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Menard et al.

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[54] **ROTARY SWITCH ASSEMBLY WITH ADJUSTABLE PROGRAMMING LIMIT MECHANISM**

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[52] **U.S. Cl.**.....**200/11 R**, 200/11 DA, 200/17 R

[51] **Int. Cl.**.....**H01h 21/78**

[58] **Field of Search**.....200/8 R, 11 J, 11 TW, 200/14, 17 R, 166 PC, 11 R, 11 DA

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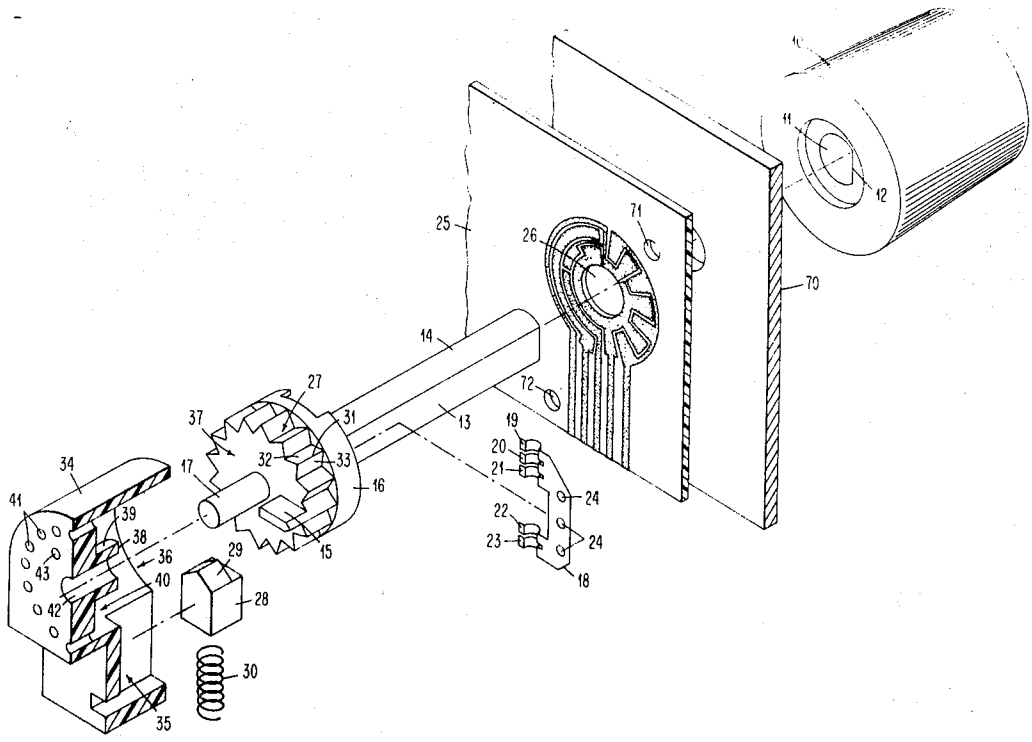
[57] **ABSTRACT**

A multifunction switch selectively providing a multiposition rotary, a multiposition toggle, or a momentary toggle switch function. A switch rotor carries a movable switch member. A detent means cooperates with the rotor and establishes a plurality of stable rotor positions and intermediate unstable rotor positions. A selectively changeable switch function program member selectively limits movement of the rotor relative to its stable and unstable positions in a manner to achieve the desired switch function.

