April 26, 1927. 1,626,467

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AUTOMATIC RECLOSING CIRCUIT BREAKER SYSTEM

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Fig. 1.

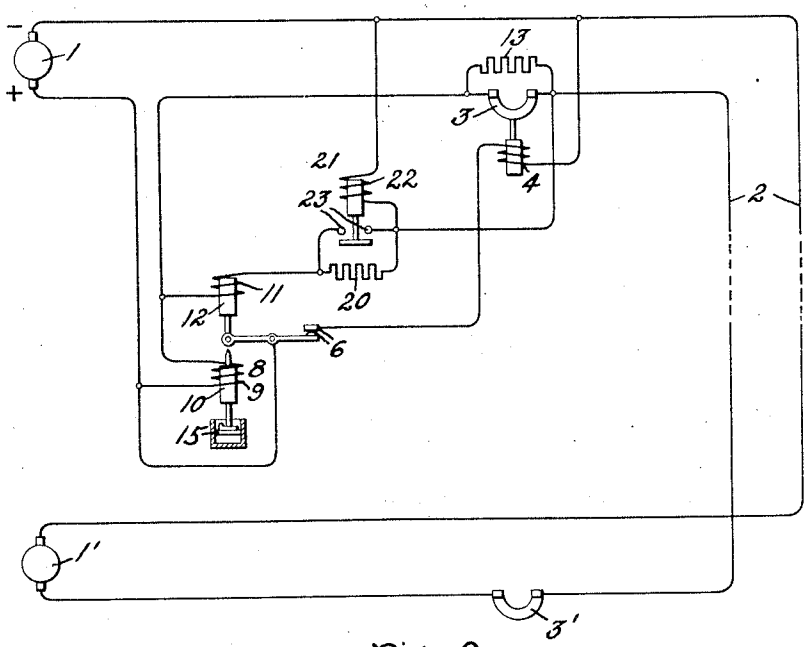
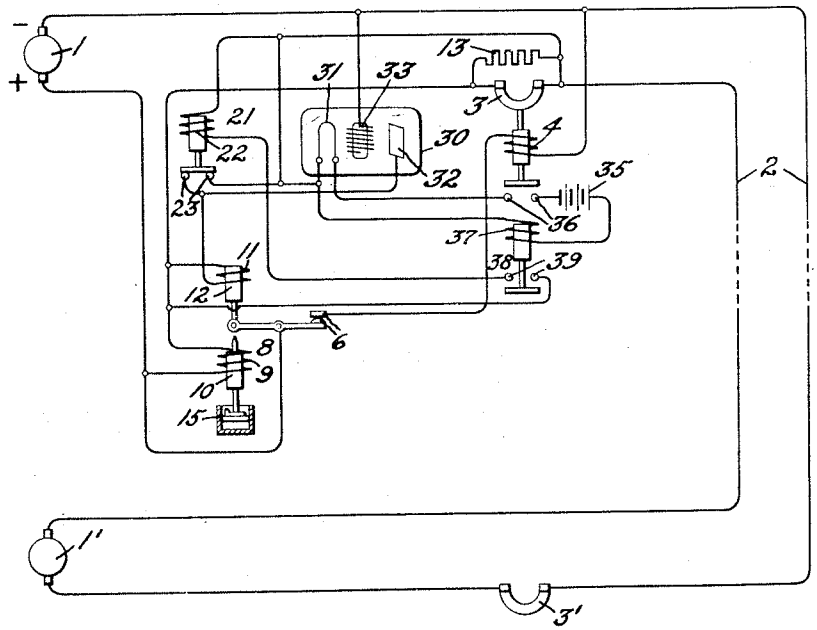


Fig. 2.



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UNITED STATES PATENT OFFICE.

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AUTOMATIC RECLOSING-CIRCUIT-BREAKER SYSTEM.

Application filed December 20, 1921. Serial No. 523,768.

My invention relates to automatic reclosing circuit breaker systems and particularly to such systems in which a circuit breaker is arranged to connect automatically a source of current to a load circuit as soon as the load conditions are such that the circuit breaker can be closed without overloading the source.

It is well known that in such systems, in which the load circuit is supplied with current at a plurality of points, there are two different conditions under which the automatic reclosing circuit breaker, which controls the connection between a source of current and the load circuit, must function properly to connect the source to the common load circuit. One of these conditions is when circuit breakers in all of the other feeders supplying current to the common load circuit are opened and the other condition is when one or more of the circuit breakers in the other feeders are closed, and one object of my invention is to provide a new and improved automatic reclosing circuit breaker system which will function properly under these different conditions.

