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Forrest

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[45] **May 27, 1975**

[54] **SWITCH OPERATING DEVICE FOR USE WITH AN OVER CENTER DIAPHRAGM SWITCH CONTACT ASSEMBLY WITH CONTACT RAMP CAMMING SURFACE**

[75] Inventor: **John W. Forrest,** West Acton, Mass.

[73] Assignee: **Bowman/Ali, Inc.,** Acton, Mass.

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[52] **U.S. Cl.** ...... **200/328;** 200/159 B; 200/153 LA; 200/60; 200/157

[51] **Int. Cl.** **H01h 9/22**

[58] **Field of Search** ...... 200/159 B, 166 G, 166 PC, 200/5 A, 5 R, 153 LA, 169 PB, 157, 60, 239, 321, 322, 328, 340

[56] **References Cited**

UNITED STATES PATENTS

1,592,225	7/1926	Pieper	200/157
2,992,307	7/1961	Reifel	200/166 G
3,725,907	4/1973	Boulanger	200/5 A

FOREIGN PATENTS OR APPLICATIONS

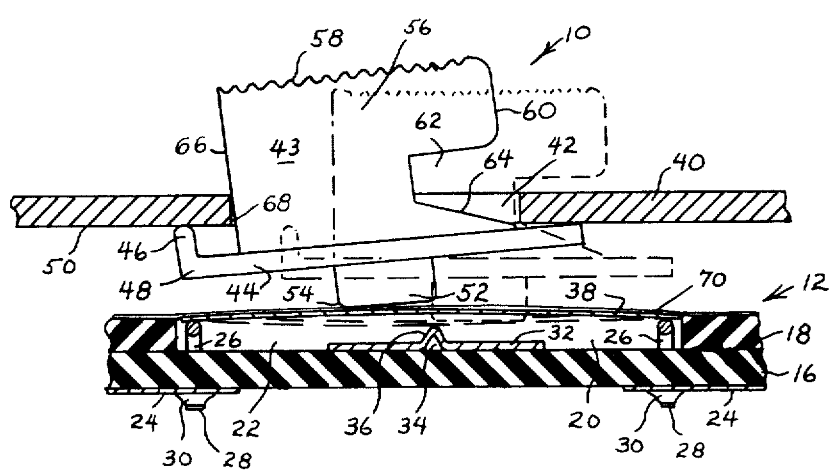
1,225,262	9/1966	Germany	200/169 PB

Primary Examiner—Robert K. Schaefer
Assistant Examiner—Gerald P. Tolin

[57] **ABSTRACT**

An operating device for use with an over center diaphragm switch contact assembly which includes a contact supporting board, a fixed contact, and an over center diaphragm contact resiliently deformable from a first position spaced apart from said fixed contact to a second position in electrical contact therewith. The operating device includes a guide plate having a slot therein and a knob element slidably received in the slot. The knob element includes a ramp surface which slidably, frictionally engages the surface of the guide plate proximal the diaphragm contact and a nib portion which slidably engages the diaphragm contact and arranged such that sliding movement of the knob element longitudinally within the slot operates the diaphragm contact from its first position to its second position. The ramp surface of the knob element maintains the diaphragm contact in electrical contact with the fixed contact whereby the operating device converts the resilient diaphragm contact assembly into a bistable "on-off" switch.

