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ELECTRICAL PROTECTIVE SYSTEM

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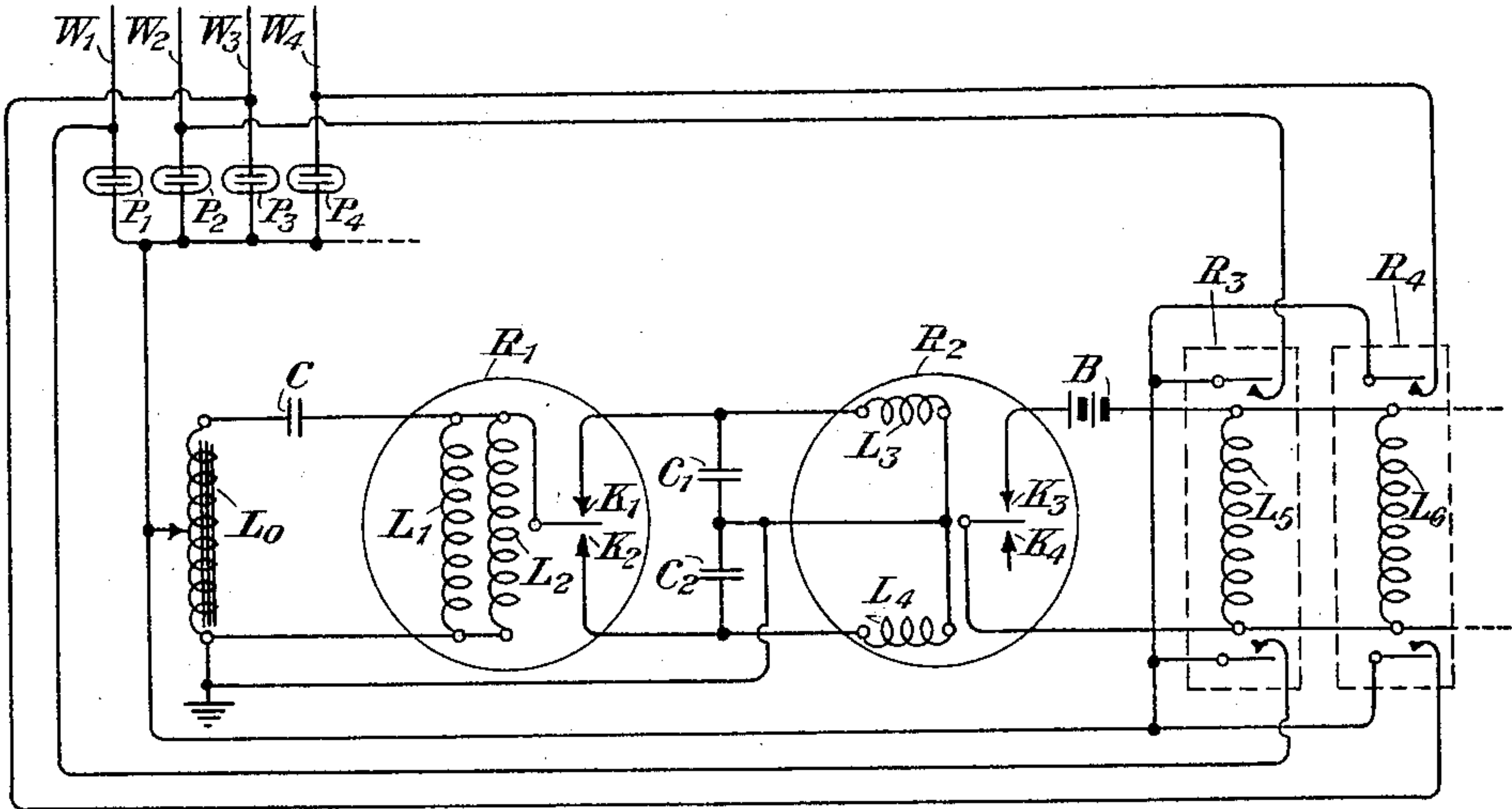


