W. H. SCOTT.

ELECTRIC CIRCUIT BREAKER.

APPLICATION FILED DEC. 23, 1907.

959,171.

Patented May 24, 1910.

5 SHEETS—SHEET 1.

Fig. 1.

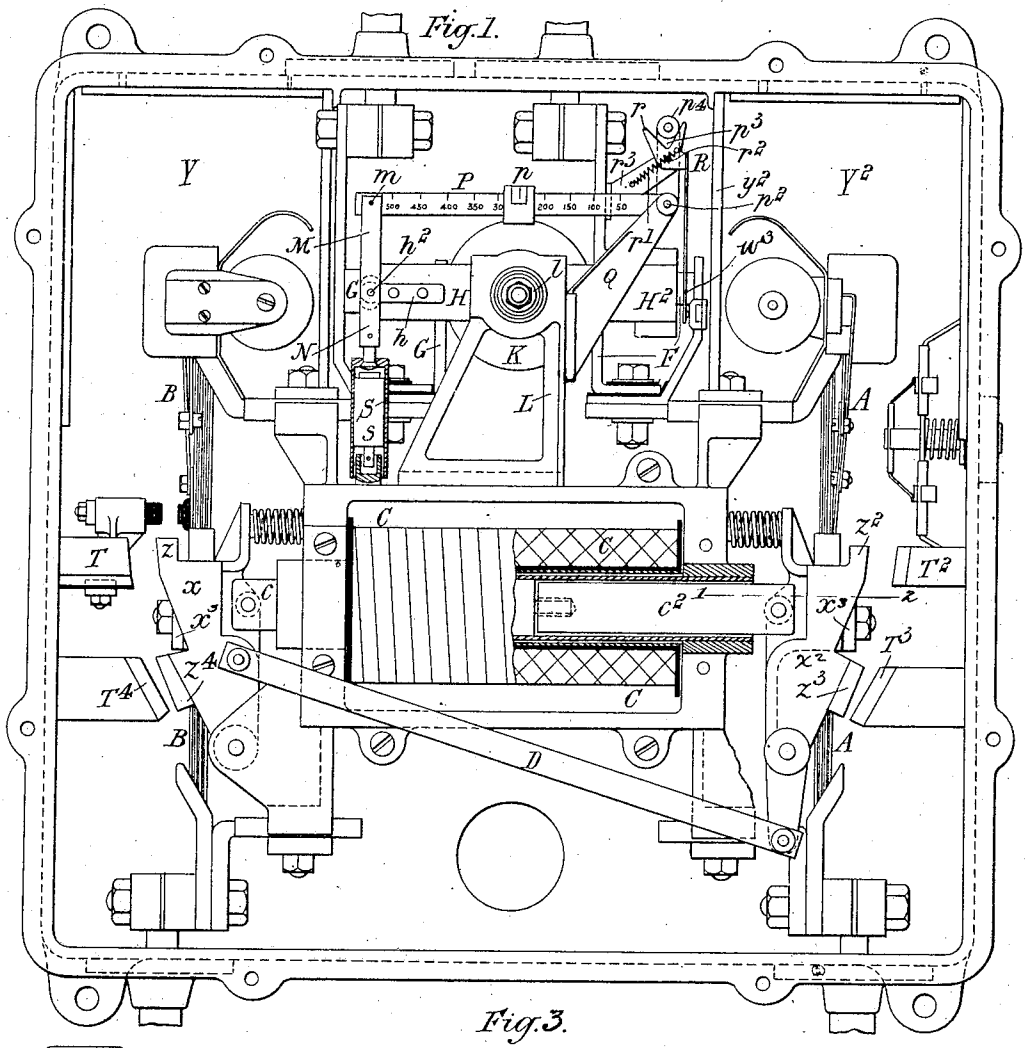
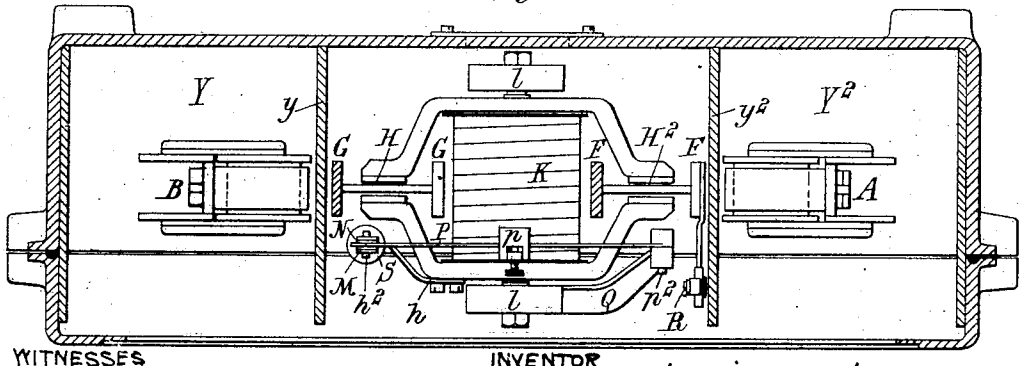


