United States Patent

Swanke et al.

[15] **3,678,357**

[45] **July 18, 1972**

[54] MULTIPLE PUSH BUTTON SWITCH SPEED CONTROL SYSTEM

[72] Inventors: **Roy L. Swanke,** Newington; **Gordon H. Raymond,** Southington, both of Conn.

[73] Assignee: **Dynamic Corporation of America,** New Hartford, Conn.

[22] Filed: **April 24, 1970**

[21] Appl. No.: **31,803**

Related U.S. Application Data

[62] Division of Ser. No. 766,280, Oct. 9, 1968, abandoned.

[52] **U.S. Cl.**.....**318/245,** 318/252

[51] **Int. Cl.**.....**H02k 23/00**

[58] **Field of Search**.....318/245, 252, 305, 225, 244, 318/251, 521, 523

[56] **References Cited**

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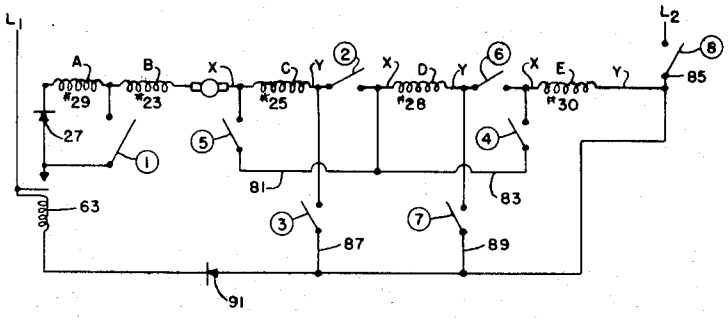
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Primary Examiner—Bernard A. Gilheany
Assistant Examiner—Thomas Langer
Attorney—Harbaugh and Thomas

[57] **ABSTRACT**

A speed control system for a universal electric motor wherein field windings on one side of the armature are permuted by contacts of a multiple push button switch into a predetermined number of different series and parallel interconnections to achieve a maximum number of significantly different motor operating speeds with a minimum number of switch contacts. The number of speeds thus available is preferably doubled by selectively switching an additional diode and field winding into the field circuit, and a series switch contact is further provided in this circuit to interrupt current flow therein while the winding interconnections are being permuted to reduce the maximum current carried by the permutation switch contacts.

