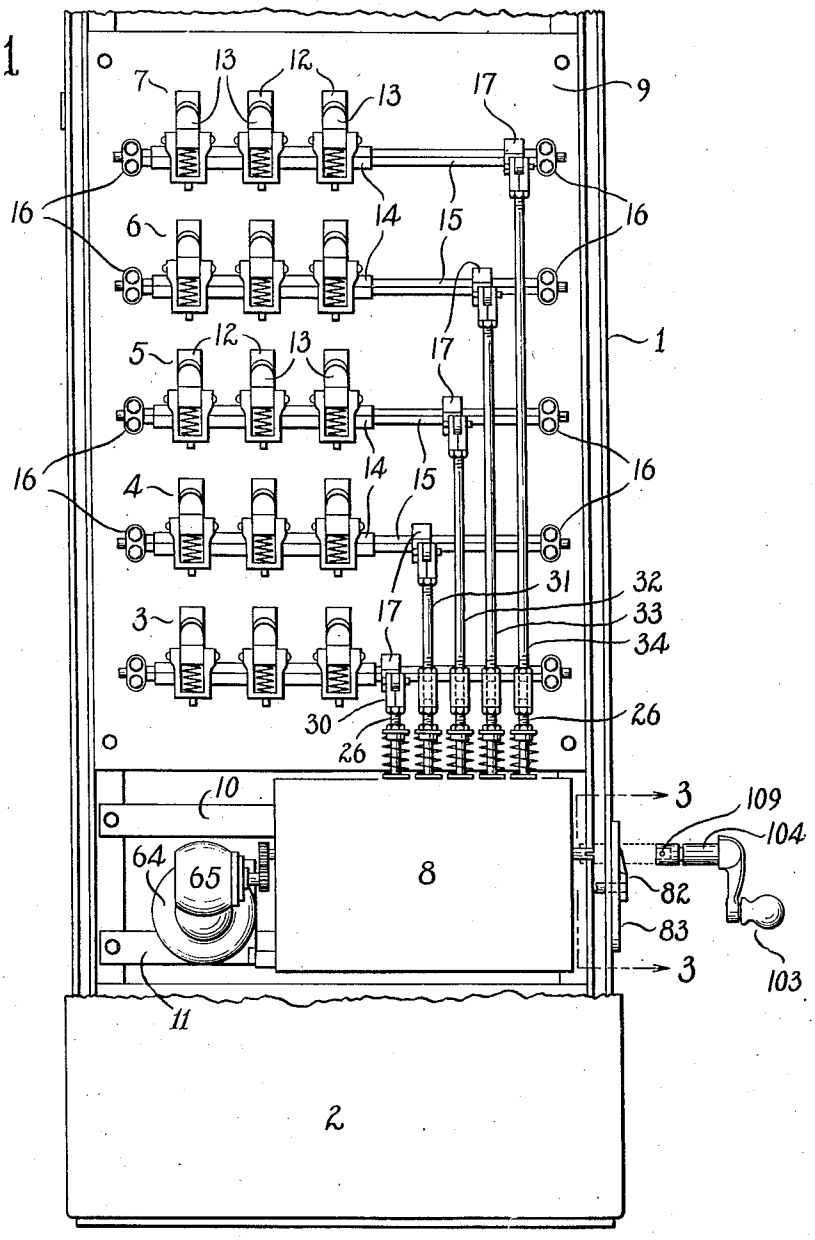
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CIRCUIT CONTROLLING DEVICES