My invention will be better understood from the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

Referring to the accompanying drawing, Fig. 1 is a diagram showing an automatic reclosing circuit breaker system embodying my invention; and Fig. 2 is a modification of the arrangement shown in Fig. 1.

Referring to Fig. 1, 1 represents a source of current, such as a direct current generator, which is arranged to be connected to a load circuit 2 by means of an automatic reclosing circuit breaker 3. While the automatic reclosing circuit breaker 3 is shown as being of the contactor type and is closed and held in its closed position by the energization of the closing coil 4, it is evident that my invention is not limited to this particular type of circuit breaker and that any other well known type may be used. The load circuit 2 is also shown as being arranged to be supplied with current from another source 1′ which is arranged to be connected to the load circuit by means of a circuit breaker 3′ which may be closed either manually or automatically.

The closing coil 4 is connected to any suitable source of current, such as the generator 1, by means of the contacts 6 of a control relay 8. The relay 8 in the particular embodiment illustrated comprises a coil 9 arranged to control the core 10 and connected in series with the load circuit, and a shunt coil 11 arranged to control the core 12 and connected in parallel with an impedance 13 which is connected in series with the generator 1 and the load circuit 2 when the circuit breaker 3 is opened. The impedance 13 is connected to the main terminals of the circuit breaker 3 so that it is short circuited when the circuit breaker is closed and therefore the coil 11 is also short circuited when the circuit breaker is closed and the core 12 is in its unattracted position, in which position it closes the contacts 6. The core 10 when attracted by the series overload coil 9 engages the core 12 and moves it into its attracted position thereby, opening the contacts 6 so that the closing coil 4 is deenergized and the circuit breaker 3 is opened. The opening of the circuit breaker inserts the impedance 13 in series with the load circuit and so long as there is an overload connected to the load circuit, the voltage drop across this impedance is sufficient to cause the coil 11 to maintain the core 12 in its attracted position. Consequently the contacts 6 are not opened when the core 10 drops down due to the decrease in the load current produced by the insertion of the impedance 13 into the load circuit. The contacts 6 remain open until the condition of the load circuit is such that the circuit breaker 3 can be closed without overloading the source 1.

The relay 8 may be arranged in any suitable manner to delay the closing of the contacts 6 after they have been opened. In the particular embodiment of my invention shown in the drawing, this result is obtained by means of a dash-pot 15 connected to the core 10. Furthermore the relay 8 may be constructed in any suitable manner such as is disclosed in Carichoff Patent 1,091,630, which is assigned to the same assignee as this application, whereby the core 12 will always drop at substantially the same value of current irrespective of the position of the core 12 within certain limits.

In order to change the setting of the coil 11, so that the core 12 drops down and closes the contacts 6 in response to a different volt-

age drop across the impedance 13 when the load circuit 2 is supplied from some other source than when the load circuit is not supplied from some other source, I provide the impedance 20 in series with the coil 11 and the relay 21 for short circuiting this impedance when some other main source is connected to the load circuit 2.

In order to make the relay 21 short circuit the impedance 20 when some other source is connected to the load circuit 2, I connect the coil 22 of the relay 21 directly across the load circuit 2 and design the relay so that it will close its contacts 23 when the voltage across the load circuit is above a predetermined value. The winding 22 may, however, be connected to the load circuit in any other suitable manner so that the relay will be controlled by the voltage across the load circuit due to some other source being connected thereto to change the setting of the coil 11.

The operation of the embodiment of my invention shown in Fig. 1 is as follows: Under normal operating conditions the circuit breakers 3 and 3′ are closed and the circuit of the closing coil 4 is completed through the contacts 6 of the control relay 8. Upon the occurrence of an overload or short circuit on the load circuit 2, the overload coil 9 attracts the core 10 so that the core 12 is pushed up into the coil 11 and the contacts 6 are opened. The closing coil 4 becomes deenergized and the circuit breaker 3 opens thereby inserting the impedance 13 in series with the source 1 and the load circuit 2. The impedance 13 is so designed that if the load resistance is below a predetermined value the voltage drop across the impedance is sufficient to cause the coil 11 to hold the core 12 in its attracted position. As soon as the circuit breaker 3 opens, the current through the series coil 9 is not sufficient to maintain the core 10 in its attracted position. The core 10 drops but this movement is delayed by the dash-pot 15 so that contacts 6 cannot be closed until a predetermined interval after the opening of the breaker.

