only where it is desired to exclude direct current from the
 35 input circuit of the gas tube.

As soon as this glow discharge occurs, the impedance between the anode of the tube N and its input electrodes will become greatly reduced and current will then flow from the source B
 40 through the circuit which includes the winding of the slow-operate relay R_s , its armature and its normally closed contact, the anode and lower input electrode of the tube N and the lower winding of the relay R_0 . Flow of current through the
 45 latter circuit will cause the armature of the relay R_0 to close its contact. When this occurs, current will flow from the source B through the windings of the relays R_{11} , R_{12} , etc. over the circuit completed by the armature and contact of the
 50 relay R_0 . The closure of the contacts of the relays R_{11} , R_{12} , etc. will provide paths for shunting the various protector blocks P_1 , P_2 , P_3 , etc. as already explained.

After the protector block P_1 has been shunted
 55 by the circuit formed by the lower armature and contact of the relay R_{11} , current will then flow from the conductor W_1 through the latter circuit and through the coil W_0 to ground. No current will then flow between the input electrodes of the
 60 tube N . Consequently the glow between the input or actuating electrodes of the gas tube N will become extinguished. Shortly after operation of the relay R_0 , the slow-operating D. C. relay R_s will open the circuit from the anode of the gas
 65 tube N to the battery B . The short circuit of the input electrodes of the gas tube N by an armature and contact of the relay R_{11} will extinguish the glow between said input electrodes and thus the tube will become completely deionized. The
 70 short circuit of the protector block P_1 by an armature and contact of the relay R_{11} will cause a large current to flow through the upper winding of the relay R_0 . This current will maintain the relay R_0 operated independently of the flow
 75 of current through its lower winding. The ar-

mature of the relay R_0 will maintain its contact closed just as long as sufficient potential exceeding a predetermined value continues to become impressed across the terminals of the coil W_0 .

The relay R_s is of the slow-operate type and
 5 is so designed that the time required for opening its normally closed contact is somewhat greater than the time required to operate the relays R_{11} , R_{12} , etc. and the additional time required to provide circuits for shunting the protector blocks
 10 P_1 , P_2 , P_3 , etc. In other words, the slow-operate relay R_s will not open the circuit established between the anode and lower input electrode of the tube N until all of the protector blocks have become short-circuited.
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It will be understood that the coil W_0 may be eliminated, if desired, in which case the lower terminal of the protector block P_1 will be connected to ground through the upper winding of
 20 relay R_0 .

Fig. 2 represents a modification of the arrangement shown in Fig. 1 in which the relay R_0 has but one winding. The circuit of the input electrodes of the tube N includes the condenser C and the coil W_0 across which is connected the
 25 winding of the relay R_0 , as shown. The circuit of the anode of the tube N includes the winding of the slow-operate relay R_s its armature and contact, the source B , the windings of the relays R_{21} , R_{22} and R_{23} and the lower input electrode of
 30 the tube N . Upon the operation of the relay R_0 , its armature and contact will close a circuit which includes the source B and the windings of the relays R_{21} , R_{22} , R_{23} , etc. which are arranged in series relationship, as shown.
 35

When the potential between the conductor W_1 and ground is sufficient to cause the gas between the input electrodes of the tube N to glow, current will flow through the circuit of these electrodes, the condenser C and the winding of the
 40 relay R_0 . Upon reduction of the impedance between the various gaps of the tube N , current will flow through the circuit which includes the winding of the relay R_s , its armature and contact the source B , the windings of the relay
 45 R_{21} , R_{22} and R_{23} , and the lower input electrode and anode of the tube N . The current flowing through the latter circuit will be sufficient to operate the relays R_{21} , R_{22} and R_{23} and their armatures and contacts will then provide paths
 50 in shunt with the various protector blocks as already pointed out.

