May 8, 1945. W. M. SCOTT, JR 2,375,328

CIRCUIT BREAKER-MOVABLE CONTACT

Filed June 10, 1940 2 Sheets-Sheet 1

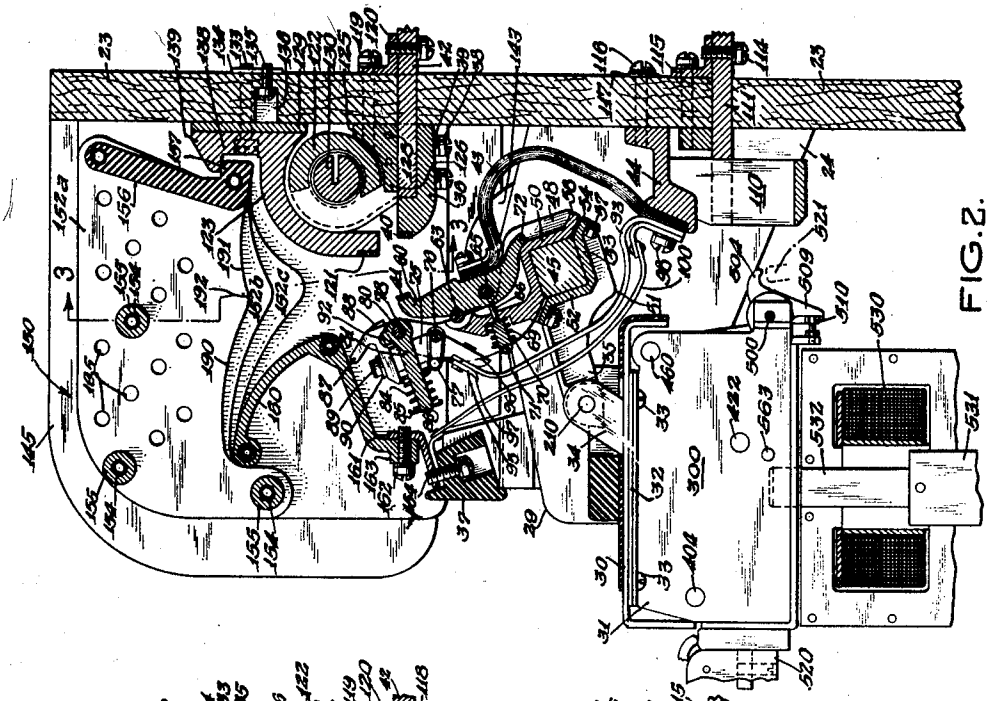

FIG. 2.

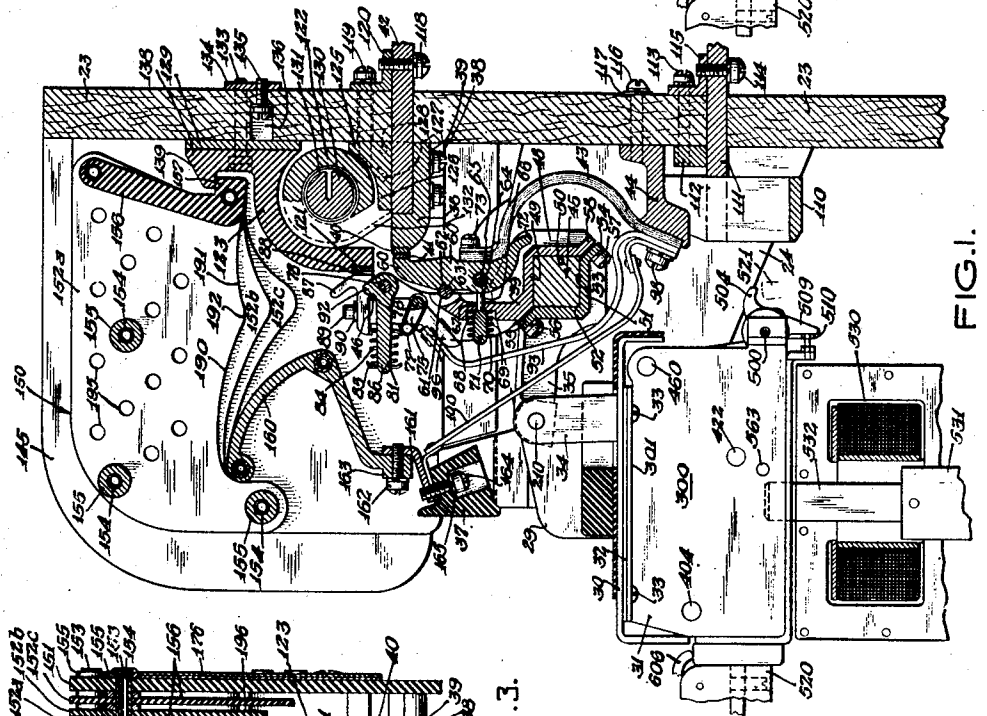

FIG. 1.

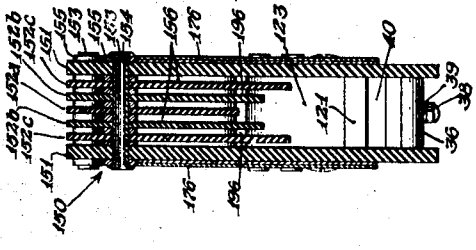

FIG. 3.

