July 12, 1966 W. F. AUER 3,260,829

ELECTRICAL SWITCH CONTACTS WITH A FOLLOWER CONTACT SURFACE

Filed Nov. 3, 1964

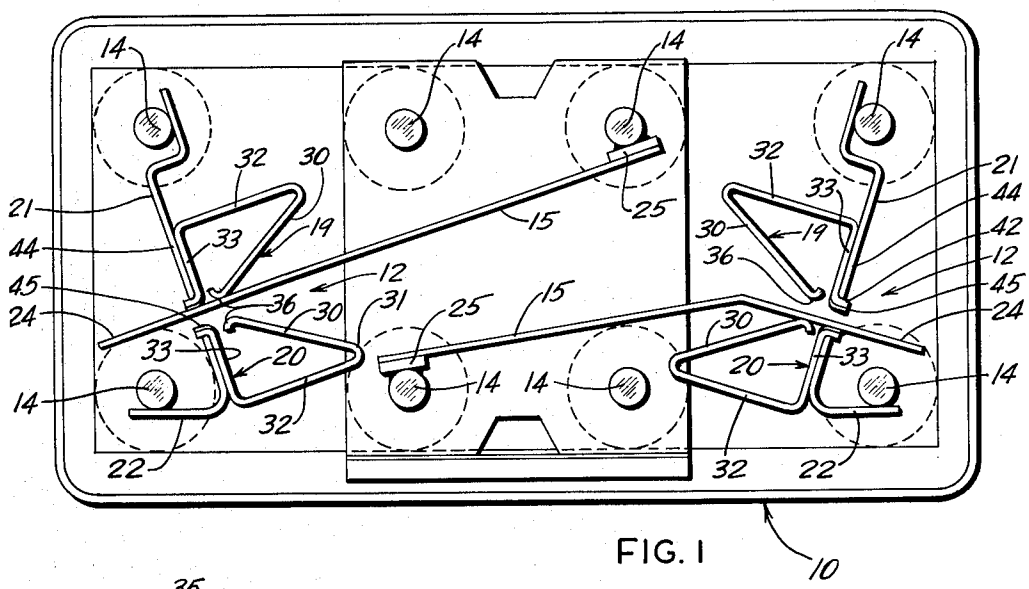


FIG. 1

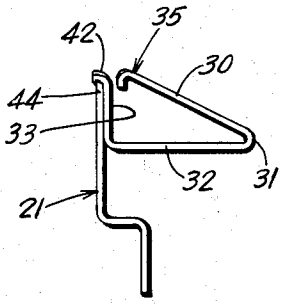


FIG. 2

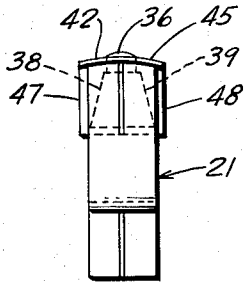


FIG. 3

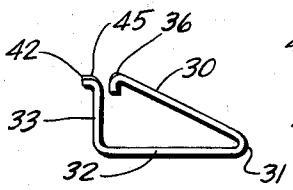


FIG. 4

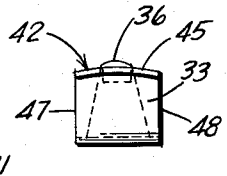


FIG. 5

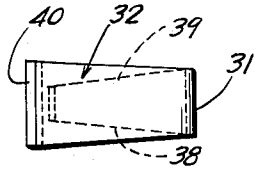


FIG. 6

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ELECTRICAL SWITCH CONTACTS WITH A FOLLOWER CONTACT SURFACE

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This invention relates to electrical switch contacts and to switch assemblies employing these switch contacts.

A persistent problem with switch contacts is that of rebound of the contact surfaces away from one another after the initial closing engagement between their respective contact surfaces. This phenomenon is commonly referred to as contact bounce. As is commonly known, the rebounding of contact surfaces away from one another permits a slight air gap through which current arcs or sparks with a consequent disintegration of the contact surfaces. Over a period of time, repeated contact bounce causes pitting and deterioration of the contact surfaces so as to substantially reduce the life of the switch contacts. Such contact bounce is a particular problem in relays which must function for a considerable number of cycles.

Accordingly, a primary object of the present invention is alleviation of arcing and deterioration of the surfaces of electrical contacts by new and improved forms of electrical contact elements.

