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W. VERMEULEN

2,878,329

PUSH BUTTON SWITCH WITH TIME DELAY SLIDER

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2 Sheets-Sheet 1

FIG. 1.

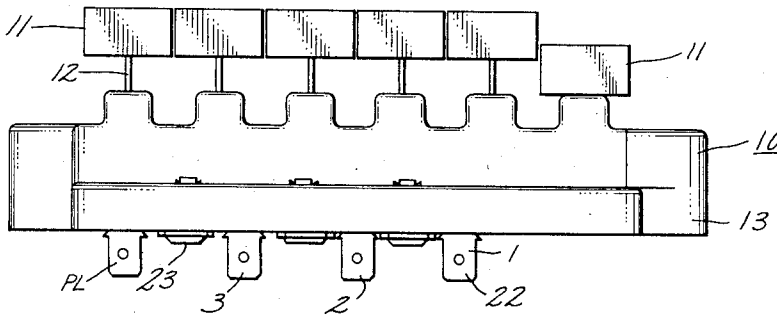


FIG. 2.

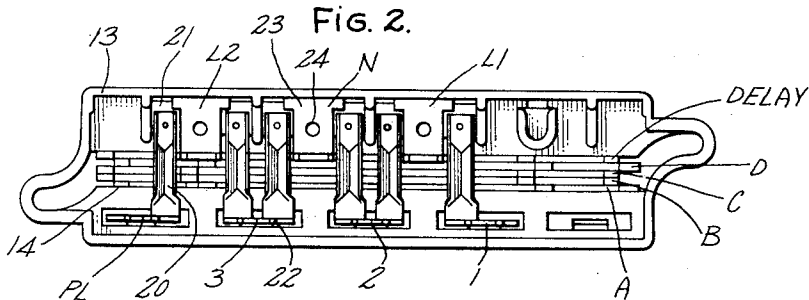
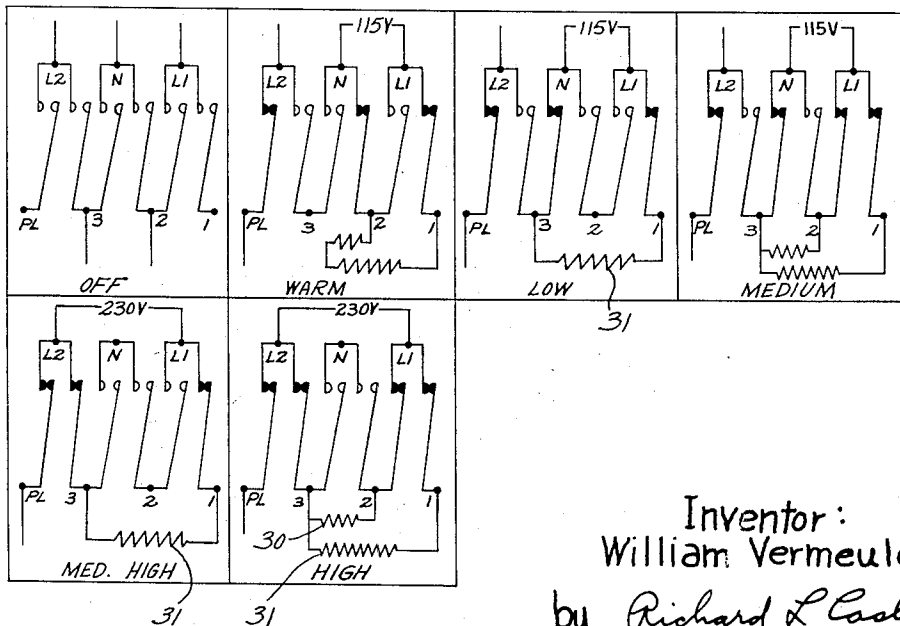


FIG. 3.