INVENTOR.
William Maxwell Scott Jr.
BY
Samuel Osterlund
ATTORNEY

May 8, 1945. W. M. SCOTT, JR 2,375,328

CIRCUIT BREAKER-MOVABLE CONTACT

Filed June 10, 1940 2 Sheets-Sheet 2

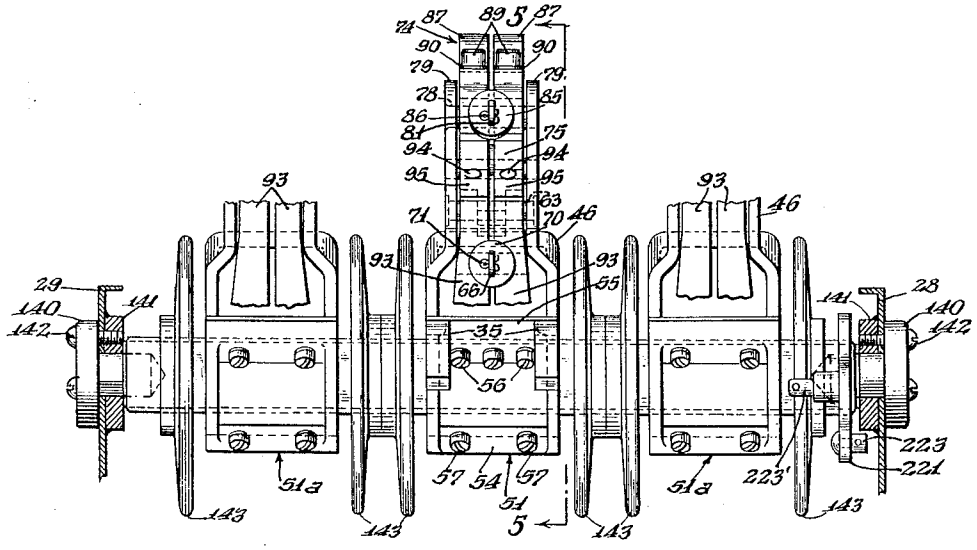

FIG. 4.

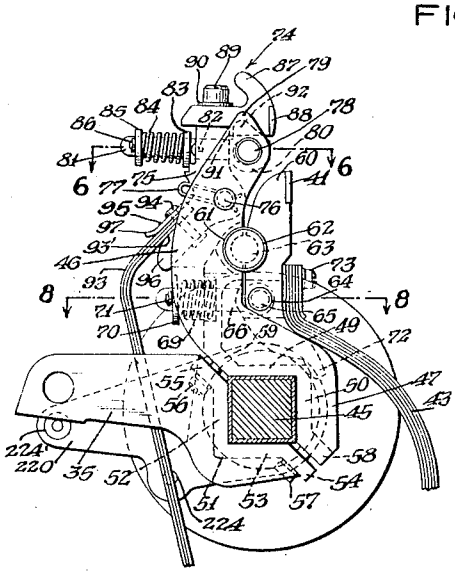

FIG. 5.

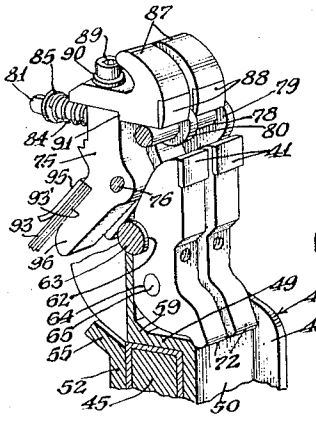

FIG. 7.

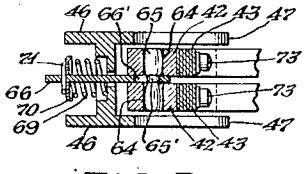

FIG. 8.

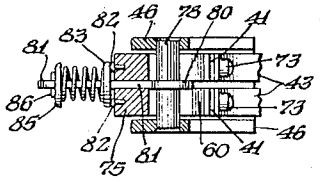

FIG. 6

INVENTOR.
William Maxwell Scott Jr.
BY
ATTORNEY

Patented May 8, 1945 2,375,328

UNITED STATES PATENT OFFICE

2,375,328

CIRCUIT BREAKER—MOVABLE CONTACTS

William Maxwell Scott, Jr., Bryn Mawr, Pa., assignor to I. T. E. Circuit Breaker Company, Philadelphia, Pa., a corporation of Pennsylvania

Application June 10, 1940, Serial No. 339,689

17 Claims. (Cl. 200—164)

This invention relates to circuit breakers and switch gear and more particularly to movable contact apparatus therefor.

In the circuit breaker of the present invention, various latching and operating controls may be utilized and various safety features may be incorporated in connection with the controls, the main contacts and the arcing contacts.

In circuit breakers of this type, wherein toggle mechanism is permitted to rapidly open the contacts and wherein substantial currents may nevertheless flow, arcing across the contacts as they open and even after they may be opened presents a serious problem. The main contact may be protected by an arrangement wherein the arcing contact is caused to open an instant after the main contact, so that whatever arc is established would tend to pass between the arcing contacts. The arcing contacts may be made readily replaceable and of relatively inexpensive materials.

The protection of the main contacts therefore ensures that when the contacts are re-engaged once more in closed circuit position, the current may flow freely therebetween without undue heating.

As a further protection, however, a magnetic blow out coil may be provided and the stationary arcing contact may actually be mounted on or immediately over the coil to bring the arc more closely under the influence of the magnetic blow out means. The movable arcing contact as it opens may come into arcing relation with a stationary arcing horn to which the arc may be transferred.

Stationary magnetizable plates on either side of the contacts may engage the core of the blow out coil so that the magnetic field may extend in a predetermined manner substantially through the entire space occupied by the arc and thus cause the arc to move in a predetermined direction in accordance with the current flow.

The magnetizable plates may be magnetized not merely by their contact with the core of the magnetic blow out coil; but the arc itself, while it is in existence, may itself constitute virtually a half turn coil which energizes the magnetic blow out plates and results in a movement of the arc along the arcing horns in a predetermined direction.

The arrangement of the arcing horns so that they separate in the direction in which the arc is forced to move serves further to attenuate the arc.

And finally in this path of movement of the arc, I interpose an arc quenching device consisting preferably of plates of fibrous material between which the ionized gases forming the arc are squeezed and brought into contact with cooling and de-ionizing surfaces which serve to de-ionize the gases to extinguish the arc.

In the operation and use of circuit breakers and switch gear of various types, it often becomes important to disassemble the same or at least to remove parts thereof in order to obtain access to various portions of the circuit breaker for replacement or repair. I have attempted in the present invention to so arrange each of the parts that they may be readily removable without any complicated operations whatever.

Thus the entire arc quencher assembly including the magnetic pole pieces of the blow out coil may be removed after rotating a single screw. The entire contact assembly may be removed after having simply removed the two outer bearings of the contact shaft and the single pin connecting the contact shaft with the toggle mechanism and removing the flexible conductors from the lower terminal. And even here the link between the toggle mechanism and the contact shaft is hinged sufficiently to permit the entire contact assembly to be rotated outwardly to permit inspection and repair thereof.

