

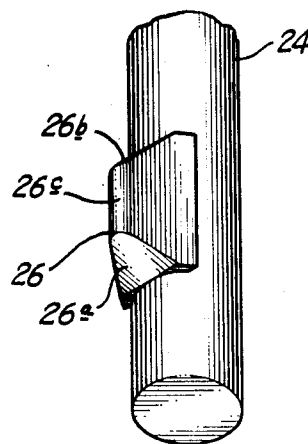
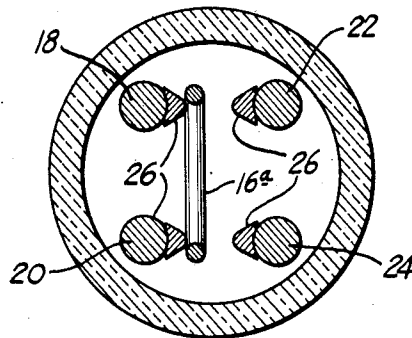
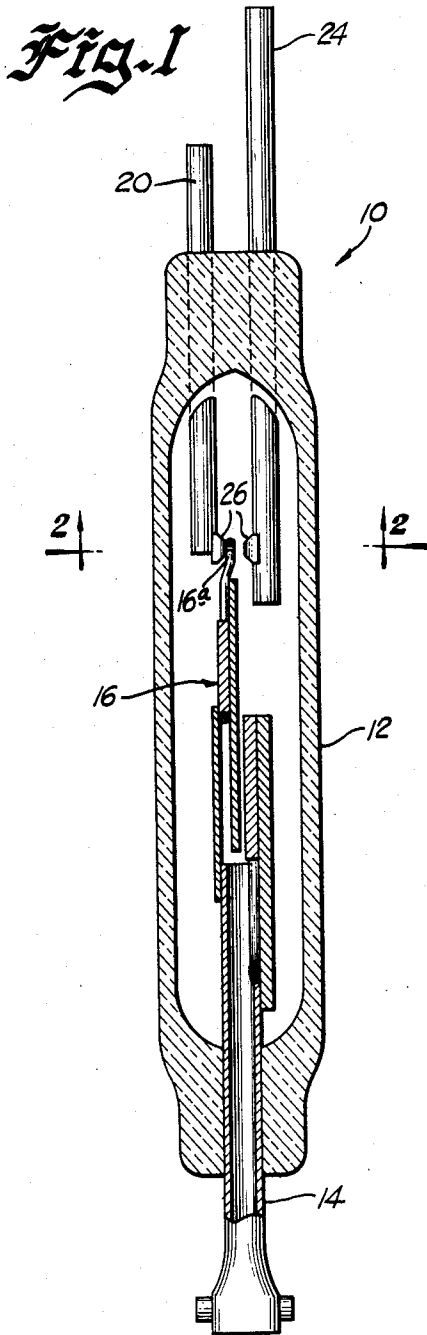
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CONTACT STRUCTURE FOR MERCURY RELAYS

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CONTACT STRUCTURE FOR MERCURY RELAYS

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This invention relates to a relay construction and, more particularly, to an improved contact element for use in mercury contact switches.

The improved operating characteristics of mercury contact switches such as high operating speeds, lack of contact bounce, and low contact resistance with small contact pressure, have led to the increased use of these types of switches in many different applications. In some types of apparatus, such as computing equipment, the high speed of operation of the mercury switch has made it a useful computer component because of the high speeds at which computing operations are performed. However, in the high speed operating conditions normally encountered in computing operations, a bridging of the contacts which has been observed to occur at random intervals adversely affects the reliability of these switches as computer components. In the bridging phenomena, the make and break contacts of the switch, which are alternately engaged by a movable armature, are shorted.

A study of the operations of the mercury contact switches with high speed photographic equipment indicates that, during the operation of the relays, the deflections or excursions of the capillary type armature result in throwing mercury from the armature to the contact elements and terminal pins on which the contact elements are mounted. After random periods of time, this mercury forms globules on the terminal pins and, in particular, in the fillets formed between the contact elements and the terminal pins. When the mass of mercury contained in the globules becomes great enough to be displaced by gravity or vibration, for instance, these globules move toward the upper end of the armature and the contact elements to form a coherent mass of mercury electrically bridging the oscillating armature and the make and break contact elements. This "avalanche" effect is of variable duration and occurs at random intervals. However, it has been observed to persist for periods of up to two hundred and fifty milliseconds at intervals having a median recurrence of around four hours. In the speeds normally used in the operation of computing apparatus, a short circuit of this duration and this frequency of repetition cannot be tolerated because of the adverse effects on the accuracy of the apparatus.

