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(71) Applicant: **TRW INC.**
1900 Richmond Road
Lyndhurst Ohio 44124(US)

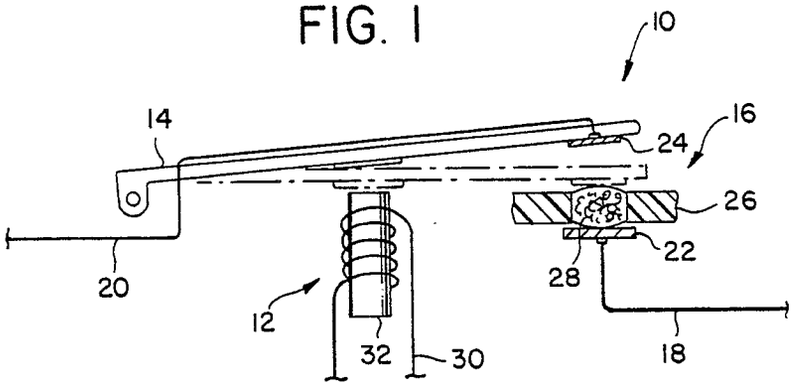
(72) Inventor: **Smolley, Robert**
56 Limetree Lane
Porteuguese Bend California 90274(US)

(74) Representative: **Allden, Thomas Stanley et al**
A.A. THORNTON & CO. Northumberland House 303-306 High Holborn
London WC1V 7LE(GB)

(54) Improved electrical switch.

(57) An improved electrical switch providing a low electrical-resistance connection and a simple, inherent wiping action of the contact surfaces. The improved electrical switch includes a pair of electrical contacts, an insulating board disposed between the electrical contacts, and a switch mechanism. The insulating board has a wadded-wire connector element disposed in an opening in the insulating board at a position corresponding to the electrical contacts. The wadded-wire connector element makes electrical contact at multiple points when compressed against a contact surface by the switch mechanism, thus wiping the contact surfaces free of any film or surface contamination and providing a low electrical-resistance connection.

FIG. 1



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IMPROVED ELECTRICAL SWITCH

BACKGROUND OF THE INVENTION

This invention relates generally to electrical switches and, more particularly, to electrical switches providing reliable, low-resistance electrical connections.

Electrical switches are used in a wide variety of applications, including, for example, electromagnetic relays in telephone switching systems, push-button switches in push-button telephones, and key switches in electronic keyboards that control various electronic systems, such as computers and calculators. An electrical switch that is utilized in one of these applications can be expected to make and/or break an electrical circuit millions of times during its lifetime. Not only must the switch provide good performance during each making and/or breaking of the electrical circuit, but the switch must also provide a low and stable electrical resistance when the circuit is closed. Consequently, the key component of an electrical switch is the contact assembly, which is typically a pair of electrical contacts that mechanically open or close to make or break the electrical circuit.

Electrical contacts are subject to a variety of hazards that can result in their failure. These hazards include, for example, film formation on the contact surfaces, which can cause excessive resistance, surface contamination of the contact surfaces, which can prevent the contacts from closing, and erosion of the contact surfaces, which can cause the contacts to weld together. Several techniques, such as contact-protection circuits and elaborate mechanical systems for wiping the contact surfaces, have been used in the past for enhancing contact life and, therefore, switch reliability. However, these techniques have generally added unnecessary complexities to the switch and, in some cases, have actually increased the likelihood of a failure of the switch.

Accordingly, it is apparent that a new approach for making electrical connections is needed. The new approach should preferably minimize electrical contact resistance, be relatively simple and, most importantly, prevent film formation, surface contamination and erosion of the contact surfaces. The present invention is directed to these ends.

SUMMARY OF THE INVENTION

The present invention resides in an improved electrical switch providing a low electrical-resistance connection and a simple, inherent wiping action of the contact surfaces. Briefly, and in general terms, the improved electrical switch includes a pair of electrical contacts, an insulating board disposed between the electrical contacts, and a switch mechanism. The insulating board has a conductive connector element disposed in an opening in the insulating board at a position corresponding to the electrical contacts. The switch mechanism compresses the electrical contacts and the conductive connector element together, thereby electrically connecting the electrical contacts.

