United States Patent

Swanke et al.

[15] **3,678,288**

[45] **July 18, 1972**

[54] **MULTIPLE PUSH BUTTON SWITCH SPEED CONTROL SYSTEM**

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[73] Assignee: **Dynamics Corporation of America,** New York, N.Y.

[22] Filed: **Aug. 13, 1970**

[21] Appl. No.: **63,511**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 766,280, Oct. 9, 1968, abandoned.

[52] **U.S. Cl.** ....**307/113,** 200/5 R, 200/5 A

[51] **Int. Cl.** **H01h 15/00**

[58] **Field of Search** 200/5, 50.3, 153.12; 307/113

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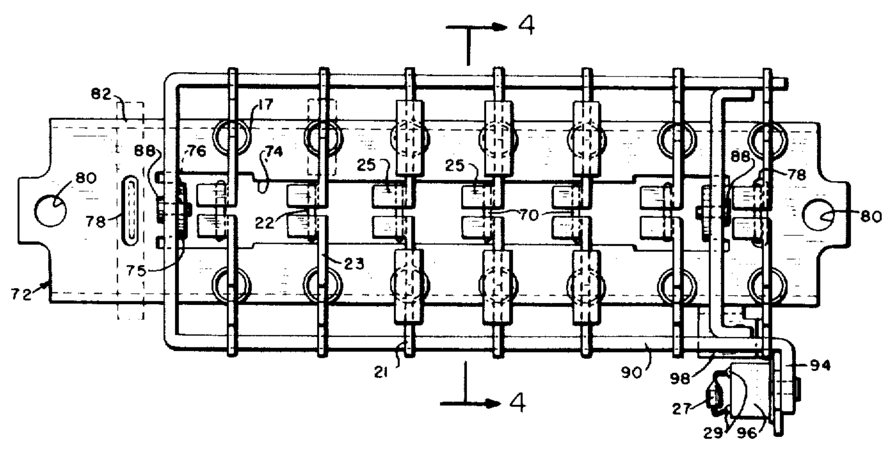
[57] **ABSTRACT**

A multiple switch in which a plurality of individually operated actuators arranged in groups or pairs permute three switches in four patterns which are identical for the actuators of each pair. A two position switch serially connected therewith is oppositely actuated by the individual actuators of each pair to either an open or closed position and thereby provides two modes for each of the four permutations. Preferably, a serially connected switch actuated each time the switches are permuted is rated to make and break a high wattage current and the others are rated to handle a substantially lesser wattage, said permuted switches being timed sequentially to be either open or closed during the moment that the serially connected switch is being opened or closed.

44 Claims, 21 Drawing Figures



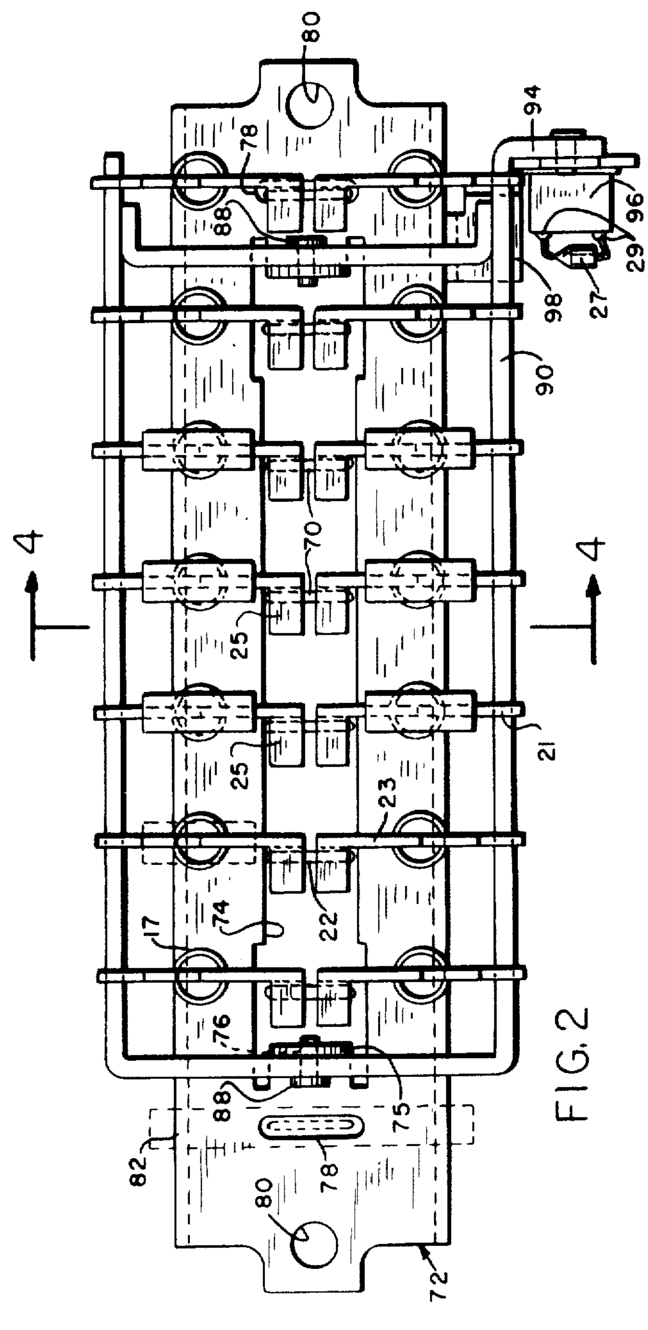


FIG. 2

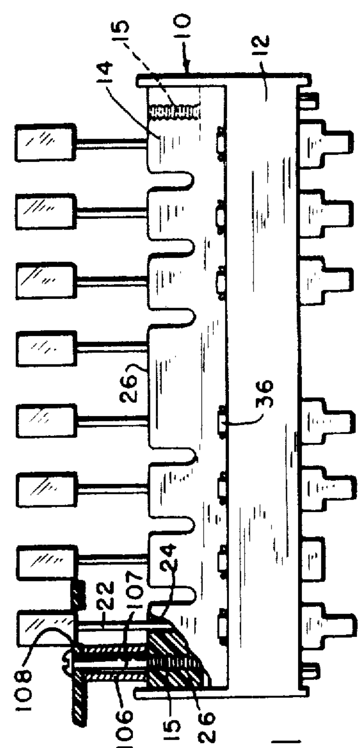


FIG. 1

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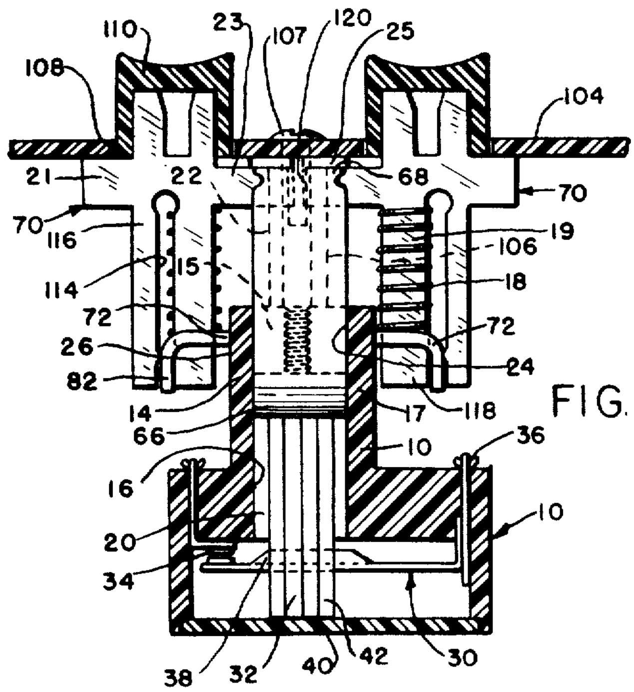
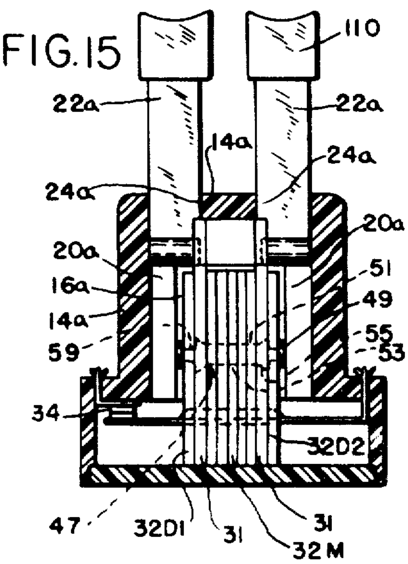