Another object of the invention is elimination of arcing between a pair of electrical contact surfaces separated during contact bounce by an auxiliary follower contact adapted to maintain an electrical path between these contact surfaces while these contacts are separated. More specifically, under this object of the invention, one of the contacts is provided with a flexible follower contact which is flexed to engage and to follow the other contact during the time of bouncing of the contacts relative to one another so that an electrical path is continually maintained between the contacts.

It has been observed that where one of a pair of contacts is fixed, i.e. generally immovable, and the other contact moves thereagainst with considerable velocity, that the movable contact bounces or rebounds at a relatively high frequency. Under the present invention the movable contact is allowed to impart most of its energy to the fixed contact and rebounds at a high frequency. Conversely, the easily movable follower contact is adapted to absorb a much smaller amount of energy and move at a low frequency to maintain continual contact with the movable contact during its high frequency rebound.

A specific object of the present invention is a new and improved contact having a free follower portion for engaging a contact blade and having an integral fixed contact portion with the follower contact portion juxtapositioned to engage the contact blade prior to engagement by the fixed contact portion, the follower contact moving under spring bias to engage and to maintain an electrical path to said contact blade to prevent the arcing between the blade and the fixed contact portion.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawing which, by way of illustration, shows preferred embodiments of the present invention and the principles thereof and what is now considered to be the best mode contemplated for applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention.

In the drawings:

FIG. 1 is a plan view of a relay header employing contact assemblies in accordance with a preferred embodiment of the invention;

FIG. 2 is a side view of a contact and its support;

FIG. 3 is a side view of the contact and support of FIG. 2;

FIG. 4 is a front view of a contact;

FIG. 5 is a side view of the contact of FIG. 4; and

FIG. 6 is a bottom view of the contact of FIG. 4.

Referring now to the drawings, and more particularly FIG. 1, there is illustrated a typical relay header base **10** on which are mounted a plurality of contact assemblies **12**. The contact assemblies **12** are adapted to be switched by an armature (not shown) of an electromagnetically operated relay. The contacts and contact assemblies to be described hereinafter have particular utility in the field of electromagnetic relays which undergo large numbers of operations. The present invention is particularly adapted for use in micro-miniature relays which not only must undergo a large number of cycles, but must also have the capability of resistance to shock, vibration and other changes in environmental conditions. The principles of the present invention are applicable to other types of switch contacts and other types of electrical devices wherein contact bounce of switch contacts is a problem.

The header base **10** has a plurality of terminals **14** through which an electrical path is made to and through one of the contact assemblies **12**. The contact assemblies **12** have a movable or blade switch contact **15** which is adapted to be moved for engagement with either one of a pair of switch contact elements **19** or **20**. The contact elements **19** and **20** are referred to as fixed contacts in that the contact elements **19** and **20** are fixed, i.e., generally immobilized, on supports **21** and **22** secured to their respective terminals **14**.

In contrast the movable or blade contact **15** is adapted to be pivoted or swung between contact elements **19** and **20** when an actuator (not shown) movable by an armature of the electromagnetic relay engages the end portion **24** of the blade contact **15** to flex the blade contact **15** back and forth between the contacts **19** and **20**. The movable or blade contact **15** is secured as by welding to a plate **25** which in turn is welded to a terminal post **14**. Thus, the movable contact is flexed about its respective terminal **14** by the armature actuator (not shown) to move the outer free end **24** back and forth between the switch contacts **19** and **20**.

The contact elements **19** and **20** are generally identical in construction and are formed from a metal which has good electrical conducting properties. The contact elements **19** and **20** are made from pieces of sheet metal which is easily bent into the complex forms illustrated herein and which has a good degree of flexibility. The contact elements **19** and **20** have a free arm portion **30** adapted to flex about its bent connection **31** to an integral long leg **32** extending to a normal and short leg **33** which is welded or otherwise secured in flat engagement with a support **21** or **22**.

The free end portion **30** terminates in a rounded and downwardly turned follower contact portion **35** the upper surface of which is generally curved as at **36**, FIG. 3, between tapered side walls **38** and **39**. The follower contact portion **35** is of reduced cross-sectional width with respect to the width of the long leg portion **32**. As best seen in FIG. 6, the long leg portion **32** also tapers in width across its length from a bent portion **40** at the short leg **33** to the bent portion **31** at the arm **30**.

