B. H. SMITH.

ELECTRICAL PROTECTIVE DEVICE.

APPLICATION FILED JULY 11, 1914.

1,204,508. Patented Nov. 14, 1916.

Fig. 1.

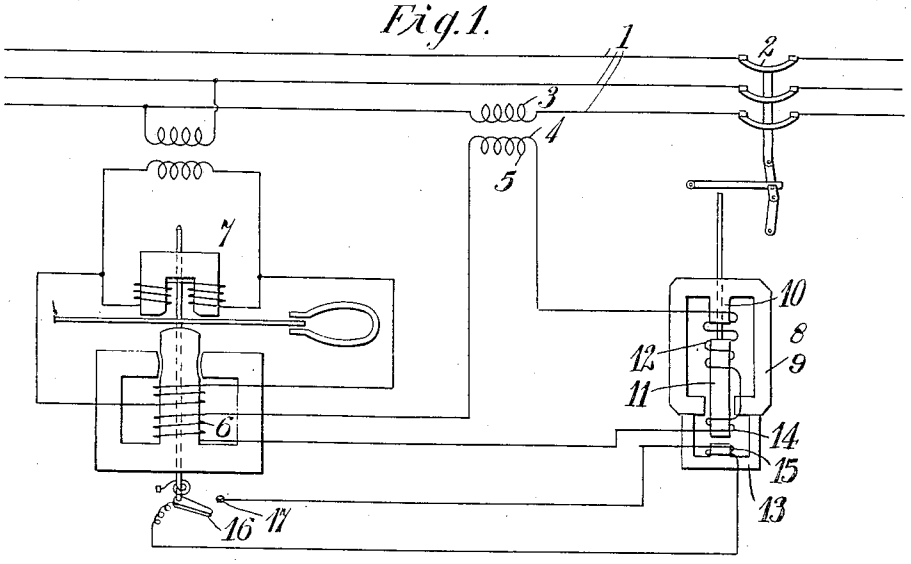


Fig. 2.

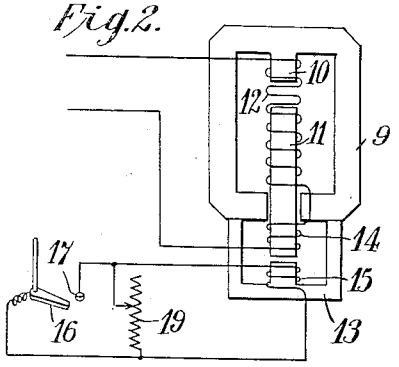


Fig. 3.

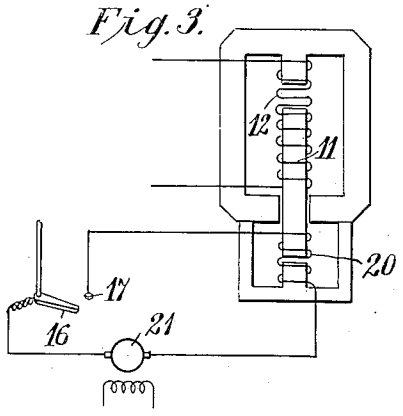


Fig. 4.

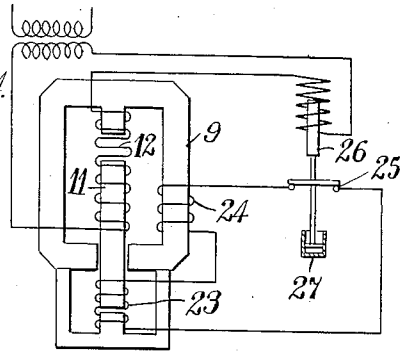
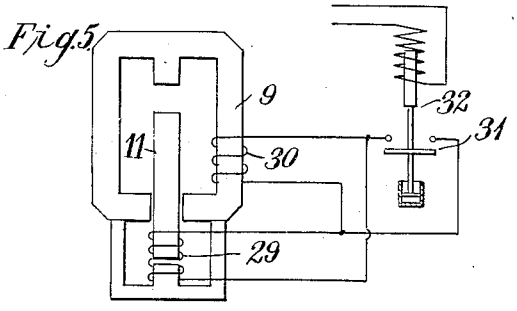


Fig. 5.



