ABSTRACT OF THE DISCLOSURE

A circuit breaker control system including a first circuit for providing a continuous close signal as long as the circuit breaker closing contact is held in its closed position, a second circuit for energizing the circuit breaker closing coil in response to the close signal and a third circuit operable after a time delay to disable the second circuit if the closing signal continues so that pumping of the circuit breaker contacts is prevented.

BACKGROUND OF THE INVENTION

Circuit breakers are often provided with a manually operated closing control switch for initiating a contact closing operation and means for reopening the contacts should the circuit breaker close in on a fault. Thus, if a circuit breaker is closed on a faulted line and the operator holds the closing control switch in its closed position, damaging repetitive opening and closing operations, commonly called pumping, may occur unless this action is prevented. For this reason, circuit breakers are often provided with antipumping circuits or mechanisms, or both, which permit only one contact closing operation each time the closing control switch is actuated.

Prior art circuit breakers are generally protected against pumping by a relay arrangement known as an X-Y control. This includes an X relay for operating the circuit breaker closing coil and a Y relay which prevents repetitive operation of the X relay in the event the closing control switch is held in its closed position. Such mechanical relay schemes are not wholly satisfactory, however, because false operation of the relay contacts may occur as the result of mechanical vibration of the circuit breaker.

It is an object of the invention to provide a new and improved circuit breaker closing control means.

Another object of the invention is to provide a new and improved static closing control means having antipumping means for circuit breakers.

A further object of the invention is to provide a circuit breaker antipumping means which is not subject to false operations due to circuit breaker vibration.

Yet another object of the invention is to provide an economical circuit breaker antipumping means.

These and other objects and advantages of the instant invention will become more apparent from the detailed description hereinafter.

SUMMARY OF THE INVENTION

A control system for a circuit interrupter having main contacts and a contact closing mechanism, the combination of first means for selectively instituting a switch closing operation, first circuit means for providing a continuous signal during the operation of the first means, second circuit means responsive to the signal for energizing the circuit breaker closing mechanism and third means for disabling the second means if the signal continues after a time delay period to prevent pumping of the circuit breaker contacts.

BRIEF DESCRIPTION OF THE DRAWINGS

The single figure of the drawings schematically illustrates a circuit breaker closing control according to the instant invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings in greater detail, the circuit breaker is shown to include main switches 10, overload responsive means 11, switch opening means 12, switch closing means 13, switch closing contact CSI and a switch closing control 15, according to the instant invention. In general terms, the overcurrent responsive means 11 is operable to actuate the switch opening means or trip coil 12 upon the occurrence of an overload in the system being protected so that the main switches 10 will be moved to their open position shown in the drawing. When it is desired to reclose the main switches 10, the switch closing contact CSI is operated to actuate the switch closing control 15, which, in turn, initiates a switch closing operation and provides antipumping in the manner set forth hereinbelow.

The closing control 15 includes a closing signal circuit 20 for providing a close signal when the switch closing contact CSI is closed and a close circuit 21 which is responsive to the closing signal for energizing the closing coil 13. As will be pointed out more fully hereinbelow, the closing signal will continue as long as the switch closing contact CSI is held in a closed position and, accordingly, a disabling circuit 22 is provided to disable the close circuit 21 should the closing signal continue for a predetermined time delay, to thereby prevent pumping. A suitable voltage source such as battery B, is provided for operating the closing control 15.

The closing signal circuit 20 includes a Zener diode D1 and a resistor R1 which are connected in series with each other, and the series combination is connected across the battery terminals 24 and 25 through contact b1, which is closed when the main contacts 10 and contact CSI are open. Resistors R4, R3 and R16 are connected across the Zener diode D1. A capacitor C1 has a negative terminal connected to the negative battery terminal 25 and a positive terminal connected to the emitter of a unijunction transistor Q3 which has its base-two electrode connected to resistor R2 and its base-one electrode connected to one winding of an isolation transformer T. The other winding of transformer T is connected through a diode D3 to the gate of silicon controlled rectifier SCR1 and to the negative battery terminal 25 through a resistor R4. The cathode of SCR1 is also connected to resistor R4 and its anode is connected to the positive battery terminal through switch closing contact CSI.

The closing circuit 21 includes a unijunction transistor Q1 whose base-one electrode is connected to the negative battery terminal 25 through resistor R5 and whose base-two electrode is connected to conductor 28, which, in turn, is connected through resistor R7 to the cathode of SCR1. The emitter electrode of unijunction transistor Q1 is connected to the junction between a resistor R8 and a capacitor C2 which are, in turn, connected between conductor 28 and the negative battery terminal 25.

The closing circuit 21 also includes a silicon controlled rectifier SCR2 whose gate is connected to the base-one electrode of unijunction transistor Q1 through resistor R9 and whose cathode is connected to terminal 25 of battery B. The anode of SCR2 is connected to the closing coil 13 through contacts b2 which are closed when the main switch 10 is open while the other side of closing coil 13 is connected to the positive battery terminal 24 through resistor R10. It should be understood that a resistance such as R10 connected in series with the closing coil 13

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is required only if the resistance of the closing coil 13 itself is insufficient to limit the current from battery B to a value acceptable to silicon controlled rectifier SCR1. A capacitor C11 is connected in series with each other in the series combination connected across the anode and cathode of SCR2.

