This invention relates to circuit breakers and more particularly to contact structures of air circuit breakers.

Conventional air circuit breakers are usually provided with one or more auxiliary sets of contacts which are designed to by-pass a large portion of the current for a short interval of time during circuit interruptions for the purpose of minimizing damage to the main contacts due to burning or pitting. The sets of contacts usually separate in sequence during a circuit opening operation with the main contacts separating first, the auxiliary contacts second and the arcing contacts last to draw the arc. In the usual contact arrangement wherein the moving contacts of the respective pairs of coating main, auxiliary and arcing contacts are carried by a pivoted contact arm, the main and auxiliary contacts being closer to the pivot of the contact carrying arm, are separated a lesser distance than the arcing contacts at the time of interruption. Under certain conditions a switching surge is produced of sufficient magnitude to cause the arc to restrike and since, at this time, the main contacts have separated a lesser distance than the arcing contacts, the tendency is for the arc to restrike across the main contacts.

Should a restrike of the arc occur across the main contacts, considerable burning and pitting of contacts may result. The interrupter also may not clear the circuit on such a restrike if the arc fails to transfer to the auxiliary and arcing contacts and continues to play outside the arc extinguishing structure.

It is an object of the invention to improve the circuit interrupting ability of circuit breakers of the foregoing type.

A more specific object of the invention is to provide a circuit breaker embodying an improved contact structure which obviates the above-mentioned electrical and mechanical difficulties.

Another object of the invention is to provide a circuit breaker embodying an improved contact structure in which increased main contact separation is provided at the time of arc extinction.

The novel features that are considered characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to structure and operation, together with additional aspects and advantages thereof will be best understood from the following detailed description of several embodiments thereof when read in conjunction with the accompanying drawings.

In said drawings:

Figure 1 is a side elevational view, partly in section, of a circuit breaker embodying the principles of the invention.

Fig. 2 is an enlarged side elevational view, partly in section, showing the improved contact structure in the closed contact position.

Fig. 3 is an enlarged elevational view, partly in section, showing the improved contact structure with the parts in the position they assume at the instance the arcing contacts separate.

Fig. 4 is an elevational view, partly in section, showing a modification of the improved contact structure.

Fig. 5 is a detail view of the latch mechanism.

Referring to Fig. 1 of the drawings, the circuit breaker is of the roll out type and is mounted on a truck comprising a pair of side plates 11 (only one being shown) which are rigidly joined by cross members 12, 13, 17 and 18 to form a rigid frame for supporting the circuit breaker. The truck is mounted on wheels 20 to facilitate rolling the circuit breaker into and out of a cubicle in order to connect and disconnect the breaker in an electrical circuit.

The circuit breaker is of the multi-pole type (only one pole being shown) and comprises a plurality of sets of separable contact means indicated generally at 21, a common operating mechanism 23, a trip device 25 and a closing means 27.

The contact means consists generally of stationary contact blocks 29 and 31 mounted respectively on upper and lower terminal members 33 and 35 which, in turn, are rigidly supported on a back plate 37. The back plate 37 is rigidly supported by angular brackets 39 (only one being shown) rigidly secured to the side plates 11 of the frame. A switch arm 41 pivotally mounted on a stud 43 on the lower terminal member 35 carries a bridging contact member 45 for cooperating with the stationary contacts 29 and 31 to open and close the circuit. The switch arm 41 also carries a movable arcing contact 47 which cooperates with a stationary arcing contact 49 mounted on the upper terminal member 33 for drawing the arc upon opening movement of the switch arm 41.

The detailed construction of the improved contact structure will be more fully described hereinafter.

The specific structures of the operating mechanism, trip mechanism and the closing means as shown, are fully disclosed in covending application Serial No. 716,104, filed December 13,
of a yoke 139 secured to a plate 141 mounted on the left-hand end of the U-shaped frame 69, an energizing coil 143, a movable armature (not shown) and a trip rod 145 attached to the movable armature.

The closing solenoid 27 comprises a fixed core member 147 and an energizing coil 149. The solenoid 27 is supported between the frame 69 and an end plate 151 secured thereto by means of bolts 163 and spacers 165.

Upon the occurrence of an abnormal circuit condition, such as for instance as an overload current in the circuit controlled by the breaker, the tripping electromagnet 137 is energized by well known means such as a fault relay. Upon energization of the tripping magnet the movable armature (not shown) thrusts the trip rod 145 upwardly to engage and operate the trip member 127 to thereby effect release of the latch member 109, which, in turn, releases the latch member 103. Upon release of the latch 103, the toggle 87--89 immediately collapses permitting clockwise rotation of the operating lever 61 to thereby cause opening of the breaker contact means.

