Nov. 2, 1965 E. C. GOODWIN, JR 3,215,803

CONTACT STRUCTURE FOR CIRCUIT BREAKER

Filed Dec. 31, 1962 2 Sheets-Sheet 1

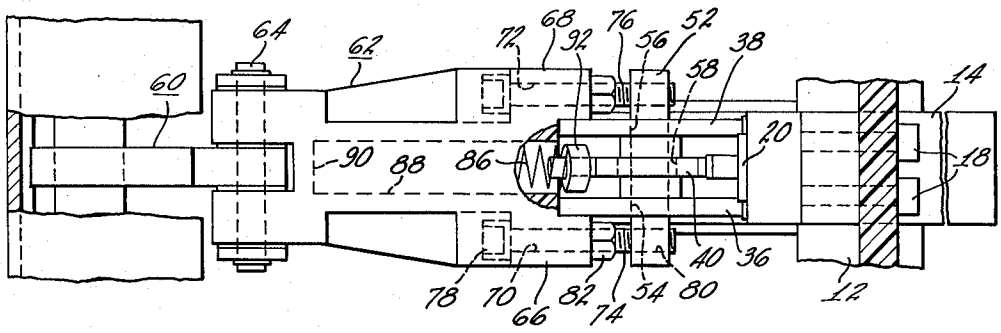

Fig. 2

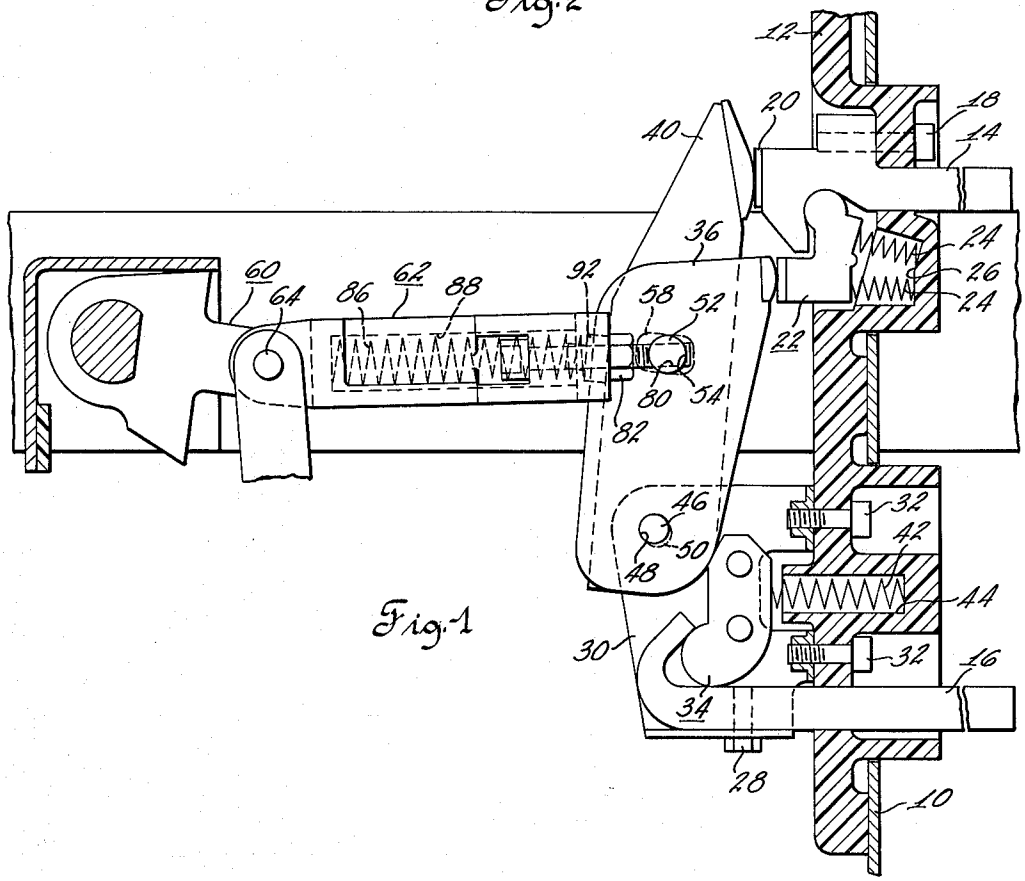

Fig. 1

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CONTACT STRUCTURE FOR CIRCUIT BREAKER

