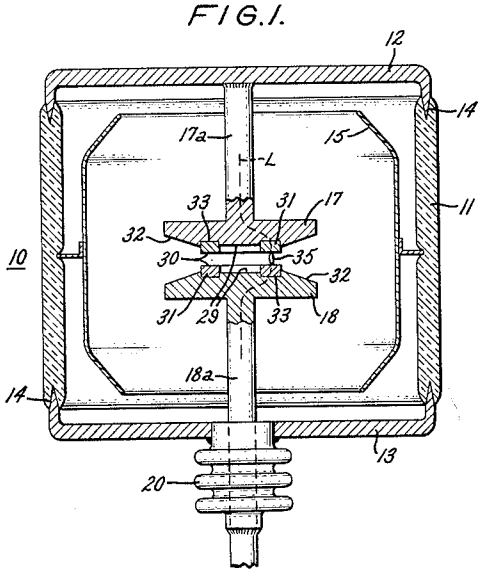
Nov. 24, 1964 G. POLINKO, JR., ETAL 3,158,719

CONTACT STRUCTURE FOR AN ELECTRIC CIRCUIT INTERRUPTER

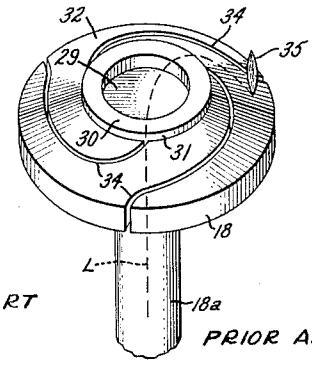
Filed April 3, 1962

FIG. 1.



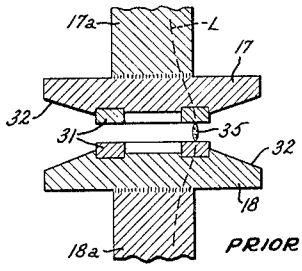

PRIOR ART

FIG. 2.




PRIOR ART

FIG. 3.




PRIOR ART

FIG. 5.

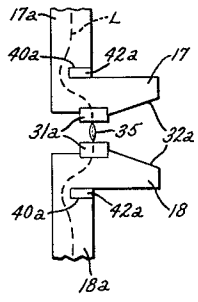



FIG. 6.

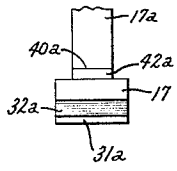
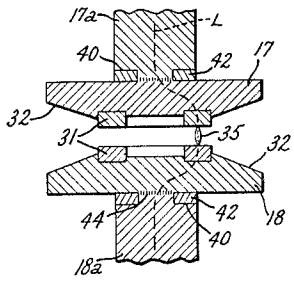



FIG. 4.





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# CONTACT STRUCTURE FOR AN ELECTRIC CIRCUIT INTERRUPTER

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8 Claims. (Cl. 200—144)

This invention relates to contact structure for an electric circuit interrupter and, more particularly, to contact structure that is especially suited for use in a vacuum-type circuit interrupter.

In the contact structure of the present invention there is an arc-initiating region on which arcs are initiated and an arc-running region on to which the arcs are magnetically forced from the arc-initiating region. The arc-running region is more suited for the interruption of high currents than the arc-initiating region, so it is important that the magnetic force be strong enough to promptly drive the arc on to the arc-running region. One way of forcing the arc on to the arc-running region is to shape the contact structure in such a way that the current path through the contacts is of a loop-shaped configuration bowing in the direction of the arc-running surface. Such a configuration results in the presence of a magnetic force tending to lengthen the loop and hence to drive the arc on to the arc-running surface.

In certain contact structures of this type, the contact cannot readily be shaped to provide the desired configuration of the loop. For example, the desired contact shape might be too weak structurally or might be so involved as to be excessively expensive to form.

An object of the present invention is to construct the contacts in such a way that a current path of the desired loop-shaped configuration can be obtained without materially weakening the contact structure and without resorting to excessively involved and expensive shapes.

In carrying out our invention in one form, we provide separable contacts having arc-initiating regions between which an arc is drawn upon separation of said contacts and an arc-running region located laterally outward from said arc-initiating regions. Current-directing means is provided for forcing the net current flowing through the contacts and an arc present at the arc-initiating regions to follow a loop-shaped path that bows laterally outward in the immediate vicinity of said arc to provide a laterally-outwardly acting magnetic force on the arc. This current-directing means comprises a recess formed in the conductive structure immediately behind the arc-initiating region of at least one contact and generally aligned with this arc-initiating region. Located within this recess is an insert of high resistivity material for forcing most of the current flowing through said one contact to follow a path that bypasses said recess. The shape of the recess is such that the path of the net current through said one contact in the immediate vicinity of the arc is more effectively lateral than if appreciable current could flow directly across the recess, thus increasing the extent to which the net current path bows laterally outward in the immediate vicinity of the arc.

