April 6, 1965 C. L. DEEKEN 3,177,310

SWITCH PROGRAMMING DEVICE

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Fig. 1.

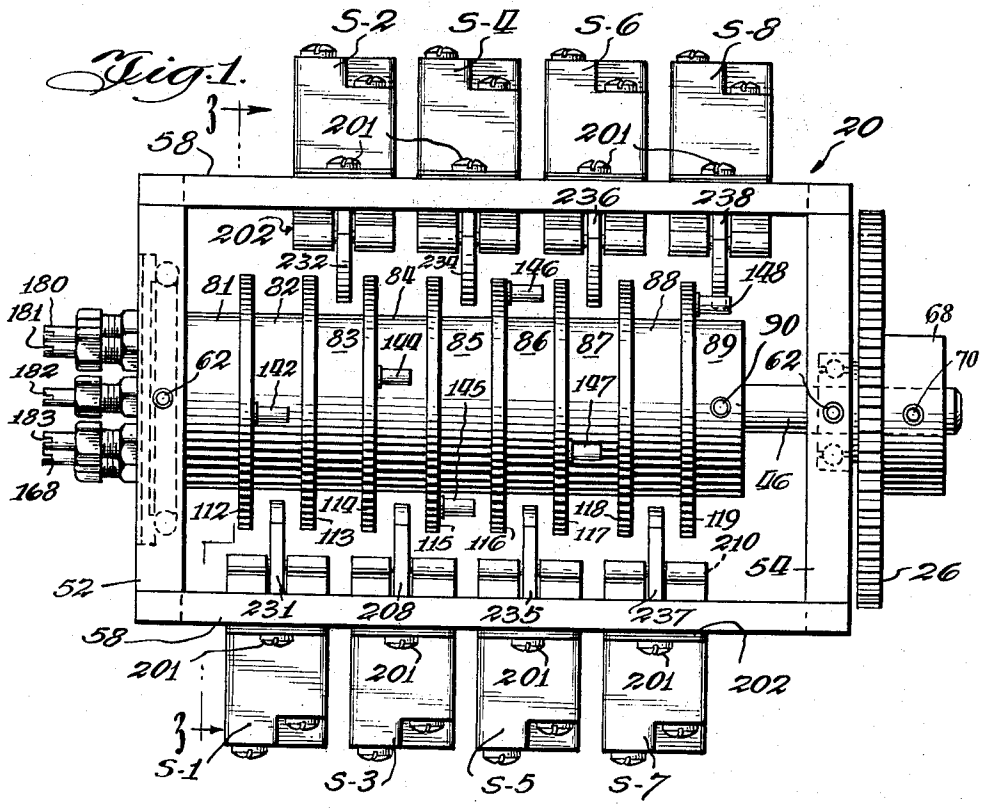
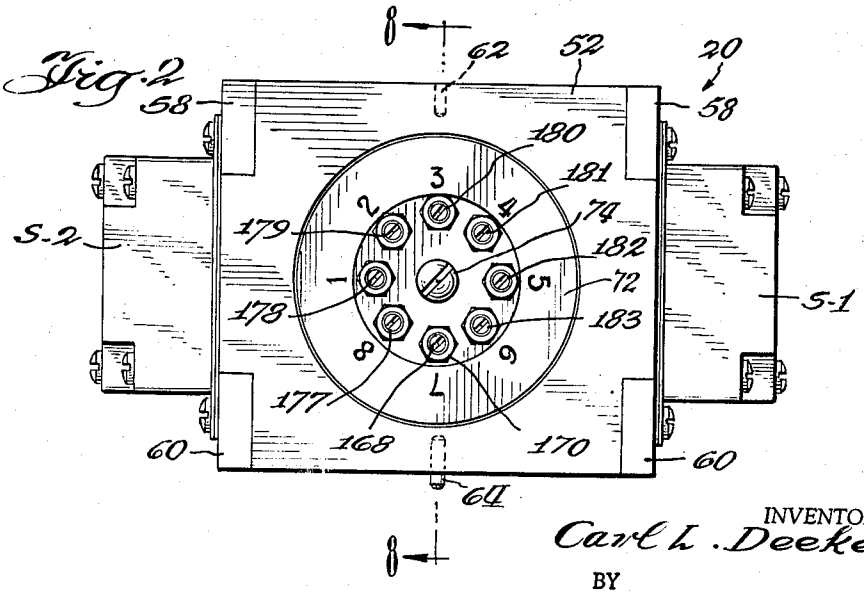


Fig. 2.



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SWITCH PROGRAMMING DEVICE

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Fig. 3.

