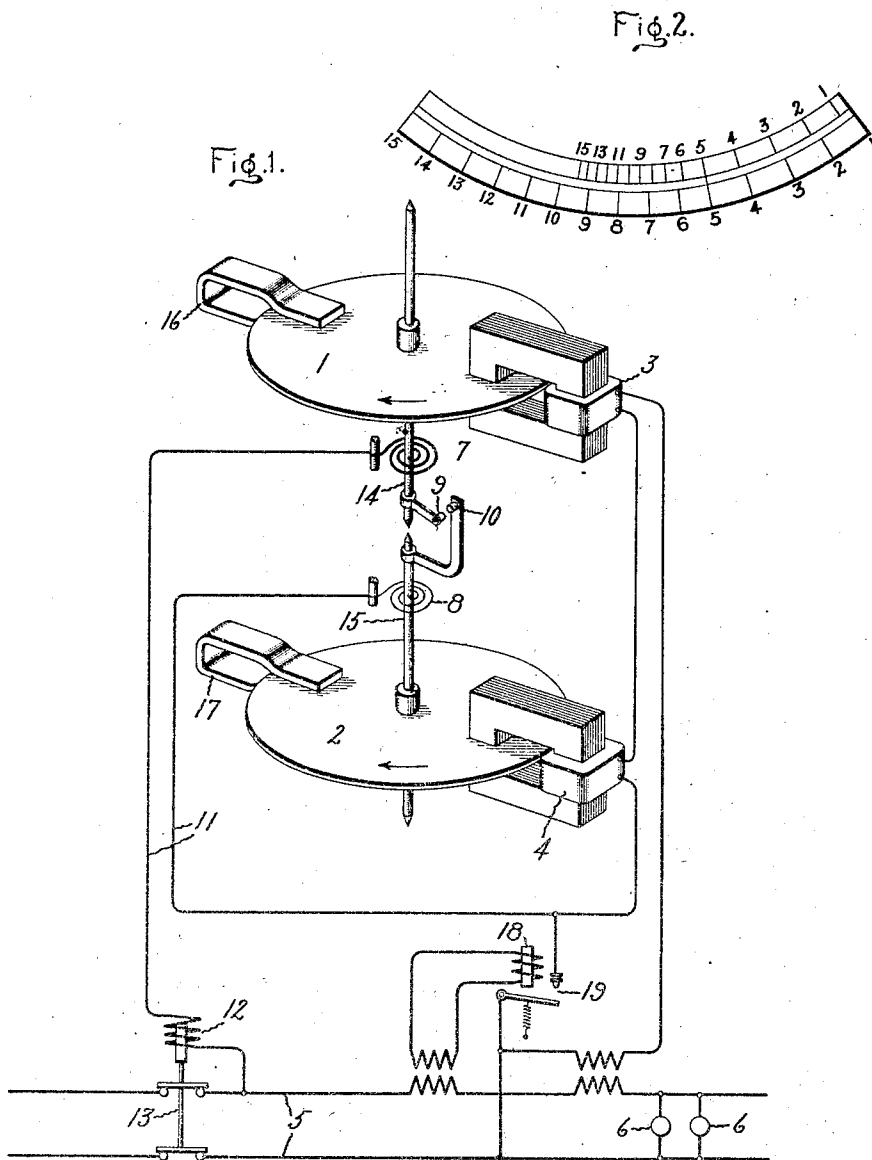


J. R. CRAIGHEAD.  
TIME LIMIT RELAY.  
APPLICATION FILED SEPT. 2, 1914.

1,250,806.

Patented Dec. 18, 1917.



Witnesses:

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His Attorney.

# UNITED STATES PATENT OFFICE.

JAMES R. CRAIGHEAD, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## TIME-LIMIT RELAY.

1,250,806.

Specification of Letters Patent.

Patented Dec. 18, 1917.

Application filed September 2, 1914. Serial No. 859,849.

*To all whom it may concern:*

Be it known that I, JAMES R. CRAIGHEAD, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Time-Limit Relays, of which the following is a specification.

My present invention relates to relays and particularly to relays designed to protect electrical installations from the injurious effects of overloads and similar abnormal conditions. More specifically, my invention relates to relays of the time limit type to be used for controlling protective devices for electrical apparatus.