FIG. 4

FIG. 15



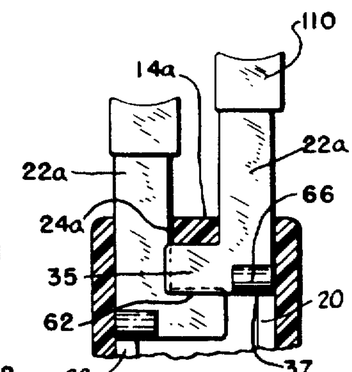


FIG. 17

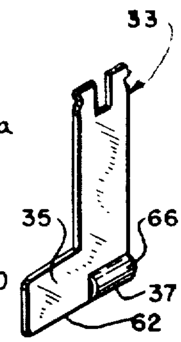


FIG. 18

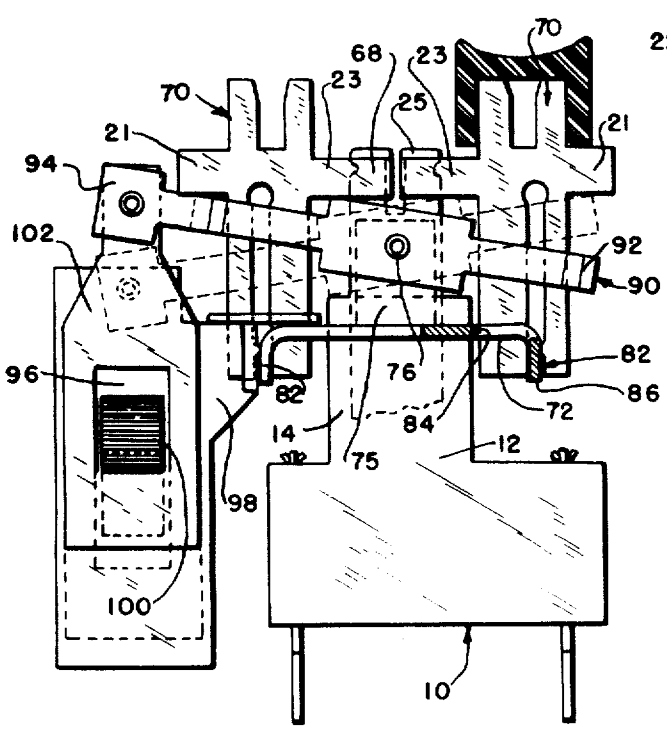


FIG. 3

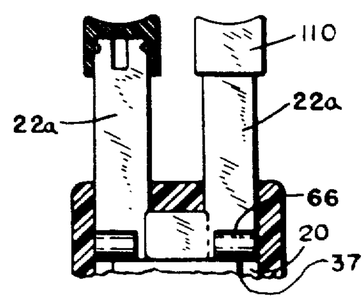


FIG. 16

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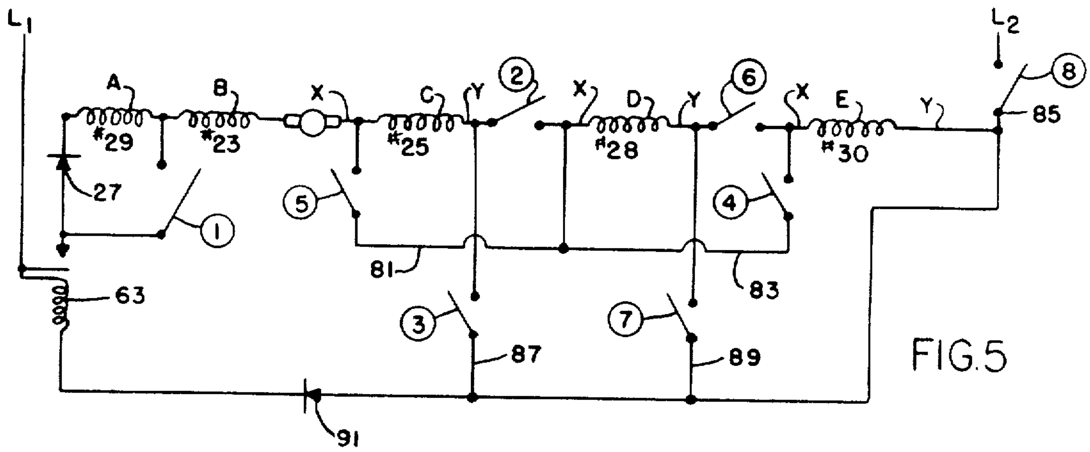

FIG.5

COILS PATTERN	SWITCHES CLOSED	SPEEDS SELECTED
C D E	2 6	X
D E	5 6	X
C E	2 4	X
C D	2 7	X
C D/E	2 7 4	X
DE/C	3 5 6	X
C	3	
D	5 7	
E	5 4	
C D E	3 5.7 4	X
C/D	3 5 7	
D/E	5 7 4	
C/E	3 5 4	
13		7

FIG.6

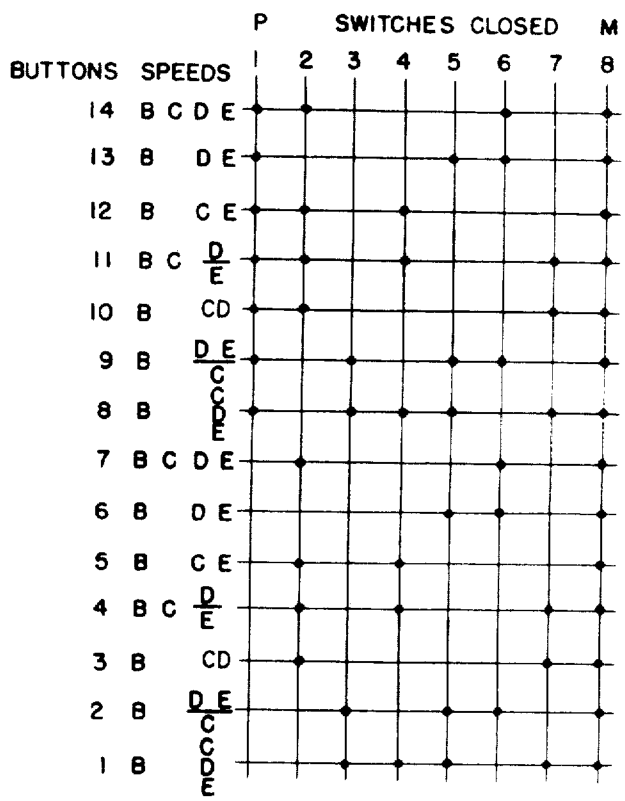

FIG. 7

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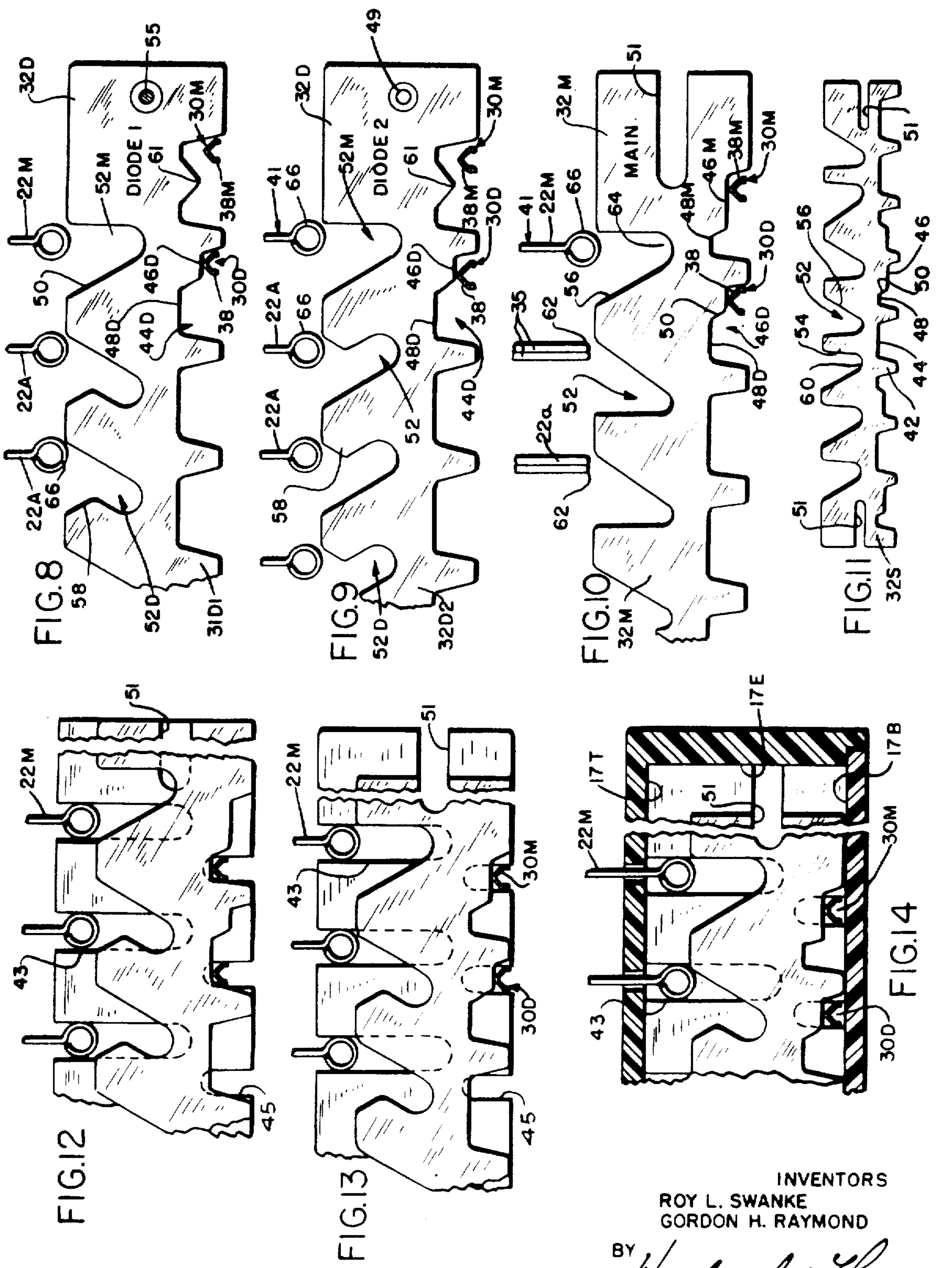