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Fig. 1



Inventor
Clyde F. Robbins
By Frank H. Hubbard
Attorney

May 22, 1945. C. F. ROBBINS 2,376,506

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Fig. 2

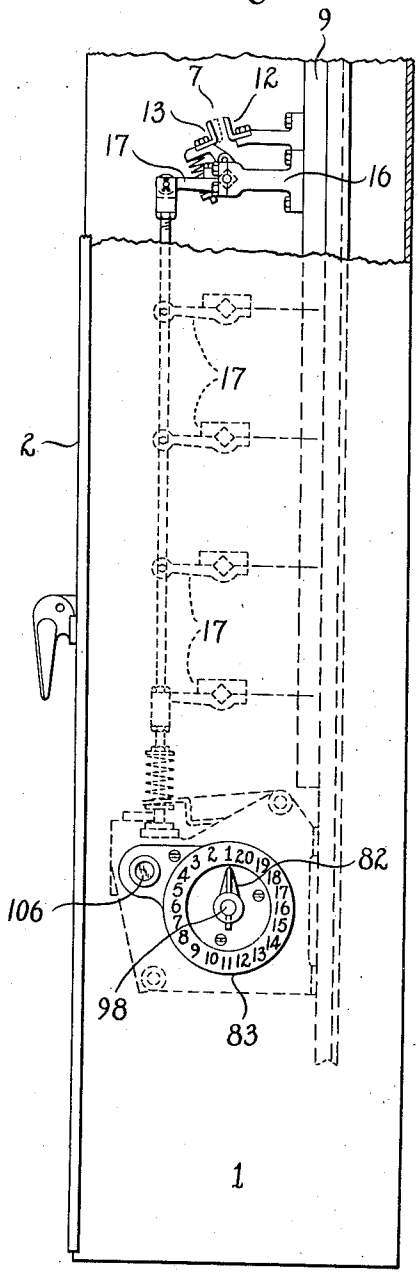


Fig. 3

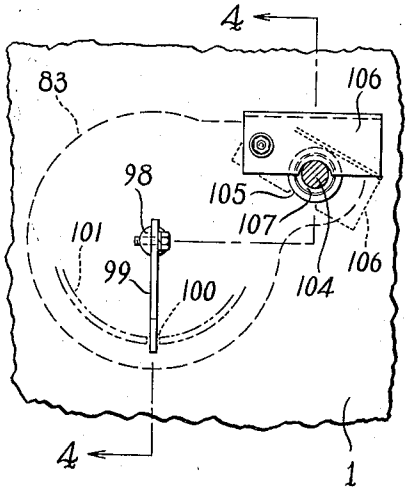
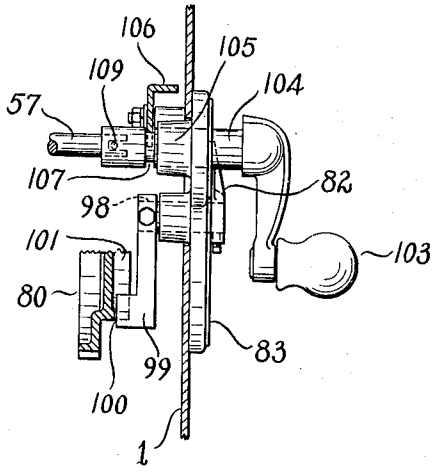


