Aug. 25, 1925. 1,551,297

C. LE G. FORTESCUE

RELAY

Filed Jan. 12, 1920

Fig. 1.

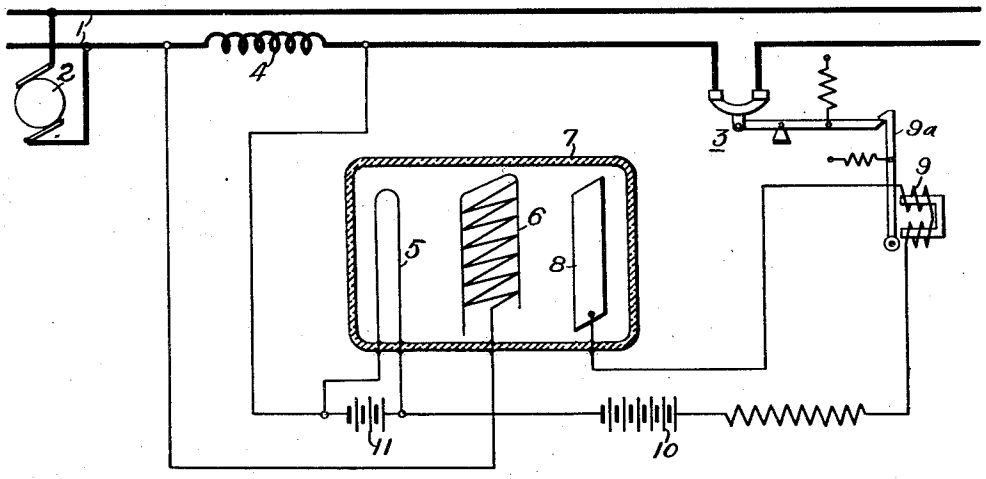


Fig. 2.

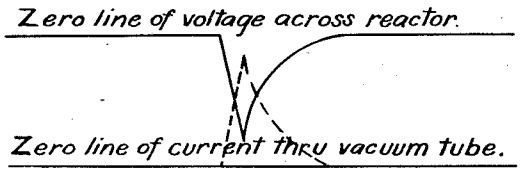
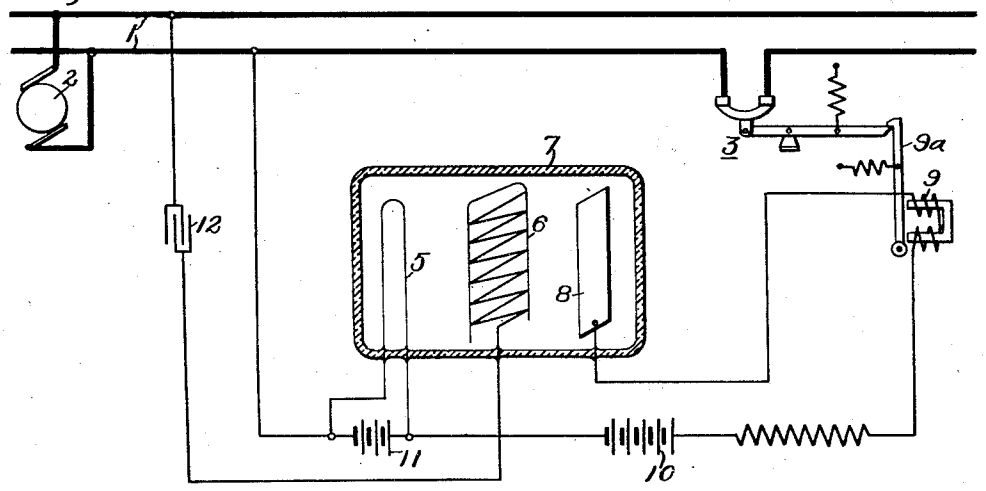


Fig. 3.



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UNITED STATES PATENT OFFICE.

CHARLES LE G. FORTESCUE, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

RELAY.

Application filed January 12, 1920. Serial No. 350,800.

To all whom it may concern:

Be it known that I, CHARLES LE G. FORTESCUE, a subject of the King of Great Britain, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Relays, of which the following is a specification.

My invention relates to relays and particularly to amplifying relays for quick-acting interrupters.

One object of my invention is to provide a relay that shall be adapted to distinguish between a short circuit and a heavy overload in its operation.

Another object of my invention is to provide a device of the above indicated character for the control of a circuit interrupter that shall be especially sensitive in the event that a short circuit occurs thereon.

Another object of my invention is to provide a controlling or relay device, of the above indicated character, that shall be simple and compact in construction and sensitive and reliable in operation.

There are a large number of limiting features in the design of quick-acting devices for use with circuit interrupters that have been proposed in the past. One of the main difficulties with such devices has been to obtain a relay circuit that shall be properly selective, that is, one which can discriminate between an impulse caused by a short circuit and an impulse caused by the switching of heavy loads. The characteristic of the former impulse is an abrupt change of voltage across an inductor that is connected in series with the circuit, while the characteristic of the latter impulse is a comparatively gradual increase in voltage across the inductor.