FIG. 8 FIG. 9 FIG. 10 FIG. 11 FIG. 12 FIG. 13 FIG. 14

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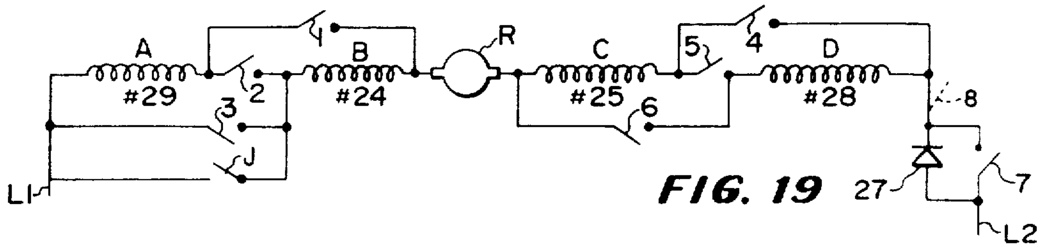

FIG. 19

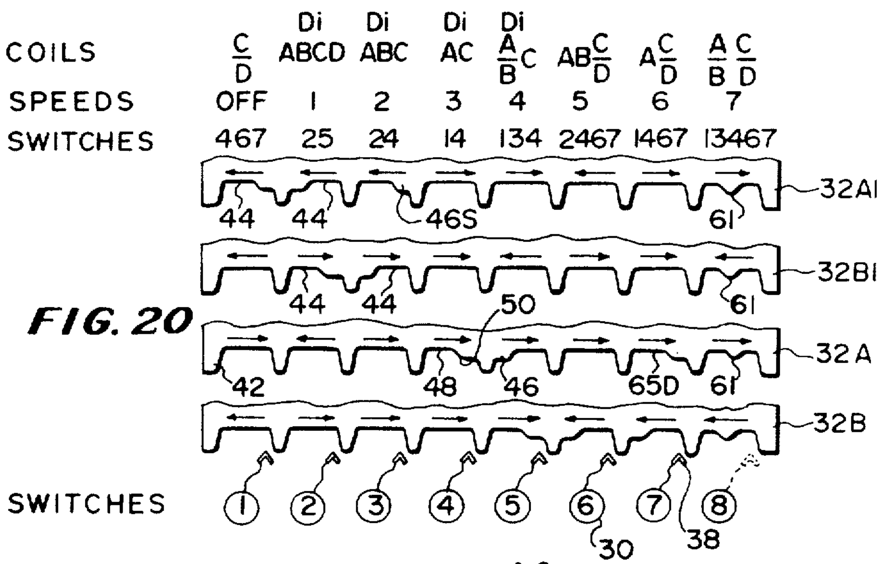

FIG. 20

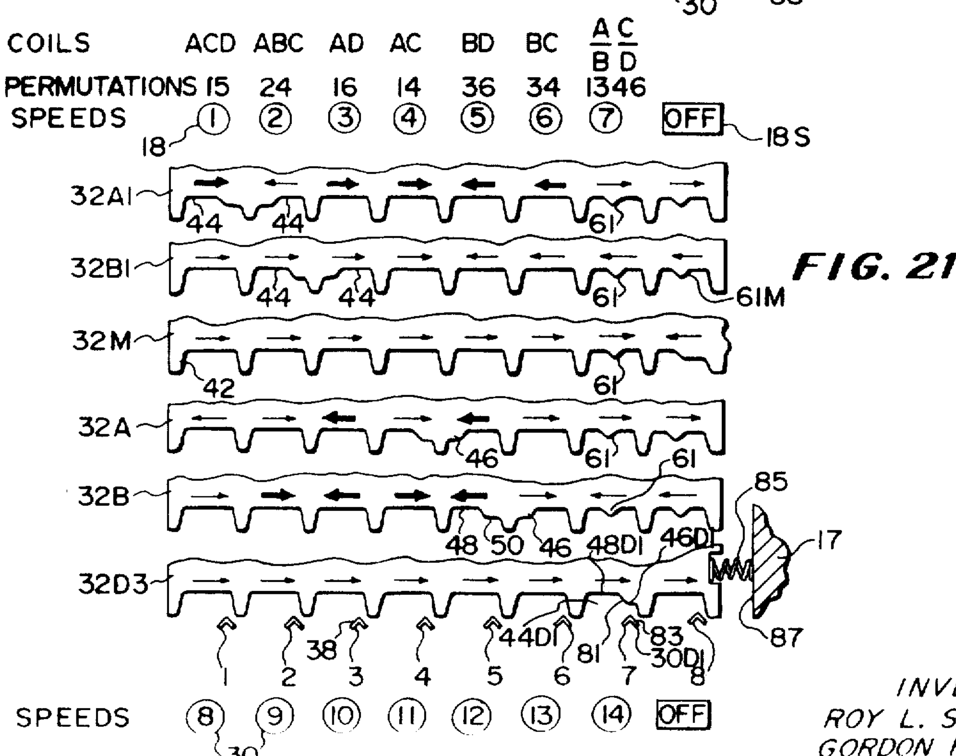

FIG. 21

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MULTIPLE PUSH BUTTON SWITCH SPEED CONTROL SYSTEM

CROSS REFERENCES TO RELATED APPLICATIONS

Swanke Ser. No. 636,457, now U.S. Pat. No. 3,493,833.
Bull Ser. No. 508,309, now U.S. Pat. No. 3,440,438.
This application is a continuation-in-part application of Ser. No. 766,280, filed Oct. 9, 1968, now abandoned.

BACKGROUND OF THE INVENTION

With increasing knowledge and research in laboratories and in the field of food and drink preparation, the need for definiteness of timing with a greater range of selectable fixed agitator speeds is becoming increasingly important for formulas, recipes, and quantities of ingredients to provide the best results when ingredients are being comminuted, mixed or blended. Factors such as particle size, aeration, fluidity, weight, and overrun are not only concerned with timing but also a wide selection of accurately controlled significantly different fixed speeds.

Multiple push button switches have been used in great numbers, by way of example, for the control of electrical appliances and are increasingly used in home and industry with demands for a greater number of push buttons for quickly selecting fixed speeds as distinguished from an infinitely variable control that must be carefully adjusted. Conservation of space within an appliance housing for multiple switches is a problem as well as minimizing the increasing cost of the greater versatility desired.

Increase of speed selections along with minimization of space requirements and reduction of costs are objects of the invention in which selector switches only carry current, the field coils are multiple in number on each field pole, are cowound directly on each core in one winding operation and are of different gage sizes and impedances.

The speed selection is related to various combinations of coils with various combinations of switches selected by push buttons in which the selection is completed and terminated without any current passing through them. Furthermore, the selection of speeds is doubled without any additional switches, each switch combination serving for two or more speeds.

The present invention embodies a multiple switch assembly having movable permutating elements that slidably engage the switches each being provided with a series of notches arranged along one edge having translating cams engaged by respective actuators or push rods for movement between two terminal positions, and along their other edges being provided with cams arranged in recesses permuted to dispose the movable contacts of the switches in either open or closed positions according to predetermined patterns for each actuator pressed. For instance, the switches that are actuated can connect individualized field coil windings of a universal motor in an energizing circuit selectively either in series or parallel, or each individually, to change the effective impedance of the motor field for fixed motor speed selection purposes.

It has been found that four useful permutations are provided by actuating three switches with two sliders controlled to assure that one of the switches is open when either or both of the other two switches are closed.

Furthermore, when the complement of three switches and two sliders is doubled the permutations possible are quadrupled even with one switch in each complement closed simultaneously. Counting the OFF position and the closing of only one switch in some permutations in both complements provides more than 16 possible permutations. Also, one or more permutations or an additional switch may be utilized to change the overall impedance or the electrical potential applied to the circuit controlled by the switches, would further double the permutation effects to thirty-two with at least one switch of each group of three closed. With this range of permutations available a versatility is attained for a wide range of uses.

Also, the space required to house the switch can be substantially reduced by a time sequence switching in which, at a savings in cost of parts and material, seven switches that selectively control a circuit and its applied electrical potential are selectively closed first and opened last with respect to the operation of a heavy duty main switch which makes and breaks the electrical current circuit. The six or seven selective switches are lightly built as rated to merely conduct current and do not need expensive contact elements as long as they are non-oxidizing or have a wiping action, or both, to provide excellent electrical conductivity. The switch for closing and opening the circuit can either be back-to-back silicon controlled rectifiers that share the breaking of the circuit load with a lightly built mechanical switch with little arcing as described in the Bull patent or a heavy duty mechanical switch that is readily embodied in multiple slider gang switch as described herein to make and break as well as carry the full load itself.

