March 5, 1968 J. M. BELL 3,372,260

POSITION INDICATOR FOR ROTARY ELEMENT

Filed Oct. 19, 1965

FIG. 1.

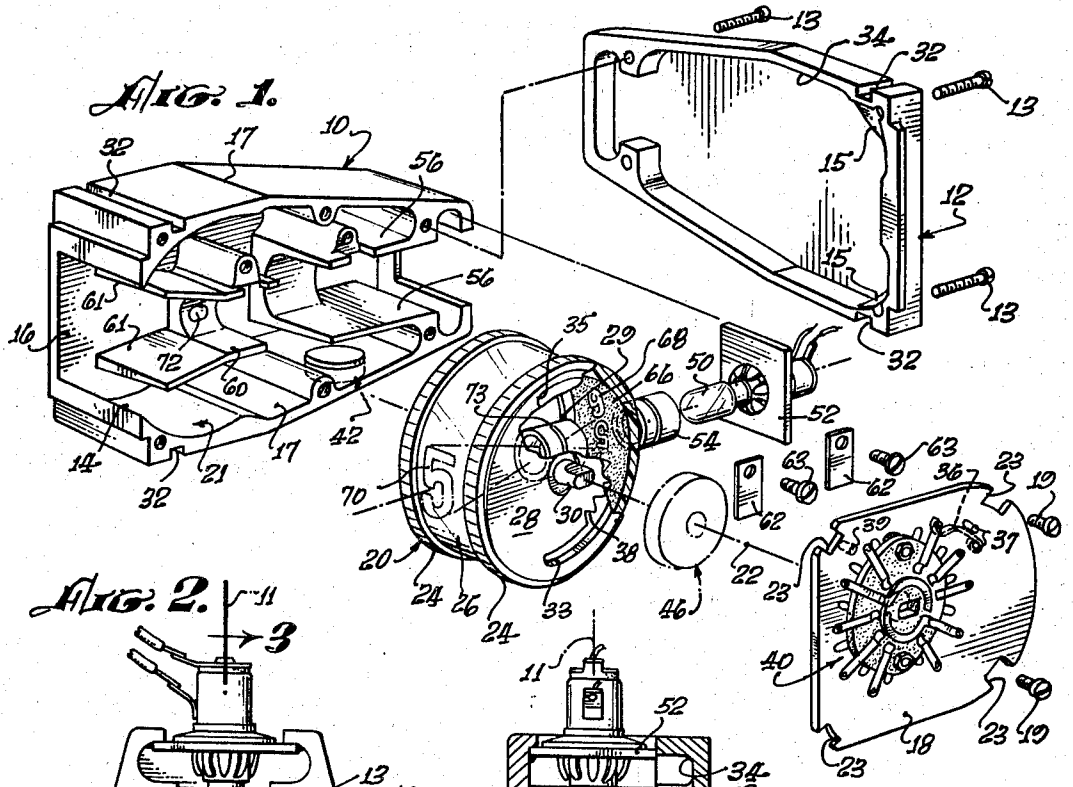


FIG. 2.

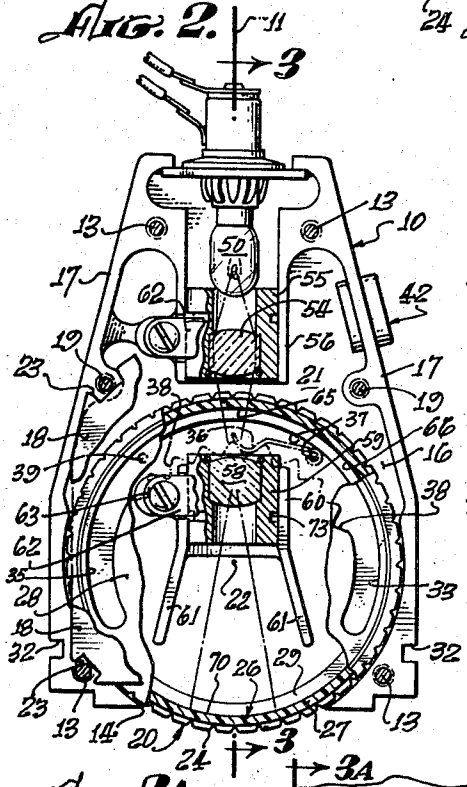


FIG. 3.