Fig. 3.



WITNESSES

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5 SHEETS—SHEET 2.

Fig. 7.

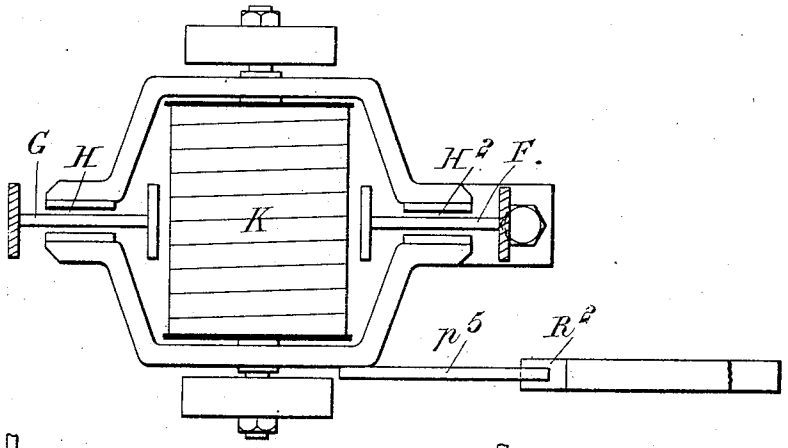


Fig. 8.

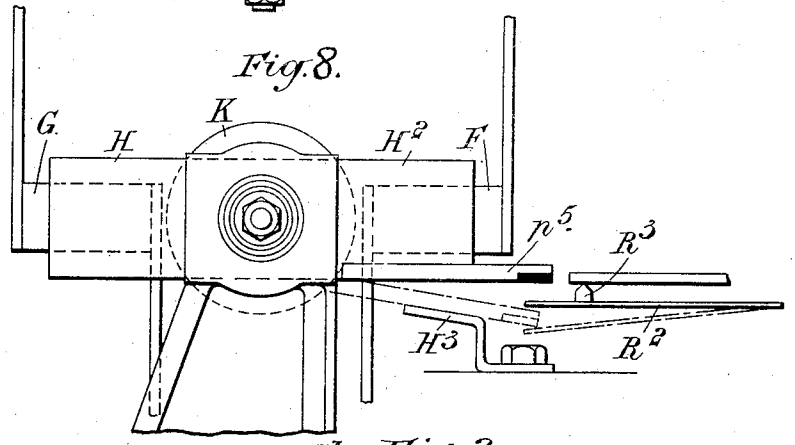
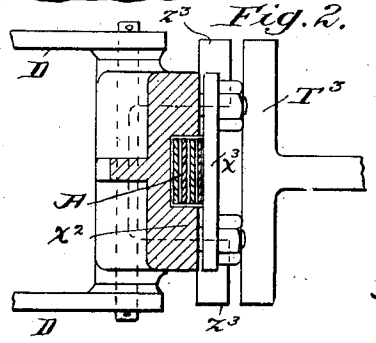


Fig. 2.



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5 SHEETS—SHEET 3.

Fig. 5.

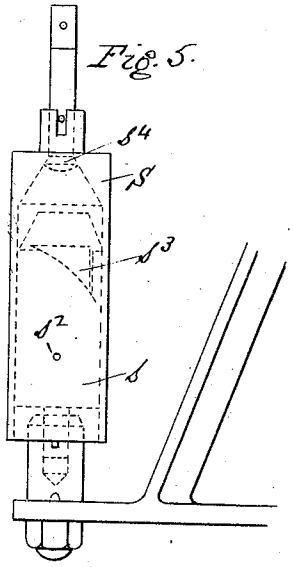


Fig. 6.