6 Claims, 18 Drawing Figures



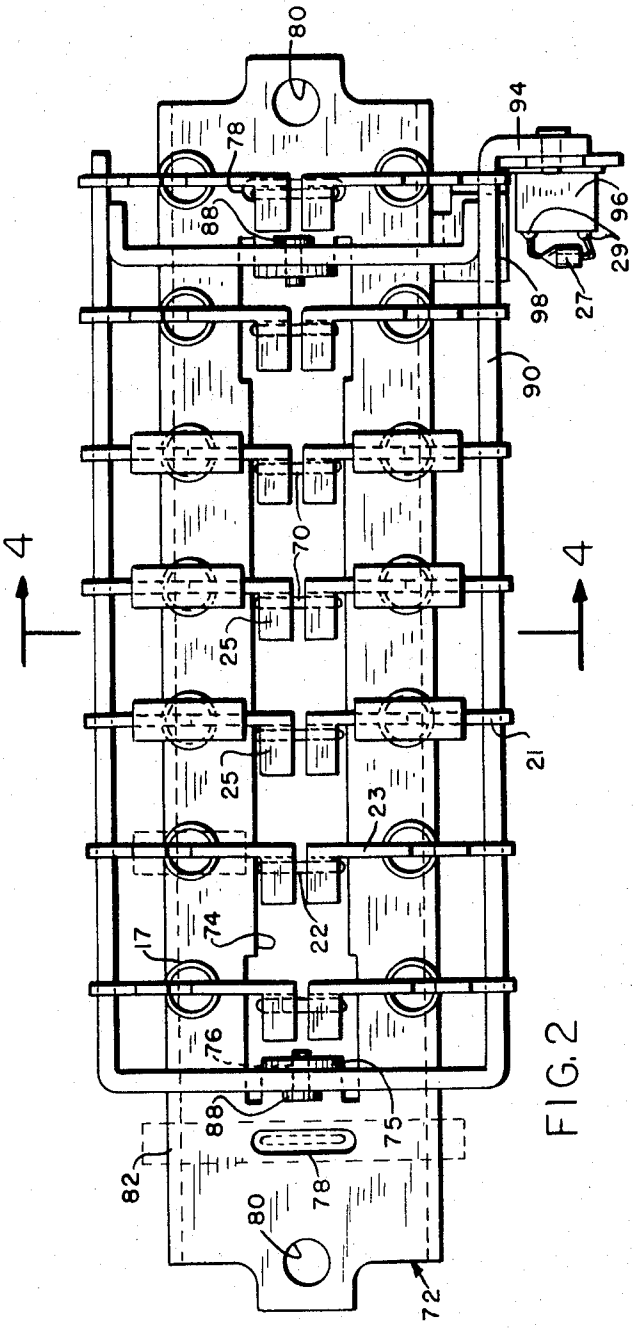


FIG. 2

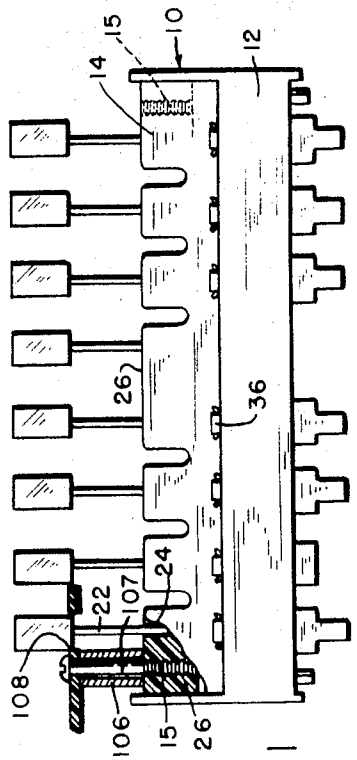


FIG. 1

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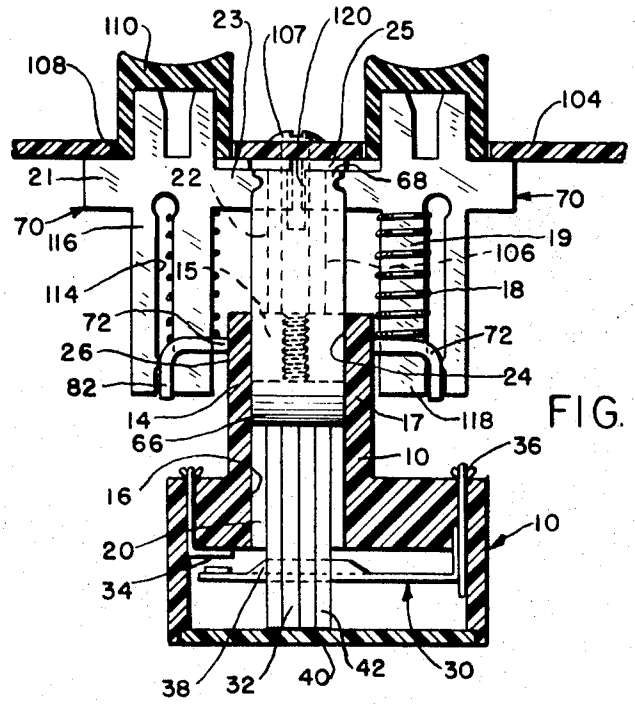
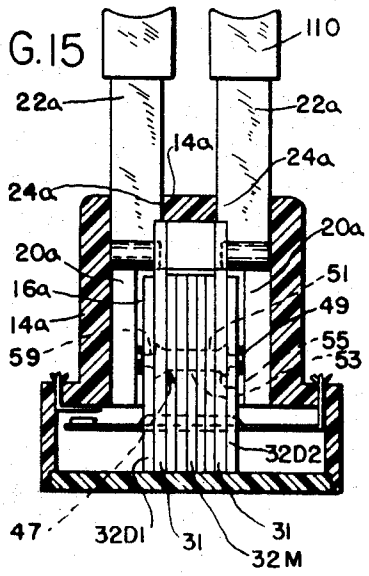


