CONTACT STRUCTURE FOR AN ELECTRIC VACUUM SWITCH

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ABSTRACT OF THE DISCLOSURE

A vacuum switch contact having an annular ridge which provides the contact surface and is formed with inclined slots which extend into the ridge from the contact surface and divide that surface into discrete contact areas. The ridge is provided with an internal or an external resilient skeleton which permits relative displacement of the contact areas so that they can accommodate irregularities in a surface against which the contact surface is pressed.

This invention relates to switch contacts of, or suitable for use in, electrical vacuum switches suitable for interrupting large currents.

In electrical vacuum switches the current normally flows in series through a pair of contacts located in a chamber which is either evacuated or contains a gas at a very low pressure, the two contacts being so arranged that they may be moved apart to interrupt the flow of current. In order that the switch should have a large current carrying capacity, it is desirable that the surfaces of the two contacts through which the current flows should be in firm contact with each other over substantially the whole of their areas. However, this firm contact tends to be impeded by any slight irregularities which may be present on the contacting surfaces. It is a disadvantage of known vacuum switch contacts that if a "high spot" is present on one of the contacting surfaces due to a fault in manufacture, or uneven wear of or deposition on the contact surfaces during use, the contact surfaces will not meet properly, and the current carrying capacity of the vacuum switch is impaired.

An object of this invention is to provide a vacuum switch contact which to some degree reduces the above disadvantage.

According to one aspect of the present invention, a contact member suitable for use in a vacuum switch has an annular ridge which provides an annular contact surface and is formed with a plurality of substantially radial slots extending into the ridge from the annular contact surface to divide the annular contact surface into discrete contact areas, the slots being inclined to the longitudinal axis of the ridge and that part of the contact member forming the annular ridge having resilience permitting relative displacement of the contact areas to accommodate surface irregularities in a cooperating contact surface against which the contact surface is pressed.

According to another aspect of the invention, a vacuum switch comprises an evacuable envelope, and a pair of relatively moveable contact members disposed inside the envelope and having adjacent contact surfaces, one of the contact members having an annular ridge which provides an annular contact surface and which is formed with a plurality of substantially radial slots extending into the ridge from the annular contact surface to divide the contact surface into discrete contact areas, the slots being inclined to the longitudinal axis of the ridge and that part of the one contact member forming its annular ridge having resilience permitting relative displacement of the contact areas to accommodate surface irregularities in the contact surface of the other contact member when the contact surfaces of the two contact members are pressed together.

Preferably both contact members of the pair are contact members in accordance with the invention in which case the slots in the two contact members are inclined in opposite directions.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIGURE 1 is a perspective view of a vacuum switch contact in accordance with the invention;
FIGURE 2 is a fragmentary side view of an alternative form of the switch contact shown in FIGURE 1;
FIGURE 3 is a plan view of another form of the switch contact shown in FIGURE 1; and
FIGURE 4 is a side view, partly in section, of a vacuum switch including a contact assembly embodying the invention.

Referring to FIGURE 1, a contact member 1 suitable for use in an electrical vacuum switch has an annular contact surface 3 divided into a number of discrete contact areas such as 3A, 3B and 3C by a plurality of substantially radial slots 5 which extend into the member from the contact surface 3. The slots 5 are inclined at an angle to the surface 3, and effectively divide the annulus into a plurality of contact elements 7 each of which provides one or more contact area(s). The material from which the contact member 1 is formed has resilience such that when the contact surface 3 is pressed firmly against a co-operating contact having minor surface irregularities, it permits relative displacement of the contact areas such as 3A, 3B and 3C so that the contact surface 3 tends to conform to the shape of the irregular surface. Thus the presence of a "high spot" on either the surface 3 or the corresponding surface of the co-operating contact member will not prevent firm contact between the majority of the contact areas and the surface of the co-operating contact.

The resilient material from which the contact member is formed can be a suitable alloy of copper and one or more metals which has a degree of resilience after baking at a temperature of 700 degrees centigrade for 12 hours.

Such an alloy can conveniently consist of copper and one or more of the following metals in suitable proportions, iron, zirconium, titanium and chromium.

Alternatively, the required resilience may be provided by a contact member 1 constructed as shown in FIGURE 2 and comprising a resilient skeleton 9 formed from a resilient ring 11 having a plurality of resilient fingers 13 secured thereto and embedded in a suitable metal casting. The skeleton 9 can be of steel or other metal which does not anneal appreciably at 700 degrees centigrade, and the metal forming the casing of the copper. The slots 5 are cut in the portions of the casting between the fingers 13. The skeleton 9 can conveniently be formed from perforated strip to ensure a firm bond with the copper of the casing and the dimensions of the fingers 13 can be chosen to give the desired degree of resilience.

Instead of using a resilient skeleton as shown in FIGURE 2, the resilience may be provided by suitable metal fibres or wires embedded in the copper casting. Such wires or fibres can be of stainless steel, nickel-iron alloy, molybdenum, or tungsten, orientated in either a predetermined manner or a random manner. If the fibres are orientated in a random manner they should be of a substantially gas free metal to avoid any deleterious effects during out-gassing of the vacuum switch chamber, as some of the fibres are likely to be exposed when the slots 5 are cut. When the wires or fibres are orientated in a predetermined manner they are arranged to extend...
lengthwise along the contact elements 7 substantially parallel to the slots 5. Typically such wires would be about 0.5 millimetre in diameter and would be spaced about 1 millimetre apart. When such wires are of a suitable refractory metal such as molybdenum or tungsten the ends of the wires can be arranged to extend to the contact surface 3.