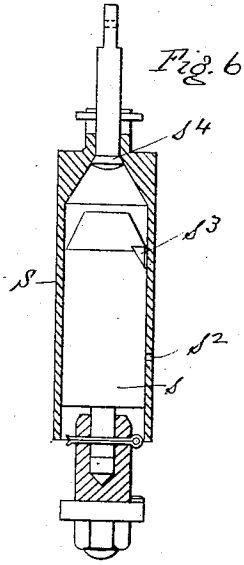
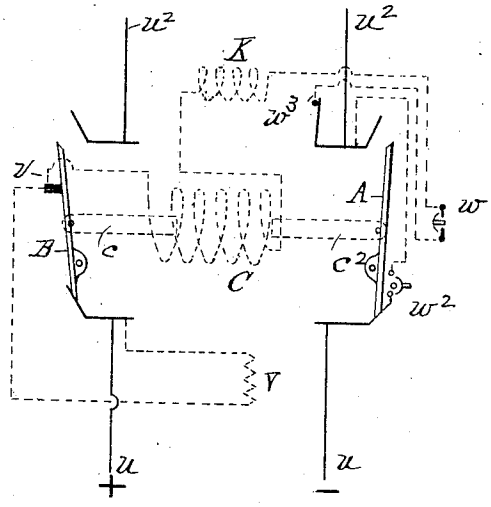


Fig. 4



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5 SHEETS—SHEET 4.

Fig. 9.

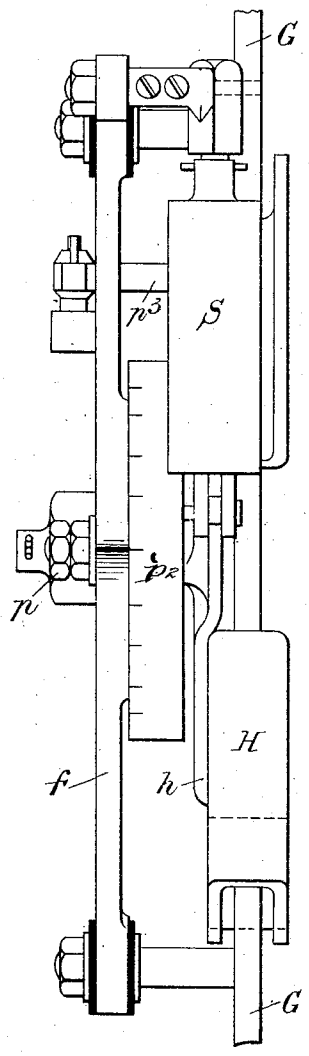
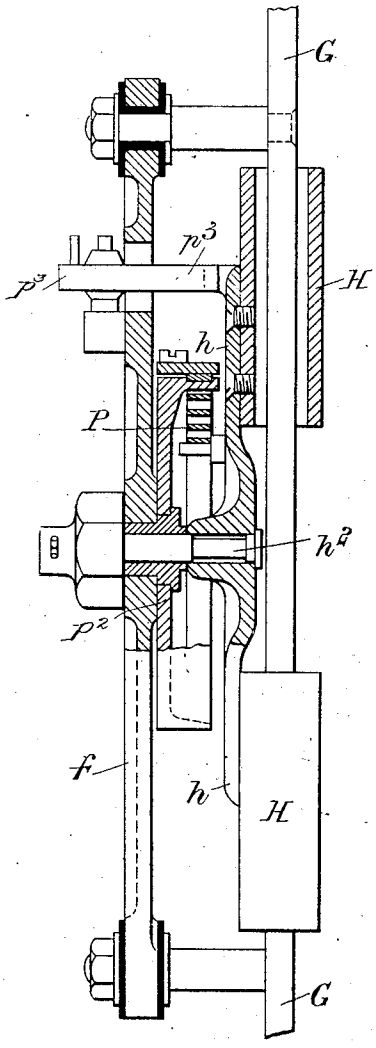


Fig. 11.



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5 SHEETS—SHEET 5.

Fig. 10.