Accordingly, the actuators and sliders are sequentially coordinated to actuate the permuted speed control switches to open first and close last and the main switch to open last and close first with respect thereto each time the control switches are set or reset by actuators.

The rectifier switch alluded to above is either opened or closed through intermediate elements that are alternately reciprocated by the actuators of the different pairs at the time the speed control switches and the main switch are being sequentially controlled by any actuator that is being operated to provide the desired permutation pattern of speed control switches.

One of the objects of the present invention is to enable greater freedom of choice of switch combinations for well selected fixed control effects of an electrical device connected thereto as where all permutation switches are not required to be in "OPEN" position when the electrical device is idle thereby providing greater versatility with or without a timer or jogger being present having a separate switch.

Another object of the invention is to provide particularized selections of different component circuit patterns not only for series connection but also for parallel connection on either side or both sides of a serially connected electrical element.

A further object of the invention is to interlock the switching with sliders in common therewith in the above objects that prevent one switch closing while either one of the other two switches are closed.

The invention is also characterized by the number of switches used for an electrical control, being less than one-fourth the number of different fixed circuits mathematically permutatable with a multiple circuit appliance having four or more sets of circuit connections on either or both sides of a power driven element.

The invention also provides at least twice as many power selector buttons as there are control switches for different fixed power settings.

The invention also contemplates a basic switch construction that can be provided with a particular number of control push buttons for a set number of fixed electrical results or twice the number of push buttons for double the number of electrical results without increasing the number of control switches.

The invention provides for a time dimensional sequential switch operation in which only one switch need be rated for making and breaking the power current.

Other objects and advantages of the invention will appear more fully from the following description and from the accompanying drawings, in which similar characters of reference indicate similar parts throughout the several views with or without additional suffix identifications.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a side elevational view of a multiple push button switch embodying fifteen push buttons and eight switches;

FIG. 2 is a top plan view of the speed selection multiplier attachment for the switch shown in FIG. 1 with the buttons removed;

FIG. 3 is an end elevational view of the switch shown in FIGS. 1 and 2;

FIG. 4 is a sectional view taken on line 4—4 in FIG. 2 as oriented with respect to a mounting plate;

FIG. 5 is an electrical schematic of a representative circuit used in the present invention;

FIG. 6 is a graph of the possible fixed speed selections available with the circuit in the present invention utilizing six speed control switches;

FIG. 7 is a chart of seven fixed speed selections showing the permutation of switches with respect thereto, controlled by selective push button actuation;

FIGS. 8 and 9 are enlarged fragmentary side elevational views of the diode sliders in their diode energizing positions;

FIG. 10 is a fragmentary side elevational view of the main switch slider in OFF position;

FIG. 11 is a side elevational view of a representative speed selector switch;

FIGS. 12 and 13 are fragmentary side elevational views of the slider in FIG. 8 in alternate positions in combination with guide plates;

FIG. 14 is a side elevational view showing the elements of FIG. 13 mounted in a housing;

FIG. 15 is a cross-sectional view similar to FIG. 4 of another embodiment of the invention;

FIGS. 16 and 17 are end views partly in section through the housing shown in FIG. 14 showing transversely paired push rods in resting position and actuated position respectively;

FIG. 18 is a perspective view of the push rod employed in the embodiment shown in FIG. 14;

FIG. 19 is another electrical schematic view of a circuit embodying the invention with the armature electrically between two pairs of co-wound coils of different impedances;

FIG. 20 is a composite view of the switch engaging portions of the speed selector sliders employed with the circuit shown in FIG. 19 for eight speeds including three permutation sliders and a diode switch control slider; and

FIG. 21 is a view similar to FIG. 20 for switch modification incorporating a diode doubling for 14 speeds provided for the circuit shown in FIG. 19 and including a diode switch slider and a main switch slider.

DESCRIPTION OF EMBODIMENTS OF INVENTION

By way of illustration but not limitation the invention will be described as applied to the control of a fractional horsepower universal motor powering a food blender for a clearer understanding of its versatility.

The construction of switch 10 shown in FIGS. 1 to 4 is somewhat conventional in that it has a hollow elongated housing 12 molded of suitable insulating material having an upright central portion 14 defining a slider chamber having mounting holes 15 and 16 whose side walls 17 support the sliders 32 as a group for relative longitudinal reciprocation. Opposing vertical grooves 20 in the side walls 17 receive push rods 22 in guided relation which extend through narrow slots 24 in the top 26 of the central portion 14 for purposes selective selective actuation. The switches 30 actuated by the sliders 32 are located below the sliders and comprise a row of stationary terminals 34 having downwardly facing fixed contact areas along one side of the slide chamber 16 and a row of fixed terminals 36 along the other side resiliently supporting one end of bridging conductors 38 whose other ends provide contact areas resiliently urged to close against the stationary contacts 34 in an upward direction. A flat cover plate 40 of insulating material is secured to the housing 12 by suitable means to close the switch chamber with sufficient clearance to permit operation of the bridging conductors 38.

The sliders 32 of the embodiment shown in FIG. 4 are four in number, are made of insulating phenolic board and are supported by spaced extensions 42 (FIG. 11) along their lower edges slidably bearing against the cover plate 40 to carry the downward thrust of the push rods 22 against them. Between successive extensions 42 the lower edges of the sliders have recesses 44 at each switch station or conductor 38 and are provided with various shapes to operate or not operate the conductors as their permutation requires. Generally, if the conductor is to be actuated at a particular recess, there are provided a high dwell 46 and a low dwell 48 separated by a cam incline 50 which either closes the switch or opens it depending upon the relative location of the conductor and the direction of movement of the slider when actuated. Thus, when a switch 30 is open the corresponding recesses 44 of the four sliders are arranged so with respect to the switch conductors 38 that one or more high dwells 46 of those present engages the conductor to hold the switch open in a downward direction, and when a switch is closed the low dwells 48 of all four recesses 44 at that station coincide to permit the resilient conductor 38 to rise and close the contacts.

For permutation of the sliders 32 and thereby the switch closures, the upper edges of the sliders have notches 52 for each push rod 22. The notches generally define a vertical side 54 and a side inclined thereto to provide an actuated cam surface 56. In some embodiments the vertical sides have horizontally directed tickler V-cams 58 (FIGS. 8, 10) adjacent the top to partially retract the slider 32 by an actuated push rod preliminary to returning the slider to its advanced position by final engagement of the push rod against the inclined cam 56. The apices 60 of the recess sides have a contour matching the shape of the lower end of the push rods 22. Preferably this shape is rounded and such can either have a small radius for the edge 62 of the rod or have a larger radius as at 64 to mate with the curled enlarged edge portion 66 of the push rod.

The upper ends 68 (FIG. 4) of the push rods 22 where they extend above the openings 24 have a substantial width to be alternately actuated as later described by two adjacent plungers 70.

For this purpose a main mounting bracket 72 (FIGS. 2 and 4) is provided having a central aperture 74 received over the upstanding control portion 14 as provided at both ends with upstanding ears 75 having pivot holes 76 therein. Transversely elongated slots 78 are provided outside of the ears to accommodate the endmost push rods projecting from the switch housing. Beyond these slots mounting holes 80 are provided for mounting the assembly on the housing 10 and on an appliance.

The sides 82 of the bracket 72 extend laterally beyond the central portion 14 where they are apertured as at 84 directly opposite each push rod opening 24 and then marginally turned down to form a reinforcing flange 86 that also serves as a guide element for the plungers 70 in conjunction with the apertures 84.

Pivotally mounted to the ears 75 as by rivet pins 88 is a rectangular frame 90 whose sides 92 are spaced vertically and horizontally a distance outwardly of and parallel to the flanges 86 with a tab 94 at one corner (FIG. 2). A single-pole single-throw (SPST) slide switch 96 is mounted by an auxilliary bracket 98 on the flange side 82 of the main bracket 72 with its button 100 reciprocated by a link 102 pivotally secured to the tab 94 as the frame 90 rocks about the pivot pins 88.

The switch unit 10 thus described is mounted either on a decorative plate 104, (FIGS. 1 and 4) or upon the wall of an appliance with spacers 106 locating the upper ends of the push rods a slight distance therefrom. Screws 107 extend through the plate 104, the spacers 106, mounting holes 80 and are threaded into the mounting holes 15 to secure the switch unit in place.

Whether it be a decorative plate or a wall, slots 108 are provided therein for reciprocably supporting push buttons 110 therethrough on opposite sides of the push rods 22 and in alignment with the apertures 84 in the mounting bracket 72. The cross-shaped plungers 70 provided, each have a slot 114 in its leg 116 receiving the flange 86 while one of the bifurcated portions 118 is received in the apertures 84. The upper end 120 is split to be resiliently received in the button 110. One arm 21 engages the bottom of the plate 104 on its upper edge and on its lower edge drives the side 92 of the frame 90. The other arm 23 extends into overlapping relationship with one-half of the push rod 22 and has a laterally extending ear 25, preferably reversely bent, to engage the upper end of the push rod 22 in encompassing relationship. Downward movement of any push button 110 and plunger 112 actuates the push rod 22 and rocks that side of the frame 90 downwardly to operate the slide switch 96 accordingly. Light compression springs 18 are mounted on the other bifurcated portion 19 to return the plunger.

