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CONTACT STRUCTURE FOR AN ELECTRIC CIRCUIT BREAKER

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FIG. 1.

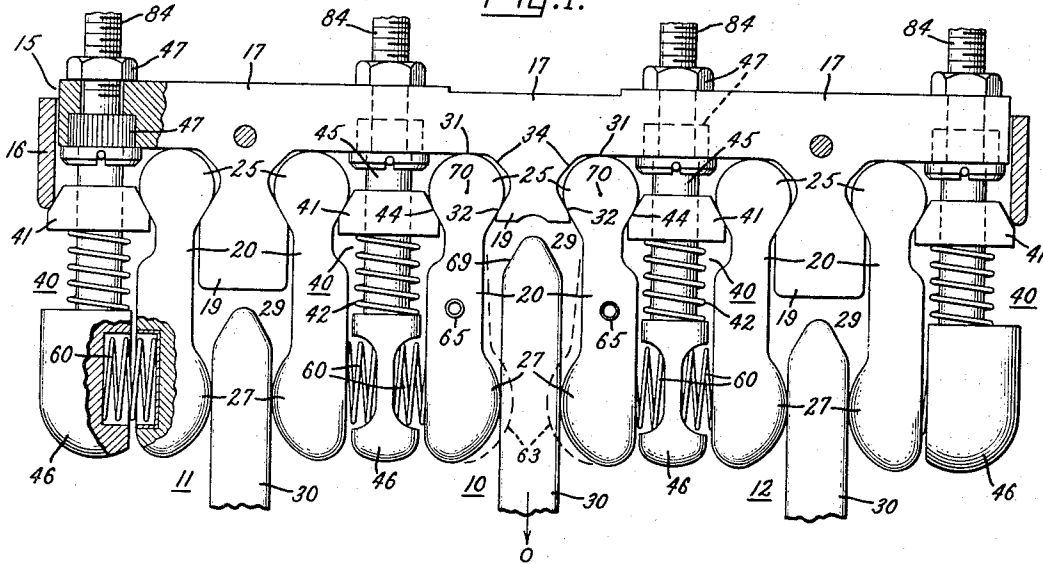


FIG. 2.

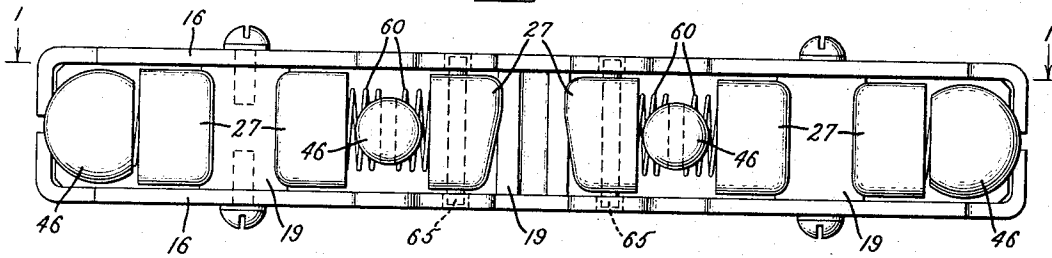


FIG. 4.

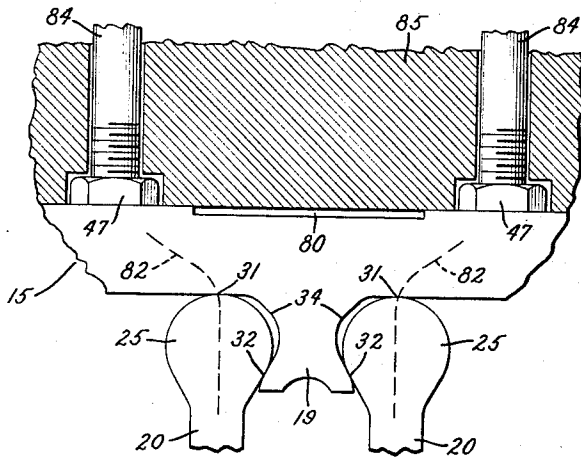
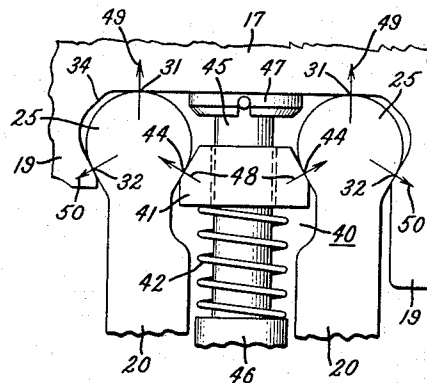


