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ELECTRICAL PROTECTIVE SYSTEM

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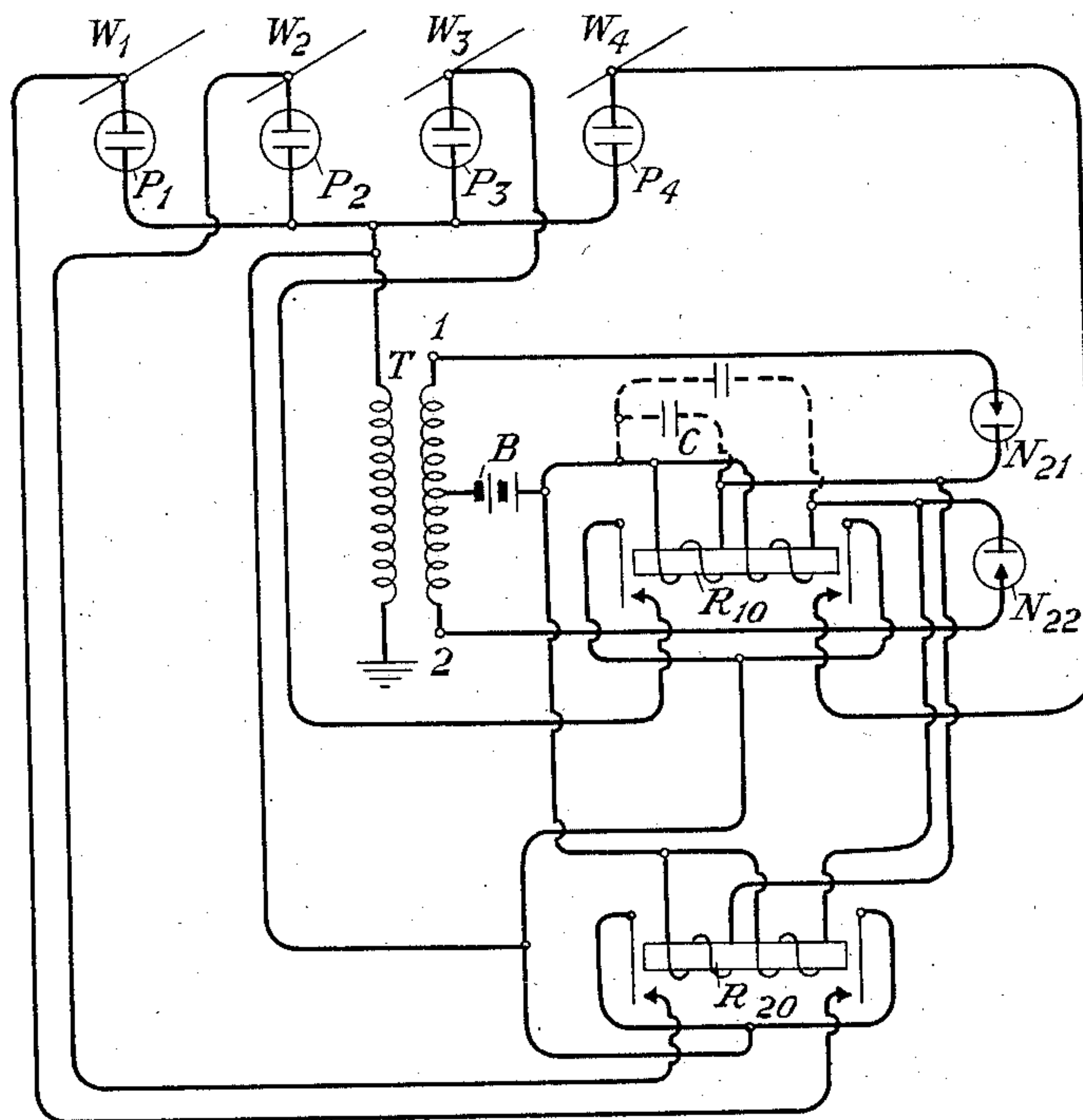