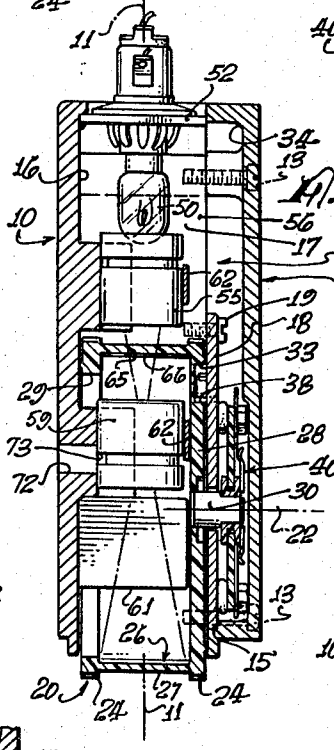


FIG. 3A.

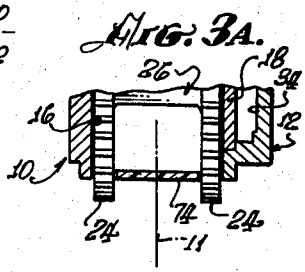
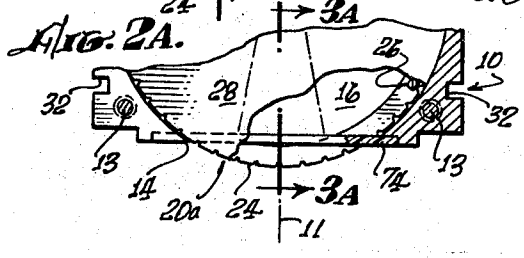


FIG. 2A.



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United States Patent Office

3,372,260

Patented Mar. 5, 1968

3,372,260
POSITION INDICATOR FOR ROTARY ELEMENT

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Filed Oct. 19, 1965, Ser. No. 497,992
8 Claims. (Cl. 200—167)

ABSTRACT OF THE DISCLOSURE

The rotary position of an element, typically a thumbwheel switch, is indicated visually by mounting symbols at corresponding positions on a cylindrical shell that rotates wth the element; illuminating the symbol at a fixed postion; and projecting a optical image of the illuminated symbol onto a diametrically opposite translucent screen. The optical projecting system is typically contained within the shell, but can greatly magnify the symbol, providing clearly readable indication even of closely spaced angular positions.

This invention has to do generally with manually adjustable devices that are rotatable to control a variable quantity, such as an electrical resistance, a spring tension, or the angle of a movable arm, for example. More precisely, the invention has to do with means for visually indicating which of its possible positions, discrete or continuously variable, the adjustable device occupies at any time.

The invention is useful, for example, for visually displaying a numeral that represents the existing position of a manually rotatable switch, typically of the panel-mounted type commonly referred to as a thumbwheel switch. Such switches may be employed for many purposes, for example as an input device for controlling an input variable such as an electrical resistance supplied to an analogue computer or other system. For supplying such a resistance it is convenient to employ several decade resistance arrays connected in series, with separately actuable switches for each decade, and to display a numeral for each decade corresponding to its actual setting. The total input resistance, or other quantity, can then be read directly as a decimal number comprising the digits of the respective switches.

Such switch assemblies are commonly controlled by thumbwheel drums or disks rotatable on a common horizontal axis and each carrying the numerals 0 through 9 on their peripheral surfaces. Such control drums may be mounted behind a panel provided with windows through which only one numeral on each drum is visible. That arrangement permits the horizontal row of digits to be seen close enough together to be read easily as a single number. However, the maximum size at which each digit can be displayed is sharply limited by the diameter of the drums.