The short leg **33** also is of a tapering width from a generally hooked and fixed contact portion **42** adapted to be disposed in flush engagement with the top surface

44 of one of the supports 21 or 22. Thus, the contact elements 19 and 20 are formed from a piece of sheet metal which is of a continually reduced or tapering thickness from the fixed contact hook 42 through the short leg 33, long leg 32 and free arm portion 30 to the follower contact 35.

Thus, the fixed contact portion 42 has a much larger upper contact surface 45 for engagement with the contact blade 15 than the contact surface 36 on the follower contact portion 35. As best been in FIGS. 3 and 5, the contact surface 45 has arcuate, convex curvature between side walls 47 and 48 on the short leg portion 43. Also, as seen in FIGS. 3 and 5, the follower contact surface 36 extends above the contact surface 45. When the contact member 19 or 20 is mounted on the terminal 14, the follower surface 36 extends farther toward the blade 15 by a few thousandths of an inch than the contact surface 45 extends toward the blade 15.

Thus, when the blade contact 15 is biased into engagement with the contact surface 45, the blade contact 15 is also in engagement with the contact surface 36 on the free arm portion 30. Because of the larger area of contact between the movable contact 15 and the contact surface 45, most of the current will flow through this lesser resistance and to the support 21 or 22 to the terminal 14. The electrical path completed between the contact surface 36 and the movable contact 15 is less in area because of the reduced size of the arcuate contact surface 36. Also the reduced thickness and longer path from the contact surface 36 through the arm portion 36, curved portion 31, and long leg 32 to the support 21 or 22 affords a greater resistance to the flow of current than that from the main or fixed contact surface 45.

The primary function of the follower contact portion 45 is to prevent the formation of an arc or spark across an air gap formed during the rebound of the contact 15 away from the fixed contact portion 42. That is, when the movable contact 15 is moved under the force of the armature (not shown), the movable blade 15 strikes the fixed contact portion 42 and rebounds away therefrom and forms a slight air gap between the contact across which a spark is formed.

Formation of the spark is accompanied by volatilization of the contact surfaces and a disintegration of these contact surfaces. A problem in closing switch contacts has been the forming of these arcs or sparks which cause pitting and disintegration of the metal thereby reducing the life and electrical contacts.

To eliminate the condition of a spark between the movable contact 15 and the fixed contact surface 45 during rebound of the movable contact 15, the follower contact surface 36 follows the movable contact 15 in its direction of rebound to maintain an electrical path through its contact surface 36, arm portion 30 and long leg portion 32 to the conductive support 21 or 22. This path has considerably less resistance than the resistance of the air gap formed between the movable contact 15 and the fixed contact surface 45. Thus, the current will flow along the path including the contact surface 36 rather than jump the air gap and cause the disintegration of these contact surfaces 15 and 45.

The contact supports 21 and 22 are formed from relatively rigid members and the end surfaces thereof are adapted to fit complementally or snugly within the hook portion 42 to rigidly hold the hook portion 42 as a fixed or non-movable surface. This is the preferred form of the invention in that the fixed contact 42 causes a high frequency rebound in the movable contact 15 when struck thereby. Conversely, the arm portion 30 when struck by the movable arm 15 flexes and exerts only a gentle pressure on the blade and does not impart much rebound energy to the movable contact 15. The low frequency bounce cycle of the arm portion 30 permits the arm 30 and its contact surface 36 to remain in continual engagement with the contact 15 during a slight separation of

contact 15 and contact surface 45. Manifestly, the follower contact 35 only follows the movable contact 15 for a few thousandths of an inch and loses contact therewith when the movable contact 15 is actuated by the relay toward the other contact assembly 12.

It will be noted that the movable contact 15 is a relatively long member and hence the bounce cycle sets up sinusoidal waves of vibration therein which are dissipated within approximately two milliseconds. The arm 30 because of its being flexed under light pressure is adapted to maintain contact with the movable contact 15 during this period of time and during its high frequency vibration.

In view of the foregoing, it will be seen that the present invention affords a one-piece integral contact member having a fixed. contact surface 45 with a juxtaposed movable contact surface 36 engaged by a movable contact member 15 prior to the engagement of fixed contact surface 36 by the movable contact member 15. The follower contact, because of being flexed from its free position, is adapted to follow the bounce of the movable contact to maintain engagement therewith to complete an electrical path between the contact elements to prevent the arcing across the air gap between the movable member and the fixed contact. Thus, prevention of arcing during contact bounce prolongs the useful life of the contact members.

