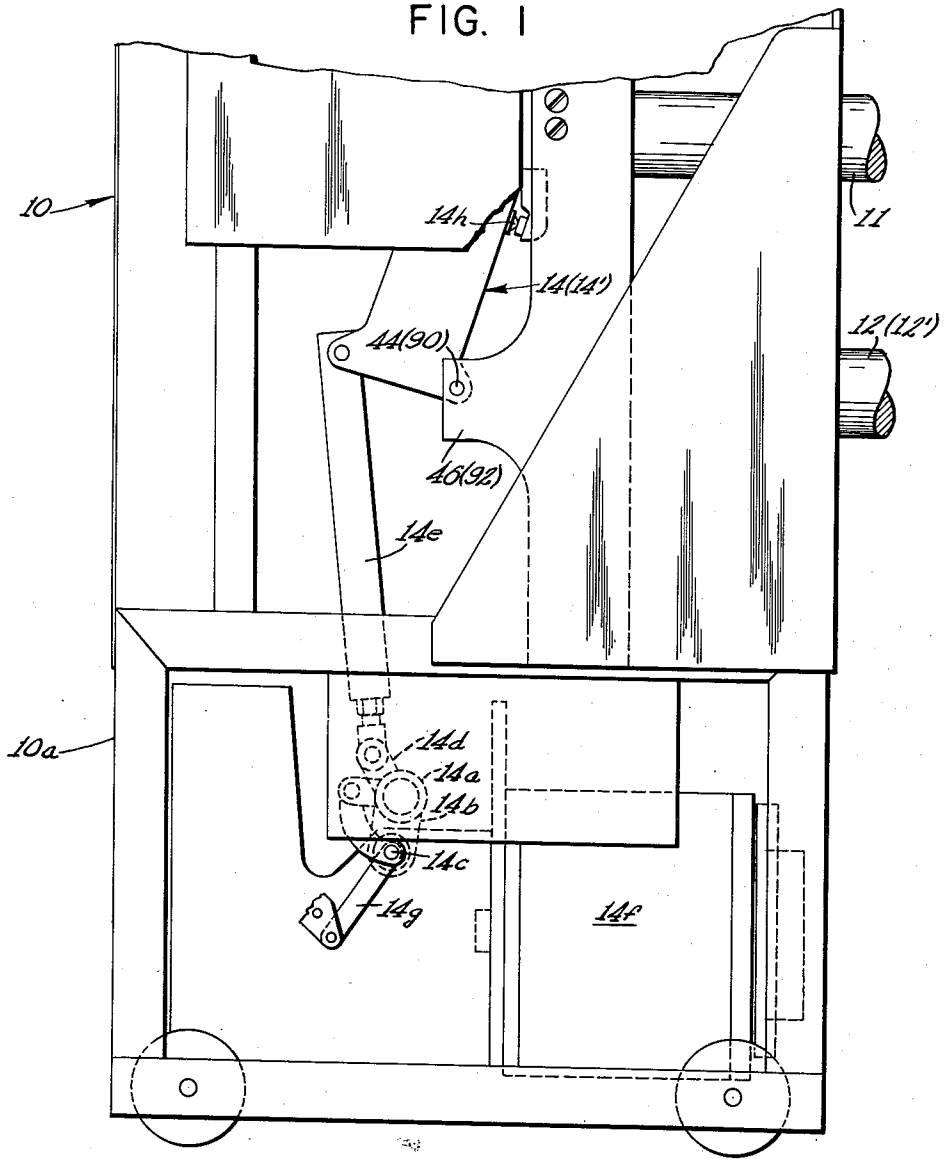
June 26, 1962 D. C. MILLS 3,041,431

CIRCUIT BREAKER

Filed June 26, 1959 3 Sheets-Sheet 1

FIG. 1