FIG. 4

FIG. 15



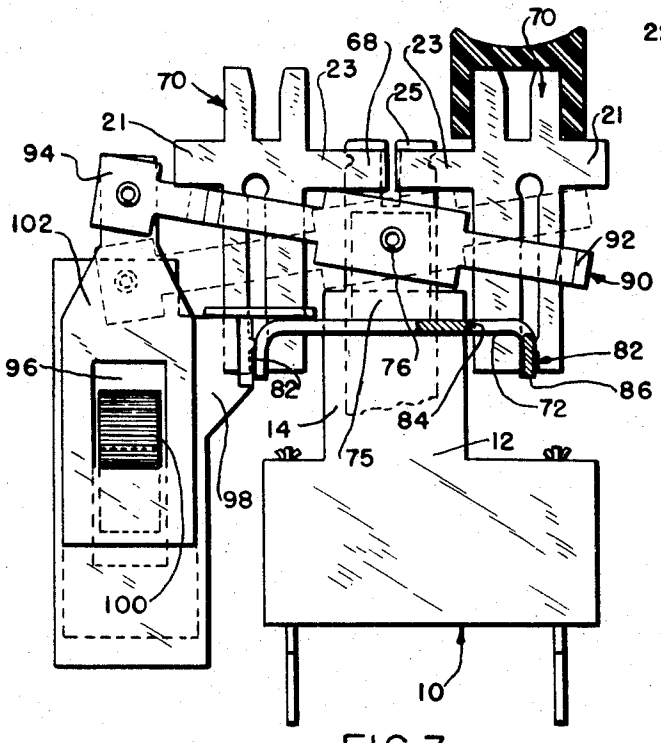


FIG. 3

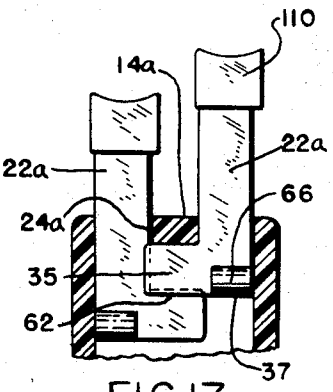


FIG. 17

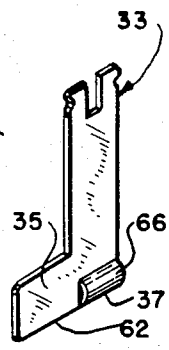


FIG. 18

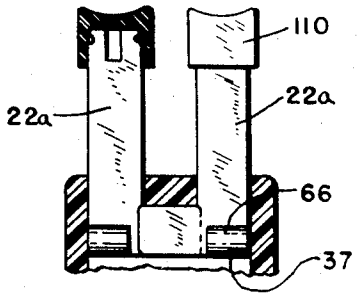


FIG. 16

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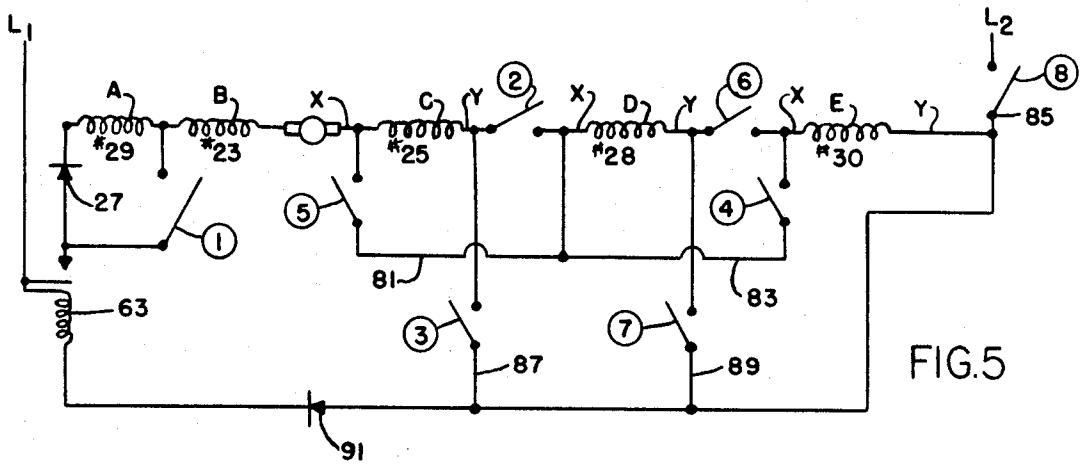