7 Claims, 3 Drawing Figures



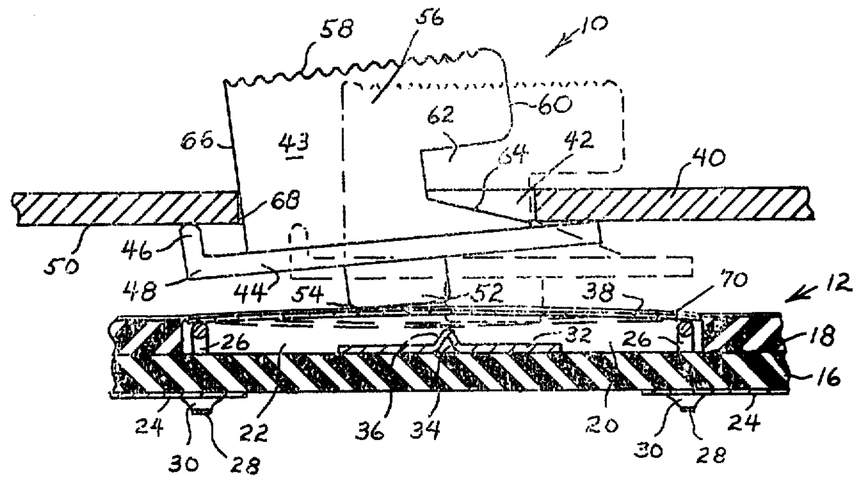


Fig. 1

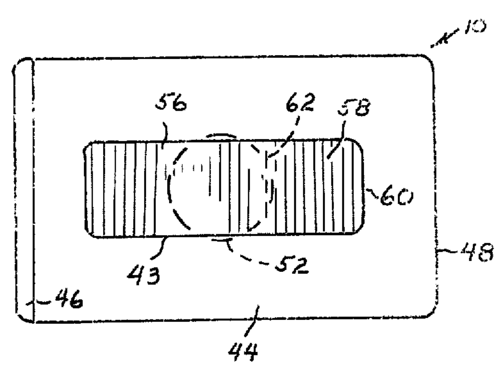


Fig. 2

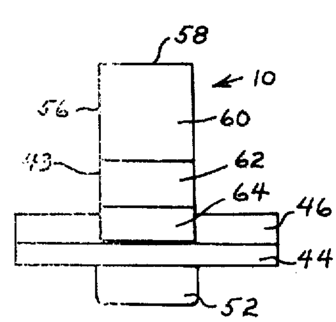


Fig. 3

SWITCH OPERATING DEVICE FOR USE WITH AN OVER CENTER DIAPHRAGM SWITCH CONTACT ASSEMBLY WITH CONTACT RAMP CAMMING SURFACE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to miniaturized electrical switches and in particular to an operating device for use with a monostable, over center diaphragm switch contact assembly, the operating device enabling operation of the diaphragm contact assembly as a bistable on-off switch.

2. Description of the Prior Art

Over center diaphragm switch contact assemblies are well known. Such switch assemblies are mechanically simple, reliable in operation, and can be fabricated in multiple switch assemblies which are exceptionally thin and compact. Correspondingly, this type of switch has proven well suited for use in miniaturized electronic equipment such as portable, hand held calculators. Such a push button keyboard switch assembly is disclosed in U.S. Pat. No. 3,684,842, issued to Boulanger.

However, this type of switch assembly, because the diaphragm contacts used therewith are resilient, deformable elements, is inherently adapted for use in applications requiring a toggle type switch, that is, a switch which is normally open and remains closed only so long as the operator device associated therewith is held. This characteristic is desirable for many applications of the over center diaphragm switch contact assemblies. Nonetheless, most miniaturized electronic equipment utilizing such switches also requires the use of bistable or on-off type switches. Correspondingly, it has heretofore been necessary to provide two separate types of switch assemblies in such equipment to provide both toggle and bistable type switches thereby adding to the expense and complexity of such equipment.

SUMMARY OF THE INVENTION

Broadly, the present invention is an operator device for use with an over center diaphragm switch contact assembly, the operator enabling the use of such a switch assembly as an on-off or bistable switch. The operator is adapted for use in an over center diaphragm switch contact assembly which includes a contact supporting board, a fixed contact, an over center diaphragm contact resiliently deformable from a first position spaced apart from the fixed contact to a second position in electrical contact therewith and means for making electrical connections thereto. The operator device comprises a rigid guide plate fixedly mounted in generally parallel, spaced apart relationship to the diaphragm contact. The plate is provided with an elongated slot therein disposed in registry with the diaphragm contact. A manually operable knob element is provided having a guide portion slidably engaging the surface of the guide plate proximal to the diaphragm contact, a nib portion protruding from the guide portion and slidably engaging the diaphragm contact, and a tab portion which is slidably received through the slot for longitudinal movement forwardly and rearwardly therein. The knob element further is provided with a ramp surface that is angled forwardly and downwardly with respect to the tab portion and which frictionally, slidably engages the aforementioned proximal surface of the guide plate. Longitudinal movement of the tab forwardly in the slot produces simultaneous downward movement of the knob element thereby operating the diaphragm contact from its first to its second positions. The ramp surface, because it frictionally engages the aforementioned proximal surface of the guide plate, maintains the knob element in its forward position thereby maintaining the switch in its closed position.

In a specific embodiment of the invention, the guide portion of the knob has a width which is greater than the width of the slot. The knob element is made of an electrically common non-conductive material. The tab may have a length about equal to the length of the slot and is provided with a notch therein on its forwardly disposed edge, the ramp surface being the lower surface of the notch.

In yet another specific embodiment of the invention, a thin film of lubricious plastic is disposed between the knob element and the diaphragm contact, the knob element nib portion having rounded edged whereby it slides smoothly on the surface of the plastic film.

It is therefore an object of the invention to provide an operating device for use with an over center diaphragm switch contact assembly which enables operation of the assembly as a bistable switch.

It is another object of the invention to provide such an operator which is simple in construction and provides a highly reliable bistable switch.

It is still another object of the invention to provide such an operator which includes a ramp surface which frictionally maintains the operator and, thereby the switch, in an "on" position.

Another object of the invention is to provide such an operator adapted for use in multiple over center diaphragm switch assemblies.

