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C. LE G. FORTESCUE

HIGH SPEED CIRCUIT INTERRUPTER

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Fig. 1.

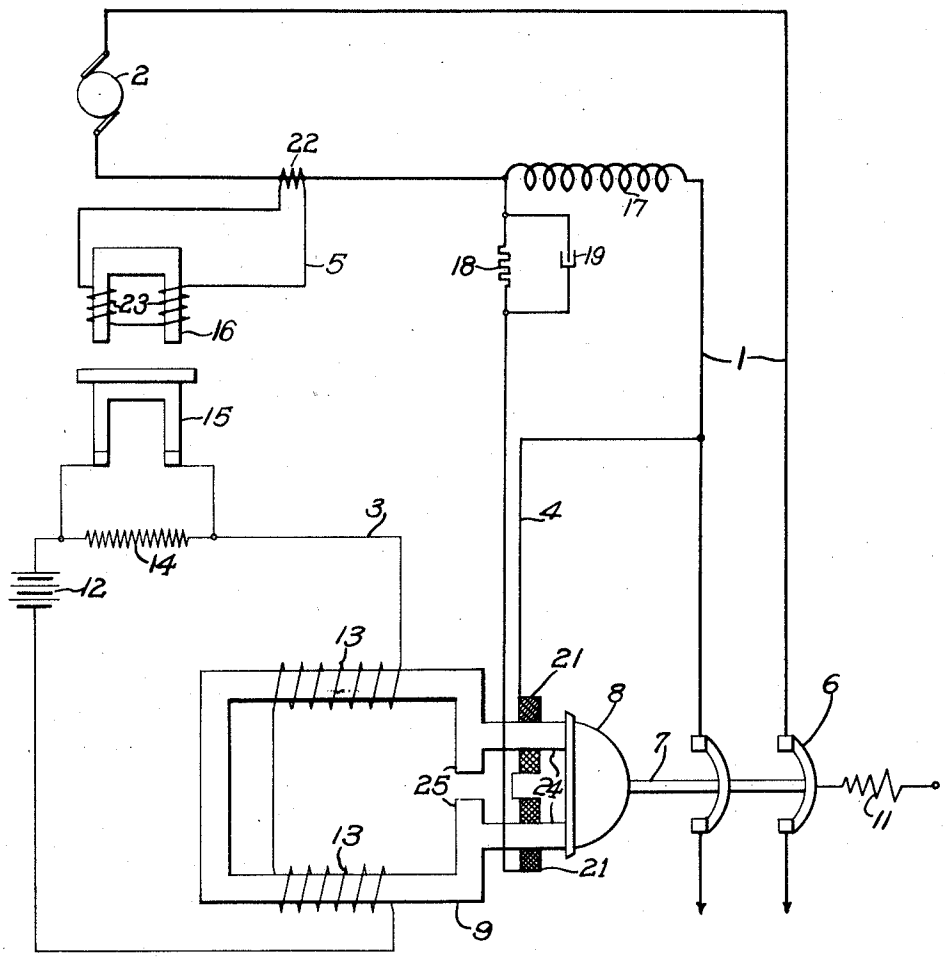
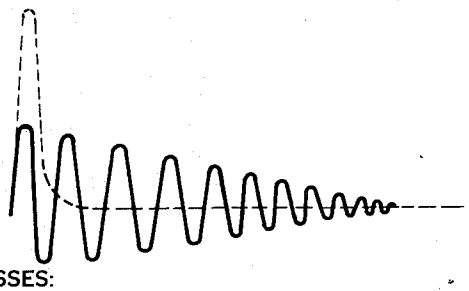


Fig. 2.



WITNESSES:

A. J. Schiefelbein.

Lester G. Budlong.

INVENTOR

Charles LeG. Fortescue.

BY

Wesley G. Carr

ATTORNEY

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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.

HIGH-SPEED CIRCUIT INTERRUPTER.

Application filed December 11, 1922. Serial No. 606,142.

My invention relates to circuit interrupters, more particularly to quick-acting circuit interrupters.

