Aug. 17, 1965 S. A. WOODWARD 3,201,531

MULTIPLE PUSHBUTTON SWITCH

Original Filed July 14, 1960 7 Sheets-Sheet 1

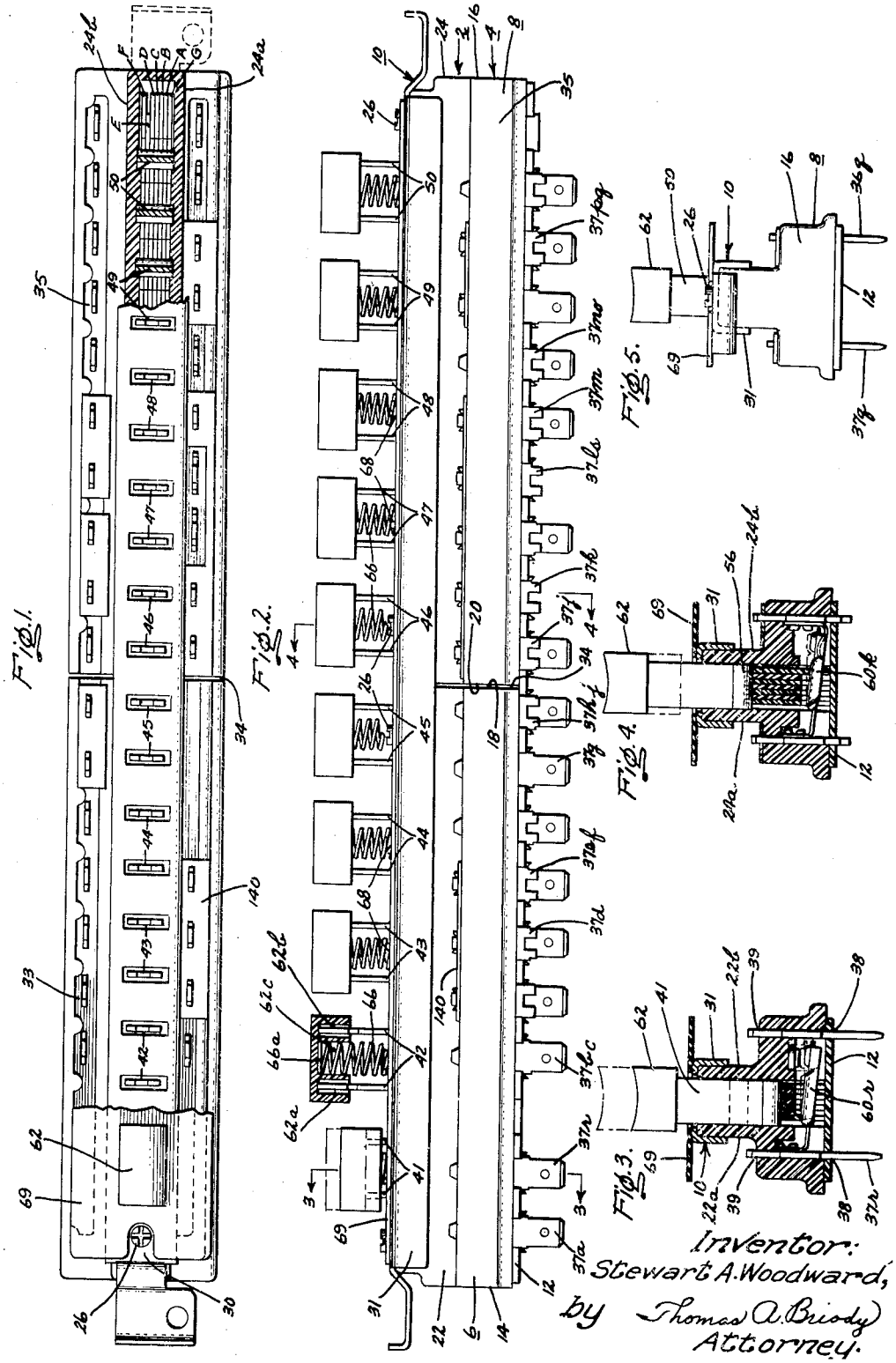

Fig. 1.

Fig. 2.

Fig. 5.

Fig. 4.

Fig. 3.

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MULTIPLE PUSHBUTTON SWITCH

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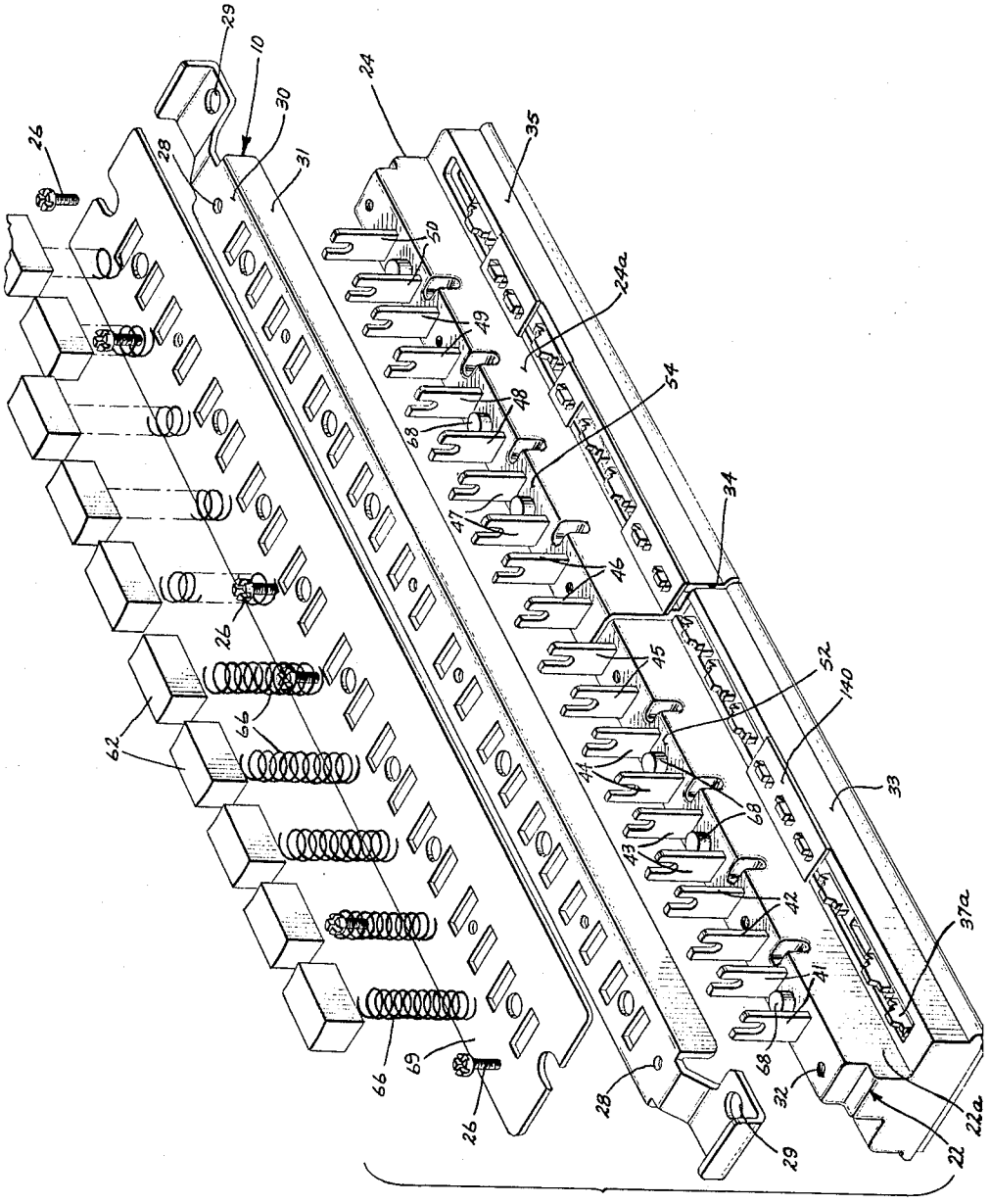

Fig. 6.