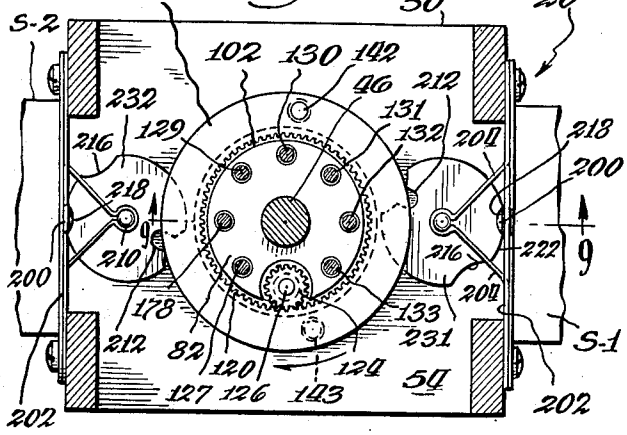


Fig. 4.

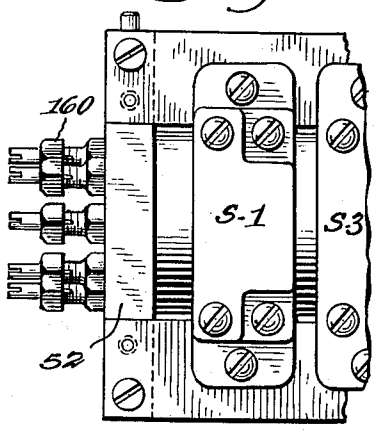


Fig. 5.

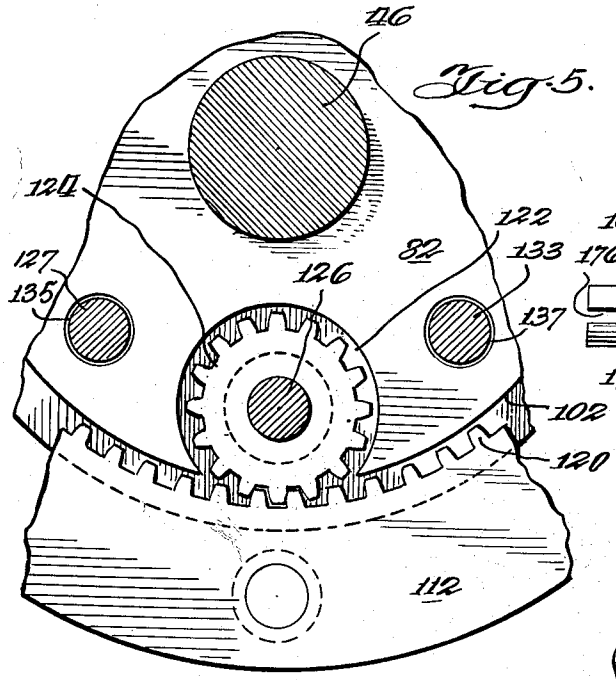
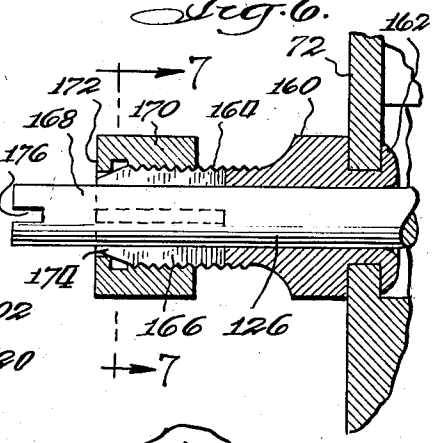


Fig. 6.



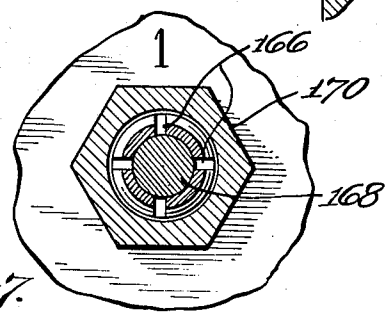


Fig. 7.

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Fig. 8.