Fig. 1

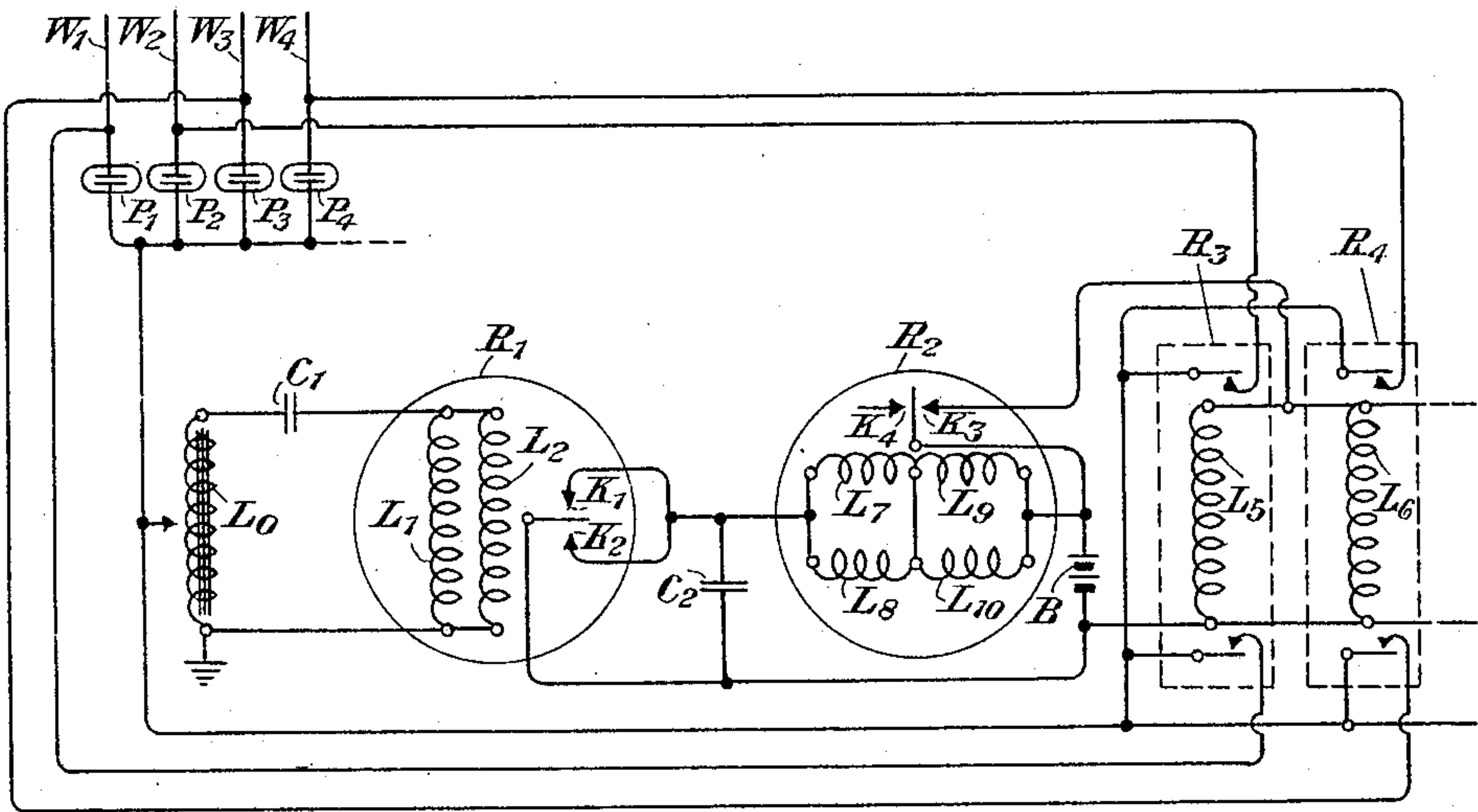


Fig. 2

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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.

