July 11, 1950 A. S. CASWELL 2,514,839

BROKEN BACK CIRCUIT BREAKER CONTACT

Filed June 17, 1944 4 Sheets-Sheet 1

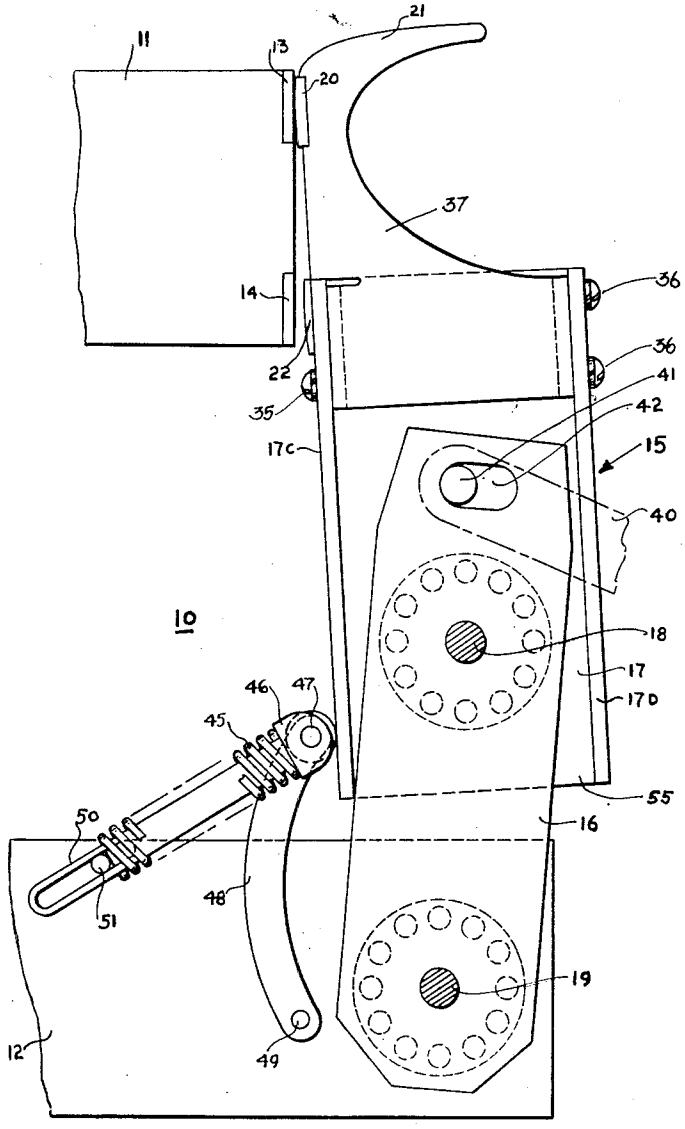

Fig. 1

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BROKEN BACK CIRCUIT BREAKER CONTACT

