United States Patent

Lambert et al.

[15] **3,689,856**

[45] **Sept. 5, 1972**

[54] **SWITCH HAVING OPPOSED DOME AND FLEXIBLE BIFURCATED CONTACTS**

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[22] Filed: **Sept. 15, 1971**

[21] Appl. No.: **180,629**

[52] **U.S. Cl.** **335/133,** 200/164, 200/166, 335/196

[51] **Int. Cl.**.....**H01h 1/18**

[58] **Field of Search**.....335/106, 131, 133, 196; 200/166 BH, 166 J, 164, 67 D

[56] **References Cited**

UNITED STATES PATENTS

2,149,699	3/1939	James et al.	200/164 R
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3,270,156	8/1966	Stewart	200/67 D
3,286,049	11/1966	Drain	200/166 BH
3,418,608	12/1968	Angel et al.	335/131
3,493,702	2/1970	Ramstetter	200/166 BH

Primary Examiner—Harold Broome
Attorney—John C. Dorfman

[57] **ABSTRACT**

In a switch a convex domed contact is opposed to a bifurcated contact consisting of a pair of elements providing contact surfaces spaced from one another and each having a dome contact wiping edge opposed to a portion of the dome contact and supported by a pair of flexible spring supports capable of resilient flexing and twisting so that as the contacts are urged together the spring supports continuously urge each of the contact surfaces into wiping engagement with the dome contact.

5 Claims, 6 Drawing Figures

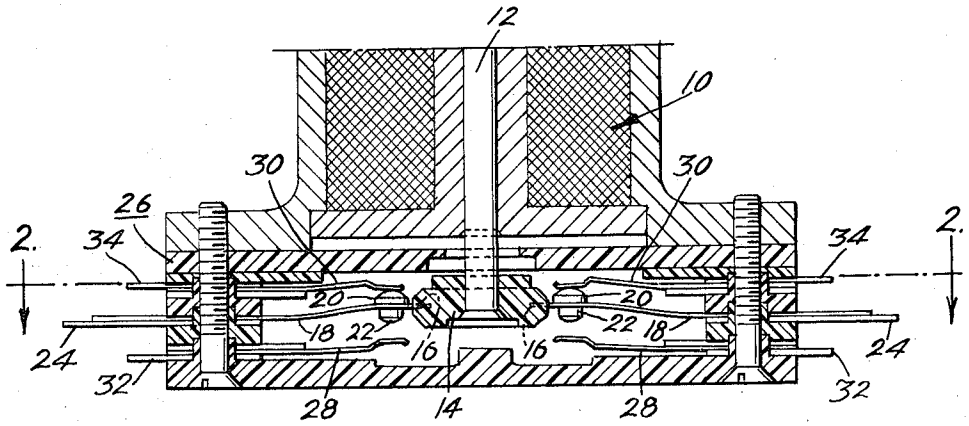
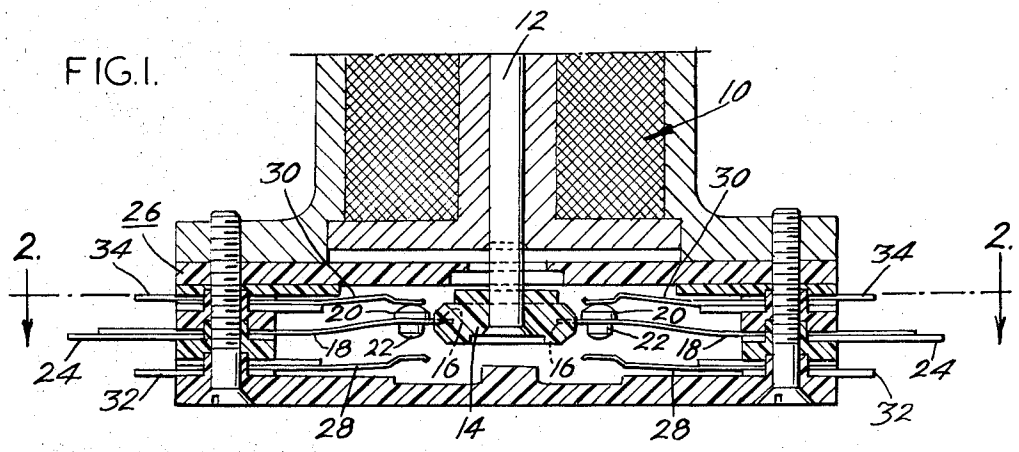


FIG. 1.