The leads from slide switch (1) (FIG. 5) are connected in series between the switch unit 10 and one side L_1 of the AC power line. A diode 27 is connected between the terminals 29 of the switch.

In operation, alternate actuation of cross-paired buttons 110 rock the frame 90, actuate the same push rod 22 but alternately actuate the slide switch 96 to place the half-wave rectifier 127 in or out of the circuit. This operation of the slide switch 96 doubles the number of speeds controlled by the multi push-button switch 10.

Referring now to the embodiment shown in FIGS. 8 to 18 the diode switching operation is incorporated in sliders 32D1 and 32D2. In this embodiment the slider chamber 16A (FIG. 15) and the central portion 14A are wider to accommodate seven sliders 32A and two guide plates 31 whose salient features are shown in FIGS. 8–14. In this embodiment two cross-paired push rods 22A are provided for each station as received in sliding supported relation in two axially aligned slots 24A provided in the top of the central portion 14A.

Each of the cross-paired push rods 22A operates in the same notches 52 of the sliders 32A and for this purpose are constructed as shown in FIGS. 16–18. All are identical for inventory purposes and each comprises an L-shaped sheet metal stamping 33 notched at the top edge to receive the push buttons 110 and rounded along the bottom edge to slidably engage the respective sliders in their respective notches. The toe portion 35 of the foot portion is flat so that two of them cooperate face-to-face (FIG. 10) while the heel portion 37 is enlarged by a curl 66 of metal to move in guided relation in the groove guideways 20 in the wall of the chamber 16A. A U-shaped push rod 41 may be used for the "STOP" button and be provided with a rounded enlarged edge 66 extending the full length of the lower edge since the "STOP" button is single and is secured to both vertical legs 22M of the push rod 41.

In the particular embodiment illustrated there are two more switches 30 than there are switches devoted to fixed speed control. These switches are the diode switch 30D' which is conjointly controlled by the speed control buttons and the main switch 30M controlled by the "STOP" button.

The diode sliders 32D are two in number, one located against one wall 17 of the slider chamber 16A and the other against the other wall 17 where they are disposed to be acted upon by the enlarged portions 66 of the push rods 22A. Holding them in place are two rectangular guide plates 31 (FIG. 15) whose four marginal edges (FIG. 14) engage the end walls 17E of the chamber 16A against longitudinal displacement while the top and bottom walls 17T and 17B provide for firmness of support.

The upper edges of the guide plates are vertically notched to provide guideways 43 matching the groove guideways 20 in the chamber walls and likewise accommodate in guided relationship the enlargements 66 on the push rods 22A, 22D and 22M. Along their lower edges the guide plates are recessed as at 45 to guide the resilient conductors 38 and 38M of the switches 30 in their vertical movement and support them against lateral displacement when cam actuated. In this connection the conductors 38, being made of spring bronze metal strip are formed by the female forming die being located on the convex side of the U-shaped cross section which is shown as ultimately formed. This provides smoothly rounded edges engaging the walls of the guide recesses 45.

Between the guide plates are located the sliders 32S for the speed control switches 30 and the slider 32M for the main switch. As a matter of convenience, the main switch slider is in the middle of the four sliders 32S for intimate operational accuracy in the performance of the switches 30.

In this embodiment a characteristic speed control slider 32S is shown in its entirety in FIG. 11, it being well known as already mentioned how the contours of the respective recesses 44 may be arranged on all four speed controls sliders for permutation of six switches for seven selected speeds. The significant end portions of the other three sliders 32D and 32M for the diode sliders and main switch slider respectively, are shown enlarged for easier viewing, the remaining recesses, not shown, being duplicates of the last recess shown towards the left as viewed.

For a better understanding of the description which follows it may be well to note at this time that the diode switch 30D is preferably opened along with the main switch 30M when the STOP button is pressed. Both the main switch and permutated speed switches 30 are closed when any speed push button is pressed. If the push button pressed in the row of buttons on the side of the diode 2 sliders, the diode switch is left open for low speeds involving half-wave rectification. If the push button pressed is in the other row of buttons on the side of the diode 1 slider, then the diode switch is closed to shunt the diode for high speeds at the full wave electrical potential. The diode switch is opened again when a low speed push button is pressed, namely, the diode 2 slider. The two slider $32D_1$ and $32D_2$, move simultaneously when either is actuated. One additional relationship is also preferred, namely, that the main switch slider is at least momentarily opened during the midpoint movement of the diode sliders whenever any speed button is pressed, as later described.

With respect to simultaneous movement of the diode sliders only the diode switch sliders $32D_1$ and $32D_2$ operate the diode switch 30D and they have recesses 44D for this purpose in which there are high and low dwells at only the diode switch station. The arrangement of these dwells depends upon the cooperative movement between the sliders. The diode sliders may be operated upon the basic theory of relative reciprocation for the diode switch actuation as described previously with the first embodiment, or upon conjoint movement in the same direction each time either one is moved. In the former, dwell contouring in the diode switch recesses are symmetrical, in the latter they are identical with respect to each other as shown. On the other hand, in the former, the actuated diode slider notches 52D are identical in being inclined in the same direction while in the latter they are symmetrical with respect to each other in being inclined in opposite directions as shown. For purposes of description, the latter is illustrated wherein the diode switch sliders operate together in the same direction of movement.

Both diode sliders have recesses 44D at the station of the diode switch 30D in which the high dwells 46D open the switch at one limit of their movement in one direction and the low dwells 48 permit the diode switch to close when both sliders are disposed at the other limit of the movement in the opposite direction. Although the notches 52M in the diode sliders for the "STOP" push rod 22M may be provided with full clearance for the main switch 30M, it is desired that the diode switch be opened with the opening of the main switch even though the diode is still in the circuit because the load of camming open the diode switch is carried by the "STOP" button every time that the "STOP" button is actuated.

Otherwise all of the speed control sliders have recesses 44 that clear the diode switch. It is only through the notches 52D provided on the diode sliders for actuation by the speed control push rods 22A that the diode switch is opened or closed. In fact, the diode sliders and the main switch slider 32M, if it is OFF, are actuated each time a button is pushed.

For this purpose the two diode sliders are rigidly cross-connected at their ends by rivets 47 and spacers 49 while the ends of the other sliders and the guide plates are slotted as at 51 to receive in mutually supporting relationship and accommodate the movement of the cross-connecting members 47. The spacers not only move the diode sliders 32D as a unit but also hold the stack of sliders 32 and guide plates in assembled relationship as a unitary sub-assembly that is easy to make and handle in production.

The spacers comprise a sleeve 53 (FIG. 15) flared at opposite ends to provide squaring flanges 55 engaging the facing surfaces of the diode sliders and a sleeve rivet 57 with widely flared heads 59 to provide squaring flanges 49 engaging the remote faces of the diode sliders 32D. The cross-connectors move both sliders as a unit. However, when one slider is positively moved, there is very little load transmitted through the connectors to move the other slider. They maintain a squared relation for simultaneous movement because both sliders are performing the same work at the same time to accomplish the same result. Their diode switch recesses are identical and whichever one is actuated, it directly carries the load encountered by its movement.

The operation from the description thus far is one in which actuation of the "stop" push rod 22S places the diode sliders 32D in the positions shown with the high dwells 46 holding the switch 30D open. If a low speed button is pressed, the diode sliders remain in the positions shown with the low dwells 48 permuting the shunting diode switch "open." If a high speed button is pressed, both diode sliders 32D are moved to release the diode switch connection to its closed position. The release-to-close effort is a slight working effort and is carried essentially by the slider that is being directly actuated which preferably is the one located nearest to the free end of the movable switch connector. Thereafter, when a low speed button is pressed for lower speed, the load of opening the diode connector switch is carried directly by the diode slider being actuated. As already mentioned, this is also true of the main switch slider at its diode switch recess.

Thus, with actuation of either one of a plurality of pairs of buttons permutating the speed control switches, the selection of a particular button of each pair with a sliding action by cams on switch conductors a desired permutation is set up that provides a fixed speed that is independent of all other speeds and particularly different from the speeds established by the actuation of the other buttons of each pair. Thereby, the speed selection is doubled with the same number of switches plus one additional switch that is related to a diode 27. It is appreciated that the actuation of any speed button will close the main switch while the stop button opens the main switch regardless of whether the other speed selection switches or diode switch remains closed or open.

Time dimensional sequence switch operations

Both the diode and speed control sliders (FIGS. 8, 9 and 10) have long switch closing dwells 48D in their recesses 44D and short switch opening high dwells 46D at their pertinent recess stations on the sliders. These time the opening and the closing of the switches in approximately the upper half of the effective movement of the push buttons so that switches which are to close will be in their closed position at the mid point of the reciprocable movement of the sliders. The main switch slider 32M on the other hand has a high dwell 46M for switch opening at the mid point of the reciprocable movement of the slider. This may be accomplished by a protuberance 61 at the mid points of the main switch recesses 44M on all sliders, or by a long high dwell 46M for switch-opening, timed for opening and closing the main switch in approximately the lower half of the effective movement of the push buttons so that the main switch is not closed at the mid point movement of the sliders. This is accomplished by either set of buttons in conjunction with the speed control sliders.

