Oct. 28, 1941. R. C. VAN SICKLE ET AL 2,261,008

CIRCUIT INTERRUPTER

Filed Sept. 19, 1939

Fig. 1.

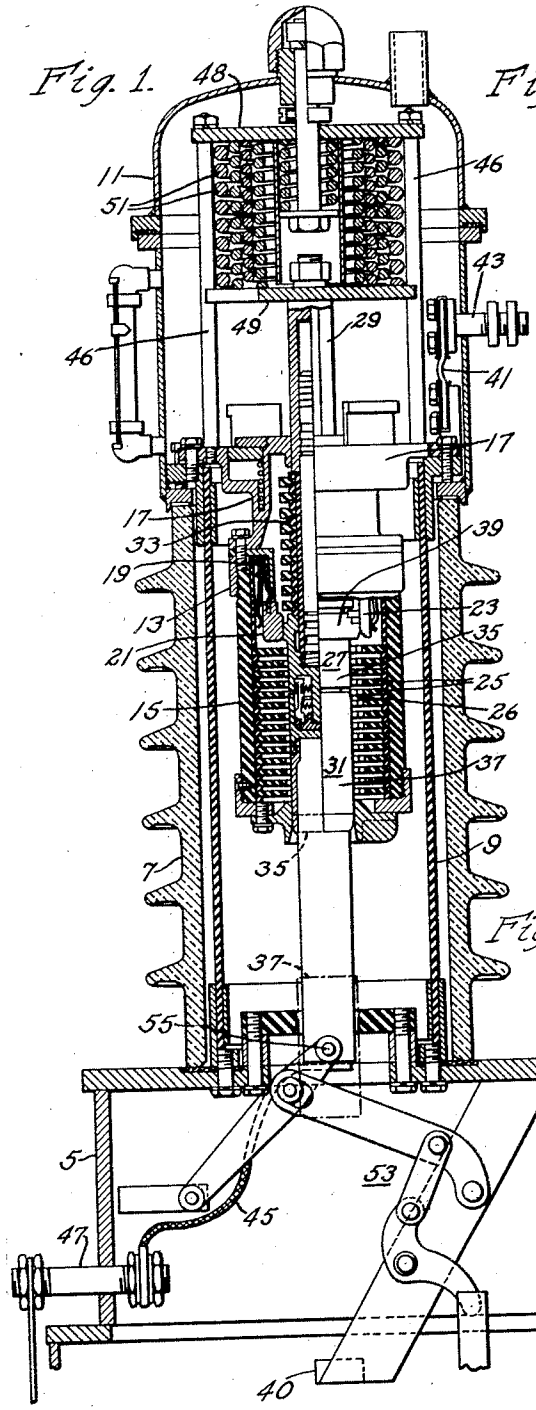


Fig. 2.

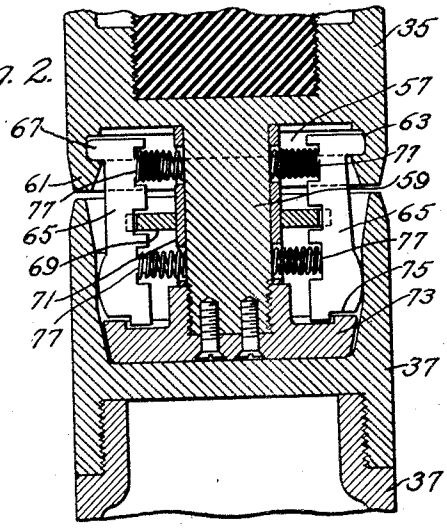
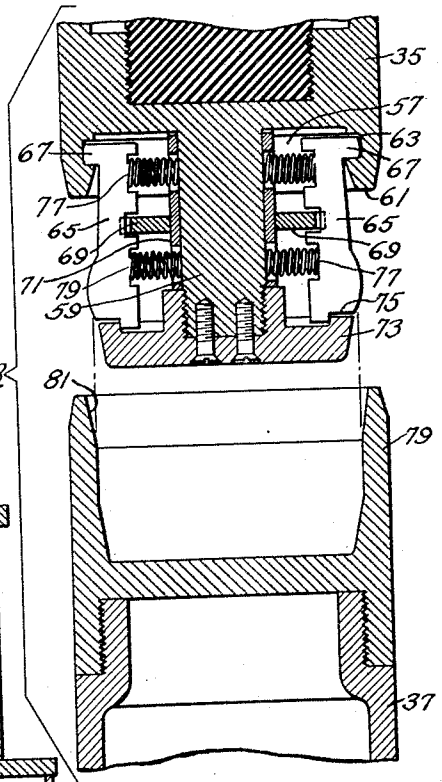


Fig. 3.



