United States Patent

[11] 3,610,939

[72] Inventor **Kenneth E. Fitzgerald**
Sudbury, Mass.

[21] Appl. No. **21,086**
[22] Filed **Mar. 19, 1970**
[45] Patented **Oct. 5, 1971**
[73] Assignee **GRI Computer Corporation**
Newton, Mass.

[54] **ELECTROOPTICAL SWITCH STRUCTURE**
11 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **250/229,** 250/233, 250/237, 315/159
[51] **Int. Cl.** **G01d 5/34,** G01d 5/36, H01j 1/56
[50] **Field of Search** ..... 250/211 K, 229, 233, 237, 227; 315/159; 200/61.02; 307/311

[56] **References Cited**

UNITED STATES PATENTS

3,011,379	12/1961	Corwin	250/229 X
3,235,741	2/1966	Plaisance	250/229

Primary Examiner—Anthony L. Birch
Attorney—Robert J. Schiller

ABSTRACT: An integrally formed switch structure for changing the level of light upon an electrical impedance from an elongated light source. The switch structure comprises a rotatable sleeve positioned snugly for sliding rotation around the elongated light source, the sleeve having light-opaque and light-transmissive portions. A resiliently biased detent mechanism is used for providing two fixed positions for the sleeve, one of the positions permitting light to pass from the source through the light-transmissive portion of the sleeve to the impedance and the other of the positions interposing the light-opaque portion of the sleeve between the source and the impedance to prevent light from the source from being transmitted to the impedance. The detent mechanism includes a ridge substantially parallel to the axis of rotation of the sleeve. The ridge is formed by the intersection of two surface areas on the outer surface of the sleeve so that the sleeve may be held in its operative and inoperative positions by the detent mechanism which bears against a selected one of the surface areas to retain the sleeve in one of the fixed positions. A masking projection extends from the outer surface of the sleeve adjacent the light-transmissive portion of the sleeve for optically isolating the electrical impedance from optical interference from adjoining sleeves. Finally, a lever arm is connected to the sleeve which is manually engageable to rotate the sleeve from one fixed position to the other fixed position.

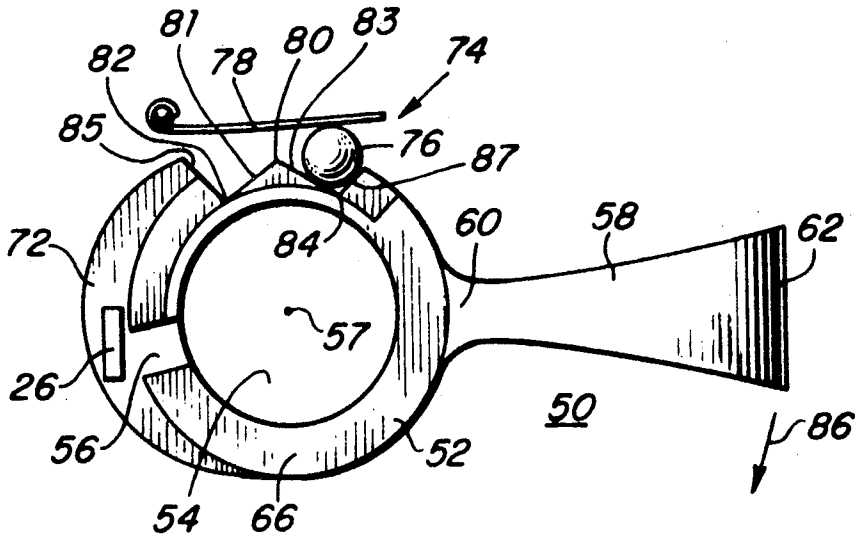
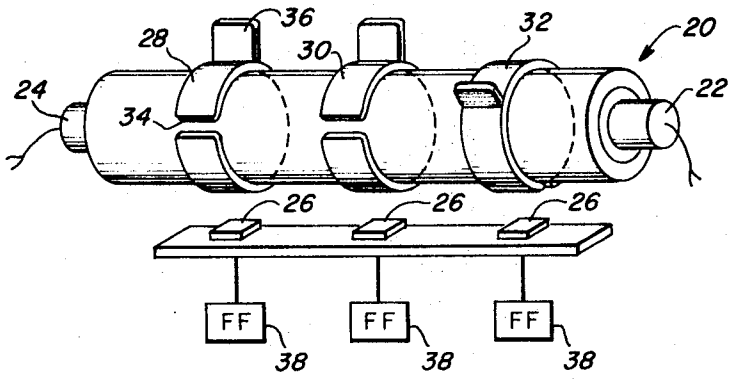


