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ELECTRICAL PROTECTIVE SYSTEM

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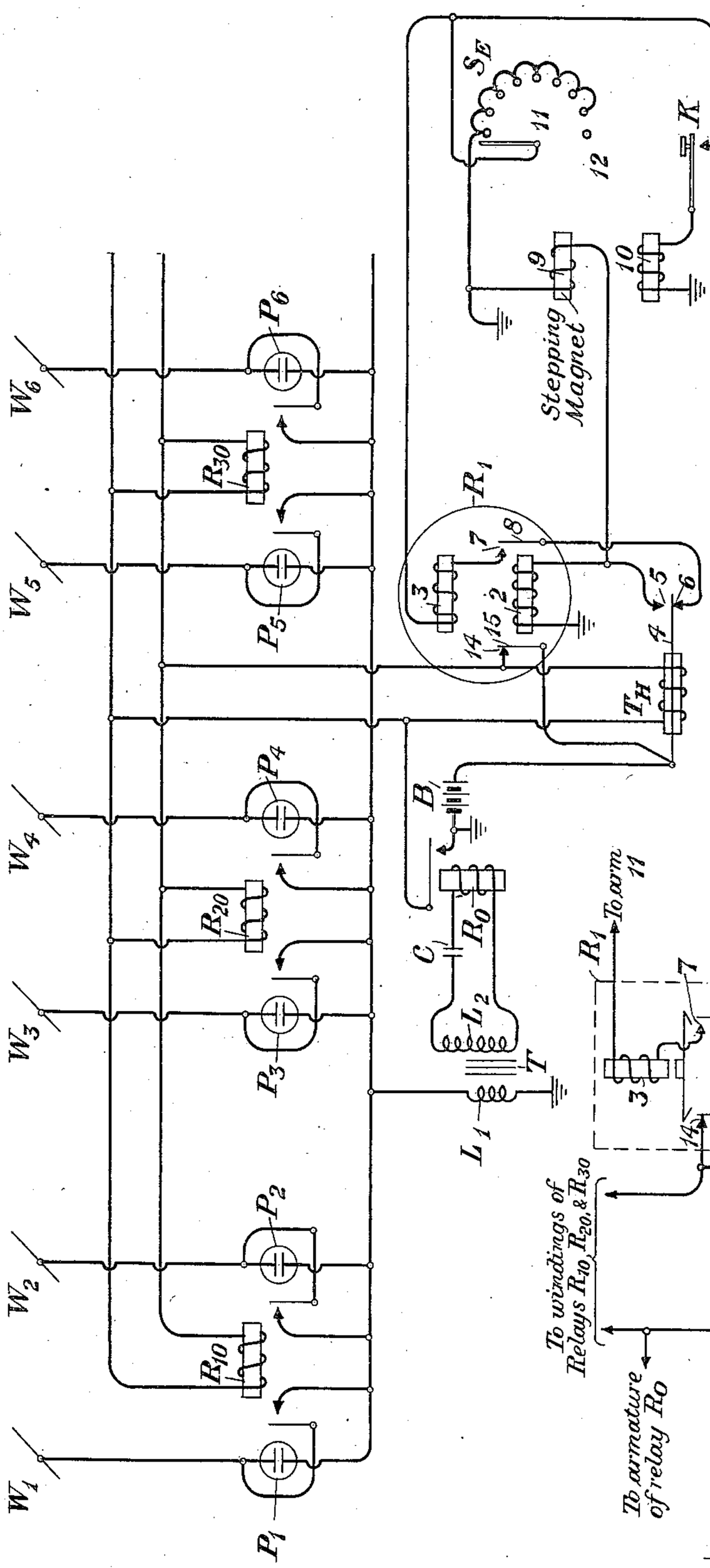