20 Claims, 5 Drawing Figures



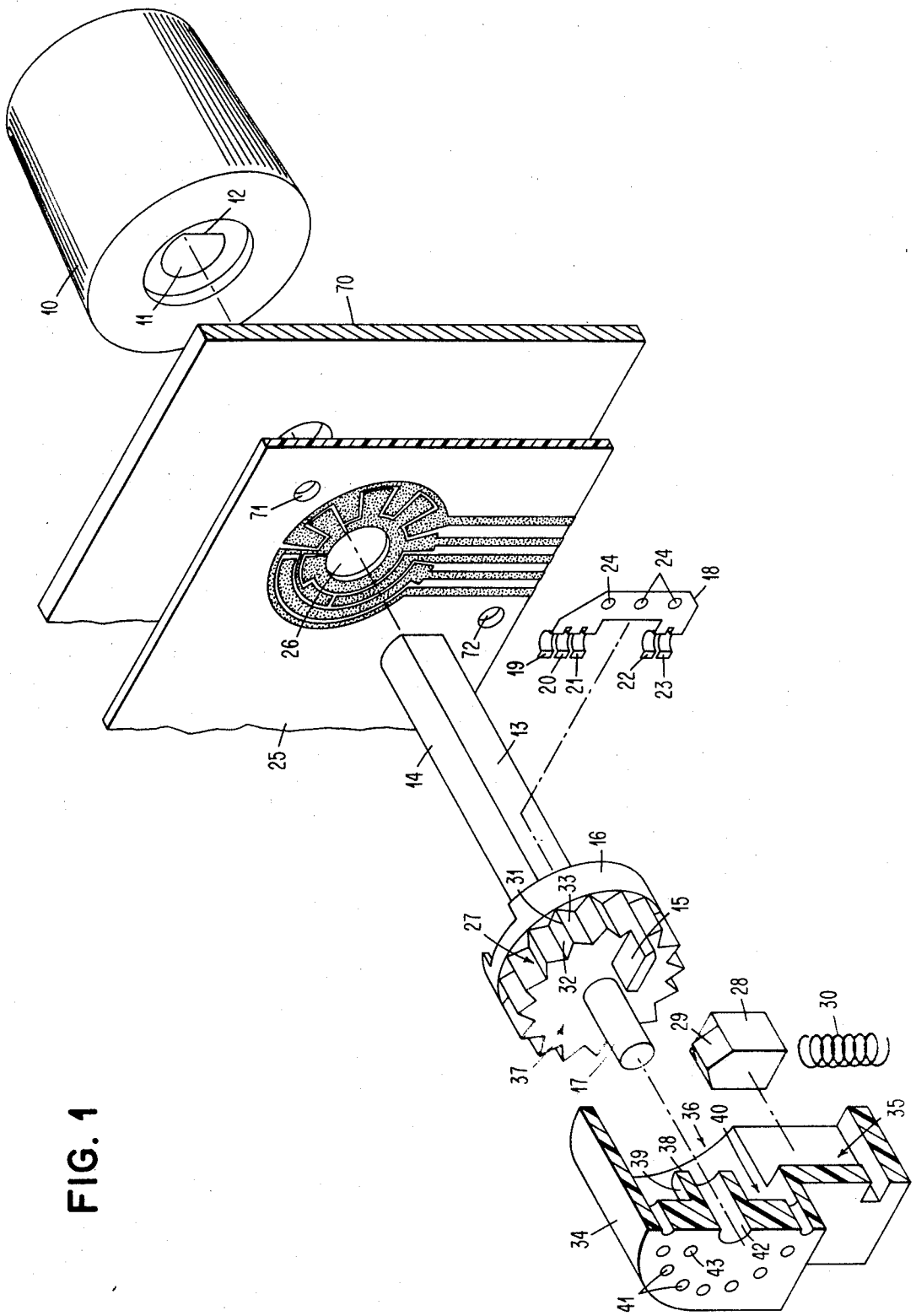

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FIG. 1

FIG. 2

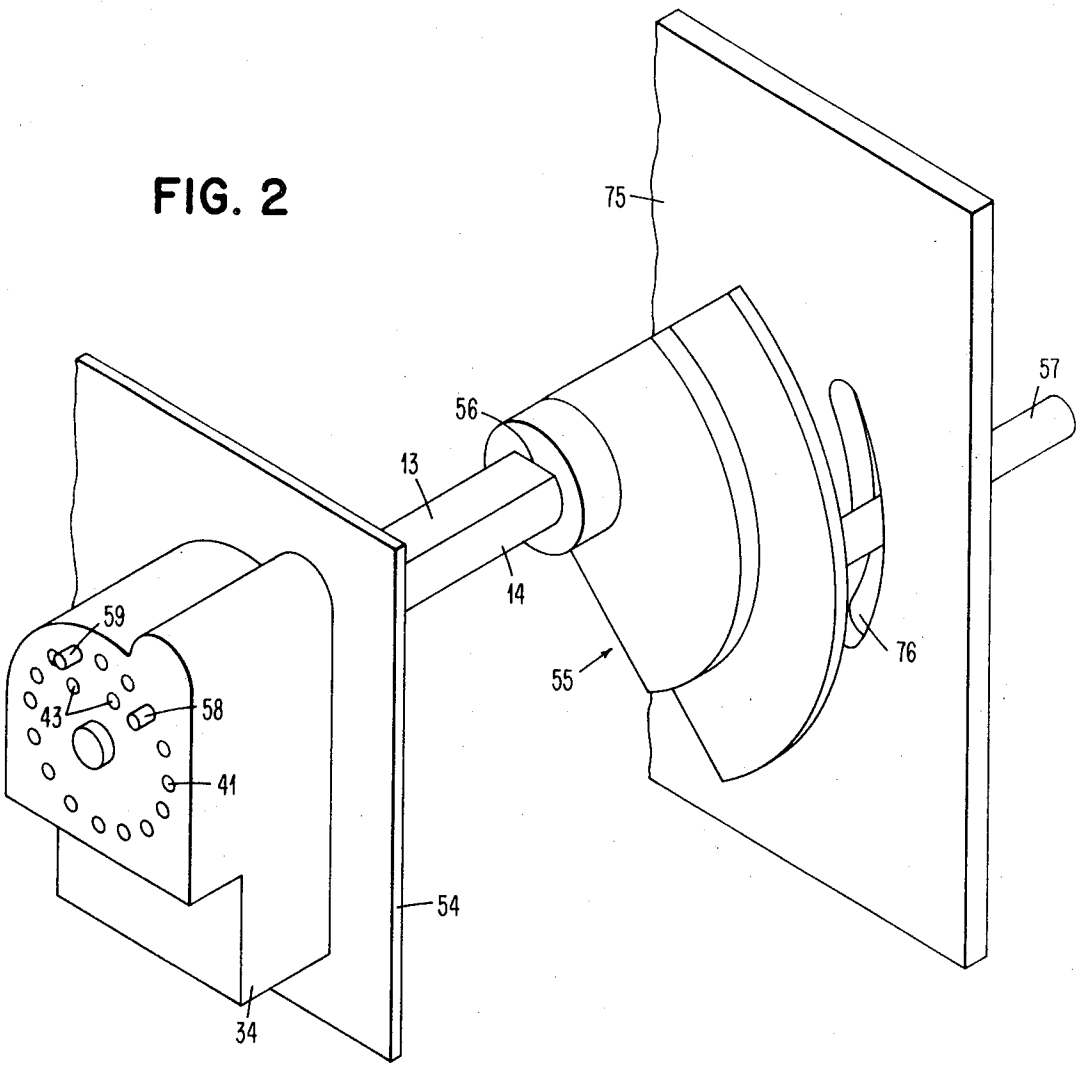