Filed June 17, 1944 4 Sheets-Sheet 2

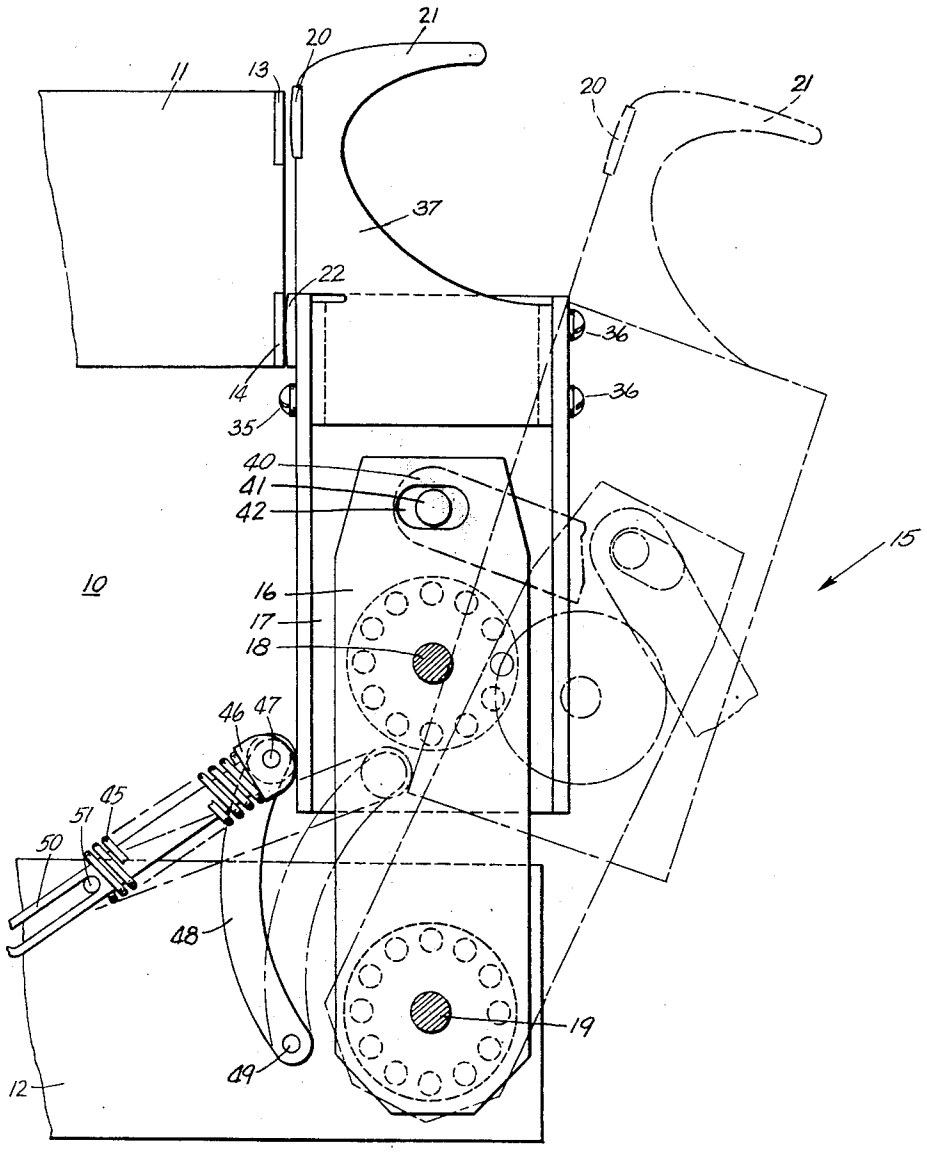

Fig. 2

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BROKEN BACK CIRCUIT BREAKER CONTACT

Filed June 17, 1944 4 Sheets-Sheet 3

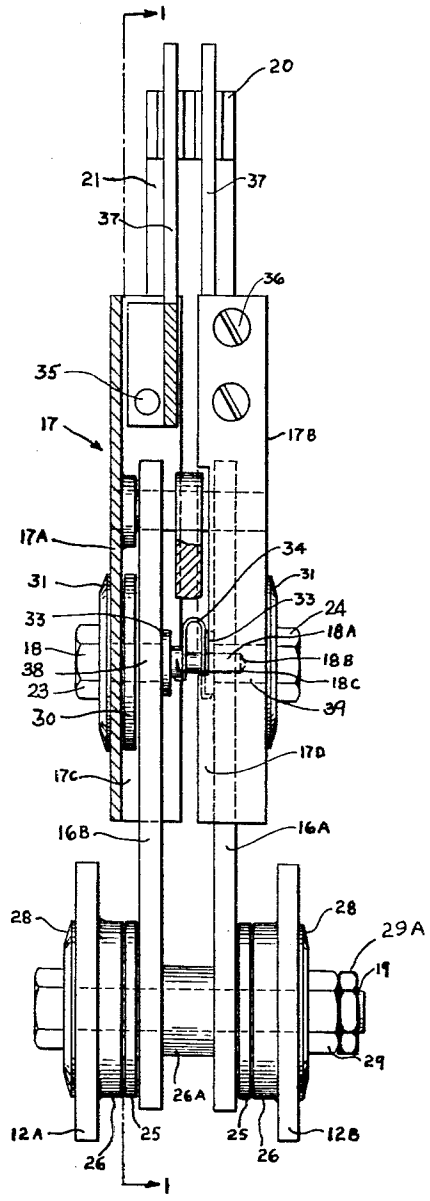

Fig. 3

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BROKEN BACK CIRCUIT BREAKER CONTACT