FIG.5

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	
C D/E	2 7 4	X
D E/C	3 5 6	X
C	3	
D	57	
E	54	
C D E C/D C/E	35.74	X
C/D C/E	357	
D C/E	354	
13		6

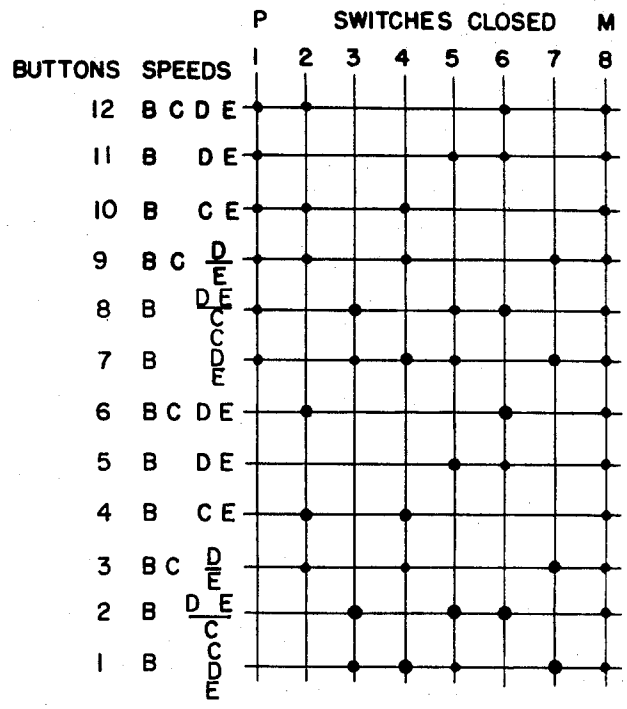


FIG.6

FIG. 7

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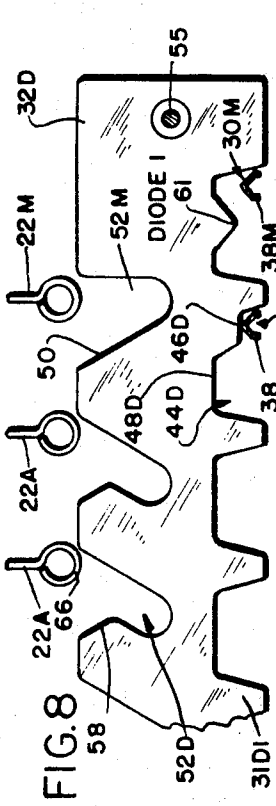