FIG. 1.



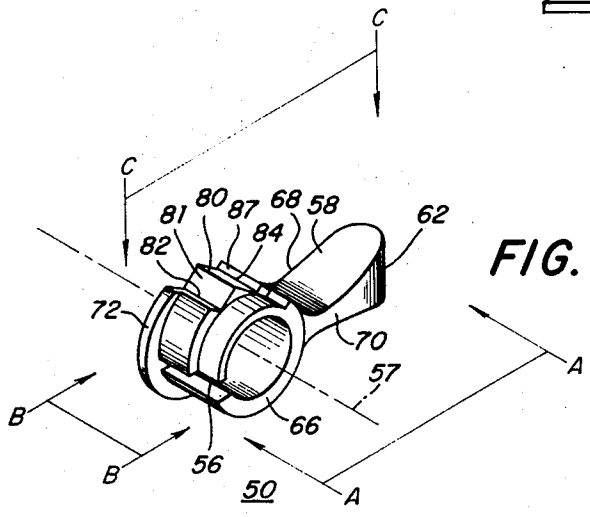


FIG. 2.

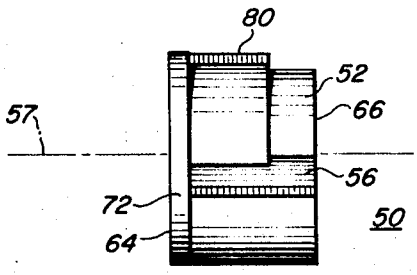


FIG. 4.

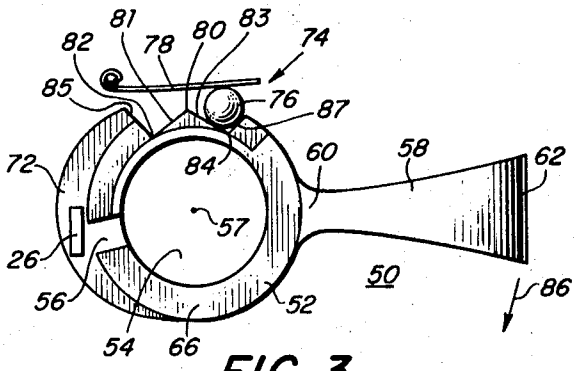


FIG. 3.

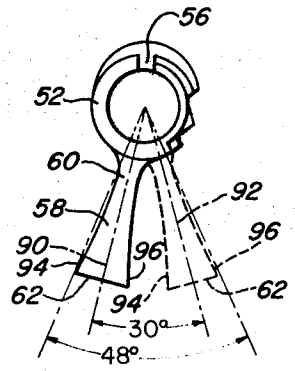


FIG. 6.

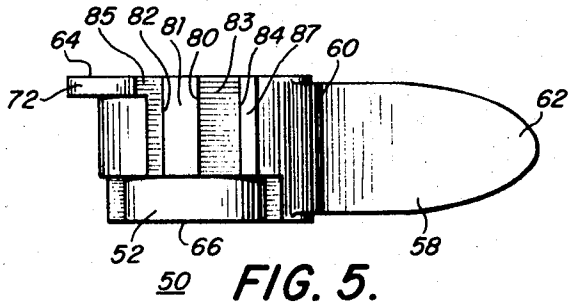


FIG. 5.