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CIRCUIT INTERRUPTER

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Application September 19, 1939, Serial No. 295,578

21 Claims. (Cl. 200—145)

This invention relates to circuit interrupters, and more particularly to contact structures therefor.

In the application of B. P. Baker, Serial No. 230,946, filed September 21, 1938, and issued August 19, 1941, as Patent No. 2,253,009, and assigned to the assignee of the instant application is shown and described a high-voltage high-power circuit interrupter of the liquid immersed type employing a relatively small quantity of arc extinguishing liquid. The contact structure of the breaker described in the aforesaid application constitutes a stationary contact means and a movable contact coacting therewith to establish an arc within an arc chamber immersed in the arc extinguishing liquid. The movable contact is carried by an operating member movable a predetermined distance through the arc chamber by an operating spring.

The operating member is formed in part of conducting material and constitutes a portion of the conducting circuit through the interrupter. In addition to the provision of a circuit interrupting break within the arc chamber, the contact structure is so arranged that an isolating break is provided in the circuit exteriorly of the arc chamber. This isolating break occurs between two separable sections of the conducting portion of the operating member. The operating mechanism for closing the breaker directly engages the free section of the operating member so that during the closing operation, the two conducting sections of the operating member are initially brought into engagement so as to close the isolating break. The operating member is then moved as a unit to close the interrupting break within the arc extinguishing chamber.

Modern circuit breaker practice demands high speed closure as well as high speed in clearing a fault. In order to obtain high speed closure, the operating mechanism is usually designed to impart high speed movement to the contacts during the initial closing movement, when the requisite closing force is relatively low and to decrease the speed of contact movement during the latter part of the closing stroke when the required closing force is high.

We have discovered that an attempt to obtain high speed closure with a simple contact structure, as shown in the aforesaid application, resulted in injury to the operating mechanism as well as the contact structure occasioned by the impact of the two separable sections forming the isolating break.

The main object of our invention, therefore, is to provide a contact structure for circuit interrupters of the aforesaid type which permits high speed closure of the interrupter without injury to the operating mechanism or the contact structure.

A further object of the invention is to provide a contact structure, for circuit interrupters arranged to insert in the connected circuit in sequence, an interrupting break and an isolating break and which structure further provides for limited relative movement of the contact members between which the isolating break is ultimately formed while maintaining a high pressure low resistance contact between the contact members.

Another object of our invention resides in the provision of separable contact members for a circuit interrupter having coacting elements for cushioning the shock resulting from forceful engagement of the contact members during the closing operation of the interrupter.

Still another object of our invention is the provision of separable contact members for high-voltage, high-power circuit interrupters which are simple in construction, rugged in design, shock-proof in closing and which when in the open circuit position present a smooth contour free from sharp projections so as to more evenly distribute the electrostatic stress to enable the gap formed therebetween to withstand high voltage.

Other objects and advantages will be apparent from the following description when taken in connection with the accompanying drawing, in which:

Figure 1 is a sectional view showing the interrupter of our invention;

Fig. 2 is an enlarged fragmentary sectional view showing the separable contact members of the contact structure in the closed circuit position, and

Fig. 3 is a sectional view of the contact members of Fig. 2 showing the contact members disengaged from each other and in the partially open circuit position.