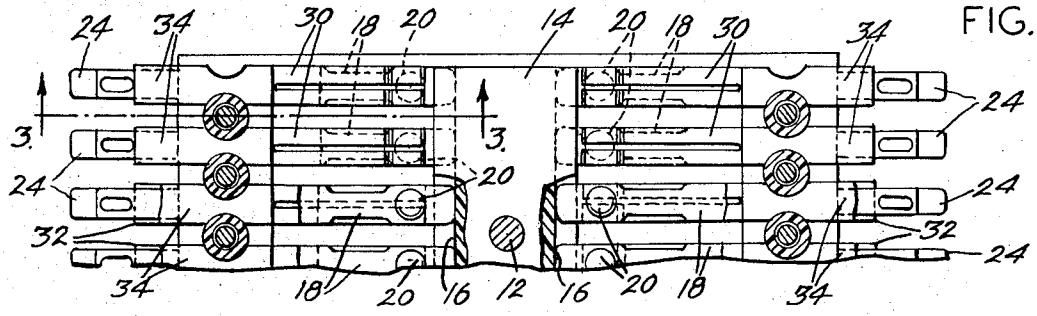


FIG. 2.

FIG. 3.

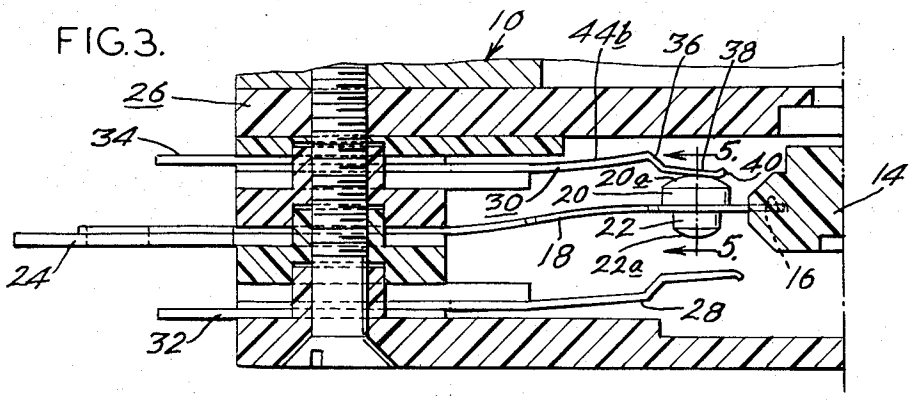


FIG. 4.

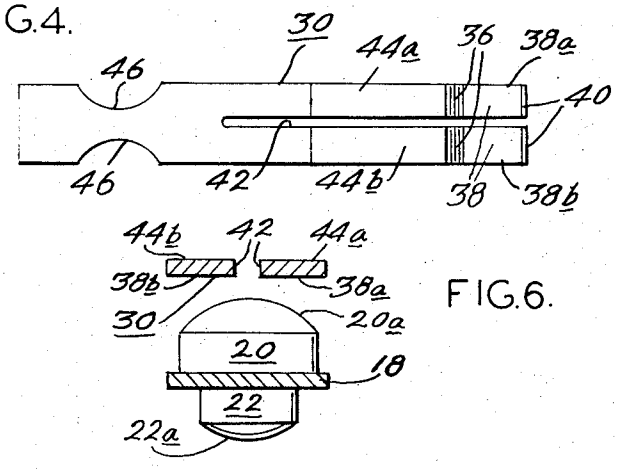
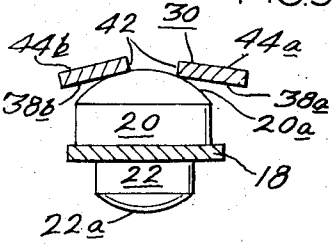


FIG. 6.

FIG. 5.



SWITCH HAVING OPPOSED DOME AND FLEXIBLE BIFURCATED CONTACTS

This invention relates to improvements in switches and specifically to a configuration of switch contacts wherein one of the contacts is dome-shaped and is opposed by a bifurcated contact each part of which is independently flexibly supported. This invention has general utility in switches, and may be used, for example, in switch and relay structures, such as those illustrated in U.S. Pat. No. 3,226,508, granted Dec. 28, 1965, to A. H. Morgan, Walter Uhl and Henry R. Angel, and No. 3,418,608 granted on Dec. 24, 1968, to Henry R. Angel and A. Henry Morgan, both of which patents are assigned to Electronic Controls, Inc.