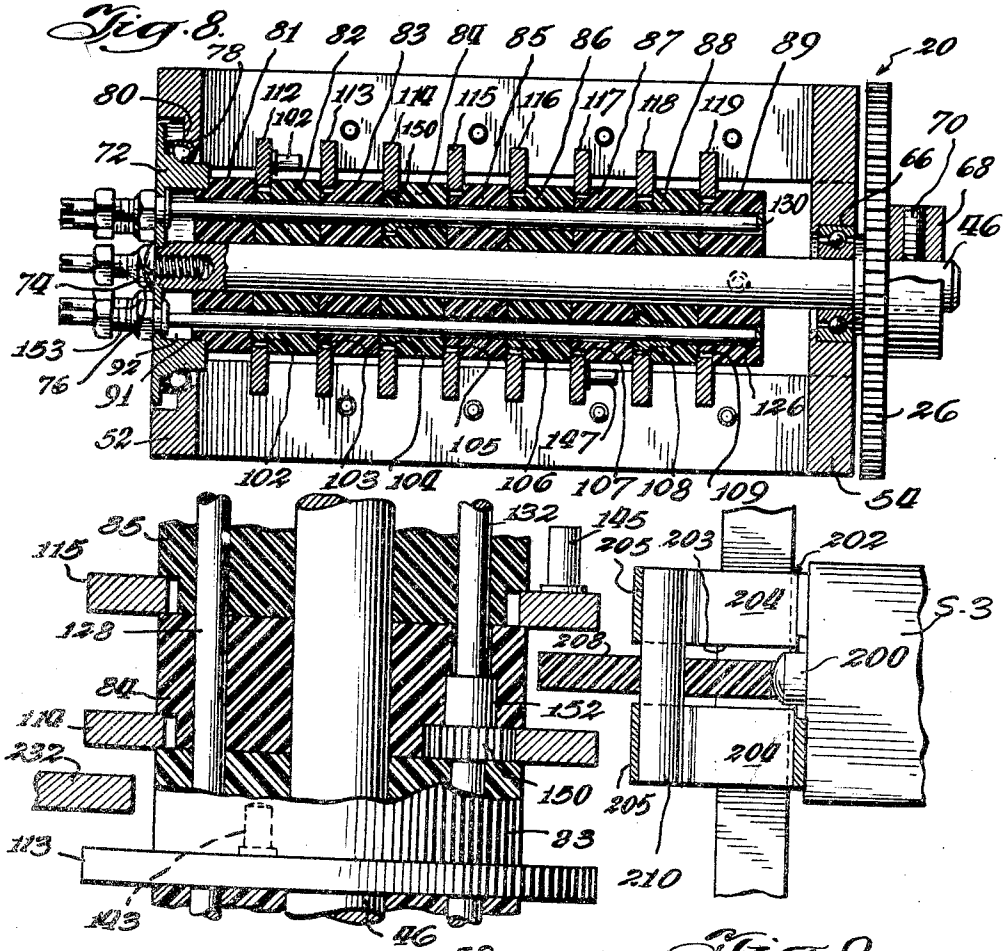

Fig. 9.

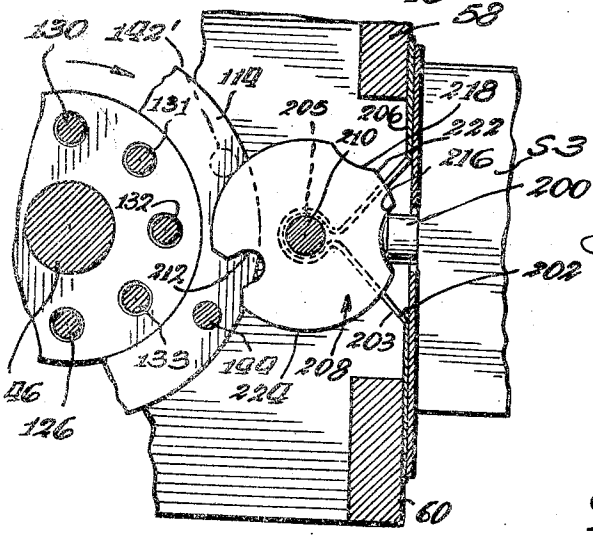

Fig. 10.

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Fig. 12.

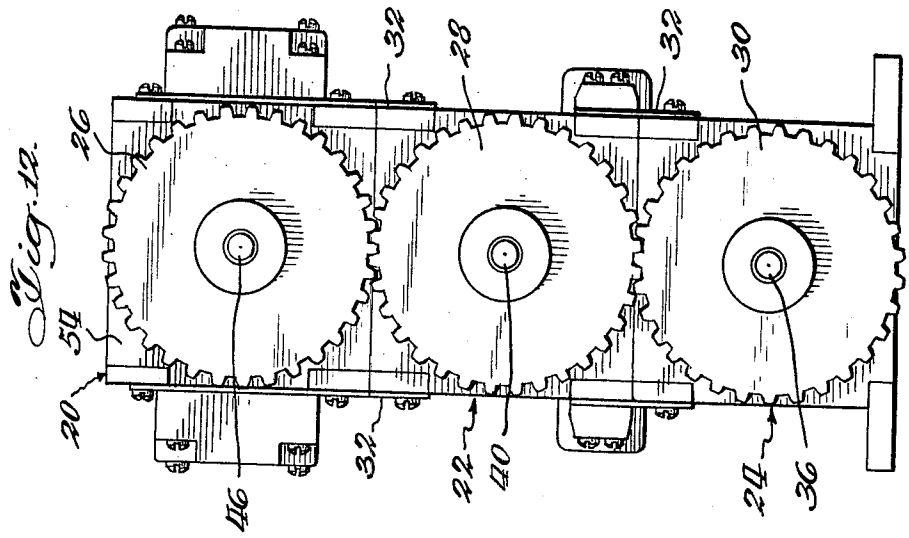
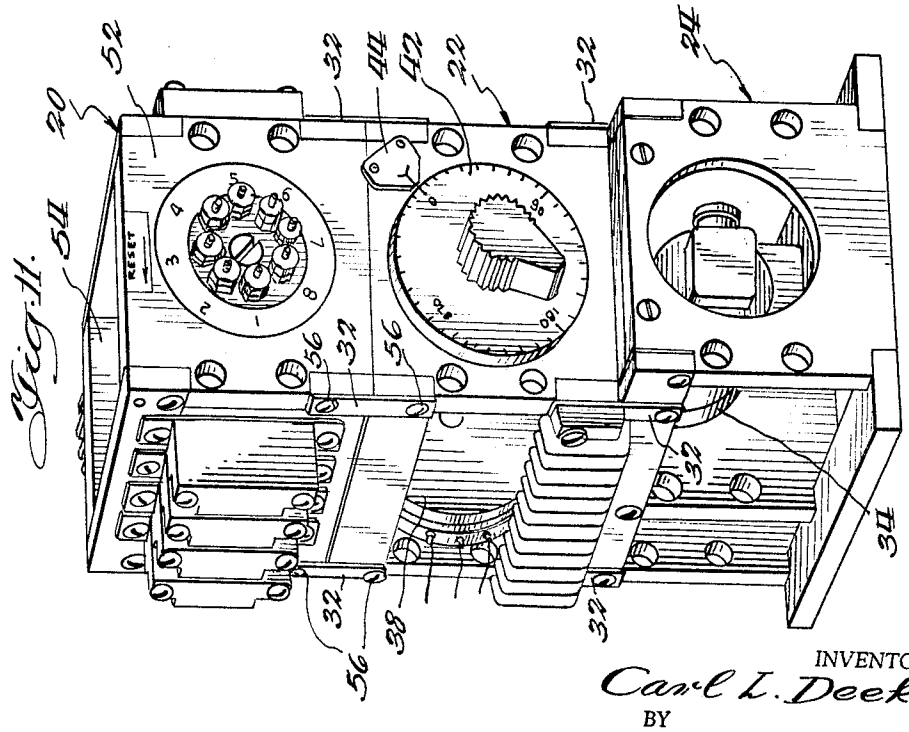