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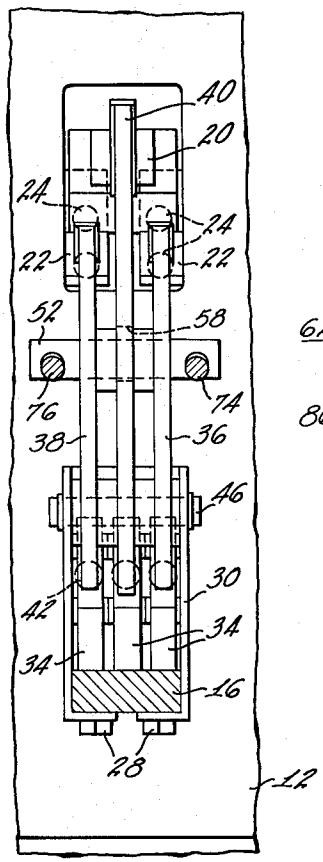

Fig. 4

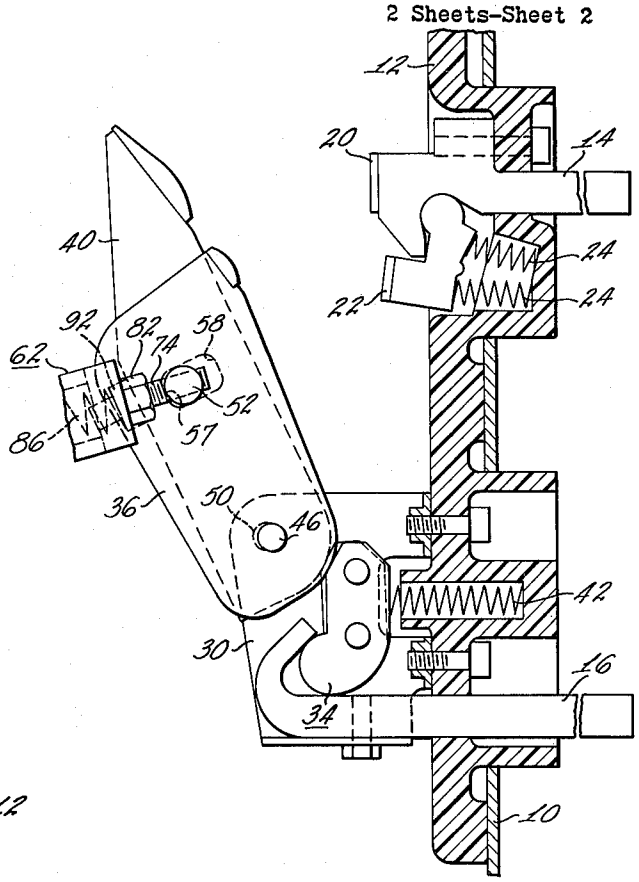

Fig. 3

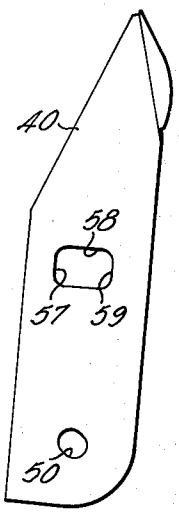

Fig. 5

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CONTACT STRUCTURE FOR CIRCUIT BREAKER

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10 Claims. (Cl. 200—146)

This invention relates generally to electric circuit breakers and, particularly, to improved primary contact structures of modular construction for use therein.