Fig. 4



Inventor
Clyde F. Robbins
By Frank H. Hubbard
Attorney

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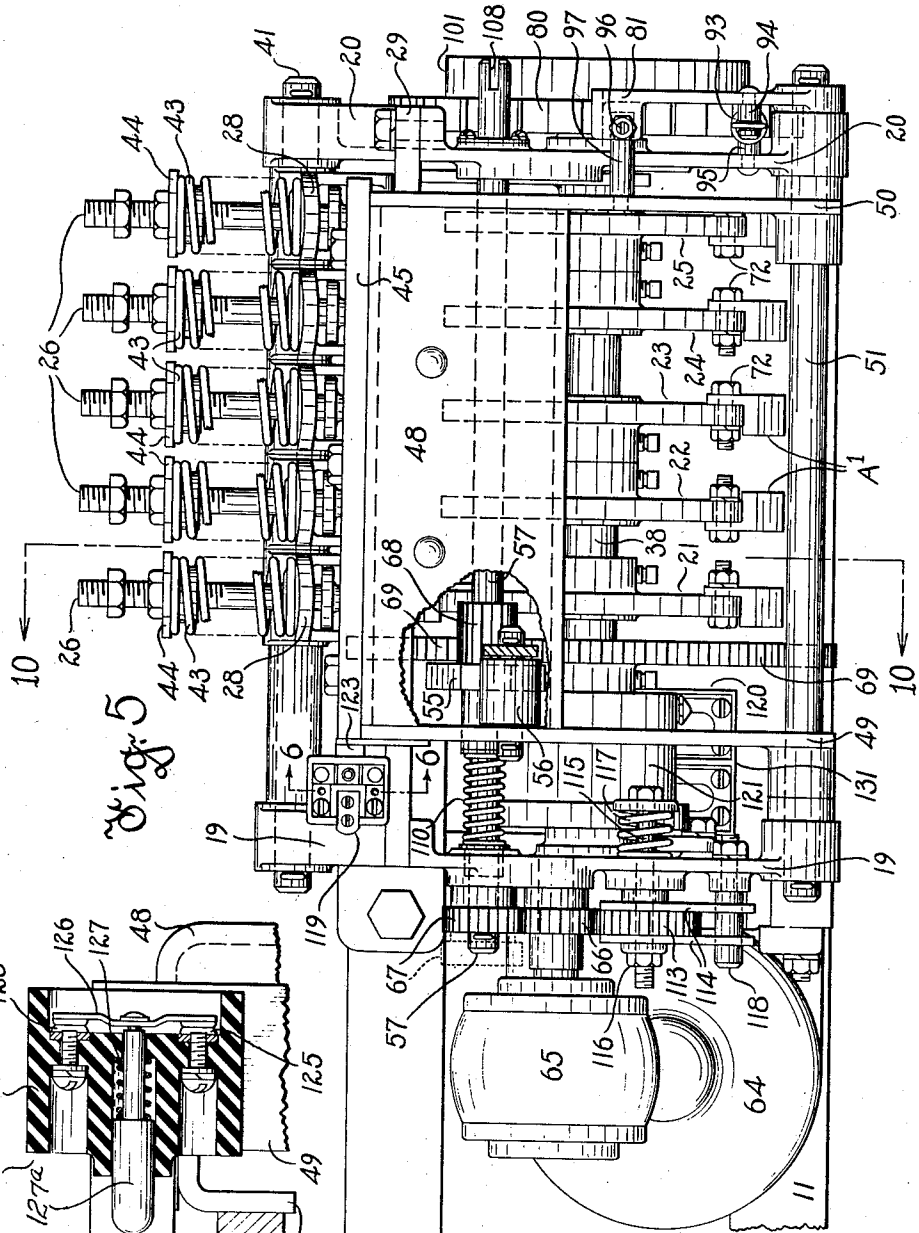