KENNETH E. FITZGERALD
INVENTOR.

BY Schiller & Pandiscio

ATTORNEYS.

ELECTROOPTICAL SWITCH STRUCTURE

This invention relates to a switch and more particularly to a novel electro-optical switch structure particularly useful in multiple-switch arrays.

In computation devices requiring a multiplicity of manually operable, two-position switches arranged in line on a control console, the use of mechanical switches poses several problems. The signal levels are usually quite low, hence the switches rarely carry enough current to keep the switch contact faces clean. Additionally, mechanical switches usually exhibit contact bounce, creating transients needing filtering and often other signal conditioning.

A principle object of the present invention is to provide an integrally formed switch structure for performing switching electro-optically, thereby overcoming a number of the problems noted above.

The switch structure of the present invention has the advantage of being an integrally formed unitary member which has all the necessary functions provided by a single unit. The unitary switch structure provides all the functions of (1) permitting the movement between two fixed positions so as to change the level of light incident on the impedance, (2) an integrally formed lever arm for rotating the structure between the two fixed positions and which arm has substantially no tactile ambiguity, (3) a single sleeve integral with the arm which in one fixed position blocks light from the source to the impedance and in the other position allows light to pass from the source to the impedance, (4) spacers provided integral with the sleeve for substantially preventing any mechanical interference between adjacent switch structures, and (5) a mask for optically isolating the impedance from being interferred with by the operation of any other switch structure adjacent the structure affecting that impedance. Other objects of the present invention are to provide a switch construction particularly adapted for use in multiple-switch systems; to provide such a switch which is low in cost, simple in operation and easy to fabricate; and to provide such a switch in a switching system particularly useful with computational equipment employing multivibrator circuits for signal conditioning, particularly circuits employing low-level signals with fast rise and fall times such as, for example, described in copending application Ser. No. 806,903, filed on Mar. 7, 1969, entitled "Rotary Toggle Switches."

To effect the foregoing and other objectives, the present invention generally comprises a switch structure for changing the level of light upon an electrical impedance from a light source, and being positively held in its operative and inoperative positions by a resiliently biased detent mechanism, said switch comprising a rotatable sleeve positioned snugly but for sliding rotation around said light source, said sleeve having at least one light-opaque portion and one light-transmissive portion; detent means for providing a first fixed position for said sleeve wherein light from said source may pass through said light-transmissive portion to said impedance, and a second fixed position wherein said light-opaque portion of said sleeve is interposed between the source and the impedance to prevent light from said source from being transmitted to said impedance, said detent means including a ridge substantially parallel to the axis of rotation of said sleeve and formed by the intersection of two surface areas on the outer surface of said sleeve so that said biased detent mechanism can bear against a selected one of said areas for retaining said sleeve in one of said fixed positions; a masking projection extending radially outwardly in a direction substantially perpendicular to the axis of rotation from the outer surface of said sleeve adjacent the light-transmissive portion of said sleeve for optically isolating the electrical impedance from any optical interference from any adjoining sleeve; and a level arm connected to said sleeve, said arm being connected for rotating said sleeve between said fixed positions wherein said sleeve is releasably retained by the bearing of said detent mechanism against the corresponding one of said surface areas.

Other objects of the present invention will in part be obvious and will in part appear hereinafter. The invention accordingly comprises the apparatus possessing the construction, combination of elements, and arrangement of parts which are exemplified in the following detailed disclosure, and the scope of the application of of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the present invention, reference should be had to the following description and drawings wherein:

FIG. 1 is a diagram of a switching system, in which a plurality of switches in accordance with the present invention may be used;

FIG. 2 is a isometric view of a specific embodiment of a switch structure of the present invention;

FIG. 3 is a view taken along the line A—A of FIG. 2;

FIG. 4 is a view taken along the line B—B FIG. 2;

FIG. 5 is a view taken along the line C—C of FIG. 2; and

FIG. 6 is a view showing the effect of rotation of the switch shown in FIGS. 2–5.

