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ELECTRICAL PROTECTIVE SYSTEM

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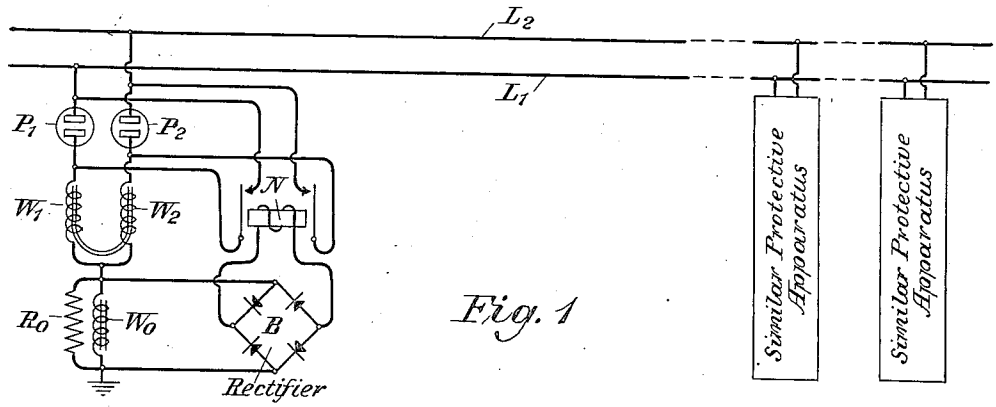

Fig. 1

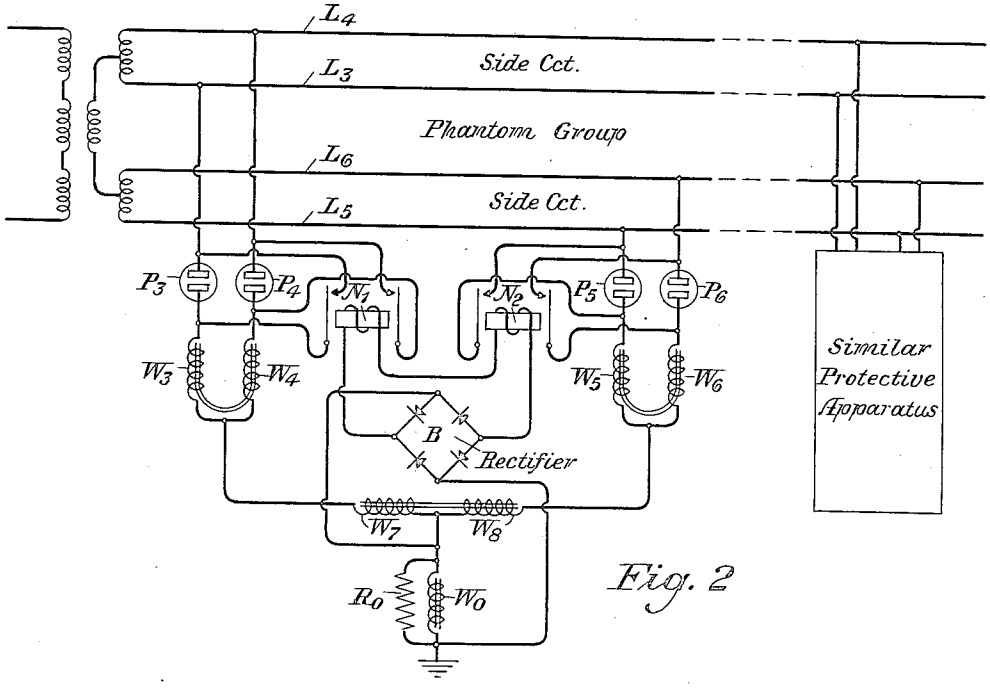

Fig. 2

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ELECTRICAL PROTECTIVE SYSTEM

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4 Claims. (Cl. 179—78)

This invention relates to electrical protective systems. This invention also relates to arrangements for simultaneously grounding a plurality of conductors when any one or more of the various conductors becomes impressed with a high voltage induced therein from a power circuit or other extraneous source. This invention further relates to apparatus for substantially reducing acoustic shock in the telephone receivers and other devices connected to the various exposed conductors when high voltages become impressed thereon.