5 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 are interposed in the ground connection of each pair of such protective blocks. 15 The resistor or the reactor, as the case may be, carries 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 of the copper oxide type. The rectified current is applied to a relay employed to shunt both protective blocks so that any induced current or currents may be carried through the heavy duty contacts of the relay. 25

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, each exposed to the same inductive effect. Apparently it will be possible to have a condition where some of the various relays will be operated and some unoperated, because the inductive effect may not be sufficiently large to cause all of the associated protective blocks to become operated. This condition creates a great hazard, since the circuit connected to the protective blocks and relays which have been operated will be at ground potential, while the circuits connected to the protective blocks and circuits which have not been operated will be at potentials considerably above ground. 45

The copper oxide rectifier forming part of the protective equipment of the prior art has been found to be unsatisfactory. The characteristics of the rectifier change with age. Moreover, this rectifier does not return to its

original state after a severe application of voltage or the passage of a large current and, furthermore, its characteristics change with temperature variations. All of these matters substantially affect the sensitivity of the device and reduce its range of operation. 55

One of the objects of this invention is to provide an arrangement for simultaneously grounding a plurality of conductors or circuits when an extraneous inductive effect becomes induced in any one of the conductors or circuits. 60

Another object of this invention is to associate a relay arrangement acting as a rectifying system with a plurality of conductors or circuits all of which may be exposed to substantially the same inductive effects so that any voltages impressed upon an associated resistor or reactor will cause the simultaneous grounding of all of the conductors or circuits. 70

While this invention will be pointed out with particularity in the appended claims, the invention itself will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing showing two embodiments of the invention merely for the purpose of illustration, Figure 1 of which includes two relays, one acting as a rectifier of impressed current and continuously operating the other relay. Figure 2 also includes two relays, the first having an armature which vibrates at the frequency of impressed current and maintaining the second relay continuously operated with current derived from an associated battery. 85

Referring to Figure 1 of the drawing, the reference characters W_1 , W_2 , W_3 and W_4 represent four of a plurality of conductors or circuits all of which may be supported by a common protector pole. Each of these conductors may be connected to ground through a protective block and a common resistor or a reactor or a transformer, a reactor or auto-transformer designated L_0 being employed herein merely for the sake of illustration. The various protective blocks are designated P_1 , P_2 , P_3 and P_4 . One terminal of each of these blocks is connected to an arm or contact 100

associated with the reactor L_0 which is shown as variable. Each of the protective blocks P_1 , P_2 , P_3 and P_4 may include two carbon electrodes spaced from each other by a gap of, for example .005 inch. 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 component electrodes.

The reactor L_0 is connected in series with a condenser designated C and with the windings L_1 and L_2 of a master relay designated R_1 , windings L_1 and L_2 being arranged in parallel relationship. Relay R_1 which may be of the polar or other type, has its armature normally spaced from its contacts K_1 and K_2 . It is to be understood, however, that a single winding may replace windings L_1 and L_2 , within the scope of this invention.

The contacts K_1 and K_2 are connected in series with the windings L_3 and L_4 of a relay designated R_2 . Relay R_2 may be of the slow release type, if desired. Condensers C_1 and C_2 shunt windings L_3 and L_4 respectively, and these condensers are preferably of large capacity. The armature of relay R_2 is normally separated from its contacts K_3 and K_4 .

A battery designated B which may be composed of a plurality of dry cells, is connected in series with contact K_3 and with the windings of a plurality of relays two of which are shown for the purpose of illustration and designated R_3 and R_4 , the windings of these relays being arranged in parallel relationship and being designated L_5 and L_6 , respectively. Each of the contacts of the relays R_3 and R_4 extends to one of the conductors W_1 , W_2 , W_3 or W_4 . Thus, the contacts of relay R_3 extend to conductors W_1 and W_2 , and the contacts of relay R_4 extend to conductors W_3 and W_4 . Moreover, the fixed terminals of the armatures of relays R_3 and R_4 are connected in parallel to ground through a portion of the reactor L_0 .