Referring to the drawing, the reference numeral 5 designates the upper end of a metallic casing forming part of the circuit interrupter housing. Disposed on top of the casing 5 is a tubular housing comprising an outer insulator 7 of weatherproof material and an inner tubular member 9 of insulating material which is rigidly secured to the casing 5 and maintains the outer tubular member 7 in compression, against the casing 5. Secured to the upper end of the tubular insulator 7 is a metallic closure 11 for enclosing the upper end of the interrupter housing. Disposed within the tubular strain member 9 and suspended from the upper end thereof is an arc extinguishing unit 13 having a lower section 15 of insulating material and an upper casing 17 of conducting material. Mounted between the casings 15 and 17 is a flanged contact support 19 carrying a plurality of stationary contact fingers 21 and 23. Immediately below the contact fingers

21 and 23 are a plurality of spaced washers 25 of insulating material which form an arc extinguishing chamber 26.

The circuit interrupting unit 13 is provided with a centrally positioned operating member 27 extending therethrough having a metallic upper portion 29 extending exteriorly thereof and another metallic portion 31 at the lower end thereof, a portion of which also extends exteriorly of the chamber 26. The two metallic portions 29 and 31 are joined by an insulating section 33, the outer surface of which is corrugated and adapted to be moved into the arc chamber 26. The lower metallic portion 31 is composed of two separable conducting sections 35 and 37. The upper section 35 is provided with a ring contact 39 which cooperates with the contact fingers 21 and 33. The casing 17 of the interrupting unit 13 is connected by conductor 41 to a line terminal 43. A flexible conductor 45 joins the movable contact section 37 with a second line terminal 47. Thus the electrical connection through the interrupter proceeds from the terminal 43, conductor 41, casing 17, contact support 19, contacts 21, 23, 39, conducting sections 35, 37 through the flexible conductor 45 to the terminal 47.

The casing 17 has a plurality of upstanding guide rods 46, the upper ends of which support a pressure plate 48. Secured to the upper section 29 of the operating member 27 and slidably operative with respect to the guide rods 46 is a pressure plate 49. A plurality of springs 51 disposed between the pressure plates 48 and 49 coact so as to move the operating member 27 to the open circuit position. Movement of the operating member 27 is controlled by an operating mechanism generally indicated at 53 disposed within the casing 5. The operating mechanism 53 is preferably of the type shown and described in the aforesaid Baker application and makes pivotal engagement with the contact member 37 at 55 and provides for substantially straight line movement of the operating member 27 through the interrupting element 17. Operation of the interrupter is as follows.

Upon the occurrence of an overload, a suitable trip mechanism, not shown, causes the operating mechanism 53 to release the operating member 27 so as to permit the operating springs 51 to move the operating member 27 downwardly. During the downward movement of the operating member 27, an arc is drawn between the contact finger 23 and the contact ring 39 and as the contact ring 39 moves into the arc chamber 26, the arc is quickly extinguished in accordance with the theory more fully set forth in the aforesaid Baker application.

As the contact ring 39 reaches the lower end of the casing 15, its motion is arrested with a dashpot action as the result of the bottom of plate 49 coming against the flat top of casing 17. The operating mechanism 53, however, continues to move to the open circuit position, carrying with it the lower conducting section 37, thereby causing the section 37 to separate from the section 35 to establish an isolating break below the casing 15 within the tubular strain member 9. Travel of the conducting section 37 to the open circuit position is limited by a suitable stop 40 positioned in the path of movement of the section as shown.

In order to provide a high pressure low resistance contact between the sections 35 and 37 when the interrupter is in the closed circuit position, and also during the circuit interrupting operation, a contact arrangement is provided as more clearly shown in Figs. 2 and 3. The section 35 has an annular recess 57 and a centrally projecting stem 59 at its lower end thereof.

The recess 57 provides a downwardly extending flange 61, the inner and outer edges of which are slightly tapered as shown. The inner surface of the flange 61 has an annular groove 63 therein for the reception of a plurality of contact fingers 65. The contact fingers 65 are disposed in circumferentially spaced relation about the stem 59 and have a lateral projection 67 extending into the groove 63. The contact fingers 65 are maintained in their spaced relation with respect to each other by a radially slotted washer 69 secured to a sleeve 71 surrounding the stem 59. The sleeve 71 is held upon the stem 59 by a cap member 73 screw threaded to the lower end of the stem. The sleeve 71 is of such length that when the cap member 73 is drawn up firmly against the stem 59, the sleeve is still free to rotate upon the stem. The cap member 73 has a slight upstanding flange 75 which serves as a stop member for the lower ends of the contact fingers 65 to limit the outward pivotal movement of the contact fingers. Each of the contact fingers 65 is biased outwardly by a pair of coil springs 77, the inner ends of which pass through suitable apertures in the sleeve 71 and bear against the stem 59. The outer ends of the springs 77 are recessed in suitable slots provided in the contact fingers 65 as shown.

