

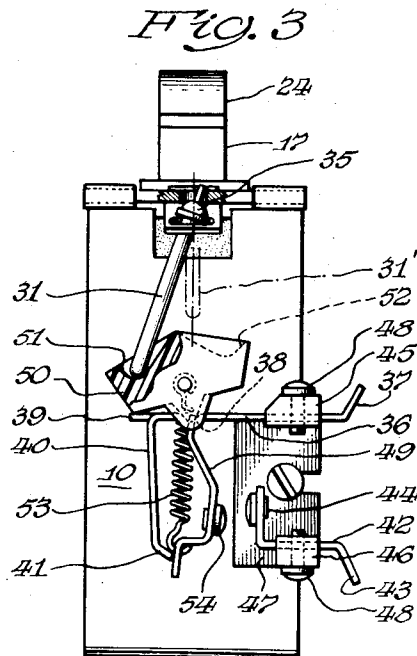
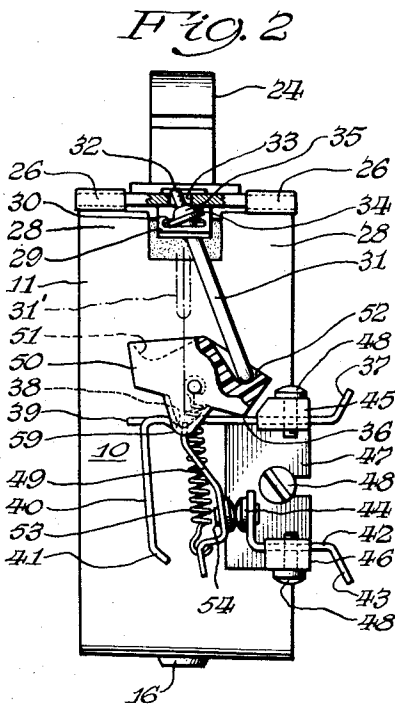
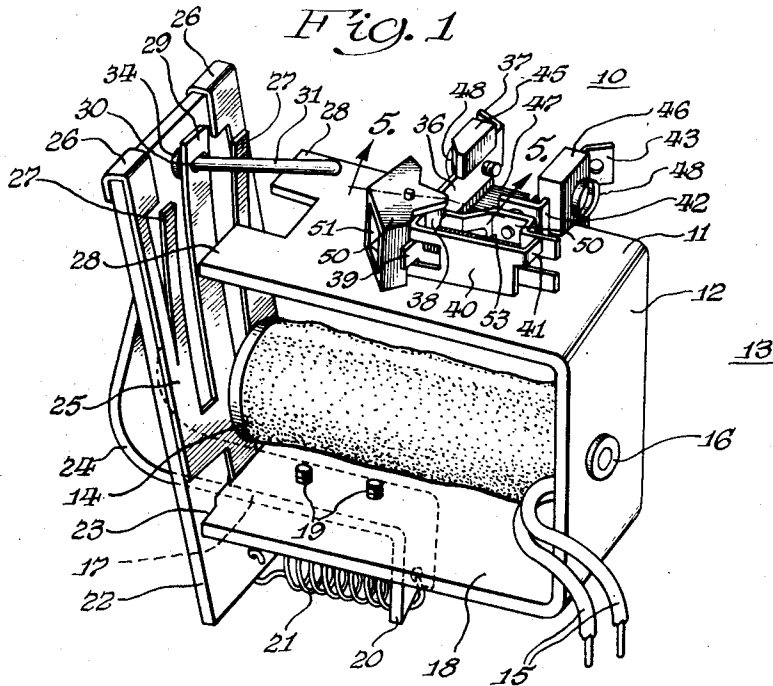
Sept. 1, 1959