When the lower armature and contact of the relay R_{21} shunts the circuit of the protector block P_1 , current will flow over the latter shunt
 55 circuit from the conductor W_1 and through the coil W_0 to ground. Hence, the potential between the input electrodes of the tube N will be insufficient to maintain the gas between these electrodes in glow. The circuit between the an-
 60 ode and lower input electrode of the tube N which includes the winding of the relay R_s will be either effectively opened by operation of the relay R_s or short circuited by the operation of the relay R_0 , whichever operates first. The
 65 source B will continue to supply current to all of the windings of relays R_{21} , R_{22} and R_{23} as long as the armature of the relay R_0 remains closed against its contact. The relay R_0 will maintain its armature and contact closed as long as suffi-
 70 cient potential exists between the conductor W_1 , and ground, this condition producing a large flow of current through the winding of relay R_0 .

The relay R_s is of the slow-operate type and is not required in the circuit of Fig. 2 except to
 75

open the anode circuit of the tube if relay R_0 fails to operate.

In the arrangement of Fig. 2, the condenser C and the coil W_0 may be eliminated, if so desired, in which case the lower input electrode of tube N will be connected to ground through the winding of relay R_0 .

Fig. 3 is similar to the arrangement shown in Figs. 1 and 2. In Fig. 3, however, the winding of the relay R_0 is connected to the coil W_0 , which may be in all figures a saturating reactor or transformer, through a circuit which includes the condenser C_2 . The circuit of the anode and lower input electrode of the tube N includes the winding of the relay R_s and its armature and contact, the source B and the winding of the relay R_0 . The armature and contact of the relay R_0 complete a circuit which includes the source B and the windings of the relays R_{11} , R_{12} , etc., the windings of the latter relays being connected in parallel relationship.

The glow may be produced between the input electrodes of the tube N by a potential acting through the circuit which includes the conductor W_1 , the input elements of the tube N , the condenser C_1 the coil W_0 and ground. When this glow is established, current will flow from the source B over the circuit which includes the windings of the relays R_0 and R_s , the latter circuit including the anode and lower input element of the tube N . The establishment of the latter circuit will operate the relay R_0 . The closure of the contact of the relay R_0 will, in turn, cause the operation of the relays R_{11} and R_{12} . The latter relays will then provide circuits through the other armatures and contacts which will shunt the various protector blocks, the input electrodes of the gas tube N and condenser C_1 .

Fig. 4 is somewhat similar to Fig. 2 except that the anode or work circuit of the tube N includes the winding of the relay R_s and its armature and contact, the source B and the winding of the multi-contact relay R_M . When the latter circuit is completed, the numerous contacts of the relay R_M will be closed and these will provide paths each of which shunts one of the various protector blocks and input electrodes of gas tube N and condenser C , as shown. It will be apparent also that after the protector block P_1 is shunted by the circuit established over one of the contacts of the relay R_M , the glow between the input electrodes of the tube N will become extinguished while current will continue to flow over the shunt circuit around the protector block P_1 and through the coil W_0 to ground, this current maintaining the winding of the relay R_0 energized sufficiently so that its armature will close its associated contact. While the relay R_0 remains operated, current will continue to flow over the winding of the multi-contact R_M , the circuit including the source B and the armature and contact of the relay R_0 . Furthermore the operation of relay R_0 withdraws the potential of source B from the anode or work circuit of the tube N , resulting in deionization of the gas between the electrodes forming a part of this circuit, as in Fig. 2. The relay R_s may be dispensed with, if so desired, as in the case of Fig. 2.

