

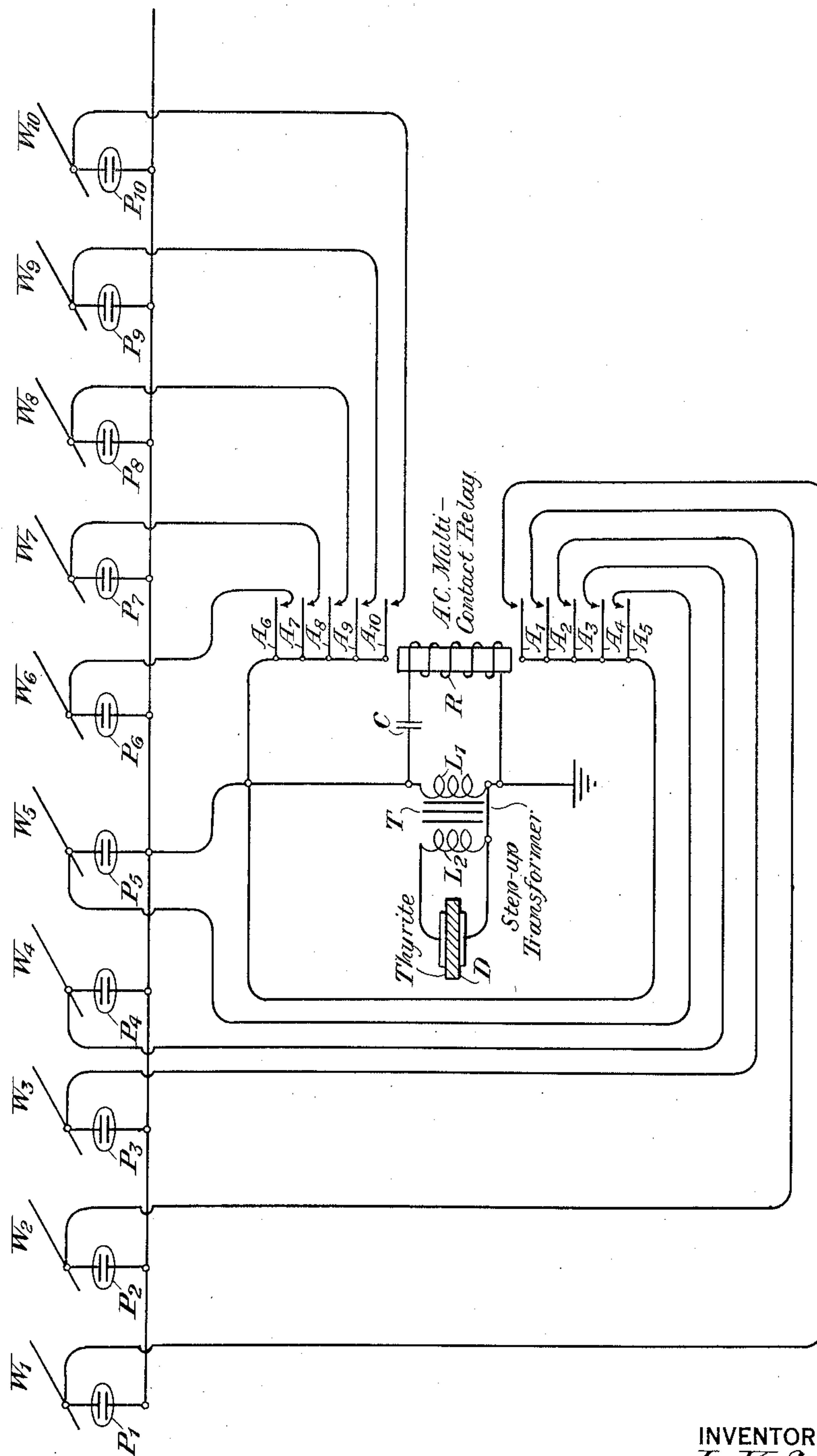
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L. K. SWART

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ELECTRICAL PROTECTIVE SYSTEM

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INVENTOR
L. K. Swart
 BY *gerfolk*
 ATTORNEY

UNITED STATES PATENT OFFICE

LELAND K. SWART, OF MOUNTAIN LAKES, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

ELECTRICAL PROTECTIVE SYSTEM

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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.

A pair of protective blocks each having an air gap which breaks down at a predetermined potential have recently 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 a saturating reactor is interposed in the ground connection of each pair of such protective blocks. The resistor or the reactor, as the case may be, carries all the operating current of the two blocks associated therewith. In these arrangements, moreover, the impedance drop across the resistor or the reactor is rectified by a rectifier which may be of the copper oxide type. The rectified current is applied to a relay which, when operated, shunts both of the protective blocks so that any induced current or currents may be carried through the heavy duty contacts of the relay.

