

[54] **PANEL DISPLAY SWITCH**

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200/167

[51] Int. Cl. **H01h 19/58**

[58] Field of Search 200/6 B, 6 BB, 11 A,
200/11 D, 14, 17 R, 18

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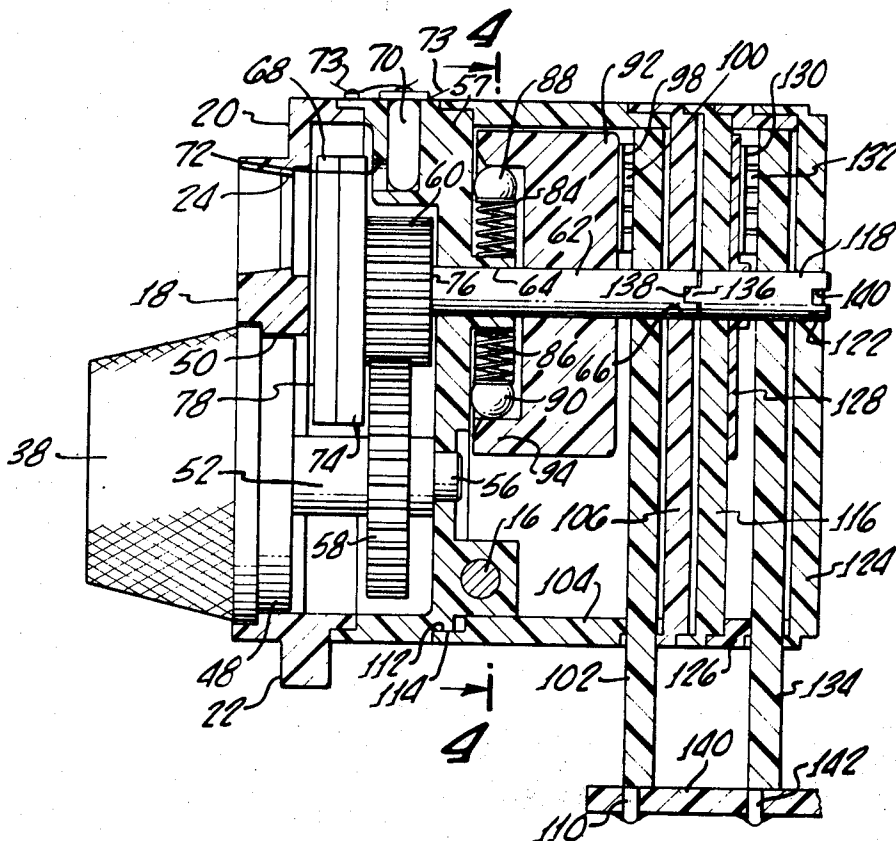