Access to principal leads and attachment thereof in operative position is provided for by means of a single screw and the entire toggle and latching mechanism is contained within a housing which may readily be removed by the rotation of the screws attaching it to the shelf.

An important object, therefore, of the present invention is the arrangement and integration of the parts thereof in such a manner as to facilitate assembly and disassembly thereof in manufacture, operation, replacement and repair.

In the construction of a movable contact of the present circuit breaker, I have provided for contacts which may be supported by a contact carrying arm and which may nevertheless yield to the pressure of the contact supporting arm to a sufficient degree to permit effective contact pressure to be maintained without destroying the contacts.

For this purpose, I have mounted the movable contacts upon contact levers which are pivotally supported upon the contact carrying arm and I have provided for various types of biasing means in order to ensure that proper contact pressure will be maintained.

Accordingly, an important object of the present invention is to so arrange the movable contacts

that proper contact pressure may be maintained.

Still another important object of the present invention is to so arrange the movable contacts that they may themselves move with respect to the contact carrying arm and thus adjust themselves to proper contact pressure.

A further object of the present invention is likewise to mount the movable arcing contacts upon a similar pivoting lever which in turn is supported by the main movable contact carrying arm.

Still a further important object of the present invention is to so arrange the movable contact and the connections thereto that the passage of current through the contact will itself create magnetic forces which will tend to increase the contact pressure of the movable contact.

There are many other objects and uses of the present invention and of the combinations and elements herein set forth. Many of them have already been pointed out. Many others will in part be apparent and where not intrinsically apparent will be pointed out in the following description and drawings, in which:

Figure 1 is a cross-sectional view of the circuit breaker embodying my invention in closed circuit position.

Figure 2 is a view corresponding to that of Figure 1 showing the circuit breaker in open circuit position.

Figure 3 is a cross-sectional view on line 3—3 of Figure 2 showing the arrangement of the arc quencher.

Figure 4 is a view of the back of the contact supporting shaft, showing the back of the contact arms.

Figure 5 is a cross-sectional view on line 5—5 of Figure 7.

Figure 6 is a cross-section of the contact assembly on line 6—6 of Figure 5.

Figure 7 is a view in perspective showing the contact surfaces.

Figure 8 is a cross-sectional view on line 8—8 of Figure 5.

Referring now to Figures 1 and 2, I have here shown a pole of a three pole circuit breaker comprising the elements of the present invention. The circuit breaker consists of a group of pole units mounted on the face of an ebony, asbestos or slate panel 23 which forms the mounting plate of the entire circuit breaker arrangement.

The main bracket or housing preferably comprises two flanged side plates (not shown) which extend on each side of a horizontal shelf 30 to which they are welded. The operating mechanism 31 comprising the toggles and other elements hereinafter described is bolted to the lower side of the shelf 30, the housing 300 of the said operating mechanism comprising flanges 32, Figures 1 and 2, through which bolts 33 may be passed to engage the shelf 30.

Link 34 connects the operating mechanism 31 to the lever 35 which is secured to the contact shaft 45 and is rotatable therewith. As seen more particularly in Figures 1 and 2, the stationary contacts 36 and their back connection stud assembly are mounted on the panel above the housing or supporting bracket 24 and support the inner end of the arc chutes in the manner hereinafter described.

A bridge 37 of insulating material secured to the outer end of the main bracket 24 supports the outer end of the arc chutes in the manner hereinafter described.

Main and Arcing Contacts

The stationary main contacts

The stationary main contacts 36 are bolted to the connecting stud 42 by means of the bolts 38 and the washers 39. The connecting stud 42 passes through the back panel 23 and is suitably arranged so that appropriate circuit connections may be made thereto. The path of the main current when the contacts are closed, as seen in Figure 1, is through the connection stud 42, the stationary contact 36, the stationary contact tip 40, the movable contact tip 41, the contact lever 60 carrying the flexible connection 43 which in turn is electrically connected to the member 44.

Movable contact support

The movable contact shaft 45 is preferably a square steel bar covered with phenolic insulation molded in place and is rotatably supported in appropriate bearings as hereinafter described.

A contact arm for each pole is mounted on this shaft. The contact arm 46 is preferably a bronze casting reinforced by flanges 47 and 48. The lower end of the bronze casting which engages the square steel shaft is preferably formed in a V comprising the members 49 and 50 set at approximately right angles to each other so that they will engage the square sides of the shaft 45 to which they are to be clamped.

The clamping member 51 comprises also a V-shaped member having the sides 52 and 53 which likewise may engage the sides of the square steel shaft and comprising also flanges 54 and 55 through which bolts 56 and 57 may be threaded to engage the flange 58 and the flat portion 59 of the contact arm 46 in order to securely clamp the same to the contact shaft 45.

As will be noted, especially in connection with Figure 1, each of the main contact arms 46 may be secured to the contact shaft 45 so that rotation of the contact shaft 45 by the lever 35 will result in corresponding movement of the contact arms 46 for the purpose of opening or closing the circuit.

While any necessary number of contact carrying arms may be mounted upon the contact shaft as the specific circuit connections may require only one lever 35 is necessary for the opening and closing operations which result in rotation of the shaft 45 and the operation of the various contacts.

In order to obtain a balanced structure it is preferred that the lever 35 be secured to the shaft 45 substantially at the center so that the mechanism may be properly balanced.

Movable main contacts

Each contact arm 46 carries a pair of contact levers 60 formed and cut from a special copper extruded bar. Each of these two levers (see Figure 5) carries at its upper end a silver nickel contact block 41 for engaging the stationary main contact tip 40. The back of the contact arm 46 has a part-cylindrical depression 61 and the front of each of the contact levers has a similar depression 62. A bronze pivot pin 63 is placed in these depressions in the manner shown in Figures 1, 5 and 7. This pivot pin has flanges at each side and also a flange in the center between the two contact levers 60 in order to prevent any lateral movement of the members with respect to each other.

Each of the contact levers 60 is drilled at 64 so that a pin 65 may be inserted therein. The

pin 65 is preferably of dumbbell shape as seen in Figure 8 and acts as an equalizing yoke between the two contacts 60—60. A link 66 engages the pin 65 between the two contact levers 60—60 and is extended up through a perforation 67 in the contact arm 46 into the recessed area 68 of said contact arm. A compression spring 69 forms the main contact spring and is retained in position between the base of the recess 68 and the spring cup 70 which is held in place on the spring link 66 by the cotter pin 71.

