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ELECTRICAL PROTECTIVE SYSTEM

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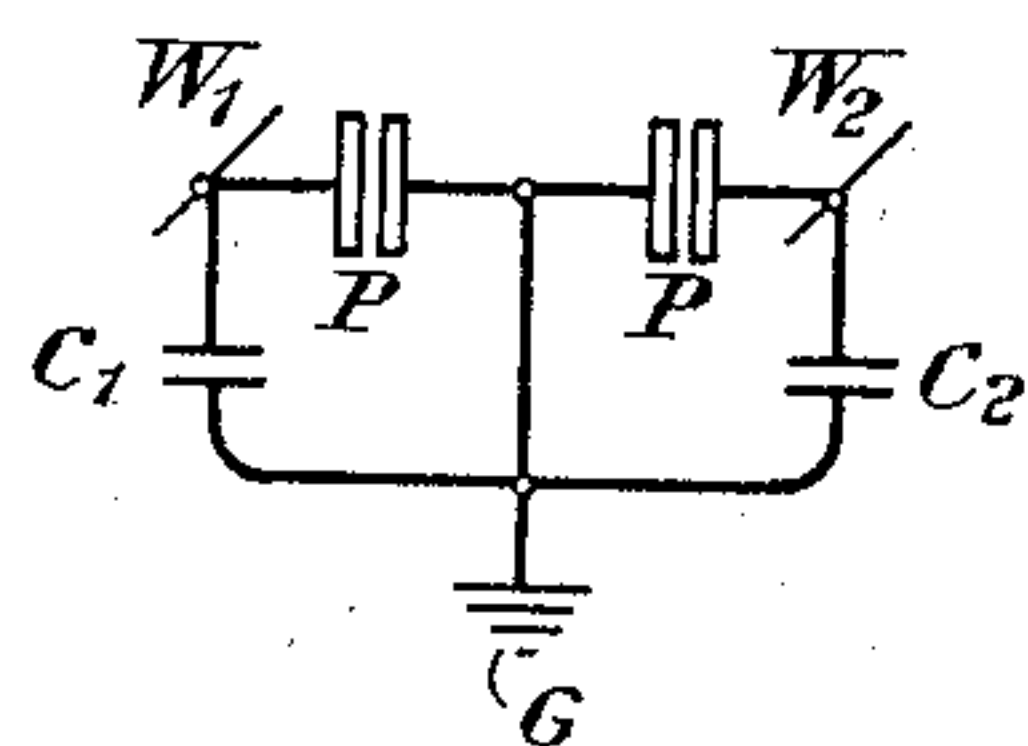


