

May 31, 1960

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2,938,986

ELECTRIC CIRCUIT INTERRUPTER

Filed Oct. 1, 1958

2 Sheets-Sheet 1

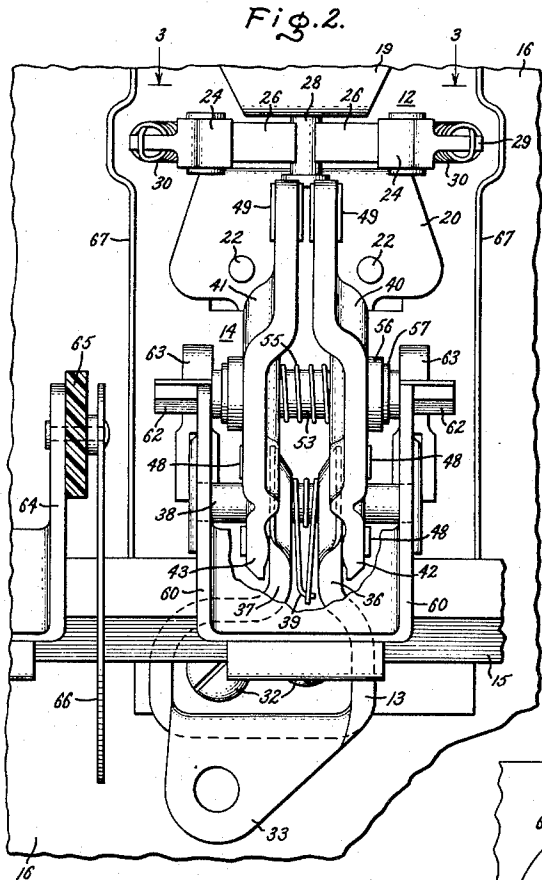


Fig. 1.

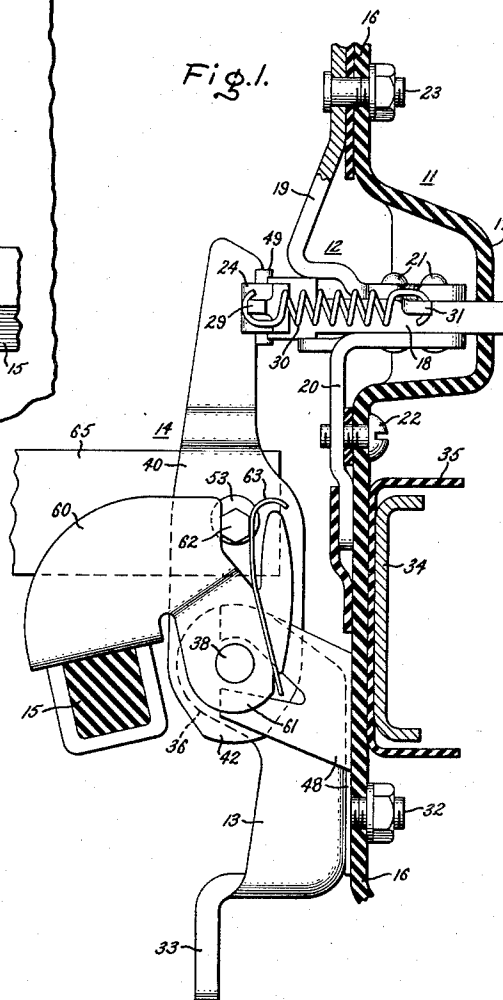
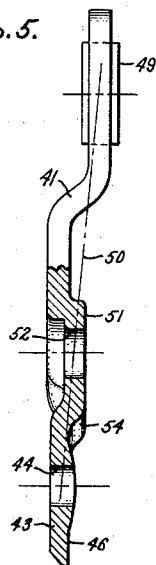


Fig. 5.



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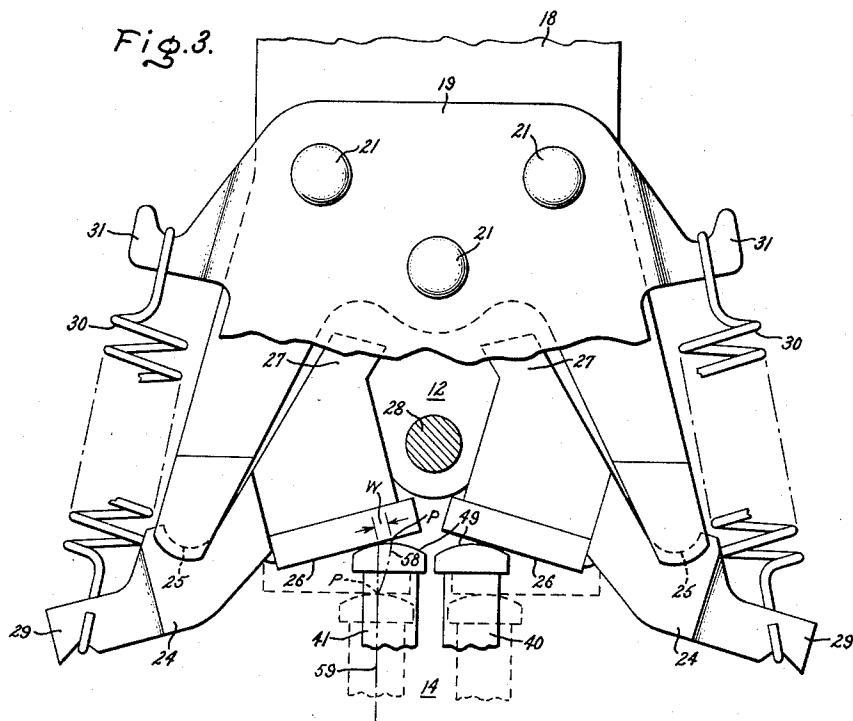
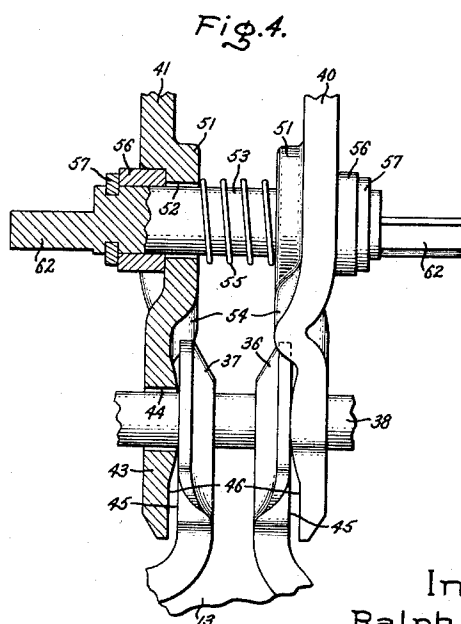
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ELECTRIC CIRCUIT INTERRUPTER

