United States Patent

Takeda et al.

[15] 3,639,865

[45] Feb. 1, 1972

[54] CIRCUIT BREAKER

[72] Inventors: **Chuzo Takeda; Yoshihiro Kojima; Yamaguchi Toshiyuki; Yasuo Ariyama,** all of Tokyo, Japan

[73] Assignee: **Tokyo Shibaura Electric Co., Ltd.,** Kawasaki-shi, Japan

[22] Filed: **Feb. 9, 1971**

[21] Appl. No.: **113,854**

[30] **Foreign Application Priority Data**

Feb. 9, 1970 Japan.....45/10901

[52] **U.S. Cl.**.....**335/18,** 200/153

[51] **Int. Cl.**.....**H01h 75/00**

[58] **Field of Search** .....335/18, 16, 190, 68; 200/153, 200/82 A, 146

[56] **References Cited**

UNITED STATES PATENTS

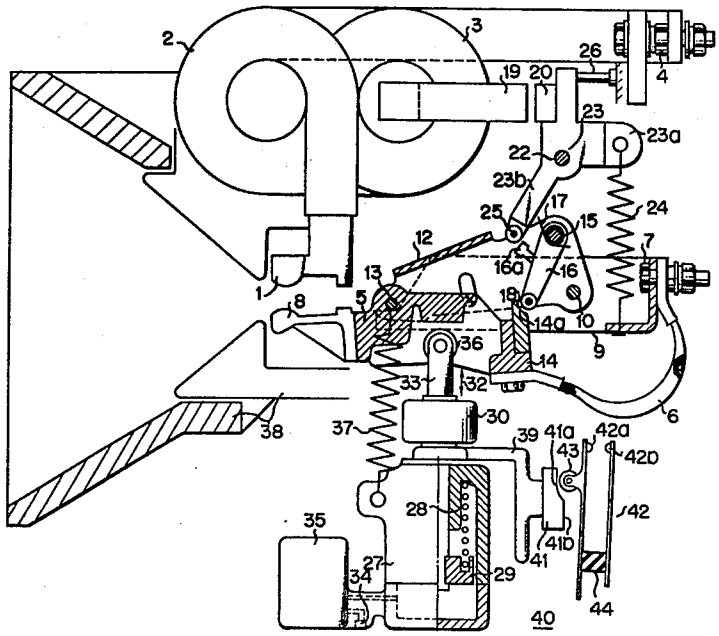
3,366,900	1/1968	Barkan	335/16
3,590,192	6/1971	Bould	335/190

Primary Examiner—Harold Broome
Attorney—Oblon, Fisher and Spivak

[57] **ABSTRACT**

A circuit breaker is provided which is capable of effecting an instant cutoff when excess current is introduced while the circuit breaker is in operation. In addition, the circuit breaker has means cooperatively associated therewith for selectively indicating normal cutoffs and those arising because of excess current from the condition in which the contact members are engaged during normal operation. In this device, a movable arm rotatably disposed on a second rotatably mounted arm has a contact secured to one end which detachably contacts a fixed contact to switch a circuit. Means are provided for normally urging the first movable arm in a direction to separate the contacts. A driving device for displacing the first movable arm and the second movably arm jointly through an engaging mechanism connected therebetween causes the contacts to engage, and another device responsive to an excess current sensing means is provided for disengaging the engaging mechanism to permit the contacts to be separated in such cases, even while the circuit breaker is being normally operated.