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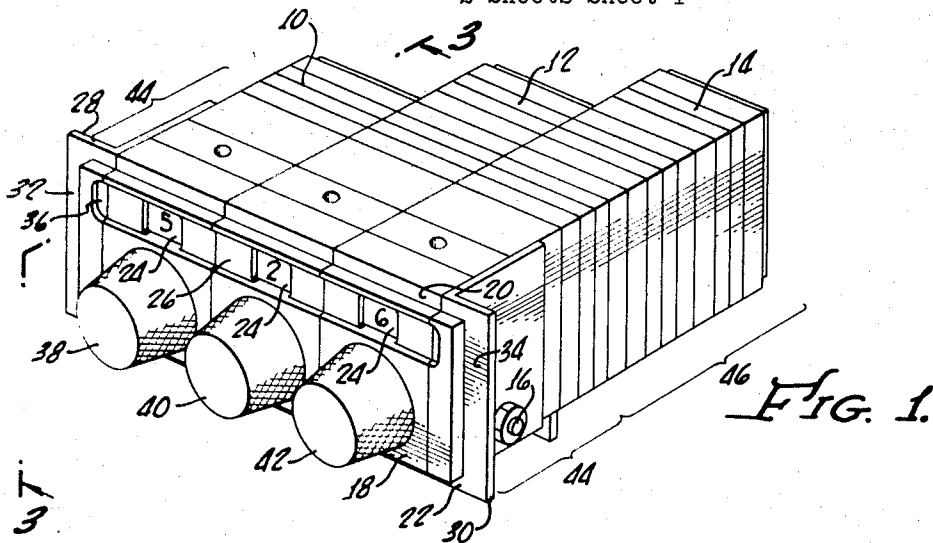
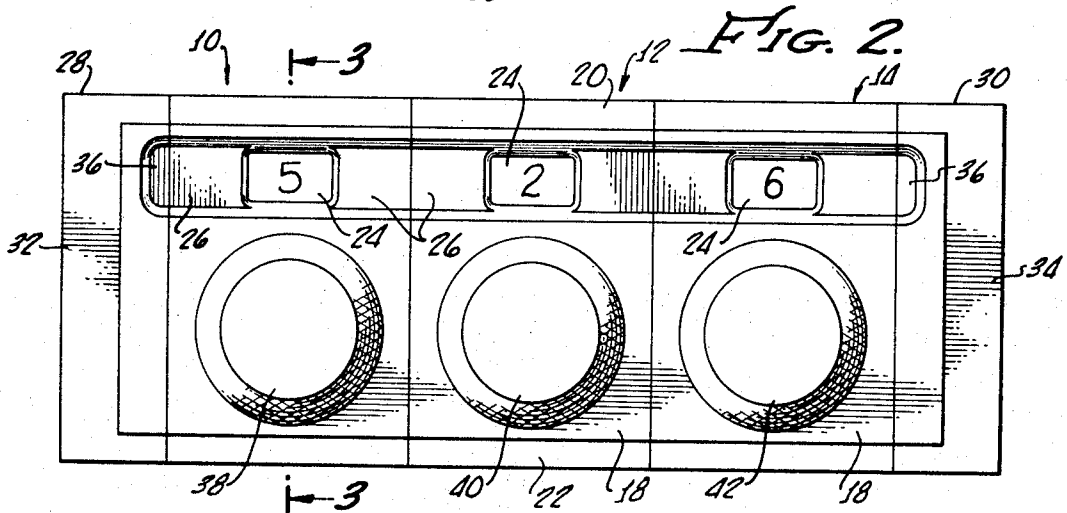
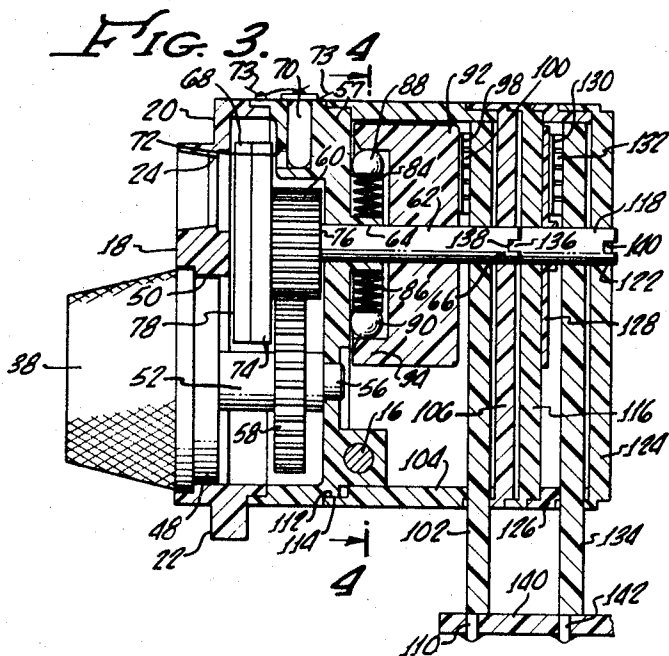
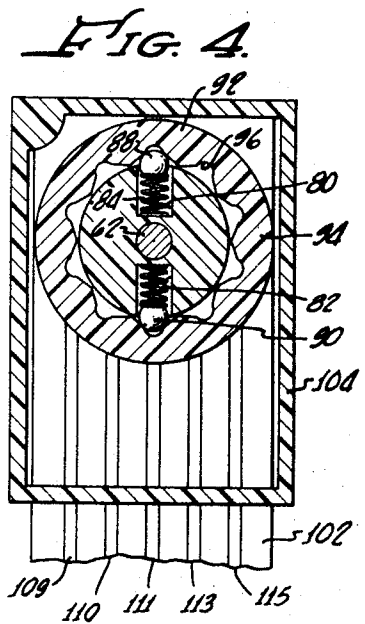
[57] **ABSTRACT**