FIG. 3.



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CONTACT STRUCTURE FOR AN ELECTRIC CIRCUIT BREAKER

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This invention relates to contact structure for an electric circuit breaker and, more particularly, relates to finger-type contact structure which is adapted to carry very high currents.

The finger-type contact structure that I am concerned with comprises a pair of finger contacts that are pivotally mounted on a suitable support and are spring-pressed toward each other. There is a space between the finger-type contacts into and out of which a mating movable contact can be driven. When the movable contact is present between the finger contacts, the finger contacts are forced into high pressure engagement with the movable contact and with a projecting portion of the support, thereby providing a good conductive path between the movable contact and the support.

Difficulty has been experienced heretofore in providing between the support and the finger contacts an electrical connection that is capable of carrying very high currents without harmful arcing. In this respect, the high currents create high magnetic forces which tend to separate the contacting surfaces, thus causing arcing at the surfaces. This problem can be overcome by providing many contact assemblies electrically connected in parallel in order to reduce the current through any one assembly, but such a structure is unduly expensive and consumes an undue amount of space.

An object of my invention is to provide a highly compact finger-type contact structure in which the connection between the finger contacts and their support can carry very high currents without arcing.

Another object is to provide finger-type contact structure in which the contact-maintaining forces between the fingers and their support are increased by the mechanical forces incident to a circuit-breaker opening operation and to a circuit-breaker closing operation.

In carrying out my invention in one form, I provide a conductive support that comprises a body portion and a projecting portion extending laterally therefrom. A pair of finger contacts are disposed at opposite sides of the projecting portion and extend laterally outward from the body portion beyond the free end of the projecting portion. Each of the finger contacts has a partially cylindrical bearing portion at one end and a contact-making portion adjacent its other end adapted to engage a contact movable into and out of the space between the contact fingers. Each of the finger contacts is mounted for limited pivotal motion about a central longitudinal axis of its partially cylindrical bearing portion. Pressure producing means is provided for urging the partially cylindrical bearing portion of each finger contact into high pressure engagement with the support at two current-transfer locations on the cylindrical bearing portion which are circumferentially spaced from each other. One of these current-transfer locations is on the body portion of the support and the other is on the projecting portion of the support. The pressure-producing means comprises a cam bearing against said bearing portion at a third location circumferentially spaced from the two current-transfer locations and spring means forcing the cam into high pressure engagement with the bearing portion at said third location.

For a better understanding of the invention, reference may be had to the following description taken in conjunction with the accompanying drawings, wherein:

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FIG. 1 is a sectional view taken along the line 1—1 of FIG. 2 and showing contact structure embodying one form of the invention.

FIG. 2 is an end view of the contact structure of FIG. 1.

FIG. 3 is an enlarged view of a portion of FIG. 1 depicting certain force relationships.

FIG. 4 is an enlarged view of a portion of FIG. 1 depicting certain current paths through the contact structure.

Referring now to FIG. 1, there is shown contact structure that comprises three juxtaposed contact assemblies 10, 11 and 12. In many respects, these three contact assemblies are identical, and identical reference numerals will therefore be used to designate corresponding parts.