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FIG. 3

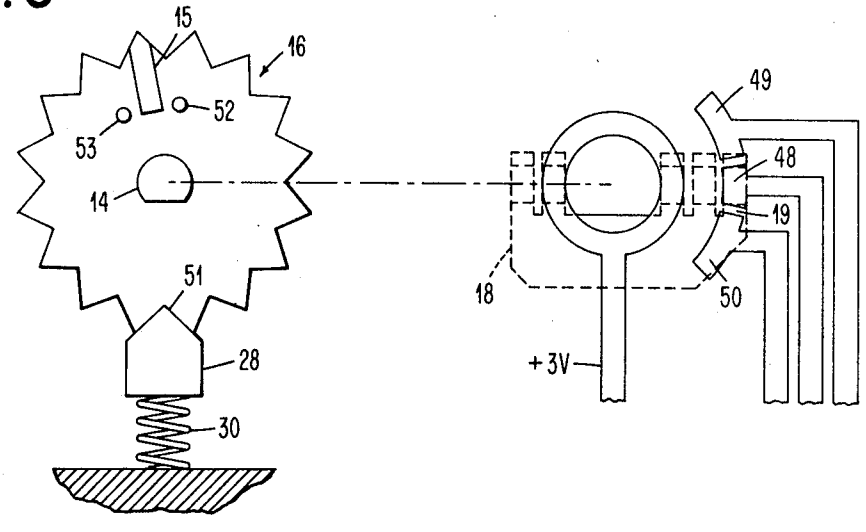
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FIG. 4