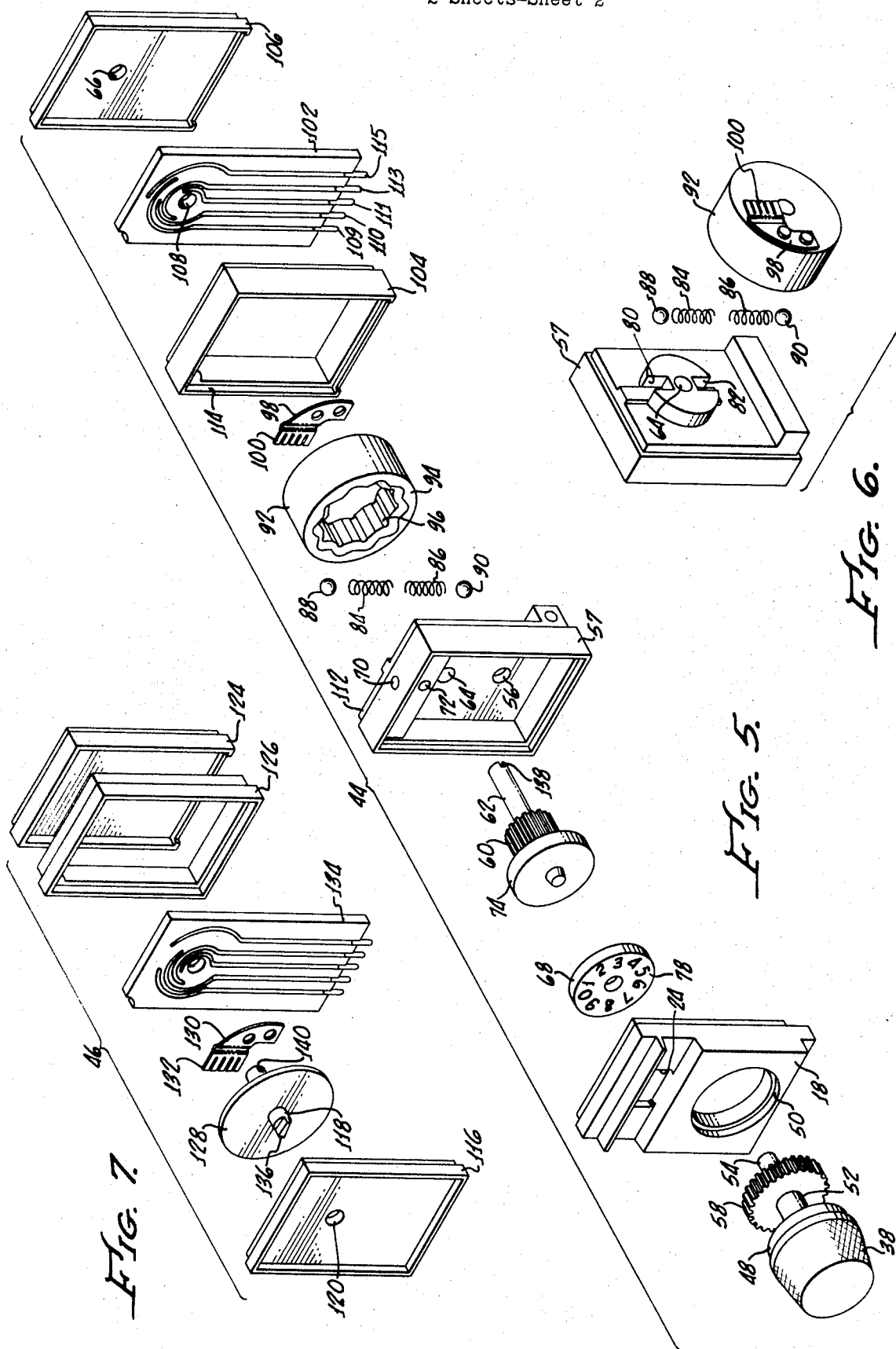
A sealed switch assembly is disclosed which includes gear reduction between rotary switching elements and a front mounted rotary knob and which allows mounting of the completely assembled switch, as a unit, in a display panel. The switch is modular in construction and permits the addition of a selective plurality of sealed switching elements to the rear of the main switch module so that a frontal display of switch position is not distorted when switches with a variety of different switch element combinations are ganged for an in-line display.