The disabling circuit 22 includes Zener diode D4 connected between conductor 28 and the negative battery terminal 25 and a resistor R12 and a capacitor C4 which are connected in series with each other in the series combination connected across Zener diode D4. In addition, the emitter of a transistor Q2 is connected to the battery terminal 25, and its collector is connected through resistor R13 to conductor 28. The base of transistor Q2 is connected to battery terminal 25 through resistor R14 and also by breakdown diode D5 to the junction between resistor R12 and capacitor C4. In addition, a resistor R15 and a diode D6 connect the collector of transistor Q2 to the emitter of unjunction transistor Q1.

One side of the trip coil 12 is connected through contacts a1 which are open when the switch 10 is open, while the other side thereof is connected to the trip control 11 which is also connected to the terminal 25 of battery B.

Assume that the main contacts 10 are open, as shown in the drawing, so that contacts b1 and b2 are closed and contacts a1 are open. When the contact b1 is closed, a fixed voltage will appear across the Zener diode D1. This voltage will also appear across the RC circuit consisting of resistor R2 and capacitor C1 so that the latter will begin charging. When the voltage across capacitor C1 reaches a predetermined value the unjunction transistor Q3 will fire, causing a voltage pulse to appear on the gate of silicon controlled rectifier SCR1.

In order to initiate a switch closing operation the contact C51 is closed to complete the circuit between positive and negative terminals of the battery B through the anode and cathode of silicon controlled rectifier SCR1. Since there is also a gating pulse on SCR1, it becomes conductive. This will provide a voltage across resistor R4 which is applied across resistor R7 and Zener diode D4. The voltage across Zener diode D4 appears across the series combination of resistor R8 and capacitor C2 when capacitor C2 begins charging. After the charge on capacitor C2 reaches a predetermined value, the unjunction transistor Q1 will fire, causing emitter-base current to flow through resistor R5. This, in turn, will provide gate current to silicon controlled rectifier SCR2 whose anode-cathode are in series with the closing coil 13 through contacts b2. As a result, closing coil 13 energized to close the main contacts 10.

It can be seen that when the contacts b2 are closed the capacitor C3 and the resistor R11, which are in shunt with the anode and cathode of silicon controlled rectifier SCR2, will be placed across battery terminals 24 and 25 through resistor R10 and closing coil 13. As a result, capacitor C3 will be fully charged. Should the anode current to silicon controlled rectifier SCR2 be interrupted after a switch opening operation has commenced, this charge current from capacitor C3 will maintain SCR2 in a conductive state until the main contacts 10 have been fully moved to their closed position.

If operating conditions in the system are normal after a switch closing operation, the main switches 10 will remain closed. However, should the system be faulty, the trip control 11 will energize the trip coil 15, and the main switches 10 will be reopened to close the contacts R11 and b2. Also, if the contact C51 is immediately released after the initiation of a switch closing operation, the anode current to SCR1 will be interrupted and it will be rendered nonconductive. On the other hand, if the contact C51 is held in its closed position, anode current will continue to flow to silicon controlled rectifier SCR1, and the latter will remain conductive even though its gate signal is only momentary. Thus, in the absence of the disabling circuit 22, a second switch closing operation would be initiated in the manner described hereinabove so that pumping of the circuit breaker contacts 10 would occur. The disabling circuit 22, however, prevents such pumping in a manner which will now be described.

As stated hereinabove, if the contact C51 is held in its closed position, the silicon controlled rectifier SCR1 will remain conductive. This will maintain the voltage across resistor R4 and Zener diode D4 which is also applied across resistor R12 and capacitor C4 which will limit the time delay current as well as resistor R8 and capacitor C2 in the closing circuit 21. If this voltage persists, capacitor C4 will continue to charge until breakdown diode D5 breaks down. Upon this event, the base of transistor Q2 will become more positive than its emitter, and Q2 will become conductive to shunt the capacitor C3 through resistor R15 and diode D6. Unjunction transistor Q1 will thereby be rendered nonconductive to interrupt the gate signal to silicon controlled rectifier SCR2. Thus, silicon controlled rectifier SCR2 will be rendered nonconductive once contacts b2 open to interrupt its anode-cathode current.

The parameters of the circuit 15 are so chosen that the time delay of the RC circuit consisting of resistor R12 and capacitor C4 of the disabling circuit 22, which is required to break down breakdown diode D5, is longer than that of resistor R8 and capacitor C2 of the closing circuit 21, which is required to fire the unjunction transistor Q1. Thus, after the contact C51 is closed, the unjunction transistor Q1 will be rendered conductive to initiate a switch closing operation in the manner discussed above. However, if the contact C51 is held in its closed position, the disabling circuit 22 will be rendered operative during the opening time interval of the main contacts 10 so that a second switch closing operation will be prevented if the main contacts 10 are closed in a fault.

