Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

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The present invention relates to circuit-breakers. More in particular, the present invention relates to high-speed automatic circuit-breakers particularly adapted for high voltages which are electro-magnetically or thermally operated, and more particularly still to circuit-breakers of the type referred to, wherein the contacts of the circuit-breaker are kept in closed position under normal operating conditions against the electro-dynamic force of the current passing through the switch.

Circuit-breakers of the aforementioned type are subject to considerable thermal and dynamic stress whenever there arise high overload currents, as, for example, in case of a short circuit. The greatest strain occurs at the respective peak value of alternating current. This strain is particularly great where the time for response of the circuit-breakers is comparatively long and the contacts are not subjected to the opening operation as soon as the electro-dynamic force produced by a predetermined overload current thrusts apart the contacts, whereby the opening movement is further enhanced and accelerated.

The circuit-breakers of this type are however extremely complicated and, in addition, the several tripping operations called for by the construction of the circuit-breaker mechanism and its inertia. It has, therefore, been tried to provide a circuit-breaker wherein the contacts perform a two-stage separating movement, the first stage comprising a comparatively small displacement rate and the second stage comprising a greater displacement rate for extinguishing the arc between the contacts, thus separating the latter electrically. The electro-dynamic force produced by the flow of current through the contacts is reduced to a minimum. A further reduction of this type is, however, limited by the construction of the circuit-breaker mechanism and its inertia. It has, therefore, been tried to provide a circuit-breaker wherein the contacts perform a two-stage separating movement, the first stage comprising a comparatively small displacement rate, the second stage comprising a greater displacement rate for extinguishing the arc between the contacts, thus separating the latter electrically. The opening movement is further enhanced and accelerated. This opening movement is effected entirely independently from the contact actuating operation effected by the electro-magnetically or thermally operated contact actuating mechanism, with which mechanism the aforesaid energy storing member is connected.

The invention will be better appreciated upon the following detailed description of the accompanying drawings, wherein

**FIGURE 1** is a partial, side elevational view of the circuit-breaker of the invention with the contacts in closed position;

**FIGURE 2** is a partial, side elevational view of the circuit-breaker of the invention with the contacts in opened position, the conventional contact-actuating mechanism still being in closed position;

**FIGURE 3** is a partial, side elevational view of the circuit-breaker of the invention with the contacts in opened position, and the conventional contact-actuating mechanism now also having been moved into opened position;

**FIGURE 4** is a top view of a preferred embodiment of the contact-breaker of the invention;

**FIGURE 5** is a partial, side elevational view of a modification of the contact-breaker of the present invention, with the contacts in opened position;

**FIGURE 6** is a partial, side elevational view of a modification of the contact-breaker of the present invention, with the contacts in opened position;

Referring now to the drawings more in detail and turning first to **FIGURE 1**, the circuit-breaker of the invention comprises a pair of relatively moveable contacts, such as a fixed contact 1c and a moveable contact 2 having a contact point 2a. The moveable contact 2 is hingedly mounted on a shaft 3 about which it is simultaneously rotatable and displaceable by shaft 8 with the center of the latter as a fulcrum.

The circuit-breaker comprises a conventional contact actuating mechanism for mechanically opening and closing contacts 1 and 2 which is known per se and, therefore, not shown in the drawings. This mechanism may be electro-magnetically and/or thermally tripped, in a manner known per se. Connected with this mechanism there is provided a shaft 8 bearing a switch traverse 7 displaceable by shaft 8 with the center of the latter as a fulcrum.

The circuit-breaker of the present invention further comprises a spring, such as tension spring 4, connected with one of its ends to a pin 14 on the switch traverse plate 7 and with its other end to a pin bolt 6 connected with the moveable contact 2. The traverse plate 7 is provided with a longitudinal guide recess 9 receiving the pin bolt 6 which is adapted to slide therein. Accord-
ingly, plate 7 with recess 9 is a guide member for pin bolt 6 permitting a limited pivot motion of moveable contact 2. It is thus possible to open the contacts by the conventional contact actuating mechanism via shaft 8 and traverse plate 7 actuating moveable contact 2 via one of the edges of guide recess 9 and pin bolt 6. Independently therewith it is also possible to open the contacts short of any displacement of the contact actuating mechanism and the traverse plate 7 due to the toggle-like action of spring 4 with pin bolt 6 traveling in guide recess 9. The detailed operation of the contact breaking movement will be further described below.

According to another, preferred embodiment of the circuit-breaker of the present invention, there are provided, associated with contacts 1a and 2a, not one but two tension springs 24 and 24a, as well as two switch traverse plates 27 and 27a bearing a pin bolt 26a to which there are attached the springs 24 and 24a with one of their respective ends, and a pin bolt 26 adapted to slide in a recess of the traverse plates, to which there are attached the other respective ends of the springs 24 and 24a. The traverse plates are mounted and fulcrumed about a shaft 28A connected with the conventional spring actuating mechanism, not shown.