17 Claims, 7 Drawing Figures



2 Sheets-Sheet 1





PANEL DISPLAY SWITCH

BACKGROUND OF THE INVENTION

This invention applies to panel mounted switches, and, more particularly, to switches which include a frontal display of switch position and are designed for installation in side-by-side arrays to provide an in-line display of the positions of a plurality of such switches. Such side-by-side arrays, for example, are used for displaying multi-digit numbers, wherein the value of each digit determines the setting of one of the switches.

In the past it has been found particularly advantageous to provide switches which, through an aperture or through the use of a face mounted bezel, frontally indicate the position of the switch at any particular time. The switches designed to accomplish this purpose fall into three general prior art categories: rotary switches, thumb wheel switches and lever action switches. Each of these switches, while producing the desired frontal display, includes inherent disabilities which make the use of any one, particularly in side-by-side arrays, a poor compromise.

Both the lever actuated and thumb wheel switches include a primary shaft which is rotated by the thumb wheel or lever about a horizontal axis which is parallel to the front face of the switch assembly. Since the degree of rotation which can be accomplished through the actuation of the lever in a lever switch is limited to less than 180°, it has been common to incorporate a gear drive in lever actuated switches in order to produce a greater rotation of a secondary shaft in response to actuation of the lever. This secondary shaft, however, has commonly been parallel to the primary shaft, that is, parallel to the front face of the switch assembly. In each of the lever actuated and thumb wheel switches, therefore, the switching elements, which are commonly in the form of printed circuit boards, are mounted in a plane which is perpendicular to the actuating shafts and parallel to one side of the switch assembly. If it is desired to add additional printed circuit boards for actuation by the driving shafts, these circuit boards must be stacked behind the initial switching element and must therefore also be parallel to one side of the switch assembly. The addition of such switching elements thus requires that the lateral dimension of the overall switch assemblies be expanded in order to house the additional circuit boards. It is obvious, therefore, that when such switch assemblies are incorporated in a side-by-side array, the increased lateral dimension of any one of the switches will increase the spacing between the display on that switch and one of the switches alongside. It is therefore impossible in such switch assemblies to add a selective indeterminate number of switching elements to each of the switches in a side-by-side display and still maintain in-line uniformity of the display so that the switch combination is easily monitored as a multi-digit number by an operator.

Rotary switches of the prior art, on the other hand, use a frontal knob to drive a switch axle which is perpendicular to the front face of the switch assembly. The switching elements, or circuit boards, are therefore mounted in a plane parallel to the rear face of the switch. Such rotary switches therefore allow the addition of an indeterminate number of switch elements to the rear of the switches without a distortion of the in-line frontal display, since such switch elements do not

increase the required lateral spacing between switches. However, rotary switches are inherently difficult to manipulate since each such switch requires a 360° rotation of the switch knob to produce a 360° rotation of the switching elements. Since in-line displays require close lateral spacing of the displayed numerals to facilitate monitoring the switches as a multi-digit number, the knobs for the rotary switches must be extremely close to one another. This close proximity makes the manipulation of an individual knob through 360° a tedious task. For this reason, many equipment manufacturers have discarded rotary switches and utilized thumb wheel and lever action switches for their convenience of manipulation, although this requires a sacrifice of display clarity.

The sealing of switches from foreign matter, such as dust and dirt, presents a continuous problem for switch manufacturers. Although the rotary switches of the prior art require only the extension of a rotary shaft through the front face of the switch assembly, thumb wheel and lever action switches require an elongate slot through which the wheel or lever extends. These switches are therefore extremely difficult to seal. Furthermore, the prior art switches are sealed in a housing which will accommodate the required switching elements. If additional switching elements are added, the housing must be exchanged for one which will accommodate and seal these elements also, or the entire switch must be exchanged for one with additional elements. These limitations severely restrict the adaptability of the prior art switches to a variety of applications.

SUMMARY OF THE INVENTION

The switch of the present invention may be mounted for in-line display and allows the addition of switch elements without distortion of the display. At the same time, the present invention includes a gear drive between a driving shaft, connected to the knob, which is perpendicular to the front face of the switch assembly and a driven shaft, carrying the switching elements, which is parallel to the driving shaft. Since the driven shaft is perpendicular to the front and rear faces of the switch assembly, it facilitates stacking additional switching elements to the rear of the switch assembly so that the lateral dimension of individual switches is not increased regardless of the number of switching elements added. The gear drive between the parallel shafts allows easy manipulation of the switching elements through a full rotation with less than a full rotation of the frontal knob. For example, in the preferred embodiment a 180° rotation of the frontal knob produces a 360° rotation of each of the switching elements stacked to the rear of the switch.

In addition, the present switch is easily sealed since only a rotary shaft extends from the face of the switch assembly. Likewise, the display of each of the switches of the present invention is conveniently placed above or below the actuating knob rather than alongside the knob as is common with thumb wheel and lever actuated switches. With the display so situated, a continuous in-line display is produced which is more easily read by the operator as a unit display since it is not broken by intervening levers or thumb wheels. An additional advantage of this type of display is that the display is not covered by the operator's hand during switch actuation as is common with thumb wheel and lever actuated switches.

An additional feature of the present switch is its modular construction wherein each of the modules is self contained and sealed. Such modular configuration allows the installation of an entire switch including the actuating knob into the front panel of a piece of equipment without the necessity for disassembling the switch during such installation. Likewise each of the switching elements which may be added to the switch are independently sealed and are attached to the primary switching element without the requirement that this primary element be disassembled or that its seal be broken.