Fig. 1

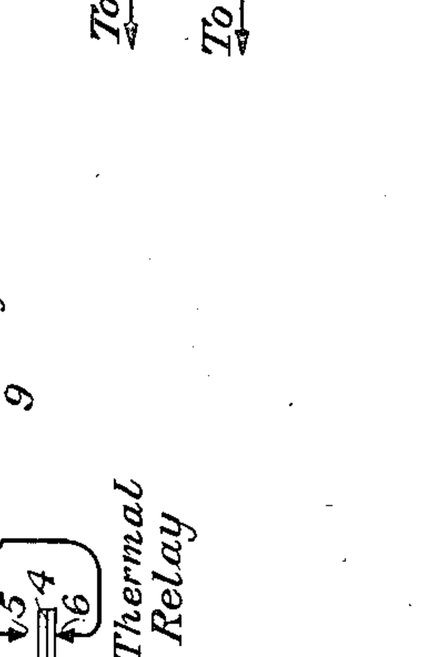

Fig. 3

Fig. 2

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ELECTRICAL PROTECTIVE SYSTEM

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11 Claims. (Cl. 179—78)

This application is a continuation in part of application, Serial Number 712,640, filed February 23, 1934.

This invention relates to electrical protective systems. More particularly, this invention relates to arrangements for simultaneously grounding a plurality of circuits when induced voltages become impressed thereon. This invention also provides methods and apparatus for preventing a total line outage due to failure of the equipment thereon.

A multiplicity 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. A multiplicity of relays, a single contact on each of which is associated with a single protector block, are used to short-circuit the various protector blocks so as to prevent a permanent closing of the gap or space within each of the various protector blocks and thereby vastly increase the life of each protector block before it becomes permanently grounded. Without such apparatus, the circuit or circuits to which the protector blocks are connected may be rendered inoperative until the protector block or blocks, which have been grounded, have been repaired or replaced.

In the short-circuiting relay protector apparatus as now manufactured, there is a possibility of permanently grounding the telephone lines to which this apparatus is applied upon the occurrence of a defect in one of the pilot relays employed in this apparatus. This grounding of the telephone wires can be brought about by any circumstance that may cause, for example, the alternating current relay (to be subsequently described) to remain operated for a long, abnormal period of time. Such circumstances may arise on account of improper adjustments in the alternating current relay or of other relays of the apparatus, or improper manufacturing construction of these relays, or upon the occurrence of abnormal temperature changes, especially if the relay contacts are initially set at too critical an adjustment. Additional circumstances for improper operation may be brought about also by undue haste or carelessness in replacing the covers upon the various relays of the apparatus.

This invention will be better understood from the detailed description hereinafter following, when read in connection with the accompanying drawing. Figure 1 of which shows embodiment of the invention merely for the purpose of illustration, Fig. 2 is an illustration of part of the apparatus of Fig. 1, and Fig. 3 illustrates a modification of a (different) part of the apparatus of Fig 1.

In the drawing, reference characters W_1 to W_6, inclusive, represent wires of an open wire line or conductors enclosed within a cable to which protector blocks P_1 to P_6, inclusive, are respectively connected, each in series with the primary winding L_1 of a saturating transformer T. The short-circuiting relays of the arrangement are designated by the reference characters R_{10}, R_{20} and R_{30}, and their windings are connected in parallel relationship with each other, although it will be understood that these windings may equally well be connected in series relationship. The contacts of the relay R_{10} function to short-circuit the protector blocks P_1 and P_2. The contacts of the short-circuiting relay R_{20} shirt-circuit the protector blocks P_3 and P_4 and the contacts of the short-circuiting relay R_{30} short-circuit the protector blocks P_5 and P_6.