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Filed Oct. 1, 1958, Ser. No. 764,640

10 Claims. (Cl. 200—164)

This invention relates to electric circuit interrupters or breakers, and more particularly it relates to an improvement in the contact structure of a low voltage air circuit breaker.

It is well known practice in designing the contact structure of circuit interrupters to provide for scrubbing or wiping action between the cooperating contact surfaces of the movable and relatively stationary contact members, respectively. This action is usually obtained by designing the contact structure so that there is relative translational movement between the cooperating contact surfaces as the movable contact member moves from a position of initial engagement with the relatively stationary contact member, wherein the cooperating surfaces just touch, to a final, fully closed position. A certain amount of contact wiping action is necessary in order to keep the contact surfaces clean and thereby assure optimum breaker performance. However, an excessive amount of contact wiping action is undesirable because of the extra amount of closing energy required to overcome the frictional resistance of wiping contacts during a circuit breaker closing operation. Accordingly, it is an object of the present invention to provide a relatively simple and inexpensive circuit breaker contact structure wherein no excessive wiping action is permitted to take place between movable and relatively stationary contact members which are respectively disposed for pivotal movement in intersecting planes.

A general object of the invention is to provide an improved circuit breaker contact structure of the character described hereinafter.

In carrying out our invention in one form, a relatively stationary contact member comprising an element disposed for relatively limited pivotal movement in a first plane is mounted on a base of a circuit breaker. A cooperating movable contact arm is mounted on the base for pivotal movement in a second plane intersecting the first plane, and one end of the arm is disposed for circuit-making abutting engagement with the contact element of the relatively stationary contact member. We provide resilient means associated with the movable contact arm to permit lateral movement of the arm while its one end is in abutting engagement with the cooperating contact element, thereby reducing the relative translational movement of the one end with respect to the element as the element moves pivotally during a circuit closing operation of the breaker.

Our invention will be better understood and its various objects and advantages will be more fully appreciated from the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a side elevation of a circuit breaker contact structure embodying a preferred form of our invention, with the movable contact member of the contact structure shown in its closed circuit position;

Fig. 2 is a front elevation of the contact structure illustrated in Fig. 1, with the movable contact member moved to its open circuit position;

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Fig. 3 is an enlarged sectional view of the contact structure of Fig. 2 taken along the line 3—3 and showing the stationary contact member with the cooperating movable contact member in its fully closed position;

Fig. 4 is an enlarged partial section of the connection shown in Figs. 1 and 2 between the movable contact member and its supporting bracket; and

Fig. 5 is a profile view of one arm of the movable contact member.

Referring now to Fig. 1, we have shown an electric circuit breaker or interrupter comprising a base member 11, a relatively stationary contact member 12 mounted on the base, an electroconductive bracket 13 mounted on the base in spaced relation to the stationary contact member, a movable contact member 14 pivotally supported by bracket 13 and disposed in cooperative relationship with the stationary contact member 12, and actuating means such as a crossbar 15 coupled to the movable contact member 14 for moving this member into and out of circuit-making engagement with the stationary contact member 12. The components 12, 13 and 14 comprise the contact structure of one pole unit of an alternating or direct current circuit breaker or interrupter, and other similar pole units (not shown) can be mounted for gang operation on the base member 11 adjacent to the pole unit that has been illustrated in Figs. 1 and 2.

The base member 11 supports the current-conducting studs of the breaker and other breaker parts connected directly to the studs. As illustrated in Fig. 1, the base member 11 comprises a sheet 16 of electric insulating material of substantially uniform thickness. The sheet 16 is shaped to form a channel-shaped section or depression at 17, and the bottom of this section is provided with an aperture for snugly admitting and partially supporting an upper breaker stud 18. For the purposes of the present description, the contact structure 12—14 will be considered mounted on the front of the base 11, and the breaker stud 18 is connected to a suitable electric power source or bus (not shown) located behind or to the rear of the base. The contact structure shown in the drawings and described herein to illustrate a preferred embodiment of our invention is designed for connection to an electric power bus rated 600 volts A.-C. and capable of supplying as much as 25,000 amperes short-circuit current.