Inventor:
William Vermeulen
by Richard L. Caslin
His Attorney

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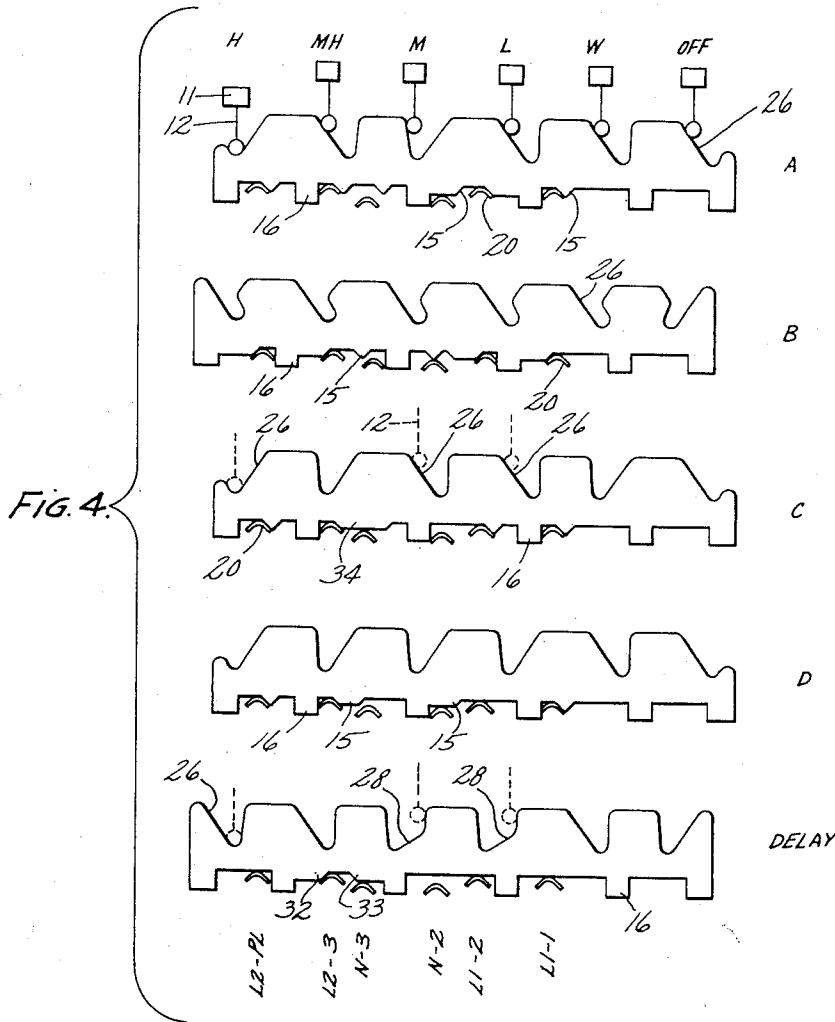
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PUSH BUTTON SWITCH WITH TIME DELAY SLIDER

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2 Sheets-Sheet 2



Inventor:
William Vermeulen
by Richard L. Caslin
His Attorney

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**PUSH BUTTON SWITCH WITH TIME DELAY
SLIDER****William Vermeulen, Fairfield, Conn., assignor to General
Electric Company, a corporation of New York****Application March 31, 1958, Serial No. 725,351****9 Claims. (Cl. 200—5)**

The present invention relates to multiple push button switches and particularly to an improvement in such switches of the type pioneered by the Andrews Patent No. 2,431,904, which is assigned to the same assignee as is the present invention. Such push button switches are widely used for controlling the heating elements of electric ranges, for clothes washing and drying machines, room air conditioners, electric broilers, window fans, etc.

This invention was conceived principally to fulfill an urgent need in eliminating the possibility of flashover in pushbutton switches for electric ranges that operate on a three-wire 115/230 volt system. A flashover is defined as an electrical discharge or arc between conducting portions of the switch of differing line potentials and is, therefore, a short circuit established through the arc. It may be of low current magnitude and/or short time duration, in which case no damage is done to the switch. If, however, the current magnitude of the arc and/or the time duration are such as to cause welding of the switch contacts, the switch itself may be destroyed and a fire may result. This phenomenon of flashover may occur in any switching action in which movable contacts connected to a common load are transferred very rapidly from a contact of one potential to a contact of ground or opposite potential. It is most likely to occur when switching rapidly from the maximum heat position with the range heating element across a 230 volt line to a lower heat position with the element across the 115 volt line.

