March 16, 1948. W. M. SCOTT, JR 2,437,863

CIRCUIT BREAKER-MOVABLE CONTACT

Original Filed June 10, 1940 4 Sheets-Sheet 1

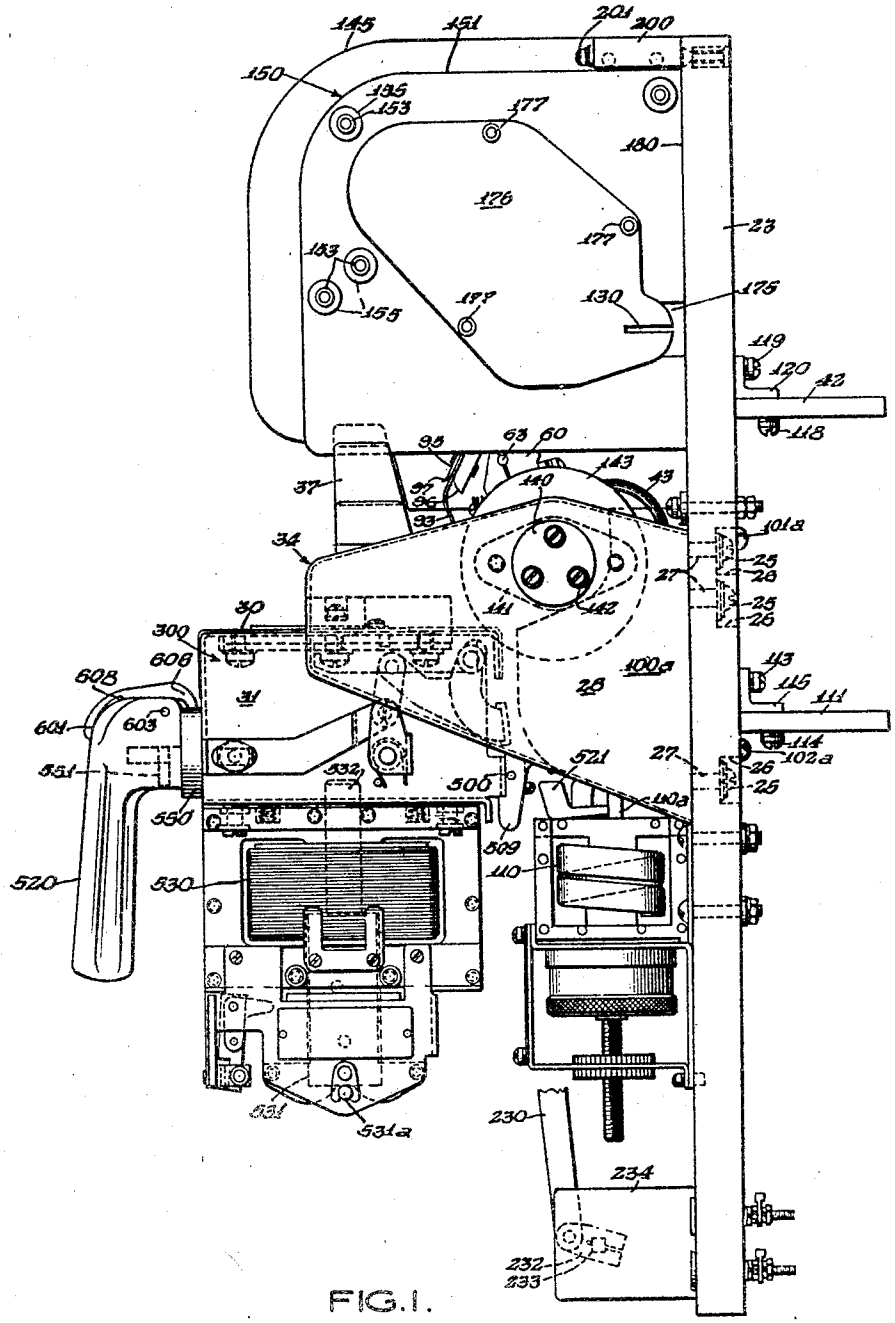


FIG. 1.