11 Claims, 7 Drawing Figures



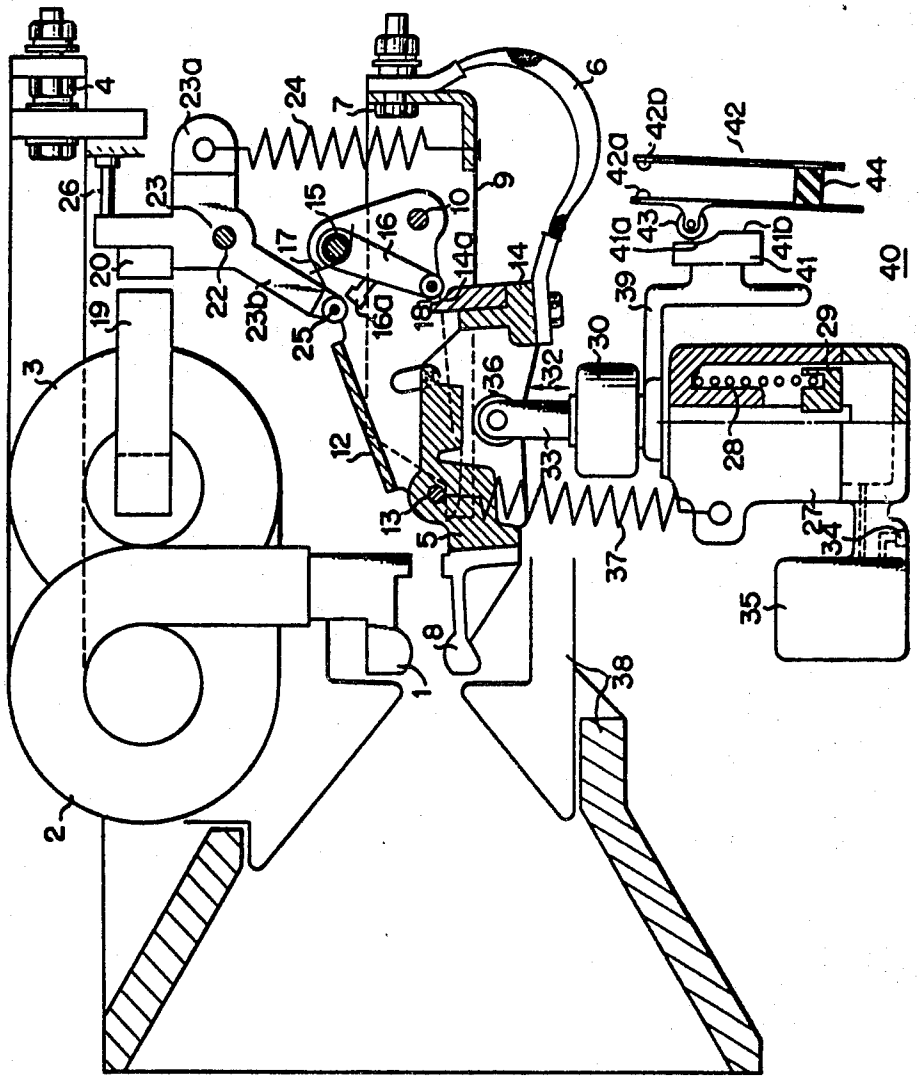


FIG. 1

INVENTORS
CHUZO TAKETA
YOSHIHIRO KOJIMA
TOSHIYUKI YAMAGUCHI
YASUO ARIYAMA

BY Oblon, Fisher & Spivak
ATTORNEYS

FIG. 2

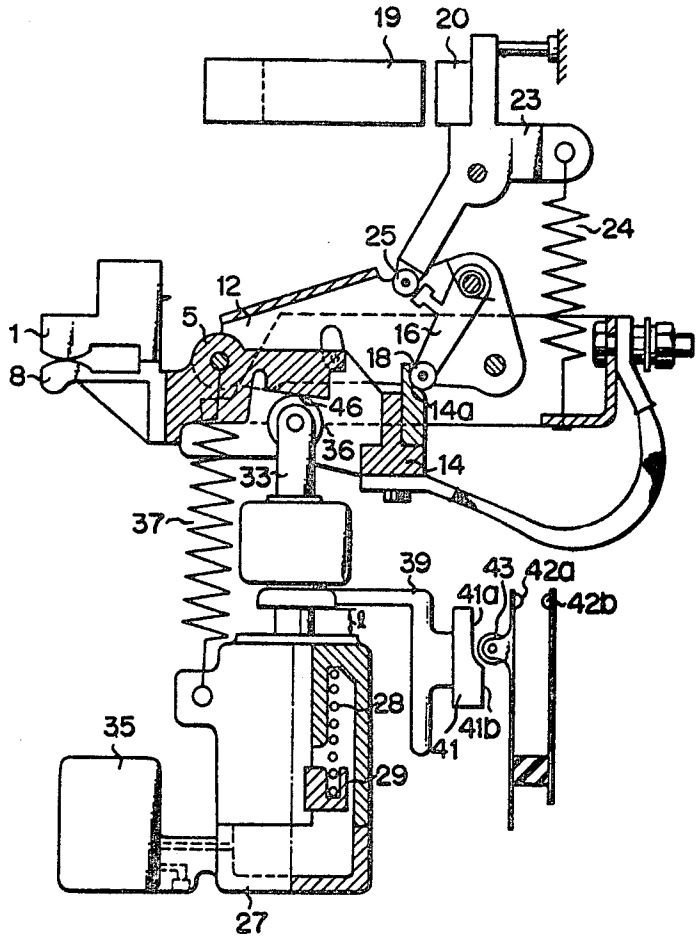

19
20
23
24
25
12
5
1
8
16
18
46
14a
36
14
33
37
39
43
42a
41a
42b
28
41b
41
35
29
27

FIG. 3

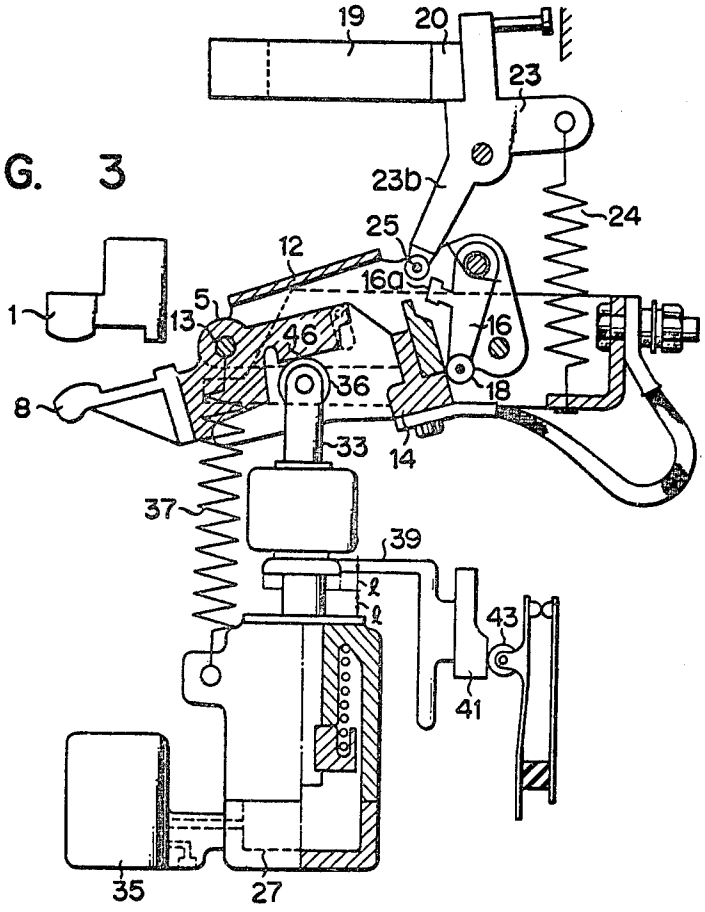
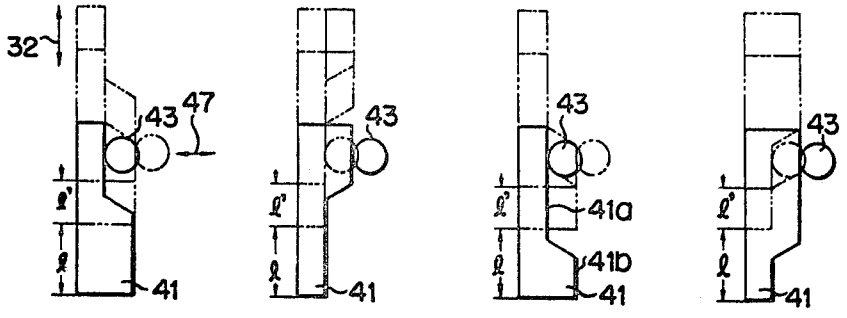


FIG. 4A FIG. 4B FIG. 4C FIG. 4D



CIRCUIT BREAKER

BACKGROUND OF THE INVENTION

The present invention relates to improvements in circuit breakers and more particularly to a circuit breaker which is automatically effective while in operation to instantly cutoff excess current being introduced in the circuit.