In a presently preferred embodiment of the invention, an electromagnetic relay utilizing the technique of the present invention includes an electromagnet, a hinged armature lever and a contact assembly. The contact assembly includes a pair of electrical contacts and an insulating board disposed between the two contacts. The insulating board has a conductive connector element disposed in an opening in the insulating board at a position corresponding to the electrical contacts. When the electromagnet is energized, the armature is attracted to the electromagnet, thus compressing the electrical contacts and the conductive connector element together to electrically connect contacts.

The connector element is preferably formed from a strand of metal wire that is wadded together to form a nearly cylindrical "button" of material having a density of between twenty and thirty percent. The wadded-wire connector element fits snugly in the opening of the insulating board and protrudes slightly above and below the board. The wadded-wire connector element makes electrical contact at multiple points when compressed against a contact surface, thus wiping the contact surfaces free of any film or surface contamination and providing a low electrical-resistance connection.

Wadded-wire connector elements of this type have significant advantages over other types of connectors and provide connections of high integrity and reliability. In contrast to other types of connections, this mechanical connector element has very few associated variables that can affect the quality of the connection. The only significant variables are the size of the connector element and the compressive force used to make the connection, both of which can be accurately controlled. The compression of the wadded-wire connector element is substantially elastic so that, when the compressive force of the armature lever is removed, the wadded-wire connector element returns to its original shape.

In another presently preferred embodiment of the invention, a push-button switch in accordance with the technique of the invention includes a push-button switch mechanism and a contact assembly. The contact assembly includes an electrical conductor, an electrical contact and an insulating board disposed between the conductor and the contact. The insulating board has a wadded-wire connector element disposed in an opening in the insulating board at a position corresponding to the conductor and the contact. The push button switch mechanism includes a switch housing, a push button positioned in a recess of the housing and a spring to maintain the push-button switch in the open position. Depressing the push button against the force of the spring compresses the electrical conductor, the conductive connector element and the electrical contact together to electrically connect the conductor and the contact.

It will be appreciated from the foregoing that the present invention represents a significant advance in the field of electrical switches. Other features and advantages of the present invention will become apparent from the following more detailed description, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates an electromagnetic relay employing the technique of the present invention; and

Figure 2 illustrates a push-button switch employing the technique of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in the drawings for purposes of illustration, the present invention is embodied in an improved electrical switch providing a low electrical-resistance connection and a simple, inherent wiping action of the contact surfaces. A switch's electrical contacts are subject to a variety of hazards that can result in their failure. These hazards include, for example, film formation on the contact surfaces and surface contamination and erosion of the contact surfaces. Several techniques, such as contact-protection circuits and elaborate mechanical systems for wiping the contact surfaces, have been used in the past for enhancing contact life and, therefore, switch reliability. However, these techniques have generally added unnecessary complexities to the switch and, in some cases, have actually increased the likelihood of a failure of the switch.

In accordance with the present invention, the improved electrical switch includes a pair of electrical contacts, an insulating board disposed between the electrical contacts, and a switch mechanism. The insulating board has a conductive connector element disposed in an opening in the insulating board at a position corresponding to the electrical contacts. The switch mechanism compresses the electrical contacts and the conductive connector element together, thereby electrically connecting the electrical contacts. In a presently preferred embodiment of the invention, the switch mechanism includes an electromagnetic relay and, in another presently preferred embodiment of the invention, the switch mechanism includes a push-button switch.