In one type of low voltage air type circuit breaker the primary contact structure comprises a stationary contact assembly and a movable contact assembly for each pole. The stationary contact assembly comprises a pair of spaced apart electrically conductive members or studs which are adapted to be bridged by the movable contact assembly. The movable contact assembly is pivotally mounted on or near one of said studs and is in permanent electrical connection therewith. The movable contact assembly is movable out of or into electrical contact with the other stud, i.e., to an open or closed position. The movable contact assembly comprises a main contact and an arcing contact which closes first and opens last in order to prevent arcing damage to the main contact.

It is an object of the present invention to provide improved primary contact structures of the foregoing type.

Another object is to provide improved primary contact structures of the foregoing type wherein the electromagnetic force in the U-shaped loop formed by the studs and the movable contact assembly, and normally tending to open the movable contact assembly, is employed to improve the electrical connection between the stationary contact assembly and the movable contact assembly.

Another object is to provide improved primary contact structures of the aforesaid type having improved connecting means between the movable contact assembly and the studs which it bridges.

Another object is to provide improved adjusting means for adjusting the main contact follow-up, i.e., contact pressure against the stationary contact of the movable contact assembly to compensate for manufacturing tolerances and wear, which means permit independent adjustment of the contact assembly at each pole and do not require any disassembly of the contact structure.

Another object is to provide improved contact structures of modular construction wherein the main contacts and the arcing contacts are readily replaceable in the event of wear and deterioration and wherein various combinations of contacts can be provided as required to handle the amounts of current the circuit breaker is intended to interrupt.

Another object is to provide improved contact structures of modular construction which comprises components which are relatively economical to fabricate and assemble, which are interchangeable, and which are readily adjustable.

Another object is to provide adjusting means of the aforesaid character which are well adapted to permit coordinated adjustment of contacts in a multicontact structure.

Other objects and advantages of the invention will hereinafter appear.

In accordance with the present invention there is provided a circuit breaker having an insulating support on which one or more primary contact assemblies are mounted. Each primary contact assembly comprises a stationary contact assembly and a cooperating movable contact assembly. The stationary contact assembly comprises a pair of spaced apart electrically conductive studs which are rigidly mounted on the insulating support, preferably

with one stud above the other and the studs are adapted to be bridged by the movable contact assembly when the latter is in closed position to form a U-shaped current path. The upper stud is provided with a stationary main contact and a stationary arcing contact. The stationary main contact is mounted on the upper stud and is spring biased thereagainst. Electrically conductive spring loaded members are provided for connecting the lower stud and the movable contact assembly. When heavy current flows through the U-shaped current path, magnetic forces generated tend to force the main contact against the upper stud and the movable contact assembly. Similarly, the magnetic forces also tend to force the spring loaded members against the lower stud and the movable contact assembly. The movable contact assembly comprises a movable main contact and a movable arcing contact. These latter contacts are pivotally mounted on a pivot pin on a bracket which is attached to the insulating support and are understood to be movable into and out of engagement with the stationary main contact and the stationary arcing contact, respectively. The movable main contact and the movable arcing contact are capable of a slight amount of relative movement with respect to each other. Means are provided to limit their relative movement and such means takes the form of a projection or pin which extends laterally from the main contact through a slot formed in the movable arcing contact. The projection or pin also transmits motion from the movable main contact to the movable arcing contact. A member is provided to move the movable contact assembly into and out of engagement with the stationary contact assembly in response to operation of the circuit breaker mechanism. The member is rigidly attached to the movable main contact by means, such as an adjustable screw, which permit adjustment of the relative distance between the member and the movable main contact. Thus, the distance between the movable main contact and the stationary main contact can be changed. Biasing means, such as a compression spring disposed between the member and the arcing contact, are provided to bias the arcing contact. Thus, when the movable contact assembly is in "open" position, the movable arcing contact is biased to a position which permits it to close before the movable main contact closes. After the movable arcing contact closes, the movable main contact closes and the compression spring becomes further compressed. As the movable contact assembly moves from "closed" to "open" position the compression spring biases the movable arcing contact in its "closed" position until after the member acting directly on the movable main contact has moved the latter to "open" position. The movable main contacts and the arcing contact are pivotally mounted on a pivot pin and are associated with the other aforementioned pin in such a manner as to be readily disassembled for replacement or substitution by contacts of similar construction or other current ratings.