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MULTIPLE PUSHBUTTON SWITCH

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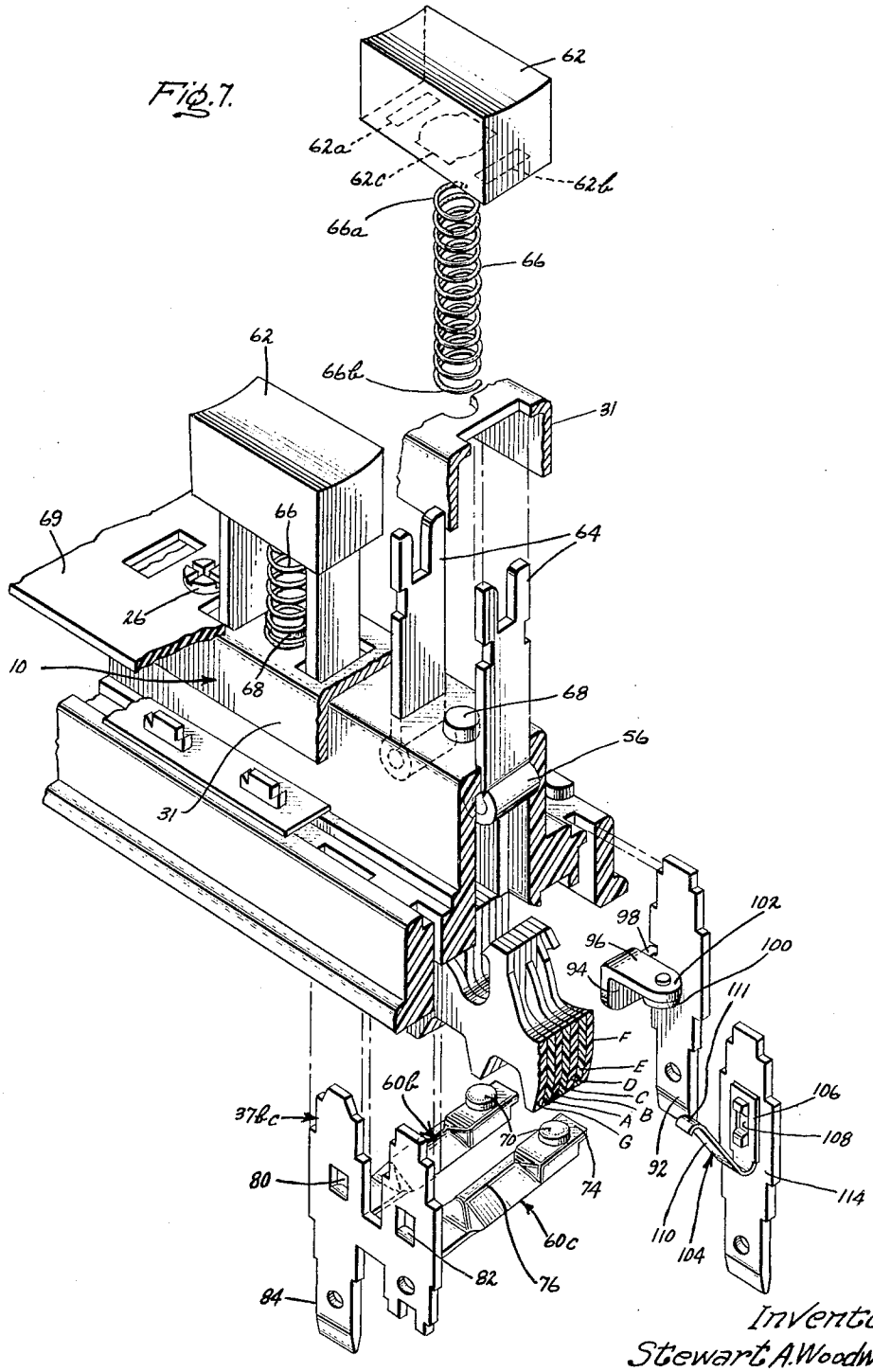
Fig. 7.



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MULTIPLE PUSHBUTTON SWITCH

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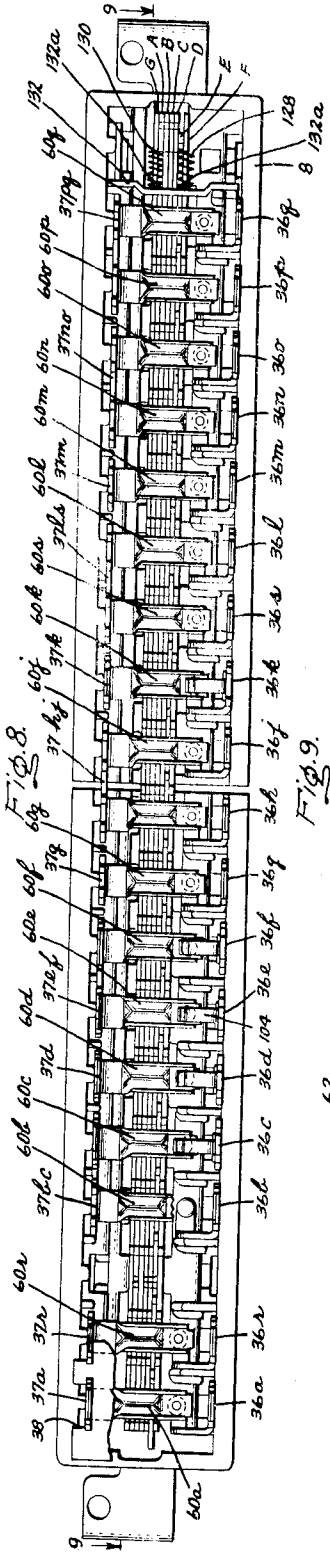

Fig. 8.

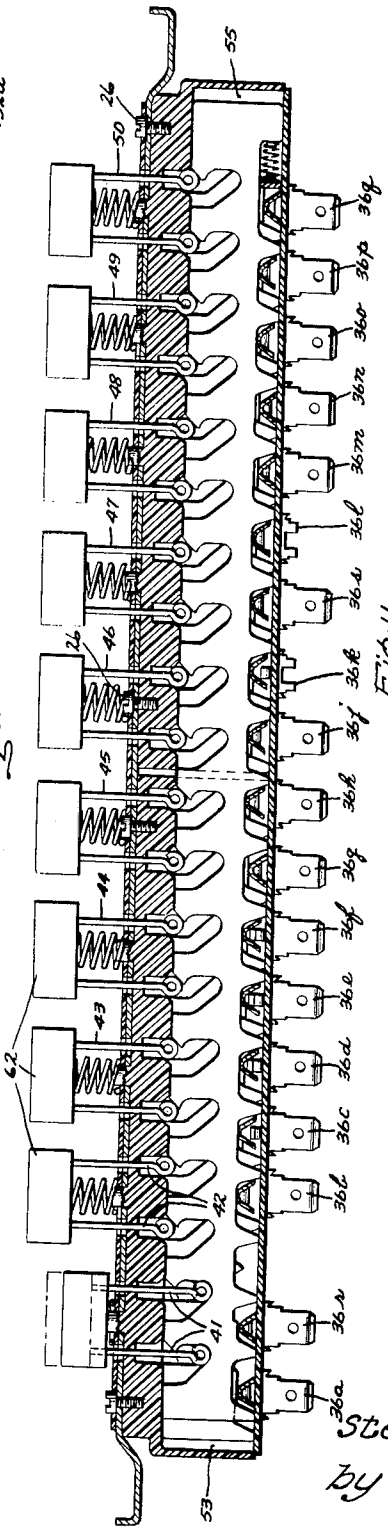

Fig. 9.

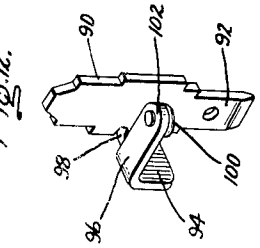

Fig. 12.

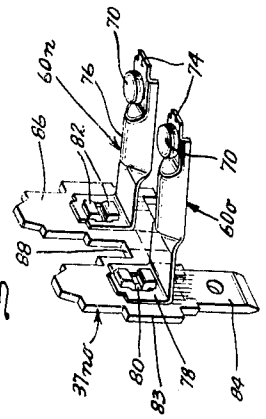

Fig. 11.

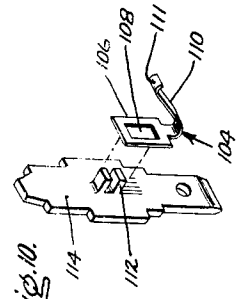

Fig. 10.