Fig. 1

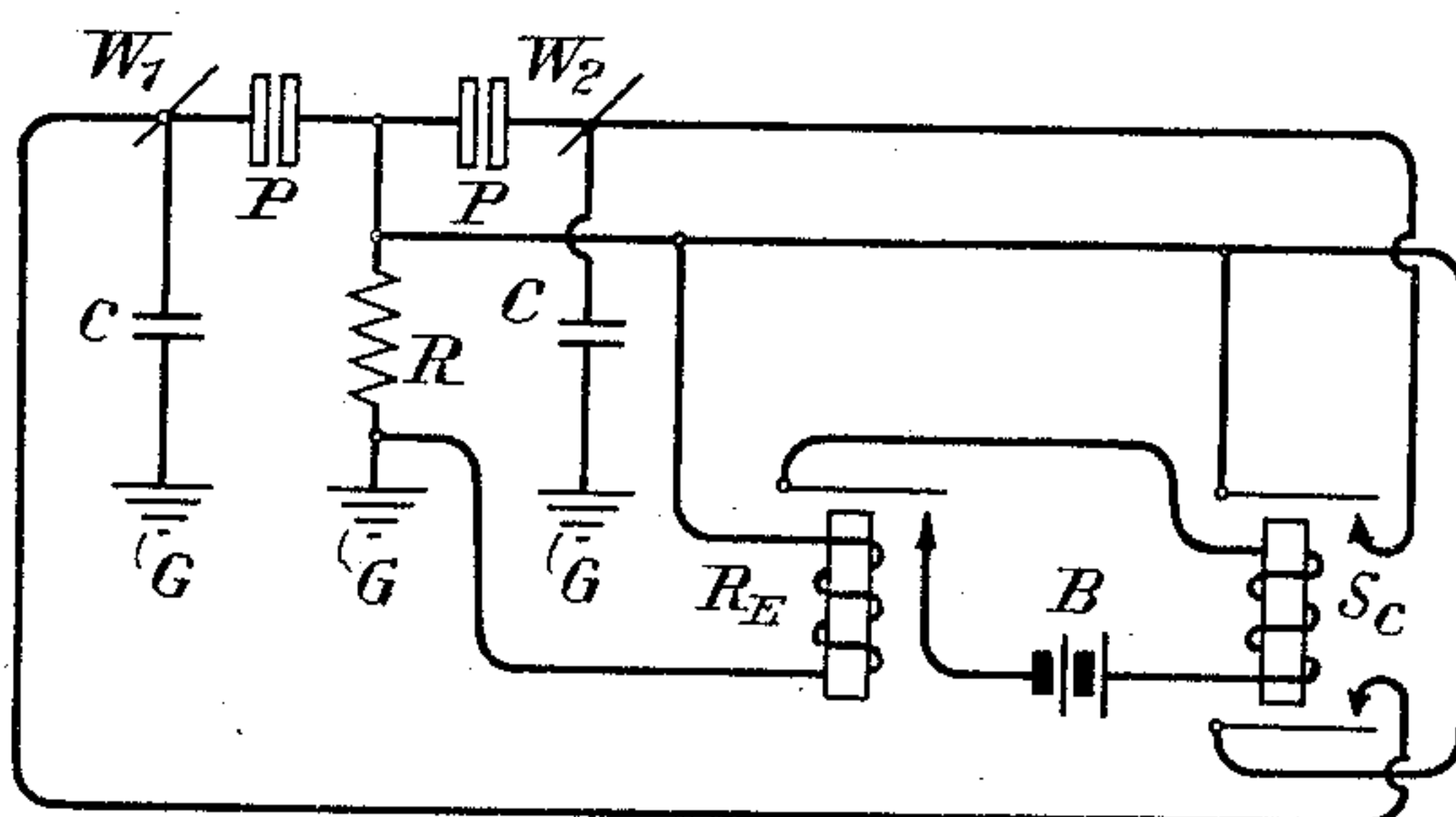


Fig. 2

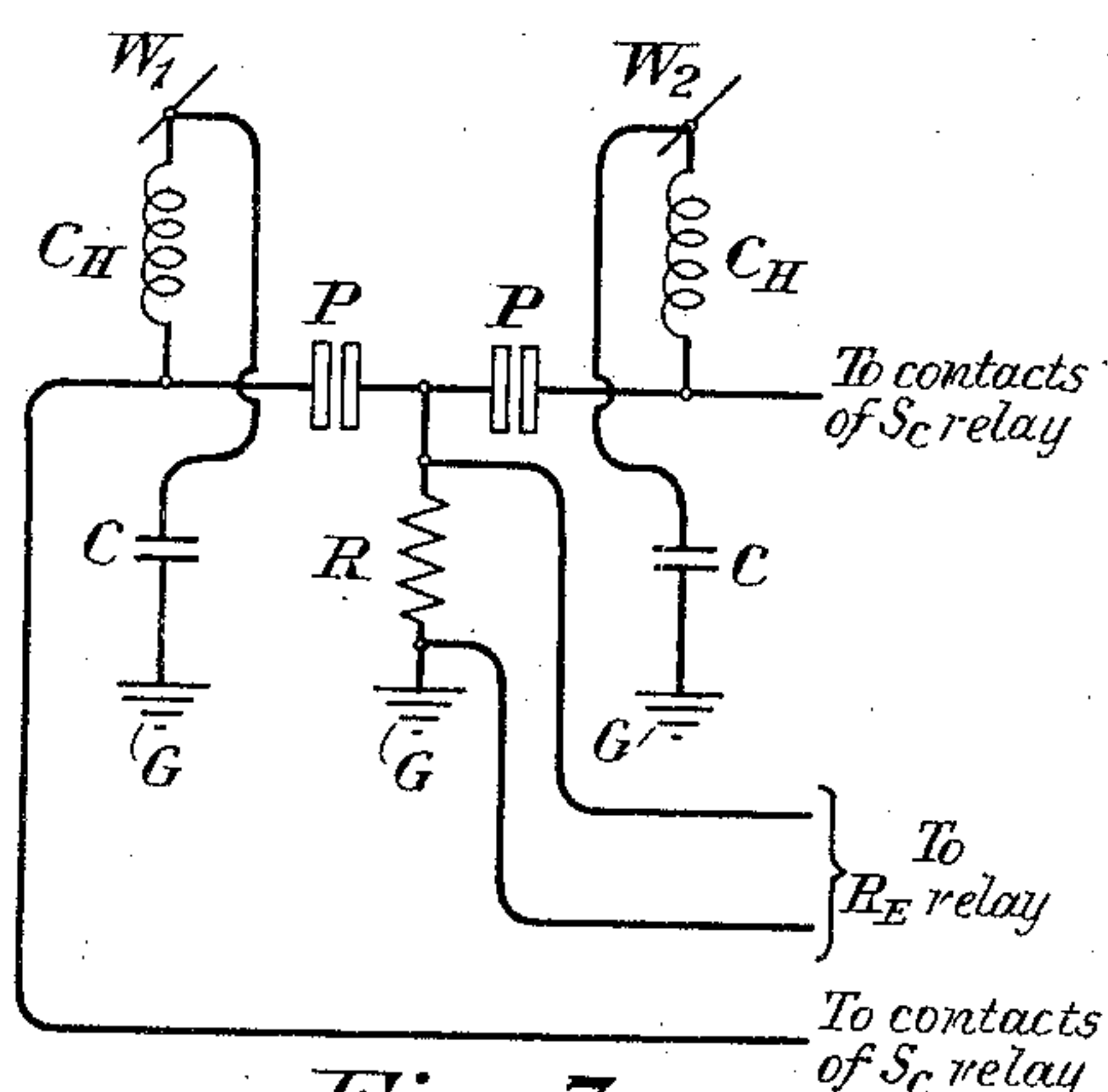


Fig. 3

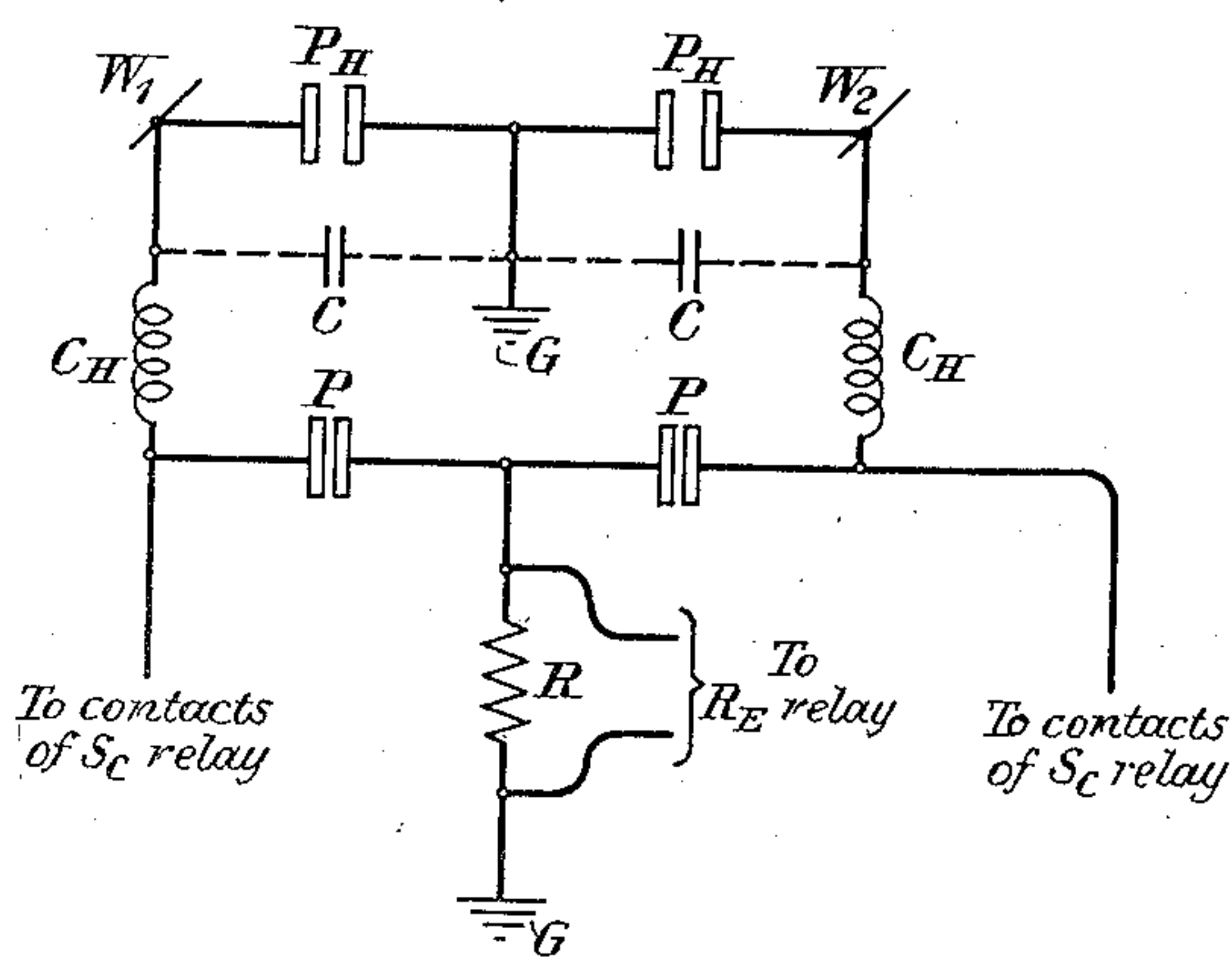


Fig. 4

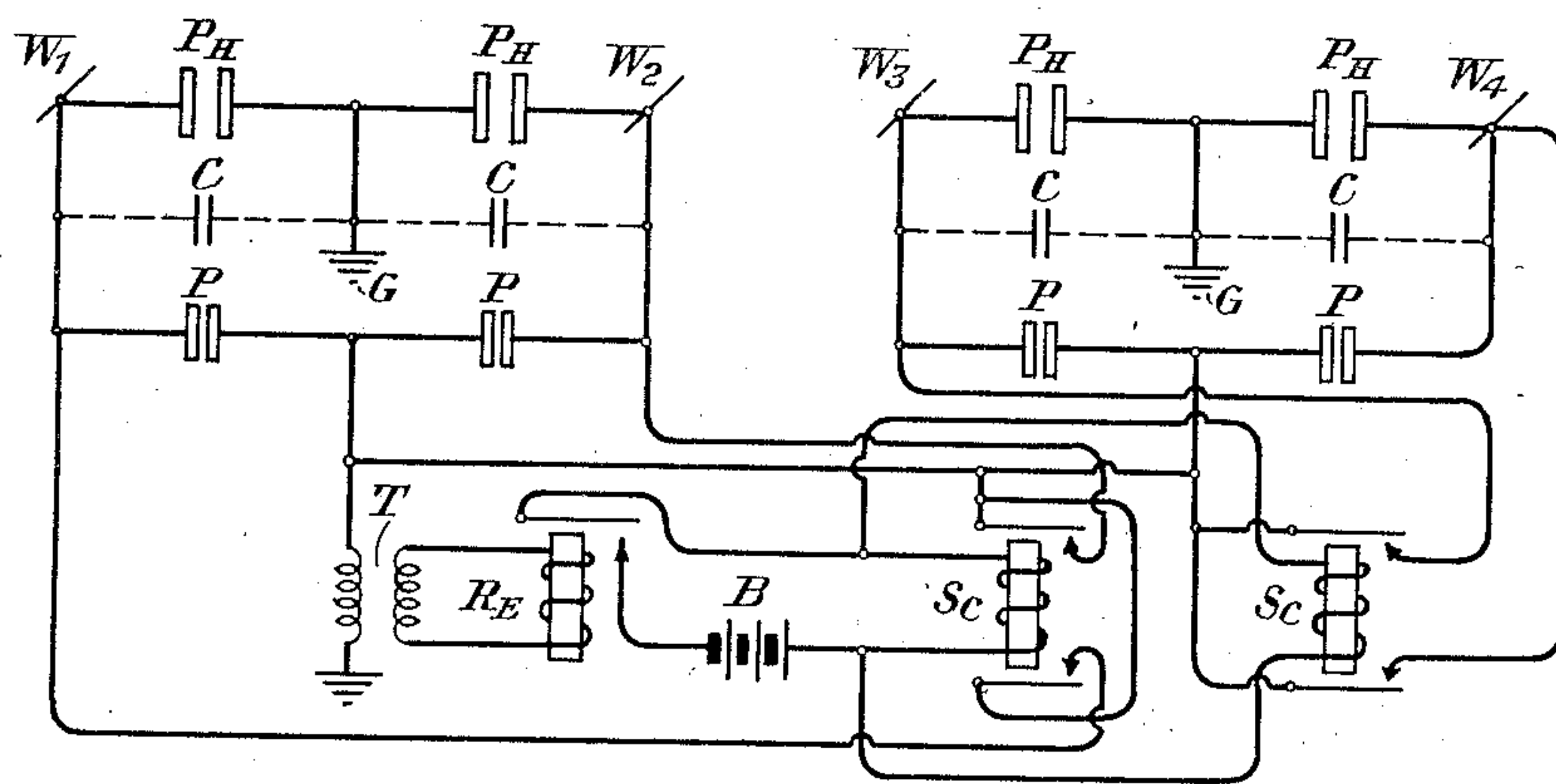


Fig. 5

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ELECTRICAL PROTECTIVE SYSTEM

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9 Claims. (Cl. 179—78)

This invention relates to electrical protective systems. More particularly, this invention relates to arrangements for reducing the current through protective blocks when these blocks are operated from lightning potentials, the reduction being made for the purpose of limiting circuit outages to a minimum.