The stationary contact member 12 is mounted on the upper breaker stud 18. As can be seen in Fig. 1, the upper stud 18 is secured to the sheet 16 of base member 11 by suitable support means such as generally L-shaped angles 19 and 20. The angles 19 and 20 are respectively disposed above and below stud 18 and are fastened thereto by three copper rivets 21 or the like. The lower angle 20 is provided with a pair of tapped holes, and a pair of appropriate bolts 22 is used to secure this angle to the base member 11. The supporting angle 19, which extends above the breaker stud 18 as is shown in Fig. 1, serves as an arc runner in cooperation with the stationary contact member 12. This angle is provided with a stud 23 for securing it to the insulating sheet 16 of the base 11.

The end of breaker stud 18 extending forward from the base member is divided into two horizontally diverging branches, whereby this stud in plan view has a generally Y-shaped appearance. In the preferred embodiment of our invention illustrated in Figs. 1, 2 and 3, the stationary contact member 12 comprises at least one pair of elongated contact elements or fingers 24, each finger 24 being pivotally supported intermediate its ends on the outer end of a different diverging branch of the breaker stud 18. For this purpose, the outer ends of the diverging branches are respectively provided with generally cylindrical bearing surfaces 25 having centerlines oriented in a vertical direction as viewed in Figs. 1—3.

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Each bearing surface 25 is recessed so that shoulders are formed at its upper and lower ends to prevent vertical movement of the associated contact finger. If desired, the length of the bearing surface can be made sufficient to accommodate more than one contact finger 24 in side-by-side relation.

Each of the two bearing surfaces 25 at the outer ends of the diverging branches of the breaker stud 18 provides a fulcrum or pivot for at least one contact finger 24, and the pivotal connection between each contact finger and the breaker stud forms a current-conducting joint. As can be clearly seen in Figs. 2 and 3, the contact fingers 24 are respectively supported on opposite bearing surfaces 25 in opposing relationship with respect to each other for pivotal movement in a common horizontal plane. The opposing or inner ends of the contact fingers are movable in separate, relatively short arcuate paths, and the opposing ends are respectively provided with generally flat, complementary contact surfaces 26 normally disposed in a common vertical plane as viewed in Figs. 1-3.

The inner end of each contact finger 24 has an extension 27 (see Fig. 3) disposed to engage a common stop 28 for determining the limit of the arcuate movement of the contact surface 26 in one direction. The stop 28, as is indicated in Figs. 2 and 3, comprises a pin vertically disposed intermediate the divergent branches of the breaker stud 18 and fixedly connected to the upper and lower supporting angles 19 and 20. Associated with the outer end 29 of each contact finger 24 is suitable spring means, for example, the illustrated tension spring 30 which may be anchored at one end to a fixed member such as provided by a laterally extending lug 31 of the upper supporting angle 19. Thus, spring means 30 establishes a biasing torque in the contact finger 24 tending to move the contact surface 26 along its arcuate path in a forward direction away from the base member 11, and such movement by the finger is limited by the stop pin 28. The above-described structure provides for a relatively limited deflection of the contact finger in a rearward direction.

The biasing torque is opposed and overcome and each contact finger 24 of the relatively stationary contact member 12 is tilted slightly on its fulcrum by the action of the movable contact member 14. As will be more fully explained hereinafter, the movable contact member 14 in the illustrated embodiment of the invention includes a pair of arms respectively provided with contact surfaces 49 which move in parallel planes disposed approximately perpendicular to the plane defined by the arcuate paths of the contact surfaces 26 of the fingers 24. The actuating means 15 provides actuating force for moving each contact surface 49 of member 14 into and out of circuit-making abutting engagement with the contact surface 26 of a different contact finger.

During a circuit making operation, the contact surfaces 49 of the movable contact member 14 are jointly carried rearwardly from their open circuit position (Fig. 2) into substantially simultaneous engagement with both of the cooperating contact surfaces 26, and further rearward movement of the contact surfaces 49 to their fully closed position (Fig. 1) forces the spring means 30 to yield as the relatively stationary contact fingers 24 tilt on their fulcrums 25. As will soon be described in detail, the arrangement is such that the cooperating contact surfaces 26 and 49 follow different paths of movement while in engagement with each other. Consequently one of the engaging surfaces is translated with respect to the other and there is a sliding or scrubbing movement therebetween. In this manner, conventional contact wiping action is obtained.

In Figs. 1 and 2 it can be seen that the electroconductive bracket 13 for supporting the movable contact member 14 is mounted on base member 11 by means of a pair of suitable bolts 32 or the like. The bracket 13

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has a lower lip 33 provided with a hole for the purpose of connecting a suitable current-conducting member or another breaker stud (not shown) to the bracket. Part of the bracket 13 is disposed adjacent the front surface of the insulating sheet 16 of base member 11, and a rigid reinforcing member 34 is disposed adjacent the rear surface of the sheet 16 in overlapping relationship with bracket 13 and the lower supporting angle 20, respectively. The reinforcing member 34 is provided so that the loading of the insulating sheet 16 in the area between the bracket 13 and the relatively stationary contact member 12 will be in compression rather than in flexure. A channel 35 of insulating material is disposed intermediate the reinforcing member 34 and the rear of sheet 16 to provide additional electrical insulation between the sides of member 34 and the fastening bolts 22 and 32.

