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SEQUENTIAL SWITCH OPERATOR ASSEMBLIES

Filed Feb. 26, 1957

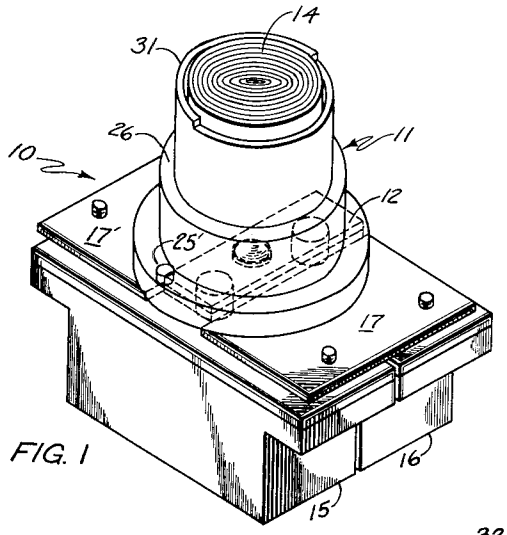


FIG. 1

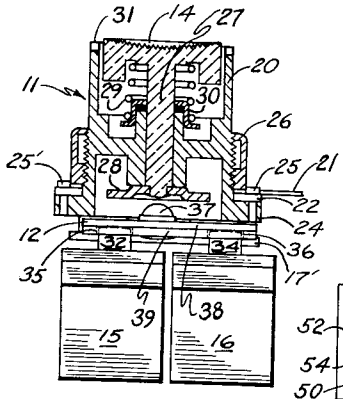


FIG. 2

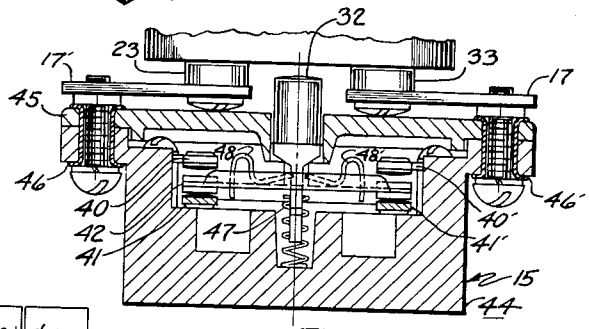


FIG. 5

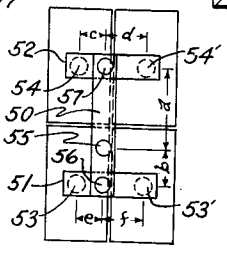


FIG. 6

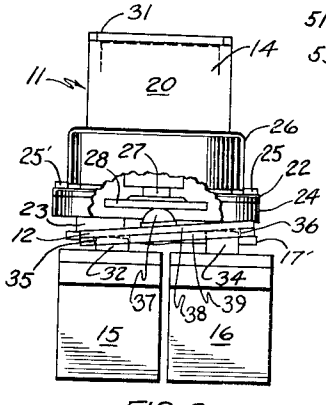


FIG. 3

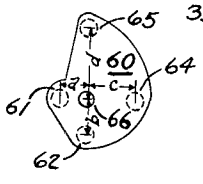


FIG. 7

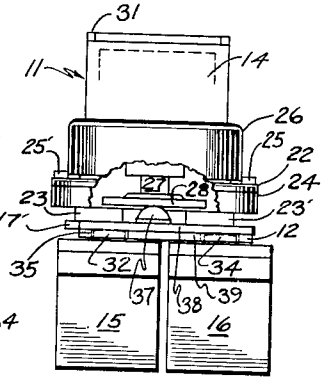


FIG. 4

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SEQUENTIAL SWITCH OPERATOR ASSEMBLIES

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7 Claims. (Cl. 200—6)

The present invention relates to sequential switch operator assemblies, and more particularly, to switch operator assemblies having an actuating lever producing graduated moments of force for sequential switch operation.