WITNESSES:

Fred H. Miller

Otto S. Schauer

INVENTOR

Benjamin H. Smith

BY

Wesley E. Barr

ATTORNEY

UNITED STATES PATENT OFFICE.

BENJAMIN H. SMITH, OF TURTLE CREEK, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

ELECTRICAL PROTECTIVE DEVICE.

1,204,508. Specification of Letters Patent. Patented Nov. 14, 1916.

Application filed July 11, 1914. Serial No. 850,331.

To all whom it may concern:

Be it known that I, BENJAMIN H. SMITH, a citizen of the United States, and a resident of Turtle Creek, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Electrical Protective Devices, of which the following is a specification.

My invention relates to electrical protective devices and particularly to relay mechanisms and systems that are employed for tripping circuit breakers, or operating other devices, upon the occurrence of predetermined circuit conditions.

The object of my invention is to provide a simple and economical relay mechanism of the character indicated that may be operated by current derived from the line or circuit in connection with which the circuit breaker or other device is employed, thereby obviating the necessity of employing a separate source of power for supplying the operating current, and the contact members of which shall not be subjected to injurious arcing, or to the possibility of welding or sticking together, or of becoming burned so that they will not conduct current.

Considerable difficulty has heretofore been experienced with relay mechanisms for circuit breakers and similar devices, that are employed in connection with alternating current circuits, when it has been attempted to derive the current for tripping or operating the breakers from the said circuits. This difficulty has been due to the fact that the current for operating the relay mechanism and tripping the circuit breakers has usually been derived from the main circuit by means of a series transformer, the secondary circuit of which includes the operating coil of the relay, the tripping coil of the circuit breakers, and the relay contact members which normally short circuit the latter coil, but are separated to permit its energization upon the occurrence of an overload or other predetermined circuit condition. There is usually a sufficient amount of current in this secondary circuit to cause arcing at the relay contact members, and at times it may be sufficient to cause them to weld or stick together, and the difficulty is rendered more serious when there is slow separation of the contact members due to the employment of a dash pot, or other retarding device, for introducing a time interval between the occurrence of an overload and the opening of the circuit breakers. Furthermore, arcing between the contact members may so burn and injure them as to prevent them from making good electrical contact when brought into engagement.

According to my present invention I have provided a tripping device that is supplied with energy from the main circuit, but that does not require the interruption of a circuit carrying an appreciable current, thereby overcoming the hereinbefore mentioned difficulties.

My invention is illustrated in the accompanying drawings, Figure 1 of which diagrammatically illustrates a part of a system embodying the same, and Figs. 2, 3, 4 and 5 respectively illustrate several different modifications of the electromagnetic device that is employed for tripping the circuit breaker.

A typical system in connection with which the present invention may be employed comprises an alternating current circuit 1 that is adapted to be interrupted by means of a circuit breaker 2 and in series with one conductor of which is the primary winding 3 of a current transformer 4, the circuit of the secondary winding 5 of which includes one of the windings 6 of a relay 7 of any ordinary or suitable construction.

The relay 7, as illustrated, is of the induction type and is preferably constructed as set forth in application, Serial No. 497,799, filed May 22, 1909, which has been assigned to applicant's assignee. This relay may be arranged to close the switch actuated by it instantaneously or after a time interval, as desired. The present invention is particularly adapted for use with relays of this type because of their light construction and very sensitive character, but any other suitable type of relay may be employed if desired.

The circuit breaker 2 is adapted to be tripped by means of an electromagnetic device or relay 8 that comprises a stationary magnetizable core member 9 in the form of a hollow rectangle with a pole piece 10 extending inwardly and downwardly from the top cross piece thereof, and having a gap in the lower cross-piece between which is interposed an armature 11 adapted for longitudinal and vertical movement. The pole piece

10 and the armature 11 are surrounded by a coil 12 which tends to raise the armature into engagement with the pole piece.

The electromagnetic device or relay as thus described is such as has heretofore been commonly employed as a relay for tripping circuit breakers, but its functions are modified by the use of an auxiliary core part 13 of substantially E-shape that is mounted with its longer legs terminating adjacent to the lower end of the core member 9. The armature 12 normally rests upon the middle leg or pole piece of the core part 13, and, together with the said middle leg or pole piece, is surrounded by two coils 14 and 15, respectively, the former of which is connected in series with the coil 12.