The bracket 13 includes a pair of spaced-apart upstanding lugs 36 and 37 projecting in front of base member 11. A removable pivot pin 38 is supported by the lugs 36 and 37, the axis of the pivot pin extending in a horizontal direction generally parallel to the plane of the base member 11 as viewed in Figs. 1 and 2. The pivot pin 38, which passes through both of the lugs 36 and 37 and protrudes from their outwardly facing sides, respectively, is retained in place by a releasable clamp 39 connected to the pin intermediate the lugs. The clamp 39 preferably comprises a resilient helical coil loosely encircling pin 38, the length of the helix corresponding approximately to the span between the lugs 36 and 37. The opposite ends of the coil of clamp 39 extend tangentially therefrom and are arranged for movement between first and second cooperating positions. In Fig. 2 the ends are shown in a position wherein they releasably engage each other, and in this self-locked position the circumference of the coil is contracted for firmly grasping the encircled pin and preventing axial movement and removal thereof. By separating the ends and permitting them to assume their other position in accordance with the resilience of the coil, the circumference of the coil can be expediently expanded for assembling or disassembling purposes.

The connection between the movable contact member 14 and the supporting bracket 13 will now be described with particular reference to Figs. 2 and 4. The movable contact member 14 comprises a pair of elongated contact arms 40 and 41 arranged in generally parallel relation for joint operation. One end 42 of the arm 40 is disposed adjacent the outwardly facing side of the upstanding lug 36 and is rotatably mounted on a protruding portion of pivot pin 38; and one end 43 of the other contact arm 41 is disposed adjacent the outwardly facing side of lug 37 for rotatable mounting on the opposite protruding portion of the pivot pin.

The connection between each movable contact arm 40, 41 and the electroconductive bracket 13 is arranged to provide three separate current-conducting joints. The first such joint is provided by the bearing surfaces between the contact arm and the pivot pin 38 on which it rotates, that is, between pin 38 and the periphery of a hole 44 which has been located in the one end 42, 43 to accommodate the pin 38. The surface of the pivot pin 38 and the periphery of hole 44 may be silver plated and burnished to ensure a wear-resistant, low electric resistance current-conducting path.

The second current-conducting joint is obtained by providing the outwardly facing side of each lug 36, 37 of the bracket 13 with a substantially flat, smooth slide surface 45 disposed generally perpendicular to the axis of the pivot pin 38. Each slide surface 45 is contiguous to a smooth, pertaining slide surface 46 provided on the relatively broad inner side of the pivoted end 42, 43 of each movable contact arm 40, 41, i.e., on the side of the contact arm facing the supporting bracket 13. Each slide surface 46 is disposed generally parallel to the respective adjoining slide surface 45 of the bracket 13, and there-

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fore all of the slide surfaces 45 and 46 are substantially perpendicular to the axis of pivot pin 38 which corresponds to the axis of rotation of the movable contact arms 40 and 41.

The slide surface 46 of each movable contact arm includes a raised section which, as can best be seen in Figs. 4 and 5, preferably comprises a portion of a cylinder. The crest of this raised section is oriented so that it extends in a direction substantially perpendicular to the longitudinal centerline of the contact arm, and it is intersected by the hole 44 provided for pivot pin 38. The crests of the raised sections of the two slide surfaces 46 respectively cooperate with and are contiguous to the slide surfaces 45 of bracket 13, and pivotal movement of the contact arms on pin 38 causes each crest to slide over the associated slide surface of the relatively stationary bracket 13. The contiguous portions of each pair of cooperating slide surfaces define a line contact which provides the second current-conducting joint between each movable contact arm and the supporting bracket. Of course, as an alternative to the specific arrangement illustrated and described above, a raised section could be located on each of the slide surfaces 45 and the slide surfaces 46 could be made substantially flat.

Contact pressure at the joints formed by the respective pairs of contiguous slide surfaces 45 and 46 is maintained by means of an electroconductive spring member 48 which preferably comprises a U-shaped spring clip. As indicated in Figs. 1 and 2, the resilient upstanding legs of the clip 48 are split for respectively bearing against the relatively broad outer sides of the pivoted ends 42 and 43 of the contact arms 40 and 41 at points disposed on opposite sides of the pivot pin 38. The electroconductive spring member 48 is secured to the bracket 13, and since it also is in engagement with each movable contact arm it provides the third current-conducting joint. In addition, spring member 48 applies a sidewise force which maintains contact pressure at the contiguous surfaces of both pairs of cooperating slide surfaces 45 and 46. This force is supplemented by an electromagnetic force whenever the movable contact member 14 is conducting current. Whenever the parallel contact arms 40 and 41 conduct alternating current, a magnetic force is established tending to reduce the spacing between these two arms and thereby establishing additional contact pressure at the contiguous slide surfaces, the magnitude of this sidewise force being proportional to the square of the current magnitude.