The need for a selective switch operator assembly arises out of requirements for a rapid transfer from one circuit to another circuit such as in hoist controls where the change of speed or transfer from low to high speed and from high to low speed must be rapid and require only the minimum of effort by the individual controlling the apparatus. One of the simplest operators is a pushbutton station; therefore one of the most desirable means to provide this change or transfer from one speed to another speed is a pushbutton operator or the like. Prior to the present invention the control transfer has required the use of control relays to energize contactors or the like individual to separate power circuits requiring rapid sequential energization.

The present invention has simplified the prior art arrangement by the elimination of the need for a control relay and provision of an operator for the sequencing of switches or snap switches by an actuating lever or teeter bar having an offset contact point for engagement with the operator whereby a pressure or force applied by the operator or pushbutton was unequally distributed between the switches or more particularly, the switch stems or plungers which are resiliently biased to engage and support the teeter bar. This arrangement provides operation of the switches in the inverse order of the length of lever arm whereby a greater pressure is applied by the switch operator or pushbutton on the switch stem closest to the actuating lever contact point.

Conversely, as the pressure is relieved on the switch operator, the switches return to their original position sequentially and in the reverse order of operation. The transfer from one speed to another therefore may be made selective by indexing the switch operator or where the operator is not indexed, by gauging the travel of the switch operator. A further advantage of the present invention in the selection of the operator is the "feel" of the pushbutton on the teeter bar or lever which is transmitted through the operator upon each movement of the teeter bar or lever to indicate the position of the switches. It is an object therefore of the present invention to provide a sequential switch operator assembly having the foregoing features and advantages.

Another object is to provide an operator assembly for sequential actuation of switches.

A further object of the present invention is the provision of a selective operator for actuating switches sequentially.

Still another object of the invention is the provision of a simple operator for rapid transfer of circuits.

A further object is to provide an actuating member operated by a reciprocal operator for sequentially actuating two or more switches on an operating stroke and deactuation in the reverse order on the return stroke.

Further objects and features of the invention will be

readily apparent to those skilled in the art from the specification and appended drawing illustrating certain preferred embodiments in which:

Fig. 1 is a pictorial projection of the operator assembly illustrating a preferred embodiment of the invention.

Fig. 2 is a side elevation partially in cross section to show the internal construction of the switch operator.

Fig. 3 is a side view of the operator assembly partially broken away to show the operation of the actuating lever and operator.

Fig. 4 is a side view similar to Fig. 3 showing another position of the operator and actuating lever.

Fig. 5 is a cross section of one of the snap switches shown in Figs. 1–4.

Fig. 6 is a diagrammatic view of an embodiment, shown partially in top plan, of a simple complex actuating lever assembly.

Fig. 7 is a diagrammatic view of another modification of the actuating lever assembly for sequential actuation of a plurality of switches.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in Fig. 1 which illustrates a preferred embodiment, a selective and sequentially operated pushbutton electric switch assembly **10** according to the present invention comprising a rectilinearly movable reciprocally operated pushbutton apparatus **11**, a captive floating actuating lever or teeter bar **12** in operative relation relative to said pushbutton operator **14** between the pushbutton assembly and a pair of switching units **15** and **16** secured to one another by mounting plates **17** and **17'** on either side of their actuating stems **18**, **19** and below the actuating lever **12**.

The internal construction of the operator assembly is more clearly shown in Fig. 2 where the coupling with the actuating lever **12** and switches **15** and **16** is visible. In the operating position of the switch assembly **10** the operator housing **20** may be mounted in a sheet metal panel **21** having a corresponding opening to accommodate the housing whereby the operator housing **20** may extend therethrough to abut the periphery of the panel opening along a sealing gasket **22** seating on a peripheral flange **24** at the base of the operator housing.

Adjacent the circular opening in the panel **21** accommodating the operator housing **20**, one or more smaller openings may be provided in the panel to index the switch assembly by means of dowels or pins **25**, **25'** inserted in the flange **24** projecting through the sealing gasket **22** and into or through the smaller openings. The external periphery of the operator housing **20** is threaded adjacent the sealing gasket **22** or the flange **24** to accommodate the ring nut **26** securing the assembly **10** in the panel opening.

Four vertical mounting posts **23**, **23'**, **33** and **33'** may be formed as part of the housing **20** projecting downwardly and secured to mounting plates **17** and **17'** by tap screws or the like whereby the posts support the operator assembly **11** above the plates **17**, **17'** and switch units **15** and **16** and provide clearance for the actuating lever **12** and movement thereof.