A typical switch used on electric ranges is a six button, five heat position switch where the sixth button is the "off" button. Each heating element usually consists of two resistance units which are connected in various single, series, and parallel circuits operating at either 115 or 230 volts to give the different levels of heat for cooking. In the "high" or "medium high" positions, the resistance units are connected across the 230 volt line from one 115 volt terminal to the other of opposite polarity. In the "medium" or "low" positions, the resistance units are connected across the 115 volt line from one 115 volt terminal to neutral. In switching from "high" or "medium high" to "medium" or "low," the load connection is transferred from one of the 115 volt line terminals to the neutral terminal. If the switching is done sufficiently rapidly, the arc at the 115 volt terminal may not have been interrupted prior to the switch blade having closed on the neutral terminal, and a short circuit is established through the arc between the 115 volt line and neutral, causing a flashover. Dependent on the severity of the flashover, the temperature of the arc may be of such high intensity that it will weld the contacts together, destroying the usefulness of the switch.

The arc established between the contacts of a switch of this type operating in an alternating current circuit may be interrupted in one of two means, first by opening the contacts far enough so that the arc is extinguished,

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and secondly by the alternating current of the arc going through a current zero as occurs at each half cycle. There is a practical limit to which the contacts can be separated to establish a long gap, thereby extinguishing the arc. This limit is imposed by factors of size and cost of materials of the switch. It is therefore preferable to interrupt the arc by having the current reach a zero value on the sine curve of the alternating current. If the contact to be closed can be kept from closing for a full half cycle after the contact being interrupted is first opened, then flashover cannot occur since there is no arc to sustain the short circuit. As a practical matter, the time can be considerably less than a half cycle since the available gap does help to interrupt the arc, and since flashovers that occur late in the half cycle are of such short duration and of such low magnitudes of instantaneous current that the heat of the arc is not sufficient to cause damage. Experimental work has demonstrated that a switching interval of one third cycle, rather than one half cycle, provides adequate protection for a 2600 watt resistive load on a 115/230 volt line operating at 60 cycles per second.

For a common load, the switching time interval between opening a first switch element connected to a line of one potential and closing a second switch element to a line of neutral or opposite potential is a function of the speed of movement of the sliders of the switch that control the positions of the movable contact blades. This will be better understood after a careful reading of the detailed description of the present invention which follows. It will suffice to say at this time that the greater the time taken between opening the line contacts and closing the neutral contacts, the greater will be the likelihood that the arc is extinguished by the natural characteristic of the alternating current passing through a zero value on the sine wave at the halfway point of the complete cycle.

The primary object of this invention is to provide a multiple push button switch with a time delay slider which will delay the closing of the neutral contacts of a circuit of low potential until sufficient time has been allowed for the opening of the line contacts in a circuit that operates at a higher potential.

A further object of this invention is to provide a multiple push button switch with an additional slider that will provide a delay in the time of closing of a given circuit until sufficient time has been allowed for the opening of a previously closed circuit in order to prevent flashover from occurring.

A still further object of this invention is to provide a multiple push button switch with sliders that have a lost motion feature in cooperation with at least one of the buttons to cause the movement of some of the sliders before one of the sliders is actuated by the button, to provide a delay in the time of actuating a given circuit until another circuit has been actuated.

The illustrated embodiment of the present invention is a six button, five heat position push button switch having a hollow housing of suitable molded insulating compound. Four elongated sliders of insulating sheet material are stacked in the housing in side-by-side relation for independent reciprocating movement on the bottom wall of the housing. A plurality of movable contact blades are each fastened at one end to the housing and arranged crosswise of the sliders for cooperation with a series of cam surfaces cut into the lower edge of each slider. Complementary fixed contacts are positioned near the free end of the movable contact blades. Accordingly, the shifting movement of the sliders moves the cam surfaces which in turn open or close the contact blades to change the circuitry of the switch. A plurality of push buttons extend through openings in the top wall of the switch

housing and cooperate with inclined surfaces on the sliders so that the depression of each button in succession will act upon certain of the inclined surfaces to shift the sliders in a predetermined manner.