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CIRCUIT BREAKER

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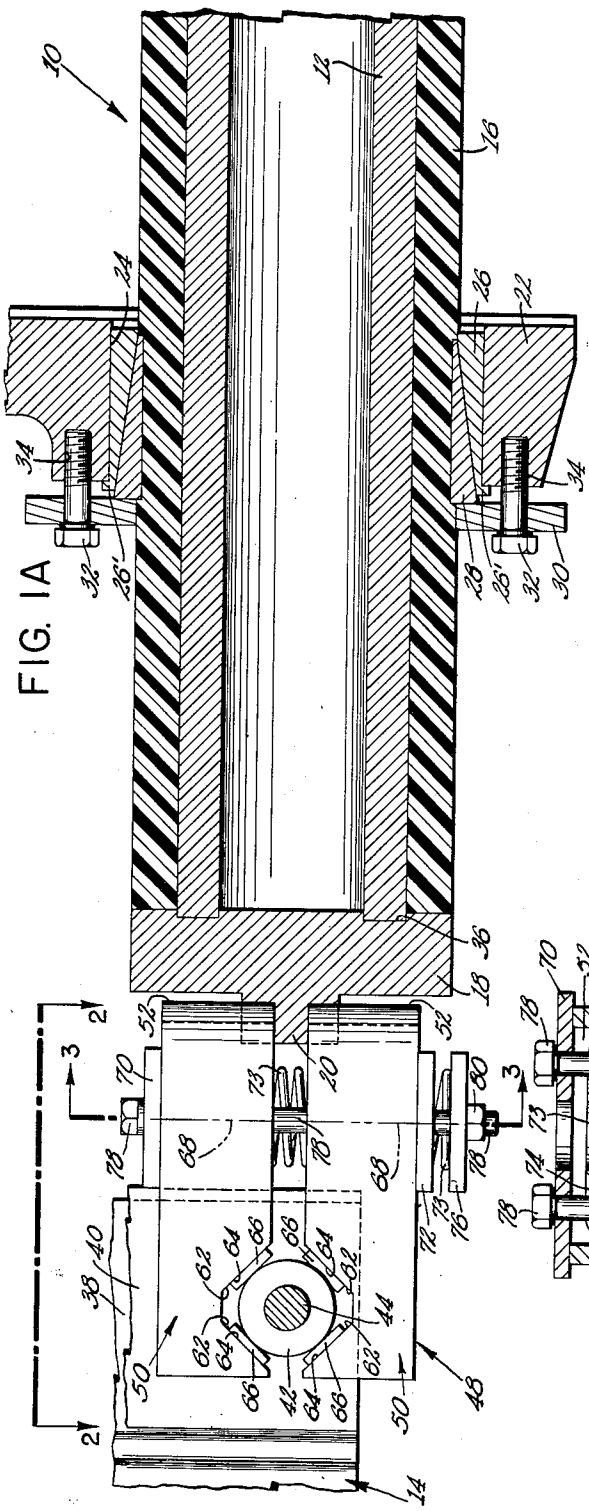