If the short circuit or overload opens the circuit breaker 3′, the voltage across the load circuit 2 decreases to a very low value thereby indicating that normal potential is not being impressed upon the load circuit at some other point, and the relay 22 opens its contacts 23 thereby inserting the impedance 20 in series with the coil 11 so that a very small current is supplied to the load circuit from the source 1. It is evident that when the impedance 20 is connected in series with the coil 11, the core 12 will drop down and close the contacts 6 in response to a higher voltage drop across the impedance 13 than when the impedance 20 is short circuited.

Let it be assumed that the short circuit or overload has opened the circuit breaker 3′ so that the contacts 23 of the relay 22 are open. So long as the overload or short circuit remains connected to the load circuit, the drop across the impedance 13 is sufficient to keep the core 12 in its attracted position. As the load resistance increases the voltage across the load circuit increases and the voltage drop across the impedance 13, which is the difference between the voltages of the source and the load circuit, decreases. When the load resistance reaches a predetermined value, the voltage drop across the impedance becomes sufficiently low to cause the core 12 to drop and close the contacts 6 thereby completing the circuit of the closing coil 4 to close the breaker.

Let it now be assumed that the short circuit or overload on the load circuit does not open the circuit breaker 3′. The voltage across the load circuit 2 then remains high enough to maintain the relay 21 in its attracted position so that the impedance 20 is short circuited. The coil 11 now maintains the core 12 in its attracted position until the voltage drop across the impedance 13 is equal to a predetermined difference between the voltages of the source 1 and the load circuit 2. When the core 12 drops down the contacts 6 are closed and the closing coil 4 energized to reclose the breaker 3.

From the above description it is evident that with this arrangement the circuit breaker 3 closes in response to a voltage drop across the impedance 13 corresponding to a predetermined difference in the voltages across the source and the load circuit when the load circuit is supplied with current from some other main source and closes in response to a voltage drop corresponding to a predetermined load resistance when the load circuit is not supplied from some other main source.

The modification of my invention shown in Fig. 2 is similar to the embodiment shown in Fig. 1 except that the impedance 20 is replaced by an electron discharge tube 30 which is connected so that the current through it is varied in accordance with the load resistance and the coil 22 of the relay 21 is connected in parallel with the impedance 13 instead of directly across the load circuit. In this particular embodiment of my invention the electron discharge tube 30 comprises a cathode 31 of filamentary form, an anode 32 and a grid 33 interposed between the cathode and anode. The anode and cathode are connected in series with the coil 11 of the control relay 8, the anode 32 being connected so that the potential impressed thereon is positive relative to the potential of the cathode 31. The circuit through the electron discharge tube 30, however, is normally short circuited by the contacts 23 of the relay 21, which in this modifi-

cation are closed when the relay coil 22 is deenergized. The grid 33 is connected to the load circuit so that the potential thereon becomes more negative with respect to the cathode 31 as the load resistance increases. The heating circuit of the filament 31 is arranged to be connected to any suitable source of current, such as the battery 35 by means of the auxiliary contacts 36 of the circuit breaker 3 when the circuit breaker is opened. The coil 37 of a relay 38 is connected in series with the filament 31. The relay 38 controls contacts 39 in the circuit of the coil 22 so that it is deenergized when the heating circuit of the filament is open.

The operation of this modification of my invention is similar to the operation of the embodiment shown in Fig. 1. When an overload or short circuit occurs on the load circuit 2, the overload coil 9 attracts the core 10 which in turn moves the core 12 upwardly into the coil 11 and opens the contacts 6. The closing coil 4 then becomes deenergized and circuit breaker 3 opens. The opening of the circuit breaker closes the contacts 36 thereby completing the heating circuit of the filament 31. Relay 38 then operates and connects the coil 22 across the terminals of the impedance 13. If the overload or short circuit does not open the circuit breaker 3', the voltage across the load circuit remains high enough so that the voltage drop across the impedance 13, which is the difference between the voltages across the source 1 and the load circuit 2, is not sufficient to cause the relay 21 to open its contacts 23. The electron discharge tube 30 is then short circuited and the reclosing of the circuit breaker 3 is controlled by the difference in the voltage across the source and the load circuit in the same manner as in Fig. 1. If, however, the circuit breaker 3' is opened by the overload or short circuit the voltage across the load circuit drops to a low enough value so that the voltage drop across the impedance 13 is sufficient to operate the relay 21. The current through the coil 11 now flows from the coil 11 through the tube 30 to the load side of the impedance 13 instead of through the contact 23. So long as the load resistance is below a predetermined value the resistance of the tube 30 is such that the current through the coil 11 is sufficient to hold the core 12 in its attracted position. As the load resistance increases the grid 33 becomes a more negative with respect to the cathode 31 so that the resistance of the tube increases and the current through the tube and coil 11 decreases. When the load resistance reaches a predetermined value the current through the coil 11 becomes insufficient to maintain the core 12 in its attracted position. The core 12 then drops and closes the contacts 6 thereby completing the circuit of the closing coil 4 to close the breaker 3.