Fig. 11.



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United States Patent Office 3,177,310 Patented Apr. 6, 1965

3,177,310

SWITCH PROGRAMMING DEVICE

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Filed Mar. 26, 1962, Ser. No. 182,331
5 Claims. (Cl. 200—38)

This invention relates generally to a switch programming device or sequential timer, as this type of structure is known in the industry, and more particularly is concerned with a switch programming device in which the sequence of operation of a plurality of switches both as to order and time between respective operations may be adjusted readily.

The device of the invention, while especially intended for use in connection with the control of the various operations required in a press drive such as, for example, for driving rotogravure and the like printing presses, nevertheless is admirably adapted for use in control systems in industry in general.

The structure may be incorporated into computers, machine tools, electrical systems and the like.

The primary object of the invention is to provide a switch programming device of extremely compact construction suitable for use in causing not only the sequential operation of a plurality of switches, but suitable for causing the resetting of the said switches in reverse order.

An important object of the invention is concerned with the provision of novel means for changing the sequence of operation and resetting of the plurality of switches.

Still a further object of the invention is to provide a device of the character described which is adapted to be incorporated in a structure of generally modular form including driving as well as driven elements operating in conjunction with the said programming device.

In connection with the object immediately described above, it is an important end of the invention to mount the programming device upon a structure composed of a plurality of such devices operating from the same driven source, or upon a module of substantially the same configuration and construction as that housing the device which contains a potentiometer to be driven in unison with the device and/or a motor for driving the device and all others which may be associated therewith.

Certain specific objects of the invention are concerned with the provision of a structure for permitting facile adjustment of the sequence of operation of the switches as well as the time between the operation thereof.

Many additional objects will occur to those skilled in the art as the preferred embodiment of the invention is described in detail hereinafter in connection with which the drawings illustrate the same.

In the said drawings:

FIG. 1 is a top plan view of a switch programming device constructed in accordance with the invention.

FIG. 2 is an end elevational view of the device taken from the left side of FIG. 1.

FIG. 3 is a sectional view taken generally along the line 3—3 of FIG. 1 and in the direction indicated.

FIG. 4 is a fragmentary side elevational view of the left hand portion of the device as viewed in FIG. 1.

FIG. 5 is a fragmentary view of a portion of FIG. 3 on a greatly enlarged scale to illustrate the details thereof.

FIG. 6 is a fragmentary median sectional view taken through one of the shaft ends and showing the means for locking the shaft against rotation.

FIG. 7 is a sectional view taken generally along the line 7—7 in FIG. 6 and in the direction indicated.

FIG. 8 is a vertical sectional view taken generally along the line 8—8 of FIG. 2 and in the direction indicated.

FIG. 9 is a sectional view taken generally along the line 9—9 of FIG. 3 and in the direction indicated, although not necessarily through the particular disc.

FIG. 10 is a fragmentary enlarged view similar to that of FIG. 3 showing the switch operating cam in a different position.

FIG. 11 is a perspective view of an assemblage of modular components of generally the same configuration arranged to be secured in cooperative relationship to one another, including as one of said modules, the programming device described in connection with FIGS. 1 to 10 and other modules of different but cooperative function.