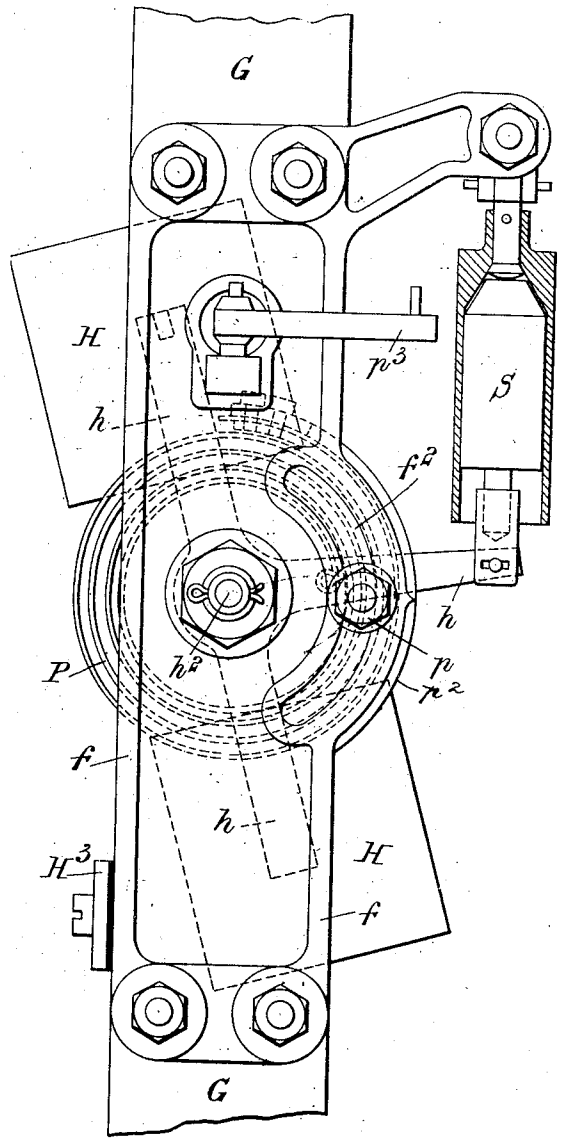


Fig. 12.

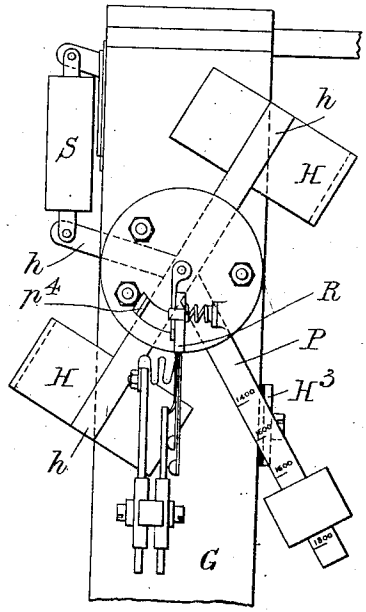
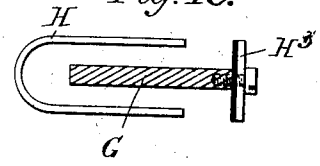


Fig. 13.



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UNITED STATES PATENT OFFICE.

WILLIAM HARDING SCOTT, OF NORWICH, ENGLAND.

ELECTRIC-CIRCUIT BREAKER.

959,171. Specification of Letters Patent. Patented May 24, 1910.

Application filed December 23, 1907. Serial No. 407,830.

To all whom it may concern:

Be it known that I, WILLIAM HARDING SCOTT, a subject of the King of Great Britain and Ireland, of Gothic Works, Norwich, in the county of Norfolk, England, electrical engineer, and whose post-office address is Gothic Works, Norwich aforesaid, have invented new and useful Improvements in Connection with Electric-Circuit Breakers, of which the following is a specification.

This invention relates to relay electric circuit breakers in which the main circuit is made by means of an electro-magnetically operated switch, the circuit being broken by the opening of the relay circuit.

I will describe my invention with reference to the accompanying drawings,

Figure 1 is an elevation; Fig. 2 is a section on the line 1, 2, Fig. 1; Fig. 3 is a plan of Fig. 1; Fig. 4 shows the arrangement of the circuits; Figs. 5 and 6 are an elevation and vertical section respectively, of the dash pot; Figs. 7 and 8 show in plan and elevation respectively, a quick breaking modification as hereinafter described; and Figs. 9 to 13 represent modifications in the overload device for breaking the relay circuit and thus breaking the main circuit, the movable member being shown in different positions in Figs. 9 and 11.

