CONTACT PRESSURE ADJUSTING MEANS


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REFERENCES CITED

UNITED STATES PATENTS
3,268,702 8/1966 Grycko 200/170 R
3,198,924 8/1965 Brumfield 200/170 R
3,263,051 7/1966 Gauthier 200/170 R

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ABSTRACT

A multiphase air magnetic circuit breaker of very high continuous current rating is provided with a compact movable contact structure for each phase thereof by having a first plurality of main contacts positioned in a first transverse row adjacent to and in front of a second plurality of main contacts positioned in a second transverse row. These main contacts are symmetrically arranged on each side of the arcing contact arm, and the arms for the first plurality of main contacts are aligned with and extend over the arms for the second plurality of main contacts. First pivot means provides a common mounting pivotally securing the arms for the arcing contact and first plurality of main contacts to the contact bridge. Second pivot means at one end of the arms for the second plurality of main contacts mounts the latter to the contact bridge and auxiliary bridges at the other end of the arms for the second plurality of main contacts cooperate with the contact bridge to establish the open circuit position for the second plurality of main contacts. Engagement of the first and second pluralities of contacts establishes the open circuit position of the former, and engagement between the second pivot and the arcing contact arm establishes the open circuit position of the latter. Individually adjustable biasing springs are provided for each contact of the first plurality of main contacts, and individually adjustable springs are provided for each section of the auxiliary bridge.

12 Claims, 12 Drawing Figures
CONTACT PRESSURE ADJUSTING MEANS

This invention relates to molded case circuit breakers in general and more particularly relates to adjustable contact pressure means for the compact movable contact structure of a molded case circuit breaker having a high continuous current rating.

The separable contact structure of any circuit breaker must be capable of carrying the rated current of the circuit breaker continuously without overheating and must be able to withstand arcing that occurs between the separable contacts during interruption of overload currents within the interruption rating of the circuit breaker.

Prior art molded case circuit breakers of lower ratings have, for the most part, one pair of separable contacts per phase to carry out the functions of continuously carrying the rated current of the breaker and withstand ing arcing during the current interruption. In some constructions the stationary contact is modified for operation in conjunction with an arc runner, and the moving contact is provided with an extension or arc horn to facilitate arch interruption during high overloads. On moderately high-rated molded case circuit breakers, separate pairs of contacts are commonly provided for each of the aforesaid functions, with one pair of arcing contacts per phase also commonly being provided. A single pair of arcing contacts for each phase is usually sufficient when used in conjunction with one or more pairs of main contacts that are used to carry the rated current continuously.

In the usual contact configuration for a molded case circuit breaker having more than one pair of main contacts, the pair of arcing contacts usually extends forward of the main contacts and into the arc interrupter and the main contact pairs are arranged in a single row to the rear of the arc interrupter, as illustrated in U. S. Pat. Nos. 3,198,924 and 3,268,702. An increase in the continuous current rating of the circuit breaker brings with it a requirement that a number of main contact pairs required is increased, so that it may become necessary to increase the width of each pole considerably in order to accommodate all contact pairs of that pole unit in a single row transverse to the plane of movement of the movable contact structure. For many molded case circuit breaker constructions, the length of the movable contact row is the factor limiting minimum width of the circuit breaker.

In order to maintain at a minimum the overall width of a molded case circuit breaker having a very high continuous current rating, usually at least 2,000 amperes at 600 volts, the instant invention arranges the main contacts of each phase into two parallel rows positioned one behind the other and transverse to the plane of movement for the contact structure. This contact arrangement achieves considerable saving of space so that the resulting circuit breaker is not excessively wide. Utilizing a novel arrangement of a contact bridge and auxiliary bridges, the contacts are mounted to the contact bridge in a configuration that provides the requisite number of contact adjustment points and establishes the proper sequencing of the arcing and main contacts during opening and closing of the circuit breaker.

Accordingly, a primary object of the instant invention is to provide a compact movable contact structure for a very high current molded case circuit breaker.

Another object is to provide each phase of a molded case circuit breaker with a plurality of movable contacts arranged in first and second rows behind the arcing contacts, with a requisite number of contact pressure adjusting points.