FIG. 12 is an end elevational view showing the rear of the assemblage of FIG. 11 to illustrate the manner in which cooperation between the said modules is achieved.

The invention herein is characterized by the provision of a frame or housing mounting a plurality of switches, each adapted to be actuated by a suitable cam or tripping member mounted to the frame or housing. Within the frame or housing there is provided a plurality of spaced rings adapted to be rotated together, each ring having at least one drive pin thereon arranged to engage the cam or tripping device associated with one of the respective switches. The rings are mounted each on an individual disc, all of the discs being stacked together and in turn mounted upon a central shaft for rotation in unison. Each disc is provided with a small pinion gear that meshes with gear teeth provided on the interior circumference of the associated ring and each pinion, in turn, is secured to an elongate adjustment shaft which passes through the stack of discs and out to a wall of the frame or housing so that the rotation of the adjustment shaft will rotate the position of the ring and its drive pin relative to the disc and hence will change the disposition of the pin relative to the central shaft. Means are provided for locking each of the adjustment shafts in any rotative disposition.

The invention is further characterized by providing a large gear at one end of the central shaft outside of the housing, by means of which the central shaft may be rotated. Likewise, the construction of the frame or housing is such that other similar configurations of frames or housings may be mounted thereon or connected therewith so that the programming device may be one of a stack of such modules or integers with the said other components, the said components housing motors, potentiometers, as well as other programming devices.

Referring now to the details of the invention, the reference character 20 is used to designate generally the programming device which is specifically described in connection with FIGS. 1 through 10 inclusive. As shown in FIG. 11, the programming device 20 is built into what may be termed a module or construction integer, enabling the same to be associated with other modules or integers of the same or similar general construction. For example, in FIGS. 11 and 12, there are illustrated two other modules or integers 22 and 24. The modules 20, 22 and 24 are each provided with a large external gear as shown at 26, 28 and 30 and when the modules are stacked one on top of the other as, for example, by the straps 32, the gears 26, 28 and 30 mesh. The module 24 houses a motor 34 adapted to be energized through a suitable source of electrical current, driving the shaft 36 which, in turn, drives the gear 30. The module 22 has a potentiometer 38 mounted therein, the shaft 40 of which is fixed to the gear 28 at one end and fixed to a dial 42 at the other end so that the disposition of the wiping arm (not shown) of the potentiometer 38 may be ascertained at any time visually when viewing same in relationship to an index as shown at 44.

The gear 28 in turn meshes with the gear 26 so that rotation of the motor 34 will rotate a central shaft 46 to which the gear is fixed. This in turn operates the

switch programming device 20 in a manner which will be described presently.

Obviously, additional modules of the same structure as 20 and 22, for example, may be mounted on top of the assemblage shown in FIGS. 11 and 12, having similar gears meshing with one another and gear 26, for example. All of these may be driven by the one motor 34 or by means of some similar source of motive power.

Referring now to FIGS. 1 through 10 inclusive, the switch programming device 20 is mounted in a housing or framework 50 of relatively simple construction. There are a pair of end plates 52 and 54 being shown to the left and right respectively in FIG. 1, each provided with suitable rectangular corner notches, as best seen in FIG. 2, so that four elongate bars of rectangular cross section may be seated in the said notches and held in place by suitable fastening means. For example, the screws 56 in FIGS. 11 and 12 which are used to tie the straps 32 down can at the same time retain these bars in their respective notches. The bars may be identified in FIG. 2 as the top bar 58 and the bottom bars 60.

Each of the end plates 52 and 54 is provided in its top edge with a socket 62 and in its bottom edge with a pin 64, to assist in stacking in the manner shown in FIGS. 11 and 12.

The central shaft 46 to which reference has been made above is journalled in the right end plate 54 by any suitable means such as, for example, ball bearing 66 set into a suitable cavity provided in the said end plate 54. As mentioned above, the external gear 26 is fixed to the shaft 46 as, for example, by means of the hub 68 integral with the gear 26 and the set screw 70.

At its left end, the central shaft 46 is secured to a circular disc 72 by means of a central screw 74. Any suitable means for accomplishing this may be used such as, for example, the end 76 of the central shaft 46 may be of reduced diameter and squared off and adapted to engage a suitable opening formed in the disc 72 in the center thereof so that the screw head of the screw 74 clamps the disc to the left end of the shaft 46. The external face of the disc 72 preferably is flush with the external face of the left end plate 52 and the body of the disc 72 may mount circumferentially spaced antifriction balls 78 riding in a suitable race 80 formed in the said end plate 52.

As appreciated from the above description, the shaft 46 together with the disc 72 is mounted for anti-friction rotation in the end plates 52 and 54.