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CIRCUIT BREAKER-MOVABLE CONTACT

Original Filed June 10, 1940 4 Sheets-Sheet 2

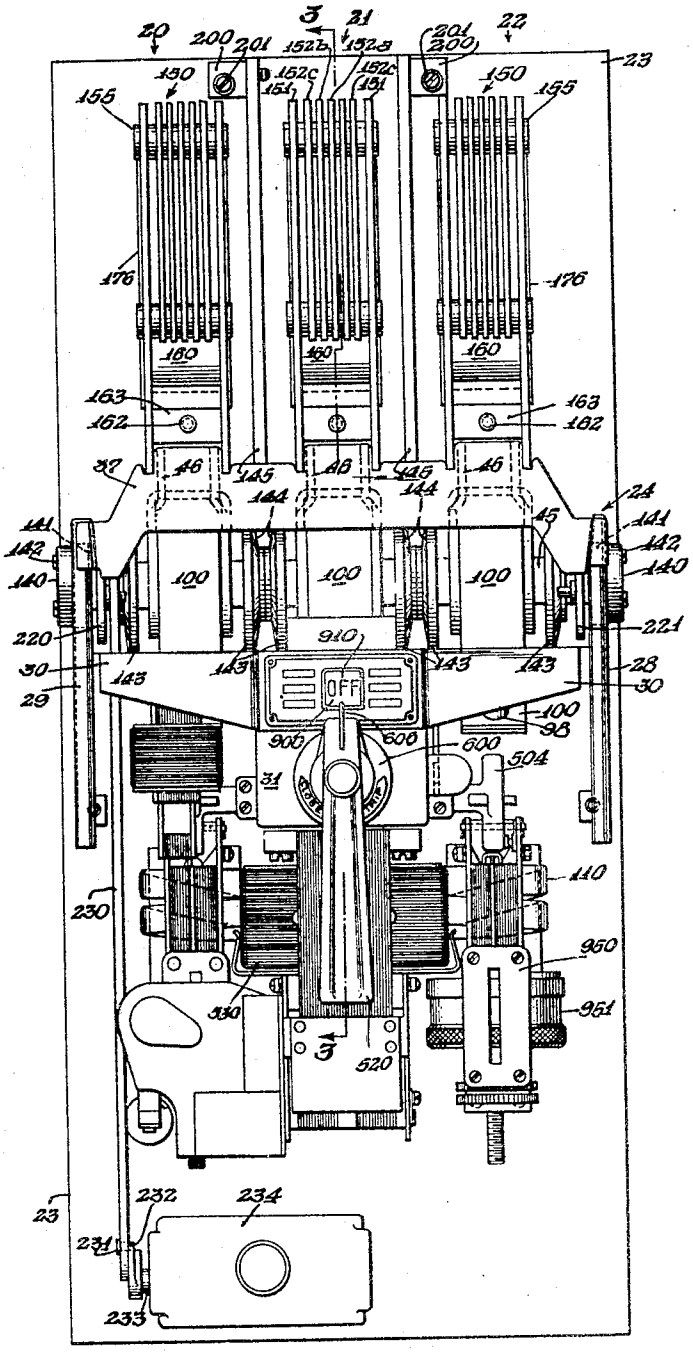


FIG. 2

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CIRCUIT BREAKER-MOVABLE CONTACT