These and other features of the present invention are best understood in reference to the following description of the preferred embodiment of this invention and the accompanying drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of three switch assemblies mounted side-by-side for in-line display, each of the switches having a different number of switching elements attached thereto.

FIG. 2 is a front elevation of the switch configuration of FIG. 1.

FIG. 3 is a sectional view taken along lines 3—3 of FIGS. 1 and 2 and showing the elements of one of the switches in the in-line display of FIG. 1.

FIG. 4 is a sectional view taken along lines 4—4 of FIG. 3 showing the detent mechanism of the switch of FIG. 3.

FIG. 5 is an exploded perspective view of one of the primary switching elements of FIG. 1.

FIG. 6 is an exploded perspective view of the detent mechanism of the switch of FIG. 5, shown from the rear; and

FIG. 7 is an exploded view of one of the additional switching elements which may be added to the rear of the primary switching element, a plurality of such additional switching elements being incorporated to the rear of each of the switch assemblies shown in FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring initially to FIG. 1, an in-line array of three switch assemblies 10, 12 and 14 is shown, each individual switch assembly being maintained in side-by-side configuration by fastening means such as a bolt 16 which passes through each of the individual switches 10, 12 and 14. Each of the switches 10, 12 and 14 includes a front face plate 18 which may conveniently be recessed, as at 20 and 22, to provide upper and lower indexing flanges which facilitate mounting the entire switch assembly in the panel of a piece of equipment so that the front face 18 is flush with the front face of the panel. Each of the switches 10, 12 and 14 includes a frontal switch position indicator 24 which is conveniently included in an elongate slot 26 which extends across the width of each of the switches 10, 12 and 14. The switch position indicator 24 comprises an aperture in the front face plate 18 which, for purposes of sealing the switch housing, is covered by a transparent window. This elongate slot 26 lends an appearance of continuity to the switch position indicators 24 so that a single, multi-digit number or display appears at the front of the switch combination. For example, in FIGS. 1 and 2 the number 526 appears on the switch position indicators 24. To further facilitate this appearance of continuity,

a pair of end mounting brackets 28 and 30 is used to provide recessed indexing flanges 32 and 34 for placement of the switch combination in an equipment panel. These brackets 28 and 30 include recesses 36 which attractively terminate the slot 26. At the front of each of the switches 10, 12 and 14 are knobs 38, 40 and 42 which rotate about axes perpendicular to the front face plate 18 to adjust the position of each of the switch assemblies as well as the position indicators 24. Each of the switch assemblies 10, 12 and 14 includes a primary switching element 44 and a different plurality of additional switch assemblies 46, which additional switch assemblies 46 are removably connected to the rear of the primary switch assemblies 44.

Referring now to FIGS. 3, 4, 5 and 6, the structure of each of the primary switch assemblies 44 will be described in detail. The adjustment knob 38 includes a recessed shoulder 48 which is journaled within a mating shoulder 50 of the face plate 18. These mating shoulders 48 and 50 provide both the radial and forward thrust bearing functions for the forward end of a driving axle or shaft 52 which is rigidly attached to the knob 38. The other end of the driving shaft 52 is reduced in diameter, as shown as 54, and journaled within a bore 56 in a detent mounting plate 57 which is rigidly attached to the rear of the face plate 18. The combination of the reduced diameter shaft 54 and bore 56 provides a radial and rear thrust bearing surface for the driving shaft 52. A driving gear 58 is rigidly attached to rotate with the driving shaft 52 and is positioned to mesh with a driven gear 60. The gear ratio between the driving gear 58 and the driven gear 60 is designed to facilitate a complete rotation of the driven gear 60 with only a partial rotation of the knob 38 and its associated driving gear 58. In the preferred embodiment, for example, the gear ratio between the driving gear 58 and the driven gear 60 is 2 to 1 so that rotation of the knob 38 through one-half revolution will accomplish a total revolution of the driven gear 60 and the elements attached thereto.