I arrange the two switches A and B at opposite ends of an electro-magnet C. The switch contacts themselves I prefer to arrange as shown in Fig. 1, the actual circuit being broken principally at the top contact, which is provided with a magnetic blow-out with sparking contacts as shown. The lower end of each switch remains practically always in contact. When the upper end is away, the lower end may just leave; it does not matter whether it does or not, but on the switch being closed the motion at the lower end of course is very much smaller than at the upper end, as is apparent from the location of the pivots. These brushes have very considerable springiness, and the small motion of the lower part is entirely, or almost entirely, taken up by this springiness.

I prefer the electro-magnet C to be an iron-clad solenoid with plungers c, c^2 to which the switch frames x, x^2 are hinged, which plungers are attracted toward each other in the middle of the solenoid, although this electro-magnetic arrangement may be of any other suitable description. I prefer to connect the two frames x, x^2 by links D to make the switches work simultaneously. This arrangement enables the two switches (which of course have full voltage between them) to be arranged at a maximum distance apart, and also enables the breaking portions of the switch to be arranged in separate compartments Y, Y^2 in accordance with my concurrent divisional application for a patent.

The iron-clad solenoid C, or its equivalent, is wound with fine wire in shunt to the mains, or it may be across a separate circuit as may be most convenient.

The overload operating device is shown in the drawings above the iron-clad solenoid C, and it consists of a device for producing a movable magnetic field in which the main current, passing through fixed conductors, can flow. In the drawing these conductors are shown on their respective poles F and G, the movable magnetic fields being at H, H^2, and being induced by the electro-magnet K, this electro-magnet being supported, on the ball-bearings l, or their equivalent, in standards L. The coil of this electro-magnet K may be excited in any convenient way, though I prefer generally to put it in series with the switch-operating solenoid C. The magnetic fields H, H^2 can, if desired, be produced by permanent magnets swung on anti-friction bearings. In the example illustrated, attached to part of this magnetic, or electro-magnetic, system, is a bar h on the end of which is a pin h^2 engaging a link M above the said pin, and a link N below the said pin, the link M being connected by a pin m to the end of a steel-yard P on which is a sliding weight p for setting the overload, and in connection with this steel-yard P, at its other end, is a circuit-breaking device R arranged primarily for breaking the circuit of the operating solenoid C. This circuit-breaking device preferably takes the form of a quick-break switch. The quick break may be effected as follows: The end of the steel-yard P is connected by a pin p^2 to a bracket Q and provided with a link p^3 carrying a roller p^4 acting on a fork lever r centered at r^2 to a bracket r^3 on the pole F, the quick-break action being obtained by means of a spring r^4 pulling beyond the center r^2. The last named details are omitted from Fig. 2.

When an excessive current flows through the conductors at F and G, or one of them, so that the force produced by the magnetic fields, or field, at H, H^2 is sufficient to over-

come the weight p on the steel-yard P, then the circuit is broken at the lower end w^3 of R, and the two main switches A and B are opened.

The link N underneath the pin h^2 is connected with a dash-pot S, which constitutes the time element, or retarding device. This I prefer to be a vacuum dash-pot of the type shown, comprising the dash-pot proper or cylinder S working over a plunger s. The link N through which the cylinder is lifted, is provided with a valve head s^4 which automatically closes the port in the head of the cylinder when the link N is actuated. In order to relieve the vacuum which results as the cylinder moves over the plunger, I arrange an opening s^2 in the cylinder which permits the entry of air as soon as it comes opposite the recess s^3 in the plunger. This recess is cut at an angle to the axial plane of the cylinder, and thus affords means, by mounting the plunger on a pivot, for controlling the time of the dash-pot action, since by turning the plunger, the relative positions of the angular recess s^3 and the opening s^2 may be varied at will. Owing to the retarding action of the dash-pot, a sudden kick of overload, unless excessive, does not open the circuit breaker. The greater the overload, the less is the time lag. This overload arrangement forms an operating device which gives a force which is proportional to the current flowing at any point in the travel, the force increasing and decreasing exactly with the main current. With the ordinary solenoidal overload device, as the plunger, or its equivalent, rises, the force exerted by a given number of amperes is very much increased, so that when once motion is started, the current has to drop down to a very large extent before this motion is arrested, and the consequence is that a sudden excess load may start the motion of the overload device, and this, by the time this very excessive load is removed, has got into such a position that a comparatively small current will maintain sufficient pull on the retarding device to make the circuit breaker go in a few extra seconds, any solenoidal arrangement of circuit breaker with a vacuum dash-pot retarder being open to the objection that it will, after it had once been started with a heavy momentary overload, or overload of short duration, only require a much smaller current than the normal to make it act. In the arrangement according to this invention, this defect is overcome, and the magnet turning on its center will return to its "right off" position directly the current has dropped below the current at which it ought to start in motion. To assist this return, the vacuum dash-pot is fitted with a valve s^4 which only retards in the one direction.