Particularly in relays and switches which undergo repeated use but are expected to provide long life, it is important that good electrical contact having low electrical resistance be made between the switch contacts each time the contacts are closed. In the prior art, various expedients have been used to assure positive and good electrical contact, such as arranging the contacts so that they do not simply move toward and away from one another but have some lateral movement to produce wiping and cleaning of the contacts. Other expedients used to assure good positive contact to include opposing contacts with sharp edges which are arranged transverse to one another. However, such sharp edges have a tendency to flatten with use, leaving switches which are less effective than switches with traditional "button" contacts. The use of precious metals to improve contacts and lower switch contact resistance has also been employed in a wide variety of applications. However, with all of these expedients that have been available in the prior art, it has been difficult to make a switch which is highly reliable and gives a repeatable electrical effect over a long period of time, and particularly one whose contact resistance does not tend to change either through accumulation of dirt, variation in mechanical engagement forces or change in condition of the contact surfaces. In many applications, a substantial change in contact resistance is highly undesirable, even though the switch is relatively reliable from the standpoint of repeatedly closing electrically over a long period of time.

The present invention provides a switch which has particular applicability in low level circuits, commonly known as "dry circuits", but has applicability in other applications, as well. It is of the class of opposed contact switches, but it is more highly reliable than other switches of this class and will consistently make good electrical contact of an essentially constant contact resistance over a long active life. It has inherent in its structure a contact wiping action in more than one direction, and, therefore, will maintain clean contacts. At the same time it provides two very positive contacts, instead of one insuring that at least one contact is always closed. As a practical matter both contacts always close and the contact resistance of each of these contacts remains essentially constant because the nature of the contact is always the same, even though it may vary in position due to some minor shifting of the switch parts, due to wear, or for other reasons.

More specifically, the structure of the present invention involves a switch employing a pair of contacts, at least one of which is supported on a resilient support, supported by an insulating supporting frame which

holds the contact support structure and maintains a predetermined relationship between said contacts. An actuator means moves at least one contact relative to the other contact to change switch condition. In this structure, one of the contacts is provided with a convex dome-shaped contact area with no flat portions over said area. The other contact is bifurcated and consists of a pair of elements providing contact surfaces spaced from one another, and each having a dome contact wiping region opposed to a portion of the dome contact and supported by a pair of flexible spring supports capable of resilient flexing and twisting such that as the contacts are urged together the flexible spring supports will continuously urge each of the contact surfaces into wiping engagement with the dome contact. Independently flexing, twisting and yielding is provided by the supports for each contact surface to accommodate to the position of the other and for accommodating to a position producing good electrical contact itself.

Preferably the contact areas are coated with precious metal by plating, or otherwise, and preferably the bifurcated contact is an integral part of a long narrow strip provided with a slot extending part way along the strip to divide the strip into two flexible spring supports, such that each spring support is sufficiently long and narrow relative to its thickness to permit needed twisting to accommodate movement necessary to keep each contact in good wiping condition and good electrical contact with the dome contact.

In the prior art there have been some convex contacts of various types, but by and large, these have been used in high current circuits as a means wedged between two relatively massive contacts to provide a high current path from one of said massive contacts to the other. Various toggling action has been used with such switch arrangements to complete the wedging action with sufficient force (for example, see U.S. Pat. Nos. 2,743,338 and 2,846,529 to Graybill). There have also been switches in which pointed contacts have been opposed by ring contacts, such as Schuler U.S. Pat. No. 2,899,515, but the ring contact involved in such arrangements frequently results in only a single point of contact at some place along the periphery of the ring and uncertainty about how much contact area will be involved and what the electrical contact resistance will be.

A U.S. Pat. No. 2,850,602 to Breese et al. shows a domed contact opposed to a trough in order to give two regions of contact on the dome. However, the effect of ridged connection from one side of the trough to the other results under certain circumstances in contact occurring only at one point and contact at that one point may actually act to hold the second region away from the dome. The applicants' arrangement, by contrast, employs two separately supported contact surfaces of the bifurcated contact with separate flexible and yielding supports for each of the bifurcated contact elements so that the position assumed by each is independent of the other. The present invention, of course, does assume that the throw of the switch is sufficient that after the first one of the bifurcated elements strikes the dome its spring will permit it to yield, twist or slide over the dome until the second contact is in position. Thereafter both contact elements will yield, twist or slide until movement under the influence of their actuator is stopped.