Figure 1 illustrates an electromagnetic relay 10 in accordance with a presently preferred embodiment of the invention. The electromagnetic relay 10, a normally-open, single-pole, single-throw relay, includes an electromagnet 12, a hinged armature lever 14 and a contact assembly 16. The contact assembly 16, which electrically connects lead 18 to lead 20 when the relay is in the closed position, includes a pair of electrical contacts 22, 24 and an insulating board 26 disposed between the two contacts. Electrical contact 22 is attached to the base of the relay 10 (not shown) and electrical contact 24 is attached to the non-hinged end of the armature lever 14. The insulating board 26 has a conductive connector element 28 disposed in an opening in the insulating board at a position corresponding to the electrical contacts 22, 24. When the electromagnet 12, which includes coil 30 and metal core 32, is energized, the armature 14 is attracted to the electromagnet 12, thus compressing the electrical contacts 22, 24 and the conductive connector element 28 together to electrically connect lead 18 to lead 20.

The connector element 28 is preferably formed from a strand of metal wire that is wadded together to form a nearly cylindrical "button" of material having a density of between twenty and thirty percent. As shown in Figure 1, the wadded-wire connector element 28 fits snugly in the opening of the insulating board 26 and protrudes slightly above and below the board. The wadded-wire connector element 28 makes electrical contact at multiple points when compressed against a contact surface, thus wiping the contact surfaces free of any film or surface contamination and providing a low electrical-resistance connection.

Wadded-wire connector elements of this type have significant advantages over other types of connectors and provide connections of high integ-

rity and reliability. In contrast to other types of connections, this mechanical connector element has very few associated variables that can affect the quality of the connection. The only significant variables are the size of the connector element and the compressive force used to make the connection, both of which can be accurately controlled.

The wadded-wire connector element 28 employed in the illustrative embodiments can be fabricated using nickel wire, or wire made from such alloys as beryllium and copper, silver and copper, or phosphorus and bronze. The compression of the wadded-wire connector element 28 is substantially elastic so that, when the compressive force of the armature lever 14 is removed, the wadded-wire connector element 28 returns to its original shape. In the embodiments described, the wadded-wire connector element 28 is manufactured by Technical Wire Products, Inc. of Piscataway, New Jersey, under the trademark Fuzz Button. The insulating board 26 is preferably formed from an insulating material, such as a glass ceramic or a plastic.

Figure 2 illustrates a push-button switch 40 in accordance with another presently preferred embodiment of the invention. The push-button switch 40 includes a push-button switch mechanism 42 and a contact assembly 44. The contact assembly 44 includes an electrical conductor 46, an electrical contact 48 and an insulating board 50 disposed between the conductor and the contact. The insulating board 50 has a wadded-wire connector element 52 disposed in an opening in the insulating board at a position corresponding to the conductor 46 and the contact 48. The push button switch mechanism 42 includes a switch housing 54, a push button 56 positioned in a recess of the housing and a spring 58 to maintain the push-button switch 40 in the open position. Depressing the push button 56 against the force of the spring 58 compresses the electrical conductor 46, the conductive connector element 52 and the electrical contact 48 together to electrically connect the conductor and the contact.

From the foregoing, it will be appreciated that the present invention represents a significant advance in the field of electrical switches. Although several preferred embodiments of the invention have been shown and described, it will be apparent that other adaptations and modifications can be made without departing from the spirit and scope of the invention. Accordingly, the invention is not to be limited, except as by the following claims.

Claims

1. An improved electrical switch, comprising:
a pair of electrical contacts;
an insulating board disposed between the electrical contacts, the insulating board having an opening at a position corresponding to the electrical contacts;
a conductive connector element disposed in the opening in the insulating board; and
a switch mechanism for compressing the electrical contacts and the conductive connector element together, thereby electrically connecting the pair of electrical contacts.

2. The improved electrical switch as set forth in claim 1, wherein the connector element includes:
a wadded strand of conductive wire that is deformed when compressed and makes multiple electrical contacts with each electrical contact.

3. The improved electrical switch as set forth in claim 2, wherein each wadded strand of wire has a density of approximately 20 to 30 percent.

4. The improved electrical switch as set forth in claim 1, wherein the switch mechanism includes an electromagnetic relay.

5. The improved electrical switch as set forth in claim 1, wherein the switch mechanism includes a push-button switch.

6. The improved electrical switch as set forth in claim 1, wherein the insulating board is fabricated from a glass ceramic or a plastic.