Should the contact C51 be released after the first switch closing operation and before the operation of the disabling circuit 22, the anode-cathode current for silicon controlled rectifier SCR1 will be interrupted, and charging current will no longer flow to capacitor C4. As a result, capacitor C4 will discharge through the resistors R12, R7 and R4 to reset the disabling circuit 22 in preparation for a subsequent operation.

In this manner, the closing control circuit, according to the instant invention, insures that only a single switch closing operation will be initiated each time the contact closing switch C51 is actuated. In addition, the closing control circuit 15 is completely static so that false operation will not be initiated as the result of circuit breaker vibrations.

While only a single embodiment of the invention has been illustrated and described, it is not intended to be limited thereby, but only by the scope of the appended claims.

What is claimed:

1. A control system for a circuit interrupter having main contacts movable between open and closed positions and contact closing means, the combination of first means for selectively initiating a switch closing operation, first circuit means for providing an electrical signal during the operation of the first means, second circuit means responsive to said signal for actuating said contact closing means and third circuit means responsive to said signal after a predetermined time delay to disable said second means and prevent pumping of the circuit interrupter contacts.

2. The control system set forth in claim 1 wherein said third circuit means includes time delay means for providing said time delay and being coupled to said first circuit means and static switching circuit means coupled to said time delay means, said time delay means and static switching circuit means being operative in response to the presence of said signal during said predetermined time delay to disable said second circuit means.

3. The control system set forth in claim 1 wherein said second circuit means comprises static switch means.
coupled to said first circuit means and responsive to said electrical signal for providing a gate signal, and gating means coupled to said static switch means and to said main switch means and normally operable in response to said gate signal and to the open condition of said main switch means to actuate said contact closing means.

4. The control system set forth in claim 3 wherein said third circuit means includes energy storage means coupled to said first circuit means for charging during the occurrence of said electrical signal and static switching circuit means coupled to said energy storage means and being operable independently of said positions of the contacts of the circuit interrupter when the charge on the energy storage means equals a predetermined value to disable said second circuit means.

5. The combination according to claim 1 wherein said third circuit means includes time delay means coupled to said first circuit means and to the second circuit means and being effective in response to said signal to provide said predetermined time delay.

6. A control system for a circuit interrupter having main contacts movable between open and closed positions and contact closing means, the combination of first means for selectively instituting a switch closing operation, first circuit means comprising static gating means effective to produce an electrical signal during operation of the first means and while said main contacts are open, said first circuit means responsive to said signal for actuating said contact closing means and second circuit means actuated in response to said first circuit means to disable said second means after said main contacts close to prevent pumping of the circuit interrupter contacts.

7. The control system set forth in claim 6 wherein said first circuit means comprises gate signal circuit means coupled to said static gating means and being effective to supply a gate signal to said static gating means independently of the operation of said first means.

8. The control system set forth in claim 6 wherein said first circuit means includes pulsing circuit means for producing a repetitive pulse signal to said static gating means.

9. The system set forth in claim 1 wherein said second circuit means includes first time delay means responsive to said signal to delay said actuating by the second circuit means a first predetermined time interval and said third circuit means includes a second time delay means responsive to said signal to delay said disabling by the third circuit means a second predetermined time interval longer than the first predetermined time interval.

10. The system set forth in claim 9 wherein said first and second time delay means each comprise RC timing circuits.

11. A control system for a circuit interrupter having main contacts and contact closing means, the combination of first means for selectively instituting a switch closing operation, first circuit means comprising static gating means coupled to said first means and being operable to produce an electrical signal upon the receipt of a gate signal, said first circuit means also comprising gate signal circuit means coupled to said gating means for supplying a gating signal upon the operation of said first means, second circuit means comprising static triggering means coupled to said first circuit means and responsive to said electrical signal for providing a gate signal, said second circuit means also comprising gating means coupled to said triggering means and to said main switch means and being normally operable in response to said gate signal and to the open condition of said main switch means to actuate said contact closing means, third circuit means comprising first RC time delay circuit means for charging during the occurrence of said electrical signal, said third circuit means also comprising static switching circuit means coupled in a shunt circuit relation to said first RC time delay circuit, said static switching circuit means including translating means having a base electrode and a collector electrode coupled to said second circuit means and breakdown means in circuit between said first RC time delay circuit means and said base electrode, said static switching circuit means being operable to disable said second circuit means when the charge of the first RC time delay circuit means equals a predetermined value to cause conduction of said breakdown means and application of a signal to said base electrode and also conduction by the translating means through said collector electrode, and second RC time delay circuit means coupled to said first circuit means, said static triggering means comprising unijunction transistor means having an emitter connected to said second RC time delay circuit means, said gating means comprising controlled rectifier means having a gate electrode connected to the base-one electrode of said unijunction transistor means and an anode-cathode in circuit with said switch closing means, the time constant of said second RC time delay circuit means being more rapidly than said first RC time delay circuit means.

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