May 14, 1963 H. D. WRIGHT 3,089,923

SECTIONAL DIGITAL SWITCH

Filed June 15, 1959 2 Sheets-Sheet 1

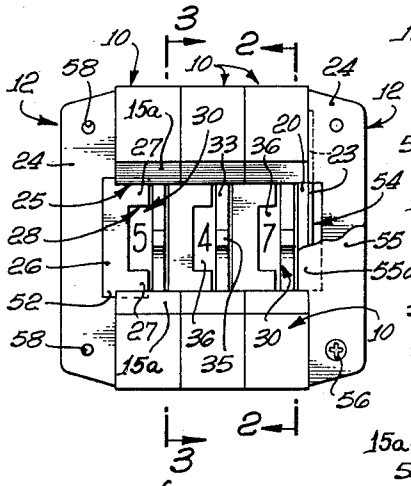


FIG. 1.

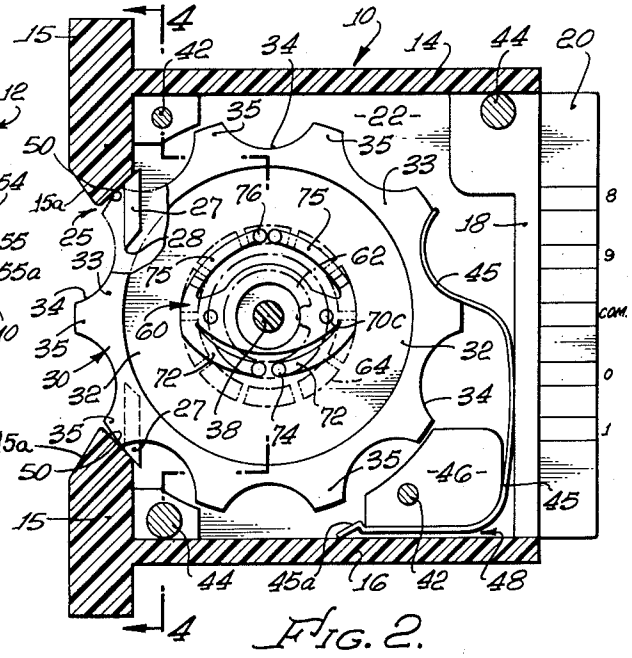


FIG. 2.

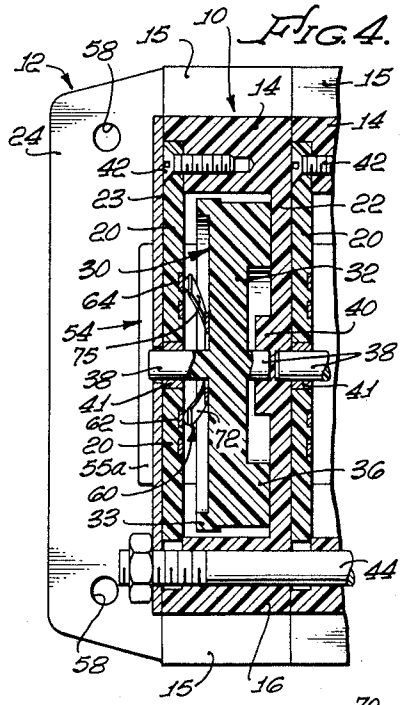


FIG. 4.

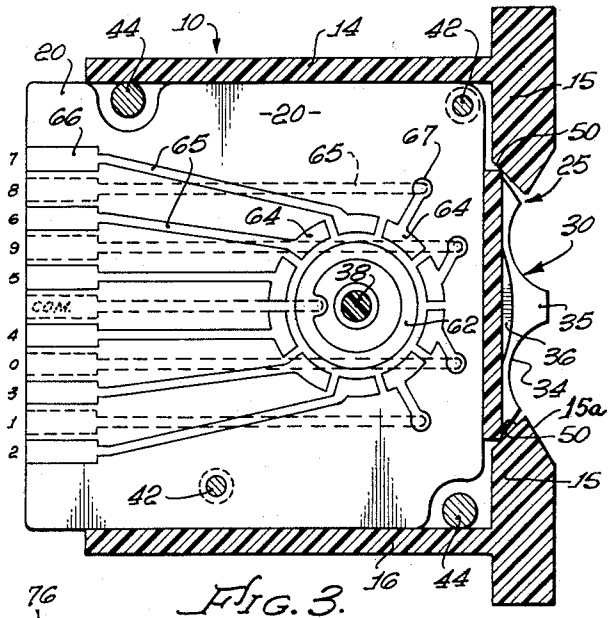


FIG. 3.