In the case of failure of voltage, of course, the circuit breaker comes out of itself, but in the case of a "dead short" it is necessary that the circuit breaker should come out with the utmost speed in order to prevent, as much as possible, the current in the "dead short" from becoming very great. With this object I arrange the iron pieces T, T^2, T^3, T^4 for the frames carrying the contact brushes A and B (which are held in the iron frames x, x^2 by means of clamping pieces of brass, or other non-magnetic metal x^3), so that when a very heavy current passes along these brushes, the projecting pairs of side pieces z, z^2, z^3, z^4 of the frames become magnetized, and, in the case of very excessive current, there is powerful attraction between these projections z, z^2, z^3, z^4 and the pieces T, T^2, T^3, T^4 so that the switches are forcibly opened. This switch obviously can be operated from a distance by means of the circuit of the operating solenoid C.

Referring to the diagram Fig. 4 the action of the relay circuits is as follows:— The opening press-button w is normally closed so that there is a circuit from the main u through resistance V by the contact v through the coils C and K, then through the opening press-button w to the contact w^3 which also is normally closed, on to the branch circuit u^2. But as shown in the diagram, there is not a complete circuit right through from u^+ to u^-. The break is at switch A. Now if this break be bridged momentarily by the closing press-button w^2, the whole of this relay circuit is closed and a current flows in it sufficient to so energize the magnetic plungers c and c^2 as to close the switches A and B. Directly the closing of the large switch A is accomplished, the press-button w^2 becomes unnecessary because it is short-circuited by A and press-button w^2 can be released. The switch then keeps closed as long as there is a certain voltage between u^+ and u^-.

To open the circuit the opening press-button w is pressed momentarily. This breaks the whole relay circuit and switches A and B open because there is no current flowing in the coil C. This pressing of the opening-button w only requires to be momentary, because the switches A and B come out instantly, and when w is closed again the relay circuit remains broken at the large switch A and cannot be closed again until the press-button w^2 is closed.

The overload-operated switch w^3 acts in exactly the same way as the opening press-button w. It is in fact an opening press-button operated by the overload device.

The resistance V and the contact v are not really necessary parts of the apparatus; they are only utilized to economize the current used in the relay circuit. When the switch B is completely open, the contact v.

is closed, and the resistance V is short-circuited, so that a current of a certain amperage flows through the coils C and K and the plungers c and c^2 are powerfully attracted, or pulled in toward one another in this particular construction. A smaller current, however, is required for holding these switches in than for starting them in, because the two plungers when they are "home" are closer together. The resistance V is inserted, thereby reducing amperage of the relay current that is used.

Referring to the modification shown in Figs. 7 and 8, in place of the quick break arrangement hereinbefore described, I may employ a short-circuiting, or attracting, piece of magnetic material, such as soft iron, in such a position that it comes into operation, or exercises its influence, when the moving magnet is swung around to nearly its position of maximum deflection, the said moving magnet, except toward the end of its travel, being out of the range of influence of the said short-circuiting, or attracting, piece, but just before the said moving magnet attains the position to break the relay circuit, it comes under the influence of the said short-circuiting, or attracting, piece, which causes it to make a sudden and definite jump, thus giving a quick break to the relay circuit.

K is the shunt-wound electro-magnet, H, H^2, are the movable magnetic fields, and F, G, the conductors, as hereinbefore described.

H^3 is a piece of soft iron secured in such a position that it begins to exercise its influence on the movable magnet when near its maximum of deflection so as to cause the said magnet to make a sudden and definite jump and quickly break the relay circuit by any suitable device, such, for instance, as an arm p^5 secured to the magnet and provided with a piece of insulating material bearing on the spring arm R^2 carrying the contact R^3.

The piece of soft iron H^3 may be arranged in any other suitable position, such, for instance, as above the field H instead of below the field H^2 or below one field and above the other.