Original Filed June 10, 1940 4 Sheets-Sheet 3

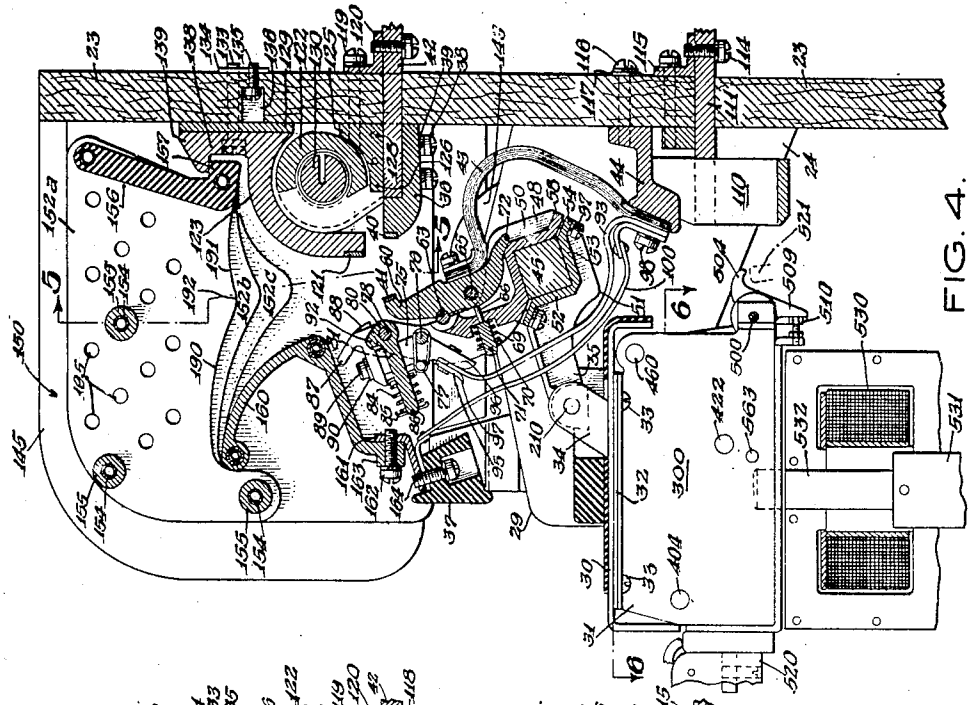

FIG. 4.

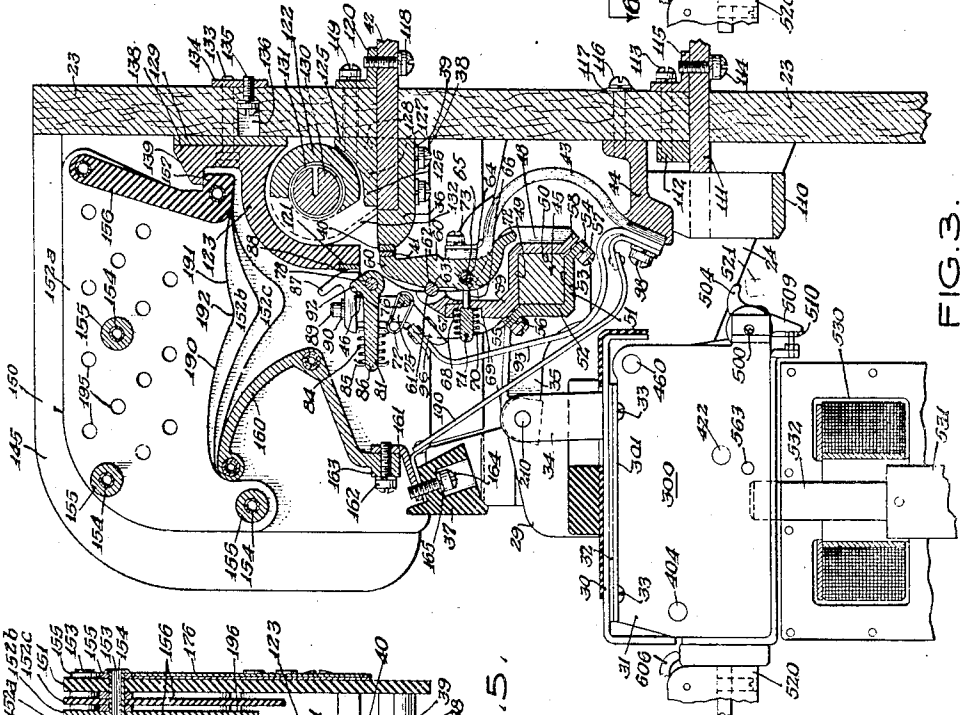

FIG. 3.

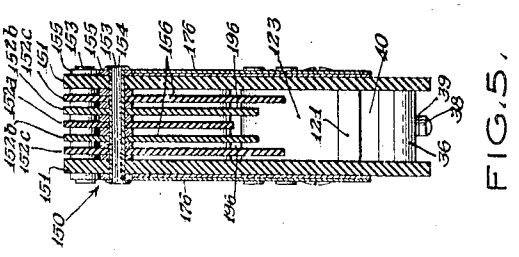

FIG. 5.

