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B. O. AUSTIN

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TIME DELAY RELAY MEANS

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Fig. 1.

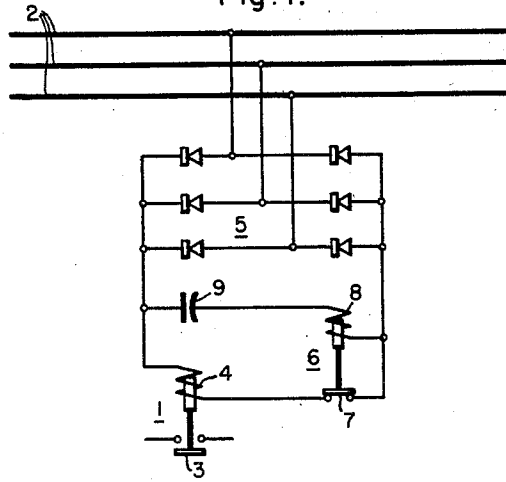


Fig. 2.

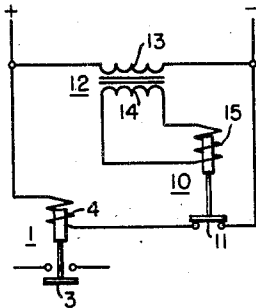


Fig. 3.

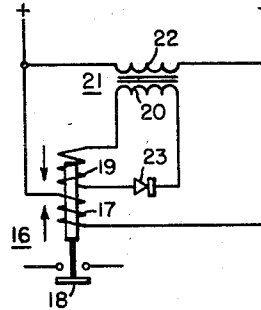


Fig. 4.

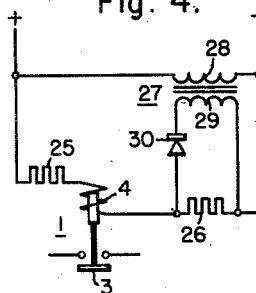
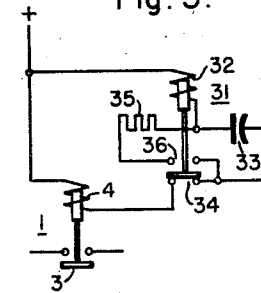


Fig. 5.



WITNESSES

Robert C. Baird
Leon J. Vaya

INVENTOR

Bascum O. Austin.

BY

7. P. Lyle
ATTORNEY

1

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TIME DELAY RELAY MEANS

Bascum O. Austin, Lima, Ohio, assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

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The present invention relates to protective relays, and more particularly to improved means for obtaining a desired time delay in the operation of such relays.

In the use of protective relays, such as overvoltage relays, it is frequently necessary or desirable to provide a time delay in the operation of the relay, in order to prevent undesired operation under transient conditions. These relays are usually designed to have inverse time characteristics, and this characteristic has sometimes been relied on alone to prevent operation on transients, or an additional fixed time delay has been provided for this purpose. Various types of mechanical and electrical time delay means have been used for this purpose, either singly or in combination, to obtain the desired operating characteristics, but the known arrangements have not been satisfactory in practice, and it has been very difficult to obtain the desired result of preventing operation of the relay on transients while obtaining accurate and reliable operation under sustained or steady-state conditions.

The principal object of the present invention is to provide an effective and reliable means for preventing operation of a relay under transient conditions, while permitting accurate and reliable operation in response to sustained or steady-state conditions.

Another object of the invention is to provide means for delaying the operation of a relay when the voltage, or other quantity, to which it responds is changing rapidly, so as to prevent operation under transient conditions.

A further object of the invention is to provide means for controlling the operation of a relay which is effective under transient conditions to prevent relay operation, and which is ineffective under sustained or steady-state conditions so that the relay is permitted to operate.

Other objects and advantages of the invention will be apparent from the following detailed description, taken in connection with the accompanying drawing, in which Figs. 1, 2, 3, 4 and 5 are schematic diagrams showing illustrative embodiments of the invention.

Fig. 1 shows means for controlling the operation of a protective relay 1 which is responsive to the voltage of an alternating current line 2. The relay 1 is intended to close its contacts 3 upon the occurrence of a predetermined overvoltage to effect a corrective operation, or to actuate a signal, or to perform any other desired function. The relay 1 has an operating coil 4 which is designed for direct current energization. The line 2 is shown as a three-phase alternating current line, and the relay coil 4 is energized by means of a three-phase rectifier bridge 5, which provides a direct current output voltage proportional to the average of the three-phase voltages of the line 2.