7. An improved electromagnetic relay, comprising:
an electromagnet;
a hinged armature lever;
a first electrical contact attached to the non-hinged end of the armature lever;
a second electrical contact;
an insulating board disposed between the first and second electrical contacts, the insulating board having an opening at a position corresponding to the electrical contacts; and
a conductive connector element disposed in the opening in the insulating board;
whereby energizing the electromagnet attracts the armature lever, thus compressing the electrical contacts and the conductive connector element together to electrically connect the electrical contacts.

8. The improved electromagnetic relay as set forth in claim 7, wherein the connector element includes:
a wadded strand of conductive wire that is deformed when compressed and makes multiple electrical contacts with each electrical contact.

9. The improved electromagnetic relay as set forth in claim 8, wherein each wadded strand of wire has a density of approximately 20 to 30 percent.

10. The improved electromagnetic relay as set forth in claim 7, wherein the electromagnet includes a coil and metal core.

11. The improved electromagnetic relay as set forth in claim 7, wherein the insulating board is fabricated from a glass ceramic or a plastic.

12. An improved push-button switch, comcomprising:
an electrical contact;
an electrical conductor;
an insulating board disposed between the electrical contact and the conductor, the insulating board having an opening at a position corresponding to the contact and the conductor;
a conductive connector element disposed in the opening in the insulating board; and
a push-button switch mechanism for compressing the electrical contact, the electrical conductor, and the conductive connector element together, thereby electrically connecting the contact and the conductor.

13. The improved push-button switch as set forth in claim 12, wherein the connector element includes:
a wadded strand of conductive wire that is deformed when compressed and makes multiple electrical contacts with the electrical contact and the electrical conductor.

14. The improved push-button switch as set forth in claim 13, wherein each wadded strand of wire has a density of approximately 20 to 30 percent.

15. The improved push-button switch as set forth in claim 12, wherein the push-button switch mechanism includes:
a switch housing;
a push button positioned in a recess of the housing; and
a spring to maintain the push-button switch in an open position.

16. The improved push-button switch as set forth in claim 12, wherein the insulating board is fabricated from a glass ceramic or a plastic.

FIG. 1

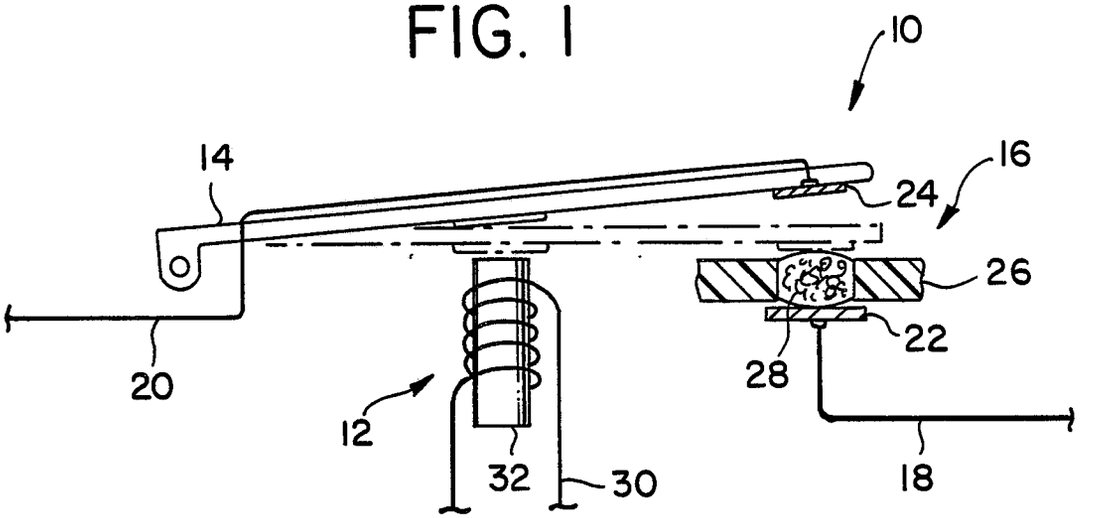

FIG. 2