FIG. 1A

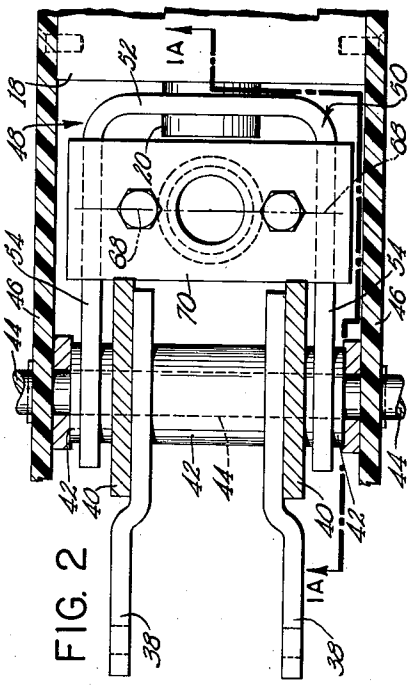

FIG. 2

FIG. 3

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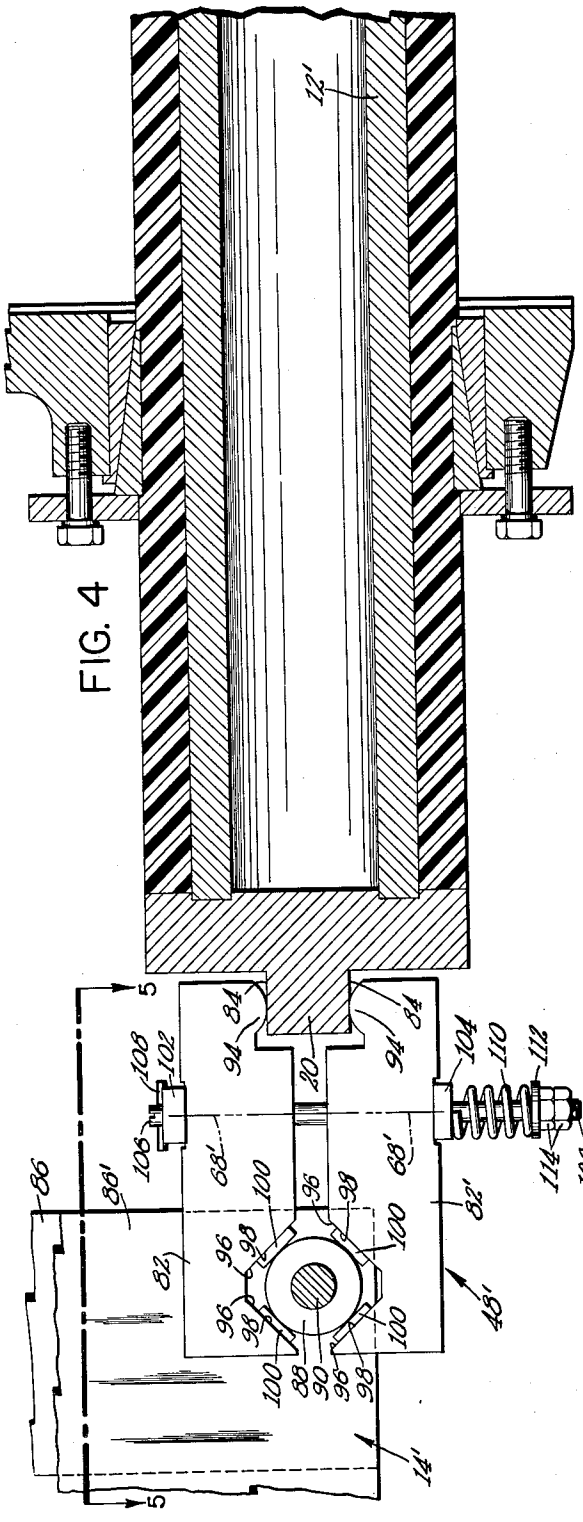

FIG. 4

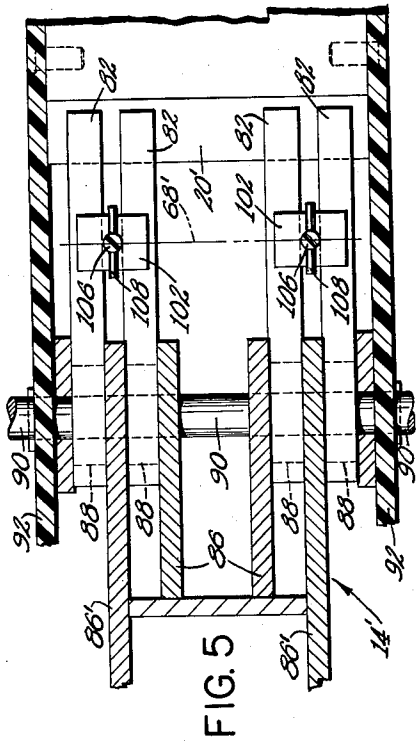

FIG. 5

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3,041,431

CIRCUIT BREAKER

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Filed June 26, 1959, Ser. No. 823,251
9 Claims. (Cl. 200—170)

This invention relates generally to a circuit breaker and, more particularly, to a high voltage high capacity circuit breaker such as is used in metalclad switchgear.

In the illustrative type circuit breaker, each pole includes two main conductors that are bridged by a moving contact arm pivotally mounted for movement between circuit open and circuit closed positions. The moving contact arm of each pole of this type of circuit breaker is electrically connected to one of the main conductors of that pole and moves into and out of substantially normal contact engagement with a companion contact carried by the other main conductor of that pole. Each moving contact arm is electrically connected to one of its main conductors at all times and throughout its pivotal movement.

The primary aim and object of the present invention is the provision of an improved arrangement for both providing mechanical support for the contact arm and for electrically connecting one of the main conductors of each pole to the associated movable contact arm. A related object resides in the provision of a novel pivotal support and electrical connection for such a pivoted contact arm which avoids the need for connecting braid. A more particular object of the present invention resides in the provision of an improved arrangement for electrically connecting a main conductor to a companion movable contact arm as aforedescribed in which the electrical connection is made through a pivotal connection at the pivotal mounting of the movable contact unit, this arrangement providing a reliable electrical connection from such conductor to the contact arm during the range of pivotal movement thereof.