In present open wire line protection systems where the current carrying conductors are exposed to extraneous potentials of magnitudes which will cause the operation of protector apparatus, it is the practice in this art to provide a pair of protector blocks connected to each end of or at various points along the conductor and ground, each of said protector blocks having a spacing of, for example, .003 inch between its electrodes. Such protector blocks may be considered as closely spaced devices and are intended to protect the current carrying conductor against induced voltages due to outages on parallel or other electrical systems which may induce undesired voltages in the conductor or conductors.

In addition to the aforementioned protector blocks a second set of protector blocks may be provided, each of which may have a wider spacing between its electrodes of, for example, .007 inch. The latter protector blocks operate at a substantially higher voltage than the blocks of smaller electrode spacing, but the wider spaced blocks are employed for conducting to ground steep wave front surges produced, for example, by lightning discharges and such other voltages as the closer spaced blocks fail at times to conduct to ground.

It is now common in this art to provide a system of short-circuiting relays to short-circuit the protector blocks within a few thousandths of a second after the passage of a current through any one of these blocks. After these short-circuiting relays become operated, they remain operated throughout the entire interval of application of voltage to the conductor or conductors to which they are connected, and maintain the blocks with which they are associated short-circuited throughout this entire time interval. Lightning impulses, however, last but a few microseconds, and the relay apparatus therefore provides but a small and almost negligible amount of protection for that type of impulse. It is accordingly one of the primary objects of this invention to provide a protector system which will give adequate protection against these extremely brief lightning discharges or other impulses of steep wave front

and at the same time provide protection against those interfering voltages which are induced into the conductor or conductors transmitting signals, the induction arising on account of exposure of these conductors to parallel circuits or other extraneous sources.