This relates to the sequential switch operation heretofore mentioned. This enables the speed selector and diode switches to be constructed for a rating of merely conducting current since the invention contemplates that they will not make or break the electrical current. They merely conduct it. The heavy main switch makes and breaks the current whenever any button is pressed because the speed control switch permutations are completed and the switches are either in their open or closed position when the main switch is opened or closed.

More particularly, in accomplishing this, one of the novel characteristics of the four speed sliders and the two diode sliders is that wherever one of their recesses has two vertically spaced dwells, 46 and 48, the cam incline 50 between them is closer to the high dwell end of the recess. Moreover, since the diode sliders 32D are actuated each time a push button is pressed, a snap action protuberance 61 is provided in the upper portion of each of their main switch recesses 44M which opens the main switch each time during the midway portion of the travel of a button that is pressed without moving the main switch slider to its "OFF" position.

In event buttons happen to be pressed in a succession which does not change the diode sliders, all sliders may have a protuberance in their main switch recess 46M, or the vertical sides of all of the diode slider notches 52 may be provided with horizontally extending tickler cams 58 that are engaged and momentarily displaced by the enlarged rounded bottom 66 of the push rods 22A. When one of these cams is engaged during a downward or upward push rod thrust it is moved by the enlarged end of the push rod to clear it. This moves the slider far enough for the snap action protuberances 61 (FIGS. 9 and 10) to open the main switch 30M during the time that the other switch permutations are being set or reset. This occurs regardless of which speed selection button is pressed if the diode slider involved is already in the ultimate position intended. If the diode slider 32D involved is not in its intended position as where the push rod 22A engages a notch incline 56 to move a diode slider its full distance, the protuberance 61 on that slider will open the main switch 30M in passing during the central portion of its travel, with the same sequential operational result whenever the permutation of switches is being set or reset, whichever the case may be.

Thus, lighter, inexpensive switches rated for lesser current can be used for speed and diode switches 30 and 30D, and more closely grouped if desired to save space. The main switch 30M, on the other hand, may be provided with a heavier make and break current rating. Thus, a greatly improved and less expensive switch unit is provided which has great versatility.

The guide plate 31 maintains a predetermined close and constant relationship between the push rods 22A and the conductors 38 whereby the switches 30 may be operated with precision notwithstanding otherwise reasonably wide tolerances and springiness present in the cooperation of the sliders. Optimum operating cooperation for constancy of operation and results are accomplished in that the push rods 22A and guided switch conductors 38 interact not only on the speed switch sliders 32 and diode sliders 32D, but also upon the main switch sliders 32M with each guided push rod 22A movement. Relative play between the push rods and switches is greatly minimized whether the sliders are conventional or unique for multiple functions in a time dimension. In fact, it will be observed that regardless of the presence or absence of sequential operation of the switches, the switch blades 38 can be made much lighter at a saving of expensive bronze since the guide notches 43 provide the support against displacement by the slider cams 50 which the heavier blades had to withstand.

From the above description it will be observed that a versatile simplified system is provided having a large selection of fixed speeds available for use with a set of selector push buttons for different control applications of the apparatus. The economy of co-wound field coils that enables the wide selection without shorting any field turns is appreciated and the economically designed switching construction with its permutation capabilities makes available a wide selection of speeds in many different speed ranges desired of the motor, and, in the desired range, utilizes at least twice as many fixed speeds as there are speed control permutations available with the sliders in a multiple push button switch. Additionally, the use of the half-wave rectifier on the lower speeds provides more torque than a resistance control of the full wave AC potential at the same speed. Moreover, with space available, more speed control switches rated only for current carrying can be provided at less cost than switches made for make and break operation.

Referring to FIG. 5 the circuit shown is characterized by the three co-wound coils, D, C, and E of different wire sizes being connected by switches (2) and (6) in series in their order of diminishing sizes in a direction identified away from the armature. The armature end X of the middle coil D is connected by two connections **81** and **83** including switches (6) and (4) respectively, to the like ends X of the other coils C and E. The other like ends Y of the coils, C, D, and E are connected to the L_2 side of the AC power line through switch (8), the outside connection **85** being directly and the other ends by two connections **87** and **89** including switches (3) and (7) respectively.

This circuit is illustrative of the versatility of the switch unit for 14 different fixed speeds out of 26 possible speeds. The invention makes possible the splitting up of a stiff single maximum gage field coil into smaller gage, more closely packed co-wound coils to provide many lower speeds without loss of the heavy gage low impedance wire which is still present in effect when the co-wound coils are connected in parallel.

For instance, the coils in FIG. 5 are demonstrative. All are of the same length **120** turns:

Coil	Wire Gauge
A	0 29
B	0 23
C	0 25
D	0 28
E	0 30

Armature A has twelve poles each having **44** turns of No. **28** gauge wire. Accordingly, the impedance of the heavy gage coil B is matched by the impedance of lighter gage coils C, D and E of different impedances when connected in parallel for the highest speed. The resistance of coil A in series with the diode, when used, drops the highest diode speed below the lowest speed provided by all coils B, C, D and E serially connected under full wave potential.

With the circuit shown, the following seven fixed speed combinations marked with an X can be had which with a diode doubles them to **14** combinations out of a mathematical possibility of **26**.

Switches closed	Coil alignment		
26	B C	D E	X
56	B	D E	X
24	B	C E	X
27	B	C D	X
247	B	D C E	X
356		D E C	X
3	B B C		
57	B D		
54	B E		
3457	C B D E		X
357	C B D		
574	D B E		
354	C B E		

Selecting six switches (**2**) to (**7**) marked X listed in the order of their increasing impedances which provide desired speeds that also provide substantially equal auditory perceptions of speed differentials or significant speed changes, it will be observed that only six of the switches shown in the switch unit are devoted to coil selections by seven push rod units **22A** and the other, switches (**1**) and (**8**), are available for the diode and the main switch, respectively as described. When the diode is switched into the circuit by opening switch (**1**), the coil alignment will include the coil A and the diode rectifier R ahead of the B coil for a total of 14 fixed speeds.

Referring to the circuit of FIG. **19** and switch modification of FIG. **21** where a double row of push buttons is also employed to provide 14 speeds, but in which half are provided with the use of a diode controlled by a single slider **32D3** movable in opposite direction the coil permutations and switches employed are indicated and the single diode slider is employed in which the cam incline in the diode switch recess **44D1** is eliminated and a shoulder **81** is employed as a latch element between the high dwell **46D** and the elongated lower dwell **48D1**. The conductor **30D1** in the diode switch **7** in this instance is formed with a vertical side **83** to provide the other latching element and squarely abuts against the shoulder in latching relationship when the diode switch **7** is closed. A spring **85** interengaging the diode slider and the end wall **87** of the slider chest **17** urges the diode slider **32D3** in the direction moving the shoulder against the conductor whereby the high dwell **46D1** may slip under the conductor **30D1** and hold switch **7** open whenever the conductor is raised to dispose the diode in the circuit. Otherwise, both the resiliency of the conductor and that of the spring **85** urges the continuance of the latch engagement against dislodgement by vibration. Raising the conductor is accomplished by movement of the switch permutation sliders **32**, all of which have protuberances **59** in their notches **44** at the diode station and any time a slider is moved its protuberance **59** lifts the conductor **30D1** to open switch **7**.

The diode slider **32D3** is actuated only by the row of low speed push buttons along with the permutation sliders **32** and when this is done the slider protuberances **59** lift the conductor whereupon the diode slider is moved by spring **85** to the left as viewed in FIG. **21** so that the high dwell **46D1** is moved in under the lifted conductor to hold the switch **7** open.

On the other hand, when any push button is actuated in the high speed row the diode slider recesses are engaged to move the diode slider **32D3** in the direction of the arrows thereon and while the same protuberances **59** raise the conductor **30D1** the high speed push buttons move the diode slider to the right to remove the high dwell **46D1** from under the conductor **30D1** and this allows the conductor to close the switch **7** and shunt out the diode. As the high speed button is released after being pressed the diode slider is urged to engage the conductor with the shoulder **81** and establish the latching relationship discussed which holds the switch closed. Each time a high speed push button is pressed this sequence of relative movement occurs so that the latching relationship is renewed each time a high speed button is pressed to remove any creep that may have occurred under vibration during the previous setting.

In view of the sequence that the motor has to be turned "OFF" before the jogger push button **18J** can be operated, both physically and functionally, there is no danger in leaving a particular permutation ready when the main switch is turned "OFF." Any playing with the permutation switch buttons will only start the motor as though it were in use after which it would be turned "OFF" again. The push button **18J** need only have the burden of turning the main switch "ON" and "OFF" and in doing this rapidly will not disturb the permutation sliders when they are in "ready" condition, or after they have been made ready when a speed push button is pressed down the first time.