It will be seen that upon the occurrence of a predetermined overvoltage, the relay 1 will close its contact 3, and that this action would occur on transient voltage surges as well as on sustained overvoltages if no means were provided to prevent operation on transients. In

2

accordance with the present invention, the operation of the relay is delayed under transient conditions to prevent operation. For this purpose, an auxiliary relay 6 is provided having a normally closed contact 7 connected in series with the coil 4 of the relay 1. The operating coil 8 of the auxiliary relay 6 is connected across the direct current output voltage of the rectifier 5 in series with a capacitor 9.

Under steady-state conditions, the capacitor 9 blocks the flow of current to the relay coil 8 so that the contact 7 remains closed, and the coil 4 of the relay 1 is connected across the direct current output voltage of the rectifier 5 and thus responds to a voltage in excess of a predetermined value to close its contact 3. If a transient voltage surge occurs on the line 2, however, so that the voltage changes very rapidly, a changing voltage of relatively steep wave front is applied to the capacitor 9. Under these conditions, the impedance of the capacitor is quite low, since the rapidly changing voltage is equivalent to a high-frequency alternating current voltage, and sufficient current flows through the capacitor 9 and coil 8 to actuate the auxiliary relay 6 and cause it to open its contacts 7, disconnecting the coil 4 of the relay 1 from its energizing voltage. Thus, operation of the relay 1 is prevented while the voltage is changing rapidly, so that it will not operate under transient or surge conditions.

After the transient has passed and the voltage has returned to a steady-state condition, the capacitor 9 again blocks flow of current and the auxiliary relay 6 recloses its contact. If a sustained overvoltage is present at this time, the relay 1 will be actuated to close its contacts 3. Thus, the desired operation is obtained in a simple and reliable manner by means of the auxiliary relay 6 which controls the main relay 1 to prevent its operation under transient conditions. It will be obvious that any desired time delay characteristic can be obtained by proper choice of the capacitor 9 and of the setting of the relay 6.

The relay 1 may be any suitable type of relay and may, if desired, have inverse time characteristics to provide for high-speed operation on high sustained overvoltages. The relay 1 has been described as an overvoltage relay, but it will be obvious that it may be any type of protective relay and may be connected to respond to current or may be actuated by a voltage derived from any other quantity.

Fig. 2 shows another embodiment of the invention. In this figure, the relay 1 is shown connected to respond to a direct current voltage which may be the voltage of a direct current line, or which may be derived from an alternating current line by means of a rectifier as in Fig. 1. In this embodiment of the invention, an auxiliary relay 10 is provided having a normally closed contact 11 in series with the operating coil 4 of the relay 1. A transformer 12 has its primary winding 13 connected across the direct current voltage from which the relay 1 is energized, and has its secondary winding 14 connected to the operating coil 15 of the auxiliary relay 10.

Under steady-state conditions, a substantially constant voltage is applied to the primary winding 13 of the transformer 12 and the voltage of the secondary winding 14 is zero, so that the auxiliary relay 10 is not energized and its contact 11 remains closed. Upon the occurrence of a transient voltage surge, however, a rapidly changing voltage will be applied to the primary winding 13 and a sufficient voltage will be induced in the secondary winding 14 to energize the coil 15 and cause the auxiliary relay 10 to open its contact 11. Thus, operation of the relay 1 is prevented under transient conditions in a similar manner to that described

above in connection with Fig. 1. After the transient has passed and steady-state conditions have been restored, the rate of change of the voltage applied to the primary winding 13 again drops to substantially zero, and the secondary voltage becomes zero, so that the auxiliary relay 10 recloses its contact 11 and the coil 4 of the relay 1 is again connected to the line.

It will be seen that the operation of this embodiment of the invention is, in general, similar to that of Fig. 1 in preventing operation of the relay 1 under transient conditions. This embodiment of the invention has the advantage that by proper choice of core materials for the transformer, various delay characteristics can readily be obtained, and adjustment of the operating characteristics of a particular relay can easily be provided by varying the saturation of the transformer core by means of an adjustable air gap, or other suitable means.

Fig. 3 shows a further embodiment of the invention, which is similar to that of Fig. 2, except that the auxiliary relay is eliminated and operation of the protective relay is directly affected by the transformer. In this embodiment, the relay 16 has an operating coil 17 connected to be energized by a direct current voltage, as before, and has a contact 18. A second coil 19 is also provided on the magnetic circuit of the relay and is energized from the secondary winding 20 of a transformer 21 which has its primary winding 22 connected across the direct current voltage. The coil 19 of the relay 16 is wound and connected so that when energized its flux opposes that of the coil 17, and a rectifier 23 is preferably connected in series with the coil 19 to insure the desired polarity of the current and to prevent reverse energization of the coil 19.