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March 16, 1948. W. M. SCOTT, JR 2,437,863

CIRCUIT BREAKER-MOVABLE CONTACT

Original Filed June 10, 1940 4 Sheets-Sheet 4

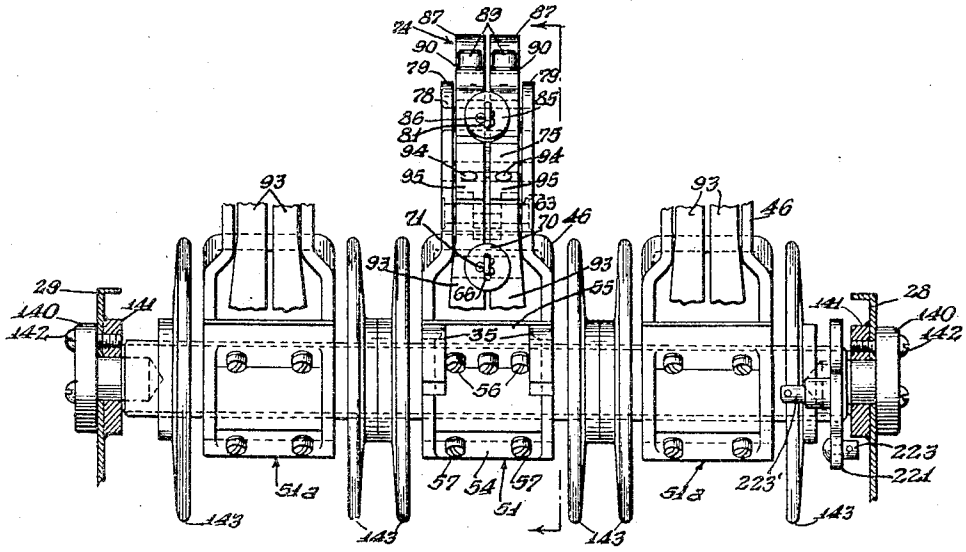

FIG 6.

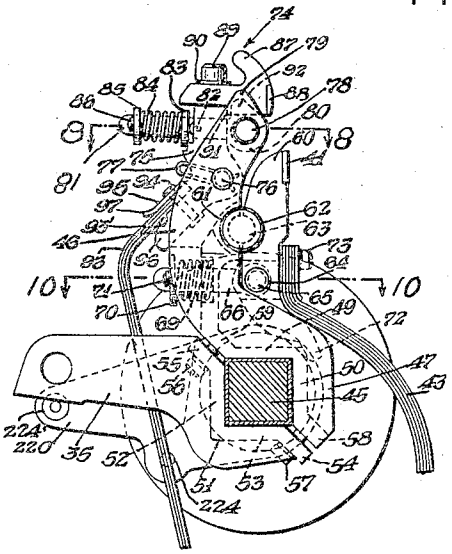

FIG. 7.

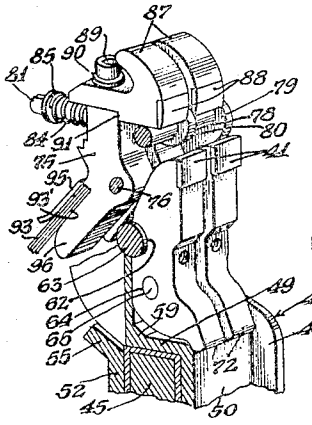

FIG. 9.

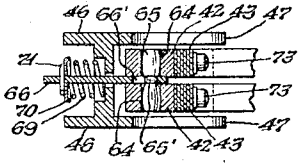

FIG. 10.

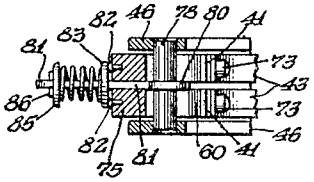

FIG. 8.

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Patented Mar. 16, 1948

2,437,863

# UNITED STATES PATENT OFFICE

2,437,863

## CIRCUIT BREAKER MOVABLE CONTACT

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

Original application June 10, 1940, Serial No. 339,689, now Patent No. 2,375,328, dated May 8, 1945. Divided and this application December 30, 1943, Serial No. 516,218

2 Claims. (Cl. 200—171)

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This invention relates to circuit breakers and switch gear and more particularly to movable contact apparatus therefor. This application is a division of my application Serial No. 339,689 filed June 10, 1940, now Patent No. 2,375,328, issued May 8, 1945.