The spring link 66 in extending between the two main contact levers 60 has an eye 66' which engages a groove 65' in the pin 65 in order to prevent its moving to either side.

When the main contacts are disengaged in the manner shown in Figure 2, the lower ends 72 of the main contact levers 60 press against the contact arm 46 in the manner shown.

For simplified assembly the only element which retains the pin 63 in place is the pressure of the spring 69 upon the main contact lever.

In the closed position the pressure through the contact lever 60 between the spring 69 (bearing on the pin 65) and the contact 41 serves to maintain the adequate pressure necessary to hold the pin 63 in place. In the open position, the pressure of the bottom end 72 of the main contact lever 60 against the contact arm 46 and the pull of the compression spring upon the pin 65 of the lever 60 using the member 72 as a fulcrum serves to maintain the pin 63 in place.

This design of pivot provides long wearing surfaces. The spring link and pressure equalizing pin may be made of hard steel so that their area of engagement may be small. The area of engagement at the pin of the contact levers may be of relatively soft material.

The pivot pin engaged by the half cylindrical surfaces of the contact arm and the contact levers provides a maximum of area for the softer parts. This area could not be obtained in the same width or pin length by any other method.

If the levers were formed to rock in a groove in the arm, there would be copper and brass bearing surfaces which are far inferior to the steel pin between them.

During the closing movement there is no instant when there is any relaxation of pressure upon the pin 63, for until the main moving contact tip 41 is brought into contact with the stationary contact tip 40, the bottom end 72 of the contact lever 60 engages the contact arm 46 in the manner shown in Figure 4.

Only after the moving contact tip 41 is in engagement with the stationary contact tip 40 is there a transfer of the fulcrum or the base of pressure from the portion 72 to the tip 41. In such case, as has been seen in connection with the closed position of Figure 1, there is again sufficient pressure to maintain the pin 63 in place.

During the opening movement, pressure is maintained upon the pin 63 by reason of the fact that spring 69 by its pressure on pin 65 forces contacts 40 and 41 against each other until, in the rotation of the contact shaft 45, the end 72 of the contact lever presses against clamping portion 48 of the contact arm 46, whereupon the base of pressure is transferred from contact tip 41 to end portion 72. In this manner, the spring pressure is always exerted to maintain pin 63 in position.

The rotation of the main contact lever 60 about the pin 62 during the closing operation necessarily results in a slight sliding motion of the movable contact tip 41 with respect to the stationary contact tip 40 so that a wiping action occurs tending to clean the contacts.

As seen also in Figures 1 and 2, the backs of the contact levers are drilled and tapped for the securing screws 73 in order to attach the flexible conductor 43 thereto.

The upper end of the flexible conductor 43 is slit so that separate screws 73 may attach the separate ends to the two separate contact members 60 to allow independent movement of the contacts. The arrangement of the lever arms above and below the contact pivot is such that during heavy current flow the magnetic forces set up will tend to increase the pressure between the moving and stationary contacts when the flow of current is between the stationary contact tip 40 and the movable contact tip 41.

By the use of two contact levers of this type for each pole of the circuit breaker, an adequate contact at each pole is ensured.

Movable arcing contacts

The arcing contacts 87 are mounted in the upper part of the contact arm 46, and are supported by arcing contact levers 75. The arcing contact levers 75 preferably are each cut from a bar of extruded copper and in this case also I have found it preferable to use a pair of such contacts and levers for a single pole. Each of the arcing contact levers 75 is pivoted on the pin 76 which is grooved between the contacts to take a hair pin spring 77 which serves to keep the pin 76 in center position. A second pin 78 is mounted in the top of the contact arm 46 between two upwardly extending flanges 79 thereof.

An appropriate bushing may be placed between the flanges so that the pin may be securely riveted over them without bending them. The eye 80 of the spring link 81 is placed over the bushing, the said spring link 81 extending beyond the back of the arcing contact levers 75.

Pins 82 having rounded heads (see Figure 6 as well as Figures 1 and 2) are driven into the upper part of the back of the arcing contact lever 75.

A spring cup 83 is pressed against these pins by the compression spring 84 which is held in place on the link 81 by the spring cup 85 at the opposite end which in turn is held in position by the cotter pin 86. The arcing contact 87 is mounted upon the arcing contact lever 75 and is preferably formed or cut from an extruded copper bar and is provided with a contact face 88 preferably of Elkonite silver which is soldered to the copper. Each of the contacts 87 of each of the contact levers 75 is held in place upon its contact lever by a socket head cap screw 89 and lock washer 90. As will be seen more particularly in Figure 7, the contacts 87 are held against turning or other displacements by the shoulder 91 which engages a corner of the arcing contact lever 75. The ends of the contact arm flanges bear against the outer sides of the two arcing contacts and the projection 92 of the spring link separates the two arcing contacts 87—87 from each other, thus serving adequately to position them.

As is seen in Figures 1, 2 and 7, the lower end of the arcing contact lever 75 is off-set at 93' to receive the end of a flexible conductor 93. The conductor 93 like the conductor 43 is also slit, the ends thereof being riveted at the off-set 93' to the

arcing contact lever 75 by means of the rivet 94 passing through the washer plate 95.

The off-set 93' is curved away at 96 from the flexible conductor and the washer plate 95 is curved away at 97 therefrom for the purpose of preventing kinking during operation. This flexible conductor 93 is led down to the lower terminal block 44 to which it is connected by the same screws 98 that hold the main contact lead 43.

The main contact levers, in contact open position, are held against their fulcrums and against a stop on the arm by a compression spring at the back of the arm, acting on a link connected to the two contact levers between the fulcrum and the stop. The contact surface is at the top of the lever above the fulcrum. The flexible conductor is secured to the bottom of the lever below the fulcrum.

When the shaft and arm are moved to contact closed position, the contact ends of the levers are rotated about their fulcrums and pushed back from their advanced position, moving the bottom stop clear of the arm. This compresses the spring and increases the contact pressure. The use of a single spring and link between the two levers permits the pin to act as an equalizing yoke.