The diameter of the hole 44 in the pivoted ends of the movable contact arms is made slightly greater than the diameter of pivot pin 38, whereby the movable contact member 14 is loosely mounted on the bracket 13. As indicated in Fig. 4, this arrangement will permit the contact arms 40 and 41 to rock on pivot pin 38. The crests of the raised sections of the slide surfaces 46 provide fulcrums for the rocking movement of the arms 40 and 41, respectively and this rocking movement takes place in a plane perpendicular to the planes of pivotal movement of the arms. This arrangement allows for a certain degree of misalignment of the various parts and a liberal manufacturing tolerance without adversely affecting the positiveness of the electric contact between the movable elements and the supporting bracket 13.

By utilizing three parallel current-conducting joints for each of the two parallel arms of the movable contact member 14, the overall electric resistance of the pivotal connection has been efficiently reduced thereby significantly decreasing temperature rise. In this manner it is possible to obtain a successful contact structure without the conventional flexible braids or conductors.

In the illustrated embodiment of our invention, the corresponding free ends of the contact arms 40 and 41 are provided respectively with transverse contact surfaces 49 disposed for abutting engagement with the contact surfaces 26 of the relatively stationary contact fingers 24.

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Rotary or pivotal movement of the contact arms on pivot pin 38 carries each of the contact surfaces 49 through its major course of movement which is along a predetermined arcuate path. The arcuate paths followed by the contact surfaces define vertical planes intersecting at approximately right angles the horizontal plane of movement of the relatively stationary contact surfaces 26, as viewed in Figs. 1-3. This arrangement permits the convenient utilization of more than one stationary contact finger for each movable contact arm, whereby more than two separate points of circuit-closing engagement can be provided between the movable contact member 14 and the relatively stationary contact member 12.

The cooperating contact surfaces 26 and 49 preferably are made of silver tungsten carbide material which will successfully perform the continuous current-carrying function of the contacts and also the required circuit making and breaking duty without appreciable contact erosion or pitting or contact welding as a result of electric arcing. Therefore it is not necessary to provide separate arcing and main contacts. With the various parts shown in Figs. 1 and 2 appropriately dimensioned, the contact structure will safely carry at least 225 amperes continuously at 600 volts A.-C., and the same contact structure can be modified to carry at least 600 amperes continuously merely by changing the relatively stationary contact member 12 so that two additional contact fingers (24) are respectively disposed adjacent those shown and by appropriately extending the contact surfaces 49 of the movable contact arms.

In order to obtain a compact arrangement at the cooperating contact surfaces 26 and 49, the contact arms 40 and 41 are spaced closer together at their corresponding free ends than at the pivot pin 38. As is shown in Figs. 2 and 5, this has been accomplished by axially offsetting the free ends of the contact arms with respect to the pivotally connected ends 42 and 43, respectively. In other words, each free end is disposed inside a plane normal to the pivot pin 38 that intersects the bearing area providing the pivotal connection between the associated movable contact arm (the periphery of hole 44) and pin 38. Thus, the center of the circuit-making surface area of the contact surface 49, that is, the center of the area of surface 49 which engages the contact surface 26 of the stationary contact finger 24, defines with the center of the pivotal connection to pivot pin 38 a straight line 50 which intersects the axis of rotation (the axis of pivot pin 38) at an oblique angle. See Fig. 5.

The contact arms 40 and 41 have been oppositely offset at intermediate portions 51. As is indicated in Figs. 4 and 5, the offset portion 51 is provided with a transverse hole 52 the centerline of which is oriented parallel to the pivot pin 38. An actuating member such as a cylindrical impelling shaft 53 is rotatably disposed in hole 52, and by this means actuating force is applied to the movable contact member 14 for jointly moving the contact arms 40 and 41 between open and closed circuit positions. The off-set portion 51 of each of the contact arms is so arranged that the line of action of the resultant actuating force intersects the straight line 50. In other words, a common plane of action and reaction is defined by the center of the bearing surface between the impelling shaft 53 and the offset portion 51 of the contact arm, the center of the pivotal connection between pin 38 and the pivoted end of the arm, and the center of the engaging area of the contact surface 49. This plane will include the intersection of the respective planes of movement of the cooperating movable and relatively stationary contact surfaces 49 and 26. As a result, there is no net component of actuating force having a moment arm with respect to the straight line 50, and there is substantially no torsion or twisting tendency in the contact arm in its closed circuit position. Such a tendency would be undesirable because it would cause uneven forces along the length of the crest of the raised section of slide surface 46 with respect to

the contiguous slide surface 45, whereby the effectiveness of this current-conducting joint between the movable contact member 14 and the supporting bracket 13 would be seriously impaired.

In the vicinity of the offset portions 51 of the contact arms 40 and 41, protrusions 54 are formed. These protrusions 54, which preferably are in the form of curved embossments on the inner sides of the contact arms, are respectively disposed to extend in overhanging relationship with the lugs 36 and 37 of bracket 13. In this manner, the current-conducting joints formed by the two pairs of contiguous slide surfaces 45 and 46 are shielded from the electric arc and arc products which may be produced during circuit breaking action of the contact structure. The protrusions 54 will prevent particles of foreign matter generated during circuit breaking action from entering these joints by straight-line paths from the area of arc interruption. Such foreign matter, if permitted to enter the joint, could cause excessive wear and increased contact resistance.