FIG.8

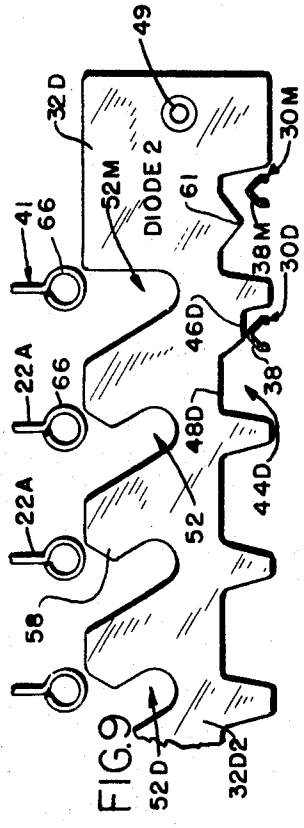


FIG.9

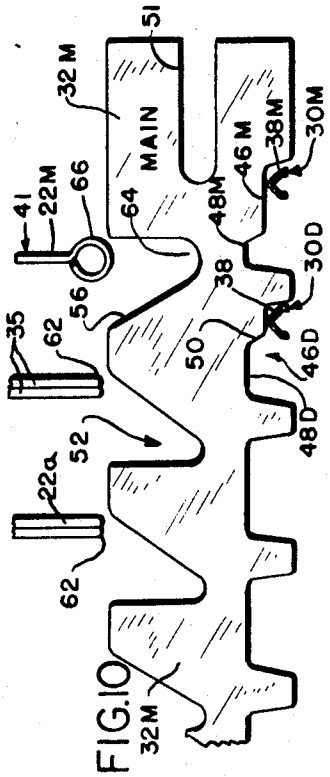


FIG.10

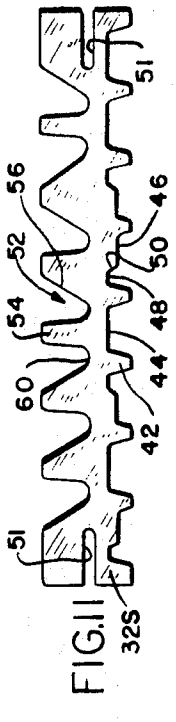


FIG.11

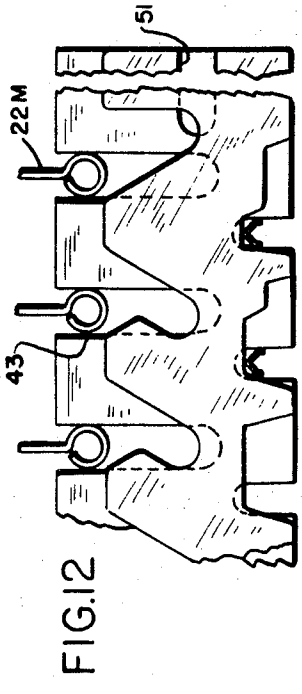


FIG.12

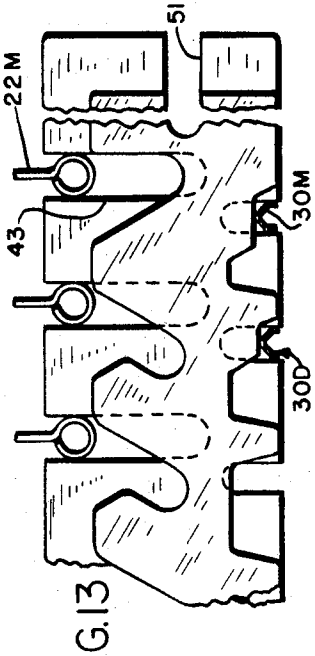


FIG.13

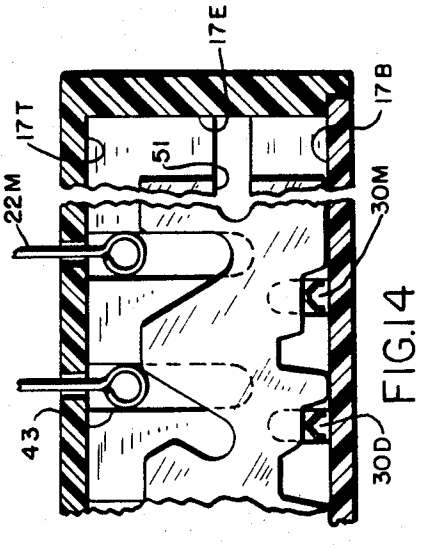


FIG.14

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MULTIPLE PUSH BUTTON SWITCH SPEED CONTROL SYSTEM

CROSS REFERENCES TO RELATED APPLICATIONS:

Swanke, U.S. Pat. No. 3,493,833

Bull, U.S. Pat. No. 3,440,438

This application is a division of application, Ser. No. 766,280, now abandoned, of which Ser. No. 63,511 is a continuation-in-part.

BACKGROUND OF THE INVENTION

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

Multiple push button switches have been used in great numbers 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 adjusted. Adequate space within an appliance housing for multiple switches is a problem as well as minimizing the increasing cost of the greater versatility that is 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 simultaneously wound directly on each core in one winding operation and are of different gage sizes and resistances.