The driven gear 60 is rigidly attached to rotate with a driven axle or shaft 62 which is journaled to rotate within a pair of spaced bores 64 and 66. The driven shaft 62, in addition to the gear 60, supports a switch position display indicator 68 which is preferably a transparent disc which is permanently attached to the driven shaft 62 and which includes opaque position indications such as the numeral indications shown in FIG. 5. A lamp 70 is mounted in the detent mounting plate 57 to shine through an aperture 72 and thereby illuminate the opaque position indication on the disc 68 so that it may be viewed through the switch position indicator 24. The lamp 70 is electrically connected to a power source by means of a pair of terminals 73. The transparent disc 68 may conveniently be made of a thin flexible material and, in that instance, will require a rigid transparent backing such as the disc 74 which is rigidly mounted to the driven shaft 62. Since the disc 68 rotates with the driven shaft 62, it is possible to use the entire circumference of this disc for indicating switch position so that a more accurate and legible switch position indicator is produced than would be available through the use of a bezel or indicator attached to the driving shaft 52.

The rear face 76 of the driven gear 60 and the forward face 78 of the disc 68 may conveniently be used as thrust bearing surfaces for the driven shaft 62, bear-

ing against the detent mounting plate 57 and front face plate 18, respectively.

The rear face of the detent mounting plate 57 includes a pair of vertical guides 80 and 82 which constrain the movement of a pair of detent springs 84 and 86 and associated detent ball bearings 88 and 90. A detent cylinder 92 is rigidly attached to rotate with the driven shaft 62 and includes an annular ridge 94 which surrounds the vertical guides 80 and 82. The inside surface of the annular ridge 94 includes a series of detent grooves 96. In operation, the springs 84 and 86 bias the ball bearings 88 and 90 into the grooves 96 to maintain the detent cylinder 92 and its associated driven shaft 62 in any one of a plurality of fixed positions. It will be noted that, in the preferred embodiment, as best shown in FIG. 4, the pair of ball bearings 88 and 90 simultaneously index a pair of grooves 96 to provide a substantial detent pressure at each of the various switch positions.

A switch wiper 98, which includes a plurality of switch contact fingers 100, is attached to the rear of the detent cylinder 92 so that the fingers 100 project from the rear face of the detent cylinder 92. These fingers 100 are utilized to complete electrical circuits on a printed circuit board 102. This circuit board 102 is mounted between a spacer housing 104 and a switch rear face plate 106, and includes an aperture 108 through which the driven shaft 62 is free to rotate. The printed circuit board 102 includes a plurality of protruding terminals 109 110 111, 113, and 115 each of which is connected to a printed conductor which includes a semicircular portion concentric with the aperture 108. Each of the fingers 100 of the wiper 98 is positioned to contact one of the plurality of semicircular conductors on the circuit board 102 so that the wiper 98 will complete a circuit between various combinations of the terminals as the wiper 98 is rotated by the driven shaft 62. The combination of the wiper 98 and printed circuit board 102 may assume various configurations depending on the particular pole and throw combination of the switch which is desired. As is obvious, however, only a finite number of concentric conductors and fingers 100 may be included in a given switch, so that the primary switch assembly has a limited number of possible switch configurations.

It should be noted that the switch face plate 18, the detent mounting plate 57, the spacer housing 104 and the rear face plate 106 are each constructed to include mating surfaces, such as the shoulder 112 on the detent mounting plate 57 and the corresponding mounting flange 114 on the spacer housing 104. These mating surfaces are designed to conveniently interlock to form a sealed housing and to position each of the outside housing members into an integral unit.

In order to make the switch as versatile as possible, a variable plurality of additional switch assemblies 46 may be mounted on the rear face plate 106 of the primary switch assembly 44 to operate as a unit with the primary switch assembly 44. Each of the additional switch assemblies 46, as shown in FIGS. 3 and 7, includes a front face plate 116 which is designed to interconnect, as with a shoulder and flange, with the rear face plate 106 of the primary switch assembly. A slave shaft 118 is journaled in an aperture 120 in the front face plate 116 and in an aperture 122 in a rear face plate 124. A spacer housing 126 joins with the front face plate 116 and rear face plate 124 to form a sealed

housing for the additional switch assembly 46. The shaft 118 carries a rigidly attached switch wiper mounting plate 128 to which is mounted an additional wiper 130 having associated switch contact fingers 132 which make contact with the conductors on an additional printed circuit board 134 in a manner identical to the switch contacts of the primary switch assembly. The switch wiper mounting plate 128 and the switch wiper 130 act as thrust bearings for the slave shaft 118, bearing against the front face plate 116 and printed circuit board 134, respectively.

The front end of the shaft 118 includes a key 136 which is designed to interlock in one direction only with a slot 138 in the rear of the driven shaft 62 of the primary switch assembly. The rear of the slave shaft 118 includes a similar slot 140 into which the key 136 of an additional switch assembly may be positioned. Likewise the rear side of the rear face plates 106 and 124 have identical mating contours. It can be seen, therefore, that an undetermined number of additional switch assemblies may be stacked on one another on the rear of the primary switch assembly, and, through interconnection of the driven shaft 62 and slave shafts 118, may each be made to operate in response to positioning of the knob 38 of the primary switch assembly. Since each of the additional switch assemblies 46 may be different in configuration from one another, that is, they may contain different printed circuit board 134 and wiper 130 combinations, an almost limitless variety of switch combinations may be applied to the rear of the primary switch assembly.