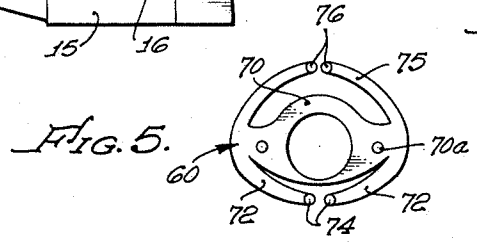


FIG. 5.

INVENTOR.
HARRY DUDLEY WRIGHT
BY Reed & Lawlor
ATTORNEY.

May 14, 1963 H. D. WRIGHT 3,089,923

SECTIONAL DIGITAL SWITCH

Filed June 15, 1959 2 Sheets-Sheet 2

FIG. 6.

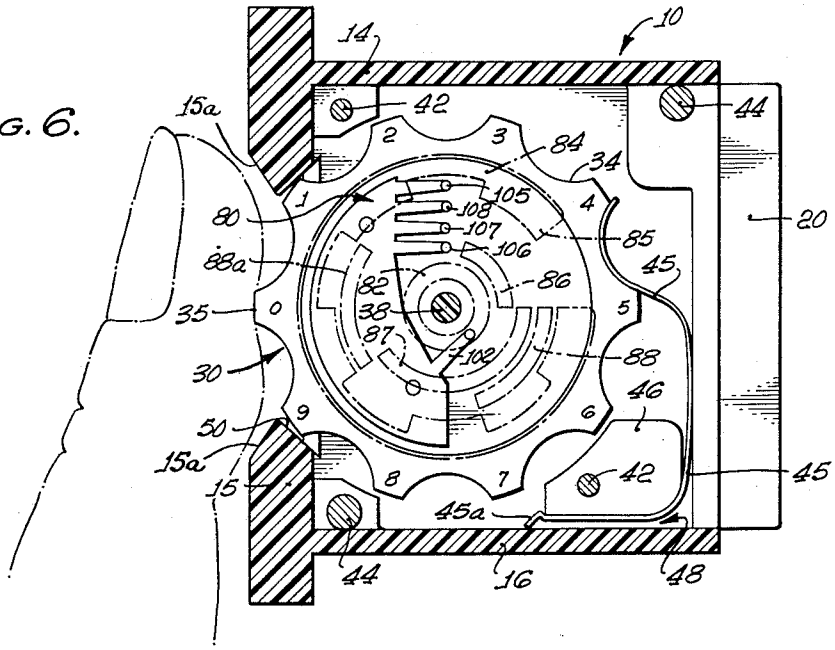
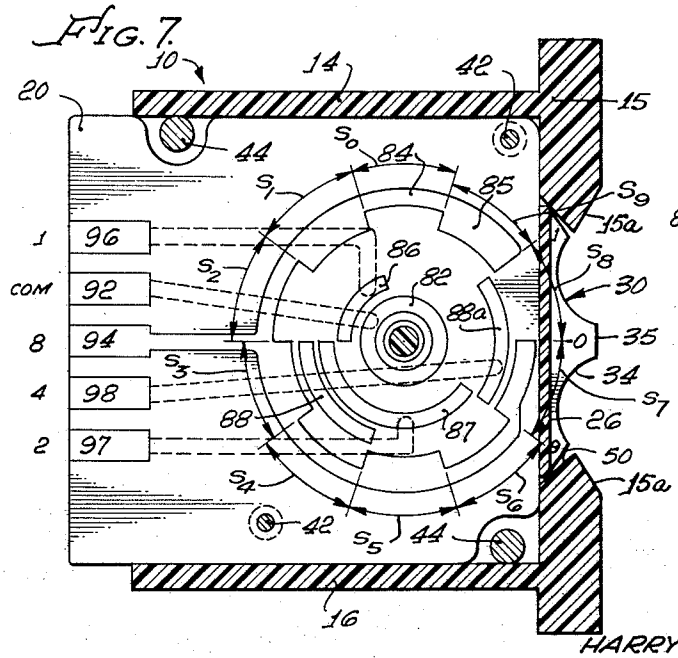


FIG. 7.