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 push button switch assembly having movable permutation sliders each provided with a series of notches arranged along one edge and having cams engaged by respective push rods for movement between two terminal positions. One or more sliders are activated by each button and have cams arranged in recesses along their other edge permuted to actuate movable contacts of particular switches according to predetermined patterns for each button pressed. The switches that are actuated connect individualized field coil windings of a universal motor selectively in series or parallel, or both, to change the effective resistance of the motor field for fixed motor speed selection purposes.

In the present invention, however, as described in said Swanke application, the different speed selections that are available with a given number of switch patterns are doubled. This is accomplished automatically in the present invention by another series of buttons increasing the overall field resistance and changing the applied electrical potential as controlled by the same switches in identical patterns.

Moreover, the housing space required for the switching is further reduced by a time sequence switching in which, at a savings in cost, the switches that selectively control the field resistance and 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 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 circuit load with a lightly built mechanical switch as described in the Bull application 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 buttons 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 push buttons.

The rectifier switch is either opened or closed through intermediate elements that are alternately reciprocated by the buttons of the different pairs at the time the speed control switches and the main switch are being sequentially controlled by any button that is being actuated 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 speeds in that all speed control switches are not required to be in "OFF" position when the motor is idle thereby providing greater versatility with or without a timer being present having a switch.

Another object of the invention is to provide particularized selections of different field coils not only for series connection but also for parallel connection on either side or both sides of a serially connected armature.

The invention is also characterized by the number of switches used for speed control, being less than one-fourth the number of different fixed speeds mathematically available with a multiple field coil motor having four or more field coil leads on either or both sides of the armature.

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

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 speeds or twice the number of push buttons for double the number of speeds 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.

FIG. 1 is a side elevational view of a multiple push button switch embodying 15 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 six fixed speed selections showing the permutation of switches with respect thereto controlled by selective push button actuation;

FIG. 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 or 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 shown transversely paired push rods in resting position and actuated position respectively; and

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

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 of 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 arms 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 auxillary 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 decora-tive 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 piece 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. 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 35 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 **17B** 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 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, now 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** sliders. The two sliders $32D_1$ 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.

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 those 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 **46** 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** provide 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 stick of sliders **32** and guide plates in assembled relationship as a unitary subassembly 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** permitting 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 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 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 low 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. The main switch slider **32M** on the other hand has a short low dwell **48M** for switch-closing and 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. This is operated by either set of buttons in conjunction with the speed control sliders.

This relates to the sequential switch operation heretofore mentioned. For this purpose speed selector and diode switches are 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 speed control switch permutations are completed and switches actuated either to open or to close while the main switch is open, after which the main switch is 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.

In event buttons happen to be pressed in a succession which does not change the diode sliders, the vertical sides of all of the diode slider notches **52** are provided with horizontally extending tickler cams **58** that are engaged and momentarily displaced by the enlarged rounded bottom **66** of the push rods **32A**. 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** 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, 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.

The circuit shown in FIG. **5** is illustrative of the versatility of the switch unit for 13 different fixed speeds out of 26 possible speeds.

The coils are all of the same length 120 turns:

Coil	Wire Gauge
A	No. 20
B	No. 23
C	No. 25
D	No. 28
E	No. 30

Armature A has 12 poles each having 44 turns of No. 28 gauge wire. Accordingly, the resistance of coil B is matched by the resistance of Coils C, D and E connected in parallel for the highest speed, while 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 serially connected under full wave potential.

With the circuit shown, seven fixed speed combinations 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 B	X
56	B D B	X
24	B C B	X
27	B C C D	
247	B C B D B	X
356	C	X
3	B C	
57	B D	
54	B B C	
3457	B D B C	X
357	B D D	
574	B B C	
354	B B	

Selecting six switches (**2**) to (**7**) marked "X" listed in the order of their increasing resistance 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.

The circuit is characterized by the three co-wound coils, D,C, and B of different wire sizes being connected by switches (2) and (6) in series in their order of diminishing sizes in a direction away from the armature. The armature end X of the middle coil D is connected by two connections **81** and **85** 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 (E), the outside connection **85** being directly and the other ends by two connections **87** and **89** including switches (3) and (7) respectively.