A group of protector 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 a group of conductors which are exposed to extraneous voltage effects. In these arrangements a resistor or saturating reactor is usually connected between the various protector blocks and ground. When the gap of one or more of the protector blocks breaks down upon the application of a high voltage to the exposed conductors, a substantial current will flow through the resistor or reactor. The resistor or reactor, as the case may be, is connected to apparatus including a relay which operates when current flows through the resistor or reactor. The operation of the relay may be employed to provide a plurality of circuits each of which will shunt one of the various protector blocks associated with one of the exposed conductors, thereby preventing the permanent short circuiting of said protector blocks.

In the arrangements just referred to, the circuits which are provided by the relay for the purpose of shunting the various protector blocks are completed some time after the extraneous voltage or voltages have reached the various exposed conductors. In other words, the operation of the relays to short-circuit the protector blocks is not instantaneous. During this interval of delay the voltage upon one of the exposed conductors may be different from that upon the other (or another) exposed conductor, due to the lack of symmetrical operation of the protector blocks. There will, therefore, be a metallic voltage between any pair of such conductors and this metallic voltage may be sufficient to cause acoustic shock in telephone receivers or other devices connected to these conductors. This metallic voltage, moreover, may be so high as to shock linemen and others working with the circuits.

The present invention is intended to overcome the defects just referred to. The apparatus employed in carrying out the principles of this invention will, in effect, simultaneously ground all of the exposed conductors when a single one of these conductors becomes impressed with a high and predetermined voltage such as that due to lightning or as the result of exposure to a power circuit. Before the various exposed conductors become grounded, the voltages applied to the various conductors will be equalized, in which case there will be very little metallic voltage between these conductors, and the danger to the apparatus connected to the circuits and to the people working with the circuits will be greatly diminished.

This invention will be better understood from the detailed description hereinafter following, when read in connection with the accompanying drawing. Figure 1 of this drawing shows one embodiment of this invention illustrating a plurality of protector blocks connected to exposed conductors, and the circuits include what will be termed a discharge balance coil, a saturating reactor and apparatus for simultaneously grounding all of the conductors soon after any one of these conductors has become exposed to a large inductive effect. Fig. 2 illustrates an improved form of arrangement for carrying out the principles of this invention in which the invention is applied to a phantom group of circuits.

Referring to Fig. 1 of the drawing, the reference characters L_1 and L_2 represent two of a plurality of exposed conductors which will be used for transmitting telephonic currents or other currents used in the transmission of signals. These conductors are connected to a pair of protector blocks P_1 and P_2, as shown. The terminals of the protector blocks P_1 and P_2 are connected to the terminals of a pair of equal windings of a discharge balance coil W_1 and W_2, which have the same number of turns and which are mounted upon a common core of, for example, iron, so that they will have a large mutual inductance therebetween. The midpoint or terminal common to the windings W_1 and W_2 is connected to ground through a saturating reactor or transformer W_0. A resistor R_0 may be connected in shunt with the reactor W_0.

The terminals of the saturating reactor W_0 are connected to the input terminals of a full wave rectifier B which may be, for example, of the copper oxide type. The output terminals of the rectifier B are connected to the terminals of the winding of a relay N. The armature at the left of the relay N and its contact, provide a circuit for shunting the protector block P_1, while the armature at the right of the relay N and its

contact, provide a circuit for shunting the protector block P_2.

Similar protective apparatus may be connected to the conductors L_1 and L_2 at other points along their length, as indicated in the drawing.

When voltage becomes impressed upon the conductors L_1 and L_2, of sufficient amplitude to break down the gap of one of the protector blocks, for example, P_1, but of insufficient amplitude to break down the gap of the other protector block, i. e., P_2, current will flow from the conductor L_1, through the winding W_1, through the saturating reactor W_0 and the parallel resistor R_0, to ground. The voltage appearing across the terminals of the saturating reactor W_0 will be rectified by the rectifier B and the rectified current will operate the relay N, the armatures of which will provide circuits for shunting both of the protector blocks P_1 and P_2. Before both of the protector blocks become shunted by the circuits provided by the armatures of the relay N, the discharge balance coil windings W_1 and W_2 introduce their effect against acoustic shock, this effect being transmitted to the protector blocks and to the conductors L_1 and L_2 to which they are connected.