The contact structure comprises a common base 15 of highly conductive material that has removable end plates 16 (FIG. 2) suitably secured to its opposite sides. The base 15 may be thought of as comprising three integrally-connected supports for the three contact assemblies. As viewed in FIG. 1, each support is of a T-shape and comprises a body portion 17 and a projecting portion 19 extending laterally from the body portion. Disposed at opposite sides of each projecting portion are a pair of finger contacts 20. These finger contacts extend laterally outward from the body portion 17 beyond the free end of the projecting portion 19. These finger contacts are barred by the end plates 16 from moving vertically, as viewed in FIG. 2.

Referring to FIG. 1, each finger contact has a partially cylindrical bearing portion 25 at one end and a contact-making portion 27 adjacent its other end. The contact-making portion 27 of the finger contacts of each assembly face each other on opposite sides of a space 29 disposed between the two finger contacts. In each assembly, a movable contact 30 is adapted to pass into and out of the space 29 and to make contact with the contact-making portions 27 when disposed in the space. In the illustrated form of the invention, the center contact assembly 10 serves as a current-carrying and arcing contact assembly, and the two outer contact assemblies serve merely for current-carrying purposes. Along these lines, when the three movable contacts 30 are in their illustrated position of FIG. 1, current is carried through all three contact assemblies. Note, however, that the central movable contact 30 is longer than the two outer movable contacts 30. Thus, when the movable contacts 30 are moved together (by suitable conventional means not shown) in an opening direction O, the central movable contact 30 is the last to break contact with its finger contacts 20. Thus, assuming current is then flowing, the primary arcing duty occurs at the central contact assembly. On closing, the central movable contact 30, being longer, approaches its stationary contact assembly 10 first and thus bears any arcing duty that might occur as a result of closing an energized circuit.

The partially-cylindrical bearing portion 25 of each finger contact 20 makes line-contact with its support 17, 19 at two current-transfer locations 31 and 32 which are circumferentially spaced from each other about the periphery of the cylindrical bearing portion. One of these current-transfer locations is on the body portion 17 and the other on the projecting portion 19 of the support 17, 19. In the illustrated embodiment, a concave recess 34 is provided at the intersection of the projecting portion 19 and the body portion 17 of the support for receiving the generally cylindrical bearing portion 25 of the finger contact.

For urging each finger contact into high pressure engagement with its support at the two current-transfer locations 31 and 32, pressure-producing means 40 is provided. This pressure-producing means comprises a cam

member 41 and a compression spring 42 urging the cam member 41 into high pressure engagement with the cylindrical bearing portion 25 at a third location 44 circumferentially spaced from the two current-transfer locations 31 and 32. The cam member 41 and the spring 42 are mounted on a supporting pin 45 which is fixed to the support 17, 19. Each of these supporting pins 45 is suitably secured by nuts 47 to the support 17, 19 and projects laterally from the support 17, 19 alongside one of the contact fingers.

The spring 42 bears at one end on a stationary abutment 46 carried by the pin 45 at its outer end. At its opposite end the spring 42 bears against the cam member 41, which is slidably and loosely mounted on the pin 45. Referring to FIG. 3, the spring 42 thus exerts a force on the cam member 41 which is applied to the cylindrical bearing portion 25 as a force 48. This force 48 produces contact-maintaining forces 49 and 50 acting through the two current-transfer locations 31 and 32, respectively.

The outer ends of the finger contacts 20 are urged toward each other by additional compression springs 60. One of these compression springs 60 is located between each finger contact 20 and the abutment 46 on the pin 45. When the movable contact 30 is in the space 29 between the finger contacts, the compression springs 60 urge the contact-making portions 27 of the finger contacts into high pressure engagement with the movable contact.

When the movable contact 30 is not in the space 29 between the finger contacts 20, the finger contacts occupy the dotted line position 63 of FIG. 1. They are blocked from moving further together by suitable stop means. In the two outer contact assemblies 11 and 12 the stop means is constituted by surfaces of the projecting portion 19. In the center contact assembly 10 the stop means comprises stop pins 65 which move in suitable slots in the end plates 16.