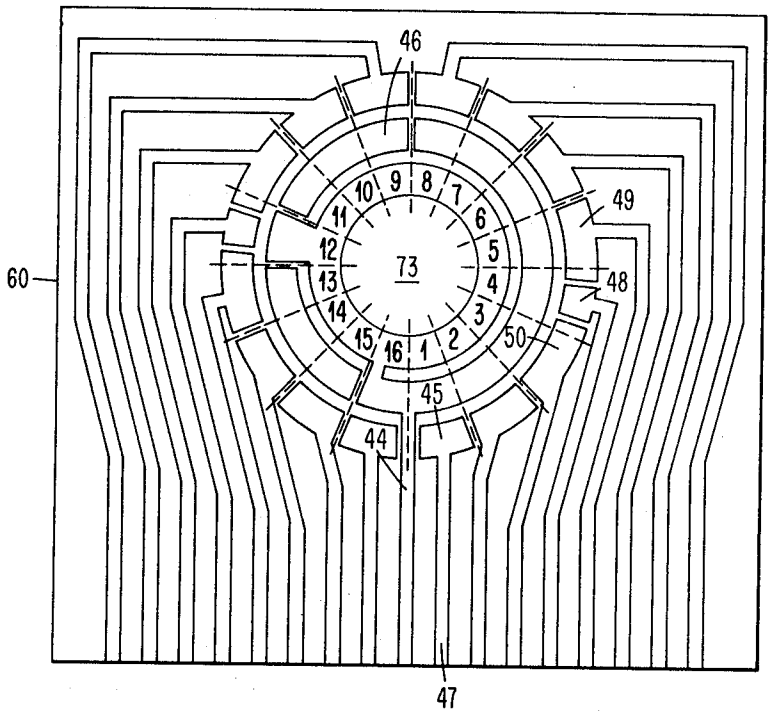
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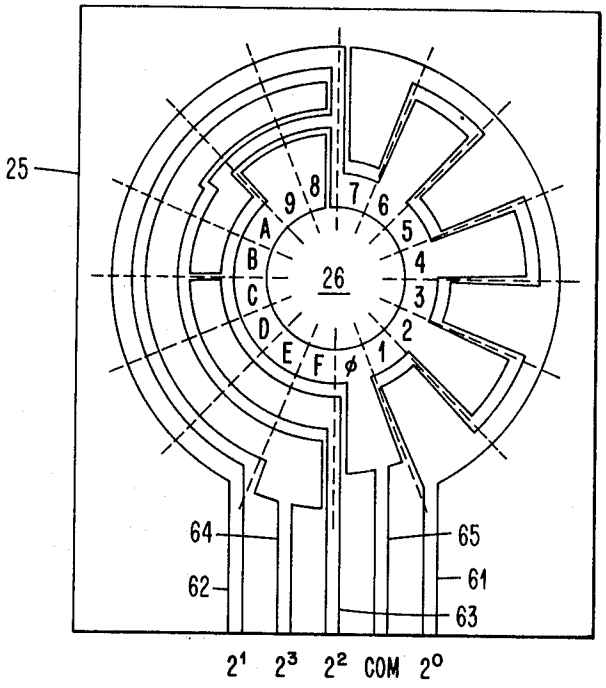
FIG. 5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ROTARY SWITCH ASSEMBLY WITH ADJUSTABLE PROGRAMMING LIMIT MECHANISM

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to the field of electrical circuit makers and breakers, and specifically to a switch having pivoted or rotary contacts which are carried by a rotating mechanism, wherein adjustable or programmable means limits rotation of the mechanism to accomplish different desired switch functions.

The prior art discloses switches of this general type wherein rotation of a switch shaft is selectively limited to two-or-more stable positions in accordance with the manual adjustment of a movable member.

The prior art also discloses switches which selectively provide stable and/or unstable switch positions by the selective use of interchangeable camcarrying parts whose cams are designed to accomplish the desired switch function.

The switch of the present invention is selectively programmable to provide a multiposition rotary, a multiposition toggle or a momentary toggle switch function. In addition, special decode functions, such as hexadecimal-to-binary, may be provided by selective design of a stationary printed circuit switch member.

A movable, brush-like, switch member cooperates with the printed circuit member and is attached to a rotor, to rotate therewith. The rotor carries, for example, 16 notches for hex-to-decimal conversion. These notches are circumferentially equally spaced about the rotor axis. Adjacent notches are separated by a ridge formed by the line-intersection of the oppositely sloped sides of adjacent notches. A spring-biased wedge-like member cooperates with these notches to define a detent means. This detent means establishes 16 stable rotor positions when the wedge is seated in a notch, and establishes unstable rotor positions when not seated.

The rotor also carries an extending flag or tab which coincides in circumferential position with one of the above-mentioned ridges.

The rotor is mounted for bidirectional rotation within a housing having, for example, 16 selectively usable stop means in the form of 16 holes. Each hole is critically located so that when the rotor is in one of its 16 stable positions, the rotor's flag is in substantial coincidence with one of these holes. Stop pins may be inserted in spaced holes to program the switch for less than 360° rotation and for from two to 16 stable positions.

The rotor's housing also includes additional holes critically located so that when the rotor is in one of its unstable positions, with the spring-biased wedge in substantial coincidence with one of the above-mentioned ridges, the rotor's flag is in substantial coincidence with the one of these two holes.