Yet another object of the present invention is the provision of a generally improved circuit breaker of the aforenoted character which is eminently suitable for the accomplishment of its intended purposes.

The illustrative embodiments of the invention, which have been generally referred to above as incorporating the various novel features of the invention, is more fully described in the remainder of this specification, from which further novel features and objects and advantages will become apparent. In the following description reference is made to the accompanying drawings forming part of this disclosure. In the drawings:

FIGURE 1 is a side elevation, with parts broken away, of an illustrative circuit breaker embodying the present invention in both detailed forms shown in the remaining figures;

FIGURE 1A is a vertical section as viewed from the line 1A—1A in FIGURE 2, showing a part of the circuit breaker of FIGURE 1 embodying the features of the present invention;

FIGURE 2 is a plan sectional view taken on the line 2—2 of FIGURE 1A;

FIGURE 3 is a sectional view taken on the line 3—3 of FIGURE 1A;

FIGURE 4 is a view similar to FIGURE 1A showing another embodiment of the present invention; and

FIGURE 5 is a plan sectional view taken on the line 5—5 of FIGURE 4.

Referring to the drawings, and more particularly to FIGURE 1A, there is shown a part of circuit breaker **10** which is of the same general type shown and described in my application Serial No. 684,268, filed September 16, 1957, for Circuit Breakers, now Patent No. 2,943,168, June 28, 1960, and assigned to the assignee herein, reference being made to said application for a more detailed description of the circuit breaker. Each pole of the circuit breaker **10** includes studs **11** and **12**, these studs also being referred to herein as main or stationary conductors. These studs are bridged by the moving contact arm **14** which is pivotally mounted in the manner to be described in detail below. The circuit breaker has three poles, and accordingly there are three pairs of main conductors and three contact arms **14**, the latter being pivotally movable between circuit open and circuit closed positions. Each contact arm **14** is pivotally mounted on its own supporting shaft **44** (**90**) of steel or the like carried in "boards" or plates **46** of insulation that flank each pole. (The numbers in parentheses refer to parts in FIGURES 4 and 5 whereas the other numbers refer to parts in FIGURES 1A, 2 and 3.)

The common operating mechanism for all of the moving contact arms **14** includes a casting **14***a* that extends across all of the poles. This casting is carried in arms **14***b* that are suitably pivoted at **14***c*. Casting **14***a* has arms **14***d* connected to push rods **14***e* of insulation there being one push rod for each moving contact arm **14**. A solenoid **14***f* provides driving power for operating casting **14***a* to drive and retain contact arms **14** to the closed position illustrated, acting through a trip-free release coupling **14***g*. The details of this mechanism are more fully shown and described in my application mentioned above and are omitted here inasmuch as they are apparently not essential to an understanding of the present invention.

It will be understood that in closing the circuit breaker and keeping it closed, a powerful upward force is directed along rod **14***c*, this force acting about shaft **44** (**90**) for operating contact arm **14** and for maintaining contact pressure of companion contacts **14***h* against each other. Conventionally suitable spring biasing means is incorporated in the contact structure. Reaction force is provided by insulation plates **46** (**92**) fastened to base **10***a* and to stud **11** or to both studs **11** and **12** as may be preferred. Plates **46** (**92**) carry supporting shafts **44** (**90**). An additional vertical rod of insulation (not shown) is added to each pole when required for increased strength, having its lower end fixed to a portion of base **10***a* and at its upper end having a hole tightly receiving shaft **44** (**90**) or the hub of contact arm **14** midway between boards **46** (**92**) of each pole. Shaft **44** (**90**) provides mechanical pivotal support for the moving contact arm **14**, providing a pivotal axis at right angles to stud **12**.

Electrical connection from conductor or stud **12** to pivotal moving contact arm **14** is provided separate and independent of the mechanical pivotal support without resort to braid, in a manner to establish an excellent electrical connection despite inevitable mechanical variations in the relationship between the location of stud **12** and the pivotal axis of the contact arm. Such variations occur in production as a result of manufacturing tolerance, and variations also occur in use due to wear, mechanical stresses and other causes.