The object of my invention is to provide a novel and improved construction of relay and especially a relay construction having a time limit which will be variable for varying strength of current in the circuit to which it is connected. A further object of my invention is to provide a relay construction in which the various elements may be so proportioned that the device has an inverse time limit characteristic of any degree desired.

In carrying my invention into effect, I employ two cooperating movable contacts connected to two movable elements which are actuated by the current in the circuit to which the relay is connected. The two contacts are arranged to travel in the same path in the same direction and are normally separated from each other. The movable elements are so constructed, however, that when the current in the circuit exceeds a predetermined amount, one contact will quickly assume a position which is a measure of the load and the other contact will follow over the same path toward the first contact at a rate which is a measure of the load and will overtake the first contact, and thus close a circuit and operate the protective apparatus controlled by the relay. By varying the characteristics of the movable elements, the time characteristic of the relay may be varied as desired.

The features of my invention which I consider novel are pointed out with particularity in the appended claims. The construction and mode of operation of a relay embodying the features of my invention will best be understood, however, from the following description taken in connection with

the accompanying drawings, in which Figure 1 is a diagrammatic view in perspective of a relay embodying my invention and connected to a circuit breaker in an electric installation, and Fig. 2 illustrates one relation which may be given to the scale characteristics of the two movable elements of the relay.

As indicated in the drawing, the relay comprises two indicating meter elements or ammeter elements having two movable disk armatures 1 and 2, which are rotated in the direction of the arrows by motive elements having current coils 3 and 4 respectively connected to the circuit 5 supplying apparatus 6 which is to be protected. It is understood that the magnetic circuits of the coils 3 and 4 are provided with the usual shading coils to enable them to exert a torque on their respective disk armatures. The movement of the armatures 1 and 2 is resisted by springs 7 and 8. Contacts 9 and 10 are connected to the armatures and so mounted that when the armatures revolve, they will travel over the same path. As long as the current in the circuit does not exceed a predetermined amount, the two contacts will not touch each other. The movable elements are so designed, however, that when the current does exceed the desired amount, contact 9, called the leading contact will travel quickly and take up a certain position and contact 10 called the following contact, and which is simultaneously operated, will follow in the path of contact 9 and will travel far enough to overtake contact 9 and thus close circuit 11 and energize the trip coil 12 of the circuit breaker 13. Electrical connection may conveniently be made between the circuit 11 and the contacts 9 and 10 through the springs 7 and 8 and the armature shafts 14 and 15, as indicated.

Armature 1 is lightly damped by the usual damping magnet 16, while armature 2 is more strongly damped by another stronger magnet 17. With this arrangement, the speed of movement of the armature 1 is rendered greater than that of armature 2 and hence contact 9 is moved more quickly than contact 10 and it will be seen that upon the occurrence of an overload sufficient to actuate the relay, that armature 1 will carry contact 9 quickly to a certain position, while armature 2 will cause contact 10 to follow contact 9 more slowly until it engages contact 9 and closes the tripping circuit, the

two contacts not being able to come together until after the lightly damped armature has reached the end of its travel. If the springs 7 and 8 on the two ammeter elements exert equal torques, the path of movement of each of the disk armatures 1 and 2 would be equal and the contacts 9 and 10 would not come into engagement until the heavily damped element 2 reaches the end of its natural travel, that is, where the torque exerted on the disk is balanced by the counter-torque exerted by its spring, the distance traveled being the measure of the load on the circuit. With this arrangement the two movable contact elements 1 and 2 would have the same scale characteristics, the distance traveled varying as a function of the current in the circuit. As the torque varies with the square of the current, however, the velocity may be made to increase in substantially the same proportion as the distance traveled so that the relay will have a practically definite time element, that is the leading contact 9 always determines the limit of travel of the following contact 10 and if the two contacts have the same limit of travel, the leading contact 9 is always positioned at the limit of travel of contact 10 where engagement of the contacts takes place, thus although the leading contact is positioned at a greater distance, the greater the overload and the following contact 10 has to cover this greater distance to engage contact 9, still the following contact moves this greater distance in the same time, as the speed of movement of the disk increases at the same rate as the distance over which it has to move increases. If, however, the leading element were stationary, the time required to close the contacts would vary inversely nearly as the square of the current. Hence by varying the relation between the scale characteristics of the two elements, the relation between time and applied current may be adjusted so as to give a time limit characteristic which is any inverse function desired of the applied current.