One object of my invention is to provide a circuit interrupter that shall be responsive both to conditions of slow changes, such as those due to normal overloads, and to sudden current surges, such as occur upon the creation of a short circuit.

Another object of my invention is to provide a quick-acting circuit interrupter that shall be quickly responsive to abnormal current conditions, without the necessity for intermediate protecting devices, such as relays.

Another object of my invention is to provide a circuit interrupter that shall be more sensitive to conditions of current change than those employing secondary protective devices.

A further object of my invention is to provide a device of the above-indicated character that shall be simple, inexpensive in construction, and still be sensitive and reliable in its operation.

In my co-pending application, Serial No. 404,206, (Case No. 7629) filed August 17, 1920, I have shown and described a device for the quick interruption of an electrical circuit in anticipation of a short circuit. Such device is not responsive to conditions of overload which arise slowly, there being no accompanying surge of current, which is necessary for its operation. Moreover, the differential action on which this device depends necessarily retards the action of the interrupter in the case of sudden surges of current. Such overloads endanger the circuits carrying them and should be guarded against.

In carrying out my present invention, I provide a circuit interrupter with a critically damp condenser whereby I obtain a control circuit having a low surge impedance and a high impedance to slow changes in current.

I propose to construct a quick-acting circuit interrupter comprising an electromagnet whose armature member holds a circuit breaker in its closed postion against the force of a strong spring. The electromagnet is energized by a pair of circuits to be more fully described, hereinafter.

One of these circuits comprises a pair of normally inactive coils mounted on the electromagnet. These coils are controlled by a disposition of elements hereinafter described, in such manner that they become active only upon the occurrence of sudden changes of current traversing the main circuit. The flux set up by these coils, when energized, is opposed to the flux of the coils normally energizing the electromagnet, the resulting flux, being thereby diverted from the main pole pieces.

The magnetic field holding the armature being thus weakened, the spring operates the circuit breaker against the lessened resistance offered by the armature member. The operation and assembly of this system forms the subject matter of my co-pending application for Letters Patent.

I provide means responsive to conditions of overload in the circuit to be protected for controlling the circuit for normally energizing the electromagnet whereby the value of the current traversing the latter circuit is automatically reduced upon the occurrence of overload. Upon the reduction of the current strength, with an accompanying decrease in the strength of the electromagnet, the circuit breaker is opened by the spring.

In the accompanying drawing,

Figure 1 is a diagrammatic view of a preferred arrangement of circuits and apparatus embodying my invention.

Figure 2 is a composite curve diagrammatically illustrating the operation of the critically damp condenser.

My invention comprises a main electrical circuit 1 that is supplied by any source of energy 2, and secondary electrical circuits 3, 4 and 5. In electrical circuit 1, there is a circuit breaker 6, connected by a rod or link 7, to armature member 8 of electromagnet 9, the armature member being biased to its open position by a spring 11.

Electrical circuit 3 comprises a source of electromotive force 12, coils 13, 13 for energizing the electromagnet 9, and a resistor 14 in shunt circuit with armature member 15 of electromagnet 16.

Electrical circuit 4 is a shunt circuit around reactor 17, which is an element of circuit 1. In this circuit, a resistor 18 and

a condenser 19 are arranged in parallel relation, and in series with coils 21, 21, mounted near one end of electromagnet 9.

Electrical circuit 5 is a circuit in shunt around a resistor 22, forming an element of circuit 1. In this circuit, coils 23 energize electromagnet 16.

Electromagnet 9 is provided with the usual pole pieces 24 and an auxiliary or secondary set of pole pieces 25 having a small air gap between them.

In operation, normal values of current traversing the circuit 1 have no tendency to actuate the circuit breaker 6. Coils 13 energize electromagnet 9 to attract armature member 8 to its pole pieces 24 and, by means of the connecting link 7, to hold the circuit breaker 6 closed against the tension of spring 11. Under such conditions, the voltage drop across the reactor 17 in circuit 1 is so slight that only a minute current traverses circuit 4 in shunt thereto. Under the same current values, the voltage drop across resistor 22 in circuit 1 is sufficient to cause current to traverse circuit 5, but this current is not of sufficient strength to cause electromagnet 16 to overcome the resistance of armature member 15 and produce movement thereof.