The upper end of the contact section 37 is provided with a cup-shaped portion 79 into which the contact fingers 65 and the cap portion 73 extend when the two sections 35 and 37 are in engagement. As clearly shown in Fig. 2, the biasing springs 77 urge the contact fingers 65 outwardly so that the ends of the fingers are respectively maintained in high pressure engagement with the inner surfaces of the hollow portions 57 and 79. In other words, the contact fingers 65 serve as bridging members electrically connecting the two contact sections 35 and 37 without the use of flexible shunts usually employed in structures of the prior art. When the interrupter is in the closed circuit position a high pressure butt type contact is maintained between the cap member 73 and the bottom of the cup-shaped portion 79 in addition to the contact provided by the contact fingers 65.

As more clearly shown in Figs. 2 and 3, it will be noted that the portion 79 of the contact section 37 has a depth sufficient to permit considerable relative longitudinal movement between the sections 35 and 37 prior to disengagement of the contact fingers 65 from the inner surface of the cup-shaped portion 79. Thus during the opening operation of the interrupter following initial movement to the open circuit position by the operating mechanism 53, the sections 35 and 37 are maintained in electrical contact even though there may exist a tendency for these sections to separate prior to extinction of the arc drawn between the contacts 23 and 39. The tendency for the sections 35 and 37 to separate at the outset of the opening operation is due to unequal rates of acceleration of these two sections. The section 37 is pivotally coupled to the operating mechanism 53 and may start its opening movement with a relatively high acceleration due to the sudden application of force made possible by slack inherently in the operating mechanism linkage, whereas the section 35 is accelerated more uniformly by the springs 51 and does not receive the benefit of slack in the operating mechanism.

From Figs. 2 and 3, it also clearly appears that the cap member 73 carried by the lower end of the stem 59 coacts with the cup-shaped portion 79 so as to form a dashpot for cushioning the impact of the member 37 with the member 35 during the closing stroke of the interrupter. The inner surface adjacent the open end of the cup-shaped portion 79 is tapered, as shown at 81, and the side walls of the cap member 73 are also tapered so as to provide considerable clearance between the cap member 73 and the entrance of the cup-shaped portion 79 to permit liquid to escape more freely from the cup-shaped portion 79 at the beginning of the shock absorbing action.

As the cup-shaped portion 79 is moved upwardly, the clearances become less and greater resistance to relative movement between the cap member 73 and the portion 79 is encountered. Thus the cap member 73 is finally brought into engagement with the bottom surface of the cup-shaped member 79 without imparting shock or injury to the operating mechanism 53 or the contact structure.

As evidenced in Fig. 3, the contact fingers 65, the cap member 73 and the open end of the cup-shaped portion 79 present smooth contours so that when the sections 35 and 37 are separated an even distribution of electric stress is obtained in the gap between the sections 35 and 37, which prevents the formation of corona and permits the gap to withstand a higher voltage. By making the sections 35 and 37 of equal diameter and arranging the contact fingers 65 to bear outwardly against the inner surfaces of the hollow end portions in the sections 35 and 37, a smooth external contour of these sections is maintained which permits free movement of the sections through the arc extinguishing unit 13. This particular arrangement permits considerable saving in space in that the total height of the interrupter housing is thereby correspondingly reduced.

Although we have shown and described a particular contact structure for circuit interrupters of a given type, it is to be understood that the same is for the purpose of illustration and that the contact structure described as well as changes and modifications thereof may be employed in circuit interrupters of various types, as for instance, those employing grounded metal tank structures, without departing from the spirit and scope of the appended claims.