A high speed circuit breaker used in, for example, an electric train is generally operated by introducing compressed air into a cylinder through an electromagnetic valve, thereby pushing an insulation rod carried by a piston operatively disposed in the cylinder and effectively moving a movable contact member into contact with a fixed contact member. Once the circuit breaker is put into operation, an electromagnet excited by a holding coil maintains the contact between said contact members. Accordingly, even when the insulation rod is brought back to its original position by releasing the compressed air from that side of the cylinder, the contact condition is retained. Cutoffs are classified into normal cutoffs and those made whenever excess current is realized in the circuit. Normal cutoffs are effected by demagnetizing the electromagnet. Emergency cutoffs because of excess current are usually realized because the holding force of the holding coil is extinguished by the passage of the excess current through a trip coil. Thus, the holding coil and the trip coil are differentially operated with respect to excess current.

A circuit breaker of the aforementioned arrangement fails to cut off excess current which happens to be introduced when the movable contact member is brought into contact with the fixed contact member by operation of the piston carrying the insulation rod, unless it is fully brought back to its original position. These types of circuit breakers therefore do not offer adequate safety provisions because of the absence of a suitable free tripping mechanism. Since the holding and trip coils are differentially operated with respect to excess current, current passing through the holding coil should have a prescribed direction. However, excess current does not always have a fixed direction. Further, the aforesaid type of circuit breaker presents difficulties in selectively indicating normal cutoffs and those of excess current.

SUMMARY OF THE INVENTION

It is accordingly an object of the present invention to provide an improved circuit breaker having a free tripping mechanism unaffected by the direction of excess current and which can easily distinguish between normal cutoffs and those made in recognition of excess current.

The foregoing and other objects are realized by the circuit breaker of the present invention which comprises a fixed contact member connected to one end of the circuit breaker through an excess current detecting coil; a first movable arm provided at one end with a movable contact member connected to the other terminal of the circuit breaker so as to close and open both terminals by detachably engaging the movable contact member with the fixed contact member; a second movable arm provided at one end with a shaft for rotatably supporting the first movable arm at an intermediate point thereof, and being rotatably supported at its other end by a fixed shaft; engagement means for jointly moving the first and second movable arms when a driving surface for the first movable arm positioned between its point of rotation and a point at which the other end of the first movable arm engages an element on the second movable arm is urged in a direction to cause the movable contact member to contact the fixed contact member; mechanisms for automatically disengaging the engagement means upon introduction of excess current; means for normally displacing the first movable arm to urge the fixed and contact members to remain separated; driving mechanisms for advancing a movable member in a direction to effect the mutual contact of the contact members by urging the driving surface of the first movable arm in the given direction for jointly moving the first and second movable arms, and upon the disengagement of the engagement means, further advancing the movable member for causing the contact members to be detached from each other; and means for selectively indicating normal cutoffs and those of excess current from the condition in which the contact members contact each other.

According to the present invention, after the movable contact member has been brought into contact with the fixed contact member by advancing the movable member of the driving mechanism, that is, when the circuit breaker is in operation, if an excess current is introduced, then the engagement means are disengaged by an electromagnet which is excited by the passage of the excess current through a detecting coil thereof. Following the disengagement of the engagement means, the movable member of the driving mechanism is further advanced, thereby causing the first movable arm to rotate in a direction to effect a separation of the contact members. This means that the present invention permits free tripping with respect to excess current. The aforementioned disengagement originates with the action of an electromagnet which is excited by excess current and is not affected by the direction of the current. Further, the advancement of the movable member of the driving mechanism from its one end position varies between normal cutoffs and those made in response to the detection of excess current, so that it is easily possible to individually indicate these two types of cutoffs by monitoring the different degrees of advancement by the movable member of the driving mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