Fig. 1

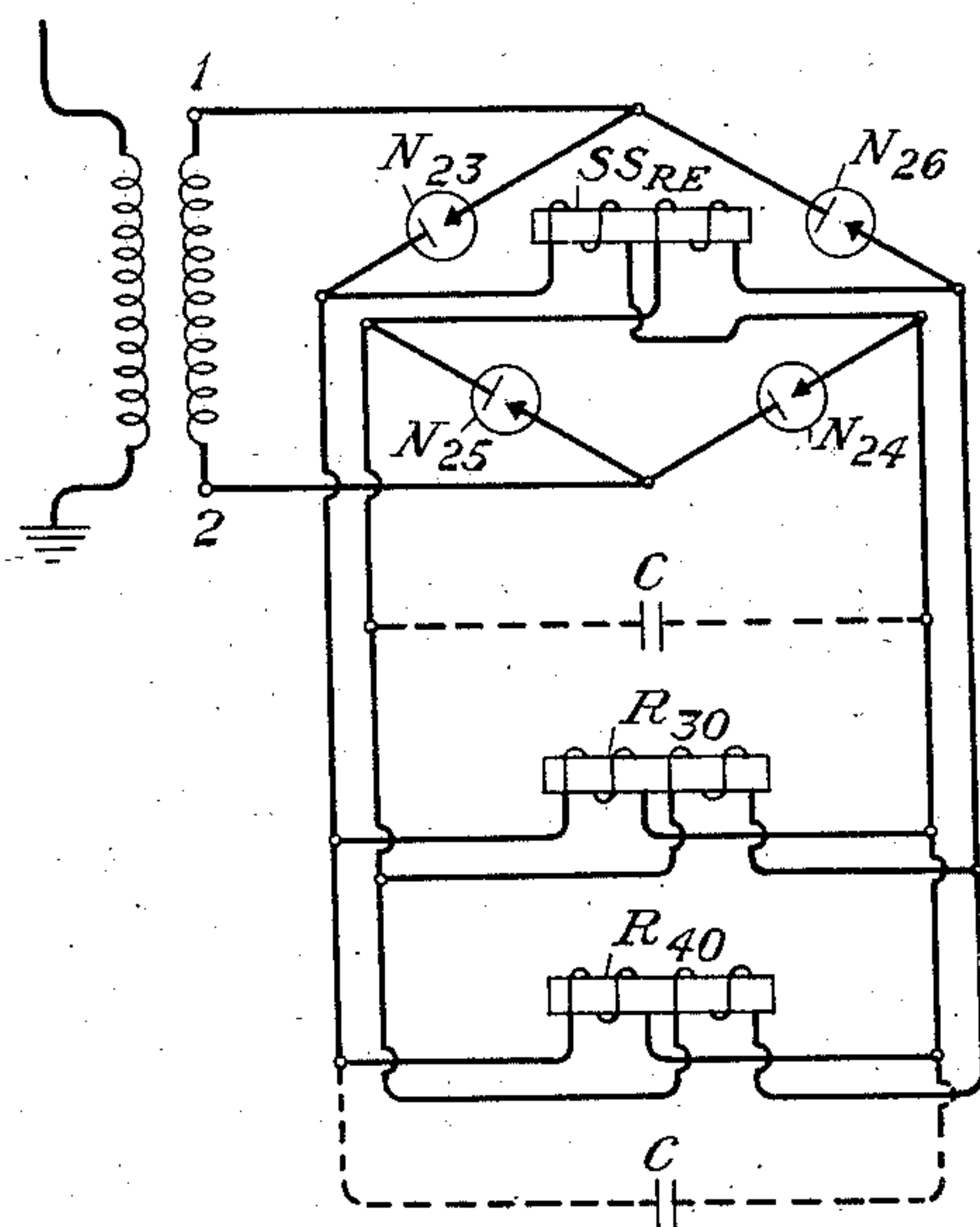


Fig. 2

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## UNITED STATES PATENT OFFICE

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## ELECTRICAL PROTECTIVE SYSTEM

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2 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 become impressed thereon.

Protector blocks having air gaps which break down at predetermined potentials have recently been used in the telephone art for the protection of telephone circuits from high voltages set up therein by one or more sources extraneous to the circuits themselves. Various arrangements have been used to accomplish this result. Some of the arrangements employed a resistor or a saturating reactor interposed in the ground connection of said protector blocks. The resistor or reactor as the case may be, carries all of the operating current of the blocks associated therewith. The impedance drop across the resistor or reactor is rectified by a rectifier which generally is of the copper-oxide type. The rectified current is applied to the winding of a relay which, when operated, shunts the protector blocks so that any induced current or currents are carried through the heavy duty contacts of the relay.

In other arrangements a saturating reactor or transformer has been employed to operate a common master relay which applies a local battery potential to the windings of a multiplicity of short-circuiting relays to cause simultaneous grounding of all conductors associated therewith. There is an advantage in eliminating the maintenance expense in connection with the dry cell batteries frequently used on the latter type of relay protector system, especially where these protectors are located in outlying districts.