An important object of the present invention is to overcome that limitation, so that for a given drum diameter the size of the displayed numeral can be greatly increased. That is accomplished by utilizing optical projection for displaying the positional numerals. The mechanical configuration and the optical arrangement provided by the present invention are distinctively different from prior art attempts to utilize optical projection for related purposes, leading to a more compact, economical and efficient product. In particular, only a minimum of space is required outside of the actual control wheel itself.

A further advantage of the invention is that the alternative positions of the thumbwheel may be grouped within a relatively small angular range of rotation without loss

of clarity of indication. A smaller rotational angle is then required to shift the thumbwheel between two positions, especially between positions 0 and 9 in devices that do not permit complete rotation of the control. That greatly facilitates manual operation of the switch.

In one illustrative form of the invention, a cylindrical shell of translucent material is mounted for rotation with the thumbwheel device. Numerals are carried on one sector of that shell, and are projected optically onto the diametrically opposite sector. Optical means for illumination and projection of the numerals are fixedly mounted outside and inside, respectively, the shell surface. With that arrangement very considerable magnification of the numerals is readily attained.

Whereas the invention is especially useful in decade devices in which the indication is in terms of decimal numerals, other number systems can also be employed, or the positions may be indicated by symbols of any desired type other than numbers. For example, a calibrated scale of any desired type may be employed in connection with a fixed reference index for indicating continuous rotation of the control element.

A full understanding of the invention and of its further objects and advantages will be had from the following description of certain illustrative manners in which it can be carried out. The particulars of that description and of the accompanying drawings which form a part of it are intended only as illustration and not as a limitation upon the scope of the invention, which is defined in the appended claims.

In the drawings:

FIG. 1 is an exploded perspective representing an illustrative thumbwheel switch embodying the invention;

FIG. 2 is a plan, partly broken away, showing the device of FIG. 1 in horizontal position with cover removed;

FIG. 3 is a section on line 3—3 of FIG. 2 with cover in position; and

FIGS. 2A and 3A are details corresponding to portions of FIGS. 2 and 3, respectively, and representing a modification.

The device illustrated in FIGS. 1 to 3 comprises an elongated main housing **10** of rectangular transverse section with longitudinal axis **11**, a flat bottom wall **16**, side walls **17** and a removable cover **12** normally secured in place by the screws **13**. A flat mounting plate **18** is removably mounted on side walls **17** inside the cover and parallel to bottom wall **16**, defining a main housing chamber **21**. Plate **18** is retained by the internal shoulder **15** on the cover (FIG. 3) and is secured by the screws **19** which work in circumferentially slotted apertures **23** in the plate, permitting convenient rotational adjustment of the plate about thumbwheel axis **22**.

The thumbwheel **20** is rotatably mounted within chamber **21** on the axis **22** perpendicular to mounting plate **18**. Thumbwheel **20** is of hollow, generally cylindrical form, with notched finger flanges **24** at both axial edges of its periphery to facilitate manual rotational adjustment. Between those flanges extends a cylindrical shell formation **26**, typically of translucent plastic material. One axial face of thumbwheel **20** is closed by the circular disk **28**, in which the shaft **30** is coaxially mounted. The other axial face is essentially open, except for the internal radial flange indicated at **29**. Shaft **30** is journaled in a bore in mounting plate **18**, and the wheel is freely guided axially by housing wall **16** and the parallel inner face of plate **18**. At the forward end of housing **10** is a rectangular open window **14**, through which a portion of the wheel periphery projects slightly, so that finger flanges **24** are accessible for manipulation and a limited sector **27** of shell **26** is visible from outside the housing. Channels **32** are shown

in the housing exterior to facilitate mounting a row of devices in a rectangular aperture in a panel.

Cover **12** is internally recessed to form a chamber **34** between the cover wall and the outer face of mounting plate **18**. The rotary switch **40** is mounted in that chamber coaxially of thumbwheel **20**, representing any desired device to be operated by the thumbwheel. Electrical connections for switch **40**, not explicitly shown, may be provided in any desired manner, as via a conventional connector which may be mounted in a side wall of the housing as indicated at **42**. Shaft **30** projects upward through mounting plate **18** and is squared to mate with the rotatable element of switch **40**. A more complex coupling device may be employed if desired between shaft **30** and the device to be controlled by the thumbwheel, such as a gear box or linkage, as indicated schematically at **46** in FIG. 1.