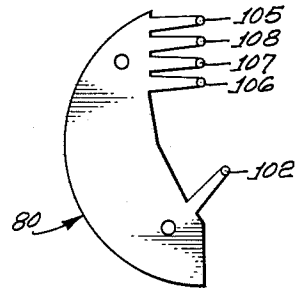


FIG. 8.

INVENTOR.
HARRY DUDLEY WRIGHT
BY
Reed & Lawlor
ATTORNEY.

United States Patent Office 3,089,923 Patented May 14, 1963

3,089,923

SECTIONAL DIGITAL SWITCH

Harry Dudley Wright, Pasadena, Calif., assignor to Endevco Corporation, Pasadena, Calif., a corporation of California

Filed June 15, 1959, Ser. No. 820,543
11 Claims. (Cl. 200—5)

This invention relates to digital switching devices which may be constructed as a plurality of assembled units that are manually actuable to operate electrical switching means in each unit for feeding the results into appropriate electronic instruments for whatever purpose required.

An important object of this invention is to provide a novel digital switching unit, by means of which a plurality of substantially identical such units may be arranged in a compact in-line series to provide for counting to as high a number as may be desired.

Another object of the invention is to provide an efficient digital switching unit, especially one containing electrical switching means, which is easily duplicated for assembling into a multiple in-line switching system to whatever extent needed for any given purpose.

A still further object of the invention is to provide a digital switching unit embodying a finger-operated wheel positioned to be engaged by an operator's finger for positive movement of the wheel, one step at a time or two steps at a time, to advance the wheel for bringing into viewing position digits delineated thereon, such digits being successively advanced by the operator.

A still further object is to provide the wheel of such a switching unit with notches which are employed to advance the wheel from one position to another and which also cooperate with a spring to set and retain the wheel in a predetermined position.

A still further object of the invention is to provide means in such a switching unit for positively limiting movement of the operator's finger to one digit spacing at a single operation.

A still further object of the invention is to provide means in such a switching unit for readily setting the wheel in a predetermined position as the operator's finger is withdrawn after operating the switching unit.

An additional object of the invention is to provide, in conjunction with a rotary switching wheel in each unit, an electrical switching device for completing electrical circuits as the respective wheels are rotated digit by digit, whereby to conduct electrical currents through such completed circuits to an instrument into which they are to be fed.

It is a still further object to provide a switching unit of the indicated character having a casing providing means for rotatably mounting a switching wheel in the casing, the casings being so arranged that a series of such casings are alignable to mount their respective switching wheels and also the opposite sides of the adjacent switching wheels in an aligned assembly.

Other objects of the invention, and various features of construction thereof, will be apparent to those skilled in this art, upon reference to the following specification and the accompanying drawings wherein certain embodiments are disclosed to indicate what is presently deemed to be the best manner of constructing and employing the invention.

In these drawings:

FIGURE 1 is a face view of a multiple switching system of this invention made up of three aligned switching units and two end plates assembled therewith;

FIG. 2 is a cross-section taken from the line 2—2 of FIG. 1 on an enlarged scale;

FIG. 3 is a similar cross-section taken from the line 3—3 of FIG. 1;

FIG. 4 is a transverse cross-section taken from the line 4—4 of FIG. 2;

FIG. 5 is a detail showing of a wiper switch;

FIG. 6 is a view similar to that of FIG. 2, but showing switching mechanism employing a binary system as distinguished from the decimal system of FIGS. 2 to 5;

FIG. 7 is a cross-section corresponding with that of FIG. 3, but illustrating the binary system switching mechanism of FIG. 6; and

FIG. 8 is a detail of the wiper switch of FIGS. 6 and 7.