Referring now to FIGS. 1A, 2 and 3, conductor **12** is tubular and of circular cross section and is mounted within a complementary insulating sleeve **16**. Conductor **12** has a conductor stub **18** suitably secured thereto. Stub **18** has a terminal fitting **20** in the form of a solid circular stub shaft. The assembly of parts **12**, **16** and **18** is supported at back plate **22**. More particularly, the back plate **22** is apertured as indicated at **24** and a tapered bushing **26** having a peripheral collar **26'** is disposed in said aperture in engagement with the tapered clamp ring **28** seated in a peripheral recess of sleeve **16**. The clamp ring is forced into engagement with bushing **26** by the bushing flange **30**, by tightened clamping bolts **32** extending through suit-

able openings of said flange and received in threaded companion apertures 34 of the back plate. Thus the fitting 20 is electrically connected to conductor 12. The stub 18 is provided with a peripheral recess 36 and the inner end of the conductor 12 is seated and secured therein, as by brazing.

The contact arm 14 comprises a pair of laterally spaced operating arms 38 having conductive blades 40 as of copper secured thereto, said arms and blades being united to bushings or the like constituting a conductive hub 42. The unitary contact arm 14, including parts 38, 40 and 42, is a rigidly interconnected assembly, preferably brazed and the hub 42 is pivotally mounted on the stationary shaft 44 carried by the insulator plates 46. Thus the contact arm 14 is movable about the pivotal axis established by shaft 44 between circuit open and circuit closed positions.

A contact assembly, generally designated 48, is interposed between terminal fitting 20 and hub 42 for electrically connecting the conductor 12 to pivotal contact arm 14. The contact assembly 48 comprises a companion pair of U-shaped bridging contact members 50 which are spring biased towards each other in the manner to be described in detail hereinafter, each member 50 comprising a part 52 at the base of the U and having a pair of laterally spaced legs 54. Base part 52 engages terminal fitting 20 and legs 54 engage hub 42, the members 50 thereby bridging conductor 12 and contact arm 14. More particularly, the base part 52 is cut away as indicated at 56 to define the oppositely inclined pair of surfaces 58 which mutually diverge (FIG. 3) to receive fitting 20 and slant approximately 45 degrees to the horizontal. Surfaces 58 have two silver-tungsten contacts 60 secured thereon for corresponding electrical contact with the peripheral surface of fitting 20. Each leg 54 is similarly provided with a cutaway area 62 having similarly slanted surfaces 64 provided with silver-tungsten contacts 66, the latter engaging the peripheral surface of hub 42 to provide a pair of conducting paths from each leg to the hub 42. From the above it will be apparent that two current paths are provided from fitting 20 to each member 50 and that four current paths are provided from the hub to each of the U-shaped members. Where hub 42 is engaged by contacts 66, it is advantageously provided with a sleeve of silver, united to the body of the hub, for low-resistance contact.

The members 50 are spring biased towards each other, for pressure engagement both with fittings 20 and with hub 42. The axis 68 of the spring bias is disposed substantially closer to fitting 20 than to said hub, approximately at a distance of one-third the distance between base part 52 and the axis of the hub. This off-center positioning of the biasing axis provides higher contact pressure between contacts 60 and fitting 20 than the pressure between contacts 66 and the hub 42. This increased contact pressure is provided to reduce the contact resistance at the position of the lesser number of current paths.

A flat plate 70 bridges legs 54 of upper member 50 and a U-shaped plate 72 bridges legs 54 of lower member 50, said plate 72 having a base wall 74 spaced from plate 70. A flat plate 76 is spaced below plate 72 and a coiled compression spring 73 is disposed between wall 74 and plate 76 to provide the requisite biasing force. Plates 70, 72 and 76 are maintained is assembled relation by the bolts 78 and nuts 80 as shown. Thus the major portion of the biasing force exerted by spring 73 is applied between contacts 60 and fitting 20, the current flowing through each of the four contacts 60 splitting into a pair of current paths at the eight contacts 66.

Upon pivotal movement of the moving contact arm 14, the hub 42 rotates with respect to the members 50 and high current conduction through said members 50 to the hub is maintained for the full range of pivotal movement. All of the contacts are biased into engagement with a companion cylindrical contact surface and due to the inclined engagement of the contacts with their companion surfaces a force multiplication is provided to thereby increase the biasing force exerted at such contacting areas. The downward component of biasing force is applied to the cylindrical contacting surfaces through contacts disposed on an inclined plane thereby substantially increasing the contact pressure at such contacts. From the above, it will be apparent that the contact pressure at contacts 60 is substantially greater than the contact pressure at contacts 66 to compensate for the greater current flow through contacts 60.

