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J. W. McNAIRY

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CIRCUIT BREAKER AND METHOD OF CALIBRATING THE SAME

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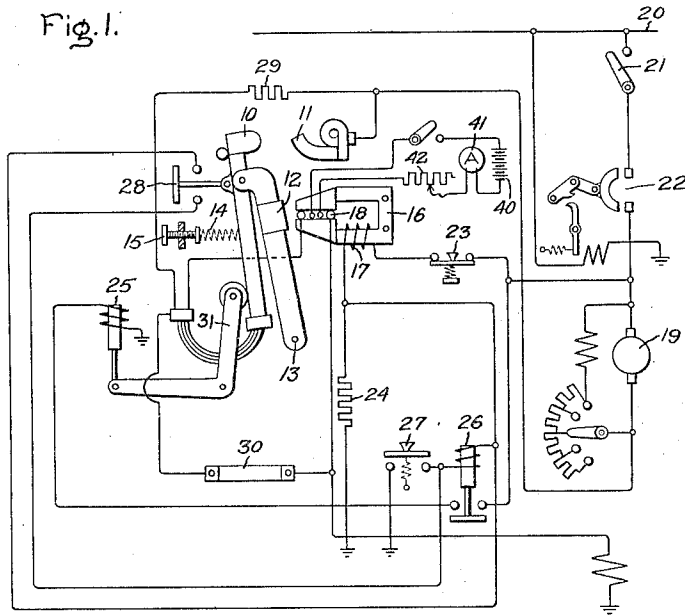
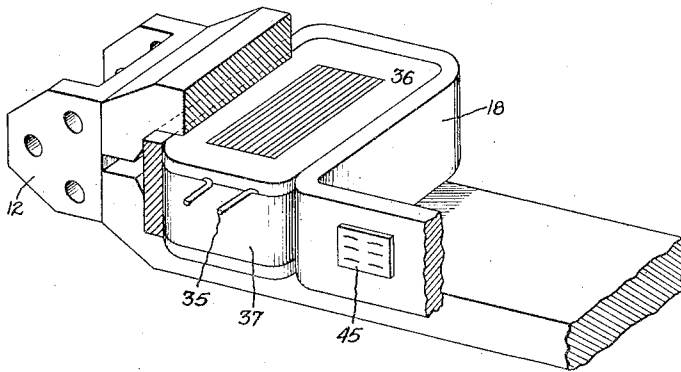


Fig. 2.



Inventor:
Jacob W. McNairy
by *Charles E. Tullar*
His Attorney.

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CIRCUIT BREAKER AND METHOD OF CALIBRATING THE SAME

Jacob W. McNairy, Erie, Pa., assignor to General Electric Company, a corporation of New York

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11 Claims. (Cl. 175—294)

My invention relates to circuit breakers of the type released in response to current flow and has for its object the provision of a simple, reliable, and accurate means for and method of calibrating circuit breakers.

Although not limited thereto, my invention has special application to high-speed circuit breakers of the type described and claimed in the Tritle and McNairy Patent No. 1,771,935. It has been found that during its life the response of a circuit breaker of this type to load current varies and consequently calibration is required. Heretofore, no easy method of calibration has been available. The current required to trip a breaker of this type depends upon a number of variables. For example, after repeated operation the contact tips wear down considerably; the spring tension decreases and a certain amount of rusting may take place on the armature. It therefore becomes essential to check periodically the tripping value of current required for the circuit breaker if it is to afford protection against current flow exceeding a predetermined value.

In order to calibrate this circuit breaker it has been proposed to measure the amount of wear on the contacts. This method is not satisfactory, however, because the wear on the contacts is not uniform, and consequently it is very difficult to ascertain the change in spring pressure resulting from a given amount of wear. It has also been proposed to calibrate the circuit breaker by using a costly motor-generator set of sufficient capacity to produce through the tripping coil a current equal in magnitude to the load current, which may be as great as 5,000 to 10,000 amperes.