The impelling shaft 53 fits relatively loosely in the holes 52 in the offset portions 51 of the movable contact arms 40 and 41, whereby each arm can slide somewhat on shaft 53 while rocking on pivot pin 38. Thus each arm is free to undergo minor movement in a transverse direction with respect to the plane defined by the arcuate path of movement of its contact surface 49, and in accordance with our invention such lateral movement is controlled by resilient means associated with the contact arm. As is shown in Figs. 2 and 4, the resilient means preferably comprises a helical compression spring 55 disposed on impelling shaft 53 intermediate the contact arms 40 and 41. The spring 55 applies oppositely directed transverse forces to the contact arms and establishes in each arm a relatively weak biasing torque with respect to the pivot provided by the line contact at the joint formed by the contiguous slide surfaces 45 and 46. This biasing torque is in a direction tending to spread apart the contact arms 40 and 41, whereby the free end of each arm is biased in the general direction of the pivot or fulcrum 25 of the associated relatively stationary contact finger 24. Such sidewise or lateral movement of each movable contact arm is stopped and its normal position is determined by a bushing 56 disposed on shaft 53 between a retaining ring 57 or the like and the circular outer side of the offset portion 51 of the arm.

During circuit making action of the contact structure, the actuating member or shaft 53 impels both arms of the movable contact member 14 pivotally on pivot pin 38, and the contact surfaces 49 are carried into abutting engagement with the respective contact surfaces 26 of the relatively stationary contact fingers 24. As the movable contact member 14 continues its pivotal movement toward its fully closed position, each contact surface 49 moves arcuately with respect to pin 38 thereby deflecting or tilting the cooperating contact finger 24 on its fulcrum 25 in opposition to the biasing torque provided by spring 30. The contact surface 26 of finger 24 does not follow the arcuate path of contact surface 49, and accordingly there is relative translational or sliding movement between these cooperating surfaces in a radial direction with respect to the axis of the pivot pin 38. This provides the desired amount of contact wiping action referred to hereinafter.

The above-described construction of the contact structure results in a transverse force being supplied to each contact surface 49 by the cooperating surface 26 as each contact finger 24 moves pivotally on its fulcrum 25 during a circuit making operation. This is illustrated in Fig. 3 where the reference number 58 identifies the arcuate path of movement followed by a point P of one contact surface 26 while the cooperating contact surfaces 26 and 49 are in engagement, the letter P representing the point that is initially engaged by the tip of the contact surface 49. In accordance with our invention, the resilient means 55 dis-

posed intermediate the movable contact arms 40 and 41 permits each arm and its contact surface 49 to yield to the transverse force supplied by contact surface 26, and the contact surface 49 is able to move laterally while following approximately the arcuate path 58 of contact surface 26. As a result, there will be no appreciable sliding movement or translation between the cooperating contact surfaces 26 and 49 in a radial direction with respect to the centerline of the cylindrical surface of fulcrum 25. It is apparent in Fig. 3 that during a circuit making operation each movable contact arm 40, 41 moves laterally (from dotted to solid-line positions) while the relatively stationary contact finger 24 is being deflected, and the contact surface 49 in effect rolls on the cooperating contact surface 26. Without this feature of our invention, the movable contact arm 41, for example, would be obliged to move straight ahead along the line identified by reference number 59 in Fig. 3, and as a result the cooperating contact surfaces would be translated approximately the distance W in the direction indicated.

By permitting lateral movement of the contact arms 40 and 41 and thereby substantially eliminating sliding or wiping action between the cooperating contact surfaces 26 and 49 in this lateral direction as described above, a highly desirable reduction in the amount of frictional resistance encountered by the movable contact surfaces is realized and the performance of the contact structure is significantly improved. Although the cooperating contact surfaces are quite smooth when new, they become appreciably roughened during the life of the breaker and a significant amount of closing energy would be required merely to overcome the frictional resistance to the translation W indicated in Fig. 3. By eliminating this translation and the accompanying friction, we can obtain satisfactory breaker operation with less closing energy and consequently with lower impact stresses, whereby the mechanical life of the contact structure is enhanced. It will be noted that the eliminated amount of translation is not necessary and may be considered excessive insofar as the function of contact wiping is concerned, since sufficient translation is obtained for this purpose in a direction perpendicular to the plane of the paper on which Fig. 3 is drawn.

The movable contact member 14 is coupled to the actuating means or crossbar 15 by means of an actuating member 60 which is coupled to the impelling shaft 53 and which preferably comprises a generally U-shaped connecting link securely fastened to the crossbar. Each leg of the connecting link 60 is provided with an extension 61 connected to the pivot pin 38 as shown in Fig. 1, and thus the crossbar 15 is supported for pivotal movement by pin 38. End portions 62 of impelling shaft 53 extend laterally from the contact arms 40 and 41 and are made eccentric with respect to the cylindrical body of the shaft, as is shown in Figs. 1 and 4. The end portions 62 are coupled to the connecting link 60 in a manner permitting controlled rotation of the shaft 53. This has been done by providing each end portion 62 with flat sides forming a hexagon, parallel sides of the hexagon being positively but resiliently locked between a shoulder of the connecting link 60 and a cooperating cantilever flat spring 63 carried by link 60. See Fig. 1.

By means of a conventional open-end wrench applied to the hexagonal end portion 62, the shaft 53 may be rotated to any one of six angular positions. In each of these six positions, the movable contact member 14 is located in a different relative angular position with respect to the crossbar 15 and with respect to the relatively stationary contact member 12. The purpose of this adjustment is to accurately establish the fully closed position of the movable contact member regardless of liberal manufacturing tolerances, whereby the desired amount of contact wipe can be precisely obtained.