G. V. MORRIS  
SWITCHING APPARATUS

2,902,559

Filed June 6, 1957

2 Sheets-Sheet 1



Inventor  
George V. Morris  
By *John J. Pederson*  
Attorney

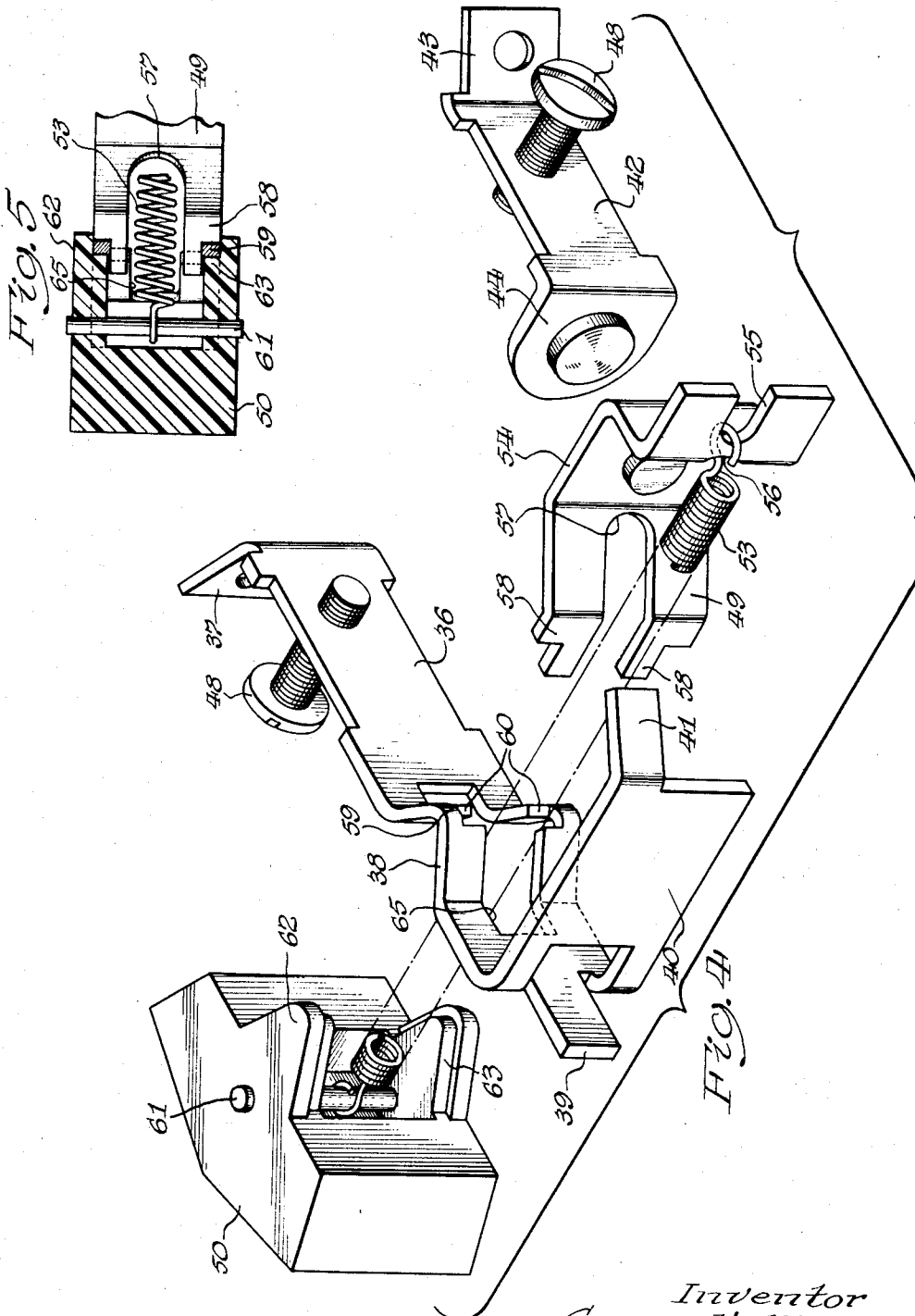
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By John J. Pederson  
Attorney

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## SWITCHING APPARATUS

George V. Morris, Chicago, Ill., assignor to Zenith Radio Corporation, a corporation of Delaware

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7 Claims. (Cl. 200—87)

This invention relates to switching mechanisms and in particular to an improved switching apparatus which can be advantageously employed for sequential or alternate switching operations.