The accompanying drawings illustrate a preferred embodiment of the invention but it is to be understood that the invention illustrated is susceptible to modifications with respect to details thereof without departing from the scope of the appended claims.

In the drawings:

FIG. 1 is a cross sectional view of a primary contact assembly incorporating the present invention and shows the stationary contact assembly and the movable contact assembly in closed condition;

FIG. 2 is a top plan view of the primary contact assembly shown in FIG. 1;

FIG. 3 is a view similar to FIG. 1 but showing the stationary contact assembly and the movable contact assembly in open condition;

FIG. 4 is a side view of the primary contact assembly; and

FIG. 5 is a detail view of a movable arcing contact element which is part of the movable contact assembly.

FIGS. 1 through 4 show a portion of the primary contact structure of an electric circuit breaker, such as a low voltage air type circuit breaker. It is to be understood that a primary contact structure of the type shown normally comprises a plurality of primary contact assemblies, one for each pole of the circuit breaker, but only one primary contact assembly is discussed herein. The primary contact structure comprises supporting means such as a sheet metal member or pan **10** on which a molded insulating member or base **12** is rigidly attached and the base affords support for the primary contact assembly.

Each primary contact assembly comprises a stationary contact assembly and a movable contact assembly. The stationary contact assembly comprises a pair of spaced apart electrically conductive studs **14** and **16** which extend through openings in base **12** and are rigidly attached thereto. Preferably, the studs take the form of heavy copper bars somewhat wider than they are thick. Upper stud **14** is secured to base **12** by means such as the bolts **18**. Upper stud **14** is provided with a stationary arcing contact segment **20** which is rigidly attached thereto as by brazing. Upper stud **14** is also provided with a pair of stationary main contact fingers, such as the fingers **22** shown in FIGS. 1, 3 and 4, which are electrically connected thereto. The fingers **22** are movably connected to upper stud **14**, as by pivoting in a recess therein, and are biased against the upper stud and into proper position by the springs **24** which are disposed in a recess **26** in base **12** behind the contact fingers.

Lower stud **16** is secured in position on base **12** by means such as bolts **28**, shown in FIGS. 1, 3 and 4, which are connected to a bracket **30**. Bracket **30** is secured to base **12** by bolts **32** shown in FIGS. 1 and 3. One end of lower stud **16** is bent or hooked as shown in FIGS. 1 and 3 and is thereby adapted to make frictional engagement with a plurality of kidney shaped electrically conductive members **34** which are part of the electrical connection or path between lower stud **16** and the movable contact assembly. In the embodiment disclosed herein the movable contact assembly is shown as comprising two movable main contact segments **36** and **38** and a movable arcing contact segment **40** disposed between them. Accordingly, three conductive members **34** are provided; one for each movable contact segment. However, in accordance with the invention a greater or lesser number of movable main contact segments could be employed, provided that other necessary adaptations are made. The conductive members **34** are supported against lateral displacement by the sides of bracket **30** and are understood to be independently movable with respect to each other. Each conductive member **34** is biased against lower stud **16** and against its respective movable contact segment by means such as a compression spring **42** which is disposed in a recess **44** in base **12** behind the conductive member.