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MULTIPLE PUSHBUTTON SWITCH

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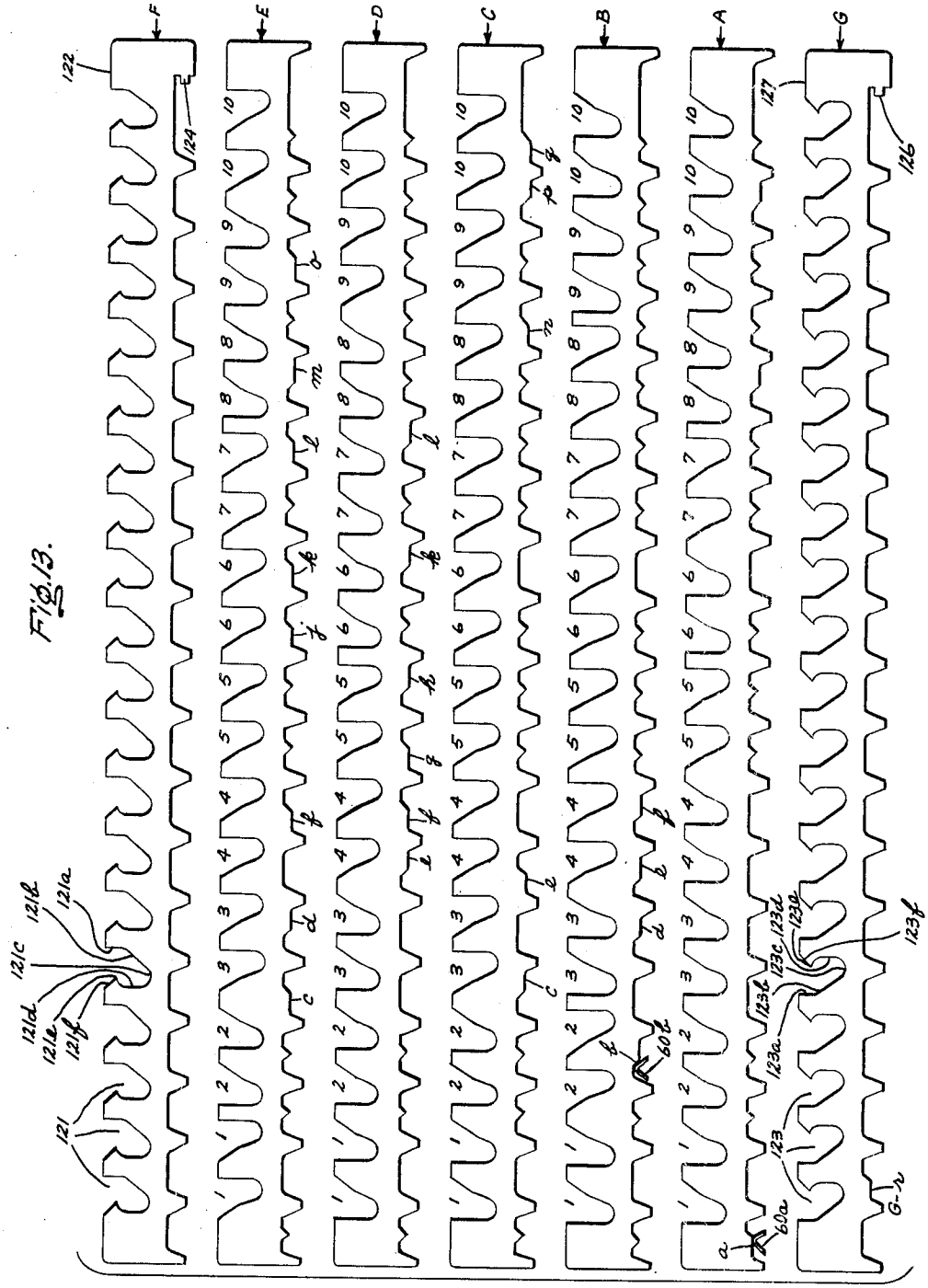

Fig. 13.

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Fig. 14.

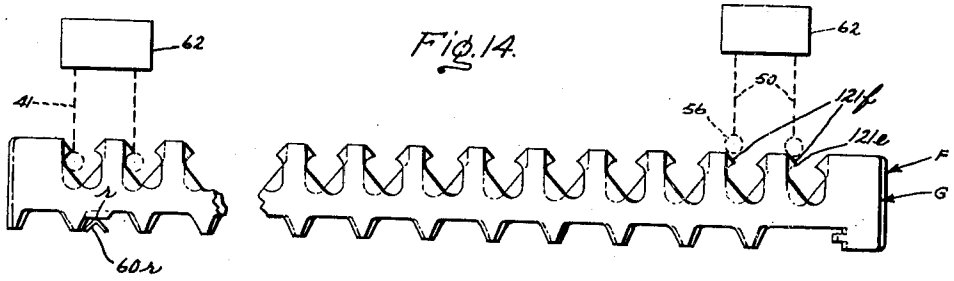


Fig. 15.

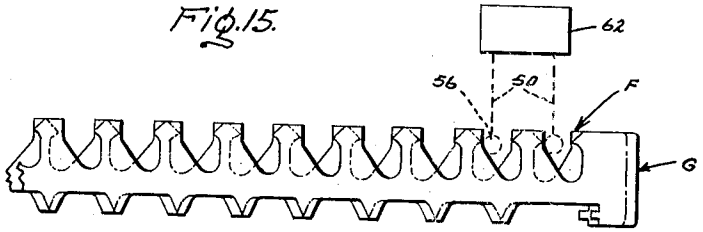


Fig. 16.

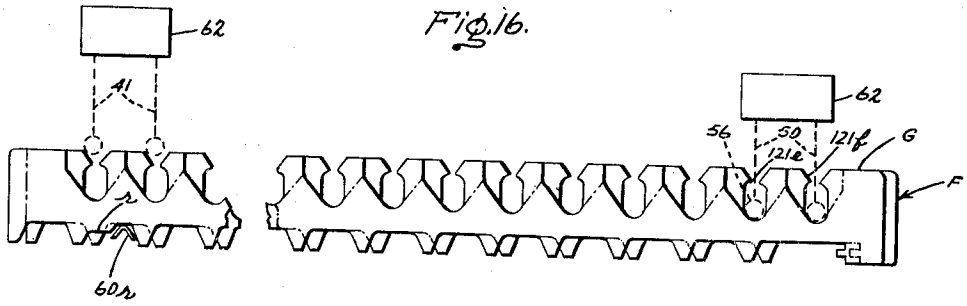


Fig. 17.

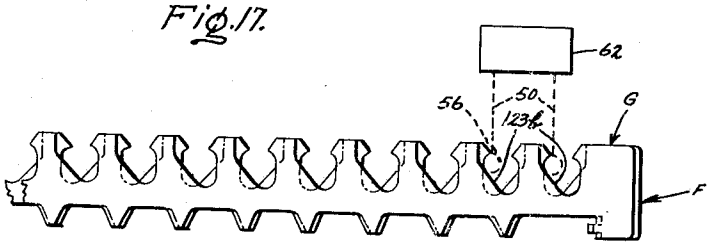
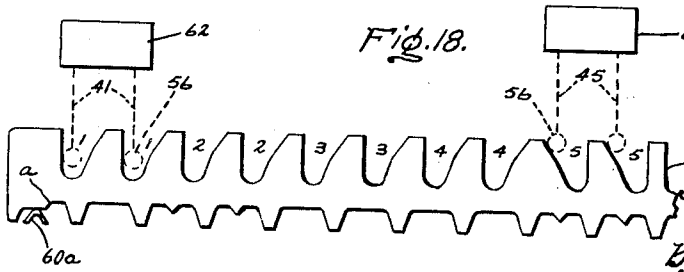


Fig. 18.



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MULTIPLE PUSHBUTTON SWITCH

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Fig. 19.

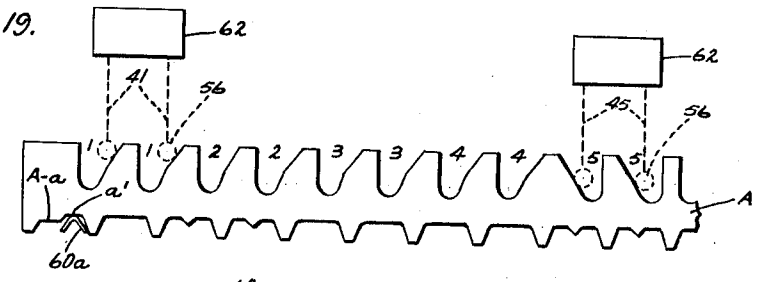


Fig. 20.

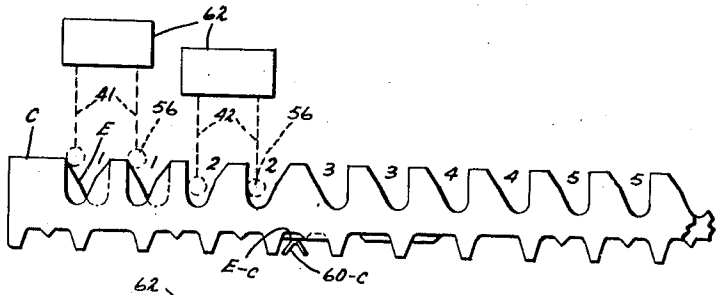


Fig. 21.

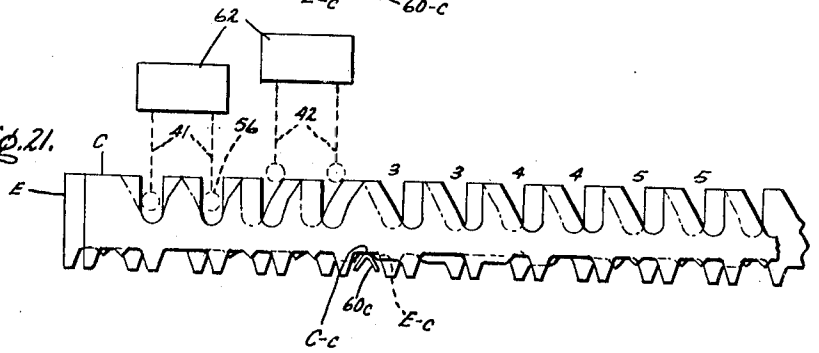


Fig. 22.