Since a very small change in the relative potentials of the grid and cathode of an electron discharge tube produce a very large change in the resistance of the tube, it is evident that a very small change in the load resistance produces a large change in the resistance of the tube 30. Consequently, with this arrangement the operation will be very sensitive even though the impedance 13 be made very great compared to the full load resistance since by means of the electron discharge tube 30 the relay 8 is responsive to the very small change in voltage drop across the impedance produced by the load resistance increasing from its overload or short circuit value to its normal full load value.

It is apparent that if the filament should burn out or the heating circuit of the filament should be interrupted in any other way, the circuit breaker would be closed irrespective of the load resistance when the relay 21 opens its contacts 23 since the current through it would, under these conditions, drop to zero. In order to prevent the circuit breaker from reclosing under these conditions, I provide the coil 37 of the relay 38 in series with the heating circuit of the filament so that if the filament circuit is open, the contacts 39 of the relay 38, which controls the circuit of the coil 22, are also open. Consequently the contacts 23 of the relay 21 remain closed and short circuit the tube 30 so that the circuit breaker 3 remains open until the voltage drop across the impedance 13 drops below the predetermined value at which the coil 11 is set to operate when the load circuit is supplied from some other source.

While I have shown and described several embodiments of my invention, I do not desire to be limited to the exact arrangements shown and described, but seek to cover in the appended claims all those modifications that fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In an automatic reclosing circuit breaker system, the combination with a supply circuit, a load circuit connected to said supply circuit, a circuit breaker adapted to control the connection between said supply circuit and said load circuit, and closing means for said circuit breaker, of means controlled by the difference between the voltages across said two circuits when said circuit breaker is open for controlling the said closing means, and means arranged to be affected by a condition of said load circuit for determining the predetermined voltage difference at which said last mentioned

means responds to effect the energization of said closing coil.

2. In an automatic reclosing circuit breaker system, the combination with a supply circuit, a load circuit connected to said supply circuit, a circuit breaker adapted to control the connection between said supply circuit and said load circuit, and closing means for said circuit breaker, of means arranged to be affected by the difference between the voltages across said two circuits when said circuit breaker is open for controlling the said closing means, and means responsive to a predetermined difference between the voltages across said two circuits for varying the setting of said last-mentioned means so that said last mentioned means responds to effect the operation of said closing means.

3. In an automatic reclosing circuit breaker system, the combination with a supply circuit, a load circuit connected to said supply circuit, a circuit breaker adapted to control the connection between said supply circuit and said load circuit, and closing means for said circuit breaker, of a relay connected across the terminals of said circuit breaker when said breaker is open, and means controlled by a condition of the load circuit for varying the impedance of the circuit of said relay to vary the setting thereof.

4. In an automatic reclosing circuit breaker system, the combination with a supply circuit, a load circuit connected to said supply circuit, a circuit breaker adapted to control the connection between said supply circuit and said load circuit, and closing means for said circuit breaker, of means operative to effect the operation of said closing means when the difference between the voltages across said circuits is less than a predetermined value but greater than a second predetermined value and operative to effect the operation of said closing means when the difference between the voltages across said circuits is less than a third predetermined value which is less than said said second predetermined value.

5. In an automatic reclosing circuit breaker system, the combination with a supply circuit, a load circuit connected to said supply circuit, a circuit breaker adapted to control the connection between said supply circuit and said load circuit, and closing means for said circuit breaker, of means operative to govern the operation of said closing means in accordance with the difference between the voltages across said circuits under one condition of the load circuit and operative to govern the operation of said closing means in accordance with the load resistance under another condition of the load circuit.