Still another object is to provide a contact structure of this type in which sequencing between arcing and main contacts is achieved in a simplified manner.

These objects as well as other objects of this invention will become readily apparent after reading the following description of the accompanying drawings in which:

FIG. 1 is a plan view of a circuit breaker constructed in accordance with teachings of the instant invention.

FIG. 2 is a longitudinal cross-section taken through line 2—2 of FIG. 1, looking in the direction of arrow 2—2 and including a handle operating mechanism, not shown in FIG. 1.

FIG. 3 is an exploded perspective of one overcenter toggle mechanism and selected elements connected thereto.

FIG. 4 is an exploded perspective of the movable contact structure for one phase.

FIG. 5 is a plan view of the movable contact structure and its overcenter toggle operating mechanism for the center phase of the circuit breaker of FIG. 1.

FIG. 6 is a side elevation of the elements of FIG. 5, looking in the direction of arrows 6—6 of FIG. 5.

FIG. 7 is a cross-section taken through line 7—7 of FIG. 5, looking in the direction of arrows 7—7.

FIGS. 8 and 9 are cross-sections taken through the respective lines 8—8 and 9—9 of FIG. 6, looking in the directions of the respective pairs of arrows 8—8 and 9—9.

FIG. 10 is a fragmentary plan view similar to that of FIG. 5, with most of the overcenter toggle operating mechanism removed.

FIGS. 11 and 12 are cross-sections taken through line 11—11 of FIG. 10, looking in the direction of arrows 11—11. In FIG. 11 the contact mechanism is in its open position, and in FIG. 12 the contact mechanism is in its closed position.

Now referring to the figures. Three phase molded case circuit breaker 25 of FIGS. 1 and 2 includes an individual overcenter spring-powered toggle operating mechanism. Prior art examples of circuit breakers having more than a single operating mechanism for all phases are disclosed in U. S. Pat. Nos. 2,067,935 and 3,125,653.

Circuit breaker 25 includes a molded housing constructed of base 26 and removable cover 27 joined along line 28 and provided with longitudinal internal partitions 31, 32 which divide housing 26, 27 into three longitudinally extending compartments, one for each phase of circuit breaker 25. Cover 27 is provided with aperture 29 through which stubby bifurcated extension 33 of operating handle means 30 extends. Each section of handle extension 33 receives an individual pin 34 extending upwardly from the web portion of inverted generally U-shaped operating yoke member 35 of the center phase. Operating members 35 of the outer phases are each secured to handle means 30 by a pair of screws 152.

Member 35 is pivoted to the spaced arms of generally operating mechanism frame 36 at outwardly extending lugs 37. Bolts 48, received by threaded apertures of inwardly extending lugs 36a at the bottom of frame 36, fixedly se-
cure the latter to base 26. Transverse tie member 49 is riveted to the arms of frame 36 to maintain spacing therebetween and to stabilize the frame structure. Four-tensioned coil springs 38, each connected at one end thereof to the web of operating member 35, combine to constitute the main operating spring means for the overcenter toggle-type contact operating mechanism. The other ends of springs 38 are connected to spaced plates 39, 39 that are pivotally mounted to toggle knee pin 41 connecting upper 42 and lower 43 toggle links. The upper ends of upper toggle links 42 are pivotally connected to the spaced arms of latchable cradle 40 at pins 44, and the lower ends of lower toggle links 43 are pivotally connected to contact carrier 45 by rod 46 that extends between the spaced arms of contact carrier 45. The spaced arms of cradle 40 are positioned adjacent the inner surfaces of the spaced arms of frame 36 and are pivotally connected thereto by pins 47 that are secured to frame 36.

Under normal operating conditions plate 51, secured to web 40A of cradle 40, is in engagement with forward latchung surface 52 of auxiliary latch 53. The latter is loosely mounted to pivot rod 55 extending between the spaced arm of mechanism frame 36 and slightly outboard thereof. The coiled end sections of torsion spring member 56 are wound about pivot rod 55, with the ends of these sections bearing against rod 57 and auxiliary latch 53 to bias the latter counterclockwise against stop rod 58. The ends of rods 57 and 58 are supported by the arms of frame 36. Leaf spring 73 secured to auxiliary latch 53 bears against pivot rod 55 biasing latch 53, so that rod 55 will normally lie at the center portion of V-shaped notch 74 of primary latch 53.