When an extraneous voltage becomes induced in any one or more of the various conductors or circuits W_1 , W_2 , W_3 or W_4 , the protective block or blocks associated with the circuit or circuits so impressed will discharge a substantial current, and that current will flow through the lower portion of reactor L_0 to ground. A somewhat higher voltage will send a current through condenser C to the windings L_1 and L_2 of relay R_1 , the condenser functioning to reduce the time required to build up a substantial current in these windings. The armature of relay R_1 will vibrate at the frequency of the impressed current, and it will alternately close contacts K_1 and K_2 . It may be assumed for the purpose of illustration that contact K_1 will be closed during the positive portion of each cycle, and contact K_2 during the negative portion. Current will flow through winding L_3 of relay R_2 when contact K_1 is closed,

and through winding L_4 when contact K_2 is closed. Windings L_3 and L_4 are wound so as to maintain the armature of relay R_2 closed against contact K_3 while the armature of relay R_1 remains in vibration between contacts K_1 and K_2 . Condensers C_1 and C_2 receive charges which aid in holding the armature of relay R_2 against contact K_3 while relay R_1 is in operation. Condensers C_1 and C_2 , moreover, decrease the time required to build up magnetic fields in windings L_3 and L_4 of sufficient strength to operate the armature of relay R_2 .

When contact K_3 is closed, battery B will transmit current to the windings L_5 and L_6 of relays R_3 and R_4 , respectively, and this current will divide equally therebetween. The armatures of relays R_3 and R_4 will be simultaneously attracted and, therefore, conductors W_1 , W_2 , W_3 and W_4 will be promptly connected to ground through the circuits established by the armatures of these relays and the lower portion of the reactor L_0 .

The speed of operation of the arrangement shown in Fig. 1 is a function of the value of the current discharged through any one or more of the various protective blocks. The higher the current, the faster will relays R_1 and R_2 operate. Moreover, relays R_3 and R_4 will operate at a speed depending upon the voltage of the battery B .

The arrangement shown in Fig. 2 is somewhat similar to the one shown in Fig. 1, both arrangements depending upon the vibration of the armature of relay R_1 for operating the relay R_2 . In Fig. 1 the armature of relay R_1 acts somewhat as a rectifier, for current flows through windings L_3 and L_4 of relay R_2 unidirectionally. In Fig. 2, however, the vibration of the armature of relay R_1 permits condenser C_2 to be charged and discharged and the armature of relay R_2 remains closed throughout the period the armature of relay R_1 is in vibration, and moreover, throughout the interval during which the armature of relay R_1 is moving between these contacts.

Relay R_2 of Fig. 2 may be composed of four windings designated L_7 , L_8 , L_9 and L_{10} , as shown. Windings L_7 and L_8 are connected in parallel relationship, and windings L_9 and L_{10} are similarly connected. Although four windings are shown at relay R_2 , these may be replaced by a single winding, if desired. These pairs of windings shown are however, in series with battery B and with the armature of relay R_1 and its contacts, both of which are tied together. Condenser C_2 is bridged between contacts K_1 and K_2 and the armature of relay R_1 . Any voltage impressed upon any one of the various protective blocks P_1 , P_2 , P_3 or P_4 sufficient to bridge the gap thereof will cause current to flow through the reactor L_0 from its movable contact to its lower terminal

or ground. The voltage across the outer terminals of the reactor L_0 will cause current to flow through condenser C_1 as well as through windings L_1 and L_2 of relay R_1 , which are in parallel relationship. The armature of relay R_1 will vibrate between contacts K_1 and K_2 at the frequency of the impressed current.

When the armature of relay R_1 is separated from both contacts K_1 and K_2 , condenser C_2 will be charged to the voltage of battery B , but the charging current per se will be insufficient to cause a magnetic effect on windings L_7 , L_8 , L_9 and L_{10} sufficient to move the armature of relay R_2 to contact K_3 . When contact K_1 is closed by the armature of relay R_1 , current will flow through battery B through windings L_7 , L_8 , L_9 and L_{10} , and contact K_3 of relay R_2 will be closed by its armature. The charge of condenser C_2 will then be substantially decreased and the charge will become negligible in value. When the armature of relay R_1 departs from contact K_1 , battery B will again charge condenser C_2 and tend to maintain the armature of relay R_2 closed against contact K_3 by virtue of the magnetic fields produced about windings L_7 , L_8 , L_9 and L_{10} of relay R_2 by the charging current. The action of condenser C_2 , aided by the slow releasing property of relay R_2 , will tend to maintain the armature of relay R_2 closed against contact K_3 . When the armature of relay R_1 closes contact K_2 , current will flow from battery B through the windings L_7 , L_8 , L_9 and L_{10} of relay R_2 , and the condenser C_2 will again be discharged. And so it continues, the vibration of the armature of the relay R_1 between its contacts K_1 and K_2 causing the armature of relay R_2 to maintain its contact K_3 closed.