6. In an automatic reclosing circuit breaker system, the combination with a supply circuit, a load circuit connected to said supply circuit, a circuit breaker adapted to control the connection between the said supply circuit and said load circuit, an impedance arranged to be connected in series with said supply circuit and load circuit when said circuit breaker is open, and closing means for said circuit breaker, of a relay connected to said impedance and arranged to control the operation of said closing means and means controlled by a condition of the load circuit for varying the setting of said relay.

7. In an automatic reclosing circuit breaker system, the combination with a supply circuit, a load circuit connected to said supply circuit, a circuit breaker adapted to control the connection between said supply circuit and said load circuit, an impedance arranged to be connected in series with said supply circuit and load circuit when said circuit breaker is open, and closing means for said circuit breaker, of a relay connected in parallel with said impedance and arranged to control the operation of said closing means, and means controlled by the voltage of the load circuit for varying the impedance of the circuit of said relay.

8. In an automatic reclosing circuit breaker system, the combination with a supply circuit, a load circuit connected to said supply circuit, a circuit breaker adapted to control the connection between said supply circuit and said load circuit, an impedance arranged to be connected in series with said supply circuit and load circuit when said circuit breaker is open, and closing means for said circuit breaker, of a relay connected in parallel with said impedance and arranged to control the operation of said closing means, means for varying the impedance of the circuit of said relay in accordance with the load resistance, and means controlled by a condition of the load circuit for rendering said impedance varying means ineffective.

9. In an automatic reclosing circuit breaker system, the combination with a supply circuit, a load circuit connected to said supply circuit, a circuit breaker adapted to control the connection between said supply circuit and said load circuit, an impedance arranged to be connected in series with said supply circuit and load circuit when said circuit breaker is open, and closing means for said circuit breaker, of a relay connected in parallel with said impedance and arranged to control the operation of said closing means, means for varying the impedance of the circuit of said relay in accordance with the load resistance, and means controlled by the voltage of the load circuit for short circuiting said impedance varying means.

10. In an automatic reclosing circuit break-

er system, the combination with a supply circuit, a load circuit connected to said supply circuit, a circuit breaker adapted to control the connection between said supply circuit and said load circuit, an impedance arranged to be connected in series with said supply circuit and load circuit when said circuit breaker is open, and closing means for said circuit breaker, of means operative to govern the operation of said closing means in accordance with the voltage drop across said impedance under one condition of the load circuit and operative to govern the operation of said closing means in accordance with the load resistance under another condition of the load circuit.

11. In an automatic reclosing circuit breaker system, the combination with a supply circuit, a load circuit connected to said supply circuit, a circuit breaker adapted to control the connection between said supply circuit and said load circuit, an impedance arranged to be connected in series with said supply circuit and load circuit when said circuit breaker is open, and closing means for said circuit breaker, of a relay connected in parallel with said impedance and arranged to control the operation of said closing means, an electron discharge tube adapted to vary the impedance of the circuit of said relay in accordance with the load resistance, and means controlled by a condition of the load circuit for rendering said electron discharge tube inoperative to control the impedance of said relay circuit.

12. In an automatic reclosing circuit breaker system, the combination with a supply circuit, a load circuit connected to said supply circuit, a circuit breaker adapted to control the connection between said supply circuit and said load circuit, an impedance arranged to be connected in series with said supply circuit and load circuit when said circuit breaker is open, and closing means for said circuit breaker, of a relay connected in parallel with said impedance and arranged to control the operation of said closing means, an electron discharge tube having its cathode and anode connected in series with said relay and its grid connected to said load circuit so that variations in the load resistance varies the impedance of said relay circuit, and means controlled by the voltage of said load circuit for rendering said electron discharge tube inoperative to control the impedance of said relay circuit.

13. In an automatic reclosing circuit breaker system, the combination with a supply circuit, a load circuit connected to said supply circuit, a circuit breaker adapted to control the connection between said supply circuit and said load circuit, an impedance arranged to be connected in series with said supply circuit and load circuit when said circuit breaker is open, and closing means for said circuit breaker, of a relay connected in parallel with said impedance and arranged to control the operation of said closing means, an electron discharge tube having its cathode and anode connected in series with said relay and its grid connected to said load circuit so that variations in the load resistance varies the impedance of said relay circuit, and a heating circuit for the cathode of said tube arranged to be completed when said circuit breaker is open.