It is not quite satisfactory to use rectifying apparatus of the copper-oxide type as now generally employed in short-circuiting relay protectors, since the characteristics of the rectifiers change rapidly with age and are subject to wide variations due to humidity. Moreover these rectifiers seldom return to their original state after a severe application of voltage or after the passage of a large current. Furthermore, the characteristics continuously change with variations in temperature. The most serious drawback to their use lies in the narrow range of operating current. Even with elaborate shunting arrangements, the range of operation from minimum to maximum operating current is decidedly limited and it is relatively easy to apply voltage to the copper-oxide rectifier discs which can exceed the safe value of the disc. When this limit is exceeded a rupture in the surface insulation of the

disc takes place, rendering them thereafter ineffective. All of the described defects substantially affect the sensitivity of the device and reduce its range of operation, and any arrangement, therefore, depending upon the use of copper-oxide rectifiers is especially undesirable.

As is well known in the art, the saturating transformer can be relied upon to hold the root mean square values of voltage to low values, even though the currents applied to the primary may rise to several hundred times the minimum operating current of a device applied to said transformer. However, it is known that peak voltages may be obtained on the secondary winding of the saturating transformers for very short periods of time. These voltages are of steep wave front and if directly applied to rectifiers of the copper-oxide type, these rectifiers would be almost immediately rendered ineffective due to the puncture of the surface insulation of the rectifier discs. These steep wave front surges, however, could be suppressed by the use of thyrite. This becomes undesirable due to the space dimensions of the thyrite required.

By employing gas tube rectifiers of the cold cathode type the possibility of damage (to the copper-oxide rectifiers) is greatly removed along with all the inherent disadvantages.

Furthermore, the gas tube devices can be made to operate only above a certain desired value of voltage. The current, therefore, passing to ground through the saturating transformer or reactor can be required to exceed a certain known value before operation of the short-circuiting relay takes place. Steep wave front voltages obtained on the secondary winding of the saturating transformer will not damage the gas tube rectifiers. Moreover, the gas tube rectifying devices can be designed to have a wide margin between the breakdown value of voltage and the voltage required to sustain the glow in the gas within the tube. This wide margin of voltage renders immediately available considerable energy for the operation of the short-circuiting relays. By employing the combination of a saturating reactor or transformer which permits of wide operating values of the device, with gas tubes of the rectifier type and sensitive direct current relays, short-circuiting of the protector blocks can be accomplished at high speed for currents to ground in excess of a certain desired value and without possibility of damage to the rectifier tubes and without the inherent limitations of the copper-oxide rectifying devices. The so-called sharply defined marginal or trigger opera-



tion that is obtained by the use of gas tubes which operate at values only in excess of certain predetermined values provides a decided advantage in that it does not short-circuit nor ground the  
 5 conductors for such steep wave front short-lived impulses as are obtained from small cloud discharges or static as commonly found on open-wire telephone conductors. Only currents of magnitudes which will damage the protector  
 10 blocks would cause operation of the relay protectors.

By employing a multiplicity of short-circuiting direct current relays the windings of which are connected either in series or in multiple or  
 15 by employing a common multi-contact short-circuiting direct current relay, the short-circuiting of practically any number of conductors may be accomplished with but small amounts of power derived from the protector blocks to ground.  
 20 Short-circuiting relays even though designed to carry considerable current will operate within a few thousandths of a second after current is passed across the open spaced protector blocks and these relays will restore to normal and re-  
 25 move the short circuit from said protector blocks in a few thousandths of a second after withdrawal of the potential between the exposed conductors and earth.

Furthermore biasing direct current potentials  
 30 may be used to raise or lower the operating value of the gas tubes and where the use of biasing potential becomes feasible and where this potential is properly poled, there is an added advantage in its use in that the direct current through the  
 35 relay will be increased.

This invention and the principles underlying it, some of which have been described hereinabove, will be better understood from the description hereinafter following when read in connection  
 40 with the accompanying drawing in which Fig. 1 represents one embodiment of the invention and Fig. 2 represents a modification of some of the apparatus shown in Fig. 1.

In Fig. 1 reference characters  $W_1$ ,  $W_2$ ,  $W_3$  and  
 45  $W_4$  represent four of a plurality of conductors to which are connected individual open spaced protector blocks  $P_1$ ,  $P_2$ ,  $P_3$  and  $P_4$ , respectively. The remaining terminals of said protector blocks are multiplied together and connected to the primary  
 50 winding of a saturating transformer or reactor  $T$ . To the secondary winding of said saturating transformer are connected a pair of gas rectifying tubes  $N_{21}$  and  $N_{22}$ . To said gas tubes are also connected the windings of short-circuiting  
 55 relays  $R_{10}$  and  $R_{20}$ , only two of which are shown. The remaining terminals of the windings of said relays  $R_{10}$  and  $R_{20}$  are connected to the midpoint of the secondary of the saturating transformer  $T$  or to said transformer terminal in series with  
 60 a source of biasing potential  $B$ , as shown. The biasing potential should at all times be less than the voltage required to sustain the glow within the gas tubes, otherwise the tubes when once operated would lock said short-circuiting relays  
 65  $R_{10}$  and  $R_{20}$  in the operated position.