The conductive members **34** make tight sliding electrical contact with their respective movable contact segments in the movable contact assembly no matter what position the latter assumes. Furthermore, when heavy electrical current flows through the U-shaped loop formed by upper stud **14**, its contact fingers **22**, lower stud **16**, the conductive members **34** and the movable contact segments **36**, **38** and **40** (see FIG. 1), the electromagnetic forces generated tend to force the conductive members tightly against the lower stud and the movable contact segments. As is apparent, the contact fingers **22** and the conductive members **34** are located at the inside corner of the U-shaped current path.

Bracket **30** supports a pin **46** on which the movable contact segments **36**, **38** and **40** of the movable contact assembly are pivotally mounted. As FIGS. 1 and 3 show, the movable main contact segments **36** and **38** are provided with circular holes, such as the hole **48**, for accommodating pin **46** and movable arcing contact segment **40** is provided with an elongated hole **50** which allows segment **40** some play as it pivots. Movable arcing contact segment **40** is disposed between and adjacent the movable main contact segments **36** and **38** and is somewhat longer than the latter so as to be able to engage stationary arcing contact segment **20**.

Comparison of FIGS. 1 and 3 shows that movable arcing contact segment **40** is relatively movable with respect to the movable main contact segments **36** and **38** so that the movable arcing contact can close first and open last with respect to the closing and opening of the movable main contacts. Means are provided to limit such relative movement and to provide for movement of the movable arcing contact in response to movement of the movable main contact. Such means take the form of a pin **52** which extends through snugly fitting holes **54** and **56** which are provided in the movable main contact segments **36** and **38**, respectively. Pin **52** rigidly connects the contact segments **36** and **38** so that they move or pivot together as a unit. Pin **52** extends through a slot **58**, shown in FIGS. 1, 3 and 5, in movable arcing contact segment **40** and relative movement of segment **40** with respect to the movable main contact segments **36** and **38** is thus limited. As FIG. 5 shows, slot **58** has a rear edge **57** and a front edge **59**. Furthermore, when the main contact segments **36** and **38** are moved in either direction so that pin **52** reaches the end of its travel in slot **58**, arcing contact segment **40** then moves with the main contacts.

It will be apparent to those skilled in the art that the type of primary contact structures to which the present invention is directed normally have a number of undesirable characteristics. Thus, there is usually a lack of scrubbing action as the main and arcing contacts open and close. Further, as hereinbefore noted, there is a tendency for the contacts to blow apart at the point of contact due to the magnetic forces acting on the movable contact within the loop and localized magnetic forces at the point of contact. Then too, there is a tendency for the arcing contact to bounce at the time of making contact which results in deterioration of the contact material. Hammering of the contacts during closure also results in deformation of the contacts and cold welding. A movable arcing contact constructed and employed in accordance with the present invention has as one of its objects either elimination or minimization of the aforesaid undesirable characteristics. Movable arcing contact **40** is a resiliently balanced contact which minimizes contact bounce due to the absorption of the impact forces by biasing spring **86**. Such resilient balance also reduces deformation due to hammering and reduces cold welding.

As FIG. 5 shows, opening **50** in movable arcing contact **40** for accommodating pivot pin **46** is not a round close fitting hole but is a loosely fitting hole, such as an angularly disposed slot, serving several purposes. Opening **50** permits movable arcing contact **40** to move on pin **46** during contact closure and therefore provides the desired scrubbing action between the movable arcing contact and stationary arcing contact **20**. Furthermore, the shape of opening **50** permits movable arcing contact **40** to rotate about the point where it engages contact **20** under the increased electromagnetic forces exerted against contact **40** during heavy current flow. Such rotational movement further compresses biasing spring **86** and results in additional contact pressure being exerted to close movable arcing contact **40** and, therefore, to resist blow-off of the arcing contact by the magnetic forces.

Furthermore, pin **52** is adapted to serve as part of the means by which main contact follow-up, i.e., contact pressure, is adjusted, as will hereinafter appear.