The internal construction of the operator assembly includes the pushbutton **14** mounted for rectilinear movement inside the housing **20** having a main body portion or hub extending laterally to close the external opening end of the housing **20** to be exposed for manual operation. The center shaft **27** of the operator **14** extends through a longitudinal bearing surface which may be formed integral with the operator housing **20**. The interior end of the shaft **27** may be tapered for mounting an operating disc **28** having a center opening through which the tapered portion of the shaft **27** projects to be suitably secured thereto by riveting or the like. Circular recesses

are provided in the operator 14 longitudinally adjacent the hub and the central section of the housing providing longitudinal bearing seats for resilient operator support means such as coil spring 29 seating in the circular recess in the operator 14 and on a spring cup 30 at respective spring ends.

Lateral peripheral flanges of the spring cup 30 provide a seat for the associated end of the operator spring 29 and a stationary support rigidly coupled with the housing 20 for reciprocal operation of the pushbutton operator. A peripheral edge of the housing adjacent the exposed end of the pushbutton operator includes a semicircular extension or guard preventing accidental operation of the operator. The peripheral longitudinally extended portion or guard may project from the housing proper over a portion of the operator and taper at both ends to meet the peripheral edge of the housing.

The switch actuating lever 12, shown in Fig. 2, is arranged between the operator assembly 11 and the pair of switches 15, 16 floating or resting across resiliently supported switch stems or actuators 32, 34 which project from the upper surface of the switch enclosures and are rectilinearly movable in the respective bearing surfaces of the enclosures. The lever 12 may comprise a strap or bar having downwardly opening cavities or recesses 35, 36 slightly larger in cross section than the switch stems 32, 34 to permit the upper portion of the actuator stems 32 and 34 to seat in the recesses, to resiliently support the bar or lever 12 and prevent lateral movement.

Between the bar recesses, a bore or opening is located in the strap at unequal distances from the switch stems 32, 34 and directly below the center line of the hub 27. An operator contact point 37 may project above the opening on the upper surface of the bar 12 to engage the operator hub 27 or operator disc 28 and may include a rivet or the like having a spherical head whose shank projects through the bar and flanged on the opposite side of the bar 12. As shown in Fig. 2, the bar or strap may include a top strip 38 and a bottom strip 39, having corresponding openings for the rivet securing them together and a lower strap 39 having holes closed on top by the adjacent strap forming the aforementioned recesses for the switch stems 32, 34.

A switch unit 15 is shown in cross section in Fig. 5, having two sets of stationary contacts 40, 41 and a movable bridging contact member 42 providing a double throw switch structure. The stationary contacts 40 and 41 are secured to a contact block 44 which encloses the switch assembly and includes the cover member 45 secured to the contact block 44 by eyelets 46, 46' on opposing ends. As shown in Fig. 5, the switch stem or actuator 32 has not been operated and the movable contacts on the movable contact member 42 engage the lower stationary contacts 41, 41' to provide a normally closed circuit through the switch via respective externally located terminals not shown.

Coil spring 47 seats on a center extension or tapered portion of the stem 32 and the leaf springs 48, 48' which abut the stem and seat on extruded portions of the movable contact member to resiliently support the stem 32 in its upward position. The leaf springs 48, 48' in cooperation with the movable contact member 42 provide a toggle coupling whereby pressing or forcing the stem 32 downwardly causes the portions of the leaf springs 48, 48' adjacent to the stem to move downwardly across toggle dead center and the opposite ends of the leaf springs seating on the movable contact member 42, apply a force in the opposite direction from before, forcing the movable strap 42 upwardly to engage the upper stationary contacts 40 and 40'.

The toggle arrangement provides a snap action or rapid operation of the movable contacts from their normally closed position to the normally open position to engage the normally open contacts 40, 40'. The specific switch structure recited is not intended to limit the scope of the invention but rather to describe a completely operative embodiment of the switch assembly and to illustrate the preferred embodiment.