The operation of the short-circuiting relays R_{10}, R_{20} and R_{30} is brought about by the closure of the contact of a master alternating current relay designated R_0, the winding of which is connected to the secondary winding L_2 of the saturating transformer T through a condenser C. The closure of the contact of the alternating current relay R_0 applies a local battery B to the windings of all of the short-circuiting relays R_{10}, R_{20} and R_{30}, the windings of these relays being connected to the battery B through the armature 15 and the back contact 14 of the relay R_1. Thus the short-circuiting relays R_{10}, R_{20} and R_{30} may be operated by current from the battery B only when the armature 15 of the relay R_1 closes the contact 14, but when contact 14 is open, these relays fall off. It will be understood, however, that the contacts of the relay R_0 may, if desired, be substituted for the equivalent contacts of any pilot relay of the copper oxide type of relay protector apparatus familiar to those skilled in the art.

The relay R_1 is composed of two windings designated 2 and 3, and it includes two armatures designated 8 and 15. The winding 2 controls the attraction of the armatures 8 and 15. The winding 3 controls the release of these armatures 8 and 15. When no current flows through the winding 2 after the armatures 8 and 15 have been attracted, the armatures 8 and 15 will remain locked up mechanically until later released by the flow of current through the winding 3 of the relay.

Thus when current flows through winding 2 from source B over the circuit which includes the armature 4 and contact 5 of the thermal relay T_H, the armatures 8 and 15 will both be attracted. The armature 15 will then leave contact 14 and the armature 8 will close the contact 7. Both armatures will remain mechanically locked up in these positions until later released by the action of winding 3 of the relay R_1. When the armature of the thermal relay T_H leaves its contact 5 the armatures 8 and 15 will, however, remain in their former locked positions. When current later flows from battery B through the winding 3 of the relay R_1 over the circuit which includes the armature 4 and the contact 6 of the thermal relay T_H and over the armature 8 and contact 7 of the relay R_1, then the energization of this winding will bring about the release of the armatures 8 and 15.

The releasing action of the winding 3 of the relay R_1 is under the control of the armature 11 of the device S_E or of the key K provided armature 4 is in contact with contact 6 of relay T_H. If the armature 11 is grounded by any of its various contacts except contact 12, the winding 3 of the relay R_1 may then release armatures 8 and 15 provided armature 4 is still in contact with contact 6 of the relay T_H. When the armature 11 is ungrounded as at contact 12, the key K may be operated so as to ground the winding 3 of the relay R_1 through winding 10 of the selector. At the same time that winding 3 of the relay R_1 is operated, winding 10 of the selector operates to restore arm 11 of the selector to the normal unoperated position, in a manner well understood by those skilled in the art.

The relay R_0 is operated by the potential applied through the condenser C from the secondary winding L_2 of the saturating transformer T. The potential set up in the transformer T is derived from the current flowing to ground through the primary winding L_1 from any one or all of the several protector blocks P_1 to P_6 when the potential applied across any of these protector blocks exceeds the break-down value. At the same time that the potential of battery B is applied simultaneously to the windings of all the short-circuiting relays R_{10}, R_{20} and R_{30}, the potential of battery B is also applied to the winding of the thermal relay T_H, the circuit to the winding of this relay being completed through the armature 15 and the back contact 14 of the relay R_1 and through the armature and contact of relay R_0. If this potential is applied longer than a specified, predetermined interval of time, the thermal relay T_H will become operated. This will cause its armature 4 to leave its contact 6 and then close with contact 5. Upon the closure of the contact 5, current will flow from the battery B through the armature 4 and the contact 5 of the thermal relay T_H and through the winding 2 of the relay R_1 and ground. A flow of current through the winding 2 of the relay R_1, will cause its armature 8 to close contact 7 and at the same time cause its armature 15 to leave its back contact 14. The opening of the back contact 14 will instantly break the circuit which transmits current from battery B through the windings of all of the short-circuiting relays R_{10}, R_{20} and R_{30}, permitting the latter relays to fall off temporarily. It will be noted by reference to Fig. 2 that by the energization of winding 2 of the relay R_1, the contact 7 and armature 8 are mechanically held closed and at the same time the contact 14 is mechanically held open from armature 15. Thereafter armatures 15 and 8 of relay R_1 are under the control of winding 3 of relay R_1.