In view of these characteristics, I propose to use a three-element vacuum tube that shall be connected across the terminals of an inductor of the circuit. I provide, further, a source of energy that shall be so controlled by the vacuum tube as to actuate a circuit interrupter of the circuit substantially in anticipation of short circuit thereon. Such anticipatory action is obtained by reason of the quick change of voltage across the inductor before the short-circuit current traverses the circuit.

Fig. 1 of the accompanying drawings is a diagrammatic view of a circuit embodying my invention; Fig. 2 is a diagram illustrating the change in voltage across the terminals of an inductor in the circuit caused by a short circuit thereon, and Fig. 3 is a diagrammatic view of the circuit shown in Fig. 1, illustrating the connections of a condenser thereto.

A direct-current circuit 1 is supplied with energy from a source 2 of electromotive force and is provided with a circuit interrupter 3. A reactor 4 is connected in series with the circuit 1 and has the cathode element 5 and the grid element 6 of a three-element vacuum tube 7 connected across its terminals. The anode element 8 of the vacuum tube 7 is connected to one terminal of the trip coil 9 of the circuit interrupter 3, the other terminal of which is connected to one terminal of a source 10 of electromotive force. The other terminal of the source 10 of electromotive force is connected to the cathode element 5 of the vacuum tube 7. An auxiliary source 11 of electromotive force is employed to energize the cathode element 5. In the system illustrated in Fig. 3, the cathode element 5 and the grid element 6 of the vacuum tube 7, are connected, in series with a condenser 12, across the circuit 1.

When normal conditions obtain in the circuit 1, the potential difference across the terminals of the reactor 4 is so small that the potential of the grid element 6 is not raised sufficiently to provide an appreciable anode current. The occurrence of a short circuit, however, suddenly increases the potential difference across the reactor 4, and, consequently, raises the potential of the grid element 6. The grid element 6, by virtue of its increase in potential, increases the electron flow through the tube 7, and a current passes therethrough from the source 10 of electromotive force that is of sufficient value to actuate the trip mechanism 9^a of the circuit interrupter 3 through the trip coil 9.

In the diagram of Fig. 2, the downward curve shows the sudden change in potential across the reactor 4 that is effected by a short circuit, and the sharp upward curve shows the sudden increased current that is permitted to traverse the vacuum tube 7. Since the change in current through the

reactor 4 by switching on of heavy load is gradual and reaches a steady value, the grid element 6 is not energized sufficiently to produce an appreciable electron flow. The vacuum tube is thus able, in co-operation with a reactor, to effect selective action and, thus to actuate the circuit interrupter only when a short circuit occurs thereon. A system is shown in Fig. 3 that utilizes a condenser 12 instead of a reactor, as in the system shown in Fig. 1.

Although I have shown a plurality of systems embodying my invention, they are not so limited, as various changes may be made in the arrangement of the elements thereof without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim as my invention:

1. In an electric circuit, the combination with a circuit interrupter, of a vacuum valve for tripping the circuit interrupter only when a short circuit occurs on the circuit.

2. In an electric circuit, the combination with a circuit interrupter, of a reactor in the circuit, a vacuum tube connected to the reactor, and a source of energy controlled by the tube for tripping the circuit interrupter.

3. In an electric circuit, the combination with a circuit interrupter, and tripping means therefor, of an inductor connected to the circuit, a vacuum tube connected to the inductor, and a source of energy so controlled thereby as to trip the circuit interrupter when a short-circuit occurs thereon.

4. In an electric circuit, the combination with a circuit interrupter, of a reactor connected in the circuit, a vacuum tube operatively connected to the reactor, means for energizing the tube, and means controlled thereby for tripping the circuit interrupter.

5. In an electric circuit, the combination with a circuit interrupter, of a reactor operatively connected to the circuit, a vacuum tube adapted to select voltage changes across the reactor, means for energizing the tube, and means controlled thereby in accordance with the selected voltage changes for tripping the circuit interrupter.

6. In an electric circuit, the combination with a circuit interrupter, of a reactor operatively connected to the circuit, and a vacuum tube disposed with respect to the reactor to so distinguish between short circuits and sudden heavy-load conditions as to actuate the circuit interrupter upon an occurrence of a short-circuit condition.

7. In an electric circuit, the combination with a circuit interrupter, of a reactor connected to the circuit, a vacuum tube and a source of energy so disposed with respect thereto as to actuate the circuit interrupter only upon a predetermined rate of change of current in the circuit.

8. In an electric circuit, the combination with a circuit interrupter, of a reactor connected to the circuit, a vacuum tube connected thereto, and a source of energy controlled by the vacuum tube for actuating the circuit interrupter upon a rate of change of current above a predetermined value.