Hence, while I have illustrated and described preferred embodiments of my invention, it is to be understood that these are capable of variation and modification.

I claim:

1. An electrical switch contact adapted to be engaged by another switch contact and to maintain an electrical path to said other switch contact during contact bounce between said switch contacts, said switch contact comprising, an integral body member, a first contact surface on said body member for engagement with said other switch contact, a second contact surface on said body member juxtaposed to engage said other switch contact prior to engagement of said other switch contact and said first contact surface, and a flexible portiton on said body member carrying said second contact surface and being flexible from its free position by said other switch contact, said flexible portion urging said second contact surface to follow and to maintain engagement between said second contact surface and said other switch contact to prevent formation of a spark between said first contact surface and said other switch contact.

2. An electrical switch contact adapted to be engaged by another switch contact and to maintain an electrical path to said other switch contact during contact bounce between said switch contacts, said switch contact comprising, an integral body member, a first contact surface on said body member for engagement with said other switch contact, a second contact surface on said body member juxtoposed to engage said other switch contact prior to engagement of said other switch contact and said first contact surface, said second contact surface being smaller in area than said first contact surface so that said first contact surface constitutes the principal electrical path between said body member and said another switch contact, and a flexible portion on said body member carrying said second contact surface and being flexible from its free position by said other switch contact, said flexible portion urging said second contact surface to engage and maintain engagement between said second contact surface and said other switch contact to complete an electrical path to said body member during bounce of said other switch contact from said first contact surface.

3. An electrical switch contact adapted to be engaged by another switch contact and to maintain an electrical path to said other switch contact during contact bounce between said switch contacts, said switch contact comprising, an integral body member, a first contact surface on said body member for engagement with said other switch contact, a flexible arm portion on said body member hav-

ing one end integrally connected to said body member and the other end free and non-supported, and a second contact surface on said arm portion and juxtaposed to engage said other contact prior to engagement with said first contact surface, said flexible arm being flexed by said other switch contact and urging said second contact surface to follow and maintain engagement with said another switch contact.

4. An electrical switch contact adapted to be engaged by another switch contact and to maintain an electrical path to said other switch contact during contact bounce between said switch contacts, said switch contact comprising, an integral body member of generally triangular configuration and having three leg portions, a first contact surface on a first leg of said body member for engagement with said other switch contact, a second contact surface on a second leg portion of said body member juxtaposed to engage said other switch contact prior to engagement of said other switch contact and said first contact surface, and a third leg portion on said body member joining said first and second leg portions, said first and third leg portions being free of one another, said second leg portion being flexed from a free position by said other switch contact and following said other switch contact to said free position during movement of said other switch contact during contact bounce.

5. The contact of claim 4 wherein said third leg portion is reduced in size from said second leg portion to provide a more flexible third leg portion.

6. The electrical switch contact of claim 1 wherein said integral body member is a single piece of sheet metal of uniform thickness, said piece of sheet metal being bent to form legs having end portions juxtaposed adjacent one another, one said leg constituting said flexible portion of said body member, said end portions having said first and second contact surfaces, respectively, for simultaneous engagement by said other switch contact.

7. The switch contact of claim 6 wherein said sheet metal is bent into a triangular configuration, said leg constituting said flexible portion of said body member being of a width narrower than the width of the leg having said first contact surface thereby affording greater resistance to electrical flow than said leg having said first contact surface.

8. In a switch contact assembly, a movable contact member, a fixed support, a contact body member having integral legs, a first one of said legs rigidly secured to said fixed support, a first contact surface on said first leg of said body member for engagement by said movable contact member to constitute an electrical path between said contact members, a second one of said legs on said body member integrally connected to said first leg and having a portion adapted to be flexed by said movable contact member, a follower contact surface on said second leg extending toward said contact member and extending beyond said first contact surface in the direction of said movable contact member to engage said movable contact member prior to engagement of said first contact surface by said movable contact member, said follower contact surface extending and flexing to follow said movable contact member when said movable contact member is rebounding from engagement with said first contact surface to maintain an electrical path between said body member and said movable contact member so that an arc is prevented from jumping the gap formed between the movable contact member and said first contact surface, said integral legs being spaced from each other substantially throughout their entire lengths.

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