Immediately after the protector block P_1 breaks down and so connects the conductor L_1 to ground through the discharge balance coil winding W_1 and the parallel arrangement of reactor W_0 and resistor R_0, a large voltage will be induced in the discharge balance coil winding W_2 by virtue of the close coupling between windings W_1 and W_2. The voltage induced in the winding W_2 is of such a magnitude and in such a direction that it will bring about the break-down of the gap of the protector block P_2. When this occurs the conductor L_2 will be connected to ground through the winding W_2 and the parallel arrangement of reactor W_0 and resistor R_0. Both of the conductors L_1 and L_2 will then be simultaneously grounded, as already pointed out, and large currents will be able to flow freely between these conductors and ground.

The windings W_1 and W_2 are so wound about their common core that voltages impressed upon the respective exposed conductors L_1 and L_2 will cause current to flow through the windings W_1 and W_2 and establish fluxes in the common core of iron which are in mutually opposite directions. After both of the protector blocks P_1 and P_2 have become broken down, or after the armatures of the relays N have provided circuits in shunt with the protector blocks P_1 and P_2, the flow of current through the windings of the discharge balance coil will produce mutually opposite fluxes in the core and these will practically balance and neutralize each other. Under such conditions the resultant flux in the core will be practically negligible.

Thus it will be seen that the discharge balance coil windings W_1 and W_2 are so arranged in the circuit that they tend to equalize the voltage to ground of the two exposed conductors L_1 and L_2, and they therefore prevent the appearance of a metallic voltage between these conductors of such a magnitude as to produce acoustic shock either in the operator's receiver or in the subscriber's receiver, or in any other apparatus connected to the circuit. The windings W_1 and W_2 produce their greatest effect immediately after a single protector block has broken down, and they produce voltages which not alone swiftly break down the gap of the other protector block but they also speed up the operation of the relay N which is used for the purpose of shunting the various protector blocks out of the circuit. In other words, any asymmetrical operation of the protector blocks is quickly overcome by the effect of the windings W_1 and W_2, and the asymmetrical condition is readily converted into a symmetrical condition without the production of metallic voltages and the accompanying acoustic shocks.

Fig. 2 shows an improved arrangement which may be used in connection with a phantom group of circuits. Here the reference characters L_3 and L_4 represent one of the side circuits, the reference characters L_5 and L_6 represent another of the side circuits, and these two side circuits, together, comprise a phantom circuit, as is well known. The conductors L_3 and L_4 are connected to the protector blocks P_3 and P_4, while the conductors L_5 and L_6 are connected to the protector blocks P_5 and P_6, respectively. The protector blocks P_3 and P_4 are connected to equal discharge balance coil windings W_3 and W_4, while the protector blocks P_5 and P_6 are connected to the discharge balance coil windings W_5 and W_6, respectively, the various discharge balance coil windings W_3 to W_6 being similar to those described in connection with Fig. 1. The conductor common to the windings W_3 and W_4 is connected to the conductor common to the windings W_5 and W_6 through a circuit which includes additional discharge balance coil windings W_7 and W_8 which are also equal windings upon a common core such as iron. The terminal common to the windings W_7 and W_8 is connected to ground through a saturating reactor across which a resistor R_0 may be connected, if so desired.

As in Fig. 1, the reactor W_0 is connected to the input terminals of the full wave rectifier B, while the output terminals of the full wave rectifier B are connected with the windings of a pair of relays designated N_1 and N_2, as shown. A sufficient voltage appearing across the reactor W_0 will be rectified by the rectifier B, and the current derived from the rectifier will flow through the series-connected windings of the relays N_1 and N_2 and cause their operation. The two armatures of the relay N_1 will provide circuits for shunting the protector blocks P_3 and P_4, while the armatures of the relay N_2 will simultaneously provide circuits for shunting the protector blocks P_5 and P_6.