In all of the Figs. 1 to 4, the various protector blocks may be short-circuited, irrespective of the operation of the tube N . Irrespective of the operation of the tube N , the impression of sufficiently high voltage upon any one of the conductors W_1 , W_2 , etc. may break down the gap of the corresponding protector block to cause a heavy dis-

charge of current through the coil W_0 . When this occurs, the relay R_0 will become operated and the operation of the latter relay will cause the actuation of the relays R_{11} , R_{12} , etc. or of the multi-contact relay R_M , if this is employed, so as to simultaneously provide circuits in shunt with the various protector blocks. Immediately upon the short circuit of the various protector blocks, the control of the circuits by the tube N becomes eliminated and this condition will last until the potential impressed upon any one of the various conductors is insufficient to ultimately operate the relay R_0 . In all of these circuits, the time during which the various protector blocks remains short-circuited depends upon the duration of the currents flowing from any one of the conductors W_1 , W_2 , etc. to ground through the saturating choke coil or transformer W_0 . In the arrangements shown in Figs. 1 to 4 inclusive, testing of the protective equipment may be performed at a remote point by applying a value of potential between conductor and ground of a value sufficient to ionize the tube but below the breakdown value of the protector block.

Fig. 5 shows another form of the arrangement for testing the protection equipment from a distant point. Here an additional gas filled tube N_r is incorporated at each of protector locations. At each protector location, a different conductor will be employed for connection to this additional tube N_r . It will be observed that the conductor W_1 is connected to the upper input electrode of the tube N by a condenser C_{11} and that a condenser C_{12} interconnects the testing conductor W_r with the upper input electrode of the tube. The upper terminal of the protector block P_r is connected to the conductor W_r and the lower terminal of this protector block is connected to the upper terminal of the choke coil or transformer W_0 . Also, the lower input electrodes of the tubes N and N_r are connected to the upper terminal of the coil W_0 . The anodes of the tubes N and N_r are both connected in series with the coil of the common slow-operating relay S_r . The armature and contact are also in series with the battery (not shown) employed to energize the various circuits as shown in Figs. 1 to 4 which may be used in carrying out the principles of this invention. It will be apparent that in order to test the circuits of the various arrangements and to determine whether or not the various gas filled tubes at each protector location are operating satisfactorily, it will be necessary to impress upon the testing conductor a potential which is greater than that required to produce a glow between the input electrodes of the gas filled tube or tubes, the potential being lower in magnitude, however, than that required to break down the gap of the corresponding protector block or blocks.

While this invention has been shown and described in certain particular arrangements merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. Protective apparatus for a conductor exposed to inductive interference, which comprises a protector block, a reactor connected in series with the protector block between the exposed conductor and ground, a three-element gas filled tube having two input electrodes and a third electrode, a condenser connected in a circuit in series with the two input electrodes of the tube, said circuit

being in shunt with the protector block, a source of potential, a slow acting relay, an alternating current relay the winding of which is connected in shunt with the reactor, the winding of said alternating current relay being connected in a series circuit which includes the source of potential, one of the input electrodes and the third electrode of said tube, the winding of the slow acting relay and its armature and contact, and means responsive to the operation of the alternating current relay for completely shunting the protector block.

2. Protective apparatus for a conductor exposed to inductive interference, comprising a gas filled tube having two actuating electrodes and a third electrode, a saturating reactor connected in series with the actuating electrodes of said tube between the exposed conductor and ground, a relay having two windings one of which shunts the reactor, a source of potential connected in series with the other winding of said relay and the third electrode and one of the actuating electrodes of said tube, and means responsive to the operation of said relay for grounding the exposed conductor through said reactor.

3. Apparatus for the protection of a plurality of conductors which are exposed to inductive interference, comprising a three-electrode gas filled tube, a reactor connected in series with two of the electrodes of said tube between one of said exposed conductors and ground, a source of potential, a slow-operating relay, an alternating current relay having a winding which is connected in series with the slow-operating relay and its armature and contact and with the source of potential and with the third electrode of said tube and one of its other electrodes and means responsive to the operation of said alternating current relay for simultaneously grounding all of the exposed conductors through said reactor.