The advantage of this preferred embodiment of the invention resides in the fact that the speed of the circuit-breaking operation is even more rapid than with the basic embodiment of the circuit-breaker of the invention.

According to a modification of the circuit-breaker of the invention, there is provided a pressure spring instead of a tension spring. This is shown in FIGURES 5 and 6, wherein 31 designates the fixed contact having a contact point 31a, 32 the moveable contact having a contact point 31b, the moveable contact 32 being hingedly mounted on and fulcrumed about a pin bolt 33 attached to the switch traverse plate 37 which latter is hingedly mounted on shaft 38 connected with the conventional contact actuating mechanism, not shown. The pressure spring 33 is fixed with one of its ends to a pin 40 mounted on the traverse plate 37, and with its other end to the pin bolt 36 mounted at the lowermost end of moveable contact 32 and adapted to travel in the guide recess 39 of the switch traverse plate 37. The circuit-breaker shown in FIGURES 5 and 6 thus substantially corresponds to the device shown and described with reference to FIGURE 1, with the exception that in the last described device there is provided a pressure spring and, accordingly, the moveable contact is fulcrumed differently, i.e., in the device shown in FIGURES 1 to 3, the fulcrum is situated below the point of attachment of the spring to the moveable contact via the pin bolt 6, whereas in the circuit-breaker shown in FIGURES 5 and 6 the moveable contact 32 is fulcrumed about the fixing point of pressure spring 34 to the contact via pin bolt 36.

The contact members of the circuit-breaker, such as the contacts 1a, 2a, are preferably composed of a material having a low welding capacity; this will prevent the welding-together of the contacts under the influence of the electro-dynamic force produced by a short-circuit, and the resulting decrease of the contact pressure.

It will also be found to be advantageous to have the bolt 6 so positioned in the closed position of the contacts that it does not come close to rest against the left-hand edge of recess 9, as shown in FIGURE 1 of the drawings. The bolt 6 and the moveable contact 2 thus have a slight play towards fixed contact 1. This takes care of a certain wear of the contact points 1a, 2a, which may occur after prolonged operation, in which case a displacement of the points of attachment of spring 4 will so adapt the force moment acting upon the moveable contact 2 that the resistance at the contact points is substantially constant.

The circuit-breaker of the present invention operates in the following manner, as described with reference to the embodiment shown in FIGURES 1 through 3 of the accompanying drawings:

Under normal operating conditions the contacts 1 and 2 are closed via their respective contact points 1a and 2a, which position is shown in FIGURE 1. The pressure between these contact points necessary for conducting the rated current is produced by the tension spring 4 via the moveable contact 2. The current flows through line 13 over the fixed contact 1, contact points 1a and 2a through the moveable contact 2, thus forming a comparatively narrow loop. As soon as a predetermined overload current occurs, for example in case of a short-circuit, the current loop and the narrow current passage and the contact points 1a, 2a, produce an electrodynamic force, based on the well-known fact that the current loop tends to widen itself, which force tends to push the two contacts apart, i.e., the moveable contact 2 away from fixed contact 1 so as to separate the contact points 1a, 2a. The moveable contact is thus displaced in the direction of arrow 5 moving about shaft 3 on the traverse plate 7 as a fulcrum. The force moment of spring 4 influencing the moveable contact 2 is gradually decreased because of the decreasing lever arm, it passes zero and becomes negative so that finally it no longer tends to keep moveable contact 2 pressed against contact 1 but, on the contrary, pulls the moveable contact 2 further away from contact 1 and into the end position shown in FIGURE 2, in which the upper portion of moveable contact 2 comes to rest against detent bar 12. The electric arc definitely breaks down. Now, and without any necessity for great speed the conventional electromagnetically and/or thermally operated contact actuating mechanism comes into play to also move into the circuit-breaking position whereby the switch traverse plate 7 is moved from the position shown in FIGURES 1 and 2, to the position shown in FIGURE 3, it having been swivelled via shaft 8, and about center of this shaft as a fulcrum. By this latter movement, the moveable contact is simultaneously returned to the closed position by the pressure exercise via detent bar 12 on the upper portion of its lever arm.

The moveable contact can also be opened independently by the conventional contact actuating mechanism via traverse plate 7 which then travels along moveable contact 2 via the left-hand edge of recess 9. Thus, the moveable contact 2 can be moved away from contact 1, both by the switch traverse plate 7 as well as independently from the latter under the influence of a predetermined overload current passing through contacts 1 and 2. The latter opening operation initiated by the electro-magnetic force produced by the overload current passing through contacts 1 and 2 is enhanced and greatly speeded up by the toggle-like action of spring 4.