A detent device is preferably provided to limit the thumbwheel angle to definite discrete positions that correspond to the operating positions of switch **40**. Such a detent is illustrated by the spring **36** which is mounted on pins **37** set in mounting plate **18** and engages camming notches **38** formed at the desired angles in the circumferential channel **33** in thumbwheel disk **28**. A typical decade switch requires ten notches 15° apart, making a total operating range of 135° for the thumbwheel rotation. Positive stop abutments may be provided to limit the rotation to that operating range, as illustrated by the fixed pin **39** working in the arcuate recess **35** in the wheel flange. If device **40** is continuously rotatable, as a conventional potentiometer, for example, a detent device is normally not required.

The projection system of the present invention is alined with the longitudinal axis **11** of housing **10** and comprises a light source **50**, which is typically a small incandescent lamp mounted on a bored plate **52** which forms the rear end wall of housing **10**. Light from source **50** is directed by the condensing lens **54** onto a limited portion **65** of shell **26** of the thumbwheel in a radially inward direction. The symbols to be displayed for indication of the thumbwheel position are mounted on thumbwheel shell **26** in such position that for each angular position of the wheel the corresponding symbol lies in the light beam at **65**. The symbols are formed as areas of differential light transmission, typically comprising transparent areas on a dense black ground, but may be black on a white ground if preferred. The symbols may conveniently be formed by conventional photographic procedures on a strip of photographic film which is then mounted, as by suitable adhesive, on the inner face of shell **26** at the required angular position. Such a film is indicated somewhat schematically at **66** with symbols **68**. Light transmitted by the symbol at the illuminated shell surface is received by the objective lens **58**. That lens forms an optical image **70** of the illuminated symbol on the diametrically opposite portion **27** of the shell within window **14**.

The lenses **54** and **58** are typically mounted in respective barrels **55** and **59**, which are supported in turn in suitable molded mounting formations **56** and **60** that may be formed integrally with housing **10**. The lens barrels may be retained by leaf springs **62** and screws **63**. Condensing lens **54** is mounted outside of thumbwheel **20**, while projecting lens **58** is within that wheel between the wheel axis **22** and the illuminated portion **65** of shell **26**. The degree of magnification of the image **70** with respect to the symbol at **65** is directly controllable by the position of lens **58**, the magnification varying inversely with the separation of the lens from the illuminated shell. The focal length of the lens is selected with regard to that lens position and, of course, to the shell diameter to produce a sharp image at **70**. Accurate focal adjustment of lens **58** is obtained after assembly of the device by moving the lens against the friction of spring **62**, as by insertion of a tool through the opening **72** in case wall **16** (FIG. 3) to engage channel **73** in the lens barrel. The projected numerals or other indicia may be accurately centered in window **14** by rotational adjustment of mounting plate **18**, which carries with it both the switch assembly and the thumbwheel. Light shields **61** may be formed integrally with the housing to protect the screen at window **14** from stray light.

It will be understood that as thumbwheel **20** is rotated different portions of the symbol carrying film enter the light beam at **65**, and also different portions of translucent shell are positioned in window **14** to receive the projected symbol image. However, the shell areas that occupy the window for adjacent wheel positions typically overlap considerably, since the projected image subtends a larger angle at axis **22** than do the individual symbols on film **66**, due to the optical magnification. As an illustration, each symbol on the film may subtend an angle of 15° at axis **22**, while the projected image typically subtends an angle of 45 to 60°. The ten digits then occupy about 150° of the entire shell, while the projected images, due to the overlap just described, occupy about 180 to 195°.

The shell surface on which the symbols **68** are mounted and the screen surface on which they are projected need not comprise parts of a single continuous cylindrical shell, but may, for example, differ in radius, in material and in other characteristics, as required. Alternatively, the projected images may be displayed on a screen that is fixedly mounted on housing **10**, as represented at **74** in FIGS. 2A and 3A diametrically opposite to the illuminated symbol-carrying shell portion and essentially parallel thereto.