Operation

Figs. 2, 3 and 4 illustrate the mode of operation of the preferred embodiment in which the sequencing of two switches 15 and 16 has been simplified by an actuating lever or teeter bar 12 having an offset operator assembly 11 including an operator engaging portion 37, whereby pressure on the operator member is unequally distributed between the switch stems 32 and 34 or produces unequal moments of force on switch stems 32, 34 supported by springs of equal resiliency. Offsetting the operator engaging contact portion or projection 37 of the teeter bar relative to the switch stems 32 and 34 produces unequal lever arms or force moments on the spring biased switch actuator stems 32 and 34, whereby a greater pressure or force is produced on the switch stem 32, having the shorter lever arm, to actuate the switch stem 32. This is followed by actuation of the other switch stem 34 upon a further force being added by further depressing the pushbutton operator 14 by an additional force on the operator against the bias of the operator spring 29. Conversely, as the pressure or force on the operator is relieved, the switches 32 and 34 sequence in operation to the original position in reverse order.

Fig. 2 shows the pushbutton station or selective switch operating assembly 10 in an unoperated position with the operator member 14 or shaft 27 disposed directly above the offset lever contact projection 37 by mounting the pushbutton assembly 11 laterally offset from the switching units 14 and 15. Depressing the pushbutton or operator 14 to the edge of the housing 20 as shown in Fig. 3, causes the end of the operator shaft 27 or operator disc 28 to engage the lever contact projection 37 to apply a force thereto at a point along a lateral axis offset from the center line or midpoint between the switch actuator stems 32 and 34. Depression of the push-button 14 to the edge of the housing 20 therefore, causes the actuating lever or teeter bar 12 to exert a greater force on the actuator stem 32 located nearer the lever contact projection 37 or the stem positioned relative to the operator to have the shorter lever arm and the greater movement of force.

Further depression of the pushbutton below the peripheral edge of the housing or to the end of the stroke has been illustrated in Fig. 4. Depression of the pushbutton 14 to the end of travel exerts an additional force on the teeter bar 12 at the contact point 37 depressing the switch actuator stem 34 located at the end of the longer lever arm and against the resilient force of the switch springs or other resilient means tending to return the stem to its upward position. In the present preferred embodiment, the resilient means supporting the individual switch actuator stems 32 and 34 are of approximately the same resiliency and exert the same bias; however, this is not intended to limit the scope of the invention since the sequence action or selective operation may be adjusted or controlled by the resiliency of the means biasing the stems in their upward position.

The embodiment of Fig. 6 discloses a simple complex arrangement of teeter bars or actuating levers 50, 51 and 52 disposed or seated on four switch actuating stems 53, 53', 54, 54' rather than the two sequentially operated stems illustrated in the preferred embodiment. The actuating levers are positioned between the pushbutton operator and the switches as shown in the preferred embodiment, wherein the center bridging lever or teeter bar 50 has a projection in line with or directly below the operator shaft 27 or disc 28.

In operation, the pushbutton operator shaft 27 or disc 28 engages the center bridging lever contact projection 55 to exert a distributed force along the lever 50 and a greater force on lever 51 at lever or contact projection 56

located at the end of the shorter lever arm *b* and distributes the force exerted on its contact projection **56** by the center bridging lever **50** to actuate stem **53** having the shorter lever arm *e* of stem bridging actuating lever **51**. The switch actuating stem **53'** at the opposite end of lever **51**, having the longer lever arm *f*, may be adjusted by controlling the relative length of all lever arms to position it in the sequence of operation before the switch actuating stem **54'** located below the lever **52**. Stem **54'** is located at the end of the longer lever arm *d* and is more easily operated last in the operating sequence.

A typical operating sequence may be as follows: apply pressure on the contacting projection **55** of the center bridging lever **50** operating lever **51** first and the actuating stem **53** having the shorter lever arm *e*; added pressure operates actuating stem **53'** having the longer lever arm *f* of the stem bridging lever **51**. A further increment of travel of the operator produced by additional pressure actuates the stem bridging lever **52** and the actuating stem **54** having the shorter lever arm *c* followed by actuation of stem **54'** having the longer lever arm *d* upon traversing the remaining travel of the operator.