Fig. 5

Fig. 6

Inventor
Clyde F. Robbins
By Frank H. Hubbard
Attorney

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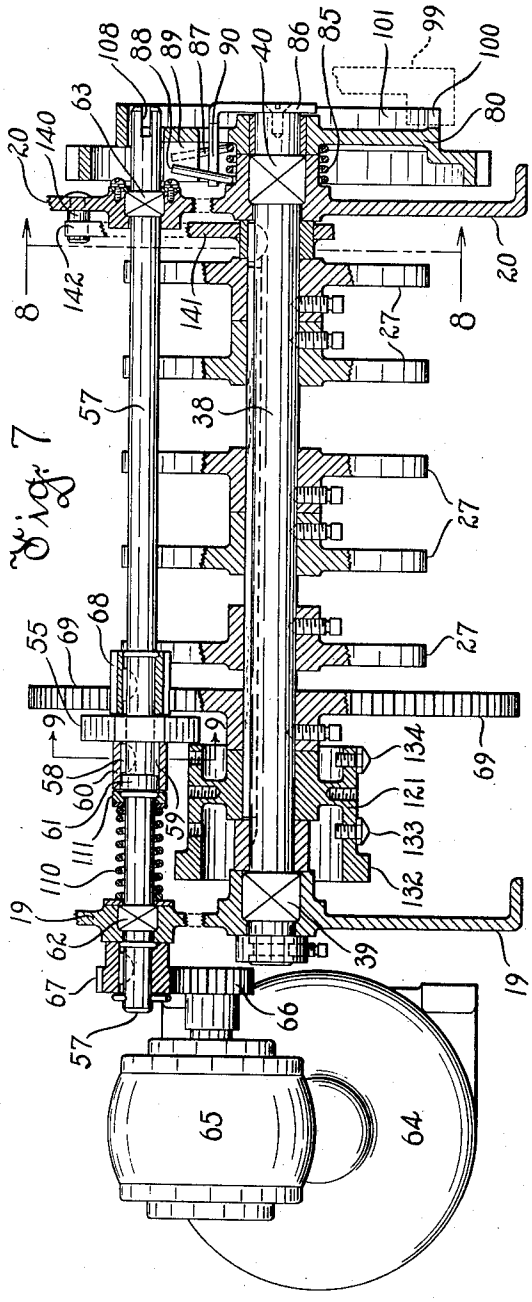