An additional slider has been added and it is herein-after described as the time delay slider. The time delay slider has at least one cam surface on its lower edge for holding the neutral contact blade from closing until one of the line contacts has opened for a sufficiently long time to extinguish the arc that forms in the air gap. This time delay feature is especially important when the switch is already set in the "high" or "med. high" heat position and the "medium" or "low" heat position is to be obtained. When the button for the "medium" or the "low" heat position is depressed, at least one of the other four sliders begins to shift and engage or disengage the proper contact blades, but the delay slider does not move immediately. This delay is due to the fact that the inclined surface on the delay slider is deeper set in the delay slider and presents a steeper slope to the push button than the inclined surfaces of the other sliders. This configuration causes lost motion between the button for either the "medium" or "low" heat positions and the delay slider when the switch is being changed from the "high" or the "med. high" heat positions. Once the delay slider begins to move, its cam surface will disengage itself from the neutral contact blade and allow it to close. All of this has been done to increase the time available from the initial opening of the contact blade for one of the line terminals until the blade for the neutral terminal is closed. The results obtained from exhaustive life tests and simulated field trials, are that the flashover problem has been solved by the present invention for the wattage loads employed and for the impact levels normally imposed on the switch by the public.

My invention will be better understood from the following description taken in connection with the accompanying drawings and its scope will be pointed out in the appended claims.

Figure 1 is a front elevational view of a multiple push button switch embodying my invention.

Figure 2 is a bottom plan view of the switch of Figure 1 with the cover plate removed.

Figure 3 represents the circuit diagrams for the six positions of the switch.

Figure 4 is a schematic drawing showing the configurations of the several sliders of the switch with relation to the movable contact blades and the push buttons.

Referring in detail to the drawings and in particular to the general view of the switch of Figure 1, 10 represents the hollow switch housing having a plurality of push buttons 11 arranged in a line above the switch. Each button 11 is attached to a metal push rod 12 that extends through a suitable opening in the top wall of the housing. Looking at the bottom plan view of Figure 2, it will be understood that the housing 10 comprises a recessed base 13 that is open at the bottom and is adapted to be closed by a thin cover plate (not shown) of insulating material as is well known in this art. A series of elongated sliders of insulating sheet material are shown in detail in Figure 4 and labeled at the right side as A, B, C, D and Delay. The sliders are stacked together in side-by-side relation within the base 13 of the housing. These sliders are supported on the bottom wall of the housing formed by the cover plate and are held in position by close-fitting partitions 14 of the base 13. The lower edge of each slider as shown in Figure 4 is undercut to form cam surfaces 15 that are held raised off of the bottom wall of the housing by the supporting feet 16.

The electrical contacts of the switch comprise a plurality of movable contact blades 20 that make and break contact with complementary fixed contacts 21. The contact blades 20 are supported in cantilever fashion in the housing along one side wall thereof, as seen at the lower portion of Figure 2. These contact blades 20 have termi-

nal ends 22 which represent the load terminals 1, 2, 3 and PL of the switch. The fixed contacts 21 have terminal ends 23 with threaded opening 24 to provide screw terminations for the line terminals L1, N and L2.

The upper edge of each slider has a series of inclined surfaces 26 as seen in Figure 4. The push buttons 11 are shown diagrammatically in cooperation with the delay slider but it should be understood that the sliders are side-by-side and the buttons may engage all of the sliders. The push rods 12 are stamped from thin metal stock and have a rounded lower end that slides on the inclined surfaces 26 of the sliders. A careful study of the various directions of inclinations of the surfaces 26 in Figure 4 should make clear to those skilled in this art that the depression of any button will bring its push rod 12 to exert a side thrust against one or more of the inclined surfaces 26 of the sliders. This will shift the sliders either to the left or right in a predetermined manner and adjust the position of the cam surfaces 15 with relation to the contact blades 20. These contact blades 20 are shown of V shape as the central portion of the blades would appear in transverse cross-section. This shape is used to render the blades suitable for being cammed as the sliders are shifted.