Stop pins may be inserted in these last-mentioned holes to program the switch for one or more stable intermediate positions and unstable positions, one or two at either or both extremities of movement.

For hex-to-binary switching, the above-mentioned example of stable rotor positions is utilized with a printed circuit member having four circuit patterns cooperating with movable switch brushes carried by the rotor. A fifth circuit pattern provides electrical input to

facilitate the binary "0" and "1" four-digit output for each of the 16 hexadecimal positions.

Another printed circuit pattern provides a conventional multi-position output, for example 16-position, such that a separate output terminal is active for each stable rotor position. In addition, this printed circuit member includes circuit patterns providing an output when the rotor is in the above-mentioned unstable positions.

The foregoing and other features and advantages of the invention will be apparent from the following more particular description of preferred embodiments of the invention, as illustrated in the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an exploded view of the multi-function switch of the present invention, showing a printed circuit board of the type used for a hex-to-decimal multiposition rotary switch function,

FIG. 2 shows the switch of FIG. 1 mounted on the printed circuit board, a toggle actuator attached to the rotor shaft, and stop pins inserted to provide a three-position toggle switch function,

FIG. 3 diagrammatically shows the switch programming member set for a two-position momentary toggle switch function,

FIG. 4 shows a printed circuit board of the type used for a multi-position rotary, a toggle, or a momentary toggle switch function, and

FIG. 5 shows the FIG. 1 printed circuit board for a hexadecimal-to-binary rotary switch function.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The FIG. 1 exploded view of the multi-function switch of the present invention shows the switch programmed to provide a multi-position continuous rotary switch function, namely a rotary switch having 16 stable positions about the 360°-rotation of knob actuator **10.** This knob includes a centrally located mounting opening **11,** having a positioning surface **12** adapted to cooperate with corresponding surface **13** of rotor shaft **14.** Surface **13** is oriented in a known manner to extending flag **15** carried by rotor **16.**

Shafts **14** and **17** establish the center of rotation of rotor **16.** Shaft **14** terminates at a relatively flat disk shaped surface of rotor **16,** not shown. Rotor **16** is preferably formed of an electrically nonconductive material, for example a form of plastic. This surface mounts metallic movable switch member **18** having five flexible brushes **19–23** formed integrally therewith. Switch member **18** may take many forms. For example, member **18** could be split for a different switching application, causing brushes **22** and **23** to be common and brushes **19, 20,** and **21** to be common, but isolated from brushes **22** and **23.** This switch member is positioned in known alignment with stop **15** and surface **13,** and thereby with knob **10,** by means of three mounting openings **24.**

Wipers **19–23** are adapted to cooperate with three concentric electrically conductive circuit patterns formed on nonconductive planar printed circuit board **25.** Brushes **21** and **22** cooperate with the innermost circuit pattern, that is, the circuit pattern immediately adjacent opening **26** adapted to freely receive shaft **14.** Wipers **20** and **23** cooperate with the intermediate cir-

cuit pattern. Wiper **19** is the only wiper cooperating with the outermost circuit pattern.

The structure of FIG. **1** is normally associated with an instrument panel **70.** This panel carries visual indicia cooperating with means such as an indicating pointer (not shown) carried by knob **10,** to visually indicate the position of rotor **16.**

Rotor **16** is constructed and arranged such that detent or indexing means establish a plurality of stable rotor positions, with unstable rotor positions intermediate adjacent stable rotor positions. Specifically, rotor **16** carries a movable portion of the detent means, this movable portion consisting of a series of notches about the circumference of the rotor. More specifically, in the embodiment shown, 16 similar shaped notches **27** are equally spaced about the circumference of the rotor. The stationary portion of the detent means is spring biased pawl **28** having a surface **29** conforming to the surface of notches **27.** This pawl is biased toward rotor **16** by spring **30** and, as knob **10** is rotated, stable knob positions are defined by surface **29** cooperating with a notch **27.** The unstable rotor positions are defined by the line-like ridges **31** between adjacent notches, these ridges being formed by the joining of the opposite sloping walls **32** and **33** of adjacent notches. The predetermined orientation of rotor flag **16** places the flag in alignment with one of these ridges, as shown in FIG. **1.**

The switch function program member, whereby a plurality of switch programs may be selectively provided, is included within housing **34.** This housing includes an elongated channel **35** which receives pawl **28** and spring **30** and facilitates radial movement of the pawl relative to rotor **16.** The housing also includes a circular cavity **36** which freely receives rotor **16,** with the flat surface **37** of the rotor engaging the top portion **38** of boss **39,** and with rotor flag **15** freely riding in doughnut shaped cavity **40.**