Fig. 7

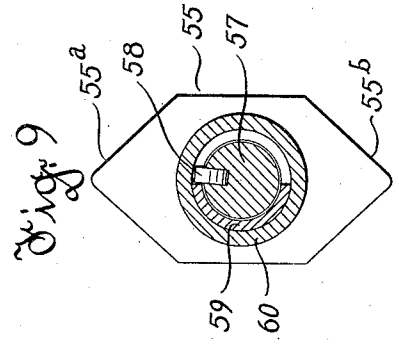


Fig. 9

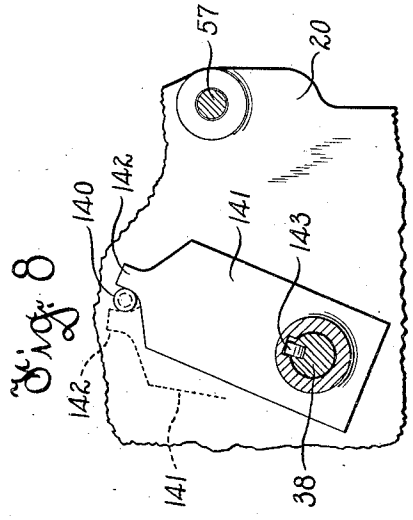


Fig. 8

Inventor
Clyde F. Robbins
By Frank H. Hubbard
Attorney

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Fig. 10

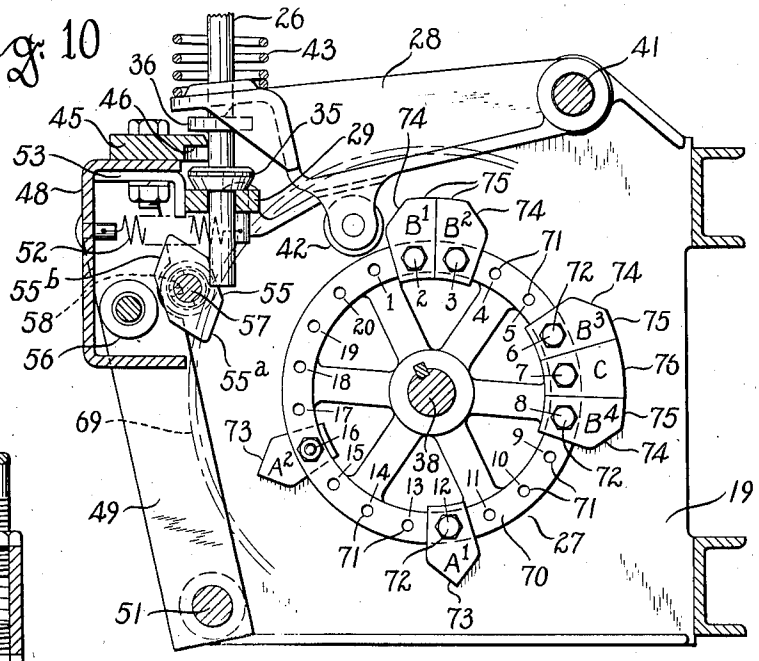


Fig. 11

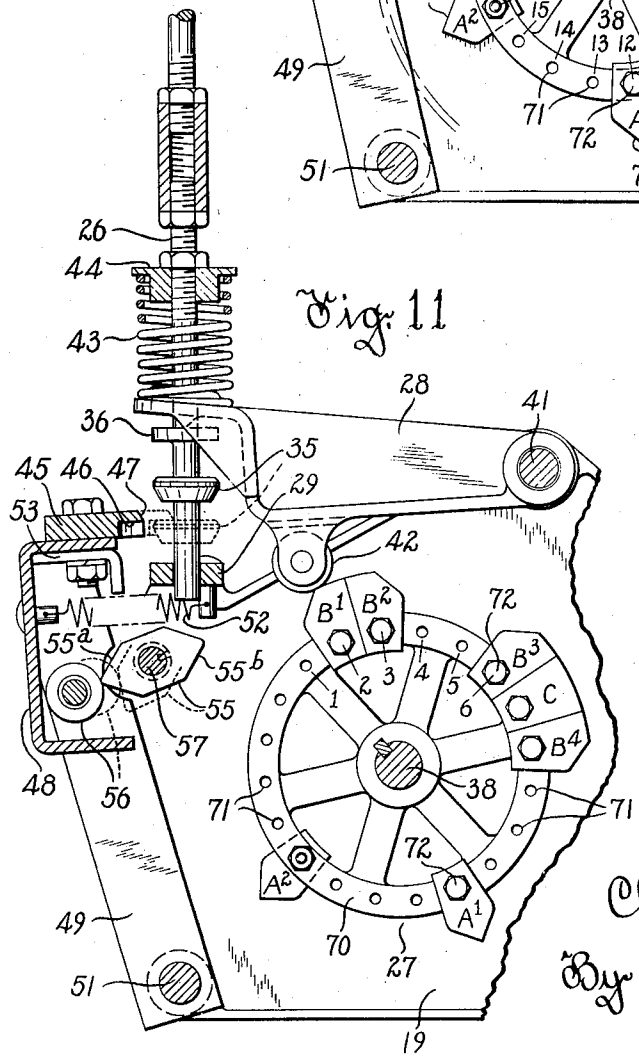
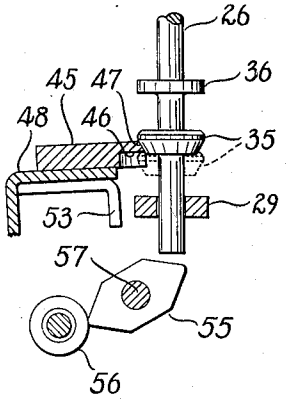