Many other changes may be made in the particular illustrated structures without departing from the proper scope of the invention, which is defined in the appended claims.

I claim:

1. A system for visually indicating the position of a rotatable device, said system comprising in combination

a cylindrical shell mounted for rotation about its axis and rotationally coupled to the device,

a plurality of symbols carried by the shell and comprising areas of differential light transmission, said symbols being angularly distributed to correspond to respective angular positions of the device,

means for illuminating the radially outer face of the shell at the symbol that corresponds to the existing position of the device, a portion of the illumination being transmitted radially inward through the shell by the differential transmission of the illuminated symbol,

structure forming a translucent surface diametrically opposite the illuminated portion of the shell and generally parallel thereto,

and optical means radially inward of the shell in the path of said transmitted light for projecting a real image of the illuminated symbol radially outward onto the translucent surface for visual observation from the radially outer side thereof.

2. A system as defined in claim **1**, and wherein said translucent surface is formed on a portion of the cylindrical shell angularly outside said range.

3. A system for visually indicating the position of a rotatable device, said system comprising in combination

a cylindrical shell mounted for rotation about its axis and rotationally coupled to the device,

a plurality of symbols carried by the shell at angularly distributed positions within an angular range of less than 180°, said symbols being visible from within the shell and corresponding to respective angular positions of the device, the shell surface diametrically opposite said symbols being translucent,

means for illuminating the symbol that corresponds to the existing position of the device,

and optical means within the shell for projecting a real image of the illuminated symbol on an optical axis substantially diametrical with respect to the shell

onto said translucent surface for visual observation from the radially outer side thereof.

4. A rotary switch assembly, comprising in combination

structure forming a housing having a window,

a cylindrical shell mounted in the housing for rotation about the shell axis through an angle less than 180°, the shell having a translucent angular portion visible at the window,

rotary switch means mounted in the housing and rotationally coupled to the shell for rotation to a plurality of discrete switch positions,

a plurality of symbols carried by the shell and visible from within the shell, said symbols corresponding to the respective switch positions and being so distributed angularly of the shell that the symbol corresponding to the existing switch position is diametrically opposite the window,

means for illuminating the symbol that is diametrically opposite the window,

and optical means within the shell for projecting a real image of the illuminated symbol on an optical axis substantially diametrical with respect to the shell onto said translucent surface at the window for visual observation from outside the housing.

5. A rotary switch assembly as defined in claim 4, and wherein said optical means comprise a lens mounted for translational movement longitudinally of the housing axis, means frictionally opposing lens movement, and means accessible from outside the housing for manually adjustably moving the lens to focus said image.

6. A rotary switch assembly as defined in claim 4, and wherein said shell includes a rim portion that is accessible at the window for manual rotation of the shell and switch means.

7. A rotary switch assembly comprising in combination

structure forming a housing having a housing axis and a window lying on the axis,

a support mounted within the housing for rotational adjustment about a movement axis perpendicular to the housing axis,

a cylindrical shell mounted in the housing for coaxial rotation about the movement axis through a limited angular range less than 180°, the shell having a translucent portion that is visible at the window,

rotary switch means mounted on the support and rotationally coupled to the shell,

detent means defining a plurality of discrete rotational positions of the shell and the switch means relative to the support,

means for illuminating an area of the shell on the housing axis diametrically opposite said visible portion,

optical means mounted on the housing structure within the shell for projecting a real image of the illuminated area onto said visible portion of the shell,

and a plurality of symbols carried by the shell and visible from within the shell, said symbols corresponding to the respective switch positions and being so distributed angularly of the shell that the symbol corresponding to the existing switch position lies in the illuminated area.

8. A rotary switch assembly as defined in claim 7, and wherein

said illuminating means comprise means for directing light radially inward toward the shell on the side thereof remote from the window,

said symbols comprising areas of differential light transmission.

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