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AUTOMATIC RECLOSING CIRCUIT BREAKER SYSTEM

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Fig. 1.

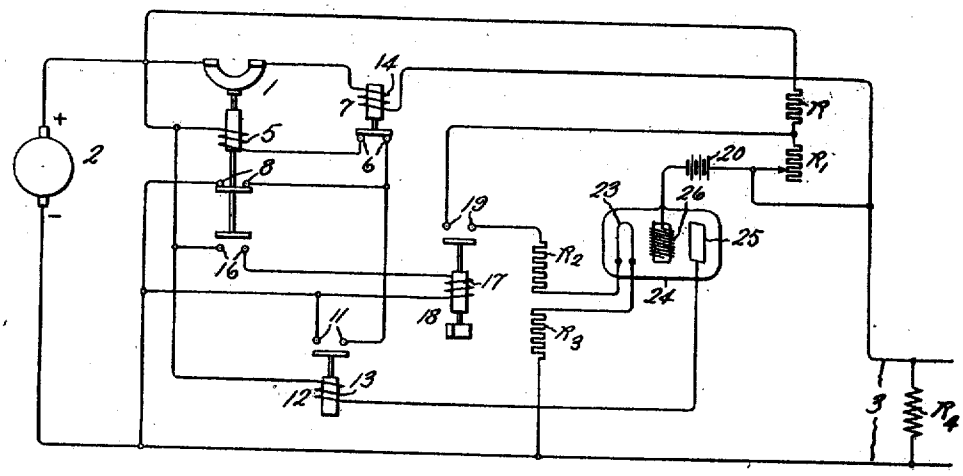
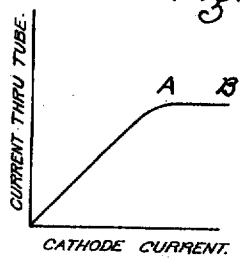


Fig. 2.



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UNITED STATES PATENT OFFICE.

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AUTOMATIC RECLOSING-CIRCUIT-BREAKER SYSTEM.

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To all whom it may concern:

Be it known that I, FRED H. HEDIN, a citizen of the United States, residing at Willimantic, in the county of Windham, State of Connecticut, have invented certain new and useful Improvements in Automatic Reclosing-Circuit-Breaker Systems, of which the following is a specification.

My invention relates to automatic reclosing circuit breaker systems and particularly to such systems in which the reclosing of a circuit breaker which connects a source of current to a load circuit, is controlled by an electron discharge tube which is arranged to be connected, when the circuit breaker is open, so that the current through the tube varies in accordance with the load resistance.

One object of my invention is to provide a new and improved arrangement of connections of an electron discharge tube, whereby variations in the voltage of the source, which is to be connected to the load circuit by the closing of the circuit breaker, have substantially no effect upon the value of load resistance required to reclose the circuit breaker.

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.

In the accompanying drawing, Fig. 1 is a diagram of an automatic reclosing circuit breaker system, embodying my invention, and Fig. 2 shows a characteristic curve of an electron discharge tube, which may be employed.

Referring to Fig. 1 of the drawing, 1 represents a circuit breaker which is arranged to connect a source of current 2, shown as a direct current generator, to a load circuit 3 to which is connected the load R_4. The circuit breaker 1, which may be of any suitable type, is shown as comprising a closing coil 5 which when energized, closes and maintains the circuit breaker in its closed position. The coil 5 is arranged to be connected to any suitable source of current, such as the generator 2. When the circuit breaker 1 is closed, the circuit of the coil 5 includes the contacts 6 of an overload relay 7 and the auxiliary contacts 8 on the circuit breaker 1, which are closed when the circuit breaker is closed. When the circuit breaker 1 is open, the circuit of the coil 5 is arranged to be completed through the contacts 6 of the overload relay 7 and the contacts 11 of a reclosing relay 12, the coil 13 of which is arranged to be energized in accordance with the load resistance, in a manner hereinafter described.

The overload relay 7 is provided with an operating winding 14 which is connected to the load circuit 3 in any suitable manner so that the current through the coil 14 is proportional to the current supplied to the load circuit when the circuit breaker 1 is closed. The relay 7 is so designed that it operates to open its contacts 6 only when the load current exceeds a predetermined value.

When the circuit breaker 1 is open, a current limiting means, such as two resistors R and R_1 is connected in series with a load R_4 so as to limit the current supplied to the load. These resistors are short-circuited by the circuit breaker when it is closed.