We claim as our invention:

1. In a circuit interrupter, stationary contact means, a movable contact piece coacting with said contact means to establish an arc when moved to the open circuit position, operating means releasably coupled to said contact piece for actuating said contact piece to the closed circuit position, and dashpot means for cushioning at least the initial engagement of said operating means with said contact piece during the closing operation of said interrupter.

2. In a circuit interrupter, stationary contact means, a movable contact piece coacting therewith, means for operating said contact piece to the open circuit position to establish an arc between said contact means and said contact piece, operating means for operating said contact piece to the closed circuit position, said last named operating means being releasable from said contact piece when said contact piece is in the open circuit position, and dashpot means operative to cushion at least the initial engagement of said last named operating means with said contact piece during the closing operation of the interrupter.

3. In a circuit interrupter, stationary contact means, a movable contact piece coacting therewith, energy storing means for operating said contact piece to the open circuit position, operating means for moving said contact piece to the closed circuit position and storing energy in said energy storing means, said operating means including an operating member having releasable engagement with said contact piece, said operating member being disengaged from said contact piece when said interrupter is in the open circuit position, and shock absorbing means including a coacting male piston member and a female cylinder member carried respectively by said contact piece and said operating member for cushioning at least the initial engagement of said operating member with said contact piece during the closing operation of the interrupter.

4. In a circuit interrupter, a pair of line terminals, stationary contact means connected to one of said line terminals, a movable contact member connected to the other of said line terminals, a movable contact piece coacting with said stationary contact means and having releasable engagement with said contact member, operating means engaging said movable contact member for actuating the interrupter to open and closed positions, said contact piece being movable with said contact member during the initial opening movement of said operating means to establish an arc with said stationary contact means and being stationary during the latter portion of movement of said operating means to cause said contact member to disengage from said contact piece, and dashpot means associated with said contact member and said contact piece to provide at least an initial cushioned engagement of said contact member with said contact piece during the closing movement of said operating means.

5. In a circuit interrupter, stationary contact means, a movable contact member, an intermediate contact member normally interconnecting said stationary contact means and said movable contact member, operating means operatively engaging said movable contact member for actuating the interrupter to open and closed positions, slidably releasable contact means for holding said movable contact member in engagement with said intermediate contact member during at least the initial opening movement of the interrupter, means for arresting movement of said intermediate contact member during the latter part of the opening movement to cause said movable contact to disengage from said intermediate contact member, and shock absorbing means including coacting male and female piston and cylinder members carried by said contact members for cushioning the engagement of said contact members during the closing operation of the interrupter.

6. In a circuit interrupter, stationary contact means, a coacting movable contact member having two sections, releasable contact means joining said sections, actuating means operative to first institute a circuit interrupting break between one of said sections and said stationary contact means and thereafter to separate said sections to provide a disconnect break, said actuating means being operative to close the interrupter by first bringing said movable sections into engagement and finally moving said contact member into engagement with said stationary contact means,

and shock absorbing means including a recess in one of said sections and a piston carried by the other of said sections operative in said recess to cushion the engagement of said sections during the closing operation of the interrupter.

7. In a circuit interrupter, a plurality of relatively movable contact members arranged to form a plurality of breaks in series, operating means for actuating at least one of said contact members to form an isolating break, said operating means being operative to actuate said one contact member into engagement with an adjacent contact member to close said isolating break and to thereafter close the remaining break, and shock absorbing means carried by said contact members forming said isolating break to cushion the initial engagement of said members during the closing operation of the interrupter.

8. In a circuit interrupter, a plurality of relatively movable contact members arranged to form a plurality of breaks in series, operating means for actuating at least one of said contact members to form an isolating break, said operating means being operative to actuate said one contact member into engagement with an adjacent contact member to close said isolating break and to thereafter close the remaining break, and dashpot means associated with said contact members forming said isolating break to cushion the initial engagement of said members during the closing operation of the interrupter.

9. In a circuit interrupter, arc extinguishing liquid, an arc extinguishing chamber immersed in said liquid, relatively movable contact structure within said chamber, a movable switch member exteriorly of said chamber in series with said contact structure within said chamber and operable in said liquid for controlling said contact structure, movement of said switch member to open circuit position causing initially separation of said contact structure within said chamber to interrupt the circuit and subsequently separation of said switch member from said contact structure to form an isolating break, said movable switch member having a recess therein, and a plunger carried by said contact structure operative in said recess to cushion the shock occasioned by the closing movement of said switch member.