When the movable contact 30 enters the space 29 of each contact assembly, it acts through its wedge-shaped forward surface 69 to force the two finger contacts slightly apart, moving them from their dotted line position to their solid line position of FIG. 1. In so moving, each finger contact pivots through a small angle about the central longitudinal axis 70 of the partially cylindrical bearing portion 25. During this pivotal movement, high pressure engagement is maintained at both the current-transfer locations 31 and 32 by the spring 42 acting through cam 41. This continuous high pressure engagement assures that there will be no arcing at these locations even under very high current conditions. This is the case not only during entry of the movable contact into space 29, but whenever the movable contact is in space 29.

The fact that current is transferred between each finger contact and its support at two spaced-apart locations (31 and 32) instead of at only one location is advantageous because it results in substantially reducing the value of current flowing through each current-transfer location. This reduces the likelihood that the local magnetic forces developed at each current-transfer location will be high enough to separate the current-transfer surfaces and thus produce harmful arcing at these surfaces.

By providing a connection between the finger contacts and the support that is capable of safely transferring exceptionally high values of current, I am able to reduce the number of parallel-connected contact assemblies required for a given current rating. This reduction, of course, contributes to the compactness of my contact structure.

Another feature that contributes to the compactness of my contact structure is the construction of the pressure-producing means 40 that is used for applying the contact-maintaining forces 49 and 50 (FIG. 3) to each finger contact. By employing the cam 41, I can use a single spring 42 to develop the two forces 49 and 50 on each finger contact. Moreover, the cam enables me to locate the

single spring in a location between the contact assemblies where it extends generally parallel to the adjacent finger contacts. This disposition of the spring 42 enables the contact assemblies to be located quite close together, further lending compactness. Referring to FIG. 3, note still further that the presence of cam 41 permits the use of a single spring (at 42) for supplying the contact-maintaining forces 49 and 50 on two adjacent fingers of the contact assemblies. Thus, a single spring 42 acts to supply four separate forces to the two contact fingers at their current transfer locations 31 and 32. The spring 42 and cam 41 consume little or no space that is not otherwise required since most of the space in which these parts are located must be provided anyway to accommodate the pin 45 and abutment 46 used for supporting the other springs 60 at the outer ends of the finger contacts.

Those cams 41 that act on the outer fingers 20 of the outer contact assemblies 11 and 12 have one surface bearing on a portion of the end plates 16 and another surface bearing on the partially cylindrical portion 25 of the finger. There is enough looseness of the cam 41 on its support rod 45 to permit the spring 42 to urge the cam into high pressure engagement with the finger despite the stationary character of the bearing on end plate 16.

When the movable contact 30 is driven into space 29 during a closing operation, frictional forces between the movable contact and the finger contacts tend to carry the finger contacts along with the movable contact in a closing direction. This tendency substantially increases the force 49 in FIG. 3. Similarly, when the movable contact 30 is moved out of the space 29 during an opening operation, frictional forces tend to drag the finger contacts along with the movable contacts in an opening direction. This tendency substantially increases the force 50 of FIG. 3.

Thus, my contact structure during both closing and opening, utilizes the above-mentioned frictional forces to increase one of the contact-maintaining forces 49 or 50. This increase in contact-maintaining force helps to prevent any contact separation from occurring at the bearing end of the finger contacts 20 during contact-opening or closing. A factor that accounts for the increase in contact-maintaining force 50 during an opening operation is that the current-transfer surface at 32 on the projecting portion 19 extends transversely to, rather than parallel to, the direction O in which the above-described opening force is applied to the finger contact 20.