The switch function program member includes selectable stop means cooperating with the rotor, and particularly with rotor flag **15,** to limit the rotation thereof, in accordance with the selected switch function. More specifically, flag **15** cooperates with stationary stop pins which are adapted to be inserted in openings **41.** One or more pins extend into cavity **40,** into interferring relationship with flag **15.** The orientation of pawl **28** relative to openings **41** is such that flag **15** is immediately adjacent an opening **41** for each of the stable positions of the rotor. Thus, for the example shown, housing **34** includes 16 openings **41** equally spaced about the center of rotation of rotor **16,** as established by shaft opening **42.** As will be discussed, housing **34** includes further type openings **43** to facilitate selection of a momentary toggle switch function.

Housing **34** carries two extending positioning posts, not shown, which cooperate with openings **71** and **72** in circuit board **25,** to thereby align, fasten, and mount the housing and its switch function program member i a known manner or registry to board **25.**

Referring now to FIG. **4,** this figure is a view of a printed circuit board **60** which may be used in the manner of board **25** shown in FIG. **1.** The printed circuit pattern of board **60** facilitates a multi-position rotary switch function providing from two to 16 stable rotary switch positions, or alternatively, provides toggle switch functions, and/or including a momentary toggle function. In this figure, the inner section of the circuit pattern, disposed immediately adjacent opening **73,** has been numbered 1 through 16, this corresponding to the 16 stable positions of rotor **16,** FIG. **1.** A circuit pattern identified by reference numeral **44** is connected to a reference source of electrical potential. The circuit pattern of board **60** provides selective connection of this reference potential to a different one of the 16 output conductors of circuit board **25** for each of the 16 distinct positions of rotor **16.** For example, in the "1" position of the rotor, wiper **19** (FIG. **1**) cooperates with contact segment **45**; wipers **20, 21** and **22** cooperate with contact segment **44**; and wiper **23** cooperates with contact segment **46.** Thus, contact segment **45** and output conductor **47** are connected to the reference. Contact segment **46** is not used and serves the function of providing a riding surface for wiper **23.**

In like manner, it is apparent that a separate one of the output conductors is connected to reference potential for each of the 16 stable switch positions.

Referring now to the momentary switch function achieved by the present invention, it is noted that segment **48** associated with the "4" position of the rotor covers a circumferential arc that is smaller than adjacent contact segments **49** and **50.** When the rotor is in the "4" stable position, contact segment **48** is connected to reference potential. Likewise, when the rotor is in either the "3" or the "5" position, segments **50** and **49,** respectively, are connected to reference potential. However, as the rotor is moved from the "4" position toward either the "3" or the "5" position, wiper **19** of the movable switch member engages contact segment **50** or **49** while the rotor is still in an unstable position.

With reference to FIG. **3,** rotor **16** is shown in the "4" stable position wherein wiper **19** engages contact segment **48.** In this position, pawl **28** engages the bottom **51** of a notch. When the rotor is moved toward an adjacent position, wiper **19** engages the adjacent segment **49** or **50** before pawl **28** leaves this notch. For the momentary two-position switch function illustrated, housing **34** (FIG. **1**) provides two openings **43** which receive pins **52** and **53** (FIG. **3**). These pins are positioned to stop rotation of rotor **16** while the rotor is in unstable positions on opposite sides of the stable position shown in FIG. **3.** Thus, rotor **16** may be manually moved to one of two unstable positions, on opposite sides of stable "4" position to thereby connect contact segments **49** or **50** to reference potential. Release of the manual force holding the knob in the unstable position causes the rotor to assume the stable position shown in FIG. **3** wherein contact segment **48** again connects to the reference potential.

As will be appreciated by those of ordinary skill in the art, the switch function program member carried by housing **34** can be constructed and arranged to provide a range of stable rotor positions, with an unstable position at one end of the range of movement, or at both ends of the range of movement.

As is apparent from FIG. **4,** circuit board **60** is constructed to selectively provide a second momentary switch function at the "11," "12" and "13" switch positions.