10. In a circuit interrupter, relatively movable contact structure for forming at least one interrupting break in the circuit to be interrupted, a contact member in series with said contact structure movable to control said contact structure and to form an isolating break with said structure upon movement to the open circuit position, said contact member having a cup-shaped recess adjacent one end thereof, a plurality of outwardly biased contact fingers carried by said contact structure adapted to engage the inner surface of said recess when the isolating break is closed, and a plunger secured to said contact structure operative in said recess to cushion the closing thrust of said contact member against said contact structure.

11. In a circuit interrupter, relatively movable contact structure for forming at least one interrupting break and an isolating break in series, said contact structure including a pair of relatively movable contact members for forming said isolating break, a plurality of contact fingers pivotally supported at one end of one of said contact members, the other contact member having a cup-shaped portion at one end thereof for receiving said contact fingers, and means for biasing said contact fingers outwardly into engagement with the inner surface of said cup-shaped portion and said pivotal supports to normally provide a high pressure bridging contact between said contact members, said pair of relatively movable contact members having substantially the same shape to provide substantial external surface continuity along said members when said members are in engagement with each other.

12. In a circuit interrupter, relatively movable contact structure for forming at least one interrupting break and an isolating break in series, said contact structure including a pair of relatively movable contact members for forming said isolating break, a plurality of contact fingers pivotally supported at one end of one of said contact members, the other contact member having a cup-shaped portion at one end thereof for receiving said contact fingers, means for biasing said contact fingers outwardly into engagement with the inner surface of said cup-shaped portion and said pivotal supports to normally provide a high pressure bridging contact between said contact members, and a plunger carried by said one contact member adjacent one end of said contact fingers and adapted for operation in said cup-shaped portion of said other contact member to absorb the shock of engagement of said contact members during movement thereof to the closed circuit position.

13. In a circuit interrupter, an arc chamber, stationary contact means in said arc chamber, a movable contact member coacting with said contact means, said contact member comprising two coaxial separable sections, at least a portion of both sections being within said arc chamber when the interrupter is in the closed position, means operating said contact member to open circuit position to establish a circuit interrupting arc in said chamber between said contact means and one of said sections and subsequently separate said sections to establish an isolating break outside said chamber, one of said sections having a hollow portion at the end thereof adjacent said isolating break, and a plunger carried by the other section operative in said hollow portion to cushion the shock of engagement of said sections during movement of said sections to the closed circuit position.

14. In a circuit interrupter, an arc chamber, stationary contact means in said arc chamber, a movable contact member coacting with said contact means, said contact member comprising two coaxial separable sections, at least a portion of both sections being within said arc chamber when the interrupter is in the closed position, means operating said contact member to open circuit position to establish a circuit interrupting arc in said chamber between said contact means and one of said sections and subsequently separate said sections to establish an isolating break outside said chamber, the opposed ends of said sections having hollow portions thereon, a plurality of contact fingers yieldingly supported at one end within the hollow portion of one of said sections and having portions thereof extending from said hollow portion adapted to be received by the hollow portion of the other section when said sections are in closed circuit position, and spring means biasing said contact fingers outwardly to provide a high pressure contact with the inner surfaces of both of said hollow portions.

15. In a circuit interrupter, an arc chamber, stationary contact means in said arc chamber, a movable contact member coacting with said

contact means, said contact member comprising two coaxial separable sections, at least a portion of both sections being wthin said arc chamber when the interrupter is in the closed position, means operating said contact member to open circuit position to establish a circuit interrupting arc in said chamber between said contact means and one of said sections and subsequently separate said sections to establish an isolating break outside said chamber, the opposed ends of said sections having hollow portions thereon, a plurality of contact fingers yieldingly supported at one end within the hollow portion of one of said sections and having portions thereof extending from said hollow portion adapted to be received by the hollow portion of the other section when said sections are in closed circuit position, spring means biasing said contact fingers outwardly to provide a high pressure contact with the inner surfaces of both of said hollow portions, and a plunger carried by said one section adjacent the free ends of said contact fingers, said plunger being operative in the hollow portion of said other section to provide a dashpot action for cushioning the impact of said sections with each other during the closing operation of the interrupter.