The circuit breaker 1 is provided with the auxiliary contacts 16 which are closed when the circuit breaker is open. These contacts are in the circuit of the coil 17 of a time relay 18, which is arranged to be connected to any suitable source, such as the generator 2. The relay 18 is arranged in any suitable manner so that it does not close its contacts 19 until a predetermined time after the coil 17 is energized by the closing of the contacts 16. The closing of the contacts 19 of the relay 18 connects the resistors R_2 and R_3 which are connected in series with each other, in parallel with the load resistance R_4 and the resistor R_1, so as to form a Wheatstone bridge. The cathode 23 of an electron discharge tube 24 is connected to a point between the resistors R_2 and R_3. As shown in the drawing, the cathode 23 is connected in series with resistors R_2 and R_3, so that the current through the resistors heats the cathode. The tube 24 is also provided with an anode or plate 25 which is connected to one end of the coil 13 of the reclosing relay 12, the other end of the coil being connected to the positive terminals of the generator 2 so that the plate 25 is more positive than the cathode 23. The tube 24 is also provided with any suitable means for varying the current through it such as a grid 26 which is connected to a point between the resistor R_1 and the load R_4. The resistors R_2 and R_3 and the resistor R_1,

which forms one arm of the Wheatstone bridge, are preferably of such values that with a given generator voltage, when the circuit breaker 1 is opened, the potential difference between the points to which the cathode and the grid are connected is zero when the load resistance R_4 is a value at which it is desired to reclose the circuit breaker, and when the load resistance is less than this predetermined value, the point to which the grid is connected is more negative than the point to which the cathode is connected, and when the load resistance is greater than this predetermined value the point to which the grid is connected is more positive than the point to which the cathode is connected. Preferably, the relay 13 is so designed that it will operate in response to the value of the current that flows through the tube 24 when the potential difference between the points to which the grid and the cathode are connected is zero. In order, however, to obtain sufficient current through the tube to operate the relay 13 under the above conditions a battery 20 may be connected in series with the grid so that the potential of the grid is more positive than the cathode although the potential difference between the two points of the Wheatstone bridge, to which the cathode and grid are connected, is zero. With such an arrangement, it is evident that variations in the voltage of the source 2, when the circuit breaker is open, has no effect upon the value of load resistance required to make the potential difference between the points to which the cathode and the grid are connected zero.

In order to compensate for variations in the current through the tube, due to changes in the temperature of the cathode produced by variations in the voltage of the source it is preferable to operate the tube on the substantially flat portion A—B of the characteristic curve shown in Fig. 2, so that within certain limits, wide variations in the filament temperature produce very small changes in the current through the tube.

The operation of the system shown in Fig. 1 is as follows:

Under normal operating conditions, the contacts 6 of the overload relay 7 are closed and the circuit breaker 1 is held in its closed position by the energization of the coil 5, the circuit of which includes the contacts 6 of the overload relay 7 and the auxiliary contacts 8 on the circuit breaker. Since the auxiliary contacts 16 on the circuit breaker 1 are open, the time relay 18 is not energized. The contacts 19 therefore are open, so that the circuit through the resistors R_2 and R_3 and the cathode 23 is open. Consequently, there is no current through the tube 24 and the coil 13 of the reclosing relay 12.

When an overload or a short-circuit occurs on the load circuit, overload relay 7 opens its contacts 6 so that the coil 5 is deenergized and the circuit breaker 1 opens. The opening of the circuit breaker 1 removes the short-circuit from around the resistors R and R_1, so that they are connected in series with the load circuit to limit the current supplied thereto. After the circuit breaker opens, the current through the coil 14 of the overload relay 7 decreases, so that the relay closes its contacts 6.

The closing of the auxiliary contacts 16 on the circuit breaker 1, when it opens, completes the circuit of the coil 17 of the time relay 18. After a predetermined time, the relay 18 closes its contacts 19, thereby completing the circuit through the resistors R_2 and R_3, and the cathode 23 of the electron discharge tube 24. The cathode 23 heats up and current flows through the tube 24 and the coil 13 of the reclosing relay 12. With a short-circuit or an overload connected to the load circuit, the current through the coil 13 is not sufficient to cause the relay 12 to close its contacts 11. As the load resistance increases, the potential of the grid 26 becomes more positive with respect to the cathode 23, so that the current through the tube and the coil 13 increases. When the load resistance reaches a predetermined value so that the potential difference between points to which the cathode and the grid are connected is a predetermined value, preferably zero, the relay 12 operates and closes its contacts 11 to complete the circuit of the closing coil 5 of the circuit breaker 1. The circuit breaker then closes and the equipment is restored to its normal condition.

The resistor R is preferably made adjustable so that the amount of load resistance required to close the breaker may be varied.

While I have shown and described one embodiment of my invention, I do not desire to be limited thereto 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, a source of current, a load circuit, a circuit breaker for connecting said source to said circuit, an electron discharge tube having its anode, cathode and grid connected to said system so that the potential difference between the points to which the grid and the cathode are connected is zero when the load resistance is a predetermined value, and means responsive to the current through said tube for causing the closing of said circuit breaker when the potential difference between the

points to which said grid and cathode are connected is a predetermined value.