As indicated in FIG. 1, three casing units **10**, which are substantially identical in construction, are shown as being assembled for the purpose of performing in-line counting operations up to 999. At each end of the assembly of the three casing units **10**, there is provided an aligned end plate **12** retained in assembled position by the same means which retain the casing units **10** in assembled position, as more fully described hereinafter.

The casing **10** in each unit, as the assembly of FIG. 1 is viewed in elevation, includes a top wall **14** (FIGS. 2 and 3) which is relatively narrow as compared with its length, a front wall in the form of two spaced wall sections **15**, and a bottom wall **16**, these having the same narrow configuration as the top wall **14**. In addition, each casing unit **10** has a back wall **18** as seen in FIG. 2, which is somewhat narrower than the walls **14**, **15**, and **16**, to provide a narrow slot-like space for the reception between the walls **14** and **16** of a projecting rearward end of a circuit board **20**, as presently to be more fully described. Additionally, each casing unit **10** is provided at one side with a side wall **22**. All of the described wall portions may be integral with one another, as conveniently provided by a molded thermo-setting plastic construction. As seen at the right of FIG. 2, the end of the circuit board **20** projecting beyond the back wall **18** is that of the circuit board of the unit **10** lying immediately behind the walls **18** and **22** shown in elevation. Each end plate **12** is desirably stamped from sheet metal to provide a side closure plate **23** and an integral right-angularly disposed flange **24**, as presently more fully described.

The spaced portions **15** of the forward wall of each casing **10** provide a generally rectangular open window **25** between them, which window is the width of the wall sections **15** and the upper and lower walls **14** and **16**. In addition, the upper edge of the side wall **22** is provided with a laterally outwardly directed and somewhat elongated lip **26**, which overhangs the circuit board **20** of the adjacent casing unit and which, as seen in FIG. 1, is at the left of its window **25**. Additionally, each elongated lip **26** is provided at its opposite ends with short inwardly overhanging flanges or lips **27**, the elongated lip **26** and the short lips **27** cooperating among them to define an inner window **28** for viewing a digit presented on a switching wheel **30**.

Each switching wheel **30** includes a body portion or hub section **32** from which extends outwardly a radially directed circumferential finger flange **33**, which is arcuately notched at **34** to provide curved finger lugs **35** for rotating the wheel. The finger flange **35** lies at one side of its wheel **30**, and at the opposite side of wheel **30** there is provided a cylindrical rim **36**, which carries a series of ten digits, 0 to 9 of the decimal system, as indicated in FIG. 1, these digits lying alongside the finger lugs **35**, of which there are also ten in number. This rim **36** rotates beneath the small inwardly overhanging flanges **27** so that, as each digit is moved into position, it is viewed through the small window **28** provided between the small overhanging flanges **27** and between the elongated outwardly overhanging flange **26** and the finger flange **33** and its lugs **35**; the finger flange **33** thus ex-

tends outwardly alongside the overhanging window-forming flanges 27 and rotates adjacent the side edges thereof.

The hub or body portion 32 of each switching wheel 30 is centrally provided at its opposite sides with pivots 38, which may be integral with the wheel 30, especially where the entire wheel is cast or is molded from thermosetting plastic or the like. These pivots 38 may be journaled in bores providing bearings, such as a bore in an adjacent boss 40 in each side wall 22 and a bore in an appropriate bearing 41 provided in each circuit board 20, as best illustrated in FIG. 4.

Each circuit board is secured in place by means of screws 42, which are threaded into appropriate cast bosses at the corners of the respective casing units 10. Additionally, the circuit boards 20 may be bound in place by means of through bolts 44 which extend entirely through the assemblage of the several casing units 10 and the end plates 12 seen in FIGS. 1 and 4, these bolts 44 being positioned in bores in appropriate corner bosses of the casing units 10 as illustrated in FIGS. 2, 3, and 4.

By the indicated mounting of the various switching wheels 30, the latter may be readily rotated to advance the various digits into the viewing positions indicated in FIG. 1, the operator's finger being disposed in a notch 34 and drawn forward against a finger lug 35 until his finger engages the nearer front wall portion or section 15, whereupon the rotary movement of the wheel 32 ceases. These wall sections 15 thus act as finger stops or finger guides.