Referring now to FIG. 1, there is shown an embodiment of a switching system employing switches in accordance with the present invention. The system includes a light source indicated generally at **20**, preferably in the form of an elongated cylinder. In the form shown, light source **20** is a light pipe, typically of a transparent synthetic polymeric plastic material, such as polymethyl-methacrylate or the like, having mounted at opposite ends thereof a pair of electrical lights **22** and **24**. The latter typically are small incandescent lamps mounted in the usual sockets to power leads for energizing the lamps. Alternatively, light source **20** can be formed itself as an elongated cylindrical incandescent lamp having a long central filament. In yet another form, light source **20** can be a tubular electrical lamp of the fluorescent or distributed filament type. It is preferred, for reasons that will appear obvious hereafter, that the light source not be also a heat source; hence, to this end, the light pipe combination with one or more end-mounted incandescent lamps is recommended.

Mounted adjacent and in space relationship to source **20** are a plurality of photocells **26**, preferably distributed along a line parallel to the long axis of source **20**. Photocells **26** are of the type which exhibit an electrical impedance which changes substantially in accordance with a change in the level of light incident thereon, at least exhibiting such change when the light level varies from substantially zero to some finite value. Such photocells are well known in the art and need no further description here.

Means are provided for varying the level of light incident on each of photocells **26** from light source **20**. Each of the photocells is connected so that it constitutes an impedance in a positive feedback circuit in an electrical multivibrator **38**. A substantial change in the impedance of the photocell thus causes a change in the state of the multivibrator circuit **38**. To vary the light level, there are provided a plurality of shuttering means, shown in FIG. **1** for simplicity in the form of rings or sleeves **28**, **30** and **32**. The actual form of the sleeve of the present invention will be described in detail with respect to FIGS. **2–6**. The sleeves of FIG. **1** are mounted so as to be rotatable normally about the long axis of source **20**. Sleeve **28**, which may be made of a light-opaque material, contains an opening or slot **34** cut transversely across the ring. The sleeve is dimensioned so that its internal diameter fits snugly but slidingly around the circular periphery of source **20**. A manually engageable rocker arm or handle such as tab **36** is connected to sleeve **28** as by being molded therewith and extends radially outwardly therefrom. It will be seen that a plurality of such sleeves can be mounted coaxially about source **20** from end to end of the latter.

If tab **36** is manually engaged and sleeve **28** to be rotated, it is apparent that for some position of tab **36**, slot **34** will be adjacent corresponding photocell **26**, thereby permitting light from source **20** to illuminate that photocell. In all other positions of tab **36** where the opaque body of sleeve **28** is inter-

posed between source 20 and correspondingly photocell 26, the latter is not illuminated by source 85. The switching system thus described is in essence that shown in the aforementioned copending application Ser. No. 806,903.

FIGS. 2–5 show one embodiment of an improved switch element 50 in accordance with the present invention. Element 50 includes a ring portion 52, which corresponds to sleeve 28 in FIG. 1, having a cylindrical opening or aperture 54. Sleeve 52 is intended to be mounted for rotation normally with the long axis of source 20 of of FIG. 1 coaxial with central axis 57 of aperture 54. Sleeve 52 comprises a simple wide ring of light-opaque material, typically a synthetic plastic such as nylon loaded with carbon black. Sleeve 52 has a narrow opening or slot 56 which corresponds to slot 34 in FIG. 1, cut transversely across the ring as seen in FIGS. 2 and 4. The sleeve 52 is dimensioned so that its internal diameter across the circular cross section formed by cylindrically shaped opening 54 can fit snugly but slidingly rotatable around the circular periphery of source 20.