The members 50 are self-centering in two directions, that is in a direction along the length of the legs 54 and in a direction along the length of base parts 52. The members 50 compensate for a large latitude of variation in the relative positioning of fitting 20 and the hub 42. Under short-circuit or fault-current conditions a powerful electrodynamic attraction force is set up between the members 50, supplementing the contact pressure applied by spring 73, to thereby insure requisite contact pressure during severe current conditions.

The electrodynamic force of attraction results from the currents carried in the same direction by each leg of the upper U and the opposed leg of the lower U. The contact pressure of the spring 110 is greatly augmented electrodynamically during short-circuit current peaks and this accommodates dimensional variations in the relative orientation of stud 20 and contact hub 42 of contact arm 14 on pivotal shaft 44 throughout the pivotal stroke of the moving contact arm.

With reference to FIGS. 4 and 5, there is shown another embodiment of some of the features of the present invention as represented in the abovedescribed embodiment. The form of bridging contact assembly is specifically different in FIGS. 4 and 5. This specific construction in these figures is an embodiment of certain features of my invention as shown in FIGS. 1A, 2 and 3, the form in FIGS. 4 and 5 being presently preferred in that it provides twice the number of bridging contact members and a larger number of contacts, for higher current carrying capacity. Although this embodiment is disclosed as a preferred form of certain features of my invention, the details thereof form no part of my invention to the extent that they depart from that in FIGS. 1A, 2 and 3.

Contact assembly 48′ in FIGS. 4 and 5 comprises companion pairs of upper and lower plate-like contact members 82 and 82′, respectively, there being a total of eight contact members interconnecting the contact arm 14′ and conductor 12′. Conductor 12′ is provided with a terminal fitting 20′ of rectangular configuration having opposite planar contact surfaces 84. Contact arm 14′ comprises contact blades or plates 86 and 86′, the latter serving not only as conductors but also mechanically in the manner of plates 38 of FIGS. 1A, 2 and 3, for mechanical connection to push rods 14e (FIG. 1). Contact bushings 88 are rigidly joined to plates 86 and 86′ as by brazing for pivotal movement and the plates are elsewhere conductively rigidly united as a single unitary contact arm. The bushings 88 are coaxially disposed at the lower end of the contact arm 14′ and are pivotally mounted on the stationary shaft 90 which is carried and located by the spaced plates 92 corresponding to the plates 46 in the other embodiment described. Each contact member 82, 82′ bridges one of the surfaces 84 and a companion bushing 88.

Each contact member 82, 82′ is provided with an arcuate contact 94 of suitable low contact-resistance material at one end and the other end (like legs 54 of the previous embodiment) is provided with a cutaway area 96 having surfaces 98 inclined approximately 45 degrees to the horizontal and provided with contacts 100 as of silver-tungsten. These contacts engage the cylindrical surface of a companion bushing 88 to provide a pair of conducting paths from the contact member 82 to the bushing. Thus

a single current path is provided from fitting 20' to each contact member 82 at contact 94 and two current paths are provided from the contact member to the associated bushing.

The upper and lower contact members are biased toward each other along biasing axis 68' and into engagement with fitting 20' and with the bushings. The biasing axis is disposed substantially closer to fitting 20' than to the bushings, substantially closer than and approximately at a point one-third of the distance between contact 94 and the axis of bushings 88, to provide for greater biasing force at each contact 94 where a single current path is provided than at contacts 88 each of which carries only half the current of contact 94, in the same manner as in the previous embodiment. Here, too, the slant angle of each contact 88 relative to the direction of force application tends to increase the pressure at each contact 88 as compared to what it would be in the case of unslanted, normal contact engagement at 94. A companion pair of upper contact members and a companion pair of lower contact members have associated therewith upper and lower plates 102 and 104, respectively, seated in suitable recesses provided therefor in said contact members, said plates being suitably apertured therethrough to receive the bolt 106, the head of which is provided with a pin 108 which is in engagement with the upper plate. A coil spring 110 is carried by the lower end of bolt 106, spring 110 being compressed between plate 104 and washer 112 which is held in place by locknuts 114. Thus the spring 110 applies a force to bias its associated four contact members into engagement with fittings 20' and bushings 88, like spring 73 that biases the four legs of the two U-shaped members into similar pressure contact.