The circuit thus provided is an easy one to permute by the switches without shorting any coils. The number of switches to operate an appliance are less than one-half the number of discrete control buttons employed to operate the circuit for the speed control of a series wound field motor.

In this particular circuit, the timer **63** is driven by half wave current through the diode **91** providing the continuous rectified current for the timer at all times when the timer is used. A mechanical timer can be employed which is started mechanically by the closing of the main switch or the setting of the timer but in the present disclosure the timer is conventional timer pulsed by the half wave to reciprocate a step ratchet for measuring the time of motor energization.

It will be observed that additional novel relationships are present in that three coils on their X side of the armature have their three lead ends separately connected to the armature through switches **5437**.

We claim:

1. A speed control for a universal electric motor connected across a source of alternating current comprising,
- an armature,
- a plurality of co-wound field coils on both sides of said armature having differing impedances,
- switch means for selectively connecting said field coil windings to said source in different permutations of series and parallel connections upon one side of the armature to change the impedance of the field coil turns with respect to the armature and to a predetermined number of low impedance field coil windings on the other side of said armature with each switch position,
- a half wave rectifier,
- selective switch means to connect said rectifier in series relationship with said switches to vary the electrical potential impressed across the armature, and
- an additional field coil winding in series with said rectifier as a unit therewith to increase the effective impedance of said field coils.

2. The speed control called for in claim **1** in which said additional field coil winding is connected in series with said field coil windings on said other side of the armature, and
- said selective switch means shunts said rectifier and additional field coil winding.

3. A speed control for a universal electric motor connected across a source of alternating current comprising,
- an armature,
- a plurality of co-wound field coils magnetically effective on both sides of said armature having differing impedances,
- switch means rated to carry low current conducted by the coils for selectively connecting said field coil windings to said source in different permutations of series and parallel connections upon one side of the armature to change the impedance of the field coil turns with respect to the armature and to a predetermined number of low impedance field coil windings on the other side of said armature with each switch position,
- a half wave rectifier an additional field coil winding in series with said rectifier as a unit therewith to increase the effective impedance of said field coils,
- selective switch means to connect said rectifier in series relationship with said switches to vary the electrical potential impressed across the armature, and
- a timer operable from half wave pulse power connected in series with said half wave rectifier and said source of alternating current for a main run down when timer switch is opened before the main switch.

4. A speed control system for a universal electric motor connectable across a source of alternating current comprising:
- an armature,
- a plurality of field coils of differing impedances disposed on one side of the armature,
- first selective switch means to connect the field coils in series between the armature and one side of said source,
- second selective switch means to connect like ends of each coil independently to said one side of said source for connecting at least two of said coils in parallel,
- connector means having connections connecting the other ends of said coils separately and to the armature and including
- switches in at least two of said connections for selecting the coils that will be connected in parallel between said armature and said one side of said source, and
- field coil means including an additional coil and a rectifier serially connected therewith as a unit and a switch shunting said rectifier and coil.

5. A speed control for a universal electric motor connected across a source of alternating current comprising,
- an armature,
- a plurality of co-wound field coils on both sides of said armature having differing impedances, and
- switch means for selectively connecting said field coil windings to said source in different permutations of series and parallel connections upon one side of the armature to change the composite impedance of the field coil turns with respect to the armature and to a predetermined number of low impedance field coil windings on the other side of said armature with each switch position,
- a half wave rectifier,
- selective switch means to connect said rectifier in series relationship with said switches to vary the electrical potential impressed across the armature,
- an additional field coil winding connected in series with said rectifier as a unit therewith to increase the effective impedance of said field coils,
- said permutating switch means being rated to conduct only the current consumed by said coils, and wherein additional switch means are provided serially connected between said field coils and said source for interrupting current flow through said coils while said permutating switch means are switching said coils from one permutation to another.

6. The speed control described in claim **5** wherein said permutating switch means comprise a multiple push button switch having a push button switch and push button station for each permutation, and wherein said additional switch means interrupt said current upon actuation of one or more of said push button stations.

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