14. In an automatic reclosing circuit breaker system, the combination with a supply circuit, a load circuit connected to said supply circuit, a circuit breaker adapted to control the connection between said supply circuit and said load circuit, an impedance arranged to be connected in series with said supply circuit and load circuit when said circuit breaker is open, and closing means for said circuit breaker, of a relay connected in parallel with said impedance and arranged to control the operation of said closing means, an electron discharge tube having its cathode and anode connected in series with said relay and its grid connected to said load circuit so that variations in the load resistance varies the resistance of said relay circuit, and a second relay connected in parallel with said impedance and arranged to complete a low resistance circuit around the cathode and anode of said electron discharge tube when the voltage drop across said impedance is less than a predetermined value and to open said low resistance circuit when the voltage drop across said impedance is greater than said predetermined value.

15. In an automatic reclosing circuit breaker system, the combination with a supply circuit, a load circuit connected to said supply circuit, a circuit breaker adapted to control the connection between said supply circuit and said load circuit, an impedance arranged to be connected in series with said supply circuit and load circuit when said circuit breaker is open, and closing means for said circuit breaker, of a relay connected in parallel with said impedance and arranged to control the operation of said closing means, an electron discharge tube having its cathode and anode connected in series with said relay and its grid connected to said load circuit so that variations in the load resistance varies the impedance of said relay circuit, a second relay arranged to open and close a low resistance circuit around said cathode and anode, a circuit for said second relay, contacts in said last mentioned circuit, a heating circuit for the cathode of said electron discharge tube, and means arranged to control said contacts so that said second relay is inoperative to open

said low resistance circuit around said cathode and anode when said heating circuit is open.

16. In an automatic reclosing circuit breaker system, the combination with a supply circuit, a load circuit connected to said supply circuit, a circuit breaker adapted to control the connection between said supply circuit and said load circuit, an impedance arranged to be connected in series with said supply circuit and load circuit when said circuit breaker is open, and closing means for said circuit breaker, of a relay connected in parallel with said impedance and arranged to control the operation of said closing means, an electron discharge tube having a cathode and an anode connected in series with said relay and a grid connected to said load circuit so that variations in the load resistance varies the impedance of said relay circuit, a second relay connected in parallel with said first impedance and arranged to complete a low resistance circuit around the cathode and anode when the difference in the voltages across said circuits is less than a predetermined value and to open said low resistance circuit when the difference in the voltages is greater than said predetermined value, contacts in the circuit of said second relay, a heating circuit for the cathode of said electron discharge tube, and a third relay connected in said heating circuit and arranged to control said contacts so that said second relay is inoperative to open said low resistance circuit across said cathode and anode if said heating circuit is open.

17. In an automatic reclosing circuit breaker system, two electric circuits, a circuit breaker for connecting said circuits together, electroresponsive means for controlling the closing of said circuit breaker having a coil so connected when the circuit breaker is open and that its energization is controlled by the voltage across one of said circuits, and means operative in accordance with a predetermined condition of said one of said circuits when said circuit breaker is open to vary the setting of said electroresponsive means whereby said electroresponsive means operates to effect the closing of said circuit breaker in response to one predetermined condition of said one of said circuits under certain conditions thereof and in response to another predetermined condition of said one of said circuits under other conditions thereof.

18. In an automatic reclosing circuit breaker system, a supply circuit, a load circuit, a circuit breaker for connecting said circuits together, an impedance arranged to be connected in series between said circuits when said circuit breaker is open, a reclosing relay for controlling the closing of said circuit breaker having a coil so connected when the circuit breaker is open that its energization is controlled by the voltage across the load circuit, and means operative in accordance with a predetermined condition of said load circuit when the circuit breaker is open to vary the setting of said reclosing relay whereby said reclosing relay operates to effect the closing of said circuit breaker in response to one predetermined electrical condition of said load circuit under certain conditions and in response to another predetermined electrical condition of said load circuit under other conditions.

19. In an automatic reclosing circuit breaker system, a supply circuit, a load circuit arranged to be supplied with current at a plurality of points, a circuit breaker for connecting said supply circuit to said load circuit, an impedance arranged to be connected in series between said circuits when the circuit breaker is open, a reclosing relay for controlling the reclosing of the circuit breaker having a coil so connected when the circuit breaker is open that its energization is controlled by the voltage across the load circuit, and means controlled by the voltage across the load circuit for controlling the connections of said reclosing relay whereby said relay effects the closing of said circuit breaker in response to a predetermined electrical condition of the load circuit when it is not supplied with current at substantially normal potential at some other point and in response to a different predetermined electrical condition of the load circuit when it is supplied with current at substantially normal potential at some other point.

In witness whereof, I have hereunto set my hand this 19th day of December, 1921.

BENJAMIN W. JONES.