A plurality of pairs of protective blocks and a plurality of relays, one corresponding to each of the pairs of protective blocks, have been associated with a plurality of telephone circuits running substantially parallel to each other exposed to the same inductive effect. There has been found to arise frequently a condition where some of the various relays will be operated and some unoperated because the inductive effect was not sufficiently large to cause the gaps of all of the associated protective blocks to become broken down. This condition created a great hazard since the circuit connected to those protective blocks and relays which had been operated were grounded, while those circuits connected to the protective blocks and circuits which had not been operated, were maintained at potentials considerably above ground. Of course this condition is highly undesirable and may be obviated by arrangements for simultaneously grounding all of the circuits.

A material commercially known as thyrite

has for some time been known in the electrical art. It is similar in appearance and in mechanical properties to porcelain, but has the further property of rapidly changing in resistance inversely with the voltage applied thereto. The current through an element of thyrite has been found to increase very rapidly with increases in voltage, and vice versa. The existing relations may be expressed mathematically as follows:

$$I = KE^{3.57}$$

In this expression I represents the current, E the applied voltage, and K a constant. From this expression it will be seen that the impedance of the element is reduced to approximately one-twelfth of its value for each doubling of the voltage, and this range of impedance change is practically unlimited. The inherent property of this element by which its impedance changes in accordance with the applied voltage, or any equivalent element or structure, may be employed in carrying out the principles of this invention which will be described hereinafter.

The objects and features of this invention will be better understood from the detailed description hereinafter following, when read in connection with the accompanying drawing showing one embodiment of the invention merely for the purpose of illustration.

Referring to the drawing, the reference characters W_1 to W_{10} inclusive, represent ten of a plurality of conductors or circuits which may be supported by a common protector pole. Each of these conductors may be connected to ground through an individual protective block and a common reactor designated L_1 , this reactor being shown as a saturating winding forming one of the elements of a transformer. The various protective blocks are designated P_1 to P_{10} inclusive. The lower terminal of each of these blocks is connected to the upper terminal of the reactor L_1 , and each upper terminal is connected to one of the conductors W_1 to W_{10} . Each of the various protective blocks may include two carbon electrodes spaced from each other by a gap of, for example, .003 inches. The two electrodes may be supported in a porcelain holder which is so

shaped as to insure the normal existence of a gap of predetermined width between the electrodes.

The reactor L_1 is connected in series with a condenser C and with the winding of a multi-contact relay R . The relay R is of the alternating current type, and its armatures A_1 to A_{10} are normally spaced from their associated contacts. These contacts are closed only when the relay is operated and remain closed as long as sufficient energy is supplied to its winding. The condenser C does not form an indispensable element of the arrangement, but it may, if desired, be used to tune the circuit in series with the winding of the relay R to some definite frequency, for example, 25 or 60 cycles, which may be the frequency of current transmitted over nearby power circuits. By so tuning the circuit, the time required to operate the relay R will be a minimum.

Each of the armatures of the relay R and its associated contact, forms a path in shunt around one of the protective blocks. Thus, the armature A_1 and its contact are shunted around the protective block P_1 and similarly the remaining armatures A_2 to A_{10} inclusive, and their respective contacts form paths in shunt around the protective blocks P_2 to P_{10} inclusive. Upon the operation of the relay R , all of these armatures will be simultaneously attracted, and these shunt paths will be closed around the various protective blocks so as to prevent current from flowing through these blocks. The various contacts of the relay R are of the heavy duty type and conveniently carry all of the required current.

The transformer T , preferably of the saturating type, includes, in addition to the winding L_1 , a secondary winding L_2 . The transformer T steps up the voltages impressed upon the winding L_1 , yet it will be understood that the transformer T may step down the impressed voltage if the winding of the relay R is of low impedance. A disc or block of thyrite designated D , included between a pair of electrodes which may preferably be metallic, is connected to the secondary winding L_2 . It is this element of thyrite which carries a highly variable current, substantially suppresses the effect of this current, and permits the winding of the relay R to be connected across the primary winding L_1 without endangering any of the associated circuits. Hence, the winding of the relay R will not be burned out even during abnormal changes in current through the winding L_1 .

The alternating current relay R , which is of the multi-contact type, is employed for connecting a plurality of conductors to ground, and it will be apparent that these conductors may be the open wire circuits of a telephone system. The winding of the relay is coupled to the common ground circuit of

the protective arrangement. The system may require protection for a very wide margin of operating current which may, in practice, vary from, for example, 1 ampere or less to 500 or more amperes. Such a wide margin of current cannot conveniently be taken care of by any ordinary design of the relay itself. For the purpose of permitting such a wide range of operation and yet not endanger any of the apparatus, the transformer T is included as one of the elements of the arrangement and proper impedance relations are maintained. This transformer may, of course, have a single winding set up as an auto-transformer, or it may comprise a multiplicity of windings, i. e., two or more windings, in inductive relationship, and, moreover, it may be replaced by a single saturating reactor. In the arrangement shown in the drawing, however, the primary winding of the transformer which is designated L_1 permits current to pass from any one or all of the various protective blocks to ground, and the secondary winding of this transformer is connected to the shunting substance of thyrite designated D . The impedance relations between the primary and secondary windings of the transformer T are such that a conveniently small amount of shunting material may be used without increasing the low impedance presented by the grounded path.