Experience has shown that a very much larger number of operations can be withstood by the wider spaced protector blocks than by those of the closer spaced type. As it is not possible to protect the closer spaced blocks against lightning impulses to prevent their becoming grounded by the action produced by these impulses, it now becomes desirable to shunt a large part of the lightning current through the wider spaced blocks which, of course, can withstand a considerably larger number of operations than the closer spaced devices before they become grounded. The shunting of the lightning currents out of the circuits of the closer spaced blocks and causing these lightning currents to take a path through the wider spaced blocks to ground, may be accomplished by the use of inductances and condensers, as will be shown more clearly hereinafter.

This invention will be better understood from the detailed description hereinafter following when considered in connection with the accompanying drawing, in which Figures 1 to 5 disclose different embodiments for carrying out the principles of this invention.

Referring to Fig. 1 of the drawing, the reference characters W_1 and W_2 represent a pair of a plurality of conductors or circuits which may be used, for example, for signaling purposes and to which may be connected a plurality of protector blocks P , as shown. One side of each of the protector blocks P is connected directly to one of the conductors W_1 or W_2 , while the other side of each protector block is connected to ground through a circuit of very low inductance. In order to shunt the steep wave front impulses to ground, condensers C_1 and C_2 are provided. These condensers should be equal in magnitude in order not to disturb the uniform capacitance of the conductors W_1 and W_2 to ground, and moreover, they should be of reasonably small capacitance.

Where relay protector apparatus is desirable, the arrangement shown in Fig. 2 may be employed. Here the protector blocks P have the terminal common to them connected to ground through a resistance or a saturating reactor or transformer R . The conductors W_1 and W_2 , the protector blocks P and the condensers C are in-

terconnected in substantially the same manner as shown in Fig. 1 except for the addition of the impedance R and the apparatus connected to this impedance. The high frequency impulses such as lightning, static and other discharges are conducted to ground through either or both of the condensers C. On the other hand, the current of low frequency impulses will be transmitted through either or both of the protector blocks P and through the resistance or reactor or transformer R. The potential drop set up across the impedance R will operate the alternating current relay R_E, the winding of which is connected across the terminals of the impedance R. The operation of the relay R_E will operate the short-circuiting relay S_C, the winding of which is connected in series with a battery B and the armature and contact of the relay R_E. Upon the operation of the relay S_C, shunt paths will be provided around the protector blocks P so that all of the extraneous voltages impressed upon the conductors W₁ and W₂ will be transmitted to ground through the impedance R, the interconnecting path around each protector block P including one of the armatures of the relays S_C and its contact. For impulses of very short duration, the short-circuiting relay protector apparatus may not have sufficient time to operate, in which event most of the current will pass to ground through either or both of the condensers C.

Where it is desirable to further limit the current from steep wave front impulses which may tend to flow through the protector blocks P from the conductors W₁ and W₂ upon which these steep wave front impulses may be impressed, the arrangement of Fig. 3 may be employed. The reference characters C_H designate radio frequency chokes of sufficient current carrying capacity and of low capacitance, each of which is connected between one of the conductors W₁ and W₂ and its respective protector blocks P, as shown. This arrangement causes most of the radio frequency current to follow the path through the condensers C to ground. The currents of lower frequency will be transmitted from the conductors W₁ and W₂ through either or both of the radio frequency chokes C_H, then through the protector blocks P and then through the resistance or saturating reactor R to ground. The potential set up across the impedance R, as already described, may operate short-circuiting relay equipment which provides protection for the protector blocks P throughout the duration of the lower frequency surge.