Filed June 17, 1944 4 Sheets-Sheet 4

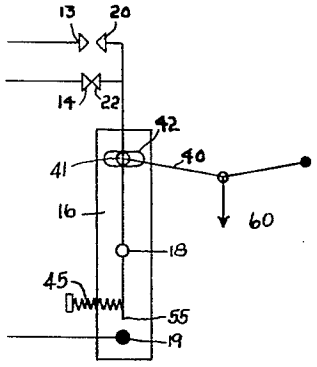

Fig. 4

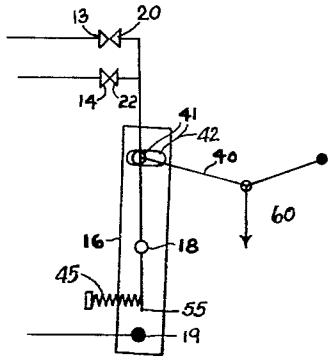

Fig. 5

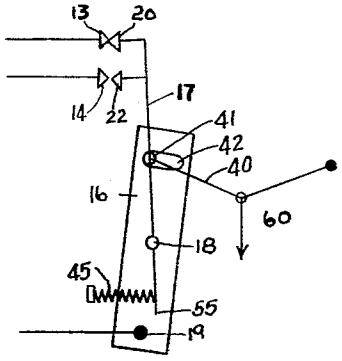

Fig. 6

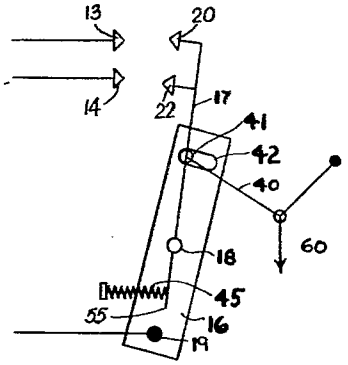

Fig. 7

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Patented July 11, 1950

2,514,839

UNITED STATES PATENT OFFICE

2,514,839

BROKEN BACK CIRCUIT BREAKER CONTACT

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Application June 17, 1944, Serial No. 540,803

4 Claims. (Cl. 200—87)

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My present invention relates to circuit interrupters and more specifically to a simple and rugged contact structure therefor.

My invention contemplates that the main and arcing contacts and their supporting members be made of solid pieces of metal, devoid of small springs, pins, washers and other fragile parts usually thought to be necessary on moving contact structures for circuit interrupters.

Such small light weight parts made necessary by prior contact structures are usually present in the arcing area where they are vulnerable to the arc flash which may cause them to fuse, melt or disintegrate. This condition has always been undesirable since it upsets breaker adjustment and reduces the efficiency of the equipment.

My invention has for its object the provision of a simple rugged construction for the moving contact in the arcing area, which construction nevertheless is light in weight, thus reducing the inertia of the contact arm and thereby speeding the breaking action of the contacts.

A primary object of my invention is the formation of a movable contact carrying arm in such manner that the contact arm itself forms a toggle or "broken back" arrangement which will permit a wiping action of the contacts to occur, will multiply the closing force for increased contact pressure, and, at the same time, will increase the opening speed.

A further object of my invention is the provision of a novel "blow-on" contact arrangement where the magnetic forces induced by the current flow are used to reinforce the contact pressure.

Many other objects of my invention will become apparent in the following description and drawings in which:

Figure 1 is a side view partly in cross-section of my novel circuit breaker contact construction with the arcing contacts closed and before the main contacts have engaged, taken on line 1—1 of Figure 3 looking in the direction of the arrows.