A manually engageable rocker arm or lever such as bat 58 is connected to sleeve 52 as by being integrally molded therewith. Bat 58 extends substantially perpendicularly to the axis of rotation 57 originating from a proximal end 60 closest the axis of rotation 57 to a distal end 62 furthest from the axis of rotation 57. Bat 58 is tapered from proximal end 60 to distal end 62 so that it is of greatest dimension at its distal end 62 in a circumferential direction about the axis of rotation for reasons which will be explained in conjunction with FIG. 6.

A plurality of sleeves 52 may be mounted coaxially about source 20 from end to end of the latter substantially without mechanical interference with one another when any one bat 58 is manually engaged. Sleeve 52 has parallel side faces or edges 64 and 66 thereof each lying in a plane which is substantially perpendicular to the axis of rotation and substantially parallel to one another. The shortest distance between the side faces or edges 64 and 66 is greater than the greatest dimension of the bat 58 in a direction parallel to the axis 57. These side faces 64 and 66 act as spacers such that a plurality of sleeves 52 may be mounted for rotation in adjacent and contacting relationship around the periphery of source 20. This spacing prevents any mechanical interference between operation of adjacent bats 58 when it is desired to manually engage any one of the bats 58 to cause rotation of its corresponding sleeve 52. Preferably, each sleeve is dimensioned to grip source 20 tightly enough to prevent any sliding friction between adjoining or contacting edges such as 64 or 66 of a pair of adjacent sleeves from causing any unwanted rotation of the sleeve not manually engaged.

If bat 58 is manually engaged to produce rotation of sleeve 52, it is apparent that for some position of bat 58, slot 56 will be adjacent a corresponding photocell 26, thereby permitting light from source 20 to illuminate that photocell. In all other positions of bat 58 where the opaque body of sleeve 52 is interposed between source 20 and correspondingly photocell 26, the latter is not illuminated by source 20.

Since a plurality of sleeves 52 may be positioned in adjacent position to one another along source 20, it is not only necessary to insure that there is no mechanical interference in the operation of the sleeves with each other, but also that there is no optical crosstalk between adjacent photocells 26. This latter problem is overcome by the provision of a masking element 72 which is an extension or projection on the end of sleeve 52 adjacent the slot 56. Masking element 72 extends radially outwardly from the sleeve 52 in a direction substantially perpendicularly to the axis of rotation and provides an optical baffle so that no crosstalk occurs between adjacent photocells 26. Element 72 could also be fitted into a corresponding groove in a frame (not shown) to provide a mechanical guide to prevent axial motion of sleeve 52 when the latter is rotated.

In order to ensure proper switching of the level of light incident on a photocell 26, it is important to provide a proper detent mechanism. In the embodiment of FIGS. 2–5, as shown only in FIG. 3, a detent mechanism 74 is provided for releasably locking sleeve 52 in one fixed position wherein corresponding photocell 26 is not illuminated and a second fixed position wherein the cell is illuminated through slot 56 in sleeve 52. Detent mechanism 74 comprises ball 76, which typically may be made of plastic, leaf spring 78 and ridge 80 on the outer periphery of one portion of sleeve 52. Ridge 80 is formed by two angularly disposed surface areas 81 and 83. Areas 81 and 83 diverge from ridge 80 downwardly below the outer surface of sleeve 52 to from grooves 82 and 84 respectively, on either side of ridge 80. Groove 82 is defined by the surface area 81 of ridge 80 and a projecting edge 85 defined by one end of masking element 72. Groove 84 is defined by the surface area 83 of ridge 80 and an adjacent projecting edge 87 on the outer surface of sleeve 52.

In the position shown in FIG. 3, ball 76 is resting in groove 84 and is biased in that position against surface area 83 by spring 78. Spring 78 can be a cantilever spring mounted on a frame (not shown). As bat 58 is manually engaged and operated to rotate sleeve 52 around axis 57 in the direction of arrow 86 in FIG. 3, ball 76 is rotated by the movement of area 83 under it. The ball 76 rotates without being displaced laterally or vertically. As ball 76 rotates, ridge 80 moves under the ball such that when rotation stops the ball 76 will be at rest in groove 82. Spring 78 will exert a force against ball 76 so as to then bias it against the surface area 81. As can be seen in FIG. 3, when ball 76 is at rest in groove 84, cell 26 will be illuminated through slot 56 which is directly opposite the cell in that position. When sleeve 52 is rotated so that ball 76 comes to rest in groove 82, the cell 26 will no longer be illuminated since the light-opaque portion of sleeve 52, not slot 56, will be directly opposite the cell. Detent mechanism 74 is one of any number of such designs which may be utilized to provide a positive-action, two position detent mechanism.