9. In an electric circuit, the combination with a circuit interrupter, of a vacuum tube, a source of energy controlled thereby for actuating the circuit interrupter, and means for operatively energizing the vacuum tube only upon a rate of change of current above a predetermined value.

10. In an electric circuit, the combination with a circuit interrupter, of an electron tube for controlling the interrupter, and means for rendering the tube operative upon a rate of change of current in the circuit above a predetermined value.

11. In an electric circuit, the combination with a circuit interrupter, of a vacuum tube for controlling the interrupter, said tube being arranged to permit a sufficient flow of current to trip the interrupter only when a short circuit obtains on the circuit.

12. In an electric circuit, the combination with an electro-responsive device, of an electron-emission device for controlling the electro-responsive device, and means for so controlling the electron-emission device as to cause current to traverse the electro-responsive device only under predetermined conditions in the electric circuit.

13. In an electric circuit, the combination with an electro-responsive device, of an electron-emission device for controlling the electro-responsive device, and means for so controlling the electron-emission device as to cause current to traverse the electro-responsive device only when a short circuit obtains on the electric circuit.

14. In an electric circuit, the combination with an electro-responsive device, of an electron-emission device for controlling the electro-responsive device, and means connected to the circuit for impressing a sufficiently high potential on the electron-emission device to effect operation thereof only when a short circuit obtains on the circuit.

15. In an electric circuit, the combination with a circuit interrupter of an asymmetric valve for controlling the interrupter, and means for energizing the valve in accordance with the rate of change of current traversing the circuit.

16. An interrupter for an electric circuit comprising a vacuum valve and means for rendering the energization thereof dependent upon a predetermined relatively quick rate of electrical change in the circuit for controlling the interrupter.

17. An interrupter for an electric circuit comprising an asymmetric valve and means for rendering it operative in response to a predetermined relatively quick rate of

change in the circuit current for controlling the interrupter.

18. The method of protecting an electric circuit from short circuit currents which consists in controlling a vacuum valve in accordance with the rate of electrical change in the circuit and then controlling the circuit in accordance with the degree of energization of the valve.

19. The method of protecting an electric circuit from short circuit currents, which consists in controlling a vacuum valve in accordance with the rate of change of current in the circuit and then causing the valve to control the circuit in accordance with such rate of change of the current.

20. The method of protecting an electric circuit from short circuit currents, which consists in controlling a vacuum valve in accordance with the rate of change of voltage between two points of the circuit and then causing the valve to control the circuit in accordance with such rate of change.

21. In an electric circuit, the combination with a circuit interrupter and a trip coil therefor, of a valve device operatively connected to the circuit for so controlling the current to the trip coil from the circuit that current traverses the trip coil only under predetermined load conditions in the circuit.

22. In an electric circuit, the combination with a circuit interrupter and a trip coil therefor, of a vacuum valve device operatively connected to the circuit for controlling the current to the trip coil.

23. In an electric circuit, the combination with a circuit interrupter and a trip coil therefor, of an asymmetric valve device operatively connected to the circuit for controlling the current to the trip coil.

24. The combination with an electric circuit and an interrupter therefor, of a trip coil for the interrupter, an asymmetric valve device connected in series with the trip coil for controlling the same, and connections between said valve device and the circuit.

25. The combination with an electric circuit and an interrupter therefor, of a trip coil for the interrupter, an electron tube connected in series with the trip coil for controlling the same, and connections between said electron tube and the circuit.

26. The combination with an electric circuit and an interrupter therefor having a trip coil, of an electron tube controlled in accordance with the current in the circuit, said trip coil being connected to said tube.

27. The combination with a circuit interrupter having a trip coil, of a hot-cathode valve connected in series with the trip coil and means for varying the cathode current dependent upon the current traversing said interrupter.

28. The combination with a circuit interrupter having a trip coil, of an electron tube having an anode, a cathode and a grid, said trip coil being connected to the anode, and means whereby the potential of said grid is varied in accordance with the current traversing said interrupter.

29. The combination with a circuit interrupter having a trip coil, of an electron tube having an anode, a cathode and a grid, said trip coil being connected to the anode, and means including a reactance device whereby the potential of said grid is varied in accordance with the current traversing said interrupter.

30. In combination, a circuit interrupter, an electron tube associated therewith, and means including said electron tube for tripping said circuit interrupter under predetermined conditions.

31. In combination, a switch, an electron tube associated therewith, and means including said electron tube for actuating said switch under predetermined conditions.

32. In combination, a circuit interrupter, an electron tube associated therewith, and means including said electron tube for tripping said circuit interrupter, said means being dependent upon the current through said interrupter.

In testimony whereof, I have hereunto subscribed my name this 18th day of December 1919.

CHARLES LE G. FORTESCUE.