Figure 2 is a side view corresponding to that of Figure 1 showing in solid lines the contact structure in closed position, and in dotted lines the contact structure in fully opened position.

Figure 3 is a front view partly broken away of the movable contact structure.

Figures 4, 5, 6 and 7 are schematic views showing the operation of the circuit breaker of Figures 1 to 3.

Referring now to Figures 1, 2 and 3, the circuit breaker 10 comprises an upper connecting member 11 and a lower connecting member 12. The upper connecting member has secured thereto in

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any suitable manner an arcing contact 13 and a main contact 14. These form the stationary contacts.

The movable contact carrying arm 15 comprises a first supporting movable arm 17 and a second movable arm 16. Movable arm 16 is pivotally mounted on pivotal support or bolt 19. Movable arm 16 carries a pivot 18 on which the supporting arm 17 is itself pivotally mounted.

The additional arm 17 carries at the upper end thereof the movable arcing contact 20 and arcing horn 21 and the movable main contact 22.

It will be seen from a comparison of the solid line positions of Figures 1 and 2 that arms 17 and 16 are in toggle relation, with the link 18 of the toggle being stationarily pivoted at 19, the knee pin of the toggle being formed by the pin 18 and the opposite pivot of the toggle being formed during the closing operation, first, by the arcing contact 20 and then by the main contact 22.

The pigtail-less construction herein shown, wherein the current is carried between rotatably related parts through ball bearings rather than through pigtails, is based on the disclosure of application Serial No. 480,619, of Otto Jensen, filed March 26, 1943, now abandoned.

The lower supporting arm 16, as seen in Figure 3, is a compound arm formed by the members 16*a* and 16*b* which are rotatable about the bolt 19. Likewise, the front end of the lower connector 12 comprises a pair of plates 12*a* and 12*b*.

A ball bearing carrier 25 is mounted on each side between plates 16*b* and 16*a* and the filler rings 26, which filler rings bear against plates 12*a* and 12*b*.

A bolt 19 passes through corresponding openings in all of the members 12*a*, 25, 26, 16*b*, 16*a* and 12*b*.

An additional filler ring 26*a* is provided between plates 16*a* and 16*b* in order properly to space them and to provide a surface against which the nut 29 may be tightened.

Spring washers 28 on the outside of the plates 12*a* and 12*b* are held in position by tightening the nut 29 on the bolt 19 and locking it in place by the lock nut 29*a*. The spring washers 28 ensure adequate pressure so that the ball bearings carried by the ball bearing rings 25 may carry current effectively from the supporting arm 16 to the lower connecting member 12.

Similarly, the additional arm 17 is pivotally mounted on the supporting arm 16 in such a manner that a rotatable current carrying engagement exists.

The arm 17 comprises the side plates 17a and 17b—which plates are provided with front and rear flanges 17c and 17d to form a complete enclosure for the connection between the supporting arm 16 and the additional arm 17.

The pivot 18 around which the additional arm 17 rotates with respect to the supporting arm 16 is composed of two special cap screws 38 and 39. The cap screw 38 passes through the supporting arm 16b, ball carrying ring 30, additional arm 17a and spring washer 31. It is held in place and tightened to give proper contact pressure by the nut 23.

The cap screw 39 passes through corresponding parts on the right hand side of the contact arm, but is somewhat different from cap screw 38 in that its head is drilled at 18b in order to receive the separating adjusting screw 18a.

The separating adjusting screw 18a, held in adjustment by spring lock 34, being threaded into the cap screw 39 and having its head 18c bearing on the head 33 of the cap screw 38 maintains the distance between the supporting arms 16a and 16b and the additional arms 17a and 17b. This adjustment will keep these parts parallel and thereby overcome distortion due to high currents which will tend to draw the arms together and cause unequal contact pressure on the joints.