In addition to operating relay R_1, the closure of the contact 5 by the armature 4 of the thermal relay T_H, as described above, will cause current to flow from the battery B through the armature 4 and the contact 5 of the relay T_H, and through the stepping magnet 9 of the selector S_E. This will cause rotation of the armature 11 of the selector S_E in a clockwise direction until it reaches the first contact of the selector. At the same time the opening of the back contact 14 will stop the flow of current from the battery B through the winding of the thermal relay T_H, thereby permitting the thermal relay T_H to cool to a lower temperature.

When the thermal relay has become sufficiently cooled, its armature 4 will leave contact 5 and restore to contact 6. Current will again flow from the battery B through the armature 4 and the contact 6 of the thermal relay T_H, and through the armature 8 and the contact 7 and the winding 3 of the relay R_1, and through the armature 11 and the first contact of the selector S_E through ground. This will cause the magnet 3 of the relay R_1 to release its armatures 8 and 15, which have been mechanically held in the operated position following the operation of magnet 2 of relay R_1. When the armature 15 again closes the back contact 14 of the relay R_1, the battery B again supplies current to the windings of all of the short-circuiting relays R_{10}, R_{20} and R_{30}, and current again flows from the battery B through the winding of the thermal relay T_H, both circuits just described being completed through the armature 15 and the back contact 14 of the relay R_1.

If, after the selector arm 11 reaches its first contact the condition that caused the relay R_0 to operate still exists, as for example, when a sufficiently high induced voltage remains impressed on any one of the conductors W_1 to W_6, or a defective pilot relay is held operated, the operation above described will be repeated again and again. It will be evident that after the winding of the thermal relay becomes sufficiently heated, the armature 4 will leave contact 6 and close its contact 5 and allow current to flow from the battery B over contact 5 to the winding of the stepping magnet 9 so that the armature 11 will be rotated in a clockwise direction to the second contact of the selector S_E and at the same time supply current from the battery B through the winding 2 of the relay R_1 over the same contact 5 of the thermal relay T_H. The armatures 8 and 15 will again be attracted, the armature 8 closing contact 7 and the armature 15 opening the contact 14 of the relay R_1. Winding 3 of the relay R_1 will be grounded through the arm 11 of the selector S_E and will remain unoperated. But just as soon as the thermal relay T_H again cools to a sufficiently low temperature, the armature 4 of this relay will again leave the contact 5 and then close its contact 6, again causing current to flow from the battery B through the winding 3 of the relay R_1, over a circuit which includes the armature 8 and the contact 7 of the relay R_1. This will again release the armatures 8 and 15 and again allow current to flow from battery B over the circuit of armature 15 and the back contact 14 of the relay R_1 to the windings of all of the short-circuiting relays R_{10}, R_{20} and R_{30}.

If for any reason the relay R_0, or the corre-

sponding pilot relay in other arrangements, remains operated when the arm 11 of the selector S_E reaches its last contact designated 12, the arm 11 will then become ungrounded and the magnet 3 of relay R_1 will no longer be able to receive current from the battery B. Thus, the relay R_1 will remain mechanically locked up. It will be apparent that while the relay R_1 remains locked up, the opening of the back contact 14 of relay R_1 will prevent the short-circuiting relays R_{10}, R_{20} and R_{30} from becoming operated and at the same time prevent the winding of the thermal relay from receiving current from the battery B. The attention of an attendant will then be required to restore the circuit to its normal condition.