The toggle 87--89 is reset—to its underset position and the latch member 103 is reset and relatched automatically during the operating operation. This is effected by means of a pair of springs 169 (only one being shown) tensioned between the movable armature 85 and the closing lever 75 at a point near the shaft 67. During the collapse of the toggle 87--89, a roller 175 carried on the toggle link 89 engages a projection 179 on the latch 85 and moves the latch downward to unlatching position to release the closing lever 75. Thereupon, the springs 169 draw the movable armature 85 of the closing solenoid toward the left, and acting through the link 81 rotates the closing lever 75 in a clockwise direction, thereby extending the toggle 87--89 to its underset position. As the toggle is extended it acts through the link 105 to rotate the latch member 103 clockwise to its latching position at which time the latching mechanism is reset and relatched to restrain the toggle 87--89 in thrust transmitting position. Thereafter the breaker is closed by energization of the closing solenoid 27 by a suitable source. When energized, the solenoid 27 attracts its armature 85 and, through the link 81, rotates the closing lever 75 in a counter-clockwise direction about the shaft 67. Since, at this time, the toggle 87--89 is held in thrust transmitting condition, the movement of the closing lever 75 is transmitted through the toggle to actuate the operating lever 61 and the rods 51 to close the contact means 21. As the closing lever reaches its closed position the latch 95 re-engages the roller 101 to restrain the breaker mechanism in the closed circuit position.

Referring now to Fig. 2 of the drawings, the switch arm 41 comprises a casting having a generally channel-shaped recess 171 in which the main bridging contact 45 is disposed. The bridging contact 45 is pivotally mounted on a pin 173 supported in the side walls of the channel-shaped recess 171. The bridging contact 45 is provided with a slightly elongated opening 176 through which the pin 173 extends. The bridging contact 45 is provided with contact elements 177 and 180 which are attracted to cooperate respectively with a contact element 181 and 183 on the contact blocks 29 and 31. Contact pressure between the contacts 177--181 and 182--183 in the closed position of the switch arm 41 is provided by means of two sets of springs 163 and 161 disposed on opposite sides
of the pivot pin 173 and compressed between the bottom of the recess 171 and the bridging contact 45. The springs 185 and 181 surround guide studs 183 and 181 respectively and mounted on the bottom wall of the recess 171. It may be noted here that the springs 187 are somewhat stronger than springs 185. A projection 193 which is integral with the switch arm 41 extends angularly upwardly therefrom toward the stationary arcing contact. A contact block 195 is secured mounted by means of bolts 197 and 199 to the forward side of the projection. The contact block 195 carries the movable arcing contact 47 and also a movable intermediate contact 201. The movable intermediate contact 201 cooperates with a stationary intermediate contact 203, which, together with the stationary arcing contact 49, is mounted on a contact platform 205. The contact platform 205 is mounted on the upper stationary contact block 25 for limited movement relative thereto by means of a pair of spaced plates 207 disposed one on each side of the contact block 25 and rigidly secured thereto by bolts 209. The platform 205 is provided with laterally extending studs 211 (only one being shown) disposed adjacent the lower end thereof and extending into elongated slots 213 in the plates 207 for supporting the platform for limited movement. Ears 215 (only one being shown) extend laterally from the sides of the platform 205 into openings 217 in the plates 207. The platform 205 is biased outwardly away from the contact block 25 by means of a coil spring 219 (Fig. 3) disposed adjacent the upper end of the platform and a coil spring 221 located near the lower end of the platform 205. The springs 219 and 221 are compressed between the contact block 29 and the contact platform 205 and the spring 219 is provided with a guide stud 223 secured to the contact block 29.

The contact platform 205 is electrically connected to the upper contact block 25 by means of a flexible shunt conductor 225 more clearly shown in Fig. 3, and a flexible shunt conductor 227 electrically connects the switch arm 41 to the lower contact block 31. In the closed circuit position of the breaker the circuit extends from the upper terminal 33, contact block 29, contacts 181—177, the bridging contact member 45, contacts 182—183, and the contact block 31 to the lower terminal 35. Another circuit extends through the arcing contacts and intermediate contacts as follows: Upper contact block 29, flexible shunt 225 (Fig. 3), contact platform 205, arcing contacts 49—41 and the intermediate contacts 203—201, contact block 195, switch arm 41, and the flexible shunt 221 to the lower contact block 31. When the trip device 137 (Fig. 1) is energized to effect collapse of the toggle 87—89, the operating lever 61 starts to rotate clockwise permitting downward movement of the rod 51 and movement of the switch arm 41 about its pivot 43 in opening direction. As the switch arm 41 moves in opening direction the contacts 177—182 under the pressure of springs 185—187 remain in contact respectively with the stationary contacts 181—183 until the pin 173 engages the left end wall of the slot 176. At this time the bridging contact member 45 will start to move in opening direction with the switch arm, but since the springs 187 are stronger than the springs 185, the contact 182 will be maintained in engagement with the stationary contact 183 and the bridging contact member 45 will be rotated counterclockwise about its pivot 173 until the upper end thereof engages the end of the spring guide stud 188. The counterclockwise movement of the bridging contact relative to the switch arm will effect higher speed separation of the main contacts 177—181 than would be attained if the springs 185—187 were of equal strength. Thereafter, the bridging member 45 will move to the open position with the switch arm 41 without further movement relative thereto.