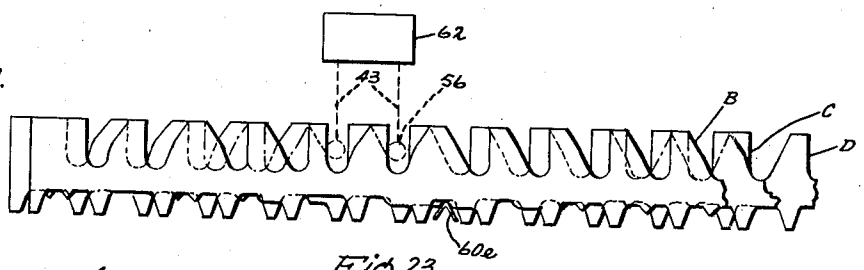
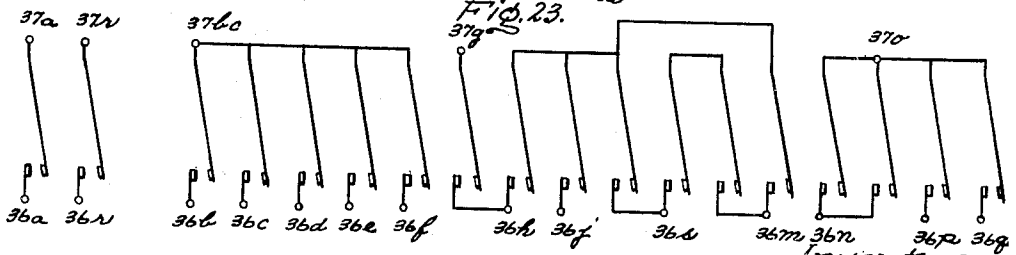


Fig. 23.



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United States Patent Office 3,201,531 Patented Aug. 17, 1965

3,201,531

MULTIPLE PUSHBUTTON SWITCH

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Continuation of application Ser. No. 42,815, July 14, 1960. This application July 23, 1963, Ser. No. 297,738
12 Claims. (Cl. 200—5)

This application is a continuation of my co-pending application Serial Number 42,815, now abandoned, filed July 14, 1960.

This invention relates to a pushbutton switch and particularly a multiple pushbutton switch with a series of manually controlled pushbuttons which may be depressed to control the operation of several circuits operating through the switch.

Pushbutton switches have been used in great numbers as appliance switches for electric ranges, washing machines, and room air conditioners, etc., to control the circuitry thereof. Such a switch is controlled by reciprocating actuators and it is desirable that it provide reliable and efficient operation with continuous use over a long period of years, often under extreme external conditions such as the vibrations provided by the appliance with which the switch is associated. With continuous use over a long period of years, the pushbuttons which are used in such a switch often become loosened or misaligned from associated actuators to which they are affixed and due to wear of certain of the switch parts, the actuators also do not retain the accurate positioning which they provide when the switch is new. It has therefore been found desirable to provide an improved multiple pushbutton switch which is simplified in operation and wherein the pushbuttons and actuators thereof are more accurately aligned and positioned. It also has been found to be advantageous in such a switch to provide an improved means for controlling the movement of the switch actuators during the reciprocation thereof while also providing momentary contact actuation and pushbutton returning action. In addition, it has also been found desirable to provide an improved housing for such a switch which is capable of controlling a large number of circuits.

The principal object of this invention is to provide an improved pushbutton switch which is dependable and efficient in operation.

It is a further object of this invention to provide an improved multiple pushbutton switch having a novel means for controlling the positioning of switch actuators during the movement thereof.

Another object of this invention is to provide an improved multiple bushbutton switch having a novel means for maintaining switch actuators thereof in accurate alignment.

It is an additional object of this invention to provide a multiple pushbutton switch having an improved means for obtaining momentary contact actuation and urging depressed actuators to their principal operating positions.

It is a still further object of this invention to provide an improved housing for a multiple pushbutton switch which controls a relatively large number of circuits.

In carrying out one aspect of my invention, in one form thereof, I provide a multiple pushbutton switch for controlling a plurality of circuits by movement of reciprocating sliders. To operate these circuits, a plurality of actuators are mounted in a housing for reciprocating movement between outer, inner, and intermediate positions. Each slider has a series of inclined working surfaces which are acted upon by certain actuators. These sliders also have formed cam surfaces for engaging a plurality of switch arms or movable contact blades. In this switch, I have also provided first and second sliders

having opposed parallel faces and at least one asymmetrical aperture formed in each of them. The aperture of the first slider is in partial alignment with the aperture of the second slider and at least one of the actuators is arranged to cooperate with these apertures. The first and second sliders for each spring biased in the same direction. The aperture of the first slider cooperates with the actuator when the actuator is in its outer position to resist movement of the actuator towards its inner position. The aperture of the second slider cooperates with the actuator when the actuator is in the inner position to force the actuator to revert to the intermediate position. The apertures of both the first and second sliders cooperate with each other and also cooperate with the actuator to maintain the actuator in its intermediate position. By arranging these first and second sliders with their asymmetrical apertures spring biased in the same direction, an improved means is thus provided for controlling the reciprocating movement of the actuator between its positions.

By a further aspect of my invention, I provide an improved arrangement for balancing the reciprocating motion of a pushbutton in a multiple pushbutton switch. This improved arrangement may, of course, be combined with the aforesaid structure to provide a particularly desirable multiple pushbutton switch. In this arrangement, a plurality of adjacent pairs of reciprocating actuators are mounted in a switch housing. A pushbutton is attached to the outer ends of each pair of adjacent actuators to control the reciprocating movement in unison of this pair of actuators. A plurality of sliders are positioned within the housing, with each of the sliders having a plurality of pairs of similarly configured inclined edges that are engageable by the inner ends of an adjacent pair of actuators. By arranging the actuators in this manner, each of the pushbuttons controls a pair of associated actuators to efficiently control, balance, and align the reciprocating motion of the pushbutton during the movement thereof.

As an additional aspect of my invention, for a multiple pushbutton switch having longitudinally elongated sliders disposed in side-by-side relationship, I provide an improved molded insulating housing arrangement. This improved arrangement may, of course, also be combined with the aforesaid structures to provide a particularly desirable multiple pushbutton switch. In this arrangement, the switch includes a pair of hollow bases, each of which has a closed outer end wall, an open inner end wall, and an open bottom. These bases are attached together by means of a mounting bracket, with their open inner end walls communicating to receive the longitudinal sliders of the switch and support pushrods of the switch in an in-line configuration. The open inner ends of the two mating hollow bases of the switch are disposed adjacent to each other at a suitable spacing to enhance the control of tolerances in the switch.

Further aspects of my invention will become apparent hereinafter, and the specification concludes with claims particulary pointing out and distinctly claiming the subject matter which I regard as my invention. The invention, however, as to organization and method of operation, together with other objects and advantages thereof, may best be understood by reference to the following description when taken in conjunction with the accompanying drawings in which:

FIG. 1 is a top view, partially in section and partially broken away, of an improved multiple pushbutton switch embodying my invention in one form thereof;

FIG. 2 is a side view of the swiches of FIG. 1 with one pushbutton shown in section and one pushbutton in its extreme depressed position;

FIG. 3 is a sectional view taken generally along the line 3—3 of FIG. 2, showing one of the movable arms of my switch which is cammed to a contacts open position;

FIG. 4 is a cross-sectional view taken generally along the line 4—4 of FIG. 2, showing one of the movable arms of the switch which is cammed to a closed position;

FIG. 5 is an end view of the switch of FIG. 1;

FIG. 6 is a perspective view of the switch of FIG. 1 with the mounting bracket, light barrier, and pushbuttons exploded therefrom;

FIG. 7 is a fragmentary exploded perspective view of a portion of the switch of FIG. 1 showing the movable switch arms and their two types of mating fixed contacts;

FIG. 8 is a bottom view of the switch of FIG. 1 with most of the cover plate and one of the switch arms partially broken away to show details of the switching structure;

FIG. 9 is a cross-sectional view taken generally along the line 9—9 of FIG. 8;

FIG. 10 is an exploded perspective view of a fixed contact and its associated terminal for one of the contact pairs of my switch which is cammed closed by the sliders;

FIG. 11 is a perspective view of a pair of switch arms which are affixed to a series connected integral double terminal;

FIG. 12 is a perspective view of one of the fixed contacts of my switch and its associated terminal, for one of the contact pairs of my switch unit which is cammed open;

FIG. 13 is a layout of the various sliders of my multiple pushbutton switch;

FIGS. 14–17, inclusive, are diagrammatic views of the momentary and detent sliders of my switch illustrating the effect they have upon the pushrods of exemplary pushbuttons during the successive depression thereof;

FIGS. 18 and 19 are diagrammatic views illustrating the camming open of one of the switch arms by its associated actuating slider;

FIGS. 20–22, inclusive, are diagrammatic views illustrating the camming closed of certain movable contact blades by their associated predetermined slider combinations; and

FIG. 23 is a diagrammatic view of the contact arrangement in my improved multiple pushbutton switch.

Referring in detail to the drawings, and in particular to FIGS. 1 and 2, there is shown a multiple pushbutton switch **2** wherein my invention has been advantageously employed. Switch **2** has an elongated over-all appearance, and to enable it to control a large mumber of circuits through the operation thereof, as shall be described in detail hereinafter, it includes ten switch positions which are controlled by the selective depression of switch actuators.