In Fig. 2 I have indicated a relation which may be given to the scale characteristics of the two elements. The upper scale is that of the lightly damped element which is designed to have a shorter natural travel for the same current value than the more heavily damped element. This may easily be accomplished in several ways such as varying the shape of the disk by making the spring 7 stronger than the spring 8 or by making the coil 4 stronger than the coil 3.

In the construction shown, I have made the spring 7 stronger than the spring 8. Upon the two scales shown in Fig. 2 the numbers denote the current values which cause an angular deflection of the amount shown by the corresponding divisions, that

is, a current of 7 amperes through the current coils 3 and 4 will cause an angular deflection of the armature 1 such that contact 9 takes up a position corresponding to the division 7 on the upper scale, while the angular deflection of the armature 2 would be such that contact 10 would be moved to a position corresponding to the division 7 on the lower scale. Due to the counter-torque exerted by the spring 7 being greater than that exerted by spring 8, contact 9 will move over a shorter path than the contact 10 and due to the fact that armature 1 is more lightly damped than armature 2, the leading contact 9 will move over its shorter path and reach its position corresponding to 7 amperes before the following contact 10. The position assumed by the leading contact 9, therefore, always limits the path of the movement of following contact 10 so that when contact 10 reaches the contact 9 it comes into firm and positive engagement with contact 9 because the armature 2 still has sufficient torque to carry it to the full extent of its travel.

It will be understood that contact 10 moves from initial position to its position corresponding to any current value, that is, completes its natural path of movement for every current value in approximately the same time. For 6 amperes, for instance, the contact 10 moves to the position marked 6 on its scale in the same time that 10 amperes will cause the contact 10 to move to the position marked 10. In order to obtain inverse time characteristics, I so proportion the path of movement of the leading contact to the path of movement of the following contact that the difference between the paths of movement increases as the load or current on the circuit increases. It takes, for example, 5 seconds for the following contact to move under 6 amperes up to the point 6 on the lower scale but the contact 10 only moves to the first 6 on the upper scale which is the point where it engages the leading contact. The time that it takes contact 10 to overtake contact 9 is therefore that part of 5 seconds which the path of movement of the contact 9 is to the natural path of movement of contact 10. If 10 amperes exist the contact 10 would move from its initial position to the point 10 on the lower scale in the same time, namely 5 seconds, but its path of movement is limited to the position marked 10 on the upper scale which means that contact 10 overtakes contact 9 in that part of 5 seconds which the path of movement of contact 9 is to the natural path of movement of contact 10. Hence by varying the torque of the spring 7 the path of movement of contact 10 is varied so that the time characteristics of the relay can be made anything desired.

It is understood that contacts 9 and 10 may be connected directly to the circuit 5 to

be protected and for such a connection, the scales diagrammatically shown in Fig. 2 applies. As shown in Fig. 2 the ammeter elements are so arranged that no current below a predetermined amount, in this case 5 amperes, will operate the relay. The current coils 3 and 4 instead of being directly connected to the line 5 may be connected through a quick acting overload relay 18 which holds the circuit of current coils 3 and 4 normally open. This relay may be arranged to operate on a predetermined overload, in this case 5 amperes, to close its contacts 19 and connect the current coils 3 and 4 in circuit. In such a case the scale shown in Fig. 2 below the 5 amperes indication is not used as the movement of the armature elements over this portion of the scale is prevented by the relay 18 holding their circuit open. I prefer, however, to use the overload relay 18, as the connection of the elements directly in circuit is liable to cause floating of the contacts under certain conditions of load which if followed by an overload will cause an operation of the relay in a shorter time than is intended.

This will cause the coils 3 and 4 to be energized by a current which is proportional to the current in circuit 5, but they will be energized only so long as the current equals or exceeds the predetermined value, as the relay 18 will allow contact 19 to be broken as soon as the current falls below that value. The tripping circuit 11 may also be closed and opened as indicated by contact 19 in order to avoid the operation of the circuit breaker by reason of the lightly damped contact overtaking the more heavily damped contact 10 in returning to the zero position when the energizing current is thus cut off from the magnetizing coils. Consequently the relay will not open the circuit upon the occurrence of a transitory excess current of shorter duration than the time limit of the relay for that particular value of current.