Accordingly, one object of the present invention is to provide a new and improved contact element for a mercury contact switch which obviates the "avalanche" effect.

Another object is to provide an improved terminal pin and contact element assembly for a mercury contact switch in which the upper and lower end surfaces of the contact element are tapered towards the armature to prevent the accumulation of globules of mercury in the fillets between the contact elements and the terminal pins.

A still further object is to provide a terminal pin and contact element assembly for use in mercury contact switches in which a contact element carried on a terminal

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pin is provided with inclined end surfaces, both of which are inclined toward a horizontal plane passing through the contact element to intersect this plane at an angle of 45° or less.

In accordance with these and many other objects, an embodiment of the present invention comprises a generally vertically extending glass envelope in the lower end of which is sealed a common terminal having an upwardly capillary type armature which is oscillated between two displaced or extreme positions under the control of an applied magnetic field. In the upper end of the glass envelope are provided two pairs of spaced and depending terminal pins, each carrying a contact element. The upper end of the armature is disposed between the two pairs of pins and is normally biased by suitable means to engage the contact elements carried on the pair of break terminal pins. Thus, when the armature is subjected to an alternating magnetic field, the upper end of the armature alternately moves into and out of engagement with the two contact elements on the make terminal pins and the two contact elements on the pair of break terminal pins.

The lower end of the sealed envelope is provided with a reservoir of mercury which moves upwardly along the armature to the upper end thereof by capillary action. Thus, when the armature is deflected between the make and break positions, the mercury on the upper end of the armature wets the contact elements and, in part at least, is transferred to the adjacent surfaces of the terminal pins and the contact elements to form globules. In accordance with the present invention, the upper and lower end surfaces of the four contact elements are beveled or tapered inwardly toward the interposed upper end of the armature so that the mercury cannot collect in the fillets between the terminal pins and the contact elements. By avoiding the accumulation of an excessively large amount of mercury in these fillets and on the terminal pins immediately adjacent the contact elements, it has been determined that the "avalanche" effect is prevented so that the contacts are not bridged by a large mass of mercury.

Many other objects and advantages of the present invention will become apparent from a consideration of the following detailed description when taken in conjunction with the drawings wherein:

Fig. 1 is a sectional view of a mercury contact switch including the improved terminal pin and contact element assembly of the present invention;

Fig. 2 is an enlarged sectional view taken along line 2—2 in Fig. 1 assuming that a complete switch is shown therein; and

Fig. 3 is an enlarged perspective view of one of the improved terminal pin and contact element assemblies of the present invention.

Referring now more specifically to the drawings, therein is shown a mercury contact switch 10 embodying the present invention and which is of the general type disclosed in detail in Burton Patent No. 2,459,306 or Pollard, Patent No. 2,732,459. As indicated therein, the switch 10 includes a glass envelope 12 in the lower end of which is sealed a common terminal pin 14 comprising a hollow header which is used during the fabrication of the switch 10 for evacuating the envelope 12 and for introducing both mercury and hydrogen gas under pressure. A flexible armature assembly, indicated generally as 16, is secured to the common terminal pin 14 and provides a path by which mercury is supplied to a bifurcated upper end portion 16a by capillary action to provide a body of mercury for wetting the contact elements.

The upper end of the glass envelope 12 has sealed therein a pair of break terminal pins 18 and 20 and a pair of make terminal pins 22 and 24 which are spaced

transversely from each other (Fig. 1) to provide a gap in which is disposed the upper portion 16a of the armature assembly 16. In accordance with the present invention, a tapered contact element 26 is secured to a lower portion of each of the terminal pins 18, 20, 22 and 24 in a position in which it is adapted to be engaged by the upper portion 16a of the armature assembly 16. The armature 16 normally engages the contact elements 26 carried on the terminal pins 18 and 20 and is adapted to move out of engagement with these contact elements and into engagement with the contact elements 26 carried on the terminal pins 22 and 24 in response to the application of an operating signal to a coil having a centrally disposed opening in which the switch assembly 10 is disposed.

Referring now more specifically to the contact elements 26, these elements preferably are formed from hard drawn platinum and are somewhat trapezoidal in cross section. The inner wall surface of the elements 26 are somewhat concave to conform to the outer surface of the terminal pins 18, 20, 22 and 24 thereby to facilitate the formation of a good bond between the terminal pins and the elements 26, preferably by welding. The elements 26 are secured to the terminal pins so that the longitudinal axis of each of these elements is generally parallel to the axes of the terminal pins.