To efficiently support and contain the operating mechanism of switch **2**, I have provided an improved elongated switch housing **4**. The switch housing **4** comprises left and right hollow bases **6** and **8** respectively (as shown in FIG. 2), which are held together by mounting bracket **10** and a relatively thin elongated cover plate **12**. Bases **6** and **8** are similar in construction, having oppositely disposed closed outer end walls **14** and **16** respectively, communicating open inner ends **18** and **20** respectively, and open bottoms. As best seen by viewing FIGS. 2, 5, and 6, bracket **10** is channel shaped, and straddles central upright portions **22** and **24** of the two bases **6** and **8** to fasten them together in an end-to-end relationship by means of screws **26**. The screws **26** are extended through apertures **28** in horizontal section **30** of bracket **10** to engage threaded recesses **32** of the upright portions **22** and **24**, for firmly securing the bases **6** and **8** together. (See FIG. 6.) With bracket **10** attached to the two bases, the two longitudinally extending sides **31** of the bracket engage the oppositely disposed longitudinally extending sides **22***a*, **22***b*, **24***a*, and **24***b* of the upright portions **22** and **24** to preclude any lateral movement of the bases and rigidly secure them to the bracket. (See FIGS. 3 and 4.) As may be clearly seen in FIGS. 1 and 2, when the bases **6** and **8** are secured together by bracket **10**, they are spaced apart slightly so that a suitable narrow gap **34** exists between the adjacent lower portions **33** and **35** of the bases at their open inner ends **18** and **20**. This gap **34** also extends upwardly on each side of the housing **4** to the bottom edges of the bracket sides **31** (as seen in FIG. 2), being formed by bridging the two bases **6** and **8** while they are spaced slightly apart, as shown in FIG. 6, by the attachment of bracket **10** and cover plate **12** thereto. By forming switch housing **4** from the two hollow bases **6** and **8** joined together in slightly spaced apart relationship by bracket **10**, it has been found much easier to control the tolerances (i.e., the dimensional relationships) of the switch housing and reduces the possibility of the occurrence of molding problems in manufacturing molded insulating bases for such a switch. To conveniently mount switch **2** to a suitable supporting structure, the ends of channel **10** are extended outwardly from base end walls **14** and **16** as shown in FIG. 2, and having mounting apertures **29** formed therein (FIG. 6).

To close the open bottom of hollow bases **6** and **8** of switch **2** and cooperate with these bases to provide a compact housing structure for the operating mechanism of the switch, the elongated cover plate **12** engages the underside of each base (as shown in FIGS. 2 and 5), being securely attached thereto by spaced oppositely disposed terminals **36** and **37** of the fixed and movable contacts, respectively, which shall be described in detail hereinafter. These terminals, as shown representatively by movable contact terminal **37***a* in FIGS. 2, 6, and 8, each extend through cover plate slots **38** (FIG. 8) and aligned or overlying slots **39** (FIG. 3) formed in the upper wall of the base lower portions, being lapped over in the well-known manner to hold the terminals in place and secure the cover plate and bases together. (See FIG. 2.)

Turning now to a further aspect of my invention, to actuate the various switches of multiple pushbutton switch **2** in an improved and efficient manner spaced pairs of adjacent pushrods or actuators **41–50** are extended downwardly (as shown in FIG. 9) through appropriate slots formed in bracket section **30** and through top walls **52** and **54** (FIG. 6) of the bases **6** and **8**, into the hollow base portions **53** and **55**. These pushrods reciprocate in pairs, having integral cylindrically configured actuating portions **56** at their innermost ends which cooperate with pairs of associated aligned groups of inclined upper working edges **1–10** of sliders A–E to operate the switches. Sliders A–E are disposed in parallel side-by-side relationship (as shown in FIG. 8), and they reciprocate longitudinally in response to the selective depression of pairs of pushrods to control the positioning of switch arms or movable contact blades **60***a–60h*, **60***j–60q* (FIG. 9) by means of cam surfaces formed on certain predetermined sections of their undersides. (See also FIG. 13.) The cam surfaces of the sliders A–E which control the blades **60** are identified in FIG. 13 by lower case letter designations which correspond to the letter suffix of the blades. For example, cam surface A–*a* of slider A controls movable contact blade **60***a*. The inclined working edges **1–10** of the sliders A–E are arranged on each slider in the form of consecutive adjacent pairs of similarly configured edges which are disposed in the same direction. In viewing FIG. 13 of the drawings, it will be noted that the inclined working edges of the associated pairs of edges of the sliders A–E have thus been given the same reference numeral to indicate that they are similarly configured and disposed, and operated by the same pair of pushrods. The inclined working edges on the respective sliders are disposed in the switch unit in the form of generally aligned

groups to cooperate with pairs of associated pushrod actuating portions as each pair of pushrods reciprocates. The arrangement of the inclined working edges of the sliders is such that the different sliders A–E allow only one pair of pushrods 41–50 to be fully depressed at any one time and certain of the sliders act upon any previously depressed pushrod pair to return it to its outermost position upon the subsequent depression of another pair of pushrods.

Considering now my improved means for manually controlling each pair of associated pushrods in switch 2, as shown in FIGS. 2 and 7, each pair of the pushrods 41–50 is equipped with a pushbutton 62 which is press fit to the bifurcated outer ends 64 of the pushrods. More particularly, the pushbuttons 62 each have three inner cavities or recesses 62*a*, 62*b*, and 62*c* formed in the underside thereof. (See FIGS. 2 and 7.) Cavities 62*a* and 62*b* receive the bifurcated outer ends 64 of an associated pair of pushrods. Cavity 62*c* is disposed between cavities 62*a* and 62*b* and is generally cylindrical in configuration for receiving one end 66*a* of compression spring 66. The other end 66*b* of each spring 66 fits around a base projecting boss 68 or the head of one of the screws 26 to engage bracket 10. The arrangement of the spring ends in button cavity 62*c*, and around the bosses or screws, is such that the spring 66 may run in compression between bracket 10 and button 62, with a minimal lateral movement. Suitable apertures have been formed in the bracket section 30 so that bosses 68 of the base top walls 52 and 54 project outwardly from the bracket intermediate each pair of bracket slots through which the pushrods are extended. The bosses 68 also serve to accurately locate the bracket 10 on the bases and to provide additional securement for the housing. (See FIG. 7.) It should also be noted that light barrier 69 of dark material is suitably positioned between horizontal section 30 of the bracket and the bottoms of the buttons, as shown in FIG. 1. The barrier 69 has been provided to occlude light from emanating outwardly through a suitable mounting panel, and also to serve as an electrical insulator for the pushbuttons.

It will thus be seen that each pushbutton 62 is spring biased to its outermost position by compression spring 66 and is also pressed into engagement with the bifurcated ends of an adjacent pair of parallel pushrods. The pushrods of each pair extend through their appropriate slots in bracket 10 and the top base walls so that the actuating portions 56 of each pair of pushrods transversely overlie similarly configured pairs of diagonal working edges of the sliders A–E. By arranging the pushrods in pairs, it has been found that the action of each pushbutton 62 upon depression thereof is conveniently stabilized by the reciprocating motion in unison of the associated pushrods. This improved pushbutton action also provides more accurate control over the movement of each pair of pushrods and enhances the dependability and durability of multiple pushbutton switch 2.

Turning now to a consideration of the circuit opening and closing elements of my multiple pushbutton switch, in viewing FIG. 8, it will be noted that movable contact switch arms or blades 60*a*–60*h*, and 60*j*–60*s* are all of the same configuration and dimensions. These arms are suspended in cantilever fashion from their associated supporting terminals which are located on one side of the switch housing, and they are spaced apart in parallel relationship near the bottom of the housing with each blade having a movable contact button 70 extruded through an opening formed in the free end 74 thereof. (See also FIG. 11.) Blades 60 (as shown representatively by blades 60*n* and 60*o* in FIG. 11) are L-shaped and include a raised intermediate portion 76 in the elongated section that carries the contact button. Portion 76 has a V-shaped cross-section to enhance the strength of the contact blade and furnish a narrow mechanical contact surface for engagement with slider cam surfaces. The shorter section 78 of each blade is turned over to furnish a support for the blade, having a slot 80 formed therein for that purpose. Each movable contact supporting terminal has one or two pairs of adjacent lanced projecting fingers 82 (as illustrated by the integral double bridging terminal 37*no* of FIG. 11 with its attached blades). The supporting portion 78 of each movable contact blade is attached to its associated supporting terminal by bending over each pair of the fingers 82, as shown in FIG. 11, after they have received slot 80 of the movable contact blade.

To support the movable contact blades and fulfill certain circuit requirements in my switch, the movable contact terminals 37 are of four general types. All of these types may be understood by further reference to the perspective view of the integral double bridging terminal 37*no* shown in FIG. 11. This terminal, as shown in full provides a long blade section 83 having a single outer blade portion 84 with a detent hole formed therein for engagement with an associated "quick connecting" terminal, and a short blade section 86 connected to long section 83 by bridge 88. Another type of double bridging movable contact terminal, such as, for example, terminal 37*hj* (FIG. 8) is essentialy similar to terminal 37*no* (FIG. 11) except that long section 83 is shortened as suggested by the dot-dash lines thereof in FIG. 11, so that the terminal has no outer blade portion and comprises two similar short sections which are connected together by bridge 88. A third type of movable contact terminal, such as, for example, terminal 37*a* (FIG. 8) consists of a single long section with the same configuration as section 83 of terminal 37*no* (including the outer blade portion). The fourth type of movable contact terminal such as, for example, terminal 37*k* of FIG. 8, is a single short section similar to section 86 of FIG. 11, having no outer blade portion.