The contact platform 205, under the influence of the springs 219 and 221 (Fig. 3) will follow the moving arcing and bridging contacts 47—201 respectively until the studs 211 engage the left end walls of the slots 213 in the plates 207. Thereafter the platform 205 will turn counterclockwise about the studs 211 until the ears 215 engage the left walls of the openings 217. The intermediate contacts 201—203 separate upon engagement of the studs 211 with the ends of the slots 213 and the arcing contacts 47—49 will separate when the ears 215 are arrested by the walls of the openings 217.

Figure 3 illustrates the improved contact structure at the point, during an opening operation, when the arcing contacts 47—49 are about to separate. Continued movement of the switch arm 41 in opening direction will effect separation of the arcing contacts 47—49 and drawing of the arc therebetween. The arc is drawn into an arc extinguishing structure indicated generally at 229 (Fig. 1) where it is quickly extinguished. The arc extinguishing structure 229 may be of any suitable type, but is preferably of the type fully disclosed in Patent No. 2,442,199, issued May 25, 1949, to R. E. Dickinson and R. E. Frink and assigned to the assignee of the present invention.

In the type of circuit breaker illustrated the arc will usually be extinguished when the arcing contacts 47—49 have separated approximately two inches. Under certain conditions when the circuit constants give a low damping factor, and the current is of sufficient magnitude, a switching surge may be produced which will cause the arc to restrick across a gap of this dimension. If, at this time, the main contacts 177—181 which are outside the arc chute 228 are closer together than the arcing contacts, the arc will restrick across the main contacts 177—181 and will not go back into the arc chute and damage will result.

According to the present invention, this is obviated by giving the main contacts 177—181 a greater separation than the arcing contacts 47—49 at the time of arc extinction so that any restricking of the arc will occur between the arcing contacts within the arc extinguisher structure 229.