Fig. 12



Inventor
Clyde F. Robbins
By Frank H. Hubbard
Attorney

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Fig. 13

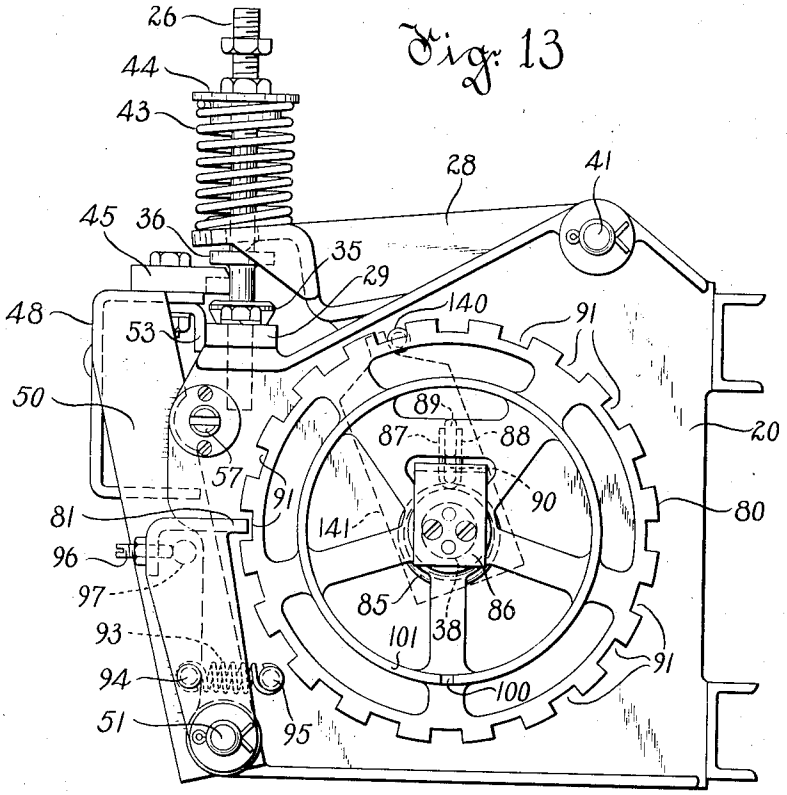
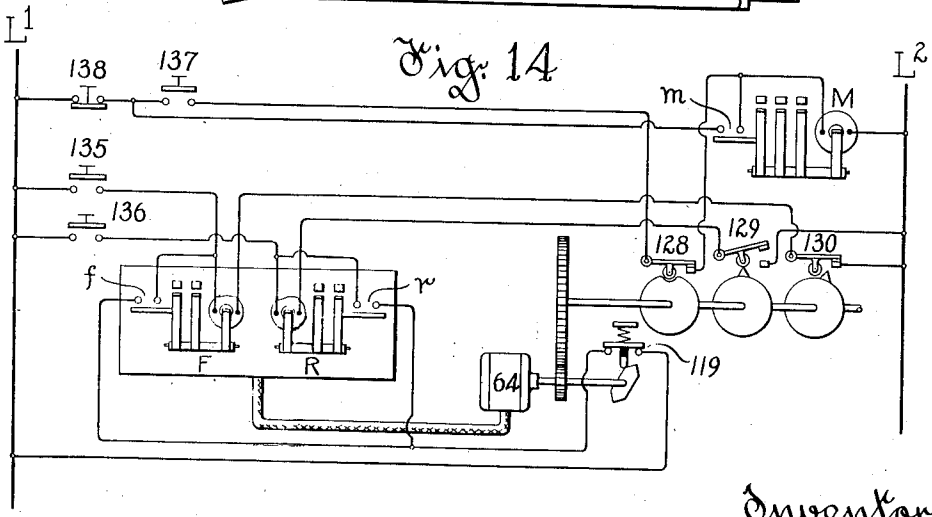


Fig. 14



Inventor
Clyde F. Robbins
By Frank H. Hubbard
Attorney

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UNITED STATES PATENT OFFICE

2,376,506

CIRCUIT CONTROLLING DEVICE

Clyde F. Robbins, Milwaukee, Wis., assignor to Cutler-Hammer, Inc., Milwaukee, Wis., a corporation of Delaware

Application September 14, 1942, Serial No. 458,242

17 Claims. (Cl. 200—17)

This invention relates to circuit controlling devices, and more particularly to cam operated multiple switch controllers.

The invention has among its objects to provide a multiple switch controller having a novel and improved cam operating mechanism which is compact and rugged in construction, exceedingly positive and reliable in operation and readily adjustable to provide for operation of the switches in any desired sequence.

Another object is to provide a cam operating mechanism of the aforesaid character which provides for closure of the control switches with a snap action and without objectionable shock or noise.

Another object is to provide a cam operating mechanism of the aforesaid character which is operable in opposite directions between given limits either manually or by means of a pilot motor and which is capable of being accurately stopped in any one of a plurality of equally spaced operating positions between such limits.

Another object is to provide an enclosed multiple switch controller having an improved position indicating mechanism associated therewith which is exceedingly simple in construction, and positive and reliable in operation.