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

FIG. 1 is a cross-sectional view of a vacuum-circuit interrupter to which our invention can be applied. The particular circuit interrupter shown does not embody our invention but is being shown to facilitate an understanding of the invention. The movable contact of the interrupter of FIG. 1 is shown in a partially-open position through which it passes during the early stages of circuit interruption.



FIG. 2 is a perspective view of one of the contacts contained in the interruptor of FIG. 1.

FIG. 3 shows contact structure similar to that of FIG. 1 but with larger conductors for carrying current to and from the contacts.

FIG. 4 illustrates contact structure embodying one form of our invention.

FIG. 5 illustrates contact structure embodying another form of our invention.

FIG. 6 is a side elevational view of the contact structure of FIG. 5.

Referring now to FIG. 1, there is shown a vacuum-type circuit interrupter comprising an evacuated envelope **10** comprising a casing **11** of suitable insulating material and a pair of metallic end caps **12** and **13** closing off the ends of the casing. Suitable seals **14** are provided between the end caps and the casing to render the envelope **10** vacuum-tight. A tubular metallic shield **15** is shown mounted on the casing **11** to condense arc-generated vapors before they can reach the casing, thereby preserving the insulating properties of the casing.

Located within the envelope **10** is a pair of separable disc-shaped contacts **17** and **18**. The upper contact **17** is a stationary contact suitably secured to a conductive rod **17***a*, which at its upper end is united to the upper end cap **12**. The lower contact **18** is a movable contact joined to a conductive operating rod **18***a* which is suitably mounted for vertical movement. The operating rod **18***a* projects through an opening in the lower end cap **13**, and a flexible metallic bellows **20** provides a seal about the rod **18***a* to allow for vertical movement of the rod without impairing the vacuum inside the envelope **10**. As shown in FIG. 1, the bellows **20** is secured in sealed relationship at its respective opposite ends to the operating rod **18***a* and the end cap **13**.

When the contacts **17** and **18** are in engagement, the interrupter is closed. Downward movement of the lower contact **18** from its engaged position to a fully separated position opens the interrupter, whereas return movement to the engaged position recloses the interrupter. The contact **18** in FIG. 1 is shown in a position through which it passes immediately after opening motion has begun.

The illustrated contacts **17** and **18** are similar in many respects to those disclosed and claimed in application Serial No. 143,170, Lee and Schneider, filed September 19, 1961, and assigned to the assignee of the present invention. Thus, each contact is of a disc-shape and has one of its major surfaces facing the other contact. The central region of each contact is provided with a recess **29** in this major surface, and an annular arc-initiating area **30** surrounds this recess. In each contact, this contact-making region is defined by the exposed surface of an annulus **31** which is integrally united with the remainder of the contact, as by means of a brazed joint at the interface **33**.

Both the annulus **31** and the remainder of the contact are formed of conductive materials, but in a preferred form of our invention, these materials are dissimilar, as will soon be explained in greater detail. Surrounding the annulus **31**, each contact has an annular surface **32**, which is hereinafter termed the arc-running surface. The arc-running surface **32** extends from the outer periphery of the annulus **31** to the outer periphery of the disc contacts **17** and **18**.

The two annular contact-making areas **30** of the contacts **17** and **18** abut against each other when the contacts are in their closed position and are of such an internal diameter that the current flowing through the closed contacts is forced to follow a loop-shaped path L, as is indicated by the dot-dash lines of FIG. 1. Current flowing through this loop-shaped path has a magnetic effect which tends in a well known manner to lengthen

the loop. As a result, when the contacts are separated to form an arc such as 35 between the arc-initiating regions 30, the magnetic effect of the current through the loop will impel the arc radially outward toward the arc-running surface 32. This is the condition depicted in FIG. 1.

