April 18, 1933. J. D. TEBO 1,904,569

PROTECTIVE DEVICE

Filed March 26, 1932

FIG. 1

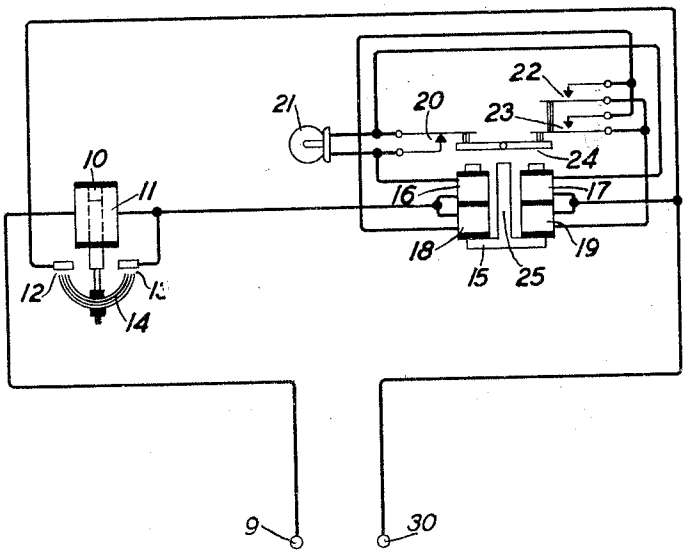
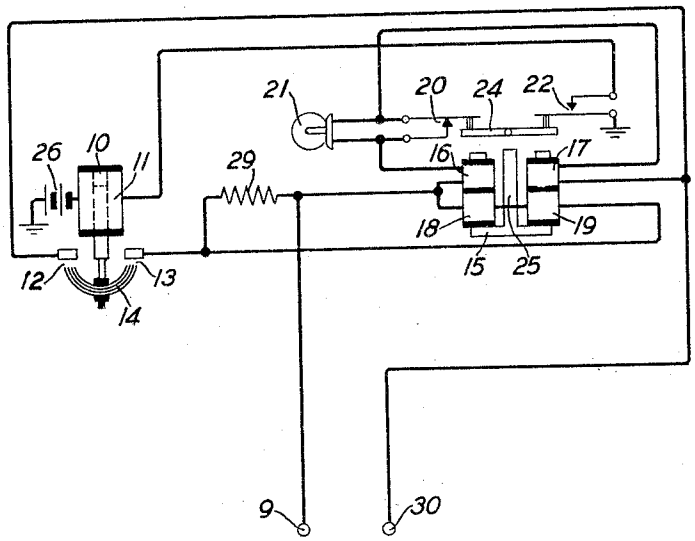


FIG. 2



INVENTOR
J. D. TEBO
BY H. G. Bansfield
ATTORNEY

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UNITED STATES PATENT OFFICE

JULIAN D. TEBO, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

PROTECTIVE DEVICE

Application filed March 26, 1932. Serial No. 601,443.

This invention relates to protective devices and more particularly to devices for protecting metallic structures from electrolysis caused by stray electric currents flowing to or from said structures.

It is well known that metallic structures, such as telephone and telegraph cables, which are in contact with the ground are exposed to disintegration by electrolytic action set up between these structures and a ground return, such as a grounded circuit of electric railways. Heretofore, this action has been prevented by connecting a switch between the cable to be protected and the negative return, which switch provides a path of low resistance when the potential of the cable becomes positive with respect to the ground, but a path of high resistance when the potential of the cable becomes negative with respect to the ground. In general, such devices are satisfactory in preventing electrolytic action when the potential existing between the cable and the negative return is relatively high, but are unsatisfactory when this potential is relatively low.

An object, therefore, of the present invention is to provide a switch, which when connected to the cable to be protected and a neighboring grounded return circuit will prevent electrolytic action when a relatively low potential exists.

In accordance with the present invention this and other objects are attained by means of an electrolysis switch connected between the metallic structure to be protected from electrolysis and a ground return. This electrolysis switch comprises a voltage sensitive polarized relay, a solenoid contactor and a high resistance connected in a manner hereinafter described in detail so that when the potential of the metallic structure is positive with respect to the negative return these elements will function, first, to set up a single path of low resistance between the metallic structure and the ground return and, subsequently, if the current flowing over the first path of low resistance attains a predetermined value, to set up a second path of lower resistance between the metallic structure and the ground return; and, thirdly, to set up a path of still lower resistance if the current flowing from the structure to the ground return continues to increase.