Referring to FIG. **2,** in this figure the multi-function switch of the present invention is shown mounted on printed circuit board **54** and toggle switch crank arm **55** is mounted on shaft **14.** Board **54** may carry a circuit pattern such as that disclosed in FIG. **4,** in which case the momentary switch function is a toggle type func-

tion. Here again, the mounting opening provided in the crank arm includes a reference surface **56** to orient the arm in a known manner to shaft **14** and to the surface **13** carried by the shaft. The crank arm includes toggle actuator or handle **57** which is displaced from the axis of rotation of the rotor, thus, amplifying the rotor movement. This arm assembly is used to selectively provide a multi-position toggle switch function or a momentary toggle switch function. The arrangement shown in FIG. **2** cooperates with instrument panel **75** having a generally vertically oriented slot **76** through which handle **57** extends. As viewed from the panel side, handle **57** appears to be a normal toggle actuator, although it in fact moves through a slight arc. For the switch program selected in FIG. **2**, pins **58** and **59** have been inserted in two of the openings **41** carried by housing **34** so as to provide a three-stable-position toggle switch function. Had the pins been placed in openings **43**, the switch function selected would have been momentary toggle, with a center stable position and an unstable position on each side of this center position, as shown in FIG. **3**.

As will be appreciated, slot **76** may be critically sized to limit movement of rotor **16**, in the manner of pins **58** and **59** (FIG. **2**) or **52** and **53** (FIG. **3**), above described.

With reference to FIG. **5**, this figure shows printed circuit board **25** of FIG. **1** which carries a circuit pattern to facilitate the hexadecimal-to-binary decode wherein the 16 rotor positions, identified by the hexadecimal indicia **0** through F, provide binary outputs on conductors **61–64** in increasing powers of 2. The presence of a binary "1" is indicated by the connection of an output conductor **61–64** to common conductor **65**. By way of explanation, and selecting the "3" rotor position, wipers **21** and **22** (FIG. **1**) engage the contact segment associated with common conductor **65**; wiper **23** engages the contact segment associated with the least significant power of 2 conductor **61**; and wiper **19** engages the contact segment associated with the next significant power of 2 conductor **62**. Thus, for the hexadecimal position "3" of the switch, the output provided on conductor **61–64** is the binary output 0011, namely, the binary equivalent of hexadecimal "3."

By way of the above description, the manner in process of making and using the present invention has been described with reference to specific switch functions and specific printed circuit board patterns. However, as will be appreciated by those of skill in the art to which the present invention pertains, the use of the present invention can be extended to a variety of circuit patterns, movable brush configurations, and stable and/or unstable switch positions as may be related to a particular desired switch function.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A multi-function switch, comprising:

a stationary switch contact member,

a movable switch contact member adapted to cooperate with said stationary contact member,

a rotor connected to said movable switch member, the position of said rotor controlling the position of said movable switch member,

detent means having a stationary member and a member carried by said rotor, said detent means being constructed and arranged to define a plurality of spaced mechanically stable rotor positions, adjacent stable rotor positions being separated only by an unstable rotor position, and

a stationary switch function program member having a plurality of selectable means selectively operable to limit the range of the rotor's movement to mechanically stable positions to thereby provide multi-stable-position switch programs equal to or less than said plurality of stable rotor positions, or to limit the rotor's movement such that at least one end of said range of movement includes a mechanically unstable position to thereby provide momentary-unstable-position switch programs.

2. A multi-function switch as defined in claim **1** wherein said switch function program member includes selectable stationary stop means cooperating with said rotor to limit the range of rotation thereof.

3. A multi-function switch as defined in claim **2** wherein said stop means includes an extending flag carried by said rotor and selectively positionable stationary stops cooperating with said flag to limit at least one end of the rotor's range of movement to a stable position or to an unstable position, in accordance with the selected switch function.

4. A multi-function switch as defined in claim **3** including a crank-arm adapted to be selectively attached to said rotor in a known orientation to said flag and including a handle disposed from the axis of rotation of said rotor and extending generally parallel thereto to provide a multi-stable-position switch program and/or a momentary-unstable switch program.

5. A multi-function switch as defined in claim **3** including a knob adapted to be selectively attached to said rotor in a known orientation to said flag to provide a multi-stable-position rotary switch program and/or a momentary-unstable rotary switch program.

6. A multi-function switch as defined in claim **1** wherein said stationary switch contact member is formed on a nonconductive planar surface including electrically conductive circuit patterns, including a hollow housing mounted on said planar surface, and a rotary shaft supported by said housing and supporting said rotor within said housing with said movable switch contact member in electrical contact with said circuit patterns.

7. A multi-function switch as defined in claim **6** wherein the stationary member of said detent means is carried by said housing and is positioned relative to said circuit patterns so as to establish a predetermined switching relationship between said movable switch contact member and said circuit patterns when said rotor is in said stable positions and when said rotor is in one unstable position.