Sequential switching by identical repetitive actuation can employ, in general, either a rotatable indexing device or an alternate action toggle. The indexing devices are by their nature the more complex and accordingly more expensive. On the other hand the toggle type mechanisms utilized for sequential switching operations which employ a push-button or other motivating plunger to activate a multi-positionable toggle admit of simplified construction with attendant savings costwise. One type of such toggle contemplates the use of a cooperating spring arrangement wherein the toggle travel, responsive to plunger actuation, energizes the spring. Subsequently, further displacement of the plunger releases the energy stored in the spring thus driving a contacting member associated with the spring and toggle arrangement into conductive engagement with a second contact member. This type of mechanism necessitates a rather sturdy construction to withstand the required operating as well as the generated actuating forces and thus is not readily nor economically adaptable to more delicate applications.

A second type of alternate switching device utilizes a direct acting toggle in which the toggle arrangement either carries a contact bearing member or drives such a member directly. Devices of this nature frequently utilize a snap-spring arrangement which can comprise a deformed spring member secured under compression or tension to exert a biasing force on the toggle. An important consideration in these arrangements is the fatigue property of the snap-spring material. This property can be compromised by the rather expensive expedient of utilizing special spring materials.

Another problem of considerable importance, possibly not of primary concern to the cumbersome spring loaded devices, but of significant importance to the smaller switching mechanisms which utilize resilient movements, relates to the stability characteristics of the switch elements when utilized with equipment subject to vibrational or impact forces. Switches comprising small lightweight elements will malfunction if the constituent elements succumb to sympathetic vibration or will become completely inoperative if a switching element becomes dislodged due to an impact force.

Furthermore, it is noted that many of the aforementioned alternate switching arrangements comprise either a substantial number of moveable elements or utilize specially mounted or complex toggles tending thereby to increase the probability of malfunctioning.

It is therefore a primary object of this invention to provide an improved switching apparatus for use with alternate or sequential switching operations.

It is a further object of this invention to provide a switching apparatus which utilizes a minimum number of simplified operating elements.

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It is also an object of this invention to provide a switching apparatus inherently stable to vibrational and impact forces.

It is also an object of this invention to provide a switching apparatus characterized by an economy in component cost and amenable to simple production assembly techniques.

In accordance with the invention a switching apparatus comprises an actuating plunger and a support member having a fulcrum disposed thereupon. An armature, displaceable to a plurality of operating positions, has one end for pivotally engaging the support member in the vicinity of the fulcrum and has a circuit controlling portion at the other end. A bi-stable toggle is pivotally seated upon the fulcrum and comprises a plurality of obliquely disposed concavities which are sequentially positionable for receiving the plunger. Resilient means, comprising a tension spring anchored to the toggle and to the armature, retains the toggle on the fulcrum and also retains one end of the armature in pivotal engagement with the support member so that the armature follows the toggle in response to displacement of the toggle by the plunger. Further, means are provided for actuating the plunger to sequentially position the toggle and the armature from one to another of the operating positions in response to successive actuations of the plunger.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The organization and manner of operation of the invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in the several figures of which like reference numerals identify like elements, and in which:

Figure 1 is a perspective view of a switching apparatus embodying the subject invention cooperatively associated with a conventional relay;

Figure 2 is an elevation view partly in section showing the switching apparatus of Figure 1 in one of its operative positions;

Figure 3 is an elevation view partly in section of the switching apparatus of Figure 1 in an alternate operative position.

Figure 4 is an exploded view of the toggle and electrode arrangement of the switching apparatus shown in Figure 1; and,

Figure 5 is a sectional view along line 5—5 of Figure 1 showing the pivotal mounting of the toggle arrangement of the subject switching apparatus.