It will be apparent that if one of the protector blocks P_3, for example, breaks down because of the presence of a large extraneous voltage upon the conductor L_3, the voltage induced in the discharge balance coil winding W_4 will promptly bring about the breakdown of the gap of the protector block P_4. Similarly, the breakdown of the gap of either of the protector blocks P_5 or P_6 will produce an inductive effect in the discharge balance coil winding associated with the protector block that is not broken down so that that protector block may also be promptly broken down. By virtue of the common connection of the discharge balance coil windings W_3, W_4, W_5 and W_6 through the circuit which includes the discharge balance coil windings W_7 and W_8, any breakdown of one of the circuits associated with any one of the various conductors as, for example, L_4, will cause a voltage to be produced across the winding W_8, which will bring about the prompt breakdown of the gaps of both of the protector blocks P_5 and P_6. Similarly, any breakdown of the gap of one of the protector blocks, such as P_5, will not alone bring about the breakdown of the protector blocks P_6, but a large voltage will be induced in the discharge balance coil winding W_7 which will

promptly break down the gaps of both of the protector blocks P_3 and P_4.

Thus, it will be observed, the discharge balance coil windings W_3 and W_4 are provided to protect the side circuit of conductors L_3 and L_4 against acoustic shocks to the receivers or other devices connected with that side circuit, and the discharge balance coil windings W_5 and W_6 protect the side circuit composed of conductors L_5 and L_6 against acoustic shocks to the receivers or other devices connected to the latter side circuit, at the same time the discharge balance coil windings W_7 and W_8 act to diminish acoustic shock to any receivers or apparatus connected to the phantom circuit formed by the two side circuits.

It will be apparent that in Fig. 1, for instance, the resistor R_0, coil W_0, rectifier B and relay N may be replaced by an alternating current relay having a winding connected between the terminal common to windings W_1 and W_2 and ground and preferably wound upon a saturating core, the relay having two armatures which may be used to shunt the blocks P_1 and P_2 in the same manner as described in connection with relay N.

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. Apparatus for the protection of a pair of conductors exposed to inductive or extraneous interference comprising a pair of protector blocks, a pair of coils wound upon a common core of magnetic material, a saturating reactor one terminal of which is connected to ground and the other terminal of which is connected to both of the exposed conductors, the connection to each of the exposed conductors being established through one of the coils wound upon the iron core and the corresponding protector block, and means coupled to the saturating reactor responsive to a voltage impressed thereacross for simultaneously shunting both of the protector blocks.

2. Apparatus for the protection of a pair of conductors exposed to inductive or extraneous interference and for preventing acoustic shock in circuits connected to said conductors comprising a pair of protector blocks, a pair of coils wound upon a common core of magnetic material, each of which is connected to one of the exposed conductors through its corresponding protector block, a saturating reactor common to the coupled coils of wire, and means including a relay responsive to the flow of current through the saturating reactor providing paths in shunt with the protector blocks.

3. Apparatus for eliminating acoustic shock in the circuits of a pair of conductors exposed to inductive or extraneous interference comprising two gapped devices, two coils of wire between which there is a high mutual inductance, each of the exposed conductors being connected to ground through one of the gapped devices and one of the coils of wire, and means responsive to a breakdown of either of the gapped devices for producing circuits for shunting both of said gapped devices.

4. Apparatus for the prevention of acoustic shock in a plurality of conductors which form two side circuits and a phantom circuit and are exposed to inductive or extraneous interference comprising a plurality of protector blocks two of which are connected to each side circuit, three pairs of coils, the coils of each pair being wound upon a common core so as to have a high mutual inductance therebetween, one pair of coils being connected respectively to one pair of protector blocks connected to one of the side circuits, the coils of another pair being connected to the protector blocks associated with another of the side circuits, means for connecting one of the coils of the third pair in common with the two coils of each of the other pairs associated with the side circuits, and means responsive to the breakdown of the gap of any one of the various protector blocks for providing circuits in shunt with all of the protector blocks.

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