The crossbar 15 is connected to a circuit breaker operating mechanism by means of another link 64 and a con-

necting member 65. The operating mechanism, which has not been shown, may be of any suitable type for moving the connecting member 65 in a generally horizontal direction (as viewed in Figs. 1 and 2) thereby reciprocally moving the crossbar 15 about its pivot between first and second relatively fixed positions. The crossbar 15 may be extended across the width of the circuit breaker for connection in a similar manner to other pole units of a multipole circuit breaker. An isolating barrier 66 of insulating material is shown mounted on the crossbar 15 in Fig. 2. Other barriers 67 are provided for the purpose of isolating the various current-conducting parts of the illustrated pole unit from the corresponding parts of adjacent pole units and from ground. A suitable arc chute, not shown in the drawings, may be mounted on the base member 11 to enclose the cooperating contact surfaces 26 and 49 for the conventional purpose of arc extinction.

While we have shown and described a preferred form of our invention by way of illustration, many modifications will occur to those skilled in the art. Therefore, we contemplate by the concluding claims to cover all such modifications as fall within the true spirit and scope of our invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In the contact structure of an electric circuit interrupter: a base member; a relatively stationary contact comprising an electroconductive member mounted on the base, a contact finger pivotally supported by said electroconductive member for movement in an arcuate path, and spring means for establishing a biasing torque in the contact finger; a bracket mounted on the base in spaced relation to the stationary contact; a contact arm loosely mounted on the bracket for major movement at one end along a predetermined path, said arm being disposed in relation to the contact finger so that the respective paths of movement define intersecting planes, said loose mounting of the arm on the bracket being arranged to permit minor movement of the arm in a transverse direction with respect to the plane defined by said predetermined path of said one end; actuating means coupled to the contact arm for moving said one end along its predetermined path into and out of circuit making engagement with the finger of the relatively stationary contact; and resilient means associated with the contact arm for yieldably opposing said minor movement of the arm while engaging the contact finger.

2. In the contact structure of an electric circuit interrupter: a base member; a relatively stationary contact member including an element disposed for relatively limited deflection, said element having a first contact surface movable in an arcuate path defining a first plane upon deflection of said element; a cooperating, elongated movable contact arm pivotally supported on the base for movement in a second plane intersecting said first plane, one end of the arm having a second contact surface disposed for circuit-making abutting engagement with said first contact surface; actuating means coupled to the movable contact arm for moving said second contact surface into circuit making engagement with said first contact surface and thereby deflecting the relatively stationary contact element; and resilient means associated with the movable contact arm to permit lateral movement of the arm while said first and second contact surfaces are in engagement thereby enabling said second contact surface to follow approximately the arcuate path of movement of said first contact surface while said element is being deflected.

3. In the contact structure of an electric circuit interrupter: a base member; a relatively stationary contact member mounted on the base and including at least one pair of opposing contact fingers disposed for relatively limited pivotal movement in a common plane, each finger of said pair having a contact surface; a bracket mounted on the base in spaced relation to the stationary contact

member; a movable contact member comprising a pair of arms pivotally connected to the bracket and having corresponding ends respectively disposed for arcuate movement in generally parallel planes which intersect said common plane, said corresponding ends having transverse contact surfaces disposed in abutting relation to the contact surfaces of said fingers, respectively; actuating means coupled to the movable contact member for jointly moving said arms and their contact surfaces into and out of circuit making engagement with the respective contact surfaces of said fingers; and a compression spring disposed intermediate said arms for applying oppositely directed transverse forces to the arms, respectively, to permit sideways movement of the arms while the respective abutting contact surfaces are in circuit making engagement.

4. In the contact structure of an electric circuit interrupter: a base member; a relatively stationary contact comprising an electroconductive member mounted on the base and disposed to provide a fulcrum, a contact finger pivotally supported intermediate its ends on the fulcrum and having at one end a generally flat contact surface movable in a first direction, spring means associated with the other end of the contact finger for establishing a biasing torque in the finger, and stop means disposed to engage the finger near said one end to determine the limit of its pivotal movement under the influence of the biasing torque; a bracket mounted on the base in spaced relation to the stationary contact; an elongated movable contact arm pivotally connected to the bracket for rotation on an axis, one end of the arm being arcuately movable in a direction different than said first direction to engage said one end of the contact finger and having at least one contact surface disposed in abutting relationship with the contact surface of said finger; actuating means coupled to the movable contact arm for moving the contact surface of said arm into and out of circuit making engagement with the contact surface of said finger; and resilient means associated with the movable contact arm to permit lateral movement of the arm while said contact surfaces are in engagement.

5. In the contact structure of an electric circuit interrupter: a base member; a relatively stationary contact comprising an electroconductive member mounted on the base, a contact finger pivotally supported by said electroconductive member for movement in an arcuate path, and spring means for establishing a biasing torque in the contact finger; an electroconductive bracket mounted on the base in spaced relation to the stationary contact; an elongated movable contact arm rotatably connected to the bracket for movement at one end along an arcuate path, said arm being disposed in relation to the contact finger so that the respective arcuate paths define intersecting planes, the connection between bracket and arm including contiguous slide surfaces disposed generally perpendicular to the axis of rotation to form a current-conducting joint, one of said surfaces being substantially flat and the other surface being raised so that said current-conducting joint provides a fulcrum oriented at approximately a right angle with respect to the longitudinal centerline of the arm for rocking movement by the arm; resilient means disposed to apply a transverse force to the movable contact arm for establishing with respect to the fulcrum provided by said joint a relatively weak biasing torque; and actuating means coupled to the movable contact arm to move said arm into and out of circuit making engagement with the relatively stationary contact finger.