As the switch arm 41 continues its opening travel from the Figure 3 position, the bridging member 45 rotates counterclockwise about the pin 173 relative to the switch arm 41 due to the fact that the springs 187 are stronger than the springs 185. The counterclockwise rotation of the bridging member 45 is arrested by the upper end thereof striking the spring guide or stop 189. In this position, and at the time the arc is extinguished, the contacts 177—181 are separated a greater distance than the arcing contacts 47—49, hence, any restricking of the arc will occur across the lesser gap between the arcing contacts within the arc extinguisher. By the time the
restricking arc has been extinguished the contacts will have separated far enough to prevent a sec-
ond restricking of the arc. Continued movement
of the switch arm 41 in opening direction after
the bridging member 43 engages the stop 165
causes separation of the contacts 197—193.
Thereafter the bridging member 43 moves to the
fully open position with the switch arm 41 with-
out further rotative movement relative thereto.
The fully open position of the movable contact
structure is indicated generally at 195 in Fig-
ure 2.
When the closing solenoid 27 (Fig. 1) is ener-
gized it acts through the operating mechanism
in the previously described manner to thrust
the rods 51 upwardly and rotates the switch
arms 41 clockwise from the fully open posi-
tion to close the contacts. The sequence of
engagement of the contacts is the reverse of the
engaging first, then, in order, the arcing contacts
47—49, the intermediate contacts 201—203 and
finally the main contacts 177—181.
According to the modification of the invention
illustrated in Figure 4, a bridging member 231,
similar to the bridging member 43 (Fig. 3) but
omitting the elongated slot, is pivoted on the pin
175 for rotative movement only relative to the
switch arm 41. The springs 195 (Fig. 3) are
omitted and the bridging member 231 is placed
in a counterclockwise direction about the pin 173
by the springs 161. The bridging member 231 is
provided with contact members 177 and 182
which are the same as those in Fig. 3 modi-
ification. The contact member 172 cooperates
with the stationary contact 153 on the lower con-
tact block 21 and the contact member 177 coop-
erates with a stationary contact member 233
mounted for limited movement on an upper con-
tact block 239, similar to the upper contact block
29 (Fig. 3), mounted on the upper terminal 33.
The contact member 233 is supported by means
of a spring clip 237 secured to the contact block
235 by means of a screw 239, and is biased into
engagement with the contact member 177 of
the bridging member 231 by means of a spring 241
compressed between a projection on the contact
block 235 and the contact member 233. The rec-
icropal sliding movement of the contact member
233 is limited by a projection 243 therein en-
gaging a slot 245 in the contact block 235. The
construction and operation of intermediate and
arcing contact of the Fig. 4 modification are the
same as those shown in Fig. 3, and, like parts
thereof have been given the same reference char-
acters.
The sequence of contact separation is the same
as for the Fig. 4 modification of the invention as
that of the modification shown in Fig. 3, that is,
the contacts 177—233 separate first followed by
separation of the intermediate contacts 201—203,
the arcing contact 47—49 and finally the con-
tacts 192—193 separate. When the switch arm
41 starts its counterclockwise rotation in open-
ing direction, the springs 181 maintain the con-
tact 182 in engagement with the contact 183 and
cause the bridging member 231 to rotate coun-
terclockwise about the pin 174, the contact mem-
ber 233 following under the influence of the
spring 241 until its movement is arrested by the
projection 243 engaging the end wall of the slot
245. As the switch arm 41 continues its coun-
terclockwise travel the bridging member 231 con-
tinues its counterclockwise rotation relative
thereto until the upper end thereof strikes the
stop member 189. Thereafter the bridging mem-
ber 231 will move with the switch arm 41 with-
out further movement relative thereto. The main
contacts 177—233 at the time the arc is
extinguished will have separated a greater dis-
tance than the arc 70—192. Hence, any restricking
of the arc, due to a switching or other surge, will occur across the arcing contacts
within the arc extinguisher.
The switch arm 41 (Fig. 4) is operated by the
mechanism shown in Figure 1 in the previously
described manner.
While the invention has been disclosed in ac-
cordance with the provisions of the patent stat-
utes, it is to be understood that various changes
in the structural details and arrangement of
parts thereof may be made without departing
from some of the essential features of the in-
vvention.
We claim as our invention:
1. A circuit interrupter comprising a pivotally
mounted switch arm, means for actuating said
switch arm to open and closed positions, a main
bridging contact member pivotally mounted on
said switch arm for limited movement relative
thereto, two spaced stationary contacts engage-
able by said bridging contact members on ac-
tuation of said switch arm to closed position,
separable arcing contact means actuated by said
switch arm for drawing an arm, and spring
means disposed between said bridging contact
member and said switch arm operable upon
opening movement of said switch arm to rotate
said main bridging contact member in opening
direction relative to said switch arm whereby at
least one end of the main bridging contact mem-
er is separated from its corresponding station-
ary contact a greater distance than the arcing
contacts when the arcing contact means are sep-
arated a distance most favorable for arc ex-
tinction.
2. A circuit interrupter comprising a pivotally
mounted switch arm, means for actuating said
switch arm between an open and a closed posi-
tion, a mean bridging contact member, a pivot
mounting said bridging contact member on said
switch arm for limited movement relative there-
to, spaced main stationary contacts engageable
by said bridging contact member and said switch
arm to the closed position, separable arcing
contact means operable by said switch arm upon
opening movement of said switch arm for draw-
ing an arc, spaced spring means disposed on
opposite sides of said pivot and compressed
between said switch arm and said bridging con-
tact member, one of said spring means being
stronger than the other and operable upon
opening movement of said switch arm to rotate
said main bridging contact member in opening
direction relative to said switch arm whereby
said bridging contact member and one of said
main contacts are separated a greater distance
than said arcing contacts at the time the arcing
contacts have separated a distance most favor-
able for arc extinction.
3. A circuit interrupter comprising a pivotally
mounted switch arm, means for actuating said
switch arm between an open and a closed posi-
tion, a main bridging contact member pivotally
mounted on said switch arm for limited move-
ment relative thereto, two spaced stationary
contacts engageable by said bridging contact
member on actuation of said switch arm to the
closed position, one of said stationary contacts
being mounted for limited movement, separable
arcing contact means actuated by said switch arm during movement thereof in opening direction to draw an arc, means for extinguishing said arc following separation of said arcing contacts, and spring means compressed between said switch arm and said bridging contact member operable during an opening movement to rotate said main bridging member in opening direction relative to said switch arm whereby said bridging contact member and said one stationary contact are separated a greater distance than said arcing contacts at the time the arcing contact means is in a position most favorable for arc extinction.