The attachment of the flexible conductor below the fulcrum causes the magnetic forces to balance about the fulcrum so that the contact pressure may remain the same or increase during fault current.

The auxiliary or moving arcing contacts are mounted at the top of the arm. In this case the spring is above the fulcrum and below the detachable contact tips. Equalization of pressure is arranged in the same way. Maintained pressure during fault or inrush current is provided in the same manner.

It should also be noted that the flexible lead 100 from the arcing horn is also connected to the terminal block 44. It will thus be seen that the three flexible conductors 100, 93 and 43 are all led from the contact structure to the lower terminal 44 to which all three are or may be secured by the same screws and lock washers.

One terminal of coil 110 is connected to the lower terminal post 44 and the opposite end of the coil is connected to the back connection stud 111 which has the securing block 112 welded to it at the face of the panel 23.

The upper back connection stud 42 is likewise connected through the panel 23 by means of screws 118 and 119 engaging and passing through the clip 120 and is therefore held in position in the same manner as the lower back connection stud 111.

When the circuit breaker therefore is closed, the current flowing into the upper stud 42 enters the main contact block 36, passes through the main stationary contact surface 40 to the main movable contact surface 41 and into the main contact lever 60 passing therefrom through the flexible lead 43 to the lower terminal block 44 around and through the coil 110 to the lower back connection stud 111 and thence back to the circuit to which the same is connected.

The over-current coil 110 will thus be in series with the main contact; and, after these are opened, with the arcing contacts; and, finally, with the arcing horns; since the leads 43, 93 and 100 each are connected to the pigtail post 44.

The movable arcing contact tip 88 engages the stationary arcing contact tip 121. Current is led to the stationary arcing contact tip 121 in the following manner:

Current from the upper connection stud 42 flows into the lower terminal 125 of the blow out magnet coil 122 around the coil to its upper terminal 129 and thence to the stationary arcing contact 123. From the stationary arcing contact, the current flows to the stationary arcing contact tip 121, thence to the movable arcing contact tip 88, thence through the arcing contact lever 75, flexible lead 93, the terminal block 44, the coil 110, and the connection stud 111 in the manner hereinbefore described.

The arcing contacts, particularly the movable arcing tip 87—88, may readily be replaced after the same have become worn. When the circuit breaker is closed, the resistance of the circuit through the main contacts 36 and 60 is low as compared with the resistance through the arcing circuit so that a relatively small current flows through the latter.

The main stationary contact 36 is attached to the back connection stud as is the lower terminal of the blow-out magnet coil 122 by means of screws 38.

A fiber tube 131 insulates the core 130 from the coil 122. Insulated side plates 132 are fastened on each side of the coil terminals. The arcing terminal 123 also cut from an extruded brass bar is secured to the upper coil terminal 129 and the panel 23 by screws 133, threaded into the nut plate 134 which is further anchored in position to provide a secure attachment of the members by the screws 135, the heads of which are embedded in the recess 136 so that they may not interfere with the securement of the coil terminal 129 to the panel.

The upper part 138 of the arcing contact 123 is extended along the panel and forms a hook 139 for anchoring the arc chute.

The arcing contact 123 curves around the blow out coil as seen in Figures 1 and 2 and forms an arcing horn.

As seen in Figure 4, the contact shaft 45 is a square steel bar which as above described is covered with phenolic insulation molded in place. Each end of this shaft is drilled at 140a to receive the bearings 140. The shaft itself extends between the side plates 28 and 29. The bearings are brass cylinders inserted in holes in the side plates to which their drilled flanges 141 are secured by screws 142.

When the screws 142 are removed and the two bearings at each end are withdrawn, the shaft and the entire contact assembly may be removed from between the side plates provided of course that the flexible leads have been disconnected and also provided that the connection between the link 34 and the arm 35 of the contact shaft are separated.

Assembly and operation of the contacts

The contact arms 46 (Figures 1 and 5) are secured to the contact shaft by clamp members 51 which are held in place by a pair of screws 56 and 57 on each side of the shaft.

The clamp or cap 51 is extended to form the shaft actuating arm 35 and is drilled to receive pin 210 in the upper end of the main toggle link 34. A movement of the operating mechanism 31 will raise or lower the pin 210, therefore raising or lowering the shaft actuating arm 35 and so rotate the contact shaft 45 to move the contacts into and/or out of engagement.

Secured to either or both ends of the steel contact shaft 45, is a steel arm 220 and 221. Each of these arms carries as will be noted, two studs 223 and 224 which are riveted in place.

Secured to one of the studs of each of the members 220 and 221 is a contact opening spring the lower end of which may be attached to studs riveted to the insides of the bracket side plates. These two springs may bias the shaft towards opening position and assure quick opening.

In the construction and arrangement of the contacts, the movable main contact is supported by an operating arm on the contact bar or shaft and is connected to the lower stud by a flexible shunt of suitable size.

Pressure on the main contact is obtained through the use of a compression type coil spring, mounted outside the current path, and, consequently, is unaffected by heating.

The pressure on the arcing contacts is also obtained by the same type of compression type coil spring protected from the arc.

The main contacts are protected by the sequence of operation in opening or closing of the device, since the main contacts close after the arcing contacts and open before them.

Although with the construction herein described, replacement of the contacts should not be necessary, the arrangement of the movable main contact lever and the movable arcing contact is such that access to both stationary and movable parts with a minimum amount of labor is possible.

Accessibility of the main contacts is such that it is necessary only to remove one screw from the arc quencher assembly and lift it off manually so as to reach the contacts. In addition, as is hereinbefore described, the removal of the two bearings 140 of the main contact shaft and pig tails is sufficient to make available all parts of the contact mechanism for replacement, cleaning or repair.

Arc chute, arc horns and blow out

In the actual operation of the contact assemblies herein described, when the contacts are fully closed and the latches are then tripped, the contact shaft 45 and the contact arm 46 rotate in a counterclockwise direction in the views of Figures 1 and 2. As the arm and the contact pivot pins 76 and 63 move away from the stationary contacts, the springs 69 and 85 maintain the moving contacts in engagement with the stationary contacts until in the rotation of the contact levers these levers 75 and 60 strike their respective stops.