A ball bearing carrying ring 30 is mounted between each pair of plates 17a—16b and 17b—16a to form a current carrying conductive path therebetween in the manner described in application Serial No. 480,619 above mentioned.

Spring washers 31, 31 captured between the outermost plates 17a and 17b and the respective bolt head and nut head, serve to ensure proper contact pressure.

The main movable contact member 22, which, as can be seen from Figure 2 is a compound member, is secured to the rear flanges 17c of the additional arm 17 by the bolt 35 and is anchored at the front flanges 17a by the bolts 36.

Vertical extensions 37, 37 of the contact members 22 support the arcing horn 21 and the arcing contact 20.

An operating means for operating the arm 17 comprising a link 40 from the operating mechanism is pivoted on a pin 41 carried between the plates 17a and 17b of the additional supporting arm 17.

The upper ends of the plates 16a and 16b are each provided with the elongated slot 42 which is substantially longer than the diameter of the pin 41.

A spring member 45 is arranged to bias the lower end of the additional arm 17 so that the same will tend to rotate in counterclockwise direction around the pivot 18. One end of the spring 45 engages the end of lug 46 which is pivoted at 47 on the control arm 48 which, in turn, is pivoted at 49 on the lower connector 12.

Lug 46 is provided with a U-shaped or hair-pin extension 50 which centers the spring 45. A guide pin 51 on the lower conductor 12 passes through the central slot of the hair pin extension 50. The other end of the spring 45 bears against the guide pin 51 so that the spring is compressed between members 46 and 51.

The control arm 48 and the guide pin 51 limit the expansion of the compression spring 45 after the moving contact arm separates from the stationary contacts.

Essentially, it will be seen that the arms 17 and 16 form a toggle, the knee pin of which is the pivot 18; and the lower end of the arm 16 is rotatably supported on the stationary pivot 19.

The action of the compression spring 45 ensures that the arms 17 and 16 of the toggle will remain in "broken" condition. The rotation of the additional arm 17 around the supporting arm 16 is limited, of course, by slot 42. Nevertheless, it will be seen that as the link 40 forces the toggle toward closed position, the compression spring 45 maintains the "broken" condition of the arm until the contacts are fully engaged.

During the closing operation (while the contact structure moves from the position shown by the dotted lines of Figure 2 to the position shown by the solid lines of Figure 2), the structure passes through the intermediate stage of Figure 1. That is, as the link 40 is forced toward the left with respect to Figure 1, it pushes the pin 41 to the left and consequently pushes the entire additional arm 17 to the left. The pin 41 also engages the left hand end of the slots 42 of the support arm 16 to rotate the supporting arm 16 in a counterclockwise direction toward the left. The spring 45 pushes the flange 17c of arm 17 up against the plates of the supporting arm 16, maintaining the "broken" condition of the toggle 17—18—16. This arrangement of the members continues as the link 40 pushes the contact arm 15 toward the closed position.

It will be noted that the elements above described maintain the additional arm 17 in such relation to the supporting arm 16 that the movable arcing contact 20 will strike the stationary arcing contact 13 first (as seen in Figure 1).

Further movement of the link 40 toward the left will continuously urge the pin 41 toward the left. Since now the end 20 (the arcing contact) of the arm 17 has reached its limit of movement toward the left, then the lower end 55 of the arm 17 is the only portion thereof which is free to move any further toward the left. Continued movement of the link 40 toward the left will now, therefore, further compress the spring 45 and will straighten out the toggle 17—18—16 formed by the supporting arm and the additional arm.

As the toggle is thus straightened out, the main contact member 22 of the additional supporting arm 17 engages the main stationary contact member 14 while the arcing contacts 20 and 13 separate. This condition is shown by the solid lines of Figure 2.

The foregoing operation may also be readily understood from an examination of the schematic showings of Figures 4, 5, 6 and 7, where the operating mechanism 60 is operable to drive the link 40 to the left to cause engagement of the contacts, and where the mechanism may be tripped in any suitable manner to effect separation.