In a further arrangement shown in FIGURE 3 the resilience is provided by inner and outer cylindrical shells 15 and 17 of a refractory metal such as molybdenum between which the copper body is cast, so that after the slots 5 have been cut these shells act to stiffen the contact elements 7.

Referring now to FIGURE 4, the vacuum switch comprises a chamber having a body 19 of electrically insulating material and two end plates 21 and 23 of electrically conductive material. An aperture 25 is formed in end plate 21 and a movable conductor 27 extends through this aperture. A bellows member 29 extends between the conductor 27 and the end plate 21 so as to seal the aperture 25 but permit movement of the conductor 27 relative to the end plate 21. A fixed conductor 31 extends through the other end plate 23. The adjacent ends of the conductors 27 and 31 are provided with contact members 1 having annular contact surfaces 8 divided into a number of discrete contact areas by slots 5 as previously described. The slots 5 in the two contact members 1 are inclined in opposite directions. The chamber is evacuated to a very low pressure of the order of 10⁻¹⁰ mm. of Hg or less. When the contact surfaces 3 of the two contact members 1 are firmly pressed together during operation of the switch to permit a flow of current through the contact members, the resilience of the contact elements 7 permits relative displacement of the contact areas so that they can accommodate surface irregularities in the contact surface 3 of either contact member 1 so that each pair of opposed discrete contact areas makes contact with one another at at least one point.

What we claim is:

1. A contact member suitable for use in a vacuum switch comprising:
   (a) a conductive member;
   (b) an annular ridge on the conductive member providing an annular contact surface;
   (c) a plurality of substantially radial slots extending into the ridge from the annular contact surface to divide the annular contact surface into discrete contact areas, the slots being inclined to the longitudinal axis of the ridge; and
   (d) at least part of the conductive member forming the annular ridge having a resilient skeleton permitting relative displacement of the contact areas to accommodate surface irregularities in a cooperating contact surface against which the annular contact surface is pressed.

2. A contact member as claimed in claim 1, wherein the resilient skeleton comprises an external skeleton formed by inner and outer cylindrical shells of a refractory metal having a cast copper body between them, the slots extending radially through the shells.

3. A contact member as claimed in claim 1, wherein the skeleton comprises an internal skeleton having a plurality of resilient fingers embedded in a suitable metal casting with the fingers extending into the ridge between the slots.

4. A contact member as claimed in claim 3, wherein the skeleton is of a metal which does not anneal appreciably at a temperature of 700 degrees centigrade, and the casting is of copper.

5. A contact member as claimed in claim 4, wherein the skeleton is formed from steel strip perforated to provide a firm bond with the copper of the casting.

6. A contact member as claimed in claim 2, wherein the refractory metal is molybdenum.

7. A vacuum switch comprising:
   (a) an evacuated envelope;
   (b) first and second relatively movable contact members disposed inside the envelope and having adjacent contact surfaces;
   (c) an annular ridge on the first contact member providing an annular contact surface;
   (d) a plurality of substantially radial slots extending into the ridge on the first contact member from the annular contact surface to divide the annular contact surface into discrete contact areas, the slots being inclined to the longitudinal axis of the ridge; and
   (e) at least part of the first contact member forming the annular ridge having a resilient skeleton permitting relative displacement of the contact areas to accommodate surface irregularities in the contact surface of the second contact member when the contact surfaces of the two contact members are pressed together.

8. A vacuum switch as claimed in claim 7, wherein the resilient skeleton comprises an external skeleton formed by inner and outer cylindrical shells of a refractory metal having a cast copper body between them, the slots extending radially through the shells.

9. A vacuum switch as claimed in claim 7, wherein the skeleton comprises an internal skeleton having a plurality of resilient fingers embedded in a suitable metal casting with the fingers extending into the ridge between the slots.

10. A vacuum switch as claimed in claim 9, wherein the skeleton is of a metal which does not anneal appreciably at a temperature of 700 degrees centigrade, and the casting is of copper.

11. A vacuum switch as claimed in claim 10, wherein the skeleton is formed from steel strip perforated to provide a firm bond with the copper of the casting.

12. A vacuum switch as claimed in claim 8, wherein the refractory metal is molybdenum.

13. A vacuum switch comprising:
   (a) an evacuated envelope;
   (b) first and second relatively movable contact members disposed inside the envelope and having adjacent contact surfaces;
   (c) an annular ridge on the first contact member providing an annular contact surface;
   (d) a plurality of substantially radial slots extending into the ridge on the first contact member from the annular contact surface to divide the annular contact surface into discrete contact areas, the slots being inclined to the longitudinal axis of the ridge;
   (e) an annular ridge on the second contact member providing an annular contact surface;
   (f) a plurality of substantially radial slots extending into the ridge on the second contact member from the annular contact surface to divide the annular contact surface into discrete contact areas, the slots being inclined to the longitudinal axis of the ridge in the opposite direction to the slots in the ridge in the first contact member; and
   (g) the parts of the first and second contact members forming the annular ridges having a resilient skeleton permitting relative displacement of their contact areas to accommodate surface irregularities in the contact surfaces, when the contact surfaces of the two contact members are pressed together.

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