The details of the switch structure as explained above have become generally standardized, although heretofore such a switch contained only sliders such as A, B, C, and D. The delay slider of Figure 4 has been added by this invention for reasons which will be better understood after study is made of the circuit diagrams of Figure 3. The circuits are labeled in the order of increasing temperature from "off," "warm," "low," "medium," "medium high" and "high." The switch is supplied a voltage of 115/230 from three conductors that are joined to the load terminals L1, N, and L2. Accordingly, any circuit across one of the line terminals L1 or L2 and the neutral terminal N would be operating at a voltage of 115 volts, while a circuit across the two line terminals L1 and L2 would be at a potential of 230 volts. There are four load terminals listed as 1, 2, 3, and PL (for pilot light). The heating element that is to be controlled by the subject switch comprises two resistance heaters 30 and 31 which are used alone, or together in series or in parallel circuits across either the low or the high voltages to provide a wide range of available cooking temperatures. In the "high" position, heating elements 30 and 31 are connected in parallel across the two line terminals L1 and L2 at a potential of 230 volts. The "medium high" position has only the resistance 31 energized, and is connected across the line terminals L1 and L2 at a potential of 230 volts. The "medium" heat position has the two resistance heaters 30 and 31 again connected in parallel, as in the "high" heat position, but across line L1 and neutral N at a potential of 115 volts. Moreover, the "low" heat position is comparable to the "medium high" position in that the heater 31 is the only element that is energized, but the difference is that it is being operated at the lower voltage of 115 volts. Finally, the "warm" position has the two heaters 30 and 31 connected in series across line L1 and neutral N.

Flashover is known to occur in push button switches of previous designs when the switch setting is changed either from the "high" or "medium high" positions to either the "medium" or "low" positions. Attention is drawn to the fact that in both the "high" and "medium high" positions the contacts L2-3 are closed between line L2 and load 3, while the contacts N-3 are opened between the neutral terminal N and load 3. However, in the "medium" or "low" positions, the contacts L2-3 are open while the contacts N-3 are closed. Hence, it will be seen that if the circuit is closed by contact N-3 before the arc is extinguished in the air gap formed by the opening of contacts L2-3, a short circuit through the arc will develop as the switch mechanism performs its switching operation from the 230 volt settings to the 115 volt set-

tings. If a sufficient time is given for the opening of the contacts L2—3 before the contact N—3 is closed, the arc in the air gap will be extinguished automatically. In the event that the button for the "medium" or "low" heat position is punched or struck with a heavy impact, some of the standard sliders A, B, C and D would shift suddenly, causing the circuit transfer to take place in considerably less than a half cycle. If this timing is in the order of three or four milliseconds, a flashover may occur across line L2 and the neutral terminal N.

Turning now to a consideration of the delay slider of Figure 4, particular attention should be given to push buttons M and L which represent the "medium" and "low" positions. Instead of having the usual inclined surfaces 26, the delay slider has a deeper set inclined surface 28 for both buttons M and L. The expression "deeper set" means that there is lost motion or a vertical drop for the rounded end of the push rod 12 before it will engage the inclined surface 28. Initially, as button M or L is depressed, the push rod 12 engages the inclined surfaces 26 of the other sliders and these other sliders begin to shift immediately. The delay slider does not move until a later time when the button has arrived at the lower position where it engages the inclined surface 28. Further downward movement of the button then causes the delay slider to move. As shown in Figure 4 of the drawing, the inclined surface 28 has a steeper slope with respect to the longitudinal axis or axis of travel of the push button 11 than the slope of the inclined surfaces 26 of the standard sliders.