Various other objects and advantages of the invention will hereinafter appear.

The accompanying drawings illustrate an embodiment of the invention which will now be described, it being understood that various modifications may be made in the embodiment illustrated without departing from the spirit and scope of the appended claims.

In the drawings,

Figure 1 is a front elevational view of a cam operated multiswitch controller embodying the invention, an enclosing cabinet for the controller being shown with portions thereof broken away;

Fig. 2 is a side elevational view of the controller shown in Fig. 1 with a portion of the upper end of the enclosing cabinet broken away;

Fig. 3 is an enlarged fragmentary sectional view on line 3—3 of Fig. 1;

Fig. 4 is an enlarged fagmentary sectional view on line 4—4 of Fig. 3;

Fig. 5 is a front elevational view of a cam operating unit shown in outline in Fig. 1 with a portion of one of the operating parts of the unit broken away;

Fig. 6 is an enlarged fragmentary sectional view on line 6—6 of Fig. 5;

Fig. 7 is a horizontal sectional view of certain parts of the cam operating unit shown in Fig. 1;

Fig. 8 is a fragmentary sectional view on line 8—8 of Fig. 7;

Fig. 9 is an enlarged fragmentary sectional view on line 9—9 of Fig. 7;

Figs. 10 and 11 are sectional views taken on line 10—10 of Fig. 5 illustrating a cam operating mechanism for one of the switches in switch opening and switch closing positions;

Fig. 12 is a fragmentary sectional view illustrating certain of the parts of the cam operating mechanism shown in Figs. 10 and 11 in an intermediate position;

Fig. 13 is an end elevational view of the cam operating unit shown in Fig. 5, and

Fig. 14 is a diagrammatic view illustrating the control circuits for the controller shown in Fig. 1.

Referring to Figs. 1 and 2, the same illustrate a controller embodying the invention, the same being enclosed within a cabinet 1 having a hinged door 2 on the front thereof. The controller illustrated is provided with a plurality of vertically spaced 3 pole switches 3 to 7, inclusive, and a cam operating unit 8 for effecting operation of said switches in a predetermined sequence. The switches 3 to 7 are mounted upon an insulating panel 9 which is secured within the cabinet 1 and the cam operating unit 8 is located below panel 9 and is carried by a pair of spaced horizontally disposed supporting members 10 and 11 which are also secured within said cabinet.

More specifically the switches 3 to 7 are of like construction and as shown each is provided with cooperating stationary and movable contacts 12 and 13, the former being mounted upon panel 9 and the latter being yieldingly mounted upon an insulated section 14 of a rotatable operating shaft 15. The operating shafts 15 of the several switches are arranged horizontally and in parallel relation, and each is supported at opposite ends by suitable bearing brackets 16 mounted upon panel 9. Each of the switches 3 to 7 has a forwardly extending operating lever 17 fixed to its operating shaft 15 and each is biased to move to open position under the action of gravity.

The cam operating unit shown in Fig. 5 is provided with spaced end brackets 19 and 20 which are bolted to the supports 10 and 11. A plurality of cam operating mechanisms 21 to 25, inclusive, are mounted between the brackets 19 and 20, said mechanisms being of like construction and being arranged side by side in equally spaced relation. As shown in Fig. 10 each of the cam operating mechanisms includes a reciprocable push rod 26, a rotatable cam wheel 27 and an operating lever 28. The several push rods 26 are arranged vertically and have their

lower ends slidably supported within openings in a horizontally disposed stop bar 29 which is secured at opposite ends to the end brackets 19 and 20. As shown in Fig. 1, the upper ends of the push rods 26 of cam mechanisms 21 to 25 are respectively connected to the operating levers 17 of switches 3 to 7 by adjustable operating connections 30 to 34, inclusive. Each of the push rods 26 is provided with a stop projection 35 of cone frustum shape which normally engages the upper face of stop bar 29 to limit opening movement of its associated switch and each is also provided with a second stop projection 36 which is spaced upwardly with respect to stop projection 35.