The major portion of the biasing force exerted by springs 110 is applied between contacts 94 and fitting 20' for minimum contact resistance. The current flowing through each contact 94 splits into a pair of current paths at the pair of contacts 100 of each bridging contact member. As in the case of the previous embodiment, the downward component of biasing force is applied to the contacting surfaces of the bushings through contacts 100 disposed on an inclined plane thereby substantially increasing the contact pressure at such contacts. The contact members are self-centering on the bushings and compensate for a large latitude of irregularities and dimensional variations between the fitting 20' and the bushings. The centering of the contacts 100 on the bushings determines the location of the contact 94 with respect to the fitting 20'. Under short-circuit or fault-current conditions, a powerful electrodynamic attraction force is set up between the opposed upper and lower bridging contact members, supplementing the spring-biased contact pressure.

Various additional modifications of the above embodiments of the invention will readily occur to those skilled in the art, and therefore the invention should be broadly construed in accordance with its full spirit and scope.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A circuit breaker having a companion pair of contacts, a first stationary conductor carrying one of said contacts, a second stationary conductor, a contact arm movable pivotally about an axis and carrying the other of said contacts, a contact hub disposed concentrically about said axis and forming a unitary portion of said contact arm, a projecting portion extending from said second conductor substantially perpendicularly toward said contact hub, mutually opposed bridging contact elements having spring biasing means and embracing said projecting portion and said contact hub and slidably engaging said projecting portion, and means providing pivotal support for said contact arm constraining the contact thereof to move about a fixed axis into and out of substantially normal contact with said one of said contacts.

2. A circuit breaker having a companion pair of contacts, a first stationary conductor carrying one of said contacts, a contact arm carrying the other of said contacts, and a second stationary conductor, means pivotally supporting said contact arm and constraining the contact thereof to move about an axis into and out of substantially normal contact with said one of said contacts, and additional means electrically connecting said contact arm to said second stationary conductor, said connecting means including a contact hub disposed concentrically about said axis and forming a unitary part of said contact arm, a projecting portion on said second conductor extending substantially perpendicularly toward said contact hub, and spring-biased mutually opposed bridging contact elements embracing said projecting portion and said contact hub and slidably engaging said projecting portion.

3. A circuit breaker having a companion pair of contacts, a first stationary conductor carrying one of said contacts, a contact arm carrying the other of said contacts, and a stationary conductor, means pivotally supporting said contact arm and constraining the contact thereof to move about an axis into and out of substantially normal contact with said one of said contacts, and additional means electrically connecting said contact arm to said second stationary conductor, said connecting means including a contact hub disposed concentrically about said axis and forming a unitary part of said contact arm, a projecting portion on said second conductor extending substantially perpendicularly toward said contact hub and said projecting portion, said contact assembly including plural opposed pairs of generally flat elongated bridging contact elements disposed in coplanar edgewise opposition, each said element adjacent one end thereof slidably engaging a lateral surface of said projecting portion of said second conductor and each said bridging contact element adjacent the opposite end thereof having divergent longitudinally spaced contacts in engagement with said contact hub.

4. A circuit breaker having a companion pair of contacts, a first stationary conductor carrying one of said contacts, a contact arm carrying the other of said contacts, and a stationary conductor, means pivotally supporting said contact arm and constraining the contact thereof to move about an axis into and out of substantially normal contact with said one of said contacts, and additional means electrically connecting said contact arm to said second stationary conductor, said connecting means including a contact hub disposed concentrically about said axis and forming a unitary part of said contact arm, a projecting portion on said second conductor extending substantially perpendicularly toward said contact hub, and a bridging contact assembly interconnecting said contact hub and said projecting portion, said contact assembly including plural opposed pairs of generally flat elongated bridging contact portions disposed in coplanar edgewise opposition, each said bridging portion extending into slidable engagement with a lateral surface of said projecting portion of said second conductor and each said bridging contact portion also having divergent longitudinally spaced contacts in engagement with said contact hub, said contact assembly including spring biasing means disposed to act against said elongated bridging contact portions at a location between the ends thereof but closer to said projecting portion than to said hub.