In Fig. 4, the conductors W₁ and W₂ are directly connected to wider spaced protector blocks P_H, as shown. As already explained, each of the blocks P_H has a wider spacing between its electrodes than those designated P which have been already described in connection with Figs. 1, 2 and 3. The protector blocks P_H of Fig. 4 are arranged so that their common terminal is connected to ground through a circuit of low inductance. In this arrangement the radio frequency chokes C_H are located in series with the lower voltage protector blocks P which have smaller electrode spacing. The terminal common to the blocks P is connected to ground through the impedance R in the manner already shown and described in connection with Figs. 2 and 3. The impedance R may also be connected to relay equipment and the contacts of relays (not shown) for the purpose of protecting the protector blocks P.

In both Figs. 3 and 4, the terminals of the impedance R may, if desired, be connected to the terminals of an alternating current relay such as R_E, which is shown in Fig. 2. The relay R_E may control the operation of a short-circuiting relay S_C, also shown in Fig. 2, and the latter relay may have a plurality of armatures, two of which are shown in the drawing, each of which controls a circuit which bridges one of the protector blocks P.

Most of the current of steep wave front will pass to ground through the protector blocks P_H and only a very small amount of this steep wave front current will be conducted to ground through the circuit which includes the radio frequency chokes C_H, the respective protector blocks P and the common impedance R. Condensers C may, if desired, be employed to shunt the high voltage protector blocks P_H, as shown, in order to provide a shunt path to ground around the protector blocks P_H for the passage of steep wave front signals.

It will be understood that the protective equipment comprising the alternating current relay R_E, the relay S_C, the battery B and the saturating transformer or resistance R may, if desired, be dispensed with and the midpoint of the protector blocks P may be directly connected to ground. In the latter instance there will be no short-circuiting path for each of the protector blocks P.

In Fig. 5 four conductors W₁, W₂, W₃ and W₄ are shown and these, of course, may be open wire lines or conductors between which high voltage protector blocks P_H may be connected, as shown. Each of the protector blocks is connected between one of the conductors W₁ to W₄ and ground through a path of low inductance. The conductors W₁ to W₄ are each connected to a low voltage protector block P of narrower electrode spacing, each of the latter protector blocks P being connected to one of the conductors and to ground through the primary winding of a saturating reactor or saturating transformer T which is of low distributed capacity. The winding of the alternating current relay R_E is connected to the secondary winding of the transformer T and this relay is operated by the potential set up across the transformer T. The potential set up across the device T is obtained from current passed to ground through the protector blocks P and through the reactor or the primary winding of the transformer T. After the relay R_E becomes operated, the short-circuiting relays S_C will become operated by virtue of the flow of current from the battery B over the armature and contact of the relay R_E to and through the windings of the relays S_C, thereby attracting the armatures of the relays S_C. It will be observed that one of the armatures of each of these relays completes a circuit which shunts one of the protector blocks P.

In the case of high voltage steep wave front impulses, most of the current will pass directly to ground through the protector blocks P_H although a very much smaller part of the current will pass to ground through the protector blocks P and through the primary winding of the transformer T. By virtue of the high impedance of the primary winding of the transformer T, comparatively little of the steep wave front current will pass through the protector blocks P, and practically all of it will find its way to ground through the protector blocks P_H.

In providing an arrangement having two distinct shunt circuits interconnected between each

conductor and ground, one of the circuits including a protector block P of narrow electrode spacing and the other a protector block P_H of substantially wider electrode spacing, the apparatus is suitable for protection against all kinds of extraneous or undesired voltages. As by far the larger part of the lightning impulses are transmitted through the protector blocks P_H, which can stand a much larger number of operations from lightning than can the protector blocks P, the protector blocks P will resist permanent grounding due to lightning discharges for a considerably longer period of time than would be the case if the circuits of the blocks P_H were not incorporated into the system. Of course voltages of low frequency of sufficient amplitude will normally break down the protector blocks P and cause current to pass from these various conductors to ground through the reactor or transformer T, thereby operating the alternating current relay R_E and the short-circuiting relays S_C which provides short-circuiting paths around the protector blocks P.

It will be understood that in the arrangement shown in Fig. 5, as in the case of Fig. 4, condensers C of small capacitance may be shunted around the protector blocks P_H for the purpose of by-passing steep wave front signaling impulses.