As the arc terminals move toward the outer periphery of the discs 17 and 18, the arc is subjected to a circumferentially-acting magnetic force that tends to cause the arc to move circumferentially about the central axes of the discs. This circumferentially-acting magnetic force is preferably produced by a series of slots 34 provided in the discs and extending from the outer periphery of the discs inwardly by generally spiral paths, as shown in FIG. 2. These slots correspond to similarly designated slots in the aforementioned Lee and Schneider application, and thus force the current flowing to or from an arc terminal located at substantially any angular point on the outer peripheral region of the disc to follow a path that has a net component extending generally tangentially with respect to the periphery in the vicinity of the arc. This tangential configuration of the net current path causes the magnetic loop L to develop a net tangential force component, which tends to drive the arc in a circumferential direction about the outer peripheral portion of the contacts. This circumferential motion increases the amount of current that the interrupter can handle and also reduces arc-erosion.

The annuli 31 of FIG. 1 are preferably made of a conductive material that has a high resistance to current-chopping and contact-welding as compared to the material of the arc-running surface 32. The material of the arc-running surface 32, on the other hand, is more suited for the interruption of high currents. Examples of materials suitable for these two regions are disclosed and claimed in the aforementioned Lee and Schneider application Serial No. 143,170.

When the general contact design shown in FIG. 1 is used for carrying high continuous currents, say 1,200 or 2,000 amperes, it is necessary that the rods 17*a* and 18*a* be of a larger diameter than shown in FIG. 1. When these larger diameter rods are used with contacts such as shown in FIG. 1, the current path L through the contacts loses much of its loop-shaped configuration, as illustrated in FIG. 3. This is disadvantageous because it lessens the radially-outward magnetic forces on the arc to such an extent that even relatively heavy current arcs are not promptly driven radially outward on to the arc-running surface 32, where they can be most advantageously handled by virtue of the contact material of these arc running surfaces and the slots 34 provided therein.

One way of preserving the desired radially-outward force with contacts supported on the enlarged rods is to increase the internal and external diameters of the annuli 31, so that the contact-making area is further removed in a radial direction from the longitudinal axes of the contacts.

A disadvantage of this approach, however, is that using these larger annuli 31 would lessen the available area of the arc-running surface 32 for contacts of a given diameter. This would detract from the interrupting ability of the contacts.

We can avoid the necessity of increasing the diameter of the annuli 31 by using the arrangement shown in FIG. 4. Here, each of the rods 17*a* and 18*a* is provided with an annular groove 40 immediately adjacent the annulus 31 and generally in alignment with the annulus 31. Disposed within this groove 40 is an insert 42 of a material having a high electric resistivity compared to that of the contacts and the remainder of their supporting rods. For example, stainless steel, which has a high resistivity and is also non-magnetic, may be used for the insert 42 and copper for the rod 17*a* and the body of the contact 17 and a low resistance copper alloy for the annuli 31. Other high resistivity materials, magnetic or non-magnetic, may also be used for the insert 42, but stainless steel is preferred. The insert 42 is of a ring form and is preferably brazed in place by brazed joints along both its upper and lower faces. This assembly operation is facilitated by the fact that the rod 17*a* and the contact 17 are formed as separate parts brazed together along the junction area 44. Preferably, the groove 40 is provided at the lower end of rod 17*a*, and the ring 42 is placed in the groove before the contact 17 is brazed to the rod 17*a*.

Since the ring 42 is of a high resistivity material compared to the material of the rod, very little current flows through it. Substantially all of the current is forced by the ring 42 to flow through a path located centrally of the rod 17*a* radially inwardly of the inner periphery of the ring 42. To reach the annulus 31 from this central location, the current must flow radially outward in the vicinity of the arc. Even if the arc is initiated on the arc-initiating face of annulus 31 at a point adjacent its inner periphery, the current must flow radially outward in the vicinity of the arc. Thus, the desired magnetic loop is present, even though the diameter of the annulus 31 has not been increased over that shown in FIG. 3.

Another advantage of the arrangement of FIG. 4 is that the presence of the insert 42 in the groove offsets the mechanical weakening effect of the groove and thus mechanically strengthens the contact structure. This helps the contact structure to resist the impacts of switch-closing without structural damage.

Although we have illustrated our invention in connection with a particular contact structure, it is to be understood that in its broader aspects the invention is not limited to the particular contact structure shown in FIG. 4. For example, FIGS. 5 and 6 show a contact which constitutes only a segment of the circular disc of FIGS. 1–4. Here a groove 40*a* is provided in the rod 17*a* adjacent the contact-making portion 31*a* and in general alignment with the contact-making portion 31*a*. Within this groove 40*a* there is an insert 42*a* of a high resistivity material such as stainless steel which forces the current to follow a more pronounced laterally-extending path to contact-making region 31*a*, so that there is a stronger magnetic force urging the arc laterally outward on to the arc-running surface 32*a*. The insert 42*a* is also brazed to the juxtaposed walls of its surrounding recess to provide for increased mechanical strength.