In cross-section, the notches 34 form arcs of about 100° to 140°. The surfaces 15*a* of the front walls slope in directions that extend along the ends of the notch arcs at both ends of the window 25, being about tangential to the ends of the arcs. With this arrangement, as the operator's finger moves the wheel from one position to another, the notches and the digit to be viewed are registered accurately in the window as the finger is withdrawn, and then the wheel is held by virtue of the friction produced by the force between the switch contacts.

For the purpose of securing centering of a finger lug 35 in the position to which the corresponding wheel 30 has been rotated, a centering spring 45 is provided within and at the back of each casing unit 10. One end of the spring is shaped to fit into slots provided between a boss 46 that receives one of the screws 42 and the adjacent bottom wall 16 and part of the spring engages the adjacent rear wall 18 of the corresponding casing unit 10 in order to anchor the spring in place. Such slots are indicated at 48 in FIG. 2, which also shows an offset retention finger 45*a* at the fixed extremity of the spring 45 to insure proper spring position. The other end of the spring 45 is movable and is shaped to match the curvature of the finger notches 34. Thus, when a switching wheel 30 has been rotated by the operator's finger to bring a digit into viewing position in the center of the small viewing window 23, and the operator's finger has engaged against a finger stop wall section 15, as indicated in FIG. 2, the curved free extremity of the spring 45 settles down into a corresponding finger notch 34 and retains the respective wheel 30 in the new position. For some uses, the spring 45 might be omitted. In such case, friction between various members is relied upon to retain the switching wheel in place. However, the use of the spring 45 is better, since it provides a more positive holding action, especially when the unit is subjected to vibration or shock forces. In prior devices, stiff springs have been used for registering rotatable wheels in desired positions. But, since registration is accomplished in this invention as a result of the shapes of the window edges in relation to the shapes of the notches, a soft spring may be employed, since their sole function is to retain the wheel in position, not to force it into position.

It will be noted, also, that the notches 34 and finger lugs 35 of the wheels 30 are adapted to rotation of

the wheels two steps at a time, as by two increments of motion through the action of the thumb. As indicated in phantom in FIG. 6, the ball of the thumb first operates against one lug 35 to move a wheel 30 one step forward and the distal end of the thumb then operates against the next lug 35 to move the wheel a second step forward. Further, in view of the symmetrical construction of the lugs 35 of each wheel 30, the wheels may be rotated in the opposite direction if desired for any reason, the end of the operator's finger pushing against the exposed lugs 35.

In connection with the assembling of a plurality of casing units 10 and end plates 12 into a complete assemblage such as shown in FIG. 1, the lip 26, which overhangs the outside of each casing unit 10 (to the left as viewed in FIG. 1) and which is integrally positioned at the top of the corresponding side wall 22, is arranged so as to interlock at its ends under the inclined or beveled edges 50 of the two finger-stop wall portions 15 shown in FIGS. 2 and 3. For this purpose, the length of the overhanging flange 27 in each instance is slightly greater than the length of the window opening 25 between the finger-stop wall portions 15; this is best indicated at the left of FIG. 1. Thus, when one unit 10 is being assembled alongside an adjacent unit, such extending lip portions, indicated at 52 in FIG. 1, lock under the beveled edges 50 of the adjacent stop portions 15. Such arrangement also helps maintain the interior of the assembly dust-free.

For the purpose of accommodating an overhanging lip 26 in an end plate 12 as seen at the left of FIG. 1, the latter is correspondingly slotted at 54 to receive the lip 26. Such a slot 54 is also seen at the right of FIG. 1 in the other end plate 12. Each slot 54 exposes the corresponding upper edge portion of the main plate or side wall 23 of the respective end plate 12. In order to cover the slot 54 of the end plate 12 seen at the right of FIG. 1, and also to conceal the upper edge of the corresponding circuit board 20 and the adjacent side wall 23 when the assembly is completed, the flange 24 of this right end plate 12 is desirably covered with a thin, stiff finish layer 55, which may be of heavy metal foil, and which is shown as approximately half broken away. This layer 55 is provided with an overhanging extension tongue 55*a* corresponding in size with the lips 26 of the casing units 10 to partially enter the larger window 25 and overhang the adjacent circuit board 20. In addition to serving as a closure plate or finish layer, the member 55 may at the same time be a name plate. It is secured in position as by means of screws 56 received in screw holes 58 in the end plate flange 24, and said screws 56 are desirably employed to mount the assembly in the customer's apparatus for which this switching mechanism has been developed.