Turning now to a consideration of the fixed contacts of switch 2, in viewing FIG. 8, it will be noted that there are two types of fixed contacts therein. Fixed contact terminals such as 36*a*, 36*b*, 36*g*, 36*h*, 36*j*, and 36*q* are each of the type shown in FIG. 12. This terminal includes a long blade section 90 having an outer blade portion 92 with a detent hole formed therein for engagement with an associated "quick connecting" terminal. Connecting intermediate portion 94 is bent over perpendicularly from one side of section 90 between its outer ends, and fixed contact supporting arm 96 is turned over from the upper side 98 of portion 94 (as shown in FIG. 12) to extend back generally toward the middle of but in front of section 90. (See also FIG. 7.) Arm 96 is thus perpendicular to section 90 and portion 94, and it has a contact button 100 extruded into an aperture formed on the end 102 thereof to mate with a contact button 70 of an associated movable contact blade. The fixed contact terminals of the switch which support contact buttons 100 are positioned against the inner side of a lower wall of housing 4 (opposite to the wall which the movable contact terminals are adjacent to), as shown in FIG. 8, with sections 90 of these terminals disposed in generally coplanar fashion, and contact buttons 100 facing outwardly to engage their mating movable contact buttons. The movable contact blades of switch 2 are all spring biased upwardly so that the free end which carries contact button 70 tends to move away from cover plate 12. When positioned in switch 2, fixed contact buttons 100 thus serve to cooperate with their mating movable contact buttons 70 to provide a plurality of pairs of contacts which are normally closed (i.e., spring biased to a contacts closed condition).

To provide a second type of fixed contact in switch 2, and substantially reduce the number of reciprocating sliders required to control a relatively large number of movable contact blades, flexible contacts 104 are mounted on fixed contact terminals 36*c*–36*f*, and 36*k*. (See FIG. 8.) These contacts 104 are arranged on fixed contact terminals 36*c*–36*f*, and 36*k* (as shown in FIG. 8), for cooperation with associated movable contact blades 60*c*–

60*f*, and 60*k*. As best seen in FIGS. 7 and 10, flexible contact 104 comprises a flat supporting portion 106 with a rectangular slot 108 formed therein, and flexible contact portion 110. Contact portion 110 extends angularly from supporting portion 106, having a curved contact surface 111 adjacent its end for engaging the underside of its mating movable contact button 70 (as shown in FIG. 4). Supporting portion 106 of each contact 104 is affixed to one of the terminals 36*c*–36*f*, and 36*k* by means of slot 108 which receives a pair of lanced projecting fingers 112 of the terminal blade 114 in the same manner as previously described for terminal 37*no* of FIG. 11, fingers 112 being swaged to overlap the side edges of the slot and thus secure flexible contact 104 to the terminal. Terminal blades 114 of the terminals 36*c*–36*f*, and 36*k* are positioned, as shown in FIG. 8, against the inner side of the same lower wall of housing 4 as blade sections 90 of the other fixed contact terminals. The curved contact surface 111 of each flexible contact 104 thus underlies the free end of an associated movable contact blade (as viewed in FIG. 9). Movable contact blades 60*c*–60*f*, and 60*k* are normally biased upwardly and away from cover plate 12 (as illustrated by blade 60*k* in FIG. 5), as are all the other movable contact blades. Flexible contacts 104 thus serve to cooperate with their mating movable contact blades to provide a plurality of pairs of mating contacts which are normaly open (i.e., spring biased to a contacts open condition). Flexible contact 104 pivots about its supporting portion 106 when its associated movable contact blade is closed thereupon, to provide overtravel for the flexible contact. This overtravel is important in compensating for variations in the positions of the cooperating movable contact blade which are introduced by manufacturing tolerances.

It will thus be seen that switch 2 has two different types of mating contact pairs therein, i.e., pairs of contacts which are normally biased to a closed condition (e.g., blade 60*a*, which is normally biased into engagement with contact button 100 of fixed contact terminal 36*a*) and longitudinally spaced pairs of contacts which are normally biased to an open condition (e.g., blade 60*k*, which is normally biased away from flexible contact 104 of fixed contact terminal 36*k*). By combining these two types of mating contact pairs in switch 2, a very large number of movable contact blades may be effectively controlled by a relatively small number of sliders. To achieve this beneficial result, and thus enable switch 2 to control a relatively large number of circuits by a relatively small number of reciprocating sliders, certain of the sliders A–E have been combined to control certain of the movable contact blades in the switch. The particular construction and arrangement of the two types of fixed contacts and their cooperation with certain of the sliders A–E in switch 2, to effectively control a relatively large number of circuits by a relatively small number of sliders comprises the invention of Philip Hutt, and this construction and arrangement are described and claimed in his copending application Serial Number 42,875, Patent No. 3,127,482, filed July 14, 1960, and assigned to the same assignee as the present invention.

Turning now to a further aspect of my invention, which provides an improved means for controlling the reciprocating movement of switch actuators between their inner and outer positions, it will be noted that, as shown in FIG. 13, I have also included two other sliders F and G in multiple pushbutton switch 2. Slider F is designed to serve as a detent, or pushrod controlling slider, and slider G has been constructed to cooperate with detent slider F to serve as a momentary and button return slider for the switch. More particularly as shown in FIG. 13, detent slider F includes a series of spaced specially constructed apertures or recesses 121 extending inwardly from its upper edge 122. The apertures 121 are all identical in configuration, having a vertical section 121*a* which is generally perpendicular to edge 122 and on the right side of the aperture (as shown in FIG. 13). Each aperture 121 further includes an intermediate angular section 121*b* which projects downwardly toward the bottom 125 of the slider F. The bottom end of angular section 121*b* is then curved at 121*c* upwardly into intermediate vertical section 121*d*. Section 121*d* is generally perpendicular to upper edge 122 and from the upper end thereof the aperture is curved toward and away from vertical section 121*a* to form point 121*e*. Each aperture 121 then finally includes an upper angular edge section 121*f* which extends upwardly and away from the right side of slider F (as seen in FIG. 13), from point 121*e* to upper edge 122. The purpose of apertures 121 of detent slider F shall be described in detail hereinafter. Slider F also includes a longitudinally extending projection 124 on the right side thereof (as seen in FIG. 13). Projection 124 extends longitudinally to the left (as shown in FIG. 13) to enter one end of a coiled compression spring 128 (as shown in FIG. 8) for continuously biasing detent slider F to the right within the switch housing. The other end of spring 128 surrounds projection 132*a* of transverse bracket 132 which is positioned athwart and adjacent the closed end 16 of base 8 in lower portion 35 thereof to limit lateral movement of the spring. Slider G is very similar in construction to detent slider F and includes a plurality of spaced apertures 123 which are identical in configuration to apertures 121 of detent slider F, but are disposed in a reverse direction or fashion. (See FIG. 13.) More particularly, apertures 123 are formed in upper edge 127 of slider G, and each aperture 123 includes vertical section 123*a*, angular section 123*b*, curved section 123*c*, intermediate vertical section 123*d*, point 123*e*, and outer angular section 123*f*, all of which sections are identical in configuration to the aforementioned sections 121*a*–121*f* of aperture 121. However, in slider G, vertical section 123*a* is disposed on the left side of each aperture (as seen in FIG. 13) so that apertures 123 are thus positioned in a reverse manner in slider G with relation to the positions of apertures 121 in slider F. The apertures 121 and 123 of sliders F and G are in partial alignment ,as shown in FIG. 14, to engage actuating portions 56 of associated pushrods. In addition, momentary slider G also includes a camming surface G–*r* which is disposed on the underside of slider G near the first two apertures 123 from the left (as seen in FIG. 13). As will be explained in detail hereinafter, cam surface G–*r* serves to actuate or control movable contact blade 60*r* for momentarily closing a pair of contacts upon depression of each pair of pushrods of switch 2. On the other side of my momentary slider G, as shown in FIG. 13, projection 126 extends longitudinally inwardly from the right end. Projection 126 enters an outer end of compression spring 130 for biasing momentary slider G to the right in the same manner and direction as spring 128 biases detent slider F. (See FIG. 9.) The other end of spring 130 surrounds projection 132*b* of transverse bracket 132 to limit lateral movement of the spring.

To facilitate an understanding of the operation of the detent and momentary sliders F and G respectively, attention is drawn to FIG. 14. It should first be understood that each of the pushrods of switch 2 cooperates with a pair of partially aligned recesses 121 and 123 to provide the same coaction with the cooperating sliders F and G. The detent slider F and the momentary slider G are both shown in fragmentary view with the momentary slider G being positioned in front of the detent slider F. For purposes of illustration, the pairs of pushrods 41 and 50 are diagrammatically shown with the pushbutton 62 that controls the pushrods 41 being in an intermediate depressed actuating position. With pushrods 41 in the position shown in FIG. 14, pushrods 50, which would be located at the other end of the switch are, of course, held in their outermost position by means of the biasing effect of associated spring 66 (as shown in FIG. 2) on the con-

trolling pushbutton. In addition to the outward biasing force of spring 66, however, angular edge sections 121*f* of adjacent recesses 121 of the detent slider F also engage the actuating portions 56 of the two pushrods 50 to urge them or cam them toward their uppermost positions by means of the spring biasing force applied by compression spring 128 to slider F. (See FIG. 8.)