A stack of cylindrical discs is mounted on the shaft 46, the discs being identified in the illustration as discs 81 through 89 inclusive. The discs 82 through 89 are identical in construction with the exception of the disc 89 which may be pinned to the shaft 46 as shown at 90. The disc 81 is a spacing disc with a reduced diameter portion as shown at 91 that engages within an annular recess 92 formed in the end of disc 72. As will be appreciated following further description, the discs 81 through 89 are assembled to rotate together with the shaft 46 and the disc 72. The left hand end of each of the cylindrical discs 82 through 89 is of reduced diameter to form a seat or shoulder 102 through 109 respectively. A ring is mounted for rotation on each seat, as shown at 112 through 119 respectively, sandwiched between adjacent discs.

Applying the construction above described to FIGS. 3 and 5, the cavity which is referred to is identified as 122 and the small planetary pinion gear designated 124. The shaft, upon which the pinion gear 124 is mounted, and to which it is secured, is identified by the reference character 126.

Looking at the view of FIG. 3, it will be appreciated that there will be a small planetary pinion gear similar to 124 associated with each of the discs 82 through 89 and likewise, there will be an elongate shaft similar to that identified at 126 for each pinion gear, all of the shafts extending throughout the entire length of the assembly.

These shafts are identified in FIG. 3 as 127 through 133, there being a total of eight shafts corresponding to the eight rings. Obviously, all of the discs must be provided with passageways which are aligned to accommodate all of the shafts, and include a respective cavity equivalent to the cavity 122 of the disc 82. In FIG. 5, the axially extending passageways to accommodate the shafts 127 and 133 are designated 135 and 137.

Each ring is seen to be capable of independent rotation relative to its disc and, hence, relative to the other rings. Each ring also is provided with an axially extending drive pin secured to the ring, whose purpose is to throw the various switches which will be presently described. These drive pins are designated 142 through 148 and are shown in several of the figures.

The planetary pinion gears of the discs 84 and 88 may be seen in FIG. 8.

Each of the shafts passes through all of the discs, but only one shaft is fixed to a pinion gear of one disc. As will be noted, especially from FIG. 9, the pinion gears such as, for example, the pinion gear 150, is provided with a hub 152 and obviously each of the cavities must be of a configuration to freely accommodate rotation of such hub 152.

The shafts 126 through 133 are evenly spaced about the central shaft 46, and each shaft passes through a bushing which is fixed to the disc 72 and protrudes from the bushing. These bushings are illustrated in FIGS. 1, 4 and 5, all of them being identical in construction, and hence, designated 160. FIG. 6 is an enlarged view of the same.

It will be seen that the bushing 160 is hollow to permit the shaft such as, for example, the shaft 126, to pass through the same. The bushing has one end swaged into engagement with the disc 72 as shown at 162, and the opposite end is threaded as at 164 and slotted as at 166. The slot in the bushing end has the effect of forming a chuck which can be compressed about the protruding end of the shaft such as 168, to fix the shaft in any rotative disposition. A nut 170 provided with a decreased diameter shoulder 172 is engaged upon the threaded portion 164 of the bushing 160 so that as the nut 170 is taken up, the reduced diameter portion 172 will engage against the tapered end 174 and thereby tend to constrict the four quadrants of the slotted end. The protruding end 168 is provided with a transverse slot 176 so that the shaft 126 may be rotated by means of a screw-driver.

In a similar manner, each of the shafts 127 through 137 has a protruding end 177 through 183 as shown in FIG. 2. Each shaft end is slotted to accommodate a screw-driver, and there is a nut identical to the nut 170 for chucking the bushing 160 upon the respective shaft for seizing or releasing the same.

Each shaft may be coded with suitable indicia on the face of the disc 72, such as shown in FIG. 2. The shaft 128, for example, may be that one which is designated by the numeral 1 and its pinion may be meshed with the ring 112. The shaft 129 may have its pinion meshed with the ring 113, and it may be identified by the numeral 2. In like manner, each numeral on the face of the disc 72 can identify that ring whose rotative disposition may be controlled by the respective shaft end. In use, the particular nut equivalent to the nut 170 is loosened by means of a wrench, the shaft end rotated by means of a small screw-driver until the ring is in the desired position, and the same wrench used to tighten the nut.

A plurality of switches is shown mounted on opposite sides of the device 20 and secured between the upper and lower bars 58 and 60 by suitable screws such as shown at 201. Switches are designated S–1 through S–8 in accordance with the position of the ring which is intended to throw the respective switch, that is, in accordance with the position of the ring relative to the left-hand end of the device 20 as shown in FIG. 1, which may be considered the front of the device. Thus, when the assembly

of discs and rings has rotated, the drive pin 142 of the ring 112 is intended to operate the switch S–1, the drive pin of the ring 113 is intended to operate the switch S–2, and so on.