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 in the present invention arranged each of the parts so that they may be readily removable without any complicated operations whatever.

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. The type of circuit breaker construction to which my invention relates is more fully shown in Patents

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Nos. 2,311,690 issued February 23, 1943, to Frank J. Pokorny; 2,348,228 issued May 9, 1944, to William M. Scott, Jr.; 2,311,701 issued February 23, 1943, to William M. Scott, Jr.; 2,338,715 issued January 11, 1944, to Herbert C. Graves, Jr.; 2,375,328 issued May 8, 1945, to William M. Scott, Jr.; and 2,390,735 issued December 11, 1945, to Frank J. Pokorny.

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 side elevation of the circuit breaker of our invention.

Figure 2 is a front view of the circuit breaker arrangement of Figure 1.

Figure 3 is a cross-sectional view of line 3—3 of Figure 2 showing the circuit breaker in closed circiut position.

Figure 4 is a view corresponding to that of Figure 3 showing the circuit breaker in open circuit position.

Figure 5 is a cross-sectional view on line 5—5 of Figure 4 showing the arrangement of the arc quencher.

Figure 6 is a view of the back of the contact supporting shaft, showing the back of the contact arms.

Figure 7 is a cross-sectional view on line 7—7 of Figure 6.

Figure 8 is a cross-section of the contact assembly on line 8—8 of Figure 7.

Figure 9 is a view in perspective showing the contact surfaces.

Figure 10 is a cross-sectional view on line 10—10 of Figure 7.

Referring now to Figures 1, 2, 3 and 4, we have here shown a three pole circuit breaker comprising the elements of the present invention. The circiut breaker consists of a group of pole units 20, 21, 22 (Figure 2) mounted on the face of an ebony, asbestos or slate panel 23 which forms the mounting plate of the entire circuit breaker arrangement.

### Main Supporting Members

The main bracket or housing 24 which supports the operating members is secured to the panel 23 by means of screws 25, 25 the heads of which are recessed in openings 26, 26 in the back of the panel 23 and which pass through the per-

forations 27, 27 in said panel to engage the main bracket 24 (Figure 1).

As seen in Figures 1 and 2, the main bracket or housing preferably comprises two flanged side plates 28 and 29 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 3 and 4), 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 3 and 4, 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 3, 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 contacts 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 Figures 2 and 3, 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 60 (see especially Figures 3 and 4; also see Figure 7) 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 3 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 10 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 4, 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 in-

stant 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 3, 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 3 and 4, the back 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 8 as well as Figures 3 and 4) 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 9, 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 3, 4 and 9, 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 held the main contact lead 43.

The main contact levers 60, in contact open position, are held against their fulcrums and against a stop on the arm by a compression spring 69 at the back of the arm, acting on a link 66 connected to the two contact levers between the fulcrum 63 and the stop. The contact surface is at the top of the lever above the fulcrum. The flexible conductor 43 is secured at 73 to the portion of the lever below the fulcrum 63.

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.

*Overcurrent coil connections*

It should also be noted that the flexible lead 100 from the arcing horn hereinafter described 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. The angle of the terminal and of the screw 98 is selected so that a repair man

may reach these screws over the back edge of the bracket shelf 30.

The lower terminal or "pigtail" posts may have connected thereto a coil 110 which may energize an over-current magnet.

This coil may have a cross-section of copper and the requisite number of turns corresponding to the current rating of the circuit breaker, one terminal of the coil being connected to the lower terminal post 44 and the opposite end of the coil being connected to the back connection stud 111 which has the securing block 112 welded to it at the face of the panel 23.

The back connection stud 111 is held in place in the panel 23 by the screws 113 and 114 which pass through and engage the clip 115. The terminal post 44 is bolted in place on the panel 23 by means of the bolts 116 and lock washers 117. In other words, therefore, the current is not led directly to the back connection stud 111 but through the lower terminal post 44 and through the coil 110 of the over current magnet to the back connection stud 111 through which the connection is made to the circuit.

The coil 110 of the over current magnet is therefore connected in series with the contacts.