The function of switching wheels 30 is to make and break circuits corresponding with the digits on the respective cylindrical rims 36, and this is accomplished through the medium of the mentioned circuit boards 22 and rotary wiper switches 60 concentrically mounted about the axes of the switching wheels 30 in position to make and break circuits by means of contact members on respective circuit boards 20.

Each circuit board 20 receives and centers one of the pivot shafts 38, and the board carries so-called printed circuits, which include the contacts to be engaged by the rotary wiper switches 60. Adjacent the respective axis or pivot shaft 38, each board 20 carries a printed continuous wiper ring or slip ring 62, and concentric therewith outside the wiper ring or slip ring 62, there is provided a circular series of printed contact segments 64 spaced from each other and constituting a commutator ring and corresponding with the ten digits on the rim 36 of the respective switching wheel 30. Printed leads 65 extend from the various contacts or ring segments 64 to appropriate terminals 66 at the projecting end of the

respective circuit board 20 where they may be wired into any instrument with which the present digital switch is to be used. Some of the leads 65 are disposed on one side of the board 20, which is formed of insulating material, and some of them are provided on the other side, appropriate through-connections, such as indicated at 67, extending through the board from some of the contact segments 64 and the respective lead 65 on the other side.

As shown in FIGS. 2, 3, and 4, the decimal system is employed, and make-and-break fingers of each wiper switch 60 are positioned to contact successively the commutator segments or contacts 64 on the circuit board 20 as respective switching wheel 30 is rotated. Each wiper switch 60 has a central ring member 70 (FIG. 5) secured in any suitable manner as at 70*a* to the hub of respective switching wheel 30, and this ring member is in general positioned inside the locus of the slip ring 62, as well as inside the locus of the outer series of commutator segments or contacts 64. To the inner ring of each wiper switch 60, there are connected two wiper fingers 72 having contacting wiper terminals 74 (FIGS. 2 and 5) to engage the slip ring 62. Also connected to the inner ring of each wiper switch 60 is a pair of wiper fingers 75 having wiper terminals 76 disposed at the locus of the circular series of contacts 64 on the circuit board 20. These wiper terminals 76 may be spaced either to constitute the non-shorting break-before-make type of switching mechanism, or they may be more widely spaced to provide the shorting or make-before-break type of switching mechanism, according to the requirements of the circuits being switched.

With the mechanism thus described, as any one of the switching wheels 30 is rotated step-by-step to present digits thereon successively to the respective windows 28, circuits are completed through the respective circuit boards, contacts thereon and the wiping fingers 72 and 75 of the respective wiper switch 60. The corresponding impulses are then transferred from the terminal 66 to the customer's instruments with which the present improvement has been connected by appropriate wiring.

The electrical arrangement illustrated in FIGS. 2, 3, 4, and 5, as has been previously indicated, is for use with a decimal electrical system. The present structure, however, lends itself readily to the employment of contact boards 20 and wiper switches 80 for use with binary electrical systems, and such an arrangement is illustrated in FIGS. 6, 7, and 8, where the same casing units 10 and switching wheels 30, with finger lugs 35, are employed as with the decimal arrangement of FIGS. 1 to 5.

Instead of employing the decimal contact arrangement represented in the structure of FIGS. 1 to 5, a binary contact arrangement may also be employed, such as that represented in FIGS. 6, 7, and 8. In the switch illustrated in those figures, a decimal or scale-of-ten switching wheel 30 is employed, but the circular series of ten stationary contact segments 64 of the contact arrangement of FIGS. 1 to 5 is replaced by a plurality of concentric annular zones in order to provide a switching arrangement operating on a binary or scale-of-two basis. Also in this case, a five-fingered wiper switch 80 is employed in place of the wiper switch 60.