Referring now to FIG. **20** in connection with FIG. **19** a further illustration of the versatility of the invention is shown wherein the four switch permutation sliders **32** not only provide the speed permutations of the coils but also operate the diode switch **7** for some of the speeds and preset the switches in the "OFF" permutation for a jogging speed by operation of the manual switch J after the stop button is pressed. Switch **8** shown in FIG. **19** is not required unless it serves as a main switch for sequential switching already described or as the jogging switch.

The field coils are **120** turns each, of the wire gauges shown, A No. **29**, B No. **24**, C No. **25**, and D No. **28**, so that the permutation selections for seven speeds opens switches **1**, **2** and **3** in the "OFF" permutation.

The operation of the three switches is controlled by sliders **32** having the same configuration as shown in FIG. **20** whereby the series switch **5** is never closed when either or both of the parallel switches are closed as already considered. Thus, there are available with FIG. **19** 16 usable speed permutation selections all including energization of both stator poles. Of these 16 speeds, seven have been selected as shown in FIG. **20**, one speed

$$\bullet \qquad \left(A\frac{C}{D}\right)$$

being used twice, once with switches **1**, **4** and **6** closed as an operative speed and the other as a high jogging speed with switches **4** and **6** closed and switches **1**, **2** and **3** open for **1** or **3** to be manually closed as mentioned.

In accomplishing this relationship a cam and high dwell is provided on sliders **32A$_1$** as shown at **46S** in FIG. **20** which opens switch **3** while switch **1** is being opened by slider permutation. Thus, all switches **1**, **2** and **3** are opened by moving both sliders **32A** and **32B**, towards the left by actuation of the OFF button while the switches **4** and **6** are closed by sliders **32A** and **32B**. In this relationship the motor is stopped and no current will flow through the motor until a jog switch **J** is closed shunting any one of the switches **1**, **2** or **3**. In the embodiment illustrated, switch **3** is the switch chosen to be closed because it completes the permutation of a high speed. Either one of switches **1** or **2** could be used if a slower speed were desired.

Considering the use of the diode **68** it is to be noted that all high speed switch permutations only use the combination of switches **4** and **6** in them and this is attained by moving the two sliders **32A** and **32B** (FIG. **20**) in opposite directions as indicated by the arrows at the push button speed stations indicated at OFF, **5**, **6** and **7**. This relative movement of sliders is employed to close the diode switch by the use of high dwells **65D** shown on sliders **32A** and **32B** cooperating to open the diode switch **7** only when switches **4** and **6** are closed. Thus, whenever the switches **4** and **6** in FIG. **20** are closed, the diode switch **7** is also closed shunting out the diode to provide full wave current.

The circuits thus made possible by multi switch units embodying the invention are free of switches that would short any coils; are easy to permute; lends itself to time sequential operation for miniaturization without lowering its current handling rating; and enables many improvements to be made in motor appliance circuits and controls. The number of switches to operate an appliance are less than one-half the number of discrete control buttons employed to permute the circuit.

In FIG. **5** is shown a timer **63** illustrated as driven by a half-wave current through the diode **91** that provides a continuous rectified current for the timer at all times when the circuit is closed with the main switch ON. Thus, the timer can be preset and then started when any switch permutation push button is pressed involving the closing of the main switch. The timer is pulsed by the half-wave to reciprocate a step ratchet for measuring the time of motor energization.

What is claimed is:

1. In a multiple switch having a housing,

a plurality of switches each having a movable conductor means supported in parallel positions in the housing and movable for independent actuation to open and close each switch,

actuating means for the movable conductor means including a reciprocable assembly of two elements having two parallel groups of permutation cams each movable between two alternate positions of switch actuation and with respect to each other to slidably engage the movable conductor means to open and close three switches,

manually operable means selectively engaging and reciprocating said movable conductor actuating means to move said two parallel groups of cams to four relative positions with respect to said movable conductors to provide at any time one of four different permutation patterns of switch openings, and

said cams being constructed and arranged in three of said relative positions to open one of the switches each time either one or both of the others are closed, and in the fourth position to open both of said other switches when said one switch is closed.

2. The switch defined in claim **1** in which,

said conductor means are normally biased to close said switches and said cams are actuated by selective movement of said groups of cams in predetermined patterns of movement to move said plurality of movable conductor means selectively to switch opening positions in different ones of said four positions.

3. The switch defined in claim **1** including,

an additional switch opened and closed by a fourth movable conductor connected in series with said three switches in said four permutation patterns,

another manually operable means to selectively reciprocate said movable conductor actuating means,

another movable conductor actuating means coacting with the first activating means and opening the fourth movable conductor of said switch means when predetermined permutations of the three conductor positions is established by the two parallel groups of cams actuated by said other manually operable means.

4. The switch defined in claim **2** in which,

said groups of cams are moved longitudinally predetermined equal distances between each of their two alternate positions, to translate each movable conductor means between an open and a closed position,

a main switch movable conductor means connected in series with said three switches, and

cam means carried by said movable conductor actuating means to open said main switch movable conductor means during the mid point travel of said cams, said cams effectively overlapping said cam means in its travel to actuate said three switches to change their permutation within the period of time the main switch movable conductor means is open during said mid point of its travel.

5. The switch defined in claim **2** in which said movable conductor actuating means comprises a plurality of dielectric sliders disposed slidably on their edges to extend and be movable transversely to said movable conductors between said manually operable means and said movable conductors and having

reciprocably actuated cams disposed along one edge of each slider at four stations and individually engaged by said manually operable means and

recesses along another edge defining reciprocably actuating cams at three stations that engage in their travel said movable conductor means to open or close them by their translation.

6. The switch defined in claim **4** in which said three switches including their movable conductors are constructed as rated low for only a specific electrical current carrying capacity, and the main switch and its movable conductor is constructed as rated high enough to make and break such specific electrical current.

7. The switch defined in claim **5** including guide means interengaging said conductors to support them against component forces of the cams exerted in directions other than that opening and closing the switches.

8. In a multiple switch having a housing,

a plurality of switches each one of six of which have an independently movable conductor supported in parallel relation with the others to define six aligned switch stations in the housing to open and close the switches in two groups of three each,

actuating means for the moving conductors including a reciprocable assembly of four elements defining four parallel groups of permutatably responsive cams at said six stations to open and close respective movable conductors of the six switches in two sections of three switches each, manually operable means to selectively reciprocate said four elements with respect to one another to permutate said groups of cams with respect to said conductors to provide eight different patterns of switch openings and closings,

said cams being constructed and arranged in three of said relative positions to open one of the switches of each group each time either one or both of the other switches of such group are closed, and in the fourth positions to open both of said other switches in the same group when said one switch is closed.

9. The switch defined in claim 8 including a switch means having a movable conductor connected in series with said switches, and

cam means carried by said movable conductor actuating means along with two parallel groups of cams to open the movable conductor of said switch means when a predetermined permutation of conductor positions are established by two parallel groups of cams.

10. The switch defined in claim 9 including an electrical current impedance means shunting said switch means.

11. The switch defined in claim 10 in which said current impedance means is a half-wave rectifier.

12. In a multiple push button switch having a housing and a plurality of push rod means mounted therein for manual operation,

a plurality of sliders reciprocably permuted by said push rod means,

a plurality of switches slidably actuated by said sliders in predetermined pattern combinations,

a plurality of push button means that are arranged in pairs the members of which independently actuate said push rod means selectively,

switch means connected in series with said switches,

means controlling said switch means alternately operated by certain members of each pair of said push button means for movement to activate said switch means and by certain other members of each pair of said push button means for movement to deactivate said switch means in relation to the actuation of said switches by said push rod means and sliders.

13. The switch called for in claim 12 in which the members of each pair of the push button means permutes the sliders identically for identical switch pattern combinations and different pairs permute said sliders for different identical switch pattern combinations.

14. The switch called for in claim 12 in which the last mentioned means comprises lever means tilted in one direction by any push button means in the group of said certain members of each pair of push button means to activate said switch means, and tilted in the opposite direction by any push button means in the group of said certain other members of push button means to deactivate said switch means.

15. The switch called for in claim 12 in which the last mentioned means comprises slider means controlling said switch means moved in opposite directions by said respective groups of said push button means.

16. The combination called for in claim 12 in which each push button means of a pair includes a plunger and both plungers of a pair are engageable with each push rod means, and

push buttons on each plunger for selective manual actuation thereof.

17. The device called for in claim 12 in which the last mentioned means includes a reciprocating lever engaged by the members of each pair on opposite sides of the fulcrum of the lever for reciprocating the lever with opposite members of each pair, and

means connecting the lever to said switch means on one side of said fulcrum.

18. In a multiple push button switch having a housing with a slider chamber,

a plurality of push rods mounted upon said housing for selective operation,

a plurality of switches mounted in the chamber each having a movable conductor member,

a plurality of sliders in said chamber having cam inclines engaged by the push rods and reciprocably permuted by said push rods, said sliders having cam inclines and dwells actuating said movable conductor members of the switches in predetermined pattern combination,

bracket means supported on said housing having spaced guide means,

plungers supported in guided relation in said guide means on opposite sides of and engaging said push rods in pairs,

a frame member pivotally mounted on said bracket means for movement about an axis extending through said push rods and engaged on opposite sides by said plungers, and

switch means connected to said frame member and alternatively activated and deactivated by movement of the frame member by said plungers.