It might here be noted that 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 arcing contact circuit is in parallel with the circuit through the main contact tips 40 and 41. The arcing contacts are designed to make before and separate after the main contacts during the closing and opening so that as is hereinbefore described, the arc particularly during the opening may be made between the arcing contacts so that the main contacts which carry the load should not be roughened or distorted to offer any substantial resistance to the passage of current.

*Blow out magnet and stationary arcing contact*

The current path from the arcing contact tip 88 to the arcing contact lever 75 and through the flexible lead 93 to the lower terminal block 44 has been described. 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 staionary 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 33. Screws 119 passing through panel 23 serve to fasten the lower terminal of blowout magnet coil 122 and angle clip 120 to panel. Screws 118 in turn fasten back connection stud 42 to the angle clip 120. The electrical connection between the back connection stud 42 and the lower terminal 125 of the blow out magnet coil 122 is made by direct contact between the angle clip 120 and the screw 119 as well as by the direct pressure of the terminal 125 against the connection stud 42.

The coil consists preferably of a strip of bar copper wound in a helix, the lower end at 126 being sweated and pinned by pins 127 and 128 to the lower coil terminal 125 and the upper end being secured to a flat plate terminal 129 which lies against the panel 123. The coil is wound so that current flowing from the lower coil terminal to the upper coil terminal flows around the slotted cylindrical iron core 130 in a clockwise direction in the views of Figures 3 and 4.

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 in the manner hereinafter described.

The arcing contact 123 curves around the blow out coil as seen in Figures 3 and 4 and forms an arcing horn. The arcing contact is preferably wider than the coil 122 and as seen in Figures 3 and 4, its under-surface rests against the edges of the insulating side plates 132. As has been above described, the arcing contact tip 121 is at the lower end of the arcing contact 123 and is preferably a contact surface of Elkonite silver.

As seen in Figures 2 and 7, 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 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 (see, for instance, Figure 7) 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 outside poles are suitably positioned (Figure 17) by the contact arm caps or clamps 51*a* while the middle pole arm is held in position by the cap 51. As is seen more particularly in Figure 3 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.

As is more clearly seen in Figures 2 and 17, 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.

The second of the studs, for instance stud 223 on the arm 220, may be utilized to operate auxiliary switches or other devices by means, for instance, of the vertical insulated shaft 230 attached to this stud and passing through the shelf of the bracket 30 (Fig. 2).

Thus, for instance, the vertical shaft 230 may operate auxiliary switch 234 in any suitable manner for any suitable purpose. The rotation of the contact shaft 45 towards opening position will through the arm 220 and the stud 223 force the vertical link 230 downwardly. The vertical link 230 is connected by pin 231 to the crank 232 on the shaft 233 of the switch 234. The downward motion of the vertical link 230 will result in rotation of the crank 232 and will therefore result in rotation of the shaft 233 and in the consequent operation of the various contacts and other portions of the switch suitably connected to and actuated by shaft 233.

Such switch 234 may be used where, for instance, the circuit breaker is to be connected with automatic reclosing circuits when it is open and such relay will obviously be reset to its original position when the solenoid or manual closing mechanism hereinafter described rotates the contact shaft 45 towards closing position thus raising the insulated link 230 and operating the switch.

As has been pointed out, preferably three contact arms 46 are mounted on this shaft, one for each pole of the circuit breaker as seen in Figure 2. On each side of each arm, there is cemented to the shaft insulation a Bakelite washer which improves the pole to pole and pole to ground insulation.

As will be noted in Figure 2, the inter-pole washers are bevelled and flanged so that the bevelled and flanged portions 144 thereof are spaced apart so that an inter-phase barrier 145 secured to the panel may extend between them. The cooperation of these parts makes it impossible for any flexible conductors of adjacent poles to be drawn together during heavy current flow while at the same time any possibility of arcing over is obviated.



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.

As hereinafter described, 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 pigtails is sufficient to make available all parts of the contact mechanism for replacement, cleaning or repair.

The individual poles of the circuit breaker are each rigidly mounted on a rigid insulating shaft so as to insure the simultaneous opening and closing of all contacts. The use of a single trip free mechanism in the manner hereinafter described, operating the main contact shaft also insures that all of the poles will operate simultaneously and precludes the possibility of opening individual poles without opening others.