4. A circuit interrupter comprising spaced stationary contacts, a main switch arm pivoted on a fixed pivot and movable between open and closed position, a main bridging contact member pivoted on said switch arm and engageable with said stationary contacts when said switch arm is moved to closed position, arcing contacts adjacent said end of said bridging contact member for establishing an arc during movement of said switch arm to open position, and resilient means disposed between said main switch arm and said bridging contact for moving said bridging member in opening direction relative to said switch arm during opening movement of said switch arm to thereby provide a greater contact separation between said one end of said bridging contact member and its corresponding stationary contact than between said arcing contacts at a predetermined time during the opening movement of said switch arm when said arcing contacts separate to a position most favorable for arc extinction.

5. A circuit interrupter comprising spaced stationary contacts, a switch member movable between open and closed positions, a main bridging contact rotatably mounted on said switch member and engageable with said stationary contacts when said switch member is moved to the closed position, and spring means between said switch member and said main bridging contact for rotating said main bridging contact in opening direction relative to said switch member whereby the separation between one end of said bridging contact and its corresponding stationary contact is increased at a predetermined time during opening movement of said switch member.

6. A circuit interrupter comprising spaced stationary contacts, a switch member movable between open and closed positions, a main bridging contact rotatably mounted on said switch member and engageable with said stationary contacts when said switch member is moved to the closed position, and spring means compressed between said switch member and said main bridging contact for rotating said main bridging contact in opening direction relative to said switch member whereby the separation between one end of said bridging contact and its corresponding stationary contact is increased at a predetermined time during opening movement of said switch member, and stop means for limiting the opening movement of said bridging contact relative to said switch member.

7. A circuit interrupter comprising spaced stationary contacts, a switch member movable between open and closed positions, a main bridging contact pivotally mounted on said switch member for limited rotative movement relative thereto, said bridging contact engaging said stationary contacts in the closed position of said switch member, and a plurality of springs disposed between said switch member and said bridging contact, certain of said springs being stronger than certain others of said springs to cause rotation of said main bridging contact in opening direction relative to said switch member whereby the separation between one end of said bridging contact and its corresponding stationary contact is increased at a predetermined time during opening movement of said switch member.

8. A circuit interrupter comprising spaced stationary contacts, a switch member movable between open and closed positions, a main bridging contact pivotally mounted on said switch member for limited movement relative thereto, said bridging contact engaging said stationary contacts in the closed position of the switch member, and a plurality of springs disposed between said switch member and said bridging contact to provide contact pressure in the closed position, certain of said springs being stronger than certain others of said springs to effect rotation of said main bridging contact in opening direction relative to said switch member whereby the extent of separation between one end of said bridging contact and its corresponding stationary contact is increased at a predetermined time during opening movement of said switch member.

9. A circuit interrupter comprising a pivotally mounted switch arm, means for actuating said switch arm between open and closed positions, a main bridging contact member, a pivot mounting said bridging contact member on said switch arm for limited movement relative thereto, spaced stationary contacts engageable by said bridging contact upon actuation of said switch arm to closed position, separable arcing contact means adjacent one end of said bridging contact member operable by said switch arm upon opening movement thereof for drawing an arc, spaced spring means disposed on opposite sides of said pivot and compressed between said switch arm and said bridging contact member to provide contact pressure in the closed position of said switch arm, one of said spring means being stronger than the other and operative upon opening movement of said switch arm to rotate said main bridging contact member in opening direction relative to said switch arm whereby said one end of said bridging contact member is separated a greater distance from the associated stationary contact than said arcing contacts at the time the arcing contacts have separated a distance most favorable to arc extinction.

10. A circuit interrupter comprising a pivotally mounted switch arm, means for actuating said switch arm to open and closed positions, a main bridging contact member pivotally mounted on said switch arm for limited movement relative thereto, spaced stationary contacts cooperating with said main bridging contact member in the closed position of said switch arm, a stationary arcing contact, a movable arcing contact rigidly mounted on said switch arm and cooperating with said stationary arcing contact during an opening operation of said switch arm to draw an arc, means for extinguishing said arc, and spring means disposed between said main bridging contact member and said switch arm operable upon opening movement of said switch arm to rotate said main bridging contact member in opening direction relative to said switch arm whereby one end of the main bridging contact member is separated from its corresponding stationary con-
tact a greater distance than the arcing contacts when the arcing contacts have separated a distance most favorable for arc extinction.

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