The arm 11 of the selector S_E is shown connected in series with a key K and the winding of a magnet 10 and ground. This key K may be located at the protector apparatus or it may be located at a remote point, as for example, the switchboard of a repeater station, or, if desired, two or more keys may be paralleled to each other, one being located at the protector apparatus and the other at a remote point, if found necessary. The closure of the key K will ground the winding of the magnet 3 of the relay R_1 through the winding 10 of the selector S_E, independently of the arm 11 of this selector, so that current may flow through the winding 3 of the relay R_1 from the battery B, over the armature 4 and contact 6 of the relay T_H, and over the armature 8 and the contact 7 of the relay R_1. It will be apparent, of course, that the flow of current from the battery B through the winding 3 of the relay R_1 will simultaneously release both armatures 8 and 15 of this relay so as to again allow current to flow from the battery B through the winding of the thermal relay T_H as well as through the windings of all the short-circuiting relays R_{10}, R_{20} and R_{30}. If the condition of trouble has not been cleared the procedure of operation as just described will be repeated until the selector arm 11 steps around to the last contact 12. Hence key K should be operated only to indicate a permanent trouble or to restore the apparatus to normal after such a trouble has been cleared. The winding 10 of the selector S_E is also employed for the purpose of releasing a spring (not shown) so as to allow the arm 11 of the selector S_E to be returned from its last contact 12 to its initial position.

In Fig. 3 is shown an arrangement by which it is possible to restore the apparatus to normal when arm 11 is on any contact in the course of its travel. The selector S_E is equipped with off-normal contacts 16 and 17 which at any point in the motion of the arm 11 other than the normal unoperated position will close contact 16 with arm 17 and place winding 10 of the selector under the control of key K without the circuit being completed through winding 3 of the relay R_1 as shown in Fig. 1. When the arm 11 of the selector is in its unoperated position, arm 17 of the off-normal contact remains in contact with contact 18. With arm 11 on any contact point in the course of its travel, the battery circuit B for winding 10 of the selector is completed through arm 4 and contact 6 of the thermal relay T_H, through winding 10 and the selector arm 17 and contact 16 of the off-normal contacts of the selector S_E and the key K to ground. Thus, when key K is pressed, the winding 10 will operate to restore arm 11 of the selector to its normal unoperated position.

After the arm 11 of the selector S_E has reached its last contact 12 and the key K of Fig. 1 is unoperated, the protector blocks P_1 to P_6 will remain unprotected, and, of course, those blocks may become grounded due to the presence of extraneous high voltages upon their associated conductors. It is improbable, however, that all of the conductors W_1 to W_6, or, if more than six conductors are employed, that a large portion of them will continue to receive extraneous high voltages for the reason that a surge of voltage originating from, for example, a power line, is generally unable to outlive the sequence of events which bring about the intermittent operation of the thermal relay T_H and the stepping apparatus of the selector S_E. The existence of such a prolonged application of extraneous high voltage probably would first seriously damage the power equipment itself, and if the power circuit itself becomes damaged, it may then become impossible for the extraneous voltage to be applied to any one of the exposed conductors W_1 to W_6.

The thermal relay T_H may, for example, comprise a pair of metallic strips having different coefficients of thermal expansion which are tied, riveted or welded together. One of these strips, for example, the one having the higher coefficient of thermal expansion, may be shorter under normal temperature conditions than the strip having the lower coefficient of thermal expansion. These strips may together form a flexible armature, and under normal conditions of temperature, be so bent as to cause the closure of contact 6 of the thermal relay T_H. The winding of the relay T_H may include a plurality of turns of resistance wire and this winding may be positioned about either of the metallic strips or about both of the strips, or it may be placed in a position not far distant from either or both of these strips so that when current flows through this winding, one or both of these strips will be heated to substantially the same temperature. In such an arrangement the application of a high temperature will cause the strip having the higher temperature coefficient to become longer than the one of lower temperature coefficient. Then the armature will be deflected in the opposite direction so as to close the contact 5.