It is particularly noteworthy that this ability to stack a variety of switch assemblies to the rear of the primary switch assembly allows the frontal display of a continuous number, such as the number 526 shown in FIGS. 1 and 2, without increasing the space between adjacent numbers when additional switch assemblies 46 are added to any one of the primary switch assemblies 44. In addition, it will be noted that the switches may be assembled in the panel of a piece of equipment and later modified or expanded without modifying the mounting hardware or the apertures in the mounting panel. Furthermore, malfunctions of any one of the additional switch assemblies 46 requires only the replacement of that one assembly 46, so that the switch of the present invention is both extremely versatile and relatively easy to maintain.

It is likewise noteworthy that the housing for the primary switch assembly 44, comprising the face plate 18, detent mounting plate 57, spacer housing 104 and rear face plate 106 is sealed as a primary switch assembly, while the additional switch assemblies each have their own sealed housings, comprising front plate 116, spacer housing 126 and rear plate 124. Each switch assembly is always sealed, and the seal of the primary switch assembly 44 need not be broken to add additional switch assemblies 46.

In order to connect the various printed circuit boards 102 and 134 to the associated circuitry of the equipment in which the switches are assembled, it is convenient to utilize an additional printed circuit board 140, as shown in FIG. 3, which printed circuit board 140 includes apertures 142 which accept the plurality of protruding terminals or conductors of the printed circuit boards 102 and 134 for a solder connection with equipment circuitry.

What is claimed is:

1. An electrical switch, comprising:
 - a front face plate;
 - a knob, mounted to rotate about an axis perpendicular to said front face plate;
 - a first shaft, mounted to rotate about an axis substantially parallel to the axis of rotation of said knob; means connected between said knob and said first shaft for rotating said first shaft in response to rotation of said knob at a rate greater than the rate of rotation of said knob;
 - a first switch assembly, driven by said first shaft to make and break first electrical contacts;
 - a second shaft, removably mounted to rotate in response to rotation of said first shaft; and
 - a second switch assembly, driven by said second shaft to make and break second electrical contacts.
2. An electrical switch as defined in claim 1 wherein said means connected between said knob and said first shaft for rotating said first shaft in response to rotation of said knob at a rate greater than the rate of rotation of said knob comprises:
 - a third shaft rigidly connected to said knob and mounted to rotate about the axis of rotation of said knob;
 - a first gear rigidly attached to said third shaft; and
 - a second gear rigidly attached to said first shaft, said second gear positioned to mesh with said first gear, said second gear having a diameter smaller than the diameter of said first gear.
3. An electrical switch as defined in claim 1 additionally comprising:
 - a first sealed housing surrounding said first shaft and said first switch assembly; and
 - a second sealed housing independent of said first sealed housing surrounding said second shaft and said second switch assembly.
4. An electrical switch as defined in claim 1 wherein said front face plate includes an aperture, additionally comprising:
 - a switch position indicator rigidly attached to said first shaft and positioned adjacent said front face plate aperture.
5. An electrical switch as defined in claim 1 additionally comprising:
 - means for removably connecting one end of said first shaft to one end of said second shaft, said means permitting connection in only one rotational position.
6. An electrical switch as defined in claim 5 wherein said removably connecting means comprises a key on one of said first and second shafts and a slot on the other of said first and second shafts.
7. An electrical switch comprising:
 - a primary switch assembly housing having front and rear faces, said primary switch assembly housing independently sealed to exclude foreign matter;
 - a primary switch assembly mounted within said primary switch assembly housing;
 - a knob protruding from said front face for manipulation of said primary switch assembly;
 - a selectable plurality of additional switch assembly housings mounted on said rear face of said primary switch assembly housing, each of said additional switch assembly housings independently sealed to exclude foreign matter;
 - an additional switch assembly in each of said additional switch assembly housings; and