19. The combination called for in claim 18 including a mounting means for said housing having openings coinciding with said plungers,

push buttons on said plungers received in guided relationship in said openings, and

spring means interconnecting said plunger and bracket means for urging the plungers and push button outwardly for manual access and actuation.

20. In a multiple push button switch,

a housing having an elongated cavity,

a plurality of switches connected in series carried by said housing each including cooperating switch contact means, one contact of which is movable with respect to the other contact,

a plurality of longitudinally reciprocable sliders received in guided relationship in said cavity with contact activating cam and dwell surfaces actuating said movable contact means of said switches in predetermined pattern combinations,

the cam dwell surface on one slider activating one of the switches being shorter than the cam dwell surfaces that activate other of said serially connected switches,

whereby said one switch is the last to close and the first to open during reciprocation of said sliders.

21. The combination defined in claim 20 in which said push buttons have an enlarged portion describing a path of movement and engaging the one slider in recesses defining a first cam surface in said path of movement throughout movement of the slider and a second cam surface overlapping a portion of the first cam moved by said first cam surface into said path of movement during the terminal movement of said push button.

22. The combination called for in claim 20 in which said shorter cam dwell is a protuberance actuating said one switch at the mid point of the reciprocable travel of said one slider.

23. The combination called for in claim 20 including one push button means for moving said sliders in one direction of their reciprocation to close said switches,

and means carried by said one slider cooperating with a second button means reciprocating said slider having the short cam dwell in the other direction a partial distance to open said one switch upon initial movement of another slider in either direction.

24. The combination called for in claim 23 in which the last mentioned means comprises two opposing cams successively engaged by the second push button means to move said one slider far enough to open the one switch on its initial movement and engage the other cam to return the slider to its switch closing position on its terminal movement.

25. In a multiple push button switch having a housing and a plurality of push rods mounted therein, arranged in cross-paired groups,

a plurality of sliders reciprocably permuted by said groups of push rods,

a plurality of switches actuated by said sliders in predetermined pattern combinations, one of said sliders having cam inclines engageable by push rods of one of the groups of push rods for movement in one direction to activate one of said switches,

another one of said sliders having cam inclines engageable by push rods of another one of said groups for movement in the opposite direction to deactivate said one of said switches.

26. The combination called for in claim **25** in which said switch means includes an electric current rectifying shunt.

27. The combination called for in claim **25** including means interconnecting said one slider and the other slider for movement simultaneously in the same direction as a unit.

28. The combination called for in claim **27** in which the remaining sliders are supported in assembled relationship upon said interconnecting means for relative movement with respect to each other and said supporting means.

29. In a multiple push button switch, a housing having a slider compartment and a set of sliders reciprocable therein having parallel groups of permutation cams movable with respect to one another between two alternate positions,

a plurality of switches actuated by said sliders,

a plurality of L-shaped push rods reciprocably mounted in said housing defining cam engaging toe and heel portions at their lower ends and arranged in pairs to engage said cams and permute said sliders,

said push rods being shaped to receive push buttons on the upper ends thereof and the lower ends of said push rods having their toe and heel portions disposed with their toe portions overlapping side-by-side in said pairs to engage the same permutation cams on some of said sliders and their heel portions spaced lengthwise from each other with the heel portion of each extending beyond the end of the toe portion of the other in each of said pairs to engage different cams on other sliders separately from each other.

30. In a multiple push button switch having a housing and a plurality of push rods reciprocably mounted therein for manually induced operation,

a plurality of sliders reciprocably permuted by said push rods,

a plurality of switches actuated by said sliders for predetermined pattern combinations of switch closures,

a plurality of pairs of push button means to actuate the push rods in which each push button means of a pair includes a plunger and a push button thereon to actuate the push rod independently of the other push button means of the pair,

switch means connected to predetermined switches, and

means controlling said switch means operated by one push button means of a group of certain push button means of each pair to activate the said switch means and operated by one of a group of certain other push button means to deactivate said switch means in conjunction with the operation of a single push rod.

31. In a multiple push button switch

a housing having a slider compartment and a plurality of push rods mounted therein,

a plurality of slider members in said compartment reciprocably permuted by said push rods,

a plurality of switches having movable connectors actuated by said sliders in predetermined pattern combinations,

guide means in said compartment including a guide member interengaging said push rods and connectors in coordinated guiding relationship against lateral movement in a direction longitudinally of said slider members during engagement of said slider members by said push rods.

32. The combination called for in claim **31** in which said guide means includes two spaced guide members and means interconnecting two of said slider members supporting other slider members in a unitary assembled relationship.

33. The combination called for in claim **31** including means interconnecting two of said members in mutually cooperative relationship,

and means supporting the other members upon said interconnecting means as a unitary assembly for relative movement of the slider members with respect to each other and with respect to said guide members.

34. The combination defined in claim **31** in which said guide member is a rectangular plate supported against longitudinal movement in said compartment, the upper edge of said plate being vertically notched to receive the lower ends of said push rods in guided relation and the lower edge being recessed to receive the connectors in their vertical movement.

35. The combination defined in claim **31** in which said guide member has recesses along its lower edge to receive said connectors, said connectors having smoothly rounded edges engaging the walls of said recesses in vertically-guided relationship.

36. The combination called for in claim **6** in which one of said switches is shunted by an electric current rectifier, one of said sliders having a translation cam inclined in one direction actuated by one of said push buttons to close said shunted switch and a translation cam in the opposite direction actuated by the other push button for opening said switch.

37. In a multiple push button switch having a housing and a plurality of push button means for manual operation independently,

a plurality of sliders reciprocably permuted by said push button means,

a plurality of switches actuated by said sliders for predetermined pattern combinations of switch closures,

an additional switch means conductively connected to predetermined ones of said switches and shunted by an electric current impedance,

means controlling said switch means including a translation cam on one of said sliders to be moved in one direction by one of said push buttons to close said switch means, and

latch means to hold said one of said sliders in a selected position when activated by movement thereof by said one of said push buttons and released by actuation of another one of the push buttons.

38. The combination called for in claim **37** in which said latch means comprises a shoulder between a high and low dwell at the station for said switch means which shoulder is engaged by the moving conductor of said switch means when closed, and

means carried by one of said plurality of switches to move said moving conductor of said switch means to clear said shoulder when actuated.

39. The combination called for in claim **37** including

resilient means urging said slider in the opposite direction upon release of the latch means.

40. The combination called for in claim **37** in which

said latching means comprises a shoulder between a high and a low dwell at the station for said switch means which shoulder is engaged by the switch means when the switch means is closed,

resilient means urging said slider in the opposite direction, and

means carried by said switching means to move said switch means from engagement with said shoulder to the level of the high dwell when said other of the two push buttons is actuated for movement by said resilient means of the high dwell under the switch means to hold the switch means open.

41. A multiple push button switch comprising

a plurality of sliders having notches along their top edges defining speed stations with engageable inclines related in permutation patterns, and recesses along their bottom edges at each switch station in related patterns,

a plurality of manually actuated push rods to engage said inclines at each speed station for reciprocably permutating said sliders,

a plurality of switches disposed at said recesses, and including

a main switch connectable in series with said switches, said recesses having cams actuating said switches in predetermined permutation pattern combinations,

one of said sliders and one of said push rods coacting to open said main switch when said one of said push rods is pressed, said push rod actuating at least one of the other sliders to establish predetermined switch permutation closures with the other switches, and

push button means to reciprocate said main switch slider to actuate said main switch to make and open the series connection during the time said predetermined switch permutation remains established.

42. In a switch the combination of

a first switch between two other switches and having a movable conductor to connect the two switches in series,

the other switches including a second switch having a movable conductor to shunt said first switch, and

a third switch having a movable conductor to shunt said first switch, a pair of circuit connector terminals between one side of the first switch and the second switch and a pair of terminals between the other side of the first switch and the third switch,

switch control means for said movable conductors including a pair of switch control sliders independently movable between alternate positions and having notches along their top edge defining four speed stations with inclines related to said four stations to provide four different permutations of the sliders,

push button means engaging said slider inclines at each speed station,

said sliders having recesses along their bottom edges one at each of the three switch stations,

one of said sliders having cams in two recesses to close the first switch conductor while opening the second switch conductor with movement in one direction and opening the first switch conductor while closing said second switch conductor with movement in the other direction,

the other one of said sliders having in two recesses cams coordinated with the movement of said first slider to close said third switch conductor when said first switch conductor is opened, and to close said first switch conductor when said third switch conductor is open whereby said first switch is open when either the second and third switch is closed.

43. The combination called for in claim **42** including a main switch at a main switch station having a conductor for connecting said switches in series with a source of electrical power, and

protuberance means in the slider recesses at the main switch station to momentarily open said main switch when a slider is moved to its alternate position.

44. The combination called for in claim **43** in which two cams for each slider are oppositely inclined, each at two of three switch stations separately and oppositely inclined at the common one of the three switch stations.

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