For a better understanding of the present invention, reference is made to the accompanying drawings in which

FIG. 1 is a partial sectional view through a relay assembly of the general type shown in FIG. 1 of U.S. Pat. No. 3,226,508 on a somewhat enlarged scale;

FIG. 2 is a partial sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is an enlarged view taken along line 3—3 of FIG. 2 showing part of the structure shown in FIG. 1;

FIG. 4 is a plan view from above of a single bifurcated spring switch blade;

FIG. 5 is a further enlarged, somewhat schematic view taken on line 5—5 of FIG. 3 showing the contacts open; and

FIG. 6 is a view similar to FIG. 5 showing the contacts closed.

Referring first to FIG. 1, the disclosure of U.S. Pat. No. 3,226,508 will be understood to be incorporated by reference to show one possible switch or relay, in which the switch of the present invention might be employed, including various alternative types of actuators. It will be appreciated that such switches can be made with electromagnetic actuators, or mechanical operators of various types. The present invention has been embodied in switches of this general type but can be embodied in switches of the type shown in U.S. Pat. No. 3,418,608, as well as switches of many other types.

Referring to FIGS. 1 and 2, a relay somewhat similar to that shown in FIGS. 1 and 3 of U.S. Pat. No. 3,226,508 is shown in energized position. An electromagnetic actuator, generally designated **10**, acts through a plunger **12** to move crossbar **14**. The ends of movable contact support blades **18** are engaged in opposed carrying slots **16** of crossbar **14**. The support blades carry on their opposite sides, in the position shown, contact buttons **20** and **22**, each of which provides a domed contact surface, which will be discussed hereafter. The blades **18**, which provide resilient spring support for the contacts as well as acting as conductors, are cantilever supported together with their terminal elements **24** by portions of an insulating support structure **26**. As best seen in FIG. **2**, similar blades are positioned in generally parallel side-by-side relationship across the width of the housing on both sides of the actuator bar **14**. The number of blades **18**, and switch pairs involved, can, of course differ in different applications, but in this instance there are 12.

Also supported by the insulating support structure **26** are two other sets of blades **28** and **30** and their respective terminal members **32** and **34**. The blades **28** and **30** are also supported in cantilever fashion generally parallel and aligned in opposition to blades **18**, with their ends being opposed to the switch contacts **22** and **20**, respectively.

In the position shown in FIG. **1**, the electromagnetic actuator **10** has pulled the rod **12** into its upper position, thereby moving bar **14** upward and with it each of the blades **18**, in opposition to the spring effect of blades **18**, so that normally open contacts **30** are closed, and that normally closed contacts **22** and **28** are open. Upon de-energization of the electromagnetic device the inherent spring effect of blades **18** will urge contacts **20** away from blades **30** and cause normally closed contact **22** to close against the blades **28**.

For a full understanding of the novel details of the present invention, reference is made to FIGS. **3** and **4**, wherein some of the details of the structure may be better appreciated. In particular, the structure shown in the drawings has been shown in proportion to actual sizes used in a preferred embodiment of the present invention with excellent results. The spring blades **18**, for supporting the contacts **20** and **22**, as well as blades **28** and **30** have been made of beryllium copper but could be made of other appropriate conductive spring material. The contacts **20** and **22** may be made of silver, or other precious metal, or of other suitable conductive contact material, preferably plated with precious metal. Contacts **20** and **22** are respectively cylindrical buttons, which, in accordance with the invention are provided with domed contact surfaces **20***a* and **22***a*, respectively. In the embodiments shown surfaces **20***a* and **22***a* are spherical surfaces, having a ¼-inch radius in their practical application. Other domed surfaces, which do not provide flats, are intended to be within the scope of the invention. It is also preferred that the surfaces be of such shape as to not even permit line contacts with the contact elements **30** and **28**, respectively.

In the preferred embodiment, the bifurcated contact elements **28** and **30** are of identical structure so that con-sideration of blade **30** will be an effective description and consideration of blade **28** as well.