6. In the contact structure of an electric circuit breaker: a base member; a relatively stationary contact member mounted on the base and including a contact element disposed for relatively limited pivotal movement in a first plane, said element having a contact surface movable in an arcuate path with respect to a pivot; an electroconductive bracket mounted on the base in spaced relation to the stationary contact member; an elongated

movable contact arm loosely mounted on the bracket for pivotal movement in a second plane generally perpendicular to said first plane, one end of the arm having a contact surface arcuately movable into and out of circuit-making abutting engagement with the contact surface of said stationary contact element, said arm and said bracket respectively including contiguous slide surfaces disposed generally parallel to said second plane to form a current-conducting joint, one of said slide surfaces being substantially flat and the other slide surface having a raised section defining with the flat surface a straight-line contact oriented at approximately a right angle with respect to the longitudinal centerline of the arm, whereby the joint provides a fulcrum for rocking movement by the arm in a third plane generally perpendicular to said second plane; spring means associated with the movable contact arm for establishing therein with respect to the fulcrum provided by said joint a biasing torque tending to move the one end of said arm in the general direction of the stationary contact pivot, thereby enabling the contact surface of said end to follow approximately the arcuate path of the contact surface of the stationary contact element while said contact surfaces are in circuit-making abutting engagement; and actuating means coupled to the movable contact arm for pivotally moving said arm.

7. In the contact structure of an electric circuit interrupter: a base member; a relatively stationary contact comprising an electroconductive member mounted on the base, a contact element pivotally supported by said electroconductive member for movement in an arcuate path, and spring means for biasing the contact element and permitting deflection thereof; a bracket mounted on the base in spaced relation to the stationary contact; an elongated movable contact arm pivotally connected to the bracket for rotation on an axis, one end of the arm being arcuately movable in a plane intersecting the plane defined by the arcuate path of said contact element and having at least one contact surface disposed in circuit making and interrupting relationship with at least one abutting contact surface of said element, said one end being axially offset with respect to the pivotal connection between arm and bracket so that the center of the circuit making surface area of said one end together with the center of said pivotal connection lie in a common plane of reaction intersecting the axis of rotation at an oblique angle; an actuating member connected to the movable contact arm for moving said arm about said axis, the connection being constructed and arranged to provide for some transverse movement of the arm and to secure the disposition of the line of action of the resultant actuating force in said plane of reaction; and resilient means associated with the movable contact arm to permit transverse movement of the arm while the abutting contact surfaces are in circuit making engagement.

8. In the contact structure of an electric circuit interrupter: a base member; a relatively stationary contact member mounted on the base and including a contact finger disposed for relatively limited pivotal movement in a first plane; a bracket mounted on the base in spaced relation to the stationary contact member; an elongated movable contact arm pivotally connected to the bracket for rotation on an axis and having an axially-offset free end, said free end being arcuately movable in a plane intersecting said first plane and having at least one con-

tact surface disposed in circuit making and interrupting relationship with at least one cooperative contact surface of the relatively stationary contact finger; an actuating member comprising a generally cylindrical shaft loosely connected to the movable contact arm and disposed substantially parallel to said axis for pivotally moving said arm with respect to said axis; said movable contact arm being constructed and arranged at its point of connection to the actuating member so that the resultant actuating force for pivotally moving said arm has substantially no moment arm with respect to a straight line defined by the center of the circuit making surface area of said one end and the center of the pivotal connection between said arm and said bracket; and resilient means associated with the movable contact arm to permit transverse movement of the arm while the cooperating contact surfaces are in circuit making engagement.

9. In the contact structure of an electric circuit interrupter: a base member; a relatively stationary contact comprising an electroconductive member mounted on the base and disposed to provide a fulcrum, a contact finger pivotally supported intermediate its ends on the fulcrum for movement at one end along an arcuate path, spring means associated with the other end of the contact finger for establishing a biasing torque, and stop means disposed to engage the one end of the finger to stop its arcuate movement caused by the biasing torque; an electroconductive bracket mounted on the base in spaced relation to the stationary contact; an elongated movable contact arm rotatably connected to the bracket for movement at one end along an arcuate path, said arm being disposed in relation to the contact finger so that the respective arcuate paths intersect each other and define different planes, the connection between bracket and arm including contiguous slide surfaces disposed generally perpendicular to the axis of rotation to form a current-conducting joint, one of said surfaces being substantially flat and the other surface having a raised section defining with the flat surface a straight-line contact oriented at approximately a right angle with respect to the longitudinal centerline of the arm, whereby the joint provides a pivot for rocking movement by the arm; resilient means disposed to apply a transverse force to the movable contact arm for establishing with respect to the pivot provided by said joint a relatively weak biasing torque; and actuating means coupled to the movable contact arm to move the one end of said arm into and out of circuit making engagement with the one end of said relatively stationary contact finger.

10. The contact structure defined in claim 9 in which an electroconductive spring member is secured to the bracket and disposed in engagement with the movable contact arm to maintain contact pressure at the current-conducting joint between bracket and arm and to provide a second current-conducting joint with the movable contact arm.

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