The coils 12 and 14 are supplied with current from the secondary winding 5 of the series transformer, and are preferably connected in series with the coil 6 of the relay 7, though they may be connected in any other suitable relation with respect thereto. The coil 15 is normally open circuited, but is adapted to be short-circuited by engagement of the contact members 16 and 17 of the relay 7 under predetermined circuit conditions, such, for instance, as upon the occurrence of an overload or of a reversal of the direction of flow of energy in the main circuit 1.

Under normal circuit conditions, the current in the winding 6 of the relay 7 is insufficient to cause the switch 16—17 to close, and consequently, the coil 15 remains open-circuited and has no effect. However, the coils 12 and 14 are continuously energized so long as the circuit breaker 2 remains closed, but, being located upon opposite sides of the lower end cross-piece of the core member 9, and being also provided with separate magnetic circuits, they exert opposing pulls upon the armature 11. The magnetic circuit of the coil 14 being substantially closed under normal conditions, the armature remains stationary in the position shown. Also, since the magnetic circuit of the coil 14 is normally substantially closed, whereas, a considerable air gap exists at the upper end of the armature 11 in the magnetic circuit of the coil 12, it is obvious that the coil 14 may, and preferably does have, a smaller number of convolutions than the coil 12.

When an overload or other abnormal condition occurs upon the circuit 1, an increased current is induced in the winding 5 of the transformer 4 which is sufficient to cause the relay 7 to close the switch 16—17, the closing of the switch being delayed or not, as desired. When the switch 16—17 is closed, the coil 15 is short circuited, and an electromotive force is induced in it by the coil 14, thereby decreasing the magnetizing effect of the coil 14 because of the counter flux produced by the coil 15. When the magnetizing effect of the coil 14 is reduced, the pull exerted by the coil 12 is permitted to predominate over that of the coil 14, and the armature 11 is accordingly raised, thereby tripping the circuit breaker. Inasmuch as, under this condition, the current in the coil 12 is large as compared with its normal value, and, since the pull of the coil 14 is nearly eliminated, the armature 11 is raised quickly and with considerable force, thereby insuring prompt and reliable tripping of the circuit breaker. When the overload or other abnormal circuit condition disappears, or the circuit breaker is opened, the switch 16—17 is opened and the armature 11 of the relay 8 is also returned by gravity to its normal position. The operations of the device are accordingly automatic, both with respect to the tripping of the circuit breaker, and to resetting in their normal positions upon closing of the circuit breaker, and the restoration of normal conditions in the circuit.

It will, of course, be understood that since the magnetic circuit of the coil 15 is separate from that of the coil 12, the coil 15 will not materially affect the pull exerted by the coil 12 upon the armature.

The coils 12 and 14 may be oppositely wound, as shown in Fig. 1, or they may be similarly wound, if desired, as shown in Fig. 2, it being only essential that they exert opposing pulls on the armature 11.

Instead of having the coil 15 normally open-circuited, it may be short circuited through a resistance 19 as shown in Fig. 2, in which case the relay 16—17 will be employed for shunting the said resistance and establishing a low resistance short circuit for the coil 15. With this arrangement, the coil 12 will become sufficiently energized at a certain excessive current value to enable it to predominate over the coil 14, even though the switch 16—17 remains open, thereby raising the armature 11 and tripping the circuit breaker instantaneously. This arrangement may be employed when it is desired to provide for a time element between the occurrence of an abnormal circuit condition, and the tripping of the circuit breaker when the abnormal circuit condition is only slightly abnormal, and when it is desirable to provide for instantaneous operation of the circuit breaker when the abnormal condition is extreme. The resistance 19 is variable for the purpose of adjusting the current value at which the circuit breaker will be tripped when the abnormal circuit condition is extreme.

Another modification that may be found useful under certain conditions is illustrated by Fig. 3 in which the coil 14 has been omitted and only a single coil 20 surrounds the lower end of the armature 11, the said coil being supplied with current from a suitable auxiliary source of power 21. The

circuit of the coil 20 is normally closed by the switch 16—17, and is opened only upon the occurrence of an abnormal circuit condition. With this arrangement, the coil 20 normally opposes the pull of the coil 12, but upon the occurrence of an abnormal circuit condition, it is open-circuited and rendered of no effect, whereupon, the coil 12 raises the armature 11.