8. A multi-function switch as defined in claim **7** wherein said switch function program member includes a flag carried by said rotor, and wherein said plurality of selectable means includes stationary stop means carried by said housing and selectively movable into the path of said flag to restrict at least one end of the rotor's range of movement to a stable position and/or to said one unstable position.

9. A multi-function switch as defined in claim 8 including a crank arm attached to said shaft by means of mating positioning surfaces, and a switch handle disposed from the axis of rotation of said rotor and extending generally parallel to said axis to provide a multi-stable-position switch program and/or a momentary-unstable-position switch program.

10. A multi-function switch as defined in claim 8 including a knob actuator attached to said shaft by means of mating positioning surfaces to provide a multi-stable-position rotary switch program and/or a momentary-unstable-position rotary switch program.

11. A programmable multi-function switch comprising:

a printed circuit board carrying an annular circuit pattern,

a housing mounted on said circuit board in known alignment with said circuit pattern,

a rotor mounted in said housing for rotation relative to said circuit pattern,

movable switch contacts carried by said rotor and engaging said circuit pattern in switching relationship,

indexing means associated with said housing and said rotor to establish a plurality of discrete mechanically stable rotor positions for a complete revolution of said rotor, adjacent stable positions being separated only by an unstable rotor position,

said circuit pattern being formed to provide a unique switch configuration for at least certain of said stable rotor positions, and additionally being formed to provide a unique switch configuration for at least one of said unstable rotor positions, and

manually adjustable program means effective to limit the range of rotation of said rotor such that each end of said range includes a stable rotor position to provide a multi-position switch function, and/or to limit rotation of said rotor such that at least one end of said range includes said one unstable rotor position to provide a momentary switch function.

12. A multi-function switch as defined in claim 11 including positioning means cooperating with said printed circuit board and said housing to produce known registry between said circuit pattern and said stable and unstable rotor positions.

13. A multi-function switch as defined in claim 12 wherein said indexing means includes spring-biased detent means operable between said rotor and said housing, a portion of said detent means including a series of notches establishing said stable rotor positions, said unstable rotor positions being defined by line-like ridges between adjacent notches as formed by the joining of the opposite sloping walls of adjacent notches.

14. A multi-function switch as defined in claim 13 wherein said program means includes an extending flag carried by said rotor, and manually positionable stops associated with said housing effective to limit the ends of the range of rotation of said rotor by virtue of engagement with said flag.

15. A multi-function switch as defined in claim 13 including manually actuable means for selective use with said rotor to selectively provide rotary knob switch functions or pivotal-handle switch functions.

16. A multi-function switch as defined in claim 12 wherein said annular circuit pattern includes a plurality of unique configurations disposed about a 360° annular circuit pattern, and wherein said indexing means establishes a like plurality of stable rotor positions in registry with the unique configurations of said circuit pattern.

17. A multi-function switch as defined in claim 16 wherein said indexing means includes a series of discrete notches formed about the 360° annular circumference of said rotor, one for each of said stable rotor positions, and a spring biased member mounted at a fixed position on said housing and cooperating with said notches to establish said stable rotor positions.

18. A multi-function switch as defined in claim 17 wherein said program means includes an extending flag carried by said rotor in substantial alignment with the line-like ridge formed by the joining of the opposite sloping walls of two adjacent notches, and a ring of holes formed in said housing adapted to receive one or more stop-pins to establish the ends of the range of rotor rotation to stable positions by virtue of engagement with said flag, and at least one additional hole formed in said housing adapted to receive a stop pin to establish at least one end of the range of rotor rotation to include an unstable position by virtue of engagement with said flag as said spring biased member engages the wall of a notch adjacent the ridge which joins said wall to the wall of the adjacent notch.

19. A multi-function switch as defined in claim 18 wherein said program means includes two additional holes formed in said housing adapted to receive stop pins to establish a range of rotor rotation which includes a stable mid-position and two unstable end positions, one on each side of said mid-position, and wherein said annular circuit pattern includes a short arcuate conductive segment corresponding to said mid-position and a relatively long arcuate conductive segment corresponding to each of said two unstable positions.

20. A multi-function switch as defined in claim 19 including a manually rotatable knob selectively usable with said rotor for rotation about the axis of rotation of said rotor when said program means is set to allow substantial rotation of said rotor, to thereby provide rotary-knob switch functions, and a manually actuable crank arm, including a handle disposed from the axis of rotation of said rotor, extending generally parallel thereto, and selectively usable with said rotor when said program means is set to allow rotation through no more than three positions of said rotor, to thereby provide pivotal-handle switch functions.

* * * * *