Figure 7 shows the open circuit position corresponding to the dotted line position of Figure 2. On movement of the connecting link 40 to the left, the additional arm 17 is driven to the left, as above described, while the spring 45 maintains the "broken" condition of the toggle 17—18—16. The pin 41 at the end of the link 40 also drives the supporting arm 16 toward the left through the slot 42.

Since the toggle 17—18—16 is in "broken" condition with the upward end of the arm 17 inclined toward the left, the arcing contacts 20 and 13 will engage first as seen in Figure 6. Once the upper end 20 (the arcing contact) of arm 17 can no longer move to the left, then the lower end 55 of this arm is the only one which may move to the left, and continued movement of the link 40

to the left, as shown in Figure 5, will now cause engagement of the main contacts 14 and 22. Further continued movement of the link 40 to the left will, as shown in Figure 4, increase the contact pressure of the main contacts 14 and 22 and separate the arcing contacts 13 and 20.

This "broken back" arrangement of the movable contact arm provides for proper sequential closing of the circuit breaker contacts; that is, the arcing contacts close first and the main contacts close last.

Similarly, during the opening operation, the condition is reversed and the main contacts separate first and the arcing contacts separate last.

The particular overload responsive mechanism by which the contacts are disengaged has not been disclosed, as any well known mechanism may be employed.

As is well known in the art, when an abnormal circuit condition of any nature, such as a short circuit, occurs, trip mechanism functions to operate the link 40 to the right to effect tripping of the circuit breaker.

Thus, examining Figures 4, 5, 6 and 7 in reverse order from the examination previously followed, Figure 4 shows the closed position.

On tripping of the circuit breaker, which tends to pull the link 40 to the right, the lower end 55 of the arm 17 will first move to the right around the pivot 18 until the pin 41 strikes the left hand end of the slot 42 in the supporting arm 16. Before the pin 41 strikes the left hand end of the slot 42, the arcing contacts have engaged while the main contacts still remain in engagement (Figure 5).

Then, as the pin 41 strikes the left hand end of slot 42 and the toggle 17—18—16 can "break" no further, the main contacts 14—22 separate while the arcing contacts 13—20 remain engaged (Fig. 6).

Finally, on further movement of the link 40 toward the right, the contacts reach the open circuit position of Figure 7.

This "broken back" construction for the movable contact arm of the circuit breaker gives the necessary resilience for closing and proper contact pressure.

The simple and rugged construction in the contact area is an important feature of this novel contact bridge or contact arm design. The main and arcing contacts and the supporting members are made of solid pieces of metal devoid of small springs, pins, washers and other fragile parts which have thus far been necessary to secure proper adjustment and contact pressure. Such light weight parts, usually present in the arcing area in prior circuit breaker designs are vulnerable to the arc flash which may cause them to fuse, melt or distintegrate. This has always been undesirable, since it upsets the circuit breaker adjustment and reduces the efficiency of the equipment. The simple rugged construction in the arcing area herein shown eliminates this objectionable feature.

Furthermore, a minimum of weight, as herein shown at the end of the bridge arm opposite the pivot point, reduces the inertia of the bridge arm and thereby speeds the breaking action of the contacts.

Natural electromagnetic phenomena are utilized in this contact structure so that the magnetic forces set up by high currents would tend to force the contact points together instead of separating them. This occurs because the length of the contact arm between the main pivot point

19 and the pin 41 (Figure 1) is much longer than the distance from the pin 41 to the arc tip 20; this causes the magnetic forces to be greater below the pin 41 and thereby force the arc tips together.

This may be explained as follows: When a short circuit occurs, the current flowing from stud 12 through the arm 16 to arm 17 and back over stud 11 sets up magnetic forces on arm 16 to drive it clockwise about its pivot 19. This magnetic force acting on arm 16 is transferred through pin 18 to the arm 17 tending to rotate it counterclockwise about the pin 41 (which at this instant is still stationary) in a counterclockwise direction and therefore increasing the contact engagement of contacts 14 and 22.