The ends of rod 55 projecting outboard of mechanism frame 36 are engaged by the hooked portions at the forward extensions 59 of the arms for U-shaped trip unit frame 60, whose web portion is seated on a forward surface of load strap 61, being secured thereto by bolts 62 that extend through clearance apertures in strap 61 and are received by threaded inserts molded in base 26.

Rear latch tip 54 engages latch tip 63, at the U-shaped forward arm of primary latch 65, whose rear latch tip 64 is engaged by latch plate 67 mounted on one leg of L-shaped carrier 66. Primary latch 65 is pivotally mounted to trip unit frame 60 at stub shaft 69, and the carrier is pivoted on rod 68 to frame 60. Tension spring 75 biases primary latch 65 in a clockwise direction about pivot 69. The other leg of carrier 66 is provided with transversely extending pin 71 that projects into triangular window 72 of primary latch 65 at a portion thereof near rear latch tip 64, for a reason to be hereinafter explained. Tension spring 76, connected between frame 60 and carrier extension 66a, biases carrier 66 in a counterclockwise direction about its pivot 68 toward latching position.

When automatic tripping occurs, carrier 66 in the faulted phase is moved clockwise either by the deflection of bimetal 77 or movement of magnetic armature 78, causing latch plate 67 to release primary latch 65, which in turn releases secondary latch 53 and permits main operating springs 38 to rotate cradle 40 in a counterclockwise direction to break toggle 42, 43. The force from main spring 38 acts through cradle 40, primary latch 53, and secondary latch 65 to drive cam surface 78, bounding opening 72, against extension 71 to rotate carrier 66 clockwise, with surface 79 thereof engagings 81 of extension 82 on tripper bar 80 which extends between all three phases. This causes tripper bar 80 to rotate in a counterclockwise direction, so that extensions 82 in the non-faulted phases rotate counterclockwise with cam surfaces 83 thereof engaging transversely extending pin 84 of carriers 66 in the non-faulted phases, rotating them clockwise or in the tripping direction, to release the cradle latching system in the non-faulted phases, so that the contacts of all three phases are open.

In order to prevent closing of the contacts of any one phase before the operating mechanisms of all phases are latched, circuit breaker 25 is provided with a defeater latching system including defeater latch 80' and defeater lever 90. Latch 80' is pivotally mounted upon rod 55 and includes protrusion 81' extending over the rear of cradle 40 when the latter is in latched position. Latch 80' further includes protrusion 82' extending over the forward end of defeater lever 90 in slot 91 thereof. Coiled tension spring 83' is connected between stop rod 57 and latch 80', passing partially around rod 55, to bias latch 80' in a counterclockwise direction about its pivot 55 and maintaining this pivot in the basic position at the right end of slot 84' in latch 80'. This basic position is established through the engagement of latch stop surface 86 and stop rod 57.

Slot 91 is in the web of the U-shaped forward portion of latch lever 90, with the U arms having pivot pin 69 for lever 90 extending therethrough. Rear portion 89 of lever 90 is positioned below and in interfering relationship with transverse pin 71 mounted to latch plate carrier 66.

During normal relatching of circuit breaker 25, inwardly protruding portions of the operating member 35 arms engage outboard portions of pin 44 to pivot cradle 40 clockwise, whereby the latter carries defeater latch 80' away and moves below auxiliary latch 53. Upon release of the circuit breaker operating handle 30, the elements of the latch train 53, 65, 66 move into place. However, should any of these elements fail to properly engage or should cradle 40 not have been moved far enough to engage auxiliary latch 53, cradle 40 will pick up defeater latch protrusion 81', causing clockwise rotation of defeater latch 80'. In turn, this causes defeater latch protrusion 82' to engage defeater lever 90 and rotate the latter counterclockwise, with the rear end 89 thereof contacting carrier extension 71 so that latch plate carrier 66 is pivoted in a clockwise or latch train releasing direction. During this releasing movement of carrier 66, surface 79 thereof engages nose 81 of one trip bar extension 82 to rotate common tripper bar 80 in a counterclockwise direction, with the other extensions 82 on bar 80 engaging pins 84 on the latch pole carriers 66 of the other poles, thereby causing the latch systems of all other poles to be released.