While this invention has been shown and described in a certain particular arrangement 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. The combination of a plurality of conductors which are exposed to interference, a plurality of protector blocks which are respectively connected to said conductors, a plurality of short-circuiting relays having their windings connected in parallel relationship and having their armature contacts arranged so as to bridge said protector blocks, an alternating current relay which becomes operated when a sufficiently high potential becomes impressed across any one or all of said protector blocks, a source of potential, a thermal relay, and a relay arrangement controlled by said thermal relay, said relay arrangement having an armature and contact which are connected in series with said source of potential and the windings of all of said short-circuiting relays upon the operation of said alternating current relay, the armature and con-

tact of said relay arrangement being also connected in series with said source of potential and the winding of the thermal relay, the operation of said relay arrangement occurring at intervals corresponding to the intervals required for the operation of the thermal relay.

2. In apparatus for the protection of a plurality of circuits exposed to interference, the combination of a source of potential, a thermal relay, a relay apparatus including a magnetizing winding which controls an armature and a contact, and a plurality of short-circuiting relays, said source of potential being connected in series with the winding of the thermal relay through the armature and contact controlled by the magnetizing winding of the relay apparatus, said source of potential being also connected to the windings of all of said short-circuiting relays through the armature and contact controlled by the magnetizing winding of the relay apparatus.

3. The combination of a plurality of conductors which are exposed to interference, a plurality of protector blocks associated with said conductors, a saturating transformer or reactor connected to said conductors through the various protector blocks, an alternating current relay, a plurality of short-circuiting relays the armatures and contacts of which simultaneously short-circuit all of said protector blocks when said relays become operated, a source of potential, a thermal relay, and relay apparatus including a magnetizing winding and an armature and contact under the control of said magnetizing winding, said source of potential being connected in series with the armature and contact of the alternating current relay and the windings of the short-circuiting relays through the armature and contact controlled by the magnetizing winding, said source of potential being also connected to the winding of the thermal relay through said armature and contact controlled by said magnetizing winding.

4. The combination of a plurality of conductors, means for simultaneously grounding all of said conductors upon the application of an abnormal potential to any one of said conductors, a thermal relay for interrupting said grounding means, and step-by-step apparatus for releasing and operating said thermal relay a predetermined number of times.

5. The combination of a current-carrying circuit exposed to interference, means for grounding said circuit upon the application to said circuit of a voltage exceeding a predetermined value, a thermal relay, means controlled by said thermal relay for interrupting said grounding means, and step-by-step apparatus responsive to the operation of said thermal relay for releasing said thermal relay and repeating its operation a predetermined number of times.

6. The combination of a plurality of current-carrying circuits exposed to interference, means for simultaneously grounding all of said circuits upon the application to any one of said circuits of voltage exceeding a predetermined value, a thermal relay, means controlled by said thermal relay for interrupting said grounding means, and step-by-step apparatus responsive to the operation of said thermal relay to periodically release said thermal relay and repeat its operation until the induced voltage is reduced below said predetermined value.

7. The combination of a plurality of exposed conductors, an alternating current relay, means responsive to the application of an excessive voltage on any one of the exposed conductors for operating the alternating current relay, means responsive to the operation of the alternating current relay to simultaneously ground all of the exposed conductors, and thermal means coupled to the alternating current relay, said thermal means including means for periodically opening the grounding circuit for the various exposed conductors after the alternating current relay has operated.

8. The combination of a main circuit, an alternating current relay controlled by said main circuit, a thermal relay connected to the alternating current relay, means responsive to the operation of the alternating current relay to vibrate the armature of the thermal relay, said armature being coupled to the main circuit.

9. In a circuit for grounding an exposed conductor, the combination of a thermal relay and means responsive to the operation of the thermal relay to periodically break the grounding circuit.

10. The combination of an exposed line, a main relay connecting the line to ground upon the impression of an extraneous voltage, a thermal relay controlled by the main relay, and means controlled by the thermal relay to periodically open and close the ground connection established to said line.

11. The combination of a relay, thermal means responsive to the operation of said relay to periodically operate and release said thermal means, a plurality of circuits, and means responsive to each operation of said thermal means to simultaneously ground all of said circuits.

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