Various other objects, features and attendant advantages of the present invention will be more fully appreciated as the same becomes better understood from the following detailed description when considered in connection with reference to the accompanying drawings wherein like reference numerals designate like or corresponding parts throughout the several figures and in which:

FIG. 1 illustrates, partly in section, a circuit breaker constructed according to an embodiment of the present invention wherein the contact members are shown in a separated condition;

FIG. 2 represents the operating condition of the circuit breaker of FIG. 1, with some parts omitted wherein the contact members are shown in contacting relation with each other;

FIG. 3 illustrates the circuit breaker of FIG. 1 showing the contact members being detached from each other upon the introduction of excess current to the circuit breaker while it is in the operating condition shown in FIG. 2; and

FIGS. 4A through 4D indicate schematic modifications of a supplementary contact mechanism which may be used in a selective indication device according to another embodiment of the invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawings, and more particularly to FIG. 1, a forked fixed contact member **1** is shown being connected to one end terminal **4** of a circuit breaker through a blow coil **2** and an excess current detection coil **3**. A first movable arm **5** is connected to the other end terminal **7** of the circuit breaker through a flexible conductor **6**. One end of the movable arm **5** is formed into a forked movable contact member **8** for switching a circuit across both terminals **4** and **7** of the circuit breaker. A second movable arm **12** is rotatably mounted on a fixed shaft **10** securably inserted into a fixed support member **9**. Disposed at one end of the second movable arm **12** is a rotary shaft **13** which rotatably supports the first movable arm **5** substantially at its middle point. At the other end of the first movable arm **5** there is provided a cam **14** having a cam surface **14***a*. The other end of the second movable arm **12** is provided with a rotary shaft **15** on which is rotatably mounted an arm **16**, normally being urged to rotate in a clockwise direction about the rotary shaft **15** by the

clockwise displacing force of a spring 17. The arm 16 has a roller 18 secured to one end for engaging the cam surface 14*a* and a projection 16*a* formed at an intermediate point, the purpose of which will be set forth hereinbelow.

There is provided a movable iron core 20 facing another iron core 19 excited by excess current passing through the detection coil 3 thereof. The movable iron core 20 is fixed on an arm member 23 rotatably mounted on a fixed shaft 22. A projecting arm 23*a* of the arm member 23 is connected to a biasing spring 24 which normally urges the arm member 23 to rotate in a clockwise direction. To the end of another projecting arm 23*b* of arm member 23 is secured a roller 25 which abuts against the projection 16*a* of arm 16 when the projection arm 23*b* is rotated in a counterclockwise direction. A fixed rod 26 is provided for restricting the clockwise rotation of the rotatable arm 23 under the biasing influence of spring 24.

A driving mechanism is provided which comprises a cylinder 27, a piston 29 disposed therein being normally biased by a spring 28 in a direction which permits the contact members 1 and 8 to remain separated, a movable rod member 33 connected to piston 29 having an insulated member 30 thereon and being movable in the directions indicated by arrow 32 by the piston 29, and an electromagnetic valve 35 for introducing compressed air to the cylinder 27 beneath the under surface of the piston 29 and exhausting the air when necessary. On the end of the movable rod member 33 there is disposed a roller 36. A return spring 37 is connected between the shaft 13 and cylinder 27 for urging the separation of contact members 1 and 8. Numeral 38 denotes means for extinguishing arcs.

Numeral 40 generally represents a supplementary contact mechanism used in the device for selectively indicating normal cutoffs and those of excess current. This supplementary contact mechanism 40 comprises a displacement member 39 displaceable in the directions of the arrow 32 according to the movement of the shaft of the movable member 33 to which it is connected, a cam 41 mounted thereon having a stepped cam surface consisting of low and high planes 41*a* and 41*b*, respectively, and a roller 43 for causing a movable contact member 42*a* of a contact device 42 forming one component part of the supplementary contact mechanism 40 on which it is disposed to be detachably pressed against a fixed contact member 42*b* of the contact device 42. Numeral 44 shows an insulation material.