The short-circuiting relays each have two windings in order that there be some ballast resistance in the circuit connected between the cathodes of the rectifying tubes. Gas tubes do not totally  
 70 block currents when poled in the reverse direction with respect to the alternating current cycle and the introduction of impedance to the flow of current in the reverse direction is required to prevent damage to the gas tubes.

75 Operation in Fig. 1 is as follows: Voltage ap-

plied to any one or all conductors  $W_1$  to  $W_4$  inclusive of sufficient amplitude to cause the breakdown of any one of the protector blocks  $P_1$  to  $P_4$  inclusive results in the passage of current through  
 5 the primary winding of the transformer  $T$ . This current introduces a potential in the secondary winding of said transformer and if of sufficient amplitude will cause current to pass from the anodes (designed by the arrows) to the cathodes  
 10 of the gas tubes  $N_{21}$  and  $N_{22}$  and thence through the windings of the short-circuiting relays  $R_{10}$  and  $R_{20}$  associated therewith and thence to the midpoint of the secondary winding of the transformer  $T$  through the source of biasing poten-  
 15 tial, if such a source is present and employed in the system. If the potential at 1 of the transformer  $T$  is positive and at 2 negative, the gas tube  $N_{21}$  will function and allow current to flow through the left-hand winding of relays  $R_{10}$  and  
 20  $R_{20}$ . If, however, the polarity is reversed, the gas tube  $N_{22}$  will function and allow current to flow through the right-hand windings of relays  $R_{10}$  and  $R_{20}$ . The passage of current through either of the windings of relays  $R_{10}$  and  $R_{20}$  causes the  
 25 armatures to be attracted to their contacts, resulting in the simultaneous short-circuiting of the protector blocks  $P_1$  to  $P_4$ , respectively. Current from the conductors to earth will continue to pass through the transformer  $T$  and the short-circuiting  
 30 relays associated with said transformer will be held operated until the disappearance of the applied potential or until it has dropped to a value less than that required to sustain the glow within the gas tubes.

In Fig. 2 full wave rectification is also ob-  
 35 tained by utilizing four gas rectifying tubes of the cold cathode type. If the potential is positive at 1, current will pass through the gas tube  $N_{23}$  and through the left-hand windings of the short-circuiting relays  $R_{30}$  and  $R_{40}$  associated  
 40 therewith to the gas tube  $N_{24}$  and returning to the transformer at 2. For a potential of opposite polarity, current will pass through the gas tube  $N_{25}$  to the right-hand windings of the short-circuiting relays  $R_{30}$  and  $R_{40}$  associated there-  
 45 with and thence through gas tube  $N_{26}$  and returning to the transformer at 1.

It will be understood that the individual short-circuiting relays can be replaced by a single short-circuiting relay having a multiplicity of arma-  
 50 tures and contacts, said individual relay containing two windings, provided the gas tubes can pass current in the inverse position of the alternating current wave. Where cold cathode gas tubes can be designed to pass current in but one  
 55 direction, a single wound relay need only be employed. It will be furthermore understood that the gas tubes of the cold cathode type may be replaced by gas tubes of the hot cathode type, in which case but a single winding will be re-  
 60 quired on the short-circuiting relays, as will be apparent to those skilled in this art. It will be furthermore understood that a condenser  $C$  or condensers  $C$  may, if desired, be used to shunt the windings of the relays to prevent chatter of  
 65 said relays by supplying current during the period in the alternating current cycle when there is no current being passed by the gas tube rectifiers.

While this invention has been described and shown in said particular arrangements merely for  
 70 the purpose of illustration it will be understood that the general principles 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. Apparatus for the protection of a plurality of circuits exposed to inductive interference comprising a plurality of protector blocks one terminal of each of which is connected to a corresponding circuit, a transformer the primary winding of which is connected between the other terminal of each of said protector blocks and ground, two two-electrode cold cathode gas-filled rectifier tubes, a relay having two windings each of which is connected in series with one of said tubes and one-half of the secondary winding of said transformer, and means responsive to the operation of said relay for simultaneously shunting all of said protector blocks.

2. Apparatus for the protection of a plurality of circuits exposed to inductive interference com-

prising a plurality of protector blocks one terminal of each of which is connected to a corresponding circuit, a transformer the primary winding of which is connected between the other terminal of each of said protector blocks and ground, two two-electrode cold cathode gas-filled rectifier tubes, a biasing battery having a terminal voltage which is less than the voltage for sustaining ionization with said tubes, a relay having two windings each of which is connected in series with one of said tubes and the biasing battery and one-half of the secondary winding of said transformer, and means responsive to the operation of said relay for simultaneously shunting all of said protector blocks.

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