The purpose of the deeper set inclined surfaces 28 will be understood after comparing the two cam surfaces 32 and 33 that are cut in the lower edge of the delay slider and their relationship to the cam surface 34 cut in the lower edge of the "C" slider. In Figure 4, the sliders and blades are illustrated as they are positioned by the push rod 12 when button H is depressed to obtain the "high" heat setting. The L2—3 blade is in the closed position as is permitted by cam surface 32 on the delay and cam 34 on the "C" slider respectively. The N—3 blade is held open by cam surfaces 33 and 34 on the delay and "C" sliders. When button M or L is depressed to achieve "medium" or "low" heat, the "C" slider immediately moves toward the left by the action of the push rod 12 on the inclined surface 26, until cam surface 33 opens the L2—3 blade. Simultaneously, cam surface 34 disengages itself from the N—3 blade. However, the delay slider has not yet moved far enough to engage the inclined surface 28 of the delay slider, and as a consequence, cam surface 33 on this slider continues to hold the N—3 blade open.

At some later time, when the push rod has moved to a position where it engages inclined surface 28, the delay slider moves to the right, and the N—3 blade is permitted to close. Cam surface 32 slides under the already open L2—3 blade. A delayed action in closing the N—3 blade after opening the L2—3 blade has therefore been achieved. The action is similar when the initial slider and blade positions correspond with those which result when button MH is depressed.

Having described above my invention of a novel push button switch with an additional delay slider to prevent flashover when switching from one potential to another in a three wire system, it should be readily apparent to those skilled in this art that this invention has use in applications other than electric ranges. One example would be for reversing the polarity of connections to motors for the purpose of changing their direction of rotation. Another is to provide assurance that one circuit change is completed prior to another circuit change being effected to protect against a situation such as the user of the switch not completely depressing a button with the result that the sliders do not move to their intended position. It is not deemed necessary to locate the deeper set inclined surfaces in an additional slider, or in the case of two or more such surfaces to put them both on the same

slider. They may be positioned on different sliders and the same operating principle will prevail. Also, different shapes of deeper set or lost motion surfaces may be preferred, such as one having a sweeping arcuate shape.

5 Modifications of this invention will occur to those skilled in this art and it is to be understood, therefore, that this invention is not limited to the particular embodiments disclosed but that it is intended to cover all modifications within the true spirit and scope of this invention.

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

1. A multiple push button switch comprising a housing, a plurality of elongated sliders assembled in the housing in side-by-side relation for sliding movement on one wall of the housing, one edge of each slider being undercut to form cam surfaces, a plurality of movable contact blades engageable with the cam surfaces of the sliders, each blade being fixed at one end to the housing and free to move at its opposite end to make and break contact with a fixed contact of the switch, each slider having inclined surfaces which cooperate with a plurality of push buttons that extend through a wall of the housing, the inclined surfaces being arranged on the different sliders so that only one button may be fully depressed at any one time, and a delay slider combined with the said sliders, the delay slider having at least one cam surface for holding one of the contact blades from closing until an adequate blade is opened and the current flowing through it is interrupted, the delay slider also having at least one inclined surface that is deeper set than the inclined surfaces of the other sliders whereby the delay slider moves at a later time than the other sliders to disengage itself from the said one contact blade and allow it to close.

2. A multiple push button switch comprising a housing, a plurality of elongated sliders assembled in the housing in side-by-side relation for reciprocating movement, one lengthwise edge of each slider being undercut to form cam surfaces, a plurality of movable contact blades engageable with the cam surfaces of the sliders, each blade being fixed at one end to the housing and free to move at its opposite end to make and break contact with an opposing fixed contact of the switch, each slider having inclined surfaces which cooperate with a plurality of push buttons that extend through a wall of the housing, the inclined surfaces being arranged on the different sliders so that the depression of any button will act upon one or more of the sliders causing them to shift the cam surfaces toward or away from some of the contact blades for changing the circuit arrangement of the switch, the inclined surfaces extending in such directions that only one button may be fully depressed at any one time; the invention comprising the incorporation of an additional delay slider having at least one cam surface for holding one of the contact blades from closing until an adjacent blade is cammed open and the circuit through that last-mentioned blade is open, the delay slider also having at least one inclined surface that is set back further from its cooperating push button than the other inclined surfaces and push buttons, whereby the delay slider is slower to move than the other sliders due to the lost motion between the push button and the deeper set inclined surface of the delay slider, the contact blade that was held open by the delay slider automatically closing as the delay slider shifts to its extreme position.