By reference now to FIGS. 1 through 4, the operation of the circuit breaker of the present invention will be described. Referring first to FIGS. 1 and 2, when compressed air is supplied to the underside of the piston 29 by exciting the electromagnetic valve 35, the roller 36 is moved upward to push against a driving surface 46 of the first movable arm 5. General counterclockwise rotation of the arm 5 about shaft 13 on the arm 12 under the force of roller 36 against the surface 46 is resisted by the sliding engagement of roller 18 over cam surface 14*a*. Consequently, both arms 5 and 12 are jointly rotated upward, thereby causing the contact members 1 and 8 to be attached to each other as indicated. At this time, the movable member 33 is moved up through a distance *l* and consequently the cam 41 affixed thereto is lifted similarly through the same distance *l*. Since, under this condition, the roller 43 contacts the lower plane 41*a* of the cam 41, the contact members 42*a* and 42*b* remain separated. Therefore, unless the compressed air is evacuated from the cylinder 27, the circuit breaker is kept in operation.

Normal cutoffs are effected in the following manner. When the compressed air is discharged or evacuated from the lower part of the cylinder 27 by operating the electromagnetic valve 35, the piston 29 is urged downwardly by the action of the spring 28, thereby causing the roller 36 to rapidly move out of contact with the driving surface 46 on arm 5 and the first and second movable arms 5 and 12 to rotate in an engaged state so as to cause the contact member 1 and 8 to be separated. The final condition of said normal cutoff is the same as that before the circuit breaker is put into operation, as illustrated in FIG. 1. At this time, the roller 43 contacts the lower plane 41*a* of the cam 41, so that the contact members 42*a* and 42*b* are detached from each other.

Where excess current passes through the detection coil 3, the movable iron core 20 is attracted, as shown in FIG. 3, to the fixed iron core 19, causing the projecting arm 23*b* of the movable arm 23 to rotate counterclockwise whereby the roller 25 engages the head of the projection 16*a* of the arm 16, to pivot thereby disengaging the roller 18 from the cam surface 14*a* of the cam 14. Accordingly, the movable member 33 is urged further upward through an additional distance of *l'* to lift the driving point 46. Since, at this time, the return spring 37 continues to urge the rotary shaft 13 downward, the arm 5 is rotated about the shaft 13 in a counterclockwise direction, whereby the movable contact member 8 on one end of the arm 5 instantly rotates counterclockwise therewith to effect a rapid cutoff of the excess current. In this cutoff operation, the force of the compressed air for lifting the movable member 33 is added to the force of the spring 37 separating the movable contact member 8 from the fixed contact member 1, thereby quickening the separation of both contact members and in consequence eliminating the formation of arcs. When the electromagnetic valve 35 is demagnetized after such a cutoff of excess current, the condition of FIG. 1 is regained. Reexcitation of the valve at this time makes the circuit breaker ready for a succeeding operation.

FIG. 4 represents modifications of the supplementary indicating contact mechanism associated with the operation of the circuit breaker of this invention and the cutoff performed thereby. Throughout the schematic illustrations of FIG. 4, the cam 41, and the low and high planes 41*a* and 41*b* thereof are denoted by the same numerals, regardless of their forms. The cam 41 is free to move in the directions of the arrow 32 and the roller 43 to shift in the directions of the arrow 47. Referring to FIG. 4C, under the cutoff condition of FIG. 1, the cam 41 assumes the solid line position and the roller 43 is located at the lower cam plane 41*a*, leaving the contact members 42*a* and 42*b* separated. Under the operating condition of FIG. 2, the cam 41 advances through the distance *l*, but the roller remains on the surface 41*a*. Therefore the contact members remain open. For the cutoff of excess current, the cam 41 is further urged through an additional distance *l'* and the roller 43 runs on the higher cam plane 41*b* to cause the contact members 42*a* and 42*b* to contact each other. In the case of normal cutoffs, the movable member 33 is brought downward, so that the roller 43 abuts against the lower cam plane 41*a* to cause the contact members 42*a* and 42*b* to be separated. Thus normal cutoffs and those of excess current can be separately carried out with great ease.