The same magnetic force acting on arm 17 below pin 41 tends to rotate arm 17 counterclockwise about 41, thus adding to the first force. That portion of this magnetic force acting between pin 41 and contact 14 tends to rotate arm 17 in a clockwise direction about pin 41. The length of the arm from 41 to contact 14 being shorter than the arm from the bottom of 17 to pin 41, the resultant force on arm 17 is still a counterclockwise rotation about 18 additive to the force applied thereto from arm 16.

As the pin 41 moves away, arm 17 applies a force effecting a rotation thereof on contact 22 as a fulcrum until the arcing contacts 13 and 20 engage—the condition obtained in Figure 1. The magnetic forces between 19 and 41 acting on arm 16 and through pin 18 continue to act on arm 17 applying a counterclockwise force therein about pin 41. This force, plus direct force on arm 17, is greater than the clockwise force on arm 17 from pin 41 to contact 20, thus insuring good contact engagement of the arcing contacts until they disengage.

As will be obvious from a comparison of Figures 2 and 1, a further desirable feature obtained with this type of construction is the wiping effect of the contact surfaces. With the loose motion in the bridge, due to the "broken back" construction, when contact surfaces meet, they slide across each other for a short distance until the bridge is finally latched. This wiping action reduces the amount of foreign particles that come between the contact surfaces and thereby reduces the resistance of the contacts.

The loose, springy action of this design produces the necessary resilience for properly closing and latching the contacts. This bit of elasticity, or free motion, allows sufficient pressure to be exerted to make good contact and at the same time permits the closing latch to be actuated without an abnormal force having to be applied.

My invention thus increases the speed with which the contact arm may act, simplifies the construction, and thereby makes possible lower manufacturing costs, quicker and easier assembly and sturdier parts which are less likely to get out of adjustment. All of these elements are obtained while, at the same time, retaining or improving the blow-on features, the wiping action, the speed of contact separation and the butt type contacts.

In the foregoing, I have described my invention only in connection with a specific preferred embodiment thereof. Since many variations and modifications of the construction herein shown within the spirit of my invention should now be obvious to those skilled in the art, I prefer to be

bound not by the specific disclosures herein but only by the appended claims.

I claim:

1. In a circuit breaker, a first movable arm, a rigidly mounted main contact and arcing contact secured to one end of said arm, an upper connecting member, a rigidly mounted main contact and arcing contact on said connecting member engageable by said first-mentioned main contact and arcing contact respectively, a second movable arm, a pivotal support, said second movable arm being pivotally supported at one end thereof on said pivotal support, a lower connecting member connected to said second movable arm, a pivot on said second movable arm, said first movable arm being pivotally supported on said last-mentioned pivot, a pin secured to said first arm intermediate said pivot and said contacts on said first movable arm, an operating mechanism secured to said pin, the distance from said pivotal support to said pin being greater than the distance from said pin to said arcing contacts, said second arm having an elongated slot at its end opposite from said pivotal support, said pin extending in said slot, a spring member engaging said first movable arm at the end opposite from the end at which said contacts are secured, said spring tending to rotate said first arm about said pivot on said second arm toward engagement of said contacts, said operating mechanism operating said first arm through said pin toward contact engaging position and said second arm about said pivotal support through said pin in engagement with one end of said slot until said arcing contacts engage, further movement of said operating mechanism moving said second arm alone until the arcing contacts separate, the magnetic forces set up by currents flowing in the loop circuit comprising the two connecting members and the two movable arms acting on said second arm being transferred through said pivot to said first arm tending to rotate it counterclockwise about said pin to increase the contact pressure of said main contacts, said magnetic forces acting on said first arm below said pin tending to rotate said first arm counterclockwise and acting on said arm above said pin tending to rotate said first arm clockwise, the length of said first arm from said pin to said main contacts being shorter than from the opposite end of said first arm to said pivot so that the resultant of said last two magnetic forces is additive to said first-mentioned magnetic force during movement of said operating mechanism in response to said fault current, said first arm applying a force effecting rotation about said main contacts as a fulcrum until said arcing contacts engage, the magnetic forces between said pivotal support and said pin acting on said second arm and through said pivot acting on said first arm producing a force about said pin to increase contact pressure and said force acting directly on said first arm below said pin being greater than the force on said first arm from said pin to said arcing contact to ensure good arcing contact engagement.