The invention may be more clearly understood by reference to the accompanying drawing in which:

Fig. 1 shows a schematic drawing of one form of the electrolysis switch which operates entirely on currents resulting from the potentials of the metallic structure; and

Fig. 2 shows another embodiment of the invention in which the solenoid contactor is energized by an external source of power.

Referring to Fig. 1, there is shown an electrolysis switch comprising a solenoid contactor 10, a polarized relay 15 and a ballast lamp 21 connected between a terminal 9 which is adapted to be connected to a metallic structure and a terminal 30 which is adapted to be connected to a negative return. The contactor 10 comprises a winding 11, a pair of contacts 12 and 13 which are electrically connected on the operation of the solenoid by the bridge 14. The polarized relay is shown in its normally unoperated position and consists of a pair of magnetic coils 16 and 17, which serve as the operating winding and a pair of low resistance coils 18 and 19 which serve as the holding winding, a pair of back contacts 20 normally closed and in shunt with a ballast lamp 21, and two pairs of front contacts 22 and 23 normally open. An armature 24 polarized by means of permanent magnet 25 is responsive to current flowing through the windings of the relay in one direction to close the front contacts and is responsive to current flowing in the opposite direction to open the back contacts.

When the switch is connected between a metallic structure and a grounded return, the elements of the switch are in their normal positions as shown in Fig. 1, in which case the back contact 20 of the polarized relay 15 remains closed and the front contacts 22 and 23 of the relay remain open. Assuming a low positive potential on the metallic structure in which case the solenoid contactor 10 remains deenergized, current flows from the metallic structure by means

of the connecting terminal 9 through the solenoid winding 11 to the operating winding 16 of the relay, thence to the shunt circuit comprising the ballast lamp 21 and the back contact 20 of the relay which remains closed when the potential of the structure is positive. From this back contact 20 current flows to the second operating winding 17 of the relay and thence to the negative return terminal 30. This completes an energizing circuit for the polarized relay 15 and also constitutes the first path of low resistance to drain the current away from the metallic structure. If the potential of the metallic structure increases there is a corresponding increase in current flowing through the windings of the relay to the negative return over this so-called first path of low resistance. When this increase in current flow reaches a predetermined value, it serves to energize the relay 15 causing its armature 24 to move in a counter-clockwise direction and close the front contacts 22 and 23 of the relay, thereby setting up a second path of low resistance between the metallic structure and the negative return. This second path of low resistance may be traced through terminal 9 through the solenoid winding 11 to the holding winding 18 of the relay, thence through the now closed front contacts 22 and 23 of the relay 15 to its other holding winding 19 and thence by the negative return terminal 30 to the ground. Due to the low resistance of holding coils 18 and 19, the resistance of this circuit is much lower than that of the circuit through the operating coils 16 and 17. If these two paths of low resistance through the contacts of the relay are still inadequate to reduce the potential on the metallic structure to a desired value, and the potential continues to increase, the corresponding increase in current flow passing through the winding 11 of the solenoid contactor 10, will be sufficient to cause it to be energized and to close its contacts 12 and 13. When the solenoid contactor operates, it completes a third path of very low resistance between the metallic structure and the negative return through the winding of the solenoid and its contacts.

When the potential of the metallic structure decreases sufficiently to allow the current flowing through the solenoid winding to decrease to a predetermined value, the contactor 10 will release and open the third path of low resistance. In the same way a further reduction of potential will serve to deenergize the relay 15 and to allow the armature 24 to return to its normal position, thereby opening the front contacts 22 and 23 of the relay and consequently opening the second path of low resistance. This action will leave only the original path of low resistance through the back contacts 20 to conduct away extremely low currents of positive potential from the metallic structure.

In case the current reverses through this circuit on account of a negative potential existing on the metallic structure, the polarized relay 15 will operate and cause armature 24 to move in a clockwise direction thus opening the back contacts 20 of relay 15. This operation will open the normally closed path of low resistance through the back contacts 20 and establish in its place a path of relatively high resistance for the reverse current through the ballast lamp 21 which was in shunt with the back contacts 20, and thus prohibit large currents from flowing onto the metallic structure. When the potential of the metallic structure again becomes positive, the above cycle will be repeated thus insuring a low resistance drainage path for current flowing from the metallic structure, and a path of high resistance for current flowing in the opposite direction.