Although pin **52** is shown as a distinct, removable element, it could be an integrally formed projection on one of the movable main contact segments and would function in the same manner. Furthermore, such a projec-

tion could be adapted to cooperate with means other than slot 58 in movable arcing contact segment 40, such as a depression in the surface of the segment 40 or the like. Such an arrangement, however, would be suited for a movable contact assembly employing one movable main contact segment.

In a primary contact assembly constructed in accordance with the embodiment of the invention disclosed, pin 52 and pivot pin 46 are removable and movable contact segments of one size and current rating can readily be replaced during manufacture or in the field by those of another size and rating. The configuration of the movable contact segments and the manner in which they are associated with pivot pin 46 and pin 52 aid in this purpose.

Means are provided to move the movable contact assembly into and out of engagement with the stationary contact assembly. Such means includes a collapsible linkage 60 and a member 62 which is pivotally connected to the linkage by a pin 64. As will be understood, linkage 60 is adapted to move member 62 in a substantially horizontal direction (with respect to FIG. 1) toward the right to circuit closed position shown in FIG. 1 and to the left to circuit open position shown in FIG. 3. Preferably, member 62 is made of electrical insulating material and is fabricated by molding.

Means are provided for rigidly but adjustably connecting member 62 to the movable contact assembly. Thus, member 62 is provided with shoulders 66 and 68 having holes 70 and 72, respectively, therein which are adapted to accommodate threaded members or screws 74 and 76, respectively.

Screw 74, for example, is provided with a head 78 which bears against one face of shoulder 66. Screw 74 is in threaded engagement with a tapped hole 80 which is provided in one end of pin 52. A lock nut 82 on screw 74 bears against the other face of shoulder 66 and rigidly secures screw 74 on member 62. Head 78 of screw 74 is adapted to accommodate means, such as an Allen wrench, which is employed to turn the screw. With lock nut 82 loosened, screw 74 can be adjusted by turning it in or out of tapper hole 80 in pin 52 to set movable main contact element 36 at a predetermined distance from member 62 and, thus, at a predetermined distance from stationary main contact 22 with which it engages.

As will be understood, screw 76 is associated with the other end of pin 52 in the same manner as screw 74. Thus, by advancing or retracting the screw 74 or 76 either together or separately, movement of pin 52 is effected and the movable main contact elements 36 and 38, respectively, can be moved into the desired adjusted position with respect to the stationary main contacts 22. Advancing or retracting one end of pin 52 with respect to its other end would, of course, effect corresponding adjnstment of the movable main contact associated with the one end of the pin.

It is apparent that the screws 74 and 76 could be attached directly to the movable main contact segments 36 and 38, respectively, in a manner other than that disclosed and still effect adjustment of those contact segments. However, in accordance with the invention they are attached to pin 52 thereby reducing the number of parts required and permitting easy replacement of the movable main and arcing contact segments.

As explained hereinbefore, movable arcing contact segment 40 is movable to two extreme positions with respect to the movable main contact segments 36 and 38. Biasing means are provided to bias movable arcing contact segment 40 to the position shown in FIG. 3 wherein rear edge 57 of slot 58 bears against pin 52. Thus, movable arcing contact segment 40 is ready to engage stationary arcing contact 20 before the movable main contact segments 36 and 38 engage the stationary main contacts 22. The biasing means also permit movable arcing contact segment 40 to assume the contact closed position shown in FIG. 1 wherein it is moved back slightly with respect to the movable main contact segments 36 and 38. Thus, as the movable contact assembly moves from the contact closed position to the contact open position, the biasing means hold movable arcing contact segment 40 closed while the movable main contact segments open. Such means comprise, for example, a compression spring 86 which is disposed in a recess 88 in member 62. One end of spring 86 bears against an end wall 90 of recess 88 and the other end of the spring is provided with an adapter 92, preferably fabricated of insulating material, which bears against the rear edge of movable arcing contact 40.