In the modification of Fig. 4, only a single coil 23 is employed at the lower end of the armature 11, and this coil is supplied with current from another coil 24 that surrounds one side portion of the core 9, and in which current is induced by the flux produced by the coil 12. The coils 23 and 24 are normally connected in a closed circuit by the switch parts 25 of a relay 26 that is here illustrated as of the solenoid or electromagnet type, and the operation of which is retarded by means of a dash pot 27. Under normal circuit conditions, the current supplied to the coil 23 from the coil 24 is sufficient to retain the core 11 in its lowermost or normal position in opposition to the pull exerted by the coil 12. However, upon the occurrence of an overload, the switch 25 of the relay 26 is opened, thereby rendering the coil 23 of no effect, and permitting the coil 12 to raise the armature.

A still further modification in which only a single coil 29 is employed at the lower end of the armature 11, is shown in Fig. 5, the coil 29 being, in this case, also supplied with current from a coil 30 that surrounds one side of the core 9. The coil 29 normally receives sufficient current from the coil 30 to prevent the coil 12 from raising the core 11, but, upon the occurrence of an overload, it is short-circuited by the switch parts 31 of a relay 32, which switch parts are normally out of engagement. Upon short circuiting coil 29, it is rendered of no effect, and the coil 12 is permitted to raise the armature 11.

It will be observed that with all the modifications illustrated, the current carried by the contact members of the relay may be small as compared with that traversing the secondary circuit of the series transformer and that, therefore, no difficulty is experienced with arcing and burning of the contact members. Furthermore, the circuit connections are very simple and are such, in most cases, as to avoid the necessity of employing an auxiliary source of current.

While I have shown and described my invention as applied to the tripping of a circuit breaker, it may obviously be employed for other purposes, if desired, without departing from the spirit of the invention.

I claim as my invention:

1. The combination with a relay having a winding, of an electromagnet comprising a stationary core member, a movable core member, two windings that produce opposing pulls upon the movable core member and that are connected in series relation with the winding of the said relay, and a third winding that is controlled by the said relay.

2. The combination with an electromagnet comprising a stationary core member, a movable core member, two windings adapted to produce opposing pulls upon the movable core member, and a third winding, of means for closing the circuit of said third winding.

3. The combination with an electromagnet comprising a stationary core member, a movable core member, and two windings adapted to produce opposing pulls upon the said movable core member, of means for neutralizing the magnetizing effect of one of the said windings under predetermined conditions.

4. The combination with an electromagnet comprising a stationary core member, a movable core member, two windings adapted to produce opposing pulls upon the said movable member, of means for decreasing the effectiveness of one of the said windings under predetermined conditions.

5. The combination with a relay, of an electromagnetic device comprising a stationary core member, a movable core member, two windings adapted to move the movable core member in opposite directions, and a third winding controlled by the said relay to neutralize the effect of one of the said oppositely acting windings.

6. An electromagnetic device comprising a stationary magnetizable core member having two magnetic paths, a movable core member, a winding for each of the magnetic paths tending to move the movable core member in opposite directions, and a third winding for decreasing the magnetization of one of the said magnetic paths.

7. The combination with a relay having an operating winding, of an electromagnet comprising a stationary core member, a movable core member, two oppositely acting windings therefor connected in series relation with the winding of the said relay, and a third coil the circuit of which is controlled by the relay.

8. The combination with an electrical circuit, a transformer connected to said circuit, and a relay having a winding supplied from the transformer, of an electromagnet comprising two oppositely acting windings that are connected in series with the relay winding, and a third winding the circuit of which is controlled by the relay.

9. The combination with an electrical circuit, a transformer connected to said circuit, and a relay having a winding supplied from the transformer, of an electromagnet comprising relatively movable core members pro-

viding two magnetic circuits, two windings respectively for said magnetic circuits, the said windings being connected in series with the relay winding, a normally open-circuited winding for one of said magnetic circuits that is short-circuited by the relay under predetermined conditions.

10. The combination with an electromagnet comprising two normally energized oppositely acting windings, and a normally open-circuited winding, of means for short-circuiting the latter winding under predetermined conditions.

11. The combination with an electromagnet comprising relatively movable core members providing two magnetic circuits, a single winding for one of said circuits, and two windings for the other, one of which is normally open-circuited, of means for short-circuiting the latter winding under predetermined conditions.