Figure 1 shows a switching apparatus 10 disposed upon a leg 11 of a U-shaped housing 12 comprising the yoke of a conventional relay 13. Relay 13 includes an electromagnet 14 which can be energized via leads 15 and is secured to housing 12 by a pin 16. A bracket 17 is affixed to leg 18 of housing 12 by threaded fasteners 19 and includes an offset tab 20 which secures one end of a return spring 21. The opposite end of spring 21 is fixed to a driver plate 2 which plate is pivotally mounted on the shoulders 23 (only one shown) of leg 18. Bracket 17 further includes a bowed portion 24 which abuts plate 22 when relay 13 is deenergized. A leaf spring element 25 comprises mounting extensions 26 and release fingers 27 which are struck from extensions 26 and which engage pedestals 28 of leg 11 when relay 13 is energized. Leaf spring 25 further includes a resilient mounting finger 29 having a slot 30 which admits a plunger 31. The upper extremity 32 of plunger 31 (as best shown in Figures 2 and 3) is disposed within an oversized aperture 33 in plate 22. Plunger 31 further incorporates a collar 34 secured to plunger bar 31 by a

rounded fillet 35. Mounting finger 29 bears against collar 34 to seat fillet 35 within aperture 33. Slot 30 in finger 29 in conjunction with collar 34, fillet 35 and aperture 33, thus comprises a universal mounting for plunger bar 31. This construction is more readily apparent in Figures 2 and 3.

Figures 2 and 3 illustrate more advantageously the switching apparatus 10 which comprises a first electrode member 36 having a terminal lug 37, a fulcrum-forming depression 38, a support lip 39 and an offset projection 40. Projection 40 includes a limit tab 41. A second electrode member 42 includes a terminal lug 43 and a contact bearing portion 44. Electrodes 36 and 42 are mounted on respective shoulders 45, 46 of an insulated mounting base 47 by conventional screw fasteners 48. A contact bearing follower armature 49 is pivotally hinged to electrode member 36 at fulcrum-forming depression 38. A bi-stable toggle 50 comprising a pair of obliquely disposed concavities 51, 52 is pivotally seated within depression 38. Armature 49 and toggle 50 are mutually pivoted about depression 38 by a resilient biasing spring 53. Figures 2 and 3 further show a dash-lined representation 31' depicting the position assumed by plunger 31 upon de-energization of relay 13.

Figure 4 details the constructional aspects of the toggle 50 and electrodes 36, 42 referred to in the discussion on Figures 1-3. Follower armature 49 is seen to comprise an offset contact bearing portion 54 disposed between a first bifurcated end portion having a mounting slot 55 which in conjunction with a loop hole 56 secures one end of biasing spring 53. Armature 49 further includes a second bifurcated end portion provided with an elongated clearance slot 57 which permits passage of spring 53. The aforementioned second end portion is further provided with keyed hinges 58. Electrodes 36 is seen to include an elongated window 65 which admits biasing spring 53. Depression 38 is provided with a nadir portion 59 having opposed keyed segments 60. Toggle 50 includes an arbor 61 which secures the farther end of biasing spring 53. Toggle 50 further comprises arcuate terminated support legs 62 having undercut pivotal shoulders 63.

Upon assembly, the undercut shoulders 61 are seated within nadir portion 59 of depression 38 so that support legs 62 straddle the nadir portion 59 to prevent lateral displacement of toggle 50. Keyed segments 60 receive hinges 58 of armature 49 while biasing spring 53 simultaneously urges both toggle 50 and armature 49 into pivotal bearing engagement with nadir portion 59.

The cut-away view of Figure 5 shows more clearly the aforementioned pivotal engagement between keyed segments 60 and armature hinge keys 58 and between nadir 59 and shoulders 63 of support legs 52.