2. In a circuit breaker, a first movable arm, a rigidly mounted main contact and arcing contact secured to one end of said arm, an upper connecting member, a rigidly mounted main contact and arcing contact on said connecting member engageable by said first-mentioned main contact and arcing contact respectively, a second movable arm, a pivotal support, said second movable arm being pivotally supported at one end thereof on said pivotal support, a lower connecting member connected to said second movable arm, a pivot on said second movable arm, said first movable arm being pivotally supported on said last-mentioned pivot, a pin secured to said first arm intermediate said pivot and said contacts on said first movable arm, an operating mechanism secured to said pin, the distance from said pivotal support to said pin being greater than the distance from said pin to said arcing contacts, said second arm having an elongated slot at its end opposite from said pivotal support, said pin extending in said slot, a spring member engaging said first movable arm at the end opposite from the end at which said contacts are secured, said spring tending to rotate said first arm about said pivot on said second arm toward contact engagement, said operating mechanism operating said first arm through said pin toward contact engaging position and said second arm about said pivotal support through said pin in engagement with one edge of said slot until said arcing contacts engage, the length of said first arm from said pin to said main contacts being shorter than from the opposite end of said first arm to said pivot, said first arm applying a force effecting rotation of said main contacts as a fulcrum until said arcing contacts engage, the magnetic forces, due to current flowing in said loop, between said pivotal support and said pin acting on said second arm and through said pivot acting on said first arm producing a force about said pin, and said force acting directly on said first arm below said pin being greater than the force on said first arm from said pin to said arcing contact to ensure good arcing contact engagement.

3. In a circuit breaker, a first movable arm, a rigidly mounted main contact and arcing contact secured to one end of said arm, an upper connecting member, a rigidly mounted main contact and arcing contact on said connecting member engageable by said first-mentioned main contact and arcing contact respectively, a second movable arm, a pivotal support, said second movable arm being pivotally supported at one end thereof on said pivotal support, a lower connecting member connected to said second movable arm, a pivot on said second movable arm, said first movable arm being pivotally supported on said last-mentioned pivot, a pin secured to said first arm intermediate said pivot and said contacts on said first movable arm, an operating mechanism secured to said pin, the distance from said pivotal support to said pin being greater than the distance from said pin to said arcing contact, said second arm having an elongated slot at its end opposite from said pivotal support, said pin extending in said slot, a member engaging said first movable arm at the end opposite from the end at which said contacts are secured, said member tending to rotate said first arm about said pivot on said second arm toward contact engagement, the length of said first arm from said pin to said main contact being less than the length from said pin to the opposite end of said first arm.

4. In a circuit breaker, a first movable arm, a rigidly mounted main contact and arcing contact secured to one end of said arm, an upper connecting member, a rigidly mounted main contact and arcing contact on said connecting member engageable by said first-mentioned main contact and arcing contact respectively, a second movable arm, a pivotal support, said second

movable arm being pivotally supported at one end thereof on said pivotal support, a lower connecting member connected to said second movable arm, a pivot on said second movable arm, said first movable arm being pivotally supported on said last-mentioned pivot, a pin secured to said first arm intermediate said pivot and said contacts on said first movable arm, an operating mechanism secured to said pin, the distance from said pivotal support to said pin being greater than the distance from said pin to said arcing contacts, said second arm having an elongated slot at its end opposite from said pivotal support, said pin extending in said slot, a member engaging said first movable arm at the end opposite from the end at which said contacts are secured, said member tending to rotate said first arm about said pivot on said second arm toward contact

engagement, the length of said first arm from said pin to said main contact being less than the length from said pin to the opposite end of said first arm, said pin acting as a fixed pivot during tripping in response to fault current.

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