It will be obvious to those skilled in the art that various changes and modifications may be made without departing from our invention in its broad aspects, and we, therefore, intend in the appended claims to cover all such changes and 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. An electric circuit interrupter comprising:

(*a*) an axially-extending conductive rod,

(*b*) a pair of separable contacts, one of which is electrically and mechanically joined to said conductive rod,

(*c*) said contacts having arc-initiating regions between which an arc is drawn upon separation of said contacts and arc-running region which are displaced in a laterally-outward direction with respect to said axially-extending rod from said arc-initiating regions,

(*d*) current-directing means for forcing the net current flowing through said contacts and an arc present at any point on said arc-initiating regions to follow a loop-shaped path which bows in a laterally-outward direction with respect to said axially extending rod in the immediate vicinity of said arc to provide a laterally outwardly acting magnetic force on said arc,

(*e*) said current-directing means comprising a recess formed in the conductive structure immediately behind one of said arc-initiating regions and generally aligned with said one arc-initiating region, said recess

extending in a laterally inward direction behind said one arc-initiating region to at least the laterally-innermost edge of said one arc-initiating region,

(*f*) said current-directing means also comprising an insert of high resistivity material compared to that of the surrounding material located in said recess to force most of the current flowing through the associated contact to follow a path that bypasses said recess, said insert engaging the opposite walls of said recess to resist deformation of the material adjacent said recess,

(*g*) the shape of said recess being such that the path of the net current through said associated contact to an arc located at any point on its arc-initiating region is more effectively lateral in the vicinity of the arc than if the net current could flow directly across said recess.

2. The interrupter of claim 1 in which said arc-running regions are formed of a material different from that of said arc-initiating regions and more suited for the interruption of high currents.

3. An electric circuit interrupter comprising:

(*a*) a pair of separable disc-shaped contacts having generally annular arc-initiating regions between which an arc is drawn upon separation of said contact,

(*b*) each of said contacts further comprises an arc-running region surrounding its generally annular arc-initiating region and extending radially outward to the outer periphery of the disc-shaped contact,

(*c*) a pair of longitudinally extending conductive rods respectively electrically connected to said contacts for carrying current to their corresponding contacts via paths located radially inwardly of said arc-initiating regions in such a position that the net current flowing between said rods through said arc-initiating regions follows a loop-shaped path bowing radially outwardly,

(*d*) and current-directing means for confining the current flowing through the portion of said rods immediately adjacent their respective contacts to the central region of said rod portions,

(*e*) said current-directing means comprising a groove in each of said rods extending about the rod periphery adjacent the contact associated with said rod and an insert fitting within said groove made of a material that has a high electrical resistivity compared to that of said rod portion and said contacts, said insert engaging the opposed walls of said groove to resist deformation of the material adjacent said groove,



(*f*) said groove extending generally radially of said rod and projecting radially inwardly at least to the radially-innermost edge of said arc-initiating region.

4. An electric circuit interrupter comprising:

(*a*) a pair of separable contacts having generally annular arc-initiating regions between which an arc is drawn upon separation of said contacts,

(*b*) one of said contacts comprising an arc-running region surrounding its generally annular arc-initiating region,

(*c*) a conductive rod electrically connected to said one contact for carrying current to and from said one contact via a path located radially inwardly of the arc-initiating region of said one contact so that the net current flowing between said rod and arc-initiating region follows a radially extending path in the vicinity of the arc-initiating region,

(*d*) and current-directing means for confining the current flowing through the portion of said rod immediately adjacent its connected contact to the central region of said rod,

(*e*) said current-directing means comprising a groove in said rod extending about the rod periphery adjacent the connected contact and an insert fitting within said groove and providing a much greater resistance to the flow of current directly across said groove than through the central region of said rod, said insert engaging the opposed walls of said groove to resist deformation of the material adjacent said groove,

(*f*) said groove extending generally radially of said rod and projecting radially inwardly at least to the radially-innermost edge of said arc-initiating region.

5. The interrupter of claim 4 in which said insert is made of a material that has a high electrical resistivity compared with that of said rod and contact.

6. The circuit interrupter of claim 1 in which the material of said insert is substantially non-magnetic.

7. The circuit interrupter of claim 4 in which the material of said insert is substantially non-magnetic.

8. The circuit interrupter of claim 1 in which said one arc-initiating region is of a generally annular form and said recess is of a generally annular form.

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