In carrying out my invention in one form thereof I provide a calibrating coil arranged in concentric relation with the single turn of the tripping coil, and I provide means for energizing the calibrating coil to produce a magnetomotive force equal to the magnetomotive force produced by the tripping coil for given values of load current. More specifically, I provide a calibrating coil having a large number of turns so that a relatively small current will produce a magnetomotive force equal to the magnetomotive force produced by a large flow of current through the tripping coil. A calibrating chart is provided showing the values of current through the calibrating coil which will produce the magnetomotive force for various values of load current in the tripping coil. In actual practice it is only necessary to have available a storage battery, an ammeter and a variable resistance in order to calibrate a circuit breaker of any size.

For a more complete understanding of my invention reference should now be had to the

drawing, wherein I have illustrated diagrammatically in Fig. 1 my invention as applied to a typical circuit breaker, while in Fig. 2 I have shown in perspective the manner of mounting the calibrating coil within a tripping coil.

Referring to the drawing, I have shown my invention in one form as applied to a circuit breaker of the type arranged to be magnetically tripped in response to a predetermined load current, as described and claimed in the aforesaid Tritle and McNairy patent. It is to be understood, however, that my invention may be applied to various types of protective devices requiring a periodical check of the operation of the device in response to currents of large magnitude.

As shown, the circuit breaker consists of a movable switch arm 10 which cooperates with a stationary contact 11 to open and close an electric circuit. The switch arm 10 is pivoted intermediate its end in suitable bearings carried at one end of the movable magnetic member 12, which in turn is mounted to rotate about the stationary pin 13. A common biasing spring 14 for both the magnetic member 12 and the switch arm 10 has one end connected to the switch arm 10 of the opposite side of the pivoted support provided for the circuit-controlling contact, and the other end connected to a stationary adjusting screw 15. The movable magnetic member 12 and the switch arm 10 thus constitute a compound switch element which is biased as a unit to the open position in which it is shown, and the switch arm 10 is maintained in the closed position when the movable magnetic member 12 is actuated to and held in the attracted position.

In order to maintain the compound switch element in the circuit-closing position, an electromagnet 16 is provided with a shunt winding 17 for normally exerting sufficient magnetic attraction on the movable magnetic member 12 when the latter is operated into an attracted relation with the poles of the electromagnet. To overcome the opening force produced by the biasing spring 14 a bucking bar or series winding 18 is interposed in the air gap between the poles of the electromagnet 16, as described and broadly claimed in the reissue patent to John F. Tritle, No. 15,441 and more particularly described and claimed in the patent to Leonhard Haag, No. 1,506,483. In the particular arrangement illustrated, the bucking bar or tripping winding 18 is connected in the power circuit of a generator 19, which circuit is completed from the high-voltage supply line 20 through a disconnecting switch 21, a low-voltage circuit breaker 22, the armature of the generator 19, contacts 10 and 11 of the trip-free circuit breaker upon closure of the respective switches, and

the bucking bar 18 to ground. The shunt-holding winding 17 of the circuit breaker is connected permanently from the high-voltage terminal of the generator 19 to ground in series circuit with the manually-operable control switch 28, which is biased to the closed position as shown, and a voltage-reducing resistor 24.

The compound switch element comprising the magnetic member 12 and the circuit-controlling member 10 is operated to the closed position by means of an electromagnetically-actuated closing mechanism 25. The energizing circuit of the closing mechanism 25 is controlled by a relay 26 which is biased to the open position. The operating winding of this relay is controlled by a manually-operable switch 27 which is normally biased to its open position. A short circuit around the operating winding of the relay 26 is established by interlock contacts 28 arranged to be operated with the movable magnetic member 12 so as to be closed when the member 12 is moved to the attracted position.

It will be observed that the contacts 10 and 11 of the circuit breaker are arranged to short circuit a current-limiting resistor 29, which is permanently connected in the power circuit of the generator 19 in order to limit the current therein to overload conditions of a predetermined safe value. As shown, a suitable shunt 30 is connected across the series winding 18, so that only a portion of the load current traverses the bucking bar or series winding 18.

The circuit breaker and the system of Fig. 1 thus far described are shown and broadly claimed in the aforesaid Tritle and McNairy Patent No. 1,771,935.