4. Apparatus for a plurality of conductors exposed to inductive interference, comprising a three-element gas filled tube, a saturating reactor connected in series with two of the electrodes of said tube between one of the exposed conductors and ground, a source of potential, a relay, the winding of which is connected in series with the source of potential between the third electrode of said tube and one of its other electrodes, means responsive to the operation of said relay for simultaneously grounding all of the exposed conductors through said reactor, and means for periodically opening the circuit of the winding of said relay during the interval of time when an inductive effect of predetermined magnitude is still impressed between the conductor to which the tube is connected and ground.

5. A protective system for a plurality of open wire lines comprising a plurality of protector blocks, one terminal of each of which is connected to one of said lines, a saturating reactor connected to the other terminal of each of said protector blocks and ground, a gas filled tube having two input electrodes and a third electrode, a condenser connected in series with the two input electrodes of the tube in a circuit which shunts the protector block associated with one of said lines, an alternating current relay having a winding in shunt with the reactor, a slow-operating relay the winding of which is connected in series with its own armature and contact and with the armature and contact of the alternating current relay and the third electrode and one of the input electrodes of said tube, a source of potential, and means responsive to the closure of the contact of the al-

ternating current relay by its armature for completing a circuit through the source of potential and for simultaneously shunting all of the protector blocks.

6. Protective apparatus for a conductor exposed to inductive interference which consists of a protector block, a three-element gas filled tube having two input electrodes and a third electrode, a condenser connected in series with the two input electrodes of the tube in a circuit which is in shunt with the protector block, a source of potential, a slow-acting relay, an alternating current relay the winding of which is connected in shunt with the reactor, the winding of said alternating current relay being connected in a series circuit which includes the source of potential, one of the input electrodes and the third electrode of said tube and the winding of the slow-acting relay and its armature and contact, and means responsive to the operation of the alternating current relay for completely shunting the protector block.

7. Protective apparatus for a conductor exposed to inductive interference which comprises a protector block, a reactor connecting the exposed conductor to ground through the protector block, a three-element gas filled tube having two input electrodes in shunt with the protector block, a source of potential, a slow-acting relay, an alternating current relay the winding of which is connected in shunt with the reactor, the winding of said alternating current relay being connected in a series circuit which includes the source of potential, one of the input electrodes and the third electrode of said tube and the winding of the slow-acting relay and its armature and contact, and means responsive to the operation of the alternating current relay for completely shunting the protector block.

8. Protective apparatus for a conductor exposed to inductive interference which comprises a protector block, a gas filled tube having two actuating electrodes and a third electrode, a relay having two windings one of which connects the exposed conductor to ground through said protector block, the two actuating electrodes of said tube being connected in shunt with the protector block, a source of potential connected in series with the other winding of said relay and one of the actuating electrodes and the third electrode of said tube, and means responsive to the operation of said relay for grounding the exposed conductor through the first-mentioned winding of said relay.

9. Apparatus for the protection of a plurality of conductors which are exposed to inductive interference, comprising a three-electrode gas-filled tube, an alternating current relay having a winding which connects the various conductors to ground through two of the electrodes of said tube, a source of potential, a slow-operating relay the winding, armature and contact of which are connected in series with the source of potential and the third electrode and one of the other electrodes of said tube, and means responsive to the operation of said alternating current relay for simultaneously grounding all of the conductors through the winding of said alternating current relay.

10. Apparatus for the protection of a plurality of conductors which are exposed to inductive interference comprising a gas filled tube having two actuating electrodes and a third electrode, a plurality of protector blocks each corresponding to one of said conductors, an alternating current relay having a winding which connects the various exposed conductors to ground through

their corresponding protector blocks, the actuating electrodes being connected in shunt with one of said protector blocks, a source of potential, a plurality of direct current relays having windings connected in a circuit which includes the
5 third electrode of said tube, the source of potential and one of the actuating electrodes of said

tube, said alternating current relay having an armature and contact connected in shunt with said actuating electrode and the third electrode of said tube, and means responsive to the operation of said direct current relays to short-circuit all
5 of said protector blocks.

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