Under steady-state conditions, the coil 19 is not energized, since the transformer secondary voltage is substantially zero, and the relay 16 is actuated by the coil 17 to close its contact 18 in response to a voltage in excess of the predetermined value for which the relay is set. If a transient voltage surge occurs, however, there will be a voltage induced in the secondary winding 20 of the transformer which energizes the coil 19 so that its flux opposes that of the coil 17 and thus prevents operation of the relay. After the transient has passed, the voltage of the secondary winding 20 again becomes zero and the relay 16 is free to operate in response to sustained or steady-state overvoltages.

In the embodiment of Fig. 4, a relay 1 as previously described is utilized, with its coil 4 connected across the direct current energizing voltage in series with a resistor 25 and a biasing resistor 26. A transformer 27 has its primary winding 28 connected across the energizing voltage and its secondary winding 29 connected across the resistor 26. A rectifier 30 is connected in series with the secondary winding 29 in such a direction that the voltage applied across the resistor 26 by the transformer will always be in opposition to the line voltage. Under steady-state conditions, there is, of course, no voltage applied to the resistor 26, and the relay 1 is free to operate in response to a predetermined overvoltage. Under transient or surge conditions, however, a voltage is applied across the resistor 26 which opposes the line voltage, and the voltage applied to the coil 4 of the relay 1 is correspondingly reduced, so that the relay is prevented from operating. Thus, the effect of this connection is generally the same as that of those previously described to prevent operation of the relay during transient conditions, that is, at times when the voltage to which the relay responds is changing rapidly.

Fig. 5 shows a circuit which is essentially the same as that of Fig. 1, including an auxiliary relay 31 having an operating coil 32 connected across the direct current energizing voltage in series with a capacitor 33. The auxiliary relay 31 has a normally closed contact 34 in series with the operating coil 4 of the relay 1, so that the operation is the same as that previously de-

scribed in connection with Fig. 1. In this arrangement, however, a discharge resistor 35 is provided for the capacitor, and the relay 31 has a normally open contact 36 in series with the resistor 35. When the relay 31 is actuated under transient conditions, it opens the contact 34 to prevent operation of the protective relay 1, and closes the contact 36 to connect the discharge resistor 35 across the capacitor 33, thus providing a discharge path and damping the discharge of the capacitor, which improves the uniformity and consistency of the operating characteristics, since the capacitor is always discharged through the resistor upon operation of the relay 31.

It should now be apparent that means have been provided for delaying the operation of a protective relay under transient conditions, while permitting the relay to operate on steady-state or sustained conditions. This result is obtained in a relatively simple and reliable manner by utilizing the rate of change of the energizing voltage of the relay to prevent operation of the relay when the rate of change is high. In this way, an operating characteristic or time delay is provided which depends on the characteristics of the transient surge and is not merely a fixed time delay, as has usually been used in the past. This is an important feature which contributes to the overall reliability and accurate performance of the relay.

It will be understood that the protective relay which is to be controlled may be a relay of any type and may, if desired, have inverse time characteristics. The invention is not limited to use with overvoltage relays, but is applicable to relays operating in response to any quantity from which an energizing voltage for the relay can be derived. Certain specific embodiments of the invention have been shown and described for the purpose of illustration, but it is to be understood that various other embodiments and modifications are possible, and are within the scope of the invention.

I claim as my invention:

1. In combination, a relay having an operating coil, means for energizing said coil from a direct current voltage source, and means responsive only to rapid change of said voltage source for interrupting the energizing circuit of the coil for the duration of such change, said last-mentioned means being non-responsive to direct current.

2. In combination, a relay having an operating coil, means for energizing said coil with direct current, a transformer having a primary winding connected to be energized by said direct current and having a secondary winding, and means responsive to the voltage across said secondary winding for interrupting the energizing circuit of the coil.

3. In combination, a relay having an operating coil, means for energizing said coil with direct current, a transformer having a primary winding connected to be energized by said direct current and having a secondary winding, and a second relay having an operating coil connected to be energized by said secondary winding and having contacts connected to control the energization of said first-mentioned coil.

4. In combination, a relay having an operating coil, a direct current energizing circuit for said coil, a second relay having contacts connected to control the energization of the coil of the first-mentioned relay and having an operating coil, and a capacitor connected in series with the last-mentioned coil across the energizing circuit.

5. In combination, a relay having an operating coil, means for energizing said coil from a direct current voltage, a second relay having contacts connected to control the energization of said coil, and means responsive only to rapid change of said voltage for effecting actuation of the second relay to prevent energization of the first-mentioned relay for the duration of such change, said last-mentioned means being non-responsive to direct current.

6. In combination, a relay having an operating coil, a direct current energizing circuit for said coil, a resistor, a second relay having first contacts connected to control the energization of the coil of the first-mentioned relay and having an operating coil, a capacitor connected in series with the last-mentioned coil across the energizing circuit, and said second relay having second contacts connecting the resistor across said capacitor upon energization of said last-mentioned coil.

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