The lower end of bimetal 77 is fixedly secured to shading coil 99, and these elements are fixedly secured to molded frame member 95 secured to trip unit frame 60. The horizontal leg of inverter U-shaped stationary magnetic frame member 98 passes through the center of coil 99. Member 98 is secured to the rear of frame 60, with the vertical legs of member 98 being on opposite sides of load strap 61. The other U-shaped magnetic frame member 96 is secured directly to load strap 61, with the ends of the arms for frame members 96 and 98 confronting one another in spaced relationship. Thus, current flowing in load strap 61 generates flux in
magnetic frame 96, 98 which induces current flow in shading coil 99 and thereby generates heat that is conducted to bimetallic 77 for heating thereof. Coiled tension spring 97, connected between armature 78 and an element mounted to the rear transverse part 68a of frame 68, biases the former away from two spaced legs 98a extending upward from the horizontal leg of member 98 and is drawn downward toward legs 98a when overload currents generate sufficient magnetic flux in magnetic frame 78, 96, 98.

With particular reference to FIG. 4, it is seen that the movable contact structure for each phase of circuit breaker 25 includes eight main contacts 103–110 and a single arcing contact 101. The latter contact 101 is mounted at the forward end of arm 112, which is pivotally mounted to carrier 45 at toggle connecting rod 46. Main contacts 103–110 are arranged in two parallel rows positioned to the rear of arcing contact 101 and disposed at right angles to the plane of movement of arcing contact arm 112.

Main contacts 103–106 in the forward row are mounted to individual contact arms 113–116 respectively, all pivotally mounted to carrier 45 on rod 46. Main contacts 107–110 in the rear row are mounted to the forward end of the respective contact arms 117–120, respectively, pivotally mounted to carrier 45 on rod 102. All of the contact arms 112–120 are connected to load strap 61 by means of individual stacks 121 of flexible sheet conductors. Contact arms 113–116 are in alignment with and extend over the respective contact arms 117–120, so that the latter group of arms 117–120 block downward movement of the former group of arms 113–116 to establish the open circuit position of contacts 103–106 in a manner which will hereinafter be seen. The open circuit position for arcing contact arm 112 is established through engagement thereof with aligned pins 123, 124 which mount the respective pairs of main contacts 117, 118 and 119, 120 to auxiliary carriers 125, 126 respectively. Notch 122 along the lower edge of arcing contact arm 112 provides clearance for pins 123, 124.

Auxiliary carrier 125 is an inverted U-shaped member whose arms extend downwardly through cutouts 131, 132 in the web portion of contact carrier 45 and straddle four contact arms 113, 114, 117, 118. Pin 123 secures contacts 117, 118 to the lower ends of the arms comprising auxiliary carrier 125. The web of auxiliary carrier 125 is biased towards the web of contact carrier 45 by coiled compression spring 127, which is wound around the threaded body of bolt 128 whose head is positioned below the web portions of contact carrier 45. Self-locking nut 133 mounted to bolt 128 is rotated to adjust the loading of spring 127, with the rectangular shoulder of bolt 128 cooperating with rectangular cutout in carrier 45 to prevent rotation of bolt 128. Thus it is seen that in the open circuit position of FIG. 11, spring 127 biases the web of auxiliary contact carrier 125 against the web of contact carrier 45, and as seen in FIG. 12, when the contacts are closed there is a spacing between the webs of the contact carrier arms 45, 125, so that the force exerted by spring 127 acts to bias contacts 107, 108 into firm electrical engagement with their respective cooperating contact portions on line strap 136.

The mounting of contact arms 119, 120 to auxiliary contact carrier 126 and mounting of the latter to contact carrier 45 is the same as the mounting of contact arms 117, 118 and auxiliary carrier 125, so that this description will not be repeated.