The primary contact assembly disclosed herein operates as follows. Assume that the components of the primary contact assembly are in the position shown in FIG. 3. In this position the stationary main contact fingers 22 are biased outwardly and the conductive members 34 are biased firmly against their respective movable contact segments. In the movable contact assembly biasing spring 86 acts upon movable arcing contact segment 40 to bias it to a position where the rear edge 57 of slot 58 is against pin 42.

As circuit breaker linkage 60 is actuated to move member 62 toward the right (with respect to FIGS. 1 and 3), the motion of member 62 is transmitted through the screws 74 and 76 to pin 52 to effect movement of the movable main contact segments 36 and 38. As those segments move, movable arcing contact segment 40 follows along due to the biasing action of compression spring 86. Movable arcing contact segment 40 makes contact with stationary arcing contact segment 20 and its movement is thereby stopped. However, the movable main contacts 36 and 38 continue to move until they engage the stationary main contacts 22. During this continued movement of the movable main contact segments, member 62 acts upon spring 86 to further compress it.

With the movable contact assembly in circuit closed position shown in FIG. 1, a U-shaped electrical path is established through upper stud 14 and its contacts 20 and 22, through main contacts 36 and 38 and arcing contact 40, through the conductive members 34, and through lower stud 16. When heavy electrical current flows through the U-shaped path, electromagnetic forces are generated which, instead of tending to blow open the contacts, act as follows. The electromagnetic forces force the main contact fingers 22 into tight engagement with the movable main contact segments 36 and 38. The electromagnetic forces acting on the contact fingers 22 are aided by the action of springs 24. The electromagnetic forces also act on the conductive members 34 and force them against lower stud 16 and the respective movable contact segments with which they are associated. The electromagnetic forces acting upon the conductive members 34 are aided by the action of spring 42. The effect of the electromagnetic forces acting upon the movable main contact segments 36 and 38 is nullified because its segments are attached to pivot pin 46 and to pin 52 which is maintained in a fixed position by member 62 and linkage 60. The effect of the electromagnetic forces acting upon movable contact segment 40 is overcome by the fact that segment 40 is mounted on pin 46 and is biased in an opposite direction by spring 86.

The movable contact assembly is moved from the contact closed position shown in FIG. 1 to the contact open position shown in FIG. 3 in the following manner. As member 62 is moved to the left with respect to FIG. 1 by linkage 60 such motion is transmitted through the screws 74 and 76 to pin 52 and thus to the movable main contact segments 36 and 38. However, if the movable main contact segments 36 and 38 are moved open, biasing spring 86 expands to maintain movable arcing contact segment 40 in the closed position. Movable arcing contact segment 40 remains in the closed position until pin 52 bears against the rear edge 57 of slot 58 and the pin forces contact segment 40 to open.

Having now particularly described and ascertained the nature of my said invention and the manner in which it is to be performed, I declare that what I claim is:

1. In a circuit breaker, in combination, a support, a stationary contact assembly comprising a pair of spaced apart electrically conductive studs mounted on said support, a movable contact assembly mounted on said support and comprising a pivotally mounted main contact and a pivotally mounted arcing contact, said main contact and said arcing contact being relatively movable with respect to each other, electrically conductive members frictionally engaging one of said studs and said main contact and said arcing contact for establishing electrical connection between said contacts and said one stud, means on said main contact and said arcing contact for limiting relative movement between them, a member for moving said main contact and said arcing contact, adjustable means for rigidly connecting said member to said main contact, and biasing means connected between said member and said arcing contact for biasing said arcing contact into predetermined positions with respect to said main contact.

2. In a circuit breaker, in combination, a support, a pair of spaced apart studs mounted on said support, a stationary arcing contact and a resiliently mounted stationary main contact mounted on one of said studs, a movable contact assembly pivotally mounted on said support, said assembly comprising a main contact element and an arcing contact element relatively movable to a limited degree with respect to said main contact element, a pair of conductive members biased into frictional engagement with the other of said studs, one of said conductive members being biased into frictional engagement with said main contact element and the other of said members being biased into frictional engagement with said arcing contact element, a movable member for moving said movable contact assembly into contact open and contact closed position, adjustable means for rigidly connecting said movable member to said main contact element, and biasing means disposed between said movable member and said arcing contact element for maintaining the latter in predetermined positions with respect to said main contact element.