It is yet another object of the invention to provide such an operator which provides an exceptionally thin and compact bistable switch assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a sectionalized side plan view of the operator device of the present invention in combination with an over center diaphragm switch contact assembly;

FIG. 2 is a top plan view of the knob element of the invention; and

FIG. 3 is an end plan view of the knob element.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, there is shown an operator device **10** in combination with an over center diaphragm switch contact assembly **12.** Assembly **12** includes a supporting plate **16** and an aperture plate **18** having therethrough a circular opening **20,** plate **18** being fixedly bonded to plate **16** whereby opening **20** defines a circular recess **22** therewith.

Plate **16** may be a conventional printed circuit board which is made from a suitable fiber reinforced resin and having a multiplicity of conductive circuit elements **24** formed thereon by conventional techniques well known to those skilled in the art.

A plurality of electrically conductive support elements **26** are secured to plate **16** adjacent the periphery of recess **22**. Elements **26** may be formed of a stiff wire material into a generally U shape with the legs **28** thereof extending downwardly through plate **16** and being mechanically and electrically coupled to the conducting elements **24** by soldering as at **30**.

A fixed contact **32**, generally disk-shaped, is secured within recess **22** adjacent the center thereof. Contact **32** may be made of a suitable thin, electrically conductive material and, preferably, is gold-plated. The central portion of contact **32** is upwardly indented as at **34** to thereby form a relatively small raised portion **36** in the center thereof.

An upwardly (as viewed in FIG. **1**) concave, disk-shaped contact **38** having a diameter about equal to the diameter of recess **22** is received within the latter upon support elements **26**. Contact **38** is made of a resilient, electrically conductive metal, preferably gold-plated, and is deformed from a flat shape to provide the concave shape thereof. Contact **38** is in electrical contact with support elements **26** and thereby also with conducting elements **24**. It will be apparent to those skilled in the art that, by reason of the concave deformation of contact **38**, contact **38** will operate in an over center or "oil can" manner whereby it can be toggled between its raised position shown in solid lines in FIG. **1** to a second position shown in dotted lines in FIG. **1**. It will be observed that contact **38** is vertically spaced apart with respect to contact portion **36** when in its first or solid line position and is in electrical contact therewith when in its second or deformed position shown in dotted lines of FIG. **1**.

A guide plate **40** is mounted in vertically spaced apart relationship to support member **14**. Guide plate **40** is made of a rigid, self-supporting material such as sheet steel and may be supported in its illustrated position by any suitable means (not shown). An elongated, rectangular slot **42** is formed through guide plate **40** in vertical registry with contact **38**.

Operator device **10** further includes a knob element **43** having a guide portion **44** which is generally rectangular in shape and has a width greater than the width of slot **42**. Preferably, guide portion **44** is provided with an upstanding flange portion **46** adjacent the rearwardly disposed edge **48** thereof, flange portion **46** slidably engaging the undersurface **50** of guide plate **40**. Flange **46** has the same width as guide portion **48**. A nib portion **52** is provided adjacent the center of guide portion **48**, nib portion **52** extending downwardly from guide portion **48** and slidably engaging contact **38**. Preferably, nib portion **52** is circular in cross-section and has smoooth, rounded corners as at **54**.

Upstanding from guide portion **44** is a tab portion **56**. Tab portion **56** has a generally rectangular cross-section and is slidably received through slot **42**. The upper edge **58** of tab portion **56** is serrated as shown to facilitate engagement thereof with the fingertip. The forward edge **60** of tab portion **56** is provided with a notch **62** extending rearwardly therefrom (to the left as viewed in FIG. **1**). The lower (as viewed in FIG. **1**) wall of notch **62** is tapered to provide a ramp surface **64** which extends forwardly and downwardly with respect to tab portion **56**.

In operation, operator device **10** is normally in its rearwardly (as viewed in FIG. **1**) disposed position within slot **42**, operator **10** being shown in this position in solid lines in FIG. **1**. Under these conditions, contact **38** is in its spaced apart position with respect to contact **34**, this being shown in the solid lines in FIG. **1**, whereby there is no electrical contact between contacts **34** and **38**.

To operate switch contact assembly **12** to an "on" position, i.e., a position wherein contact **38** is in electrical contact with contact **34**, knob element **43** is pressed downwardly and forwardly. Downward movement of knob element **43** forces nib portion **52** against contact **38** deforming same downwardly to the position thereof illustrated in dotted lines in FIG. **1**, thereby placing contact **38** in electrical contact with contact **34**. Simultaneously, movement of tab portion **56** forwardly (as viewed in FIG. **1**) slides ramp surface **64** against the undersurface **50** of guide plate **40**. As tab portion **56** is moved forwardly, ramp surface **64** is wedged against undersurface **50** thereby maintaining nib portion **52** in positive engagement with contact **38**.