For the purpose of illustration I have explained the principle of my invention in connection with the actuating means of the indicating meter type. It will, of course, be understood, however, that my invention is not limited to actuating means of this particular type but that many variations in the means employed for moving the contacts may be made without departing from the scope of the appended claims. It will also be understood that a relay constructed according to my invention is not limited in its usefulness to the particular application which I have shown and described.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A relay comprising in combination two meter elements having magnetizing coils and rotatable armatures mounted in the magnetic fields of said coils and contact

members attached to each of said armatures in such a way as to travel in the same direction over the same path when the armatures rotate, said contact members being normally separated from each other and the meter elements being so proportioned that the contact members will touch each other when the magnetizing current exceeds a predetermined amount.

2. The combination in a relay of a meter element having a magnetizing coil and a lightly damped armature mounted in the magnetic field of said coil, a second meter element having a magnetizing coil and a more heavily damped armature than the first, a contact member attached to the armature of the first element so as to rotate therewith and a second contact member attached to the armature of the second meter element so as to rotate therewith and follow the same path as the first contact member, said contact members being normally separated from each other and the meter elements being so proportioned and so related to each other that the second contact will overtake the first when the magnetizing current exceeds a predetermined amount.

3. The combination in a relay of a meter element having a magnetizing coil and a lightly damped armature mounted in the magnetic field of said coil, a second meter element having a magnetizing coil and a more heavily damped armature than the first, a contact member attached to the armature of the first element so as to rotate therewith and a second contact member attached to the armature of the second meter element so as to rotate therewith and follow the same path as the first contact member, said contact members being normally separated from each other and the scale characteristics of the two elements being such that the second contact will overtake the first when the magnetizing current exceeds a predetermined amount.

4. The combination in a relay of a meter element having a magnetizing coil and a lightly damped armature mounted in the magnetic field of said coil, a second meter element having a magnetizing coil and a more heavily damped armature than the first, a contact member attached to the armature of the first element so as to rotate therewith and a second contact member attached to the armature of the second meter element so as to rotate therewith and follow the same path as the first contact member, said contact members being normally separated from each other and the meter elements being so proportioned and so related to each other that the second contact will overtake the first when the magnetizing current exceeds a predetermined amount and that the time required for second contact to overtake the first after the excess current has been

applied will vary as an inverse function of the amount of the applied current.

5. The combination in a relay of a meter element having a magnetizing coil and a lightly damped armature mounted in the magnetic field of said coil, a second meter element having a magnetizing coil and a more heavily damped armature than the first, a contact member attached to the armature of the first element so as to rotate therewith and a second contact member attached to the armature of the second meter element so as to rotate therewith and follow the same path as the first contact member, said contact members being normally separated from each other and the scale characteristics of the two elements being such that the second contact will overtake the first when the magnetizing current exceeds a predetermined amount and that the time required for second contact to overtake the first after the excess current has been applied will vary as an inverse function of the amount of the applied current.
6. The combination in a relay of two normally separated contacts, and actuating means for each of said contacts for causing said contacts to travel over the same path in the same direction, the actuating means for said contacts being so proportioned that one of the contacts will touch the other when the actuating current exceeds a predetermined amount.
7. The combination in a relay of two normally separated contacts, and actuating means for each of said contacts for causing said contacts to travel over the same path in the same direction, the actuating means for said contacts being so proportioned that the leading contact will reach the end of its travel sooner than the following contact and that the following contact will overtake the leading contact when the actuating current exceeds a predetermined amount.
8. The combination in a relay of two cooperating contact members, means for moving each of said contacts over the same path in the same direction, and means associated with each of said contact members and so proportioned that for the same actuating current one of said contacts has a lesser natural distance of travel than the other.
9. The combination in a relay of two cooperating contact members, means for moving each of said contacts over the same path in the same direction, and means associated with each of said contact members and so proportioned that for any actuating current above a predetermined amount one of said contact members has a greater natural distance of travel than the other of said contacts, the difference between the two distances increasing with increase of actuating current.

10. The combination in a relay of two normally separated contacts, a current actuated means for moving each of said contacts over the same path in the same direction, means for permitting one of said contacts to move with greater rapidity than the other contact, and means for opposing the action of said actuating means, said actuating and opposing means being so related that for the same actuating current the faster moving contact has a lesser natural distance of travel than the slower moving contact.