As seen in FIG. **4**, blade **30** is a strip of conductive spring material. The blade is bent at its electrical contact end to provide a step **36**, which assures that the contact regions **38** are closer to the domed contact **20***a*, so that the chance of shorting between blades **18** and **30**, for example, is minimized. The end of the strip is turned upward in ridge **40** to prevent any possibility that the end of the blade might dig into the contact **20**. Of greatest significance is the provision of a long slot **42** extending lengthwise of the blade, preferably as shown dividing the blade into two equal halves **44***a* and **44***b*. This slot is carried back almost to the point where the terminal piece **34** is welded to the blade **30**. In practice the welding is done at two points on opposite sides of the circular segment cutouts **46**, which act as alignment grooves cooperating with cylindrical elements of insulating material extending through the insulating support structure. As a practical matter, the length which the slot **42** has, depends upon how long it needs to be to make spring elements **44***a* and **44***b* sufficiently long to permit the required amount of independent twisting and flexing. As can be seen in the schematic drawings of FIGS. **5** and **6**, the thickness of each contact support also will be determinative of the flexibility, and particularly the twistability, of the support elements. As is illustrated, and possibly exaggerated, in FIG. **5**, when the switch is closed the domed contact **20***a* tends to move against the contact areas of **38***a* and **38***b* and the contact areas, or surfaces at the bottom of the strip tend to flatten against the domed surface, such that a small amount of separation and a small amount of twisting, as well as a relatively large amount of flexing, by comparison occur.

In closing, the contacts move from the position of FIG. **6** to the position of FIG. **5**, and as closing occurs contact areas **38***a* and **38***b* slide laterally in a wiping action to assume the position shown in FIG. **5**. If, through

some slight error, a small amount of misalignment occurs, it is not serious because each contact **38***a* and **38***b* has its separate and independent flexible support. Thus, for example, after contact **38***b* engages its spring support **34***b*, that spring support will yield after accepting a certain amount of pressure. Spring support **34***b* will also permit twisting and flexing to accomodate the domed surface **20***a*. Until contact surface **38***a* engages, as further movement of contact carrying blade **18** occurs, flexible support **44***a* will yield and twist just as support **44***b* continues to yield and twist until the structure comes to rest.

It is of some importance that the slot **42** be kept sufficiently wide that no interference between the two contact elements **38***a* and **38***b* will occur. It is also desirable that the areas of actual contact be plated with precious metal, or otherwise covered with precious metal by inlaying, or any other appropriate process, in order to provide minimum contact resistance. Obviously many modifications to the structure shown are possible within the scope of the present invention. It is contemplated that, depending upon the particular application, many variations in the shape and size of the domed contact will be required and many variations, particularly in the shape and size of the flexible spring elements of the other contacts will be required. All such modifications within the scope of the apended claims are intended to be within the scope and spirit of the present invention.

We claim:

1. In a switch employing a pair of contacts at least one of which is supported on a resilient support with an insulating support frame to hold the contact support structure and maintain a predetermined relationship between said contacts and actuator means for moving at least one contact relative to the other contact to change switch condition, the improvement comprising

providing one contact with a convex dome shaped contact area with flat portion over said area

making the second contact bifurcated and consisting of a pair of elements providing contact surfaces spaced from one another, each having a dome contact wiping edge opposed to a portion of the dome contact and supported by a pair of flexible spring supports capable of resilient flexing and twisting such that as the contacts are urged together the flexible spring supports will continuously urge each of the contact surfaces into wiping engagement with the dome contact, independently flexing, twisting and yielding as needed to accomodate the position of the other while maintaining good contact itself.

2. The switch of claim **1** in which at least the pair of contact wiping surfaces of the bifurcated contact are coated with precious metal.

3. The switch of claim **2** in which the bifurcated contacts are integral with their spring supports and comprise conductive spring sheetmetal in an elongated strip whose thickness in the direction of principal movement toward the dome contact is small compared to its width.

4. The switch of claim **3** in which each resilient support for each of the bifurcated contacts is sufficiently long and narrow relative to its thickness to permit needed twisting to accomodate movement necessary to keep each of the bifurcated contacts in good wiping condition with the dome contact.

5. The switch of claim **4** in which the bifurcated contacts are made from an integral strip and a slot extending part way along the strip divides the flexible spring supports and defines the separate supports.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,689,856 Dated September 5, 1972

Inventor(s) James B. Lambert, Lewis J. Seiden, Henry Morgan

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 3, after "with" insert --no--.

Signed and sealed this 8th day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.

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