12. The combination with an electromagnet comprising relatively movable core members providing two magnetic circuits, two normally energized series connected windings respectively for said magnetic circuits, and a normally open-circuited winding for one of said magnetic circuits, of means for short-circuiting the latter winding under predetermined conditions.

13. An electromagnet comprising an armature, a yoke surrounding the armature and having lateral projections that extend inwardly adjacent to an intermediate portion of the armature, a winding that surrounds the armature upon both sides of the said projections, and a winding that surrounds the armature upon only one side thereof.

14. The combination with a relay, of an electromagnet comprising an armature, a yoke surrounding the armature and having lateral projections that extend inwardly adjacent to an intermediate portion of the armature, a normally energized winding that surrounds the armature upon both sides of the said projections, and a normally open-circuited winding that surrounds the armature upon only one side thereof and that is short-circuited by the relay under predetermined conditions.

15. An electromagnet comprising a movable armature, a normally energized winding tending to actuate the armature, and another winding connected in series relation to the first mentioned winding for preventing such actuation of the armature except under predetermined conditions.

16. The combination with an electromagnet comprising a movable armature, a normally energized winding tending to actuate the armature, and another winding connected in series with the first mentioned winding for normally preventing such actuation of the armature, of means for rendering the latter winding ineffective under predetermined conditions.

17. The combination with an electromagnet comprising two series-connected normally energized oppositely acting windings, of means for rendering one of said windings ineffective under predetermined conditions.

18. The combination with an electromagnet comprising two series-connected oppositely acting windings, of means for rendering one of said windings ineffective under predetermined conditions.

19. The combination with an electromagnet comprising a movable armature, a winding that normally attracts the armature to retain it in a given position, of means for causing the said winding to move the armature to another position under predetermined conditions.

20. The combination with an electrical circuit, a series transformer connected thereto, and a relay having a winding supplied from the transformer, of an electromagnet having a main winding also supplied from the transformer, and an auxiliary winding that is controlled by the said relay.

21. The combination with a relay having an operating winding, of an electromagnet comprising a stationary magnetizable core member having two magnetic paths, a movable core member, a winding for each of the paths connected in series relation to the winding of the relay, and a third winding the circuit of which is controlled by the relay.

22. An electromagnetic device comprising a stationary magnetizable core member having two magnetic paths, a movable core member, means for so energizing the said paths that the movable core member is normally held in one position by reason of its embracing more lines of flux from one path than from the other, and means for so neutralizing the energization of one path that the movable core member will be moved to another position under predetermined conditions.

23. The combination with an electromagnet comprising a magnetizable core having a divided magnetic circuit and an armature subject to the influence of both circuits but normally biased to a given position by reason of its embracing more of the magnetic flux of one circuit than the other, a main winding, and an auxiliary winding, of means for controlling the circuit of the auxiliary winding to permit the armature to move out of the position to which it is biased under predetermined conditions.

24. An electromagnet comprising a main magnetizable core member having substantially the form of a hollow rectangle and an opening in one of its sides, an armature extending through the said opening, and an auxiliary core member having legs terminat-

ing adjacent to the aforesaid core member upon opposite sides of the opening therein.

25. An electromagnet comprising a main magnetizable core member having substantially the form of a hollow rectangle and an opening in one of its sides, an armature extending through the said opening, an auxiliary core member having legs terminating adjacent to the aforesaid core member upon opposite sides of the opening therein, and windings for opposite ends of the armature.

26. The combination with an electromagnet comprising two series-connected normally energized oppositely acting windings, and a third winding, of means for so controlling the circuit of the third winding as to neutralize the effect of one of the normally energized windings under predetermined conditions.

27. The combination with an electromagnet comprising two series-connected oppositely acting windings, and a third winding, of means for so controlling the circuit of the third winding as to decrease the effect of one of the series-connected windings under predetermined conditions.

28. The combination with an electromagnet comprising a relatively movable core member providing two magnetic circuits, a winding that normally energizes one circuit more than the other to attract the movable core member to a predetermined position, of means for causing the said winding to so energize the magnetic circuit as to move the movable core member to another position under predetermined conditions.

In testimony whereof I have hereunto subscribed my name this 30 day of June 1914.

BENJAMIN H. SMITH.

Witnesses:

QUINCY A. BRACKETT,

B. B. HINES.