The embodiment of the lever assembly as shown in Fig. 7 discloses an arrangement for sequential operation of a plurality of switches having stems **61**, **62**, **64** and **65** resulting from a force applied at the contact point **66** and may take the form of a cam disc **60** in which the contact projection **66** is positioned on a plane surface and located to provide lever arms of graduated lengths to the respective switch actuating stems **61**, **62**, **64** and **65**, such as lever arms *a*, *b*, *c* and *d*. As in the other embodiments, the cam disc **60** is disposed between the pushbutton operator and the switches and may be held captive and floating, seated on the switch stems. The contact projection **66** of the cam disc lever assembly **60** is positioned below the shaft **27** or operator disc **28** whereby a force exerted on the cam contact projection **66** is distributed in graduated amounts inversely to the length of the respective lever arms.

Since the preferred arrangement provides switch stems supported by means for resiliently biasing the stems equally, they will be operated sequentially and released in reverse sequence as pressure on the operator is relieved. The switch stems operate and return to the original position in the reverse order in accordance with operation of a rigid bar free to move about an axis or fulcrum, i.e.,

$$F_a:b::F_b:a$$

where F_a is the force applied to a switch stem having a lever arm *a*, F_b is the force applied to the switch stem having a lever arm *b*, and the lever arm is equal to the distance of the stem from the contact point of the operator or a ratio of the lengths of lever arms which may be expressed as:

$$F_a=\frac{F_t \times a}{a+b}$$

where F_t=the total force applied at the contact point of the lever assembly. The above expression may be used to derive the force at each stem or required for the desired sequential or selective operation.

If the range of force or pressure applied to the contact point F_t of the lever assembly is known, the maximum lever arm and number of switches which may be practically operated can be calculated, particularly where the distance of travel of the operator over the range of F_t is determined.

While certain preferred embodiments of the invention have been specifically disclosed, it is understood that the invention is not limited thereto, as many variations will be readily apparent to those skilled in the art and the invention is to be given its broadest possible interpretation within the terms of the following claims.

I claim:

1. A progressive switch comprising a tubular housing having an upper portion adapted to be received through an opening in a panel wall and to extend upwardly therefrom and having a lower peripheral flange portion adapted to engage the lower surface of said wall surrounding said opening, mounting plate means disposed in spaced relation to and below said flange portion and extending outwardly from said housing in opposite directions, a switch enclosure means carried by and below said mounting plate means, a pair of reciprocable contact actuators extending upwardly from an upper wall of said switch enclosure means in spaced relation to each other, resilient means in said switch enclosures operative on said actuators and forcing the respective actuators to extended positions wherein the top surfaces of the respective actuators lie in a common plane, a spring biased reciprocating operating plunger mounted for reciprocation in said housing toward and away from said actuators, a disc on the lower end of said plunger, a floating planular lever disposed between the lower surface of the disc and said actuators, a pair of spaced recesses in the lower face of said lever, the upper portions of said actuators being received in said recesses, respectively, to restrain said lever in position, and a force-receiving raised area on the upper surface of said lever aligned with said disc and disposed at different distances from said recesses.

2. A progressive switch comprising a tubular housing having an upper portion adapted to be received through an opening in a panel wall and to extend upwardly therefrom and having a lower peripheral flange portion adapted to engage the lower surface of said wall surrounding said opening, mounting plate means disposed in spaced relation to and below said flange portion and extending outwardly from said housing in opposite directions, a pair of switch enclosures carried by and below said mounting plate means, each of said switch enclosures having reciprocable contact actuators, respectively, extending outwardly from an upper wall of said switch enclosures in spaced relation to each other, resilient means in said enclosures respective to said actuators and forcing the respective actuators to extended positions wherein the top surfaces of the respective actuators lie in a common plane, a reciprocating operating plunger mounted for reciprocation in said housing toward and away from said actuators, a floating planular lever disposed between the lower surface of said plunger and said actuators, a pair of spaced recesses in the lower face of said lever, the upper portions of said actuators being received in said recesses, respectively, to restrain said lever in position, and a force-receiving area on the upper surface of said lever aligned with said plunger and disposed at different distances from said recesses.