During this movement, the lower end 72 of the contact lever 60 strikes the part of the contact arm 46 which surrounds the shaft 45. At this point in the movement, the main contacts separate while the arcing contacts are still engaged. It is thus seen that the circuit through the main contacts is interrupted and all the current is transferred to the circuit of the blow out coil 122 and the arcing contacts. The core 130 therefore and its associated pole pieces are highly magnetized in proportion to the current flowing.

Surrounding each pole is an arc chute 150 comprising side plates 151 of fiber and supporting between them five shorter parallel spaced plates 152 also of fiber.

The entire group is held together preferably by rivets 153, 153 making as far as possible a rigid assembly.

As seen in Figures 2 and 3, near the panel 23, the inside plates 152 are separated by fiber members 156 which prevent the arc gases from coming in contact with the panel and which also comprise hooks 157 which engage under the hook or lip 139 of the stationary arcing contact member 123 in order to assist in supporting the arc quencher assembly. Near the front of the arc chute is secured a brass arcing horn 160 which is electrically connected to an angle-clip 161, being connected thereto by the screw 162 passing through the flange 163 of the arcing horn and a flange of the angle clip.

The metallic clip 161 is secured by the screw 164, and lock washer 165 to the bridge 31 of molded insulating material. This metallic clip 161 is electrically connected to the flexible conductor 100 which in turn connects it to the lower pig-tail terminal 44. At the end of the opening movement of the arcing contact the tip 87 of the movable arcing contact 75 moves under the stationary arcing horn 160 in the manner shown in Figure 2 so that the arc terminal is transferred to the stationary arcing horn 160 and the current flows through the conductor 100 to the lower terminal block 44. The current is first transferred from the main contacts to the arcing contacts, and, when the arc is then transferred to the stationary arcing contact or horn 160, the movable arcing contact is shunted out of the circuit.

Ferrous blow out plates or pole pieces 176, Figure 3, are secured to the outer surfaces of the side plates 151 of the arc chute by means of rivets or other suitable attaching means 177.

It will be noted that removal of the screw 162 will permit the withdrawal of the entire arc chute from the contact assembly.

The arc splitting plates 152 (five in number in the preferred embodiment) have, as seen in Figures 1 and 2, their lower edges shaped in two arcs 190 and 191 which are concave in a downward direction with the cusp 192 between them rounded. This cusp lies approximately midway between the stationary arcing horn 123 and the front arcing horn 160. The downwardly extending cusps facilitate the entrance of the arc into the slots between the plates and are so arranged that a relatively small longitudinal length of the arc is first forced between the plates and so that as the arc is blown upwardly, progressively greater lengths of the arc are forced between the plates.

As is also seen in Figures 1 to 3, the lower edges of the plates 152 are of different heights, the middle one 152*a* being the highest and the outer plates 152*c* being the lowest, that is, extending downwardly a greater distance. The intermediate plates 152*b* are of a height so that the lower edges extend in planes substantially between the position of the edges of the middle and outer members.

As is also seen in Figures 1 and 2, the five plates here shown have perforations 195 of suitable size and shape, spaced and arranged to permit the flow of arc gases from the slot 196 (Figure 3) between one pair of plates to the slot between another.

Upon opening of the main contacts and formation of the arc between the arcing contacts 74 and 123, the arc is immediately transferred from the arcing tip 74 to the arcing horn 160.

The current flowing through the coil 122 energizes the magnet comprising core 130 and ferrous plates 176 producing a flux across the arc

space. This flux forces the arc upwards towards and into the arc chute 150.

The various elements of the circuit breaker and the operation of each of the elements have been described in connection with the description of the members thereof. Each of the individual elements of the circuit breaker is in the present invention integrated with each of the other elements to form a unified integral operative whole.

The rotation of the manual operating lever in one direction causes the toggles to rise in the manner described, thus raising the link 34 rotating the arm 35, rotating the contact shaft and closing the contacts.

The arcing contacts meet before the main contacts are in engagement with each other. Rotating the manual operating lever in the opposite direction trips the toggles in a manner hereinbefore described, and causes the contacts to separate, the arcing contacts separating after the main contacts and the arc being established between the arcing contacts only.

The arc immediately thereafter is transferred to the arcing horns, and swept up by the magnetic blow out into the arc quencher 150.

The closing solenoid 530 may be utilized instead of the manual operating lever to close the circuit breaker and automatic tripping may be substituted for tripping by the manual lever by the use of the over current coil 110.

The over current coil 110 responds to currents in excess of predetermined values passing through the circuit breaker and may be adjusted and calibrated for the particular rating of the transformer.

Solenoid trip coils may be utilized in connection with any of the levers of the shaft 500 to rotate the same when the coil is energized by any suitable remote control means and thereby provide a remote control non-automatic tripping operation.

The arrangement of all of the parts of the circuit breaker is such that assembly thereof is extremely simple. The entire arc quencher 150 including the arcing horn 160 may be removed from the circuit breaker assembly by a single movement after the rotation of a single screw 162.

The arcing contact and horn 123 is secured over the magnetic blow out coil by readily disengageable screws and bolts 133. The blow out coil itself is readily removable by the removal of a single set of screws 119. Even the stationary main contact is itself readily removable by rotation of the screws 38.

Likewise the entire movable contact assembly may readily be disconnected from the remainder of the circuit breaker assembly by removing the bearings from the ends of the contact shaft and removing the pin 210 from its connection between the arm 35 and the link 34 and pigtail.

Assembly replacement and repair are thus greatly facilitated. Separation of the various parts for any purpose whatever is made easy and simple and the general arrangement of the members on the panel 23 facilitates the mounting of this panel in a switch board with other similar circuit breakers or other switch devices.

The mounting of even the movable contacts of the circuit breaker is such they may be readily removed for replacement and repair and the movable arcing contact tip which is subjected to the greatest erosion is further arranged so that the simple rotation of a screw 89 will permit the removal thereof and replacement.

In general, therefore, I have devised a circuit breaker wherein the novelty lies not merely in the specific arrangement of the individual parts thereof, and not merely in the many extremely important novel constructions comprised therein, but also in the integration and arrangement of all of these parts so that they all operate as a single unit.