Referring now to Figs. 1 and 2, it will be observed that a calibrating coil 35 is mounted within the single-turn bucking bar or tripping winding 18. The calibrating coil 35 is wound about a spool 36, which spool slidably engages the conductor forming the series coil. The calibrating coil is electrically insulated from the bucking bar 18 by the insulating material 37.

With the circuit breaker in the closed position, it may be calibrated by connecting the calibrating coil 35 in series with a suitable source of supply 40, an ammeter 41 and a variable resistance 42. The resistance 42 is adjusted until a predetermined current flows through the calibrating coil 35. If the circuit breaker operates at other than the predetermined current, the spring 14 is adjusted either to increase or to decrease this bias.

The value of current which must flow through the calibrating coil 35 to release the compound switch element is preferably determined at the factory. For example, a circuit breaker is operated to the closed position and adjusted so that a predetermined current-flow through the tripping coil 18 releases the compound switch element, which element is operated to an open position by the spring 14. The calibrating coil 35 is then connected to a suitable source of supply; the current is gradually increased until the calibrating coil produces a magnetomotive force sufficient to trip the circuit breaker. The value of this current is read by an ammeter. A table is then prepared by repeating the aforesaid operations, and this table of related values is attached to the circuit breaker, as illustrated at 45.

After the circuit breaker has been in operation for a considerable length of time, or if it

should operate to interrupt its circuit during normal operating conditions, it is only necessary to connect the calibrating coil in circuit with the source of supply 40, the ammeter 41, and the resistance 42 to reestablish quickly and accurately the correct operation of the circuit breaker. If, for example, the contact tips have worn down, it will be seen that the contact 10 is moved a greater distance by the spring 14 which greater movement results in a corresponding decrease in the spring tension holding the contact 10 against the contact 11. Consequently, an increased current is required in the tripping coil to release the circuit breaker for operation by the decreased spring tension. In other words, to recalibrate the circuit breaker for its original setting, the spring tension must be increased.

If it were not for the provision of the calibrating coil 35, it would be necessary to produce a predetermined current flow through the calibrating coil and to adjust the spring 14 until proper operation could again be obtained. To produce the relatively large direct current, which may be in the order of 5,000 to 10,000 amperes or more, presents no small problem. By utilizing the calibrating coil, however, it is necessary to have at hand only the source of supply 40, the ammeter 41, and the variable resistance 42. The source of supply 40 can be readily provided by storage batteries, such for example, as are used in automobiles.

While I have shown a particular embodiment of my invention it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I, therefore, contemplate by the appended claims to cover any such modifications as 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. The method of calibrating a circuit breaker of the type having a series tripping coil connected in series with a load circuit for producing in response to a predetermined load current a magnetomotive force to trip said circuit breaker and a calibrating coil having a larger number of turns than said series coil which consists in sending through said calibrating coil a current relatively small in proportion to a predetermined load current, and producing a magnetomotive force equal to and in the same direction as the magnetomotive force produced when said predetermined current flows through said tripping coil.

2. The method of calibrating a protective device of the type normally restrained in one position and arranged to be released by a series winding for operation to another position which consists in producing operation of said device in response to the magnetomotive forces produced by a range of current values through said series winding providing a calibrating coil for said device provided with a large number of turns, energizing only said calibrating coil with a range of current values so as to produce magnetomotive forces equivalent to the magnetomotive forces produced for said range of current values through said series winding, whereby said circuit breaker can thereafter be adjusted for operation in response to a predetermined current in said series winding by energizing only said calibrating coil.

3. The combination with a protective device, means normally holding said device in one position, and a series winding arranged to release

said device in response to a predetermined magnitude of load current, of a calibrating coil having a large number of turns as compared with said series winding and operatively associated with said series winding, means for controlling the energization of said calibrating coil to produce a magnetomotive force equal to and in the same direction as that produced by said series winding for a predetermined value of load current whereby said protective device can be calibrated without energizing said series winding.