In order to prevent the accumulation of globules of mercury in the fillets at the intersecting surfaces of the terminal pins 18, 20, 22 and 24 and the contact elements 26, each of these elements is formed with a beveled, tapered or inclined lower end surface 26a which extends generally inwardly and upwardly toward the upper end portion 16a of the armature 16 so as to intersect a plane normal to the body of the element 26 at an angle of 45° or less. Similarly, the upper end of each of the elements is formed with a tapered or beveled upper end surface 26b which extends downwardly and inwardly toward the upper end portion 16a of the armature assembly 16 so as to intersect a plane normal to the element 26 at an angle of 45° or less. The use of this angle of intersection between a plane normal to the element 26 and the planes defined by the end surfaces 26a and 26b is particularly desirable because it has been experimentally determined that this inclination of the end surfaces 26a and 26b is adequate to prevent the formation of the globules of mercury which give rise to the bridging or "avalanche" effect. The use of this degree of inclination also provides an adequate length of inner end surface 26c for maintaining satisfactory contact with the upper end portion 16a of the armature assembly 16 without unduly increasing the overall length of the contact element 26 with the attendant increase in the cost of the elements 26 due to the increased amount of platinum necessary to form these contacts.

When the switch 10 is placed in an operating coil and the coil is supplied with operating signals, a varying magnetic field is produced which repeatedly oscillates the armature assembly 16 between the position illustrated in Fig. 1 and one in which the upper end portion 16a engages the terminal elements 26 carried on the make pins 22 and 24. Incident to this oscillation of the armature 16, the mercury provided in the upper end portion 16a by capillary action is transferred to the terminal pins 18, 20, 22 and 24 and to the contact elements 26 carried thereon to provide wetted contacts of low resistance. However, this transferred mercury has a tendency to form globules on the adjacent surfaces of the pins 18, 20, 22 and 24 and on the contact elements 26.

The provision of the inclined end surfaces 26a and 26b on the elements 26 prevents the accumulation of sufficiently large amounts of mercury on the terminal pins 18, 20, 22 and 24 and the contact elements 26, particularly in the fillets between the contact elements 26 and the terminal pins, to bridge the contact elements 26 on the break pins 18 and 20 and the make pins 22 and 24. The inclined end surfaces 26a and 26b provide means by which the excess mercury from the terminal pins and the contact elements 26 is returned under the force of gravity to the lower portion of the cavity defined by the sealed glass envelope 12. By thus preventing the creation of the "avalanche" effect, the malfunctioning of the mercury contact switches 10 at high speeds is obviated, and their reliability in high speed applications, such as in computing apparatus, is materially improved.

Although the present invention has been described in conjunction with a single illustrative embodiment thereof, it should be understood that many other modifications can be made by those skilled in the art which will fall within the spirit and scope of the principles of this invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a relay including a sealed envelope containing mercury and a capillary type armature movable at high speeds relative to a plurality of contact supporting means, contact elements secured to said supporting means and adapted to be engaged by said armature, said elements each comprising a length of electrically conductive material having a longer wall surface secured to one of said supporting means and a shorter wall surface spaced from said one supporting means and adapted to be engaged by said armature, said longer and shorter walls being connected by two opposite end walls that are inclined respectively upwardly and downwardly toward said armature.

2. In a relay including a vertically extending sealed envelope containing mercury and an upwardly extending capillary type armature, a plurality of spaced terminal pins sealed in said envelope and extending downwardly within said envelope, said armature being movable relative to said terminal pins at high speeds, and an elongated contact element secured to each of said pins adapted to be engaged by the upper end of said armature, each of said elements extending generally along the axis of the terminal pin and having both an upper and generally flat end surface inclined downwardly and inwardly toward the upper end of said armature and a lower and generally flat end surface inclined upwardly and inwardly toward the upper end of said armature.

3. The relay set forth in claim 2 in which both of the inclined end surfaces of each of said contact elements intersect a horizontal plane at an angle of 45° or less.

4. A contact element for use with wetted contact relays operable at high speeds comprising an elongated length of electrically conductive material having longitudinally spaced and generally flat end surfaces which are inclined inwardly toward a plane passing transversely through the material to intersect the plane at an angle of 45° or less.

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