3. A progressive switch assembly comprising; a sleeve with an internal bore and an external mounting flange for mounting the assembly in a panel, a web intersecting the bore and having an opening therein, a pushbutton actuator slideable in the bore and having a button portion at one end of the bore externally accessible of the sleeve, a disc at the other end of the bore and a portion extending through the opening in the web interconnecting the button portion and disc, more than a pair of switches each having a reciprocating exposed actuating button, a mounting means for mounting the switches to the external flange so the switch buttons reciprocate in parallel spaced planes, said mounting means having an opening therein for exposing the actuating buttons to the disc, a plate disposed in the mounting means opening between the switch buttons and said disc, said plate having recessed portions on a bottom surface for receiving the switch buttons for locating the plate between the disc and said switch buttons and a raised portion on a top surface, and said raised

portion being unequally spaced between the respective recessed portions in alignment with the disc for transmitting movement of the disc to the plate, whereby the actuating buttons of the switch reciprocate sequentially in inverse order to the distance between the several recessed portions and the raised portion upon reciprocal movement of the pushbutton actuator.

4. A progressive switch assembly comprising; a sleeve with an internal bore and an external mounting flange for mounting the assembly in a panel, a web intersecting the bore and having an opening therein, a pushbutton actuator slideable in the bore and having a button portion at one end of the bore externally accessible of the sleeve, a disc at the other end of the bore and a portion extending through the opening in the web interconnecting the button portion and disc, a spring reacting between the web and the button portion for constantly urging the button portion outwardly of the bore, at least a pair of switches each having a spring biased exposed reciprocating actuating button, a mounting means for mounting the switches to the external flange so the actuating buttons reciprocate in parallel spaced planes, said mounting means having an opening therein for exposing the actuating buttons to the disc, and a plate disposed in the mounting means opening between the actuating buttons and disc, said plate having recessed portions on a bottom surface for receiving the actuating buttons for locating the plate between the disc and actuating buttons and a raised portion on a top surface unequally spaced between the recessed portions in engagement with the disc for transmitting movement of the disc to the plate for moving the actuating buttons of the switch.

5. A progressive switch assembly comprising; a sleeve with an internal bore and an external mounting flange for mounting the assembly in a panel, a web intersecting the bore having an opening therein, a pushbutton actuator slideable in the bore and having a button portion at one end of the bore externally accessible of the sleeve, a disc at the other end of the bore and a portion extending through the opening in the web interconnecting the button portion and disc, at least a pair of switches each having an exposed reciprocating actuating button, a mounting means for mounting the switches to the external flange so the switch actuating buttons reciprocate in parallel spaced planes, said mounting means having an opening therein for exposing the actuating buttons to the disc, and a plate disposed in the mounting means opening between the actuating buttons and disc, said plate having recessed portions on a bottom surface for receiving the actuating buttons for locating the plate between the disc and actuating buttons and a raised portion on a top surface unequally spaced between the recessed portions in engagement with the disc for transmitting movement of the disc to the plate for moving the actuating buttons of the switch.

6. A progressive pushbutton switch comprising; a frame having a central opening therein, a pair of spaced apart parallel pushbutton switches mounted on the bottom side of the frame on opposite sides of the opening, a pushbutton actuator mounting on the top side of the frame, a disc carried by the actuator and disposed above the frame and aligned with the opening, and a lever movable in the opening, said lever having recesses in a bottom surface engageable with the pushbuttons of the switch for positioning the lever in the opening and a raised portion on a top surface unequally spaced between the recessed portions and in constant engagement with the disc for transmitting movement of pushbutton actuator to the switches.

7. A progressive pushbutton switch comprising; a frame comprising two spaced plates providing a central opening therebetween, a pair of spaced apart parallel pushbutton switches mounted on the bottom side of the plates on opposite sides of the opening, a pushbutton actuator mounted on the top side of the plates, a disc carried by the actuator and disposed above the frame and aligned with the opening, and a lever movable in the opening, said lever having means in a bottom surface engageable with the pushbuttons of the switches for positioning the lever in the opening and a raised portion on a top surface unequally spaced between the pushbuttons of the switch and in constant engagement with the disc for transmitting movement of pushbutton actuator to the switches.

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