To provide a magnetic force that assists in holding the finger contacts 20 in high pressure engagement with the projecting portion 19 of support 17, 19, I provide current-directing means 80 (FIG. 4). This current-directing means 80 comprises a slot formed in the base 15 and extending thereacross between the current-transfer location 31 for the fingers 20 of the central contact assembly 10. This current-directing means 80 forces a large portion of the current flowing through the support 17, 19 into a given contact finger to follow a loop-shaped path that bows toward the other finger contact, as shown by dotted line 82. The effect of this bowing is to develop a magnetic force that tends to lengthen the loop, which force manifests itself on the finger contact 20 as a force tending to drive the finger contact toward the other finger contact. This helps to increase the contact-maintaining pressure at current-transfer location 32. With further regard to the current path, current enters the base 15 from its back side through terminal structure 85 of highly conductive metal. The base 15 is secured to this terminal structure 85 by studs 84, which are extensions of the pins 45. The slot 80 bars current from entering the base 15 from terminal structure 85 by any path extending across the slot.

The slot 80 is shown applied to the base 15 only in the region of the central contact assembly 10. This is the case because the central contact assembly 10 has higher current-carrying requirements than the other contact assemblies because during opening or closing it carries all of the current for a brief interval. This interval occurs

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during opening when the outer movable contacts 30 are out of engagement with their stationary contact assemblies 11 and 12, but the central movable contact 30 is either still in contact with its stationary contact assembly 10 or an arc is present at the central contact assembly 10. The current-directing means 80 provides a supplementary force to hold the finger contacts in high pressure engagement with the projecting portion 19 during this brief interval of very high current.

While I have shown and described a particular embodiment of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention in its broader aspects; and I, therefore, intend in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

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

1. A contact assembly for an electric circuit breaker comprising:

- (a) a conductive support comprising a body portion and a projecting portion extending laterally from said body portion,
- (b) a pair of finger contacts disposed at opposite sides of said projecting portion and extending laterally outward from said projecting portion beyond the free end of said projecting portion,
- (c) each of said finger contacts having a partially cylindrical bearing portion at one end and a contact-making portion adjacent its other end adapted to engage a contact movable into and out of the space between said finger contacts, each of said finger contacts mounted for limited pivotal motion about a central longitudinal axis of its partially cylindrical bearing portion,
- (d) pressure-producing means urging the partially cylindrical bearing portion of each finger contact into high pressure engagement with said support at two current-transfer locations on said cylindrical bearing portion which are circumferentially-spaced from each other on said cylindrical bearing portion, one of said current-transfer locations being on the body portion of said support and the other being on the projecting portion of said support,
- (e) said pressure-producing means comprising:
 - (i) a cam bearing against said bearing portion at a third location circumferentially spaced from said two current-transfer locations, and
 - (ii) first spring means forcing said cam into high

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pressure engagement with said bearing portion at said third location,

(f) and additional spring means urging said other ends of said finger contacts toward each other.

2. The contact structure of claim 1 in which:

- (a) said pressure-producing means further comprises:
 - (i) a pin fixed to said support and projecting laterally therefrom alongside one of said finger contacts,
 - (ii) means slidably mounting said cam on said pin,

(b) said first spring means exert a force on said cam in a direction lengthwise of said pin.

3. The contact structure of claim 2 in which:

- (a) said pin carries an abutment at its outer end, and
- (b) said additional spring means comprises a compression spring located between said abutment and the adjacent finger contact.

4. Contact structure comprising a pair of juxtaposed contact assemblies each constructed as set forth in claim 1, one finger contact of one contact assembly located closely adjacent one finger contact of the other assembly, the cams for the closely adjacent finger contacts of said juxtaposed contact assemblies integrally connected together to form a single cam member common to both assemblies, said first spring means acting on said single cam member to urge the bearing portions of said adjacent fingers into high pressure engagement with their respective supports.

5. The contact assembly of claim 1 in combination with current-directing means that forces a large portion of the current flowing through said base into each of said contact fingers to follow a path that bows toward the other of said finger contacts in the region of said current-transfer location on said body portion.

6. The contact assembly of claim 5 in which said current-directing means comprises a slot in said body portion extending between the current-transfer locations on said body portion.

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