11. The combination in a relay of two cooperating contacts, a current actuated means for moving each of said contacts over the same path in the same direction, means for causing one of said contacts to move with greater rapidity than the other, means associated with each of said contacts and so proportioned that for any actuating current below a predetermined amount the more rapidly moving contact has a greater natural distance of travel than the slower moving contact while for any actuating current above a predetermined amount the more rapidly moving element has a lesser natural distance of travel than the slower moving contact.

12. The combination in a relay of two normally separated contacts, actuating means for moving each of said contacts over the same path in the same direction, means for causing one of said contacts to move ahead of the other contact, and means associated with each of said contacts and so proportioned that with the same value of actuating current above a predetermined amount the following contact will overtake the leading contact after the latter has reached the end of its natural travel.

13. The combination in a relay of a rapidly moving current actuated element having a limited natural distance of travel for any actuating current above a predetermined amount, a slowly moving current actuated element having for the same actuated current a greater natural distance of travel, a contact moved by said rapidly moving element, a cooperating contact moved by said slowly moving element to follow said first mentioned contact in the same path, and means cooperating with said elements and so proportioned that said cooperating contact overtakes said first mentioned contact when the actuating current exceeds a predetermined amount.

14. The combination in a relay of a rapidly moving meter element having a limited scale of deflection, a second more slowly moving meter element having a greater scale of deflection than the first for any given current above a predetermined amount, a contact member attached to the first element and a second contact member attached to the second element so as to follow the same

path as the first contact member said contact members being normally separated from each other and the meter elements being so proportioned and related to each other that the second contact will overtake the first when the actuating current exceeds a predetermined amount.

15. The combination in a relay of a rapidly moving contact element having a limited natural distance of travel for any actuating current above a predetermined amount, a second more slowly moving contact element having a greater natural distance of travel for the same actuating current, actuating means for moving each of said contact elements in the same path and in the same direction, and means associated with each of said contact elements and so proportioned that the second contact will overtake the first mentioned contact when the actuating current exceeds a predetermined amount and that the time required for the second contact to overtake the first after the excess current has been applied will vary as an inverse function of the applied current.

16. The combination in a relay of a rapidly moving meter element having a limited scale deflection, a second more slowly moving meter element having a greater scale deflection than the first for any given current, a contact member attached to the first element and a second contact member attached to the second element so as to follow the same path as the first contact member said contact members being normally separated from each other and the meter element being so proportioned and related to each other that the second contact will overtake the first when the actuating current exceeds a predetermined amount, and that the time required for the second contact to overtake the first after the

excess current has been applied will vary as an inverse function of the applied current.

17. An overload relay comprising a first and a second contact movable over the same path in the same direction into engagement, means operatively related to each contact and so proportioned that upon the occurrence of an overload above a predetermined amount the second contact will always move over a greater path than the first contact, means operatively related to each contact and so proportioned that the first contact has a greater speed of movement than the second contact whereby the first contact assumes a position to limit the path of movement of the second contact causing the second contact to engage the first contact before the end of its natural travel.

18. An overload relay comprising a first and a second contact movable over the same path in the same direction into engagement, means operatively related to each contact and so proportioned that upon the occurrence of an overload above a predetermined amount the second contact will always move over a greater path than the first contact, means operatively related to each contact and so proportioned that the first contact has a greater speed of movement than the second contact, said first contact being so positioned that the second contact always engages the same before it reaches the limit of its natural path of movement whereby firm and positive engagement of the contact is made.

In witness whereof, I have hereunto set my hand this 1st day of September, 1914.

JAMES R. CRAIGHEAD.

Witnesses:

BENJAMIN B. HULL,  
HELEN ORFORD.

Correction in Letters Patent No 1,250,806.

It is hereby certified that in Letters Patent No. 1,250,806, granted December 18, 1917, upon the application of James R. Craighead, of Schenectady, New York, for an improvement in "Time-Limit Relays," an error appears in the printed specification requiring correction as follows: Page 5, line 36, claim 16, for the word "element" read *elements*; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 12th day of February, A. D., 1918.

[SEAL.]

Cl. 175—270.

J. T. NEWTON,

Commissioner of Patents.