When pushbutton 62 controlling pushrods 50 is depressed (i.e., moved from its position shown in FIG. 14 to its position shown in FIG. 15), the biasing force to the right applied to slider F by compression spring 128, initially provides a resisting force to the depression of the pushrods. This force is obtained by means of the engagement of the angular sections 121*f* of the two recesses 121 associated with the pushrods 50, with the pushrod actuating portions 56 of these pushrods. This resisting force provides an efficient means for controlling each pair of pushrods during their initial downward movement. When the pushrods 50 are further depressed, as shown in FIG. 15, the compressive force applied to detent slider F by compression spring 128 is overcome by the manual pressure exerted upon the controlling pushbutton 62. Slider F is then moved to the left, to the position where it is shown in FIG. 15. As pushrods 50 are then depressed further toward their extreme depressed position, as shown in FIG. 16, actuating portions 56 pass points 121*e* of the slider F. Slider F thus snaps to the right due to the force of spring 128 to its position as shown in FIG. 16. When pushrods 50 move from their position in FIG. 15 to the extreme depressed position of FIG. 16, actuating portions 56 thereof also cam momentary slider G to the left momentarily from its position as shown in FIG. 15, to hold slider G against the compressive biasing force of its spring 130 in the position shown in FIG. 16. When pushrods 50 are in their extreme depressed position, as shown in FIG. 16, rods 41 have then been moved back to their outermost position and the camming surface G–*r* moves to the left to allow normally closed movable contact blade 60*r* to make contact with its mating fixed contact. As shown in FIG. 16, apertures 121 and 123 of the sliders F and G thus cooperate when an associated pushrod pair is depressed to the innermost position, to form a closed oval-shaped recess which has a V-shaped indentation centrally positioned above it. When the pressure exerted upon pushrods 50 is then released, momentary slider G moves back to the right, to the position shown in FIG. 17, thus forcing the pushrods 50 outwardly to where they are shown. More particularly, intermediate angular sections 123*b* of recesses 123 act upon the fully depressed pushrods 50 to return them to their intermediate and principal actuating position. Pushrods 50 are then in their intermediate contact actuating position (shown in FIG. 17) and are held or restrained in that position by means of curved points 121*e* of the recesses of detent slider F.

It will thus be seen that the cooperation between the detent slider F and the momentary slider G of my multiple pushbutton switch 2 provides for efficient control of the movement of the pairs of pushrods 41–50 during the reciprocation thereof between their depressed and outer (normal) positions. In addition, momentary slider G furnishes an efficient means for returning depressed pushrods to their intermediate positions while at the same time providing momentary contact action for movable contact blade 60*r* during the depression of any pair of pushrods.

Turning now to a further explanation of the operational aspects of my multiple pushbutton switch 2, to illustrate the operation of a typical movable contact blade which is cammed open, I have chosen blade 60*a*, which is controlled by slider A. FIG. 18 shows the pushrods 41 diagrammatically as they are positioned with respect to their associated working surfaces 1 of slider A when the pushrods 41 are maintained in their intermediate depressed actuating position. It should be understood that the

aforementioned associated apertures 121 and 123 of sliders F and G cooperate to hold the pushrods 41 in this intermediate position in the manner previously described. For purposes of simplification, a section of only slider A has been shown in FIG. 18, since slider A is effectively responsible for the actuation of the movable contact blade 60*a*. When slider A is in this position, an outwardly extending section of the camming surface A–*a* overlies movable contact blade 60*a*, as shown in FIG. 18, and holds it open from engagement with its mating fixed contact against the normally closed biasing force of blade 60*a*. When pushrods 41 are in their intermediate depressed position (as shown in FIG. 18), pushrods 45 are in their outer or uppermost position with respect to the working surfaces 5 of slider A. When pushrods 45 are then depressed to their position in FIG. 19, they engage the diagonal edges of the working surfaces 5 to move slider A to the left. Movement of the entire slider A thus occurs, and the diagonal edges of working surfaces 1 of slider A engage the pushrod actuating portions 56 of pushrods 41 to move pushrods 41 back to their uppermost position (as shown in FIG. 19). Movable contact blade 60*a* thus enters an inwardly extending recess section *a'* of cam surface A–*a* and is allowed to close upon its mating fixed contact (not shown). All of the other movable contact blades of my switch 2, which are cammed open, are operated in a similar manner to that described for the pushrods 41.

Considering now the operation of the movable contact blades of my switch 2 which are cammed to a contacts closed position, in FIG. 20, the sliders C and E are represented in fragmentary fashion, along with blade 60*c*. The sliders C and E have cam surfaces C–*c* and E–*c* formed thereon. These cam surfaces combine to control blade 60*c*, by opening it when pushrods 41 are depressed, but when pushrods 42 are depressed to the position shown in FIG. 20, blade 60*c* is cammed closed. Thus, as schematically represented in FIG. 20, with pushrods 42 depressed, the left ends of the sliders C and E are adjacent, and an outwardly extending section of cam surface E–*c* (of slider E) holds or cams movable contact blade 60*c* to a contacts closed position in engagement with its associated fixed contact.

When pushrods 41 in FIG. 20 are depressed to their intermediate actuating position shown in FIG. 21, slider E is moved to the left by means of the engagement of actuating portions 56 of the pushrods 41 with the diagonal working surfaces 1 of slider E. Movement of slider E to the left, to the position in which it is shown in FIG. 21 also causes pushrods 42 to be moved outwardly by means of the coaction of diagonal working surfaces 2 of slider E therewith. The cam surface E–*c* also moves to the left so that it cooperates with cam surface C–*c* to form an aligned recess which allows movable contact blade 60*c* to move upwardly by its spring biasing force to open.

FIG. 22 illustrates the relative positions of sliders B, C, and D, when pushrods 43 are depressed. In FIG. 22, slider B is positioned in the foreground, slider C is positioned behind it, and slider D is positioned in the background behind slider C. When pushrods 43 are depressed, the cam surfaces B–*e*, C–*e*, and D–*e* (as shown in FIG. 13), cooperate to allow movable contact blade 60*e* to move into an overall aligned recess provided by the cooperation of these three cam surfaces. When movable contact blade 60*e* moves into this indented recess, it opens the circuit which it controls.

FIG. 23 illustrates diagrammatically the circuit arrangement of the terminals of switch 2. Only the terminals which are to be connected to external leads have been identified by reference numerals in this figure. It will be understood by those skilled in the art that the arrangement of the various terminals and the selection of external bridges 140 (FIG. 2) have provided this switch circuit configuration. Blade 60*s* is a dummy blade in switch

2, since it is not actuated, and is continuously biased closed.

It will now therefore be seen that my new and improved multiple pushbutton switch as herein illustrated provides an efficient and dependable means for controlling and balancing the positioning of the switch actuators and the pushbuttons. It will further be seen that I have also included in this switch a simplified and efficient combination of spring biased sliders which control the reciprocating motion of the actuators and provide momentary contact actuation, button return to an intermediate position, and an improved overall switch action. It will also be seen that my multiple pushbutton switch includes an improved two piece housing which makes the manufacturing thereof a more simplified operation. It should be understood that a pushbutton switch may easily be constructed incorporating one or more of these individual features with very beneficial results.

While in accordance with the patent statutes I have described what at present is considered to be the preferred embodiment of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from my invention and I therefore aim in the following claims to cover all such equivalent variations as fall within the true spirit and scope of this invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A multiple pushbutton switch comprising a housing, a plurality of actuators mounted in said housing for reciprocating movement therein between first and second positions and having an intermediate position therebetween, contact means including a plurality of movable contacts supported by said housing for operation by said actuators, first and second elongated sliders having opposed parallel faces and at least one asymmetrical aperture therein, the asymmetrical aperture of said first slider being in partial alignment with the asymmetrical aperture of said second slider, at least one of said actuators being positioned to fit into said apertures, spring means in said housing normally tending to move said asymmetrical apertures in the same direction along the axis of elongation of the sliders, the asymmetrical aperture of said first slider including a surface engaging with said one actuator when said actuator is in its first position to resist movement of said actuator toward said second position, the asymmetrical aperture of said second slider including a surface engaging with said one actuator when said actuator is in said second position thereby to force said actuator to revert to its intermediate position, the asymmetrical apertures of said first and second sliders including surfaces concurrently engaging said one actuator to maintain said actuator in its intermediate position, whereby said asymmetrical apertures of said first and second sliders cooperate to control the reciprocating movement of said one actuator between its first and second positions.

2. A multiple pushbutton switch comprising a housing, a plurality of actuators mounted in said housing for reciprocating movement therein between first and second positions, contact means including a plurality of movable contacts supported by said housing for operation by said actuators, first and second elongated sliders having opposed parallel faces and at least one asymmetrical aperture therein, the asymmetrical aperture of said first slider being in partial alignment with the asymmetrical aperture of said second slider, at least one of said actuators being mounted to fit into said asymmetrical apertures, spring means in said housing normally tending to move said asymmetrical apertures in the same direction along the axis of elongation of the sliders, the asymmetrical aperture of said first slider having a surface engaging said one actuator when said actuator is in it first position to resist movement of said actuator toward said second position, the asymmetrical aperture of said second slider having a surface engaging said actuator after movement thereof to said second position thereby to force said actuator to revert toward its first position, whereby said asymmetrical apertures of said first and second sliders cooperate to control the reciprocating movement of said one actuator.