In the foregoing I have described only those parts of the circuit breaker necessary to fully understand the operation of the movable contacts including the main movable contact and the movable arcing contact. The various constructions herein described may be modified in many ways which will now be obvious to those skilled in the art.

Accordingly, I prefer to be bound not by the specific description herein, but only by the appended claims.

This application is filed simultaneously with the application of Frank J. Pokorny, for Circuit breaker operating mechanism, Serial No. 339,682, the application of Frank J. Pokorny, for Arc quencher, Patent No. 2,311,690, the application of William Maxwell Scott, Jr., for Circuit breaker, Patent No. 2,348,228, and the application of William Maxwell Scott, Jr., for Stationary contact structure, Patent No. 2,311,701. In this application I have claimed those inventions and portions of the structure devised by me.

I claim:

1. In a contact structure for a circuit interrupter, a first contact structure and a second contact structure movable into and out of engagement with said first contact structure comprising a member movable between two predetermined positions, a rigid lever, having a contact face for engagement with said first structure and mounted on said member, a portion of said lever being in the shape of a partial cylinder and a portion of said member being in the shape of a partial cylinder, the said portions being positioned opposite each other and together forming a hollow cylinder and acting as a single joint bearing surface, a fulcrum pin mounted in said bearing, and means biasing said lever against said pin at all times and producing current carrying pressure between said contacts during engagement thereof, said fulcrum pin having means engaging said member and said lever to prevent relative movement of said parts parallel to the axis of said pin.

2. In a contact structure for a circuit interrupter, a first contact structure and a second contact structure movable into and out of engagement with said first contact structure comprising a member movable between two predetermined positions, a rigid lever, having a contact face for engagement with said first structure and mounted on said member, a portion of said lever being in the shape of a partial cylinder and a portion of said member being in the shape of a partial cylinder, the said portions being positioned opposite each other and together forming a hollow cylinder and acting as a single joint bearing surface, a fulcrum pin in said bearing, means biasing said lever against said pin at all times and producing current carrying pressure between said contacts during engagement thereof, and a flexible conducting member secured to said lever at a point on the opposite side of said fulcrum from said contact face.

3. In a contact structure for a circuit interrupter, a first contact structure and a second contact structure movable into and out of engagement with said first contact structure comprising a member movable between two predetermined

positions, a rigid lever, having a contact face for engagement with said first structure and mounted on said member, a portion of said lever being in the shape of a partial cylinder and a portion of said member being in the shape of a partial cylinder, the said portions being positioned opposite each other and together forming a hollow cylinder and acting as a single joint bearing surface, a fulcrum pin in said bearing, means biasing said lever against said pin at all times and producing current carrying pressure between said contacts during engagement thereof, and means for limiting the relative movement of said member and said lever, during disengagement of said contacts, said biasing means being disposed to exert pressure upon both said fulcrum and said limiting means.

4. In a contact structure for a circuit interrupter, a first contact structure and a second contact structure movable into and out of engagement with said first contact structure comprising a member movable between two predetermined positions, a rigid lever, having a contact face for engagement with said first structure and mounted on said member, a portion of said lever being in the shape of a partial cylinder and a portion of said member being in the shape of a partial cylinder, the said portions being positioned opposite each other and together forming a hollow cylinder and acting as a single joint bearing surface, a fulcrum pin in said bearing, means biasing said member against said pin at all times and producing current carrying pressure between said contacts during engagement thereof, said fulcrum pin having flanges engaging said member and said lever to prevent relative movement of said parts parallel to the axis of said pin.

5. In a contact structure for a circuit interrupter, a first contact structure and a second contact structure movable into and out of engagement with said first contact structure comprising a member movable between two predetermined positions, a pair of spaced side by side rigid contact levers each having a contact face for engagement with said first structure and mounted on said member, a portion of said lever being in the shape of a partial cylinder and a portion of said member being in the shape of a partial cylinder, the said portions being positioned opposite each other and together forming a hollow cylinder and acting as a single joint bearing surface, fulcrum means in said bearing and a single means biasing said depressions against said fulcrum means when said contact structures are in engagement and disengagement and means for producing equalized current carrying pressure between the contact face of each of said levers and said first contact structure during engagement thereof.

6. In a contact structure for a circuit interrupter, a first contact structure and a second contact structure movable into and out of engagement with said first contact structure comprising a member movable between two predetermined positions, a pair of spaced side by side rigid contact levers each having a contact face for engagement with said first structure and mounted on said member, means for pivoting said levers with respect to said member and a single means biasing said levers against said members at all times and producing equalized current carrying pressure between the contact face of each of said levers and said first contact structure during engagement thereof, said pivoting means having means engaging said member and said levers for preventing relative movement of said parts parallel to the axis of said pivoting means.

7. In a contact structure for a circuit interrupter, a first contact structure and a second contact structure movable into and out of engagement with said first contact structure comprising a member movable between two predetermined positions, a pair of spaced side by side rigid contact levers each having a contact face for engagement with said first structure and mounted on said member, complementary bearing surfaces formed in each of said levers and in said member, fulcrum means in said bearing and a single means biasing said levers against said fulcrum means at all times and producing equalized current carrying pressure between the contact face of each of said levers and said first contact structure during engagement thereof, and a flexible conducting means secured to said levers at a point on the opposite side of said fulcrum from said contact face.

8. In a contact structure for a circuit interrupter, a first contact structure and a second contact structure movable into and out of engagement with said first contact structure comprising a member movable between two predetermined positions, a pair of spaced side by side rigid contact levers each having a contact face for engagement with said first structure and mounted on said member, complementary bearing surfaces in each of said levers and in said member, fulcrum means at said bearings and a single means biasing said bearings against said fulcrum means at all times and producing equalized current carrying pressure between the contact face of each of said levers and said first contact structure during engagement thereof, said fulcrum means comprising a single pin having flanges for engaging said member and said levers for preventing relative movement of said parts parallel to the axis of said pin.

9. In a contact structure for a circuit interrupter, a first contact structure and a second contact structure movable into and out of engagement with said first contact structure comprising a member movable between two predetermined positions, a pair of spaced side by side rigid contact levers each having a contact face for engagement with said first structure and mounted on said member, complementary bearing surfaces in each of said levers and in said member, fulcrum means at said bearings and a single means biasing said bearings against said fulcrum means at all times and producing equalized current carrying pressure between the contact face of each of said levers and said first contact structure during engagement thereof, said biasing means comprising a surface on each of said levers remote from the axis of said fulcrum and being substantially in the plane thereof, an equalizing member engaging each of said surfaces in the plane of symmetry of each of said levers normal to the axis of said fulcrum, an element engaging said member at a point midway between said planes and a spring engaging said movable member and said element.