The cam 41 may be so changed in form, as illustrated in FIG. 4D, as to cause the contact members 42*a* and 42*b* to contact each other during the operation of the circuit breaker and during normal cutoffs and to be separated only during cutoffs made because of excess current. It is also possible, as shown in FIG. 4A, to cause the contact members 42*a* and 42*b* to be separated during normal cutoffs and to contact each other both during the periods of operation of the circuit breaker and cutoffs due to excess current. It is further possible, as illustrated in FIG. 4B, to cause the contact members 42*a* and 42*b* to contact each other during normal cutoffs and to be detached from each other during the operation of the circuit breaker and at cutoffs effected by excess current.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the present invention may be practiced otherwise than as specifically described herein.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A circuit breaker comprising:

a fixed contact member connected to one end terminal of said circuit breaker;

a first movable arm connected to the other end terminal of the circuit breaker;

a contact member on said first movable arm for detachably contacting the fixed contact member so as to switch a circuit across both terminals of said circuit breaker;

a second movable arm;

means on said second movable arm for rotatably supporting said first movable arm;

means for engaging the first and second movable arms to effect their joint movement when the first movable arm is urged in a direction to cause the contact member thereon to contact the fixed contact member;

excess current detecting means;

mechanism for automatically disengaging said engagement means responsive to detection of excess current by said excess current detecting means;

means for normally urging said first movable arm in a direction to cause the contact member thereon and the fixed contact member to be separated; and

means for advancing said movable arm in a direction permitting the mutual contact of the contact members, effecting the engagement of said engagement means to jointly move said movable arms and, upon the disengagement of said engagement means, further advancing said first movable arm to cause the contact members to be detached from each other.

2. The circuit breaker of claim **1**, wherein said contact on said first movable arm is disposed on one end thereof.

3. The circuit breaker of claim **2**, wherein said second movable arm is rotatably supported at one end to a fixed shaft; and

said means on said second movable arm for rotatably supporting said first movable arm is a shaft secured to the other end thereof which supports said first movable arm at an intermediate point thereon.

4. The circuit breaker of claim **3**, wherein said movable arm advancing means is a member reciprocably movable in a given path engageable upon movement in one direction with a point on said first movable arm positioned between the rotating center thereof and the point of engagement of said first and second movable arms.

5. The circuit breaker of claim **4**, wherein said first and second movable arm engaging means comprises a cam disposed on the end of said first movable arm opposite said contact and a cam follower secured to said second movable arm adjacent said one end thereof.

6. The circuit breaker of claim **5**, wherein said means normally urging said first movable arm is a spring secured at one end to said first movable arm at a point thereon between said contact member and said point engageable by said advancing member.

7. The circuit breaker of claim **5**, wherein said automatic disengaging mechanism comprises means for displacing said cam follower from said cam.

8. The circuit breaker of claim **5**, wherein said advancing means comprises:

a cylinder;

a piston slidably disposed in said cylinder and normally urged in a given direction;

a rod member secured at one end to said piston and having means on the other end for engaging said first movable arm; and

means for selectively supplying and exhausting pressurized fluid to said cylinder to move said piston therein.

9. The circuit breaker of claim **1**, further including means for selectively indicating normal cutoffs and those of excess current from the condition in which the contact members contact each other.

10. A circuit breaker according to claim **9** wherein the selective indication means comprises a cam fixed to said movable arm advancing means and supplementary contact members attachable and detachable from each other according to the displacement of said cam.

11. The circuit breaker of claim **4**, further including means for selectively indicating normal cutoffs and those of excess current from the condition in which the contact members contact each other comprising:

a cam fixed to said movable member of said movable arm advancing means; and

supplementary contact members having a cam follower associated therewith for engaging and disengaging said supplementary contact members according to the displacement of said cam.

* * * * *