The transformer T may be of the saturating or non-saturating type. If of the saturating type, peak voltages will be experienced across this transformer at each half cycle, and these voltages will be of considerable magnitude when compared with the normal voltages impressed upon the circuit by extraneous sources. These peak voltages will be of fairly steep wave front, but they will not include frequencies too high to be transmitted satisfactorily from the primary winding to the secondary of the transformer T . The shunting element of thyrite will receive these peak voltages and greatly suppress their effect.

While the arrangement shown in the drawing includes an alternating current relay of the multi-contact type, the winding of which is connected to the primary winding L_1 of the transformer T , it will be understood that this alternating current relay may be employed as a pilot relay and associated with a group of other relays, all controlled by this pilot relay, each of these other relays being employed for short-circuiting one of the various protective blocks. Moreover, the winding of the relay R shown in the drawing may, if desired, be connected to a third winding which may be coupled to the windings L_1 and L_2 and form part of the transformer T . As an alternative it will be understood that the winding of the relay R may be connected to the secondary winding L_2 of the

transformer T in shunt with the element of thyrite D. It will be also understood, however, that the element of thyrite D may, in general, be connected either to the primary winding L₁, of transformer T or to its secondary winding L₂, as may be found desirable. And it will be further understood that the element of thyrite D may, if desired, be connected in shunt with the winding of the relay R and the transformer or its equivalent saturating reactor dispensed with, in which event the lower terminals of all of the protective blocks P₁ to P₁₀ will be connected to ground through the parallel arrangement formed by the thyrite element D and the winding of relay R.

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 plurality of circuits transmitting signals and exposed to extraneous inductive effects comprising a plurality of protective blocks each associated with one of said circuits, a highly saturated reactor connected in a circuit in common to all of said blocks, a quick acting alternating current relay, a condenser in series with said reactor and with the winding of said relay, an element of thyrite coupled to said reactor, and means responsive to the operation of said relay to simultaneously shunt all of said protective blocks.

2. In a system for simultaneously grounding a plurality of conductors transmitting signals when exposed electrical effects of substantial magnitude become impressed thereon, comprising a circuit including a grounded highly saturated reactor, a plurality of protective blocks each interposed between one of the conductors and the circuit of said reactor, a device having a non-linear voltage-impedance characteristic coupled to said reactor, and quick-acting relay means coupled to said reactor and responsive to a flow of current therethrough to simultaneously shunt all of said protective blocks.

3. In a system for simultaneously grounding a plurality of open wire signaling circuits when exposed electrical effects of substantial magnitude become impressed thereon, comprising a circuit including a grounded highly saturated reactor, a plurality of protective blocks each interposed between one of said signaling circuits and the circuit of said reactor, an element of thyrite inductively coupled to said reactor, a quick-acting multi-contact alternating current relay the winding of which is connected to said reactor and operated when a substantial current

flows through said reactor, and means associated with the contacts of said relay for simultaneously shunting all of said protective blocks upon the operation of said relay.

4. Protective apparatus for a plurality of signaling circuits comprising the combination of a circuit including a reactor of inductance common to said signaling circuits and capable of carrying a very wide range of currents, an element of thyrite inductively coupled to said reactor of inductance, a quick acting alternating current relay the winding of which is coupled to said reactor, said reactor being highly saturated so that wide margins of current which may become impressed upon the reactor from any one or all of the signaling circuits will operate the alternating current relay without damage, and means responsive to the operation of said relay to simultaneously ground all of said signaling circuits.

5. Protective apparatus for a plurality of signaling circuits comprising the combination of a circuit common to said signaling circuits, a highly saturated reactor connected in series in said common circuit, the common circuit being capable of carrying a very wide range of currents, an element of thyrite inductively coupled to said reactor, a quick acting alternating current relay the winding of which is coupled to said reactor, and means responsive to the operation of said relay to simultaneously ground all of said signaling circuits.

6. Protective apparatus for a plurality of signaling circuits comprising the combination of a circuit common to said signaling circuits, a highly saturated transformer the primary of which is connected in series in said common circuit, the common circuit being capable of carrying a very wide range of currents, an element of thyrite connected to the secondary winding of said transformer, a quick acting alternating current relay the winding of which is coupled to the primary winding of said transformer, and means responsive to the operation of said relay to simultaneously ground all of said signaling circuits.

In testimony whereof, I have signed my name to this specification this 1st day of April 1931.

LELAND K. SWART.