The wiper switch 80 includes four contact fingers 105, 106, 107, and 108, which are radially aligned, as well as an additional contact finger 102. The area of the contact board 20 through which the various contacts of the wiper switch 80 move is divided into ten 36° consecutive sectors S_0, S_1, . . . S_9. Both the numbers of the digits indicated by any switching wheel and the numbers of the sectors, increase in a counter-clockwise direction about the shaft 38. In this arrangement, five zonal contacts are employed. The inner contact 82 constitutes a slip ring which is engaged by the contact 102. The outer contact 84 is provided with five uniformly spaced inwardly projecting extension segments 85 that lie in sectors S_1, S_3, S_5, S_7, and S_9. A short zonal segment 86 extends over sectors S_1 and S_2 at the radius of the contact finger 106. A longer zonal segment 87 occupies sectors S_3, S_4, S_5, and S_6 at the radius of the wiper finger 107. And two spaced electrically connected segments 88 and 88*a* occupy sectors S_3, S_4, S_5, and S_6 at the radius of the contact finger 108. With this arrangement, a coded binary output may be provided.

As illustrated in FIG. 7, the outer contact 84, together with its segments 85, are connected by a suitable printed circuit lead to terminal 94. Likewise, the contact 86 is connected by a suitable printed circuit lead to terminal 96. Similarly, the contact 87 is connected by a suitable printed circuit lead to terminal 97. And similarly the two contact segments 88 and 88*a* are connected by a common printed circuit lead to each other and to a terminal 98. And the slip ring 82 is connected by a suitable printed circuit lead to terminal 92. The five terminals 92, 94, 96, 97, and 98 are arranged at the rear edge of the contact board 20 at the rear of the casing unit 10 to facilitate insertion of the unit into and removal from a suitable electrical contact plug.

With the above described arrangement of the segment 84 and its segments 85, 86, 87, 88, and 88*a* operating in conjunction with the wiper switch 80 and its various contact fingers 102, 105, 106, 107, and 108, an appropriate binary code is readily followed and the present digital switching system readily employed in conjunction with apparatus designed for use with such coded arrangement.

From these disclosures, it is apparent that the digital switching system of this invention is readily applicable for employment with any appropriate numbers system, whether the system be decimal, binary, octal, or other usable numbering system.

Although only two specific embodiments of the invention have been illustrated and described, it will be obvious that the invention is not limited thereto, but is capable of being embodied in many other forms. Various changes which will suggest themselves to those skilled in the art may be made in the material, form, details of construction and arrangement of the elements without departing from the scope of the invention.

The invention claimed is:

1. A switch comprising an outer wall member of contoured configuration forming a limited switch actuation region disposed between and bounded by a pair of spaced, sloping and diverging outside surfaces, said pair of diverging surfaces extending outwardly from said switch actuation region and being located adjacent opposite ends of said region, said switch actuation region having an open window including a portion extending substantially from one to the other of said sloping surfaces, a rotor mounted for rotation in either of two opposite directions on an axis located anterior of said wall member and said open window portion, switching means coupled to said rotor for completing a plurality of different electrical circuits in response respectively to movement of said rotor to a plurality of predetermined different angular circuit registration positions, said rotor comprising a movable operator portion having a plurality of spaced radial members at least one of which always extends through said open window portion and each of which is adapted to be manually engaged only in said limited switch actuation region of said outer wall member, said radial members comprising lugs extending outwardly of said operator portion in sufficiently spaced relation to one another to permit insertion of a finger tip into the space at either side of each said lug between directly adjacent ones of said lugs to permit a turning force to be exerted upon said rotor in either of two opposite directions by finger pressure exerted in a direction predominantly circumferential and predominantly non-radial of said rotor, one of said radial members comprising a lug disposed adjacent a central part of said window portion at a given time and others of said radial members comprising further lugs inclined to

lie generally along both of said pair of sloping surfaces at said given time, said sloping surfaces being respectively positioned to intercept a finger, engaging one or the opposite side respectively of said one radial member, after said finger and said one radial member have moved said rotor in one or the opposite direction to bring said rotor into one of said predetermined different circuit registration positions, thereby to cause switching to be effected in a succession of limited arcuate rotor rotations determined primarily by the positioning of said sloping surfaces relative to the finger engaged one of said radial members.