The switches which are shown are of enclosed construction, having any of a plurality of circuits. Since it is intended that the switch be operated by button pressure, for the most part the switches will be single throw, but they may be single or double and under certain circumstances may even be double throw switches. As shown in FIG. 10, each switch presents its actuating button 200 to the interior of the housing or frame and each switch has an actuating cam mounted on a bifurcated bracket in position to be driven by the drive pin for actuating the switch button 200. As shown in FIGS. 9 and 10, the brackets may comprise simple sheet metal strap members 202, each having a central slot 203 to form the arms 204, and each arm having a journal loop 205 formed therein. The strap members 202 are secured between the switch and the bars 58 and 60. As shown in FIGS. 9 and 10, the actuating cam 208 is mounted on a shaft 210, journalled in the loops 205.

Each cam is generally circular but has a radial notch 212 adapted to be engaged by the rotating drive pin such as for example, the pin 144, and each cam 208 has a switch actuating recess as shown at 216 and a switch detent of lesser depth at 218, separated by surface 222. The remaining edge of the cam is designated 224. When the button 200 is engaged in the notch 216, it is extended, and the circuit of the switch S3 is in one condition, and when the button 200 is engaged upon either of the surfaces 222 or 224, or is in the shallow detent 218 it is in depressed condition, giving a second electrical condition. It will be seen also that as the ring 114 is rotated along with all of the remaining rings, it can carry the pin 144 into the radial notch 212 and rotate the cam 208 to change the electrical conditions of the switch S3. The extent and scope of such rotation and the exact manner of operation will be described below.

From an examination of FIG. 1, it will be seen that each of the switches S–1 through S–8 is provided with a similar cam, these being designated 231 through 238 except for the cam which serves the switch S–3, this being designated 208 as previously described. As will become apparent from the discussion of the manner in which the switches may be actuated and set forth below, in addition to serving as means for actuating the switch button, the cams may also serve as stop members.

Attention is first invited to FIGS. 3 and 10 for an explanation of the manner in which the switches of the switch programming device 20 are operated through the rotation of the assembly of discs 81 through 89 with their associated rings 112 through 119. As seen in FIG. 3, the position of the cam 231 is with the switch detent 218 engaging the end of the switch button 200 associated with the switch S–1. The radial notch 212 of the cam 231 opens in a direction upward and to the left. The switch actuating recess 216 is arranged as shown free of any engagement.

Assuming now that the assembly of discs is rotated in a clockwise direction, the pin 142 will rotate approximately 90°, will ride into the notch 212, and, as the ring continues to rotate, the cam 231 will be rotated in a counterclockwise direction as viewed in FIG. 3. As this occurs, first the detent 218 passes over the end of the button 200 which thereafter rides upon the dwell portion 222, and thereafter the button 200 will drop into the actuating recess 216 by virtue of spring pressure as conventionally provided in switch buttons of this kind. The resulting relationship of the parts will be somewhat as shown in FIG. 10, although in FIG. 10, the particular ring and cam are identified as 114 and 208. Further rotation of the assembly of discs in a clockwise movement will not affect the relationship of any cam which has been disposed in the condition shown in FIG. 10.

The switches are of such construction that when the respective buttons 200 are engaged in the recesses 216, one electrical condition of the circuit of the switch is established, and when the buttons 200 are engaged in a detent 218, another condition of the circuit is established. One such condition may be with an electrical circuit open in which case the other will be with the electrical circuit closed.

Referring again to FIG. 3, attention may be directed to the cam 232 which operates in conjunction with the switch S–2. It will be seen that in this case the pin 143 will rotate in a clockwise direction and will enter the notch 212 from the bottom, rotating the cam so that the button 200 rides out of the detent 218 and passes into the recess 216. Thus, the cam 232 acts as an operating lever for the switch S–2 as the notch 212 is engaged by a switch throw member, pin 143.

The cams are freely rotatable and likewise very little pressure is usually required in conventional switches of the type illustrated, and hence, unless prevented from doing so, the cams could ride past the buttons by inertia. The cams, however, are made of a very light plastic material, and the fact that the buttons are required to engage in concave detents 218 or recesses 216 means that the position to which the respective pins will move the associated cams will be maintained.

Looking once more at FIG. 3 and considering only the cam 231 and the pin 142, since the only thing that is in the path of the pin 142 as it rotates is the cam, it is feasible for the pin to rotate through at least 360° and substantially more, depending upon the location of other pins of the assembly. If the ring 112 and its pin 142 were the only structures rotating, obviously, even after the pin had rotated through 360°, it would be able to rotate until it once more engaged the edge of the cam 231. If the pin had been rotating in the same direction at all times, obviously the position of the cam would be as shown in FIG. 10. Therefore the pin 142 would engage against the edge of a cam and the ring would be required to stop rotating. This is shown at 142' in broken lines in FIG. 10. The normal programming system, however, does not require more than 360° of rotation, and hence, the various rings may be arranged in different locations circumferentially so that a predetermined sequence of operation of the switches may be achieved. Likewise the time in between operations of the switches is readily adjusted by adjusting the circumferential spacing between the various pins of the rings of the structure.