10. A movable contact structure for switching apparatus movable into and out of engagement with a complementary contact, said movable contact structure comprising a rigid arm oscillatable between two predetermined positions, a rigid contact lever mounted thereon, a contact surface on said lever, a portion of said lever being in the shape of a partial cylinder and a portion of said

member being in the shape of a partial cylinder, the said portions being positioned opposite each other and together forming a hollow cylinder and acting as a single joint bearing surface, a bearing surface in the face of said arm toward said complementary contact, a fulcrum pin supported in said bearings, said contact lever being rotatable about said pin, and means engaging said contact lever at a point thereof on the opposite side of the fulcrum from the contact surface and biasing said portion of said lever toward said arm, the end of said lever most remote from said contact surface having a stop engagement with a part of said arm during disengagement of said contact from the complementary contact, said last mentioned end of the lever being moved from its engagement with the contact supporting arm and against the bias of said additional means when the contact supporting arm is moved to a position where the movable contact surface is pressed against the stationary contact surface.

11. A movable contact structure for switching apparatus movable into and out of engagement with a complementary contact, said movable contact structure comprising a rigid arm oscillatable between two predetermined positions, a pair of spaced side by side rigid contact levers mounted thereon, a contact surface on each of said levers for engaging said complementary contact, a pin forming a common fulcrum for each of said levers, and engaging said contact levers at points remote from said contact surfaces and at the sides of the levers opposite said contact surfaces, means on said arm for positioning said pin, and means engaging said contact levers at points thereof on opposite sides of the fulcrum from the contact surfaces and biasing said portions of the levers toward said arm, said last mentioned means comprising a pin engaging each of said levers at a point lying in the plane of symmetry of said lever normal to the axis of said fulcrum pin, a link engaging the mid-portion of the pin between the levers and extending through an opening in said arm beyond the surface thereof remote from the levers, and a spring between the free end of said link and the surface of said arm remote from the levers, said last mentioned pin being constricted in the center at its connection to the link, the sides of said pin engaging the levers being curved to permit the levers to shift with respect to each other when the contacts are subject to uneven pressure.

12. In a contact structure for a circuit interrupter, a first contact and a second contact movable into and out of engagement with said first contact, a rigid contact carrying lever for carrying said second contact; and a contact arm for operating said lever and second contact into engagement with said first contact, a portion of said lever being in the shape of a partial cylinder and a portion of said member being in the shape of a partial cylinder, the said portions being positioned opposite each other and together forming a hollow cylinder and acting as a single joint bearing surface, said lever being pivotally secured to said arm at said bearing, said engaging contacts acting as a fulcrum for said lever for rocking said lever to produce a wiping movement of said first contact with respect to said second contact during continued movement of said contact arm after engagement of said contacts.

13. In a contact structure for a circuit interrupter, a first contact and a second contact movable into and out of engagement with said first contact, a rigid contact carrying lever for carrying said second contact; and a contact arm for operating said lever and second contact into engagement with said first contact, a portion of said lever being in the shape of a partial cylinder and a portion of said member being in the shape of a partial cylinder, the said portions being positioned opposite each other and together forming a hollow cylinder and acting as a single joint bearing surface; and means for urging said lever in pivotal engagement with said contact arm at said bearing, said engaging contacts acting as a fulcrum for said lever during engagement of said contacts.

14. In a contact structure for a circuit interrupter, a first contact and a second contact movable into and out of engagement with said first contact, a rigid contact carrying lever for carrying said second contact; and a contact arm for operating said lever and second contact into engagement with said first contact, a portion of said lever being in the shape of a partial cylinder and a portion of said member being in the shape of a partial cylinder, the said portions being positioned opposite each other and together forming a hollow cylinder and acting as a single joint bearing surface; means for urging said lever in pivotal engagement with said contact arm at said bearing; said contact arm acting as a fulcrum for said lever during disengagement of said contacts for continually maintaining said lever in engagement with and operable by said contact arm.

15. In a contact structure for a circuit interrupter, a first contact and a second contact movable into and out of engagement with said first contact, a rigid contact carrying lever for carrying said second contact; and a contact arm for operating said lever and second contact into engagement with said first contact, a portion of said lever being in the shape of a partial cylinder and a portion of said member being in the shape of a partial cylinder, the said portions being positioned opposite each other and together forming a hollow cylinder and acting as a single joint bearing surface; and means for urging said lever in pivotal engagement with said contact arm at said bearing, said engaging contacts acting as a fulcrum for said lever during engagement of said contacts, said contact arm acting as a fulcrum for said lever during disengagement of said contacts for continually maintaining said lever in engagement with and operable by said contact arm.

16. In a contact structure for a circuit interrupter, a first contact and a second contact movable into and out of engagement with said first contact; a contact arm; a rigid contact lever carrying said movable contact at one end and fulcrumed at its lower end on said contact arm; a portion of said lever being in the shape of a partial cylinder and a portion of said member being in the shape of a partial cylinder, the said portions being positioned opposite each other and together forming a hollow cylinder and acting as a single joint bearing surface; a pin seated in said bearing; means for maintaining said lever in contact with said pin and said lower fulcrum when said contacts are open.

17. In a contact structure for a circuit interrupter, a first contact and a second contact movable into and out of engagement with said first contact; a contact arm; a rigid contact lever carrying said movable contact at one end and

fulcrumed at its lower end on said contact arm when said contacts are disengaged and fulcrumed at said contacts when said contacts are engaged; a portion of said lever being in the shape of a partial cylinder and a portion of said member being in the shape of a partial cylinder, the said portions being positioned opposite each other and together forming a hollow cylinder and acting as a single joint bearing surface; a pin seated in said bearing; means for urging said contact lever and contact arm toward each other through said pins and said lower fulcrum when said contacts are open and said contact fulcrum when said contacts are closed.

WILLIAM MAXWELL SCOTT, JR.