When finger pressure is removed from tab portion **56**, ramp surface **64**, because it frictionally engages the undersurface **50** of guide plate **40**, maintains knob element **43** in the position thereof illustrated in dotted lines in FIG. **1** thereby maintaining switch contacts **38** and **34** in electrical contact.

To turn the switch "off", knob element **43** is pushed rearwardly (to the left as viewed in FIG. **1**) until the rear edge **66** of tab portion **56** engages the rear edge **68** of slot **42**. When finger pressure is removed, knob element **43** will move upwardly under the resilient force generated by contact **38**. Because ramp surface **64** has now moved out of contact with undersurface **50** of guide plate **40**, knob element **43** is able to move upwardly thereby breaking the electrical contact between contacts **38** and **34**.

In a specific embodiment of the invention, a thin film **70** of a tough, lubricious, and flexible plastic may be positioned in overlying engagement with plate **18** and contact **38** as shown. Film **70** enhances the sliding contact between nib portion **52** and contact **38** thereby enhancing the durability and ease of operation of the switch assembly. Preferably, knob element **43** is made from a non-conductive plastic.

From the above description, it will be seen that, because the electrical contact between contacts **38** and **34** is maintained by ramp surface **64**, minor wear of ramp surface **64** will not deteriorate operation of the switch assembly since additional forward movement thereof will compensate for this wear. Further, because of the small angle of ramp surface **64**, a positive frictional engagement between surface **64** and undersurface **50** positively maintains the switch in an on position. It is thus seen that the operator device of the present invention converts the normal toggle action or over center diaphragm switch into a bistable switch without any modification of the over center switch contact assembly. The operator is simple in construction, and self-compensates for wear. The switch action is positive and electrical contact between contacts **34** and **38** is insured. The operator thus enables the fabrication of a bistable switch which is compatible with the over center diaphragm switch widely used in miniaturized electronic equipment, the operator being an integrated part of the switch assembly, requiring the same relative amount of space, and not requiring the use of different components.

It will further be apparent that variations in the switch assembly can be made without departing from the scope of the invention. For example, ramp surface **64** may be formed as a part of the undersurface **50** of guide plate **40**. Other positionings of the ramp surface **64** to effect the same mechanical operation, i.e., the simultaneous forward and downward movement of the knob element **44** will be apparent to those skilled in the art.

In a specific embodiment of the invention, the ramp surface **64** is formed at an angle of about degrees with respect to the guide portion **48**.

While there have been described above the principles of this invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of the invention.

What is claimed is:

1. For use in an over center diaphragm switch contact assembly which includes a contact supporting board, a fixed contact, an over center diaphragm contact resiliently deformable from a first position spaced apart from said fixed contact to a second position in electrical contact therewith, and means for making electrical connections thereto, a switch operating device comprising a rigid guide plate fixedly mounted in generally parallel, spaced-apart relationship to said board and diaphragm contact, said plate having an elongated slot therein disposed in registry with said diaphragm contact, and a manually operable knob element having a guide portion positioned between said plate and diaphragm contact and slidably engaging the surface of said plate proximal said diaphragm contact, said guide portion having a width greater than the width of said slot, a nib portion protruding from said guide portion and slidably engaging said diaphragm contact, a tab portion slidably received through said slot for longitudinal movement forwardly and rearwardly therein, and a ramp surface angled forwardly and downwardly from said tab portion to said guide portion, said ramp frictionally, slidably engaging said proximal surface upon longitudinal movement of said tab portion forwardly in said slot thereby causing simultaneous downward movement of said device, said diaphragm contact being operated from said first to said second position thereof in response to said downward movement, said ramp surface frinctionally maintaining said diaphragm contact in said second position.

2. The device of claim **1** wherein said guide portion further includes an upwardly extending flange adjacent the rearwardly disposed edge thereof, said flange having a width greater than the width of said slot and slidably engaging said proximal surface.

3. The device of claim **1** further comprising a thin, flexible film of lubricious plastic material overlying said diaphragm contact, said nib portion slidably engaging said film.

4. The device of claim **3** wherein said knob element is made of an electrically, non-conducting material.

5. The device of claim **1** wherein said tab portion has a length generally equal to the length of said slot, there being a notch in the forwardly disposed end of said tab portion, said ramp surface being the surface of said notch proximal said guide portion.

6. The device of claim **1** wherein said nib portion, when said tab portion is in the rearwardly disposed position thereof, engages said diaphragm contact at a point displaced from the center thereof, said nib portion, when said tab portion has been moved forwardly, engaging said diaphragm portion at a point adjacent the center thereof.

7. The device of claim **6** wherein said nib portion is cylindrical, the distal edges thereof being rounded and smooth.

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