FIG. 6 demonstrates the importance of making bat 58 of greatest dimension at its distal end 62 furthest from the axis 57 in a circumferential direction about the axis 57. Assuming a very thin bat 58 represented by line 90, when the sleeve 52 is rotated so that it is moved from one of its positions to the other, the bat represented by line 90 will rotate through an angle of rotation of, for example, 30° to line 92. However, by making bat 58 widest at its distal end 62, rotation of sleeve 52 by operation of bat 58 about the axis of rotation 57 from one position to the other will actually move the outer edges 94 and 96 of bat 58 adjacent the end 62 thereof through a much larger angle of rotation, which in FIG. 6 is shown to be 48°. The advantage derived from the distal end 62 of bat 58 being wider than the rest of bat 58 is that tactile ambiguity is substantially eliminated. Tactile ambiguity can be a serious problem in two-position switches where the angle of rotation is a relatively small acute angle. It is important that merely through the sensory stimulation received from touching or feeling the bat or lever arm without any visual aid, the operator can determine in which position the switch is resting. Without this capability as provided in the present invention by the bat 58, tactile ambiguity might well result between the two positions of switch 50.

While switch 50, as shown in FIGS. 2–6, provides that throughout the larger portion of the angle of rotation of the sleeve 52 about the light source 20, the correspondingly photocell 26 will remain in its dark state, it is clear that an alternative structure can be employed in which the sleeve 52 is formed of a light-transparent plastic and the slot 56 is then replaced by an opaque band provided across the sleeve 52. In such case, the photocell 26 would be in a state of illumination in all angular positions of the sleeve 52 except wherein the opaque band is interposed between the source and the photocell. In all other respects, this alternative switch structure is structurally and operatively the same as that shown in FIGS. 1–6.

Since certain changes may be made in the above apparatus without departing from the scope of the invention herein involved, it is intended that all matter contained in the above

description or shown in the accompanying drawing shall be interpreted in an illustrative and not in a limiting sense.

What is claimed is:

1. A switch structure for changing the level of light upon an electrical impedance from a light source, and being positively held in its operative and inoperative positions by a resiliently biased detent mechanism, said switch structure comprising:

a rotatable sleeve positioned snugly but for sliding rotation around said light source, said sleeve having at least one light-opaque position and one light-transmissive portion;

detent means for providing a first fixed position for said sleeve wherein light from said source may pass through said light-transmissive portion to said impedance, and a second fixed position wherein said light-opaque portion of said sleeve is interposed between the source and the impedance to prevent light from said source from being transmitted to said impedance, said detent means including a ridge substantially parallel to the axis of rotation of said sleeve and formed by the intersection of two surface areas on the outer surface of said sleeve so that said biased detent mechanism can bear against a selected one of said areas for retaining said sleeve in one of said fixed positions;

a masking projection extending radially outwardly in a direction substantially perpendicular to the axis of rotation from the outer surface of said sleeve adjacent the light-transmissive portion of said sleeve for optically isolating the electrical impedance from any optical interference from any adjoining sleeve, and

a lever arm connected to said sleeve, said arm being connected for rotating said sleeve between said fixed positions wherein said sleeve is releasably retained by the bearing of said detent mechanism against the corresponding one of said surface areas.

2. A switch structure as set forth in claim 1 wherein

said sleeve, ridge, masking projection and lever arm are all a single, integrally formed unitary member.