Upon the occurrence of a sudden impulse of current traversing circuit, such as occurs upon the creation of a short circuit, the reactance of member 17 is sufficient to cause a relatively large difference in potential across the terminals. As the impedance of condenser 19 to the current impulse created by this potential difference is practically zero, a heavy current traverses circuit 4.

Before the condenser 19 has become fully charged its impedance is greater than that of the resistor 18 which condition causes the current traversing the condenser to gradually diminish and the current through the resistor to increase. The current traversing the resistor in turn gradually diminishes as the voltage surge set up by the reactor 17 subsides.

Thus the result of the combined action of the resistance and condenser is a unidirectional current impulse of steep wave front, whose maximum value depends upon the severity of the current surge in the main circuit.

It has been found that when a condenser alone is employed in circuit 4, it will charge and discharge forming a high frequency oscillating current long after the impulse which initiated this current has died out. This current is illustrated by the solid line curve in Fig. 2. Such an arrangement will therefore be sensitive to small oscillations set up by small impulses due to sudden load changes which are not severe enough to warrant the interruption of circuit 1, such as a normal change of the circuit power load. In such cases, the oscillating current, such as is shown in solid lines in Fig. 2, traversing circuit 4 for any appreciable length of time will result in the interruption of circuit 1 in a manner hereinafter explained.

A resistor alone is not responsive to current surges. But by the combination of a resistor and a condenser in parallel circuit as here shown, I am able to produce a critically damped condenser which has a high impedance to slow variations of current but a low impedance to rapid variations of currents, as shown by the dotted line curve in Fig. 2. The relation of the resistor to the condenser should follow the equation

$$\frac{1}{R} > \sqrt{\frac{C}{L}} \text{ or } R < \sqrt{\frac{L}{C}}$$

where

R=Resistance of member 18.

C=Capacity of member 19.

L=Inductance of circuit 4.

Upon the occurrence of a sufficiently heavy current surge in circuit 1, sufficient current will traverse circuit 4, due to the discharge of condenser 19, to energize coils 21. The latter are so wound that their magnetic flux tends to oppose the normal flux in member 9. The magneto-motive forces of the coils 13 and 21 are combined, however, as applied to the air gap between pole pieces 25 and the magnetic path thus established is, in effect, a shunt magnetic path for the poles 24.

The pole pieces 24, are thus partially deenergized and the armature member 8 and connected circuit breaker 6 are actuated by the spring 11 to effect the interruption of circuit 1.

By this arrangement, I provide a means for protecting circuit 1 against sudden line surges. If desired, I may employ the specific system shown and described in my copending application for this purpose, the principle involved being the same.

In the event of an overload in circuit 1, a proportionately increased current will traverse circuit 5, by reason of the increased voltage drop across the terminals of resistor 22, which is commonly termed the IR drop. At a predetermined overload in circuit 1, the current traversing circuit 5 energizes electromagnet 16 to a degree at which the latter lifts the armature member 15.

The movement of armature member 15 interrupts the shunt circuit around resistor 14 in circuit 3 to insert the latter in series with the coils 13. As the voltage at the source of energy 12 of circuit 3 is limited, the increased resistance of circuit 3, having resistor 14 directly in series connection, results in a smaller current traversing the circuit. The diminished current lessens the strength of the magnetic field induced by coils 13, with a corresponding weakening of the attraction between pole pieces 24 and

8. The spring 11 then pulls the armature 8 away from the pole pieces 24, at the same time operating circuit breaker 6 to interrupt circuit 1. By inserting the resistor 14 in the circuit, I avoid the employment of an expensive contactor that would be required to handle the arc, resulting from the complete opening of the circuit containing the coil 13.

I have provided a quick-acting circuit interrupter which is in itself responsive to conditions of overload or sudden current impulses in the circuit to be protected. It is to be observed that no relays or other control mechanism are needed to operate my circuit interrupter, thereby insuring a greater economy in installation and upkeep.