In operation, switching apparatus 10 in conjunction with an actuating means, which can be the relay device 13, can be utilized for alternate or sequential switching from one operating position to a second operating position. Accordingly, upon energization of electromagnet 14 from a source (not shown) connected to leads 15, driver plate 22 is impelled toward electromagnet 14 until the release fingers 27 carried by plate 22 engage pedestals 28. Simultaneously, plunger 31 descends upon toggle 50 and, as shown in the operative view of Figure 2, engages concavity 52 thereby rotating toggle 50 upon the shoulders 63 of support legs 62 which are pivotally disposed within the fulcrum-forming depression 38. It is to be noted at this juncture that the universal mounting of plunger 31 within the over-sized aperture 33 in conjunction with the slotted resilient mounting finger 29 permits continuing engagement between plunger 31 and concavity 52 after plunger 31 has departed from its original course.

As toggle 50 assumes the position shown in Figure 2 the over-center feature, i.e., the securing of biasing spring 53 to arbor 61 of toggle 50 above the pivotal point (shoulders 63), permits follower armature 49 to snap in the

same direction as toggle 50 thereby bringing the contact bearing portion 54 of armature 49 into conductive engagement with contact bearing portion 44 of electrode 42. In this position switching apparatus 10 can provide effective electrical continuity between external circuitry (not shown) connected to terminal tabs 37, 43 of respective electrodes 36, 42. Upon terminating energization of electromagnet 14, release fingers 27 can overcome any residual cohesive source tending to prevent the normal return of plate 22 by return spring 21 to its normal de-energization position of abutting the bowed portion 24. Plunger 31 is thus poised above the opposite concavity, in this instance concavity 51, so that a subsequent energization of relay 13 will provide the alternate switching position.

Figure 3 depicts the alternate operational position of switching apparatus 10. For this operating position to obtain, a subsequent energization of electromagnet 14 actuates driver plate 22 bringing plunger 21 to bear on concavity 51. Again, the over-center action described above causes follower armature 49 to snap to the alternate operating position. Support lip 39 comprises a stop for toggle 50 while tab 41 limits the pivotal travel of follower armature 49. In this position (Figure 3) contact bearing portion 54 of armature 49 is disconnected from contact portion 44 of electrode 43. This of course effectively disrupts the pre-existing conductive continuity between electrodes 36 and 42.

The construction of switching apparatus 10 provides a positive snap acting switch comprised of a minimum number of simplified components. Malfunctioning due to vibration is obviated through the over-center action in that displacement of the follower armature from a particular position will not disturb toggle 50. Toggle 50 can through proper design be so frictionally engaged within depression 38 as to obviate displacement from a rest position to an alternate position by any means other than positive actuation by plunger 31. Furthermore, switching apparatus 10 utilizes conventional inexpensive components which can be fabricated from ordinary untreated materials. While the actuating means, relay 13, has been discussed in this embodiment of the invention, restriction to such actuating means is in no way intended since the actuation of a switching apparatus of the nature herein disclosed might well be a manually operated push-button or other means for engaging plunger 31 with toggle 50.

While particular embodiments of the invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects, and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. In a switching apparatus: an actuating plunger; a first electrode member comprising a fulcrum-forming depression and including an offset limit projection; a contact bearing second electrode member disposed in spaced relation to said projection; a contact bearing armature pivotally hinged to and in conductive contact with said first electrode member at said fulcrum-forming depression to make electrical contact with said second electrode member in only one of two operating positions; a bi-stable toggle pivotally seated within said depression and comprising a pair of obliquely disposed concavities alternately positionable for receiving said plunger; resilient biasing means comprising a helical spring fixed to said toggle at a point over-center of said depression and to a point on said follower armature remote from said depression for biasing said armature to follow said toggle in response to displacement of said toggle by said plunger; and means for actuating said plunger to alternately position said toggle from one to the other of said operating positions and to position said follower armature from conductive engagement with said second electrode mem-

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ber to engagement with said limit projection in response to successive actuations of said plunger.