Biasing forces for each of the contacts 103–106 in the forward row are provided by individual coiled compression springs 138, and each of these springs is mounted in the same way so that only the mounting of one of these springs will be described. The lower end of spring 138 extends into depression 139 in the upper surface of main contact arm 113, and the rear of spring 138 extends into tubular support 141 through the open bottom thereof. Support 141 is mounted to the upper surface of carrier 45 at the web portion thereof, and its upper end is threaded to receive adjusting screw 142 whose lower end bears against disc 143 abutting the upper end of spring 138. If screw 142 is adjusted to set the contact pressure exerted by spring 138, lock nut 144 is tightened to lock this adjustment.

In order to increase the area of engagement between main contacts 103–110 and their respective cooperating stationary main contacts in the very limited space available, it is noted that each of the main contacts is provided with a portion extending outward of its respective contact arm. That is, in order to utilize the space below arcing contact 112, main contacts 104, 105, 108, 109 have been extended beyond their respective contact arms 114, 115, 118, 119 to project below arcing contact arm 112. Similarly, main contacts 103, 106, 107, 110 have been extended outward from their respective contact arms 113, 116, 117, 120, to lie in the space below the outboard arms of auxiliary contact carrier 125, 126 and other elements used to connect the movable contact structure to the contact operating mechanism.

The forward end of arcing contact arm 112 is biased downward away from the web portion of contact carrier 45 by coiled compression spring 171 whose lower end is positioned by pin 172 extending upward from arm 112. The upper end of spring 171 extends into tubular member 173, on the upper surface of the carrier 45 web portion, through the bottom of member 173 and abuts the closed upper end thereof.

The spaced arms of contact carrier 45 are provided with rearward extensions 45a, 45b that are spaced by and secured to shouldered cylindrical tube 146. After all contact structures, operating mechanisms, latching devices, and automatic trip units are mounted to base 26, and all adjustments to these mechanisms have been made, the contact structures of all phases are operated to the closed circuit position, so that the tubular members 146 of all phases are axially aligned and are positioned above barriers 31, 32 and the longitudinal sides of base 26. Thereafter, cylindrical tie bar 147 is driven longitudinally in the members 146 of all phases to constitute a rigid mechanical connection between the movable contact structures of all phases. The fit between tie rod 147 and tubular members 146 is tight enough to prevent unintentional axial movement of tie rod 147, yet permits tie rod 147 to be removed for convenient servicing and replacement of parts. Mechanism frame 36 is provided with aligned elongated slots 148 to provide clearances for movement of rod 147 during opening and closing of the movable contact structures.

It is noted that because of high magnitude current flow in circuit breaker 25, the magnetic fields generated are very strong. In order to reduce adverse effects of these magnetic fields, many of the frame parts and
operating mechanism parts are constructed of non-magnetic stainless steel.

For those features of construction in circuit breaker 25 that have not been described in detail herein, reference is made to one or more of the copending applications Ser. Nos. 275,568, 275,577, 275,578, 275,507, 275,454, 275,508, 275,261, 275,623, 275,624, 275,569, 275,522, 275,521, 275,523, and 275,622, all filed of even date herewith, and all assigned to the assignee of the instant invention.

Although there has been described a preferred embodiment of this novel invention, many variations and modifications will now become apparent to those skilled in the art. Therefore, this invention is to be limited not by the specific disclosure herein but only by the appending claims.

The embodiments of the invention in which an exclusive privilege or property is claimed are as follows:

1. A circuit breaker including cooperating contact means for a pole thereof; said cooperating contact means including relatively stationary contact means and relatively movable contact means movable in a plane of movement between open and closed circuit positions wherein said movable contact means is respectively disengaged from and engaged with said stationary contact means; an operating means for moving said movable contact means between its said open and closed circuit positions; said movable contact means including an arcing contact, a first plurality of main contacts arranged generally in a first row perpendicular to said plane and behind said arcing contact, and a second plurality of contacts arranged generally in a second row perpendicular to said plane; said second row being adjacent to and behind said first row; said stationary contact means being below said movable contact means; a plurality of movable arms each having one of said main contacts mounted thereto at its forward end; said arms for said first plurality of main contacts extending rearward therefrom and above the arms for said second plurality of main contacts; a main bridge interposed between said operating means and said movable contact means; a first pivot means mounting said arms for said first plurality of main contacts to said bridge; a second pivot means parallel to and laterally offset from said first pivot means; said second pivot means mounting said arms for said second plurality of main contacts to said bridge; first biasing means supported by said bridge and urging said first plurality of main contacts toward said stationary contact means; auxiliary bridge means connected to said arms for said second plurality of main contacts at a position forward of said second pivot means; second biasing means supported by said bridge and acting through said auxiliary bridge means to urge said second plurality of main contacts toward said stationary contact means.

2. A circuit breaker as set forth in claim 1 in which, with the relatively movable contact means in its said open circuit position, engagement between said bridge and said auxiliary bridges establishes the position of said second plurality of main contacts relative to said bridge and engagement between the arms for said first plurality of main contacts and the arms for said second plurality of main contacts establishes the position of said first plurality of main contacts relative to said bridge.

3. A circuit breaker as set forth in claim 2 in which the first biasing means comprises a first set of springs each acting directly on an individual one of the arms for the first plurality of main contacts; and adjusting means for individual adjustment of the forces exerted by each of said springs.

4. A circuit breaker as set forth in claim 3 in which the bridge comprises an inverted generally U-shaped portion having spaced arms connected by a web and the auxiliary bridge comprises an inverted generally U-shaped member having spaced arms connected by a web; said arms of said auxiliary bridge positioned between the arms of said bridge and said web of said auxiliary bridge positioned above the web of said bridge; said second biasing means including a spring acting directly on said auxiliary bridge and additional means for adjusting the force exerted by said second biasing means.

5. A circuit breaker as set forth in claim 4 in which the adjusting means and the additional adjusting means are both accessible for operation from above said bridge.

6. A circuit breaker as set forth in claim 5 in which there is a threaded member extending upward from said bridge and through said auxiliary bridge; said spring of said second biasing means being a coiled member through which said threaded member extends; said additional means bearing against the upper end of said spring of said second biasing means and being in threaded engagement with said thread member.

7. A circuit breaker as set forth in claim 1 in which the auxiliary bridge comprises first and second inverted generally U-shaped members each having spaced arms connected by a web; a first and a second of said arms for contacts of said second plurality of main contacts being positioned between and pivotally secured to said arms of said auxiliary bridge; a third and a fourth of said second plurality of main contacts being positioned between and pivotally secured to said arms.

8. A circuit breaker as set forth in claim 7 in which the numbers of main contacts in said first and second rows are equal.

9. A circuit breaker as set forth in claim 7 in which the bridge includes a generally U-shaped member having a web connected by spaced arms; said webs of both of said first and second U-shaped members positioned above the web of the bridge.

10. A circuit breaker as set forth in claim 9 in which the first biasing means comprises a first set of springs each acting directly on an individual one of the arms for the first plurality of main contacts; and adjusting means for individual adjustment of the forces exerted by each of said springs; said second biasing means including an individual spring for each of said auxiliary bridges; additional adjusting means for each spring of said additional biasing means for adjusting the forces exerted by said springs of said additional means.

11. A circuit breaker as set forth in claim 11 in which there is an arm having said arcing contact at one end thereof; biasing means urging said arcing contact toward said stationary contact means; said arm of said arcing contact being mounted near its other end to said first pivot means; means connected with the arms of said second plurality of main contacts and operatively positioned to engage the arm of said arcing contact and thereby establish the position thereof relative to said
9 bridge when said relatively movable contact means is in its said open circuit position.

12. A circuit breaker as set forth in claim 11 in which, with the relatively movable contact means in its said open circuit position, engagement between said bridge and said auxiliary bridges establishes the position of said second plurality of main contacts relative to said bridge and engagement between the arms for said first plurality of main contacts and the arms for said second plurality of main contacts establishes the position of said first plurality of main contacts relative to said bridge.

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