4. The combination with a circuit breaker, means for magnetically holding said circuit breaker in its closed circuit position and having a single turn releasing winding responsive to the load current for releasing said circuit breaker for operation to its open circuit position, of a calibrating coil having a larger number of turns than said single turn winding associated with said releasing coil so as to produce a magnetomotive force in the same direction as that produced by said releasing coil and means for controlling the energization of the said calibrating coil to simulate the magnetomotive force condition produced by said releasing coil for a predetermined value of said load current.

5. The combination with a circuit breaker normally biased to its open position, holding means for maintaining said breaker in its closed position, tripping means responsive to a predetermined load current through said breaker for producing a magnetomotive force of sufficient magnitude and in the proper direction to render said holding means ineffective so as to permit high speed operation of said breaker to its open position, means for simulating said predetermined load current conditions required to render said holding means ineffective comprising a calibrating coil associated with said tripping means, said coil being provided with a plurality of turns and means for energizing said calibrating coil so that said coil produces a magnetomotive force equal to and in the same direction as the magnetomotive force produced by said tripping means for said predetermined load current.

6. The combination of a protective device of the type normally held in one position and arranged to be released magnetically by a tripping winding in response to a predetermined magnitude of load current, of a calibrating coil having a large number of turns as compared with said tripping winding and operatively associated with said tripping winding, an ammeter, a resistance and a source of direct-current supply, connections for connecting said ammeter, resistance and said calibrating coil in series with said source of supply, and means for varying said resistance so as to produce a predetermined current in said calibrating coil to reproduce the magnetomotive force produced by flow of said predetermined current through said tripping winding.

7. In a protective device provided with a series coil and a calibrating coil having a larger number of turns than said series coil, the method of determining the load current required through the series coil to operate said device which consists in causing a current relatively small in proportion to said required current to flow through said calibrating coil to produce the equivalent operation of said device when operated by the series coil.

8. In a protective device provided with a series coil and a calibrating coil having a larger num-

ber of turns than said series coil, the method of determining the load current required through the series coil to operate said device which consists in causing predetermined values of load currents to flow through said series coil to produce operation of said device and then causing a current relatively small in proportion to said predetermined load currents to flow through said calibrating coil to produce equivalent operation of said device, whereby said protective device can thereafter be re-calibrated at any time by said calibrating coil for operation by a selected one of said values of load current.

9. In a circuit breaker provided with a series tripping coil and a calibrating coil having a larger number of turns than said tripping coil, the method of determining the load current required through said series tripping coil to trip said circuit breaker, which consists in causing a predetermined load current to flow through said tripping coil, adjusting said circuit breaker to trip on said predetermined current and thereafter causing a current relatively small in proportion to said predetermined load current to flow through said calibrating coil to trip said circuit breaker, whereby said circuit breaker can thereafter be recalibrated at any time by means of said calibrating coil.

10. In a circuit breaker provided with a calibrating coil having a plurality of turns, means normally restraining said circuit breaker in one position, and a series winding provided with less turns than said calibrating coil for releasing said circuit breaker for operation to another position, the method of determining the load current required through said series winding for operating said circuit breaker which consists in causing a predetermined load current to flow through said series winding, adjusting said circuit breaker until said predetermined current flow operates said circuit breaker from one to the other of said positions and thereafter causing a current relatively small in proportion to said predetermined load current to flow through said calibrating coil to produce similar operation of said circuit breaker from one to the other of said positions, said steps being repeated over a range of current values so that said circuit breaker can thereafter be calibrated for said range of current values by causing said relatively small values of current to flow through said calibrating coil.

11. The combination with a circuit breaker, a U-shaped magnet provided with a holding coil for magnetically holding said circuit breaker in a predetermined position, a single turn releasing winding arranged between the legs of said U-shaped magnet for releasing said circuit breaker for operation from said predetermined position to a second position, of a calibrating coil provided with a plurality of turns mounted within said single turn releasing winding and between said legs of said U-shaped magnet for releasing said circuit breaker when energized by a current relatively small in comparison to the current required through said releasing winding to produce an equivalent operation of said circuit breaker, and means for controlling the energization of said calibrating coil whereby conditions of circuit breaker operation by said releasing winding can be simulated at any time by energization of only said calibrating winding.

JACOB W. McNAIRY.