

1,184,844.

Fig. 1.

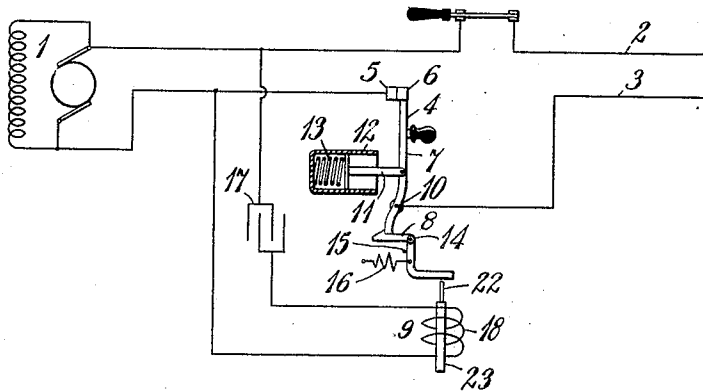
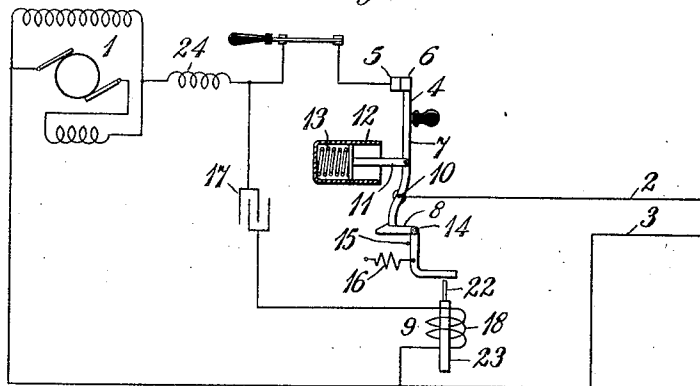


Fig. 2.



Fred H. Miller
J. B. Carbone

Charles L. G. Fortescue
BY
Wesley E. Carr
ATTORNEY

UNITED STATES PATENT OFFICE.

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

ELECTRIC-CIRCUIT INTERRUPTER.

1,184,844.

Specification of Letters Patent.

Patented May 30, 1916.

Application filed May 27, 1912. Serial No. 700,011.

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 Electric-Circuit Interrupters, of which the following is a specification.

My invention relates to means for effecting the interruption of electric circuits and to systems of electric current distribution and control embodying such means.

The object of my invention is to provide an automatic circuit interrupter which shall act in anticipation of current disturbances on the circuit with which it is associated to interrupt the circuit before the current has sufficient time to attain a dangerous or destructive value.

Overloads on electric generating apparatus amounting to several times normal full load current are usually designated as short circuits. The ultimate value of the current in a short circuit and the time required to reach that value are determined by the characteristics of the circuit.

In practice, all electric circuits include inductance and, therefore, a certain time is always required for the current to reach a maximum value.

A circuit interrupter, as heretofore constructed, has usually been provided with a tripping mechanism which was dependent upon a predetermined abnormal current in the circuit and, consequently, it was practically impossible to interrupt the circuit before the current increased to a dangerous value. In a co-pending application, Serial No. 679,297, filed by William Cooper February 23, 1912, and assigned to the Westinghouse Electric & Manufacturing Company, there is set forth and described circuit breaker apparatus of this character which is dependent upon a predetermined rate of change of the voltage or current in an electric circuit.

According to my present invention, I provide a circuit interrupter which depends upon a sudden decrease of voltage in a circuit to produce such a condenser discharge as is sufficient in intensity to either directly or indirectly effect the interruption of the circuit protected by the interrupter.

Figure 1 of the accompanying drawings is a diagrammatic view of a system of dis-

tribution embodying the circuit-interrupting apparatus of my invention. Fig. 2 is a diagrammatic view of a slightly modified arrangement in which an induction coil is employed for increasing the time necessary for the current to reach a dangerous value, following a short circuit or other abnormal condition in the system.