3. A multiple push button switch comprising a switch housing, a plurality of elongated sliders of insulating material assembled in the housing in side-by-side relation for reciprocating movement, each slider having inclined surfaces cooperating with a plurality of push buttons that extend through a wall of the housing, the depression of any one button serving to shift the sliders relative to each other in a predetermined manner, one longitudinal edge of each slider being undercut to form cam surfaces, and a plurality of movable contact blades engageable with the cam surfaces so that the shifting of the sliders causes the

cams to open or close the contact blades depending on the circuitry for the button that has been depressed, and an additional delay slider combined with the other sliders, the delay slider having at least one cam surface that is adapted to hold one of the contact blades from closing a circuit at one potential until another blade is opened in a circuit of a higher potential, the delay slider having a relatively steep inclined surface that cooperates with at least one of the push buttons and is set back to give a lost motion effect to the button, whereby the delay slider begins to shift after the other sliders have begun to move, so that once the delay slider is moved, it disengages itself from the said one contact blade and allows it to close.

4. A multiple push button switch comprising a housing, a plurality of elongated sliders assembled in the housing for independent reciprocating movement, a plurality of movable contacts engageable by the sliders for controlling the circuitry of the switch, and a plurality of push buttons extending through one wall of the housing and engageable with inclined surfaces of the sliders for shifting the sliders in a predetermined manner, at least one of the said inclined surfaces in a given slider being deeper set than the others and with a steeper slope measured with respect to its push button so there is lost motion between the complementary push button and said given slider, whereby the given slider moves at a later time than the other sliders that are acted upon by the said complementary push button.

5. A multiple push button switch as recited in claim 4 wherein the said given slider has a cam surface that holds at least one of the movable contacts from closing until another movable contact has opened for a sufficient time to interrupt the circuit.

6. A multiple push button switch as recited in claim 5 wherein the said given slider has two spaced cam surfaces along one longitudinal edge for cooperation with two movable contacts, each cam serving to hold one of the movable contacts open while the other movable contact is closed and positioned between the two cam surfaces, so that when the given slider is shifted it will open the closed contact before releasing the previously open contact so it may close.

7. A multiple push button switch comprising a hollow housing of insulating material, a stack of elongated sliders of insulating material assembled in the housing for independent sliding movement on the bottom wall of the housing, the bottom edge of each slider being undercut to form cam surfaces, a plurality of movable contacts engageable by the cam surfaces of the sliders so that the shifting of the sliders controls the opening and closing of the movable contacts, each slider having a series of inclined surfaces that cooperate with a plurality of push buttons extending into the housing through one wall thereof, at least one of the inclined surfaces of a given slider being set back into the slider and having a steeper slope relative to the complementary push button than the other inclined surfaces, whereby there is lost motion provided between the complementary button and the said given slider so that this slider is slower to move than the other sliders actuated by the complementary button, the given slider having only two spaced cam surfaces so that two adjacent movable contacts will alternate in position and both will not be closed at the same time.

8. A multiple push button switch as recited in claim 7 wherein a second slider has a single cam surface for cooperation with said two adjacent contacts for alternately opening and closing them, the said given slider preventing one of the contacts from closing even though said one contact has been disengaged by the single cam of the said second slider, the given slider finally shifting its position after the circuit is interrupted through the other of the two contacts thereby disengaging itself from the one contact and allowing it to close.

9. A multiple push button switch as recited in claim 4 wherein the said lost motion provides a delay in the time of actuating a given circuit until another circuit has been actuated.

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