In all the arrangements shown and described hereinabove, the wiring of the various protector blocks to the various conductors and ground should be accomplished in such a way as to reduce the inductance of this wiring to a minimum. In designing the saturating reactor or transformer T, its distributed capacity should be a minimum.

In the various arrangements shown and described hereinabove, the short-circuiting relay or relays S_C may, if desired, be entirely omitted, in which event, it may be desirable to employ an alternating current relay R_E of the multi-contact type, each of the contacts of which may provide a short-circuiting path for one of the protector blocks. In the latter arrangement the battery B will also be entirely dispensed with.

It is also possible to entirely omit the transformer T as well as the short-circuiting relays S_C and the battery B. This may be accomplished by interposing between the conductor common to the protector blocks P and ground, the winding of the alternating current relay R_E. In this case the relay R_E should be of the multi-contact type and its winding of the saturating type, which at the same time should have a low distributed capacity. In the latter arrangement each of the contacts of the alternating current R_E will be employed to provide a shunt path for one of the protector blocks P.

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 line transmitting signaling currents, a circuit having a protector block, said protector block forming the only interrupter of said circuit, said circuit being permanently connected between the line and ground for by-passing currents induced in the said line on account of its exposure to extraneous sources, and a separate circuit coupled to said line for by-passing lightning discharges.

2. The combination of an open wire line, two separate circuits permanently interposed between said line and ground at each of a plurality of predetermined points along the length of said line, one of said circuits including means in the form of a fixed gap device for by-passing currents induced into said line and arising from exposure to extraneous sources, and the other of said circuits including means for by-passing lightning discharges impressed on said line.

3. The combination of a signaling conductor and two permanently parallel electrical circuits interposed between a point on said conductor and ground, one of said circuits including a protector block as the sole circuit interrupter and a radio frequency choke coil through which is by-passed energy induced into said conductor from an extraneous source, and the other of said circuits including a condenser for by-passing steep wave front impulses impressed upon said conductor.

4. The combination of a conductor exposed to inductive interference, two separate electrical circuits connected in parallel between said conductor and ground, one of said circuits including a radio frequency choke coil and a protector block having two electrodes, the other of said circuits including a protector block having two electrodes of wider spacing, both circuits being always closed except at the gaps of the respective protector blocks.

5. The combination of a conductor exposed to inductive interference, two independent circuits interposed between said conductor and ground, two protector blocks each having a pair of electrodes, the electrodes of one of said blocks being spaced by a greater distance than are the electrodes of the other of the blocks, each of said blocks being interposed in series in one of said circuits, and means responsive to the passage of current through the circuit which includes the block of wider electrode spacing to by-pass the block of narrower electrode spacing.

6. Apparatus for the protection of current carrying conductors exposed to inductive interference comprising two independent circuits interposed between the exposed conductor and ground, one of said circuits including a protector block having two electrodes which are widely spaced from each other, the other of said circuits including a radio frequency choke coil and a protector block having electrodes which are spaced by a very narrow gap, and means responsive to the flow of current through the latter circuit to completely shunt and by-pass the protector block included in the latter circuit as long as current continues to flow through the latter circuit.

7. The combination of an exposed current-carrying conductor, a circuit connected between said conductor and ground, said circuit including a two-electrode protector block for by-passing interfering currents impressed on said conductor from extraneous sources and remaining otherwise continuously closed except at the protector block, and means to prevent the grounding of said protector block upon the application of lightning potential to said line, said means including a circuit for shunting current produced by the lightning potential away from the circuit of said protector block.

8. The combination of a two-electrode device and means to prevent the grounding of said device upon the application of an abnormally high potential, said means comprising an electrical circuit in shunt with said two-electrode device through which the abnormally high potential may be passed, said circuit being non-interruptible

during the application of said abnormally high potential.

9. A protector arrangement for protecting a telephone line against interfering and dangerous potentials which may become impressed thereon, comprising two parallel circuits connected between said conductor and ground, said two par-

allel circuits respectively including two two-electrode protector blocks of different electrode spacing and being non-interruptible during the application of said interfering and dangerous potentials.

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