Referring to Fig. 1 of the drawings, energy is supplied from a direct current generator 1, which may be replaced by some other suitable source of energy, to distributing circuit conductors 2—3 through a circuit interrupter 4. The circuit interrupter 4 comprises a stationary contact member 5, a cooperating movable contact member 6, an arm or lever 7, a latch 8, and a tripping magnet 9. The arm or lever 7 is pivotally supported, at an intermediate point in its length, on a pin 10 and carries the contact member 6 at its upper end. A plunger 11 is pivotally mounted on a pin 14 and is held and acts in a hollow cylinder or box 12 to compress a helical spring 13 when the circuit interrupter is closed. The latch 8 is pivotally mounted on a pin 14 and is held against a stop 15 by means of a spring 16. It is adapted to engage the lower end of the arm or lever 7 and to hold the contact members 5 and 6 in engagement, in opposition to the spring 13, when the interrupter is closed. A condenser 17 is connected across the terminals of the generator 1 in series with a coil 18 which forms a part of the tripping magnet 9.

The arrangement of Fig. 2, to which reference may now be had, includes an induction coil 24, but the system is otherwise similar to that of Fig. 1, and operates in the same way. Corresponding parts in this figure are designated by the same reference characters as those used in Fig. 1.

The operation of the system is as follows: Assuming that the circuit interrupter is closed, as shown in Fig. 1, it will evidently remain closed until the latch 8 is either manually actuated or is tripped by a hammer projection 22 of the movable core member 23. By reason of the fact that the condenser 17 is connected across the terminals of a source of direct current energy, no current will traverse the coil 18 except when a relatively rapid change in voltage occurs at said terminals. The fact that the voltage is high or low or is varying has little or no effect

on the coil 18 unless such a variation occurs as releases a sufficient quantity of energy from the condenser to energize the tripping magnet. The circuit interrupter will remain closed under all ordinary conditions of operation. Since the condenser is included in series relation to the trip coil 18, no material energy will be supplied to the coil as long as the generator voltage is constant or changes slowly. If, however, the generator voltage drops suddenly, the condenser discharges through the coil 18 which, when energized, lifts the core member 23 to cause the hammer projection 22 to strike the latch 8 and release the lever 7. As soon as the lever is released, the spring 13, which is relatively strong, separates the contact members 5 and 6, with great rapidity.

If a low-resistance connection, such as is ordinarily designated as a short circuit, is established across the distributing circuit conductors 2 and 3, the first effect, as hereinbefore pointed out, is to produce a practically instantaneous decrease in voltage at the generator terminals. Under ordinary conditions, this change of voltage is immediately followed by a very large increase in current, which is likely to injure the generator. With the arrangement illustrated, however, the coil 18 is so energized by the instantaneous discharge of the condenser 17 as to interrupt the circuit as above indicated.

By properly proportioning the parts and selecting the spring 13, the circuit may be interrupted before the increase in current in the distributing circuit attains a dangerous or destructive value. In case the current increases at such a rate that the ultimate value when the circuit breaker opens will be such as to endanger the generator, an induction coil or choke coil 24 may be inserted in the generator circuit (see Fig. 2) for the purpose of delaying or retarding the building up of the current value. The inductance may be placed in such a position as to enhance the effect of the condenser on the action of the circuit interrupter and, consequently, the circuit may be interrupted before a dangerous current value is attained. It will, of course, be understood that other abnormal conditions may make it desirable to interrupt the circuit, but such conditions, which cannot be adequately taken care of by an ordinary overload release circuit breaker, will produce such a sudden decrease in the voltage of the generator as to cause the opening of the circuit breaker of my invention. It is, therefore, evident that the circuit, as well as the generator, are fully protected.

While the theory of the operation of the condenser is not of importance to my invention, it may be noted that the current that flows in a circuit having capacity, inductance and resistance is directly propor-

tional to the voltage and inversely proportional to the impedance of the circuit. Since the impedance of a circuit depends upon the resistance and the reactance, and the reactance depends upon the capacity, inductance and frequency of the circuit, it can be stated that the current that flows through the trip coil is directly proportional to the voltage if the resistance, inductance and capacity remain unchanged; hence the greater the change in voltage, the greater will be the tripping current. Furthermore, it will be understood by those versed in the art, that the more rapid the change in voltage the more quickly will the condenser be charged. In view of the foregoing, it will be seen that the operation of the trip coil actually depends on both the extent of the drop in potential, and the rate of change in potential in the circuit.