Whenever the contact K_3 is closed, battery B will send current through the windings of relay R_3 and R_4 which are connected in parallel relationship. Thus, it will be noted that battery B not only energizes windings L_7 , L_8 , L_9 and L_{10} of relay R_2 and charges condenser C_2 , but it also supplies the current required to operate relays R_3 and R_4 . When relays R_3 and R_4 are operated, the armatures of these relays will cause the simultaneous grounding of the conductors of circuits W_1 , W_2 , W_3 and W_4 through the lower portion of the reactor L_0 .

The circuits forming the basis of this invention may be used for a line of any desired number of wires, only four of which are shown, and moreover, these circuits will operate even when a very small current ($\frac{1}{20}$ of an ampere or less) passes over any pair and through any protective block to ground. Furthermore, there will be no damage to the protective block or to any part of the circuit when a very large current (10 amperes or more) is transmitted over any pair or through any protective block. Thus, the circuits described

herein have great advantages over those employing copper oxide rectifiers, and these circuits do not have the inherent variability of the copper oxide devices. All of the wires of the pole line of the arrangement forming this invention will be simultaneously grounded even when a small fraction of an ampere is transmitted through a protective block, and the short circuiting action will occur within the time corresponding to one or two cycles, especially if the voltage of the battery is not too low. Inasmuch as the arrangement of this invention operates with great speed, the time during which any one of the protective blocks may be burned is greatly reduced and hence the useful life of these blocks before becoming pitted and permanently grounded, is extended materially. Such speedy operation, moreover, reduces the time during which an acoustic shock may be experienced and only a single transient impulse may reach a receiver.

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. The combination of a plurality of signal circuits which are exposed to extraneous inductive effects, a plurality of protective blocks each associated with one of said circuits and operated to discharge a substantial current when a voltage exceeding a predetermined value is impressed upon the associated circuit, means for receiving the current discharged by any protective block, relay arrangements for deriving direct current from the current present in said receiving means, and means responsive to the direct current for simultaneously grounding all of said circuits.

2. The combination of a plurality of signal circuits exposed to extraneous inductive effects, a plurality of protective blocks, each protective block being associated with one of said circuits and discharging a current when an induced effect of predetermined voltage is impressed thereon, a reactor upon which is impressed the current so discharged, a first relay connected to said reactor and having an armature which vibrates at the frequency of the current impressed on the reactor, a second relay which becomes operated when the armature of the first relay is in vibration, and means controlled by the second relay for simultaneously grounding all of said circuits.

3. The combination of a first relay having a winding which receives alternating current and an armature which vibrates between two contacts at the frequency of the received current, and a second relay having two wind-

ings connected in series with each other and with the two contacts of the first relay, the armature of the second relay remaining closed as long as the winding of the first relay receives alternating current.

4. The combination of a first relay having a winding which receives alternating current and an armature which vibrates between two contacts at the frequency of the received current, a second relay having two windings connected in series with each other and with the two contacts of the first relay, the armature of the second relay remaining closed as long as the winding of the first relay receives alternating current, and two condensers each in shunt with one of the windings of said second relay.

5. The combination of a first relay having a winding which receives alternating current and an armature which vibrates between two contacts at the frequency of the received current, a second relay having two windings connected in series with each other and with the two contacts of the first relay, two condensers each in shunt with one of the windings of the second relay, and a circuit controlled by the armature of the second relay, said circuit remaining closed only as long as the winding of the first relay receives alternating current.

In testimony whereof, I have signed my name to this specification this 20th day of August 1930.

LELAND K. SWART.

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