2. The switch of claim 1 wherein said rotor further includes an indicia bearing section rotatable with said rotor, said window including a further portion disposed adjacent said indicia bearing section and positioned to permit the viewing of one indicium only on said indica bearing section at any given time.

3. The switch of claim 2 wherein said further window portion is disposed adjacent to and at one side of said first mentioned window portion, said further portion being shorter in length than said first portion, the adjacent sides of said window portions merging with and opening into one another whereby said window is substantially T-shaped in configuration.

4. The switch of claim 1 wherein said switching means includes a printed circuit disposed at a position anterior of said wall member, and wiper means engaging said printed circuit, said wiper means and said printed circuit being relatively rotatable for effecting a switching operation upon rotation of said rotor.

5. The switch of claim 4 wherein said printed circuit is carried by a supporting member fixed in position relative to said wall member, said printed circuit including arcuate conductive segments disposed at different radial positions relative to said rotor axis of rotation, said wiper means comprising a plurality of conductive fingers carried by said rotor member at such different radial positions, said rotor being continuously rotatable through angles greater than 360° in each of said opposite directions.

6. The switch of claim 1 including resilient detent means engaging a portion of said rotor for resiliently holding said rotor in its said different registration positions.

7. In a digital switching system:

a plurality of substantially identical units assembled side-by-side into a compact digital switching assembly, each unit including:

a casing providing therewithin a mounting chamber,

a digit-carrying wheel rotatably mounted in said chamber,

said wheel having an interrupted circumferential finger flange providing a plurality of outstanding finger lugs and a plurality of finger notches disposed between said lugs, and said wheel having a digit-carrying rim at one side of said flange,

said casing having an outer face wall provided in its middle portion with a view opening leaving a finger-stop portion of said face wall at each end of said opening,

a peripheral portion of said finger flange projecting through said opening and a peripheral portion of said rim projecting into said opening between said finger-stop wall portions, whereby to present to view a selected member of a plurality of digits appearing around said rim;

means extending through said units and binding them together, each casing having, at the side of its view opening opposite the finger flange, a lip extending laterally a short distance toward the finger flange of the adjacent casing and underlying portions of the finger-stop portions of the adjacent unit to assist maintenance of the assembly;

a circuit board mounted in each casing at the side thereof adjacent the respective finger flange and underlying the lip of the adjacent casing;

a wiper switch plate mounted about the axis of each wheel and secured thereto on the side facing the adjacent circuit board, said switch plate and circuit board in each case having cooperating contacts; and

terminal means on each circuit board connected with the respective contacts.

8. A system as in claim 7, wherein each casing is open at one side and has at its opposite side a side wall providing bearing means for the respective wheel, said side wall also providing bearing means for the wheel of an adjacent casing.

9. A system as in claim 8, wherein the respective circuit board is provided with bearing means for the respective wheel.

10. A system as in claim 7, wherein each casing has a side wall providing bearing means for the respective wheel and the respective circuit board has bearing means for the respective wheel.

11. A system as in claim 7 wherein said finger notches correspond in number to said finger lugs and are arcuate, and the digits on said rim correspond in number to said lugs, and said view opening defines a space for presenting to view simultaneously only one finger lug, two adjacent arcuate finger notches and a single digit of said wheel.

References Cited in the file of this patent

UNITED STATES PATENTS

1,555,969	Hatch	Oct. 6, 1925
1,564,551	Gates	Dec. 8, 1925
2,414,191	Coon	Jan. 14, 1947
2,421,881	Heasty	June 10, 1947
2,662,949	Christensen	Dec. 15, 1953
2,824,191	Christensen	Feb. 18, 1958
2,853,564	Gahgan	Sept. 23, 1958
2,874,338	Pease	Feb. 17, 1959
2,967,917	Cole	Jan. 10, 1961

FOREIGN PATENTS

760,989	France	Mar. 7, 1934
440,222	Great Britain	Dec. 23, 1935
577,897	Great Britain	June 5, 1946