Referring to Fig. 2, there is shown an electrolysis switch comprising a solenoid contactor 10, a polarized relay 15 and a ballast lamp 21 connected between a terminal 9, which is adaptable to be connected to a metallic structure, and a terminal 30 which is adaptable to be connected to a negative or ground return. The contactor 10 comprises a winding 11, a pair of contacts 12 and 13 which are electrically connected upon the operation of the solenoid contactor by its bridging member 14. The solenoid contactor in this embodiment of the invention is operated from an external source of power such as the battery 26. The polarized relay 15 comprises a pair of coils 16 and 17 which serve as the operating winding, a pair of coils 18 and 19 which serve as the holding winding, a pair of back contacts 20 normally closed and in shunt with a ballast lamp 21 and a pair of front contacts 22 normally open. An armature 24 is responsive to current flowing through the windings of the relay in one direction to close the front contacts and to current flowing in the opposite direction to open the back contacts.

If the terminal 9 is connected to a metallic structure having a low positive potential and the terminal 30 is connected to a suitable grounded return, current will then drain from the metallic structure through the coil 16 of relay 15, thence to the back contact 20, through the other operating coil 17 and then to the negative return terminal and ground. This establishes a path of low resistance from the metallic structure to the negative, grounded return and also sets up an energizing circuit for the polarized relay. In this embodiment of the invention when the current increases due to an increase in the potential of the metallic structure, the operating winding of the relay 15 is energized, causing its armature 24 to move

in a counter-clockwise direction and close the front contacts 22 of the relay. When these contacts are closed, they establish an energizing circuit for the solenoid contactor 10. This circuit may be traced as follows: from the grounded source of power 26 through the winding of the solenoid, through the now closed contact 22 and to ground. The solenoid contactor 10 being energized in this manner closes its contacts 12 and 13 by drawing up its bridging member and completes a circuit from the metallic structure connected to the terminal 9 through a resistance 29 and the contacts 12 and 13 of the solenoid contactor to the negative return terminal 30. When the contacts 12 and 13 of the solenoid contactor are closed, a path is also established from the metallic structure attached to the terminal 9 through the pair of holding coils 18 and 19 and the contacts 12 and 13 of the solenoid contactor to the negative return terminal 30 and ground. The resistance 29 is placed in this second path of low resistance to cause a sufficient current flow through the holding windings of the relay to keep the front contact 22 closed. Without this resistance there is likely to be an insufficient amount of current passing through the holding windings to keep the contact 22 closed since the current tends to flow through the relatively lower resistance path made by the solenoid contactor. In the latter case the relay would become momentarily deenergized and therefore open its front contacts and thus open the energizing circuit of the solenoid contactor. However, on account of the high positive potential on the structure, the relay would immediately operate to close its front contacts and thus close the contacts of the solenoid contactor. This would cause the so-called "chattering" of the two devices. This effect is overcome by inserting the resistance 29 in the low resistance path through the contacts of the solenoid contactor thus diverting enough current through the holding windings of the relay to cause it to remain energized and maintain its contacts closed.

When the potential of the metallic structure decreases to a predetermined value, the relay 15 will become deenergized and the armature 24 will return to its normal position and open the contact 22 of the relay, which in turn opens the energizing circuit of the solenoid contactor 10. The solenoid contactor thus being deenergized opens the second path of low resistance between the metallic structure and the negative return leaving the original path of low resistance through the back contacts 20 to take care of the current flowing from the metallic structure to the negative return.

In case a negative potential exists on the metallic structure, the current flowing from the negative return to the polarized relay will act upon the operating winding so that it will cause the armature 24 to turn in a clockwise direction. This will open the back contacts 20, which simultaneously open up the first path of low resistance and set up in its place a path of high resistance through the ballast lamp 21 between the negative return and the metallic structure. This path of high resistance allows only a negligible quantity of current to flow from the negative return onto the metallic structure through the switch.

What is claimed is:

1. A system for preventing electrolysis of metallic structures comprising a normally closed path of low resistance between said structure and a negative return, and means responsive to the flow of current in one direction for maintaining said path of low resistance closed and responsive to the flow of current in a reverse direction for opening said path of low resistance and substituting therefor a path of relatively high resistance.

2. A system for preventing electrolysis of metallic structures comprising a normally closed path of low resistance between said structure and a negative return, and means responsive to the flow of current from said structure to said return for maintaining said path of low resistance closed and responsive to the flow of current from said return to said structure for opening said path of low resistance and substituting therefor a path of relatively high resistance.