When a short circuit occurs in a direct current constant-potential system, the current starts to rise with a rapidity which depends upon the resistance and inductance included by the short circuit. For example: Assume that, at the instant of short circuit, the electromotive force absorbed by the current in the resistance is V , the electromotive force developed in the generator being V_0 . Then the rate of rise of the current will be such as to produce a back electromotive force opposing that of the generator equal to $V_0 - V$. Hence, the rate of change of the current must be equal to this value divided by the self-inductance of the circuit. If part of this inductance is between the terminals of the branch circuit which includes the trip coil and the condenser, on the generator side of the circuit, a corresponding drop, proportionate to the value of this inductance, will take place in the electromotive force across the terminals of the condenser. The condenser will, therefore, discharge part of its energy through the trip coil. Part of this energy will be absorbed in the main circuit beyond the terminals of the branch including the condenser, a small part will be dissipated in ohmic resistance in the trip coil itself, and another part will be absorbed by the trip coil in doing work on the armature which actuates the tripping device. The value of the two last named portions of the energy absorbed by the circuit will depend upon the drop in electromotive force at the terminals of the circuit including the condenser and the magnet coil. This analysis is also approximately true in the case energy is supplied from a generator having series field magnet coils, since the whole action takes place before the current has risen to any appreciable extent and, therefore, since the increase in electromotive force, due to the series field magnet coils, depends only upon the value of the current, its effect will be negligible.

I claim as my invention:

1. An interrupter for electric circuits comprising relatively movable contact members, a condenser and means dependent upon a predetermined rate of electrical change in the circuit and upon the resulting change in the condenser circuit for interrupting the main circuit.
2. An interrupter for electric circuits comprising relatively movable contact members, a condenser connected across the circuit, and means dependent upon a predetermined rate of electrical change in the condenser circuit for separating the contact members.
3. An interrupter for electric circuits comprising a condenser connected across the circuit, and means dependent upon a predetermined rate of condenser discharge for actuating the interrupter to open the circuit.
4. A system of distribution comprising a source of energy, a condenser connected across the terminals of the source, and means connected in the condenser circuit and dependent upon a predetermined relatively quick electrical change in the condenser circuit for interrupting the distributing circuit.
5. A system of distribution comprising a source of energy, a condenser connected across the terminals of the source, and a trip coil connected in the condenser circuit and dependent upon a relatively quick change in the potential of the distributing circuit for interrupting the distributing circuit.
6. A system of distribution comprising a source of energy, a condenser connected across the terminals of the source, and means connected in the condenser circuit and dependent upon a relatively quick change in the potential of the distributing circuit for interrupting the distributing circuit.
7. A system of distribution comprising an electric circuit, a direct current source of energy, a circuit interrupter, a trip coil for causing the interrupter to open the circuit, a condenser connected across the circuit in series with the trip coil and an inductance included in the circuit adjacent to said source of energy.
8. A system of distribution comprising an electric circuit, a direct current source of energy, a circuit interrupter, a trip coil for causing the interrupter to open the circuit, a condenser connected across the circuit in series with the trip coil and an inductance included in the circuit to delay the building up of the current in the circuit under abnormal conditions.
9. A system of distribution comprising a direct current source of energy, a condenser connected across the terminals of the said source of energy, and means connected in the condenser circuit and dependent upon a relatively quick predetermined electrical change in the condenser circuit for interrupting the distributing circuit.
10. A system of distribution comprising a direct current source of energy, and electrostatic means connected across the terminals of the said source of energy and dependent upon a relatively quick predetermined electrical change in the distributing circuit for interrupting the same.
11. A system of distribution comprising a direct current source of energy, and electrostatic means connected across the terminals of the said source of energy and dependent upon a relatively quick drop in potential on the distributing circuit for interrupting the same.

In testimony whereof, I have hereunto subscribed my name this 23rd day of May, 1912.

CHARLES LE G. FORTESCUE.

Witnesses:

M. C. MERZ,
B. B. HINES.