3. A switch structure as set forth in claim 1 wherein

a substantial portion of said sleeve is made of light-opaque material and said light-transmissive portion of said sleeve is a slot in said sleeve parallel to the axis of rotation of said sleeve.

4. A switch structure as set forth in claim 1 wherein

said lever arm is integrally formed with said sleeve, said arm extending substantially perpendicularly to said axis of rotation and being of greatest dimension at its distal end and in the circumferential direction about said axis to substantially eliminate any tactile ambiguity in the lever arm in the two fixed positions of said sleeve.

5. A switch structure as set forth in claim 1 wherein

said sleeve has two side edges each of which lies in a plane substantially perpendicular to the axis of rotation and substantially parallel to one another, the shortest distance between said side edges being greater than the greatest dimension of said lever arm in a direction parallel to the axis of rotation.

6. A switch structure as set forth in claim 1 wherein

said surface areas forming said ridge diverge downwardly from one another below the outer surface of said sleeve.

7. A switch structure as set forth in claim 1 wherein said detent mechanism includes rotatably positioned and positive biasing means including a rotatable ball adapted to be positioned against one of said surface areas and a spring adapted to be positioned against said ball and releasably biasing said ball against said one surface area, said ball being adapted for rotation by the movement of said surface area against which said ball is selectively biased when the lever arm is manually engaged to rotate said sleeve to said other fixed position whereby said ball rotates to become positively and releasably biased against said other surface area.

8. A switch structure for changing the level of light upon an electrical impedance from an elongated light source and being positively held in its operative and inoperative positions by a resiliently biased detent mechanism, said switch structure comprising:

a rotatable sleeve positioned snugly but for sliding rotation around said elongated light source, said sleeve having at least one light-opaque portion and one light-transmissive portion, a substantial portion of said sleeve being made of light-opaque material and said light-transmissive portion of said sleeve being a slot in said sleeve parallel to the axis of rotation of said sleeve;

detent means for providing a first fixed position for said sleeve, wherein light from said source may pass through said light-transmissive portion to said impedance, and a second fixed position wherein said light-opaque portion of said sleeve is interposed between the source and the impedance to prevent light from said source from being transmitted to said impedance, said detent means including a ridge substantially parallel to the axis of rotation of said sleeve and formed by the intersection of two surface areas on the outer surface of said sleeve so that said biased detent mechanism can bear against a selected one of said areas for retaining said sleeve in one of said fixed positions;

a masking projection extending radially outwardly in a direction substantially perpendicularly to the axis of rotation from the outer surface of said sleeve adjacent the light-transmissive portion of said sleeve, for electrically isolating the electrical impedance from any optical interference from any adjoining sleeve; and

a lever arm connected to said sleeve, said arm being connected for rotating said sleeve between said fixed positions wherein said sleeve is releasably retained by the bearing of said mechanism against the corresponding one of said surface areas, said lever arm being integrally formed with said sleeve, said arm extending substantially perpendicularly to said axis of rotation and being of greatest dimension at its distal end and in the circumferential direction about said axis to substantially eliminate any tactile ambiguity in the lever arm in the two fixed positions of said sleeve.

9. A switch structure as set forth in claim 8 wherein

said surface areas forming said ridge diverge downwardly from one another below the outer surface of said sleeve.

10. A switch structure as set forth in claim 9 wherein said detent mechanism includes rotatably positioned and positive biasing means including a rotatable ball adapted to be positioned against one of said surface areas and a spring adapted to be positioned against said ball and releasably biasing said ball against said one surface area, said ball being adapted for rotation by the movement of said surface area against which said ball is selectively biased when the lever arm is manually engaged to rotate said sleeve to said other fixed position whereby said ball rotates to become positively and releasably biased against said other surface area.

11. A switch structure as set forth in claim 10 wherein said sleeve has two side edges each of which lies in a plane perpendicular to the axis of rotation and parallel to one another, the shortest distance between said side edges being greater than the greatest dimension of said lever arm in a direction parallel to the axis of rotation.