- means for actuating said additional switch assembly in response to said manipulation of said knob.
8. An electrical switch as defined in claim 7 and additionally comprising:
 - means connected between said knob and said primary switch assembly for rotationally driving said switch assemblies in response to rotation of said knob and at a rate higher than the rate of rotation of said knob.
 9. An electrical switch as defined in claim 8 wherein said means connected between said knob and said primary switch assembly for rotationally driving said switch assemblies in response to rotation of said knob and at a rate higher than the rate of rotation of said knob comprises:
 - a first gear rigidly attached to said knob; and
 - a second gear meshing with said first gear, said second gear having a diameter smaller than the diameter of said first gear, said second gear attached to said switch assemblies.
 10. An electrical switch assembly, comprising:
 - a front face plate, being integrally connected to said switch assembly and including an aperture for displaying the position of said switch;
 - transparent means for closing and sealing said aperture;
 - a rotatable knob projecting from said face plate, said knob rotating about an axis perpendicular to the plane of said front face plate;
 - a first shaft projecting from the rear of said face plate, the axis of said shaft substantially parallel to the axis of said knob;
 - a second shaft, coaxial with said first shaft, one end of said second shaft removably keyed to one end of said first shaft to rotate therewith;
 - an indicator disc rotatably mounted on said first shaft and located adjacent said aperture for indicating the position of said switch assembly as said first shaft is rotated; and
 - an electrical switch driven by said second shaft to make and break electrical contacts.
 11. An electrical switch assembly as defined in claim 10 and additionally comprising:
 - means connected between said knob and said first shaft for rotating said first shaft and said second shaft in response to rotation of said knob at a rate greater than the rotation of said knob.
 12. An electrical switch assembly as defined in claim 11 wherein said means for rotating said first shaft and said second shaft in response to rotation of said knob at a rate greater than the rotation of said knob comprises:
 - a third shaft rigidly connected to said knob and mounted to rotate about the axis of rotation of said knob;
 - a first gear rigidly attached to said third shaft; and
 - a second gear rigidly attached to said first shaft, said second gear positioned to mesh with said first gear, said second gear having a diameter smaller than the diameter of said first gear.
 13. An electrical switch assembly as defined in claim 10 additionally comprising:
 - a first sealed housing surrounding said first shaft; and
 - a second sealed housing independent of said first sealed housing surrounding said second shaft and said electrical switch.

14. An electrical switch assembly as defined in claim 10 and additionally comprising means for prohibiting keying of said second shaft to said first shaft unless the rotative position of said second shaft is properly aligned with said indicator disc.

15. A rotary electrical switch comprising:

a sealed housing having a front face plate including a switch position indicator and a rear face plate;
a driving shaft mounted to rotate on said housing about an axis perpendicular to said front face plate;
a driven shaft mounted to rotate on said housing, the axis of said driven shaft substantially parallel to the axis of said driving shaft;
means connected between said driving shaft and said driven shaft for rotating said driven shaft in response to rotation of said driving shaft at a rate greater than the rotation of said knob; and
an independently sealed electric switch assembly, removably mounted on said rear face plate, said switch assembly driven by said driven shaft.

16. A rotary electrical switch as defined in claim 15 wherein said means connected between said driving shaft and said driven shaft for rotating said driven shaft in response to rotation of said driving shaft at a rate greater than the rotation of said knob comprises a driving gear rigidly attached to said driving shaft and a driven gear rigidly attached to said driven shaft, said driven gear positioned to mesh with said driving gear

and having a diameter smaller than the diameter of said driving gear.

17. A rotary electrical switch comprising:

a housing having a front face plate;
a knob, protruding from said front face plate, mounted to rotate about an axis perpendicular to said front face plate;
a driving shaft rigidly mounted to said knob and journaled to rotate within said housing, the axis of said driving shaft being substantially perpendicular to said front face plate;
a driving gear rigidly mounted on said driving shaft;
a driven shaft journaled to rotate within said housing, the axis of said driven shaft being substantially parallel to the axis of said driving shaft;
a driven gear rigidly mounted to said driven shaft and positioned to mesh with said driving gear, said driven gear having a diameter smaller than the diameter of said driving gear;
a switch position indicator mounted on said driven shaft;
a detent cylinder rigidly mounted on said driven shaft for biasing said driven shaft to selected rotational positions; and
an electrical switch driven by said driven shaft to make and break electrical contacts.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,754,106

Dated August 21, 1973

Inventor(s) Dwayne A. MacDonald

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

Title page, after "Inventor:" delete "Wayne A. MacDonald, 11803 Windhill Way, Santa Ana, Calif. 92705" and insert --Dwayne A. MacDonald, 1921 Maryglade Drive, Grafton, Wisconsin 53024--;

Column 3, line 33, "persyective" should be --perspective--;

Column 4, line 24, delete "as" (second occurrence) and insert --at--; and

Column 8, line 3, after "7" delete "and".

Signed and sealed this 9th day of April 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,754,106 Dated August 21, 1973

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