3. In a circuit breaker, in combination, a stationary contact assembly, a movable contact assembly movable into and out of engagement with said stationary contact assembly, said movable contact assembly comprising, a pivotally mounted main contact, a pivotally mounted arcing contact relatively movable to a limited extent with respect to said main contact, biasing means acting upon said arcing contact to maintain it in a position with respect to said main contact when said movable contact assembly is out of engagement with said stationary contact assembly and permitting it to assume another position with respect to said main contact when said movable contact assembly moves into engagement with said stationary contact assembly, and means connected to said main contact for moving said movable contact assembly.

4. In a circuit breaker, in combination, a stationary contact assembly, a movable contact assembly movable into and out of engagement with said stationary contact assembly, said movable contact assembly comprising a pivotally mounted main contact, a pivotally mounted arcing contact relatively movable with respect to said main contact, means on said main contact and said arcing contact for limiting movement of said arcing contact with respect to said main contact, a member for moving said contact assembly, adjustable means rigidly connecting said member to said main contact, and biasing means connected to said member and said arcing contact for biasing said arcing contact into one position with respect to said main contact when said movable contact assembly is out of engagement with said stationary contact assembly and for permitting said arcing contact to assume another position with respect to said main contact when said movable contact assembly moves into engagement with said stationary contact assembly.

5. In a circuit breaker, in combination, a support, a main contact pivotally mounted on said support, an arcing contact adjacent said main contact and pivotally mounted on said support, said arcing contact having a slot therein, means projecting from said main contact and into said slot, a member for moving said main contact and said arcing contact, adjustable means rigidly connecting said member and said main contact, and biasing means connected between said member and said arcing contact for biasing said arcing contact to predetermined positions with respect to said main contact.

6. The combination according to claim 5 wherein said biasing means comprises a compression spring disposed between said member and said arcing contact.

7. In a circuit breaker, in combination, a support, a stationary contact assembly mounted on said support, a movable contact assembly movable into and out of engagement with said stationary contact assembly, said movable contact assembly comprising a pivotally mounted main contact and a pivotally mounted arcing contact movable with respect to the main contact, means on said main contact and said arcing contact for effecting movement of the latter by the former and for limiting relative movement between the latter and the former, and means for moving said movable contact assembly, said means for moving said movable contact assembly comprising a movable member, an adjustable threaded member rigidly connected between said movable member and said main contact, and a compression spring connected between said movable member and said arcing contact.

8. In a movable contact assembly movable to a contact open and a contact closed position, in combination, a pivotally mounted main contact and a pivotally mounted arcing contact adjacent to said main contact and movable with respect to said main contact, said arcing contact having a slot therein, means projecting from said main contact and extending through said slot, a member for moving said contacts, an adjustment screw rigidly connecting said member and said means, and a compression spring connecting said member and said arcing contact.

9. The combination according to claim 8 wherein said means is a pin journaled in said main contact and provided with a tapped hole for engaging said adjustment screw.

10. In a circuit breaker, in combination, a support, a shaft mounted on said support, a pair of main contacts pivotally mounted on said shaft, an arcing contact pivotally mounted on said shaft between said pair of main contacts, said arcing contact being provided with a slot, a pin rigidly connecting said pair of main contacts and extending through said slot in said arcing contact, said pin being provided with a pair of threaded holes, each hole being near an end of said pin, a member for moving said main and arcing contacts, a pair of adjustment screws mounted on said member and each screw adapted to engage one of said threaded holes in said pin, and a compression spring supported by said member and bearing against said arcing contact.

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