In place of the arrangement hereinbefore described to break the relay circuit, I may use a U-shaped magnetic piece, or U-shaped magnetic pieces, which will embrace the conductor, or each conductor, this piece, or these pieces, being carried by a lever, or the equivalent, which will move when the U-shaped piece is, or U-shaped pieces are, attracted by the current in the conductor, or conductors, and cause the breaking of the relay circuit. The following are suitable arrangements:

Figs. 9 and 10 are elevations at right angles to each other, and Fig. 11 is a vertical section of a modification of the overload device for breaking the relay circuit with the movable member in a different position. The relay-breaking switch is not shown, but the breaking is presumed to be effected by the bell-crank lever p^3. The circuit-breaking device consists of two U-shaped magnetic pieces H of soft iron connected to the opposite arms of a three-armed lever h capable of swinging on a center h^2 mounted on a bar f secured to the conductor G so that when excess of current passes through the said conductor, the said U-shaped pieces pass over the conductor from opposite sides and the bell-crank lever p^3 is operated to break the circuit. The third arm of the lever is connected to a dash-pot S which may be of the kind hereinbefore described. The movement of the lever is resisted by a coiled spring P, the tension of which can be altered as required by the nuts p through the intervention of the piece p^2 (to which one end of the spring is connected) being adjusted and fixed in the slot f^2 in the bar f, the other end of the spring being connected to the lever h.

Fig. 12 shows, in elevation and transverse section, a similar arrangement but with a steel-yard P' and adjustable weight thereon in place of a coiled spring. In this figure the projection p^4 on the lever h directly acts on the contact maker lever R to break the relay circuit.

In Figs. 9 to 12 I have shown a piece of soft iron H^3 to bring the U-shaped pieces over quickly as hereinbefore described with regard to Figs. 7 and 8.

The arrangements described can be used generally for causing the breaking of electric circuits, for example by releasing holding-in catches. I do not limit myself to the precise arrangements described, for example, the U-shaped pieces may embrace conductors on opposite sides after the manner in which they are embraced by the arrangement, Fig. 1.

I claim as my invention:

1. In a relay circuit breaker, a switch member, a relay circuit controlling the same, means for automatically breaking the relay circuit upon the occurrence of excessive current and electromagnetic means in connection with the movable switch member and said excessive current, for forcibly opening the main switch, substantially as described.

2. In a relay circuit breaker, a relay circuit controlling the switch member, means for automatically breaking said relay circuit upon the occurrence of excessive current, a movable switch member of magnetic material and means in connection with the magnetic field produced when said excessive current flows through said switch member for forcibly opening the main switch, substantially as described.

3. In a relay circuit breaker, a switch

member and a relay controlling the same, means for automatically breaking the relay circuit, comprising a pivoted member and electromagnetic means for actuating the same upon the occurrence of excessive current, and a contact member subject to the movement of said pivoted member, together with a piece of magnetic metal so arranged with relation to said pivoted member that its magnetic attraction for the latter comes into effective action after said pivoted member has been partially actuated, to increase its movement and thereby effect a quick break of the contact, substantially as described.

4. In a relay circuit breaker, a movable main switch member, a relay circuit controlling the same and means for breaking the relay circuit upon the occurrence of excessive current whereby the main switch is opened, in combination with a magnetic member moving with the main switch member and coöperating stationary magnetic members, said magnetic members being mutually attracted upon the passage of excessive current through said main switch member, whereby the switch is forcibly opened, substantially as described.

5. In a relay circuit breaker, a movable main switch member, a relay circuit controlling the same, and a stationary magnetic member arranged within the magnetic field produced when an excessive current flows in the main switch member, whereby the switch is forcibly opened upon the occurrence of excessive current.

6. In a relay circuit breaker, means for automatically breaking the relay circuit, comprising a pivoted member and electromagnetic means for actuating the same upon the occurrence of excessive current, and a contact member subject to the movement of said pivoted member, said electromagnetic means comprising a U-shaped piece of magnetic metal carried by said pivoted member, and a stationary current carrying member embraced thereby upon the oscillation of said pivoted member, whereby the magnetic attraction for the latter is increased after said pivoted member has been partially actuated and a quick break of the contact effected, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

WILLIAM HARDING SCOTT.

Witnesses:
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RICHARD HOLMES.