An important feature of the present invention is that the same structure may be used for single pole or multi-pole operation, that is, as seen for instance in the structure of Figure 2, the circuit breaker mechanism is so arranged that three poles are simultaneously operated by a single closing and tripping mechanism. The same type of structure may be so arranged as to take one, two or four poles or more.

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 3 and 4. 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 139 therefore and its associated pole pieces are highly magnetized in proportion to the current flowing.

As seen in Figures 2, 3, 4 and 5 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. This arc chute is more fully described in Patent No. 2,338,715 and requires no further description here.

Sufficient inter-phase barriers are provided by the side plates 151 of the arc chute. However, additional inter-phase barrier plates 145 (Figures 1–4 inclusive) may be used to make it impossible for any flashing over of the arc from one pole to the other. These interphase barriers are also fully described in Patent No. 2,338,715 and require no further description here.

Various other elements may, of course, be utilized in connection with and as an integral part of the circuit breaker mechanism. Thus, for instance, as seen in Figure 2, a suitable time delay element 950 may be provided in connection with the overcurrent coil 110 to permit the breaker to carry normal load above its trip setting for short periods of time. The specific details of the time delay elements are not herein discussed since they constitute no part of the present invention.

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 590 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 entire movable contact assembly may readily be disconnected from the remainder of the circuit breaker assembly by removing the bearings 140, Figure 2, 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.

And the entire toggle mechanism assembly may be readily removed for replacement and repair by means of the removal of screws 33. A solenoid mechanism may readily be added to a hand operated breaker in the field.

The flexible leads may be readily connected to the pigtail post by means of the screws 98, and the pole pieces of the magnetic blow out coil are automatically connected in place when the arc quencher is mounted in place since these pole pieces are fastened to the sides of the arc quencher.

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 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, we 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.

I claim:

1. A movable contact structure for switching apparatus having a contact movable into and out of engagement with a complementary contact, said movable contact structure comprising a contact arm oscillable between two predetermined positions, a contact lever carrying said movable contact on one end thereof, a pivot pin, the back of said contact arm having a part-cylindrical depression and the front of said lever having a corresponding part-cylindrical depression, the two depressions when in correspondence forming a cylindrical opening for receiving said pivot pin, means on said pin for preventing lateral movement thereof, and a spring member extending between said arm and lever at right angles to said pivot pin for maintaining the inside surface of said part-cylinder formed in said lever in abutting engagement with said pin and for maintaining the inside surface of said part-cylinder formed in said arm in corresponding opposed abutting engagement with said pin, a first connection stud connected to said complementary contact, a second connection stud, a circuit connection from said second connection stud to the other end of said contact lever opposite from the

end carrying said contact, the circuit path from said first to said second connection stud through said contacts and contact lever forming a loop, said circuit connection from said second stud including a pigtail connection extending substantially from the end of said lever in a direction to increase the effective length of said lever, the distance from said pivot point of said lever on said arm to the second connection stud being thereby greater than the distance from said pivot point to the engaging contacts to provide a blow-on action of said contacts.

2. A movable contact structure for switching apparatus having a contact movable into and out of engagement with a complementary contact, said movable contact structure comprising a contact arm oscillable between two predetermined positions, a contact lever carrying a movable contact on one end thereof, a pivot pin, the back of said contact arm having a part-cylindrical depression and the front of said lever having a corresponding part-cylindrical depression, the two depressions when in correspondence forming a cylindrical opening for receiving said pivot pin, said pivot pin protruding beyond the side of said lever and having flanges at each side to prevent lateral movement thereof, and a spring member extending between said arm and lever at right angles to said pivot pin for maintaining the inside surface of said part-cylinder formed in said



lever in abutting engagement with said pin and for maintaining the inside surface of said part-cylinder formed in said arm in corresponding opposed abutting engagement with said pin, a first connection stud connected to said complementary contact, a second connection stud, a circuit connection from said second connection stud to the other end of said contact lever opposite from the end carrying said contact, the circuit path from said first to said second connection stud through said contacts and contact lever forming a loop, the distance from said pivot point of said lever on said arm to the second connection stud being greater than the distance from said pivot point to the engaging contacts to provide a blow-on action of said contacts.

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