The operating of the preferred embodiment of the invention shown in FIGURE 4 is entirely analogous to the operation of the embodiment aforesaid. However, the contact-breaking speed is even more increased by the provision of a pair of springs.

The operation of the modified circuit-breaking device shown in FIGURES 5 and 6 is also entirely analogous to the operation as described before.

In all devices shown and described heretofore, the circuit-breaking operation under the influence of normal currents and not reaching the predetermined critical, overload level is effected by the known contact actuating mechanism (not shown in the drawings) in the manner known per se. In these circuit-breaking instances, the relative position between the moveable contact and the switch traverse plate does not change as it changes in case of the aforesaid circuit-breaking operation under the influence of overload currents.

The circuit-breaker of the present invention as heretofore described and shown in the drawings has great advantages over the art, as the contacts are separated by
two mutually entirely independent operations, namely theelectro-magnetically or thermally operated contact-actuating mechanism, on the one hand, and the electrodynamic force produced by the current flow through the contact elements, in conjunction with the energy storing member as its force component is reversed, on the other hand. The latter switching operation becomes effective where the current increases by a predetermined rate and there occurs a certain minimum overload current, e.g. a short-circuit current. The first-mentioned, conventional contact-opening operation becomes effective in the case of predetermined smaller overload currents and is entirely sufficient for that purpose.

In the case of high overload currents the only function of the conventional contact-actuating mechanism is to reset the already opened contacts to the position necessary for making contact.

The circuit-breaker of the invention ensures an early and quick opening of the contacts and safely extinguishes the electric arc between the contacts independently from the much slower, following action of the conventional contact-actuating mechanism.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

We claim:

1. An automatic circuit-breaker comprising a fixed contact and a movable contact, a contact-actuating mechanism keeping said contacts in closed position under predetermined normal current conditions while allowing for the opening of said contacts under the influence of the electrodynamic force produced by a predetermined overload current, and additional contact-actuating means connected with said contact-actuating mechanism producing a force component tending to keep said contacts in their respective end positions, which force component is reversed whenever said predetermined overload current has been reached, thereby opening said contacts independently from the opening action of said contact-actuating mechanism, said additional contact-actuating means having a shaft actuated by said contact-actuating mechanism, a switch traverse connected with said shaft and moved thereby, a guide recess in said traverse, an unstable spring, a bolt connected with said movable contact and to one end of said unstable spring, said bolt being guided in said guide recess and having a first end position in which said contacts are closed and a second end position in which said contacts are opened, said bolt being movable from said first end position to said second end position and vice versa by said traverse and also independently from said traverse and said contact-actuating mechanism by the influence of the electrodynamic force of a predetermined overload current passing through said contacts.

2. An electric switching device comprising: a stationary contact; a second movable contact for engaging said first contact, said contacts being subjected to electrodynamic repelling force when closed and conduct electric current; spring means biasing said second contact in a direction urging said second contact towards said first contact; and a movable guide member engaging said second contact for moving said spring and said second contact between a closed and an open position whereby the direction of the force of said spring means remains the same, said member permitting limited relative movement of said second contact under the influence of an excessive electrodynamic repelling force, so that the bias force exerted by said spring upon said second contact be reversed.

3. An electric switching device comprising: a stationary contact; a pivotable contact capable of engaging said stationary contact, there being an electrodynamic force exerted upon said contacts when an electric current flows therethrough urging said contacts apart from each other; a pivotally mounted switch traverse; a spring secured with one end to said traverse at location displaced from the pivot point thereof, and secured with the other end to said pivotable contact arm whereby the line between the connections of said spring is located on one side of the pivot point of said pivotable contact and a force component urges the latter towards the stationary contact when the contacts are closed, said line passing over said pivot point when said pivotable contact opens under excessive electrodynamic forces; and means for engaging said traverse and said pivotable contact for common pivot motion to a contact-open position whereby the side relationship of said line and said pivot point of said contact remain the same.

4. An electric switching device comprising: a stationary contact; a pivotable contact capable of engaging said stationary contact, there being an electrodynamic force exerted upon said contacts when an electric current flows therethrough urging said contacts apart; a spring connected to and urging said pivotable contact towards said stationary contact in opposition to said forces; a switch traverse supporting said pivotable contact and permitting relative movement in a limited range for opening and closing said contacts substantially independent from and without substantially altering the urging force exerted by said spring; and means for connecting said spring to said traverse at such a location, that excessive electrodynamic forces overcome said spring force and reverse its direction whereby the position of said traverse is unchanged.

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