Assume that the cam 231 has been rotated so that its position is equivalent to that of the cam 208 shown in FIG. 10. When a program of switch operation has been completed and it is desired to reset all of the switches to their original position, the assembly is rotated in the opposite direction, that is, in a counter-clockwise direction and as each pin in turn approaches its respective switch, it will ride into the notch 212 and return the cam to its original position, thereby once more moving the respective button 200 from the recess 216 to the detent 218.

In a construction of this kind, there is substantial room for adjusting the program of switch operations so that at least a 360° rotation will be achieved. It will be seen that the first cam to be rotated by a drive pin passing the same will become a stop member for the entire assembly moving in that same direction. The last cam to be rotated by the movement in that direction will be the stop member when the assembly is rotated in the opposite direction as in re-setting.

There is no problem in arranging the order in which the cams are to be operated since electrically one may connect any set of wires to any switch. The user merely establishes his program, ascertains the angular movement desired within which to accomplish all of the operations and adjusts the device accordingly.

An important reason for having at least 360° of rotation available is to enable a simple gearing arrangement,

such as shown in FIG. 12, to be used in connection with the potentiometer 38. Since the potentiometer is desired to have a swing of at least 360°, there is no limitation set upon the rotation of the potentiometer by the programing device. As a matter of fact, it would be a usual occurrence for the limits of movement of the wiper of the potentiometer to be the controlling factor in the amount of rotation available.

It is believed that the invention has been fully described such as to enable those skilled in this art to understand the same and apply the construction thereof to the purposes for which intended. The great flexibility of the device will be understood as one studies the construction thereof in view of the appended law. Many details can be changed without departing from the scope of the claims.

What it is desired to secure by Letters Patent of the United States is:

1. A structure for throwing a plurality of switches in any predetermined sequence which comprises a housing, a plurality of push button switches mounted on the housing, a cam mounted adjacent each switch and having a shallow detent and a deep detent adapted to engage the button of said switch to place the electrical circuit of said switch in one or another electrical condition, each cam having an actuating notch, an assembly of discs mounted on the housing and each having a ring having a pin adapted to be engaged in the cam actuating notch when the assembly is rotated, the rings being independently adjustable in circumferential disposition to enable the spacing of said pins to be adjusted, in which a second housing is provided having a potentiometer mounted therein, a shaft is provided for rotating said potentiometer, means are provided connecting the shafts for rotation together, said first and second housings having cooperating means for securing same together with the shafts so connected.

2. A structure for throwing a plurality of switches in any predetermined sequence which comprises a housing, a plurality of push button switches mounted on the housing, a cam mounted adjacent each switch and having a shallow detent and a deep detent adapted to engage the button of said switch to place the electrical circuit of said switch in one or another electrical condition, each cam having an actuating notch, an assembly of discs mounted on the housing and each having a ring having a pin adapted to be engaged in the cam actuating notch when the assembly is rotated, the rings being independently adjustable in circumferential disposition to enable the spacing of said pins to be adjusted, in which said housing has means for connecting same in a modular assemblage with other housings of similar structure.

3. A switch throwing device comprising a plurality of button switches, a framework having the switches mounted thereon with the buttons presented to the interior of the framework, a central shaft journalled in the framework and having a pluraltiy of discs coaxially mounted thereon, each disc having an internally-toothed ring gear journalled thereon and a pinion mounted enmeshed with the said gear, the plural gears associated respectively with the discs of said plurality being of substantially greater diameter than the discs and each having a drive pin mounted thereon, a plurality of axially extending shafts each passing through all discs but fixed to only one pinion and having a portion exposed at one end of said assembly, a plurality of cams, each arranged to engage a switch button and having a notch to enable operation thereof by passage of a pin, and means for rotating each shaft independently to vary the location of the pins relative one another so as to establish thereby any desired sequence of operation of the cams.

4. A programming device (20) for operating a plurality of switches (S–1—S–8) in sequence which comprises a plurality of actuating buttons (200) associated respectively with the switches of said plurality, a plurality of cams (208) having an actuating recess (216) respectively associated for operative engagement with the buttons of said plurality, said cams, further, each having a radial notch (212) and being rotatively mounted on a shaft (210), a plurality of rings (112–120) respectively corresponding to the cams of said plurality and mounted for rotative motion, a drive pin (144) on each of said rings engaging with respective radial notches (212) of said cams in the course of rotation of said rings, means for adjusting the relative rotational disposition of the rings of said plurality, said means comprising a like plurality of discs (31–39) respectively associated with said rings and coaxially mounted therewith, plural adjustment means including a rotatable pinion gear (124) for respectively engaging said rings, whereby said rings are selectively adjustable about the mounting axis of said discs, said rings being mounted for rotation with said discs, whereby said cam notches (212) are respectively engaged by respectively associated drive pins (144) of said plurality in selectively adjustable angular orientation for operation of said switches in programmed sequence in correspondence with adjustment of said rings upon rotation of said discs.

5. Apparatus as set forth in claim 4 wherein each cam of said plurality comprises means for limiting the rotation of said cams by engagement of one of said pins with one of said cam notches.

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BERNARD A. GILHEANY, *Primary Examiner.*