While I have shown the preferred form of my invention, I do not wish to be limited to the specific structure illustrated, as various modifications may be made therein within the spirit and scope of my invention, as set forth in the appended claims.

I claim as my invention:

1. The combination with an electrical circuit, of a quick-acting circuit-interrupting mechanism comprising a magnetizable member, a coil for normally magnetizing the said member, an armature adapted to be attracted by said magnetizable member, bias means adapted to oppose said attraction, means responsive to sudden variations in said electrical circuit for controlling said magnetizable member, and means for de-magnetizing said member under overload in said electrical circuit.

2. An electrical circuit having a resistance element in circuit with a reactance element, an electrical circuit in parallel with each element, means in each parallel circuit for effecting the interruption of the first-named electrical circuit under predetermined conditions.

3. An electrical circuit having a resistance element in series connection with a reactance element, an electrical circuit in parallel with each element, means in each parallel circuit for effecting the interruption of the first-named electrical circuit under predetermined conditions.

4. The combination with an electrical circuit comprising a quick-acting circuit interrupter, a resistance element and a reactance element in circuit, of means co-operating with said resistance element for effecting the operation of said interrupter under certain current conditions, and means co-operating with said reactance for effecting the operation of said interrupter under other current conditions.

5. In an electrical system comprising a main electrical circuit, a quick-acting circuit interrupter, a resistor in said electrical circuit, a magnetizable member for controlling said circuit interrupter, a second electrical circuit for energizing said member comprising a second resistor in shunt circuit with an armature member, a third circuit in parallel with the first-named resistor comprising a second magnetizable member, the second named member being so arranged with relation to said armature member that certain current conditions in the main electrical circuit cause said second-named member to actuate the armature member to interrupt the circuit in shunt with the second resistor, thereby causing current to traverse the said second resistor, resulting in the de-energizing of first-named member, whereby interruption of the main circuit is effected.

6. The combination with an electrical system comprising a main electrical circuit, a quick-acting circuit interrupter, a resistor in said electrical circuit, a magnetizable core member for controlling said circuit interrupter, a second electrical circuit for energizing said core member comprising a second resistor in shunt circuit with an armature member, a third circuit in parallel with the first-named resistor comprising a second magnetizable core member, the second-named core member being so arranged with relation to said armature member that certain current conditions in the main electrical circuit cause said second-named core member to actuate the armature member interrupting the circuit in shunt with the second resistor, thereby causing current to traverse the said second resistor, resulting in the de-energizing of the first-named core member, whereby the main circuit is interrupted, of a reactance element in said main circuit, an electrical circuit in parallel therewith comprising an impedance device and a coil mounted on the first-named core member and so ararnged that other current conditions in the main electrical circuit cause the interruption of the main electrical circuit.

7. In an electrical device, a main electrical circuit, a quick acting circuit breaker in said circuit, means for biasing said circuit breaker to its open position, magnetic means opposing said biasing means for holding said circuit breaker in its closed position, and electro-responsive means comprising means responsive to current surges in said circuit, and means responsive to overload in said circuit, each of which means controls said magnetic means.

8. The combination with an electrical circuit, of a quick-acting circuit-interrupting mechanism comprising a magnetizable member, means for normally magnetizing the said member, an armature adapted to be attracted by said member, bias means adapted to oppose said attraction, a condenser and a resistor in parallel relation that has low impedance to sudden varia-

tions in the electrical circuit for controlling said member, and means for de-energizing said member under overload in said electrical circuit.

9. A circuit interrupter comprising holding means to retain said interrupter in closed position, the said holding means comprising a magnetizable member, an armature to be attracted thereby and bias means opposing this attraction, an impedance having a positive reactance in series with said interrupter, and an electro-responsive release means for said interrupter connected in series with a condenser shunted by a resitor to constitute a path shunting said impedance.

In testimony whereof, I have hereunto subscribed my name, this 6th day of December, 1922.

CHARLES LE G. FORTESCUE.