3. A system for preventing electrolysis of metallic structures comprising a normally closed path of low resistance between said structure and a negative return, means comprising a relay responsive to the flow of current from said structure to said return for maintaining said path of low resistance closed and responsive to the flow of current from said return to said structure for opening said path of low resistance and substituting therefor a path of relatively high resistance.

4. A system for preventing electrolysis of metallic structures comprising a path of low resistance between said structure and a negative return, means responsive to the flow of current from said structure to said return for maintaining said path of low resistance closed, and means responsive to an increase in current flowing from said structure to said return for completing a second path of low resistance between said structure and said return, said first mentioned means being responsive to a flow of current from said return to said structure for opening said low resistance path and substituting therefor a path of relatively high resistance.

5. A system for preventing electrolysis of metallic structures comprising a normally closed path of low resistance to currents

flowing from said structure to a negative return, said path including the windings of a polarized relay, and means comprising a solenoid contactor and the contacts of said polarized relay and responsive upon increase in the value of said currents to establish paths of lower resistance for said currents, said means being responsive to reverse currents from said negative return to said structure to open said path of low resistance and said paths of lower resistance and to close a path of high resistance through a ballast lamp.

6. In an electrolysis switch for preventing electrolysis of underground cables, a solenoid contactor operable by an external source of power, a polarized relay having a holding winding, an operating winding and a plurality of pairs of contacts, a ballast lamp connected in shunt with one pair of said contacts, means including said shunt contacts to establish a path of low resistance from said cable to a negative return to operate said relay and to close said remaining pairs of contacts, means comprising said last mentioned contacts to establish an energizing circuit for said solenoid contactor, means comprising said contactor to establish a second path of low resistance from said cable to a negative return, means including said shunt contacts to open said paths of low resistance and to close a path of high resistance between said negative return and said cable through said ballast lamp when the potential of the cable sheath is negative.

7. A system for preventing electrolysis of metallic structures comprising a normally closed path of low resistance for current flowing from the structure to a negative return, means responsive to the flow of said current for maintaining said path of low resistance closed, and responsive to an increase in the potential of said structure to complete a second path of low resistance between said structure and said negative return, and means responsive to a further increase in potential to establish a third path of low resistance between said structure and said negative return, said last two mentioned means being responsive to a drop in potential on said structure to open said last two mentioned paths of low resistance in a reverse order, said first mentioned means being responsive to a reverse flow of current from said return to said metallic structure for opening said first low resistance path and closing a path of relatively high resistance.

8. A system for preventing electrolysis between a metallic structure and a negative return comprising a normally closed path of low resistance between said structure and said return, means comprising a polarized relay responsive to the flow of current from said structure to said return for maintaining said path of low resistance closed, and responsive to an increase of the potential of the structure to complete a second path of low resistance between the structure and said negative return, means comprising a solenoid contactor responsive to a further increase in potential of said metallic structure to complete a third path of low resistance between said structure and said negative return, said two mentioned means being responsive to decreases in potential to open said second and third paths of low resistance, said relay means being responsive to a reverse current flowing from the negative return to the structure to open said first path of low resistance and to establish a path of relatively high resistance between said negative return and said metallic structure.

9. A system for preventing electrolysis between a metallic cable sheath and a negative return comprising a normally closed path of low resistance between said structure and said return, means comprising a polarized relay responsive to the flow of current from said sheath to said return for maintaining said path of low resistance closed, and responsive to increases in the positive potential of said cable sheath to close an energizing circuit for a solenoid contactor, means comprising said energized contactor to close a second path of low resistance between said sheath and said negative return, said relay being responsive to decrease in positive potentials of said cable sheath to open said energizing circuit of said solenoid contactor, said solenoid contactor being responsive to the opening of said energizing circuit to open said second path of low resistance, said relay being responsive to a reverse current flowing from said negative return to said sheath to open said first path of low resistance and to establish a path of relatively high resistance through a ballast lamp between said negative return and said metallic sheath.

10. In a system for preventing electrolysis of metallic structures, means for providing and maintaining a closed path of low resistance for current flowing from said structure to a negative return, means for closing an additional path of lower resistance from said structure to said negative return when the potential of said structure increases to a predetermined value, and to open said path of lower resistance when the potential decreases to a predetermined value, said first means being responsive to current flowing in a reverse direction from said negative return to said structure to open said first path of low resistance and to establish a path of relatively high resistance.

In witness whereof, I hereunto subscribe my name, this 25 day of March, 1932.

JULIAN D. TEBO.