2. Switching apparatus according to claim 1, in which said plunger-actuating means comprises an electromagnet.

3. In a switching apparatus: an actuating plunger; a support member having a fulcrum disposed thereon; an armature displaceable to a plurality of operating positions having one end for pivotally engaging said support member in the vicinity of said fulcrum and having a circuit controlling portion at the other end thereof; a bi-stable toggle pivotally seated on said fulcrum and comprising a plurality of obliquely disposed concavities sequentially positionable for receiving said plunger; resilient means, comprising a tension spring anchored to said toggle and to said armature, for retaining said toggle on said fulcrum and for retaining said one end of said armature in pivotal engagement with said support member to follow said toggle in response to displacement of said toggle by said plunger; and means for actuating said plunger to sequentially position said toggle and said armature from one to another of said operating positions in response to successive actuations of said plunger.

4. In a switching apparatus: an actuating plunger; a support member comprising a fulcrum-forming depression; an armature displaceable to a plurality of operating positions having one end for pivotally engaging said support member at said fulcrum-forming depression and having a circuit controlling portion at the other end thereof; a bi-stable toggle pivotally seated within said depression and comprising a plurality of obliquely disposed concavities sequentially positionable for receiving said plunger; resilient means, comprising a tension spring anchored to said toggle and to said armature, for retaining said toggle within said depression and for retaining said one end of said armature in pivotal engagement at said fulcrum-forming depression to follow said toggle in response to displacement of said toggle by said plunger; and means for actuating said plunger to sequentially position said toggle and said armature from one to another of said operating positions in response to successive actuations of said plunger.

5. In a switching apparatus: an actuating plunger; a support member having a fulcrum disposed thereon; an electrical terminal disposed in spaced relation to said support member; an armature displaceable to a plurality of operating positions having one end for pivotally engaging said support member in the vicinity of said fulcrum and having a circuit controlling portion at the other end thereof for effecting an electrical connection between said armature circuit controlling portion and said electrical terminal in one of said operating positions; a bi-stable toggle pivotally seated on said fulcrum and comprising a plurality of obliquely disposed concavities sequentially positionable for receiving said plunger; resilient means, comprising a tension spring anchored to said toggle and to said armature, for retaining said toggle on said fulcrum and for retaining said one end of said armature in pivotal engagement with said support member to follow said

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toggle in response to displacement of said toggle by said plunger; and means for actuating said plunger to sequentially position said toggle and said armature from one to another of said operating positions in response to successive actuations of said plunger.

6. In a switching apparatus: an actuating plunger; a support member of conductive material having a fulcrum disposed thereon and comprising a first electrical terminal; a second electrical terminal disposed in spaced relation to said support member; an armature displaceable to a plurality of operating positions having one end for pivotally and conductively engaging said support member in the vicinity of said fulcrum and having a circuit controlling portion at the other end thereof for effecting an electrical connection between said terminals in one of said operating positions; a bi-stable toggle pivotally seated on said fulcrum and comprising a plurality of obliquely disposed concavities sequentially positionable for receiving said plunger; resilient means, comprising a tension spring anchored to said toggle and to said armature, for retaining said toggle on said fulcrum and for retaining said one end of said armature in pivotal conductive engagement with said support member to follow said toggle in response to displacement of said toggle by said plunger; and means for actuating said plunger to sequentially position said toggle and said armature from one to another of said operating positions in response to successive actuations of said plunger.

7. In a switching apparatus: an actuating plunger; a support member of conductive material having a fulcrum disposed thereon and comprising a first electrical terminal; a second electrical terminal disposed in spaced relation to said support member; an armature having one end for pivotally and conductively engaging said support member in the vicinity of said fulcrum and having a circuit controlling portion at the other end thereof for effecting an electrical connection with said second terminal in only one of two operating positions; a bi-stable toggle pivotally seated on said fulcrum and comprising a pair of obliquely disposed concavities alternately positionable for receiving said plunger; resilient means, comprising a tension spring anchored to said toggle and to said armature, for retaining said toggle on said fulcrum and for retaining said one end of said armature in pivotal conductive engagement with said support member to follow said toggle in response to displacement of said toggle by said plunger; and means for actuating said plunger to alternately position said toggle and said armature from one to the other of said operating positions in response to successive actuations of said plunger.

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