5. A circuit breaker having a companion pair of contacts, a first stationary conductor carrying one of said contacts, a contact arm carrying the other of said contacts, and a stationary conductor, means pivotally supporting said contact arm and constraining the contact thereof to move about an axis into and out of substantially normal contact with said one of said contacts and additional means electrically connecting said contact arm to said second stationary conductor, said connecting means including contact hub disposed concentrically about said axis and forming a unitary part of said contact arm, a projecting portion on said second conductor

extending toward said contact hub, and a bridging contact assembly interconnecting said contact hub and said projecting portion, said bridging contact assembly including a group of four elongated bridging contact portions, each bridging contact portion having longitudinally spaced divergent contact portions adjacent one end thereof engaging said contact hub, and each bridging contact portion extending to a point of contact with a lateral surface of said projecting portion, said bridging contact portions being disposed as laterally adjacent pairs of confronting elements embracing said contact hub and said projecting portion, and a common spring biasing unit acting on all four of said elongated bridging contact portions for establishing bias at each point of contact and thereby centering said divergent contact portions about said contact hub.

6. A circuit breaker having a companion pair of contacts, a first stationary conductor carrying one of said contacts, a conducting arm carrying the other of said contacts, and a stationary conductor, means pivotally supporting said contact arm and constraining the contact thereof to move about an axis into and out of substantially normal contact with said one of said contacts, and additional means electrically connecting said contact arm to said second stationary conductor, said connecting means including contact hub disposed concentrically about said axis and forming a unitary part of said contact arm, a projecting portion on said second conductor extending toward said contact hub, and a bridging contact assembly interconnecting said contact hub and said projecting portion, said bridging contact assembly including a group of four elongated bridging contact portions, each bridging contact portion having longitudinally spaced divergent contact portions adjacent one end thereof engaging said contact hub, and each bridging contact portion extending into contact with a lateral surface of said projecting portion, said bridging contact portions being disposed as laterally adjacent pairs of confronting elements embracing said contact hub and said projecting element, and a common spring biasing unit acting on all four of said elongated bridging portions for establishing bias at each point of contact and thereby centering said divergent contact portions about said contact hub, pairs of said bridging contact portions being integral with each other and of U-shaped configuration, so as to constitute two confronting U-shaped bridging contact members, embracing said contact hub and said projecting portion, the latter having a cylindrical lateral surface, and the base of each U-shaped member having divergent contact portions engaging said cylindrical lateral surface.

7. A circuit breaker, comprising a stationary conductor having a projecting cylindrical portion, a movable contact arm and a shaft pivotally supporting said arm for movement between circuit open and circuit closed positions and having a hub provided with a cylindrical contact surface, and a bridging contact assembly for electrically connecting said blade and hub to thereby electrically connect said conductor and contact unit for the range of pivotal movement thereof, said assembly comprising a pair of U-shaped contact members embracing said cylindrical projecting portion and said hub, each of said contact members comprising a base part having divergent contacts in contacting engagement with the cylindrical projecting portion of said blade and laterally spaced legs having divergent contacts spaced apart along the respective legs and in contacting engagement with said hub, and means for biasing said contact members toward each other, said contact members having an electrodynamic attraction force set up therebetween under short circuit conditions to supplement the contact pressure of said biasing means.

8. A circuit breaker, comprising first and second stationary generally parallel terminal conductors, said first terminal having a projecting end portion, a movable contact arm, and a shaft pivotally supporting said arm for movement between circuit open and circuit closed positions, a companion contact on said second conductor engageable by said contact arm in the closed position, said arm having a hub provided with a cylindrical contact surface, and a bridging contact assembly for electrically connecting said projecting portion and hub to thereby electrically connect said conductor and contact arm for the range of pivotal movement thereof, said assembly comprising a pair of substantially U-shaped members aligned in edge to edge facing relation, the opposed edges of the base portions thereof formed to receive said projecting portion therebetween, the opposed edges of each pair of legs being formed to receive said hub therebetween, and means biasing said U-shaped members toward each other.

9. A circuit breaker, comprising first and second stationary elongated generally parallel terminal conductors, a movable contact arm, and a shaft pivotally supporting said arm for rotation about an axis spaced from the end and transverse to said first conductor between circuit open and circuit closed positions, a companion contact on said second conductor engageable by said contact arm in the closed position, said arm having a hub provided with a cylindrical contact surface, a plurality of elongated conductive bridging elements for electrically connecting said stationary conductor and hub to thereby electrically connect said conductor and contact arm for the range of pivotal movement thereof, said bridging elements being arranged in opposed pairs exposed to each other and spanning said space between the conductor and the hub, and spring biasing means urging the opposed bridging elements of each pair toward each other and into contact with said hub and said conductor, said bridging elements slidably engaging said conductor.

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