16. In a circuit interrupter, relatively movable contact structure comprising a pair of coaxially arranged separable contact members, the opposed ends of said contact members having cup-shaped portions thereon, a stem extending coaxially of one of said members from its cup-shaped portion, said one cup-shaped portion having an annular groove in the inner surface thereof, a plurality of contact fingers disposed about said stem, each of said fingers having a lateral projection at one end thereof extending into said groove, the other ends of said fingers extending beyond said one cup-shaped portion and being adapted to be received by the cup-shaped portion of the other contact member when said contact members are in the closed circuit position, spring members disposed between said contact fingers and said stem for biasing said contact fingers outwardly to provide high pressure contact with the inner surfaces of both cup-shaped portions, and guide means carried by said stem for yieldingly holding said contact fingers in predetermined spaced position with respect to each other.

17. In a circuit interrupter, an arc chamber, stationary contact means in said arc chamber, a movable contact member coacting with said contact means, said contact member comprising two separable sections at least a portion of both sections being within said arc chamber when the interrupter is in the closed position, means operating said contact member to open circuit position to establish a circuit interrupting arc in said chamber between said contact means and one of said sections and subsequently separate said sections to establish an isolating break outside said chamber, and dashpot shock absorbing means carried by said separable sections operative during the closing operation of the interrupter for cushioning the engagement of said separable sections.

18. In a circuit interrupter, an arc chamber, stationary contact means in said arc chamber, a movable contact member coacting with said contact means, said contact member comprising two separable sections at least a portion of both sections being within said arc chamber when the interrupter is in the closed position, means operating said contact member to open circuit position to establish a circuit interrupting arc in said chamber between said contact means and one of said sections and subsequently separate said sections to establish an isolating break outside said chamber, and dashpot shock absorbing means carried by said separable sections operative during the closing operation of the interrupter for cushioning the engagement of said separable sections, said dashpot shock absorbing means including a male piston member and a female cylinder member arranged to coact with each other to bring said separable sections into axial alignment when said interrupter is actuated to the closed circuit position.

19. In a circuit interrupter, a plurality of relatively movable contact members arranged to form a plurality of breaks in series, operating means for actuating at least one of said contact members to form an isolating break, said operating means being operative to actuate said one contact member into engagement with an adjacent contact member to close said isolating break and to thereafter close the remaining breaks, and means for cushioning the engagement of said contact members forming said isolating break during the closing operation of said interrupter, said last named means including a piston and cylinder operative to bring said contact members forming said isolating break into predetermined alignment with respect to each other during the closing movement of the interrupter.

20. In a circuit interrupter, relatively movable contact structure comprising a pair of separable contact members, a plurality of contact fingers yieldingly supported from one end of one of said contact members, the other contact member having a hollow end portion for receiving said contact fingers, means for biasing said contact fingers outwardly into engagement with the inner surface of said hollow end portion to normally provide a bridging contact between said contact members, and a plunger carried by said one contact member operative in said hollow end portion of the other contact member to cushion the engagement of said contact members during movement thereof to the contact engaging position.

21. In a circuit interrupter, relatively movable contact structure comprising a pair of separable contact members, a plurality of contact fingers yieldingly supported from one end of one of said contact members, the other contact member having a hollow end portion for receiving said contact fingers, means for biasing said contact fingers outwardly into engagement with the inner surface of said hollow end portion to normally provide a bridging contact between said contact members, and a plunger carried by said one contact member adjacent the free ends of said contact fingers operative in said hollow end portion to provide a dashpot action for cushioning the impact of said contact members during movement thereof to the contact engaging position, the inner side walls of said hollow end portion tapering outwardly in a direction toward the open end thereof to provide progressively less clearance between said plunger and said side walls as the plunger is moved into said hollow end portion whereby said plunger coacts with said hollow end portion to bring said contact members into alignment.

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