2. In an automatic reclosing circuit breaker system, a source of current, a load circuit, a circuit breaker for connecting said source to said circuit, an electron discharge tube having its anode, cathode and grid connected to said system so that the potential difference between the points to which the grid and the cathode are connected is zero when the load resistance is a predetermined value, and means responsive to the current through said tube for causing the closing of said circuit breaker when the potential difference between the points to which said grid and cathode are connected is zero.

3. In an automatic reclosing circuit breaker system, a source of current, a load circuit, a circuit breaker for connecting said source to said load circuit, a resistor arranged to be connected in series with said source and said load circuit when said circuit breaker is open, a second and third resistor arranged to be connected in series with each other and in parallel with the circuit comprising said first mentioned resistor and said load circuit so as to form a Wheatstone bridge, an electron discharge tube having its cathode connected to a point between said second and third resistors, its grid connected to a point on said first mentioned resistor and its anode connected so as to be more positive than said cathode, said resistors and the connections of said tubes being such that the potential difference between the points to which said grid and said cathode are connected is zero when the load resistance is a predetermined value, and means responsive to the current through said tube for causing the closing of said circuit breaker when the potential difference between the points to which said grid and cathode are connected is a predetermined value.

4. In an automatic reclosing circuit breaker system, a source of current, a load circuit, a circuit breaker for connecting said source to said load circuit, a resistor arranged to be connected in series with said source and said load circuit when said circuit breaker is open, a second and third resistor arranged to be connected in series with each other and in parallel with the circuit comprising said first mentioned resistor and said load circuit so as to form a Wheatstone bridge, means operative after said circuit breaker has been open for a certain length of time to effect the connection of said second and third resistors in parallel with the circuit comprising said first resistor and said load circuit, an electron discharge tube having its cathode connected in series with and at a point between said second and third resistors, its grid connected to a point on said first mentioned resistor and its anode connected so as to be more positive than said cathode, said resistors and the connections of said tubes being such that the potential difference between the points to which said grid and said cathode are connected is zero when the load resistance is a predetermined value, and means responsive to the current through said tube when the potential difference between the points to which said grid and cathode are connected is zero for effecting the closing of said circuit breaker.

5. An automatic reclosing circuit breaker system comprising a circuit breaker for connecting a source of current to a load circuit, an electron discharge tube comprising a cathode, anode and grid connected so that the potential between said grid and cathode varies with the load resistance in such a manner that the current through the tube increases as the load resistance increases, and means responsive to the current through said tube for controlling the operation of said circuit breaker, characterized by the fact that said tube is so connected that said last mentioned means operates to cause the closing of said circuit breaker when the potential difference between the points to which said grid and cathode are connected is zero.

6. In an automatic reclosing circuit breaker system, a source of current, a load circuit, a circuit breaker for connecting said source to said load circuit, a plurality of resistors arranged to be connected to said source and said load circuit when said circuit breaker is open so as to form together with the load resistance a Wheatstone bridge, an electron discharge tube having an anode, a cathode and means for controlling the current through said tube connected and arranged so that the current through the tube is dependent upon the potential difference between two points on said Wheatstone bridge which varies with the load resistance, and means responsive to the current through said tube for causing the closing of said circuit breaker when the potential difference between said two points on said Wheatstone bridge is a predetermined value.

7. In an automatic reclosing circuit breaker system, a source of current, a load circuit, a circuit breaker for connecting said source to said load circuit, a resistor arranged to be connected in series with said source and said load circuit when said circuit breaker is open, a second and third resistor arranged to be connected in series with each other and in parallel with the circuit comprising said first mentioned resistor and said load circuit so as to form a Wheatstone bridge, an electron discharge tube, having an anode, a cathode and means for controlling the current through said

tube connected and arranged so that the current through the tube is dependent upon the potential difference between two points on said Wheatstone bridge which varies with the load resistance, and means responsive to the current through said tube for causing the closing of said circuit breaker when the potential difference between two points on said Wheatstone bridge is a predetermined value.

8. In an automatic reclosing circuit breaker system, a source of current, a load circuit, a circuit breaker for connecting said source to said load circuit, a resistor arranged to be connected in series with said source and said load circuit when said circuit breaker is open, a second and third resistor arranged to be connected in series with each other and in parallel with the circuit comprising said first mentioned resistor, and said load circuit so as to form a Wheatstone bridge, means operative after said circuit breaker has been opened for a certain length of time to effect the connection of said second and third resistors in parallel with the circuit comprising said first resistor and said load circuit, an electron discharge tube having an anode, a cathode and means for controlling current through said tube connected and arranged so that the current through the tube is dependent upon the potential difference between two points on said Wheatstone bridge which varies with the load resistance, and means responsive to the current through said tube for causing the closing of said circuit breaker when the potential difference between two points on said Wheatstone bridge is zero.

In witness whereof, I have hereunto set my hand this 18th day of October 1922.

FRED H. HEDIN.