3. A multiple pushbutton switch comprising a housing, a plurality of adjacent pairs of reciprocating actuators mounted in said housing, said pairs of reciprocating actuators extending outwardly from said housing, a pushbutton attached to the outer end of each pair of adjacent reciprocating actuators and supported thereon thereby to control the reciprocating movement in unison of said pair of reciprocating actuators, a plurality of longitudinally extending reciprocating members positioned within said housing, each of said longitudinally extending reciprocating members including a plurality of pairs of similarly configured inclined edges engageable by the inner ends of an adjacent pair of reciprocating actuators, contact means including a plurality of movable contacts supported by said housing for operation by said reciprocating actuators, whereby each of said pushbuttons controls a pair of associated reciprocating actuators and is accurately aligned and positioned during movement thereof by attachment to said pair of reciprocating actuators.

4. The multiple pushbutton switch of claim 3 wherein a compression spring is disposed between each pair of reciprocating actuators, each of said compression springs extending between said housing and the pushbutton associated with said pair of reciprocating actuators thereby to urge said pushbutton toward its outer position.

5. A multiple pushbutton switch comprising a housing, a plurality of adjacent pairs of reciprocating actuators mounted in said housing for reciprocating movement therein between first and second positions and having an intermediate position therebetween, said pairs of reciprocating actuators being disposed in spaced parallel relationship and extending outwardly from said housing, a pushbutton attached to the outer ends of each pair of adjacent reciprocating actuators and supported thereon thereby to control the reciprocating movement in unison of said pair of reciprocating actuators, a plurality of longitudinally extending reciprocating members positioned within said housing, each of said longitudinally extending reciprocating members including a plurality of pairs of similarly configured inclined edges engageable by the inner ends of an adjacent pair of reciprocating actuators, contact means including a plurality of movable contacts supported by said housing for operation by said pushbuttons, first and second elongated sliders positioned in said housing alongside of said longitudinally extending reciprocating members, said first and second elongated sliders having opposed parallel faces and at least one pair of spaced asymmetrical apertures therein, the said one pair of asymmetrical apertures of said first elongated slider being in partial alignment, respectively, with said one pair of asymmetrical apertures of said second elongated slider, at least one adjacent pair of said reciprocating actuators being arranged to cooperate with said one pair of partially aligned asymmetrical apertures, spring means in said housing normally tending to move said one pair of partially aligned asymmetrical apertures in the same direction along the axis of elongation of said elongated sliders, the pair of asymmetrical apertures of said first elongated slider having surfaces engaging said one pair of reciprocating actuators when said pair of reciprocating actuators are in the first postion to resist movement of said pair of reciprocating actuators toward said second position, the pair of asymmetrical apertures of said second elongated slider having surfaces engaging said one pair of reciprocating actuators when said pair of reciprocating actuators are in said second position thereby to force said pair of reciprocating actuators to revert to their intermediate position, the partially aligned pairs of asymmetrical apertures of said first and second elongated sliders having surfaces engaging said one pair of reciprocating actuators to maintain said pair of reciprocating actuators in the inter-

mediate position, whereby said partially aligned pairs of asymmetrical apertures of said first and second elongated sliders cooperate to control the reciprocating movement of said one pair of reciprocating actuators between the first and second positions.

6. In a multiple pushbutton switch having a plurality of longitudinally elongated sliders disposed in side-by-side relationship and a plurality of reciprocating actuators engageable with predetermined working surfaces of said longitudinally elongated sliders for selective movement of certain of said longitudinally elongated sliders in predetermined directions, contact means including a plurality of movable contacts actuated by certain of said longitudinally elongated sliders as said longitudinally elongated sliders are moved in their predetermined direction, and a two-piece housing for said switch, said two-piece housing including a pair of mating hollow bases formed of insulating material each of which has a closed outer end wall, an open inner end, and an open bottom, said mating hollow bases being attached together by means of an accurately dimensioned mounting bracket with the open inner ends thereof communicating thereby to receive the longitudinally elongated sliders of said switch and support the actuators of said switch in an in-line configuration, and said two-piece housing supporting said movable contacts, the open inner ends of the two mating hollow bases of said multiple pushbutton switch being disposed adjacent to each other at a suitable spacing to enhance the control of tolerances in said switch.

7. The multiple pushbutton switch of claim 6 wherein a cover plate is attached to and spans the open bottoms of said mating hollow bases.

8. A multiple pushbutton switch comprising a housing, a plurality of adjacent pairs of reciprocating actuators mounted in said housing, said reciprocating actuators being disposed in spaced parallel relationship and extending outwardly from said housing, a pushbutton attached to the outer ends of each pair of adjacent reciprocating actuators thereby to control the reciprocating movement in unison of said pair of reciprocating actuators, a plurality of longitudinally extending reciprocating members, each of said longitudinally extending reciprocating members including a plurality of pairs of similarly configured inclined edges engageable by the inner ends of an adjacent pair of reciprocating actuators, contact means including a plurality of movable contacts supported by said housing and selectively operable by said pushbuttons, said housing being of two-piece molded insulative contruction for supporting the actuators and reciprocating members of said switch, said housing including a pair of mating hollow bases each of which has a closed outer end wall, an open inner end wall, and an open bottom, said mating hollow bases being attached together by means of an accurately dimensioned mounting bracket with the open inner ends thereof communicating thereby to receive the longitudinally extending sliders of said multiple pushbutton switch and support the pairs of reciprocating actuators of said switch in an in-line configuration, the open inner ends of the two mating hollow bases of said multiple pushbutton switch being disposed adjacent to each other at a suitable spacing to enhance the control of tolerances in said multiple pushbutton switch.

9. As an article of manufacture, a slider for a multiple pushbutton switch having a plurality of switch actuators which reciprocate between first and second positions and have an intermediate actuating position therebetween, said slider being thin and elongated and having first and second parallel longitudinal edges, a projection formed adjacent one end of said slider for engaging a biasing spring, a plurality of uniformly configured apertures opening into said first longitudinal edge, each of said uniformly configured apertures comprising an outer diagonal edge section intersecting said first longitudinal edge and extending toward said second longitudinal edge, an intermediate edge section intersecting said outer diagonal edge section to form a point, an inner diagonal edge section spaced from said outer and intermediate edge sections and disposed transversely to said outer edge section between said first and second longitudinal edges, and a connecting edge section joining said inner and intermediate sections, said outer diagonal edge sections of said slider being disposed to engage with the switch actuators to resist the depression thereof when said slider is positioned in the switch in a first end-to-end relationship, said inner diagonal edge sections being disposed to engage said switch actuators to return them to an intermediate actuating position below said points upon the depression thereof when said slider is positioned in a second end-to-end relationship directly reverse to said first relationship.

10. A multiple pushbutton switch comprising a housing, a plurality of actuators mounted in said housing for reciprocating movement therein between normal and depressed positions and having an intermediate position therebetween, means for returning each of said actuators from said depressed position to said intermediate position following the depression thereof and for retaining each actuator in said intermediate position until another actuator is depressed, contact means, a first connecting means connecting said actuators and said contact means, said connecting means actuating said contact means when said actuators are depressed and maintaining said contact means in said actuated condition when said actuators return to said intermediate position, and at least one separate contact, second connecting means connecting said separate contact and certain of said actuators for momentary actuation of said separate contact when one of said certain actuators is in its depressed position.

11. In a multiple pushbutton switch having a plurality of longitudinally elongated sliders disposed in side-by-side relationship and a plurality of reciprocating actuators engageable with predetermined working surfaces of said longitudinally elongated sliders for selective longitudinal movement of certain of said longitudinally elongated sliders in predetermined directions, contact means including a plurality of movable contacts operated by the longitudinal movement of certain of said longitudinally elongated sliders, and a multi-part housing for said switch, said multi-part housing including a plurality of aligned mating hollow bases having open ends, closed end walls formed on the bases at the respective outer ends of the housing and an accurately dimensioned mounting bracket secured to each of the mating hollow bases attaching them together with said open ends communicating, thereby to receive the longitudinally elongated sliders of said switch and support the reciprocating actuators and the contact means of said switch, said bracket holding said mating hollow bases in a predetermined relationship with a space between the adjacent open ends thereof for tolerance control.

12. A multiple pushbutton switch comprising a housing, a plurality of actuators mounted in said housing for reciprocating movement therein between first and second positions, contact means including a plurality of movable contacts supported by said housing for operation by said actuators, first and second elongated sliders having opposed parallel faces and at least one asymmetrical aperture therein, the asymmetrical aperture of said first elongated slider being in partial alignment with the asymmetrical aperture of said second elongated slider, at least one of said actuators being mounted to fit into said asymmetrical apertures, spring means in said housing normally tending to move said asymmetrical apertures in the same direction along the axis of elongation of the elongated sliders, the aperture of said first elongated slider having a protrusion over which said actuator passes in moving to said second position, the asymmetrical aperture of said

second elongated slider having an inclined surface engaging said actuator after the movement thereof to its second position for forcing said actuator outwardly toward its first position, the underside of said protrusion on said first elongated slider engaging and limiting the movement of said actuator as it moves toward said first position under the force applied by said inclined surface of said second elongated slider, whereby said elongated sliders concurrently engage said actuator to hold it in said intermediate position until a subsequent actuator is depressed.

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