The cam wheels 27 have cam elements detachably secured to the peripheries thereof whch will be hereinafter more fully described, and said cam wheels are fixed to a rotatable operating shaft 38 which is rotatably supported at opposite ends by bearings 39 and 40 mounted within openings in the end brackets 19 and 20. The operating levers 28 are arranged horizontally above their associated cam wheels 27 and at right angles to the shaft 38. The rear ends of said operating levers are rotatably supported upon a shaft 41 which is secured at opposite ends within openings in the end frames 19 and 20, and each of said levers has a roller 42 mounted upon the under side thereof to be engaged by the cam elements on its associated cam wheel 27. The front ends of the operating levers 28 are provided with openings for receiving their associated push rods 26 and each of said operating levers is normally held in engagement with the upper face of the stop projection 36 on its associated push rod by a coil spring 43. As shown in Fig. 11, each of the springs 43 is held under compression against the upper face of its associated lever 28 by an adjustable washer 44 which is threaded upon the upper end of its associated push rod 26.

The several push rods 26 have a common latch bar 45 associated therewith which is arranged horizontally and in front of said push rods for engagement with the stop projections 35. As shown in Fig. 10, the under side of latch bar 45 is recessed to provide surfaces 46 for engaging the upper faces of stop projections 35 on push rods 26 and said bar is also provided with a beveled edge 47 for engaging the cone surfaces on said stop projections. Latch bar 45 is bolted to a horizintally disposed channeled supporting member 48 having side arms 49 and 50 fixed to opposite ends thereof. The lower ends of the side arms 49 and 50 are journaled upon a shaft 51 which is supported at opposite ends within openings in the end brackets 19 and 20. Latch bar 45 is biased to move toward the push rods 26 by a pair of springs 52 which are connected between stop bar 29 and supporting member 48. One of the springs 52 is shown in Fig. 10, and as shown in this figure supporting member 48 has a stop 53 secured thereto for engaging the front side of stop bar 29 to limit movement of latch bar 45 toward the push rods 26.

Latch bar 45 is controlled by a rotatable cam 55 having oppositely disposed V-shaped cam faces 55^a and 55^b for engaging a roller 56 mounted upon the arm 49 of supporting member 48. Cam 55 is mounted upon a horizontally disposed drive shaft 57, and as is apparent from Figs. 10 and 11 when said cam is driven in either direction the cam faces 55^a and 55^b act alternately upon successive half revolutions of the cam to effect movement of supporting member 48 and its associated latch bar 45 in opposite directions between the extreme positions illustrated in these figures. For a purpose hereinafter set forth cam 55 is connected to shaft 57 by a lost motion driving connection (Figs. 7 and 9) comprising a key 58 fixed to said shaft and a semi-circular hub projection 59 on said cam. Hub projection 59 is fixed within a sleeve 60 which is rotatably supported upon a circular projection 61 on shaft 57, and as is apparent from Fig. 9 said hub projection cooperates with the key 58 to permit relative rotation of cam 55 and shaft 57 through an angle of substantially 180 degrees.

As shown in Fig. 7, shaft 57 is rotatably supported adjacent opposite ends by bearings 62 and 63 which are mounted upon the end brackets 19 and 20, and said shaft is adapted to be driven either by motor 64 or manually, as hereinafter set forth. Motor 64 is mounted upon the end bracket 19 and is of a conventional type having a built-in speed reducing gear generally indicated at 65. Motor 64 is provided with a driving pinion 66 which meshes with a gear 67 fixed to the left hand end of shaft 57. The cam wheels 27 are driven from shaft 57 through the medium of a pinion 68 fixed to said shaft, and a gear 69 fixed to the cam wheel shaft 38. In the embodiment illustrated the cam wheels 27 have twenty equally spaced operating positions as shown in Fig. 10, and for this number of operating positions the gears 68 and 69 are of a diameter to provide for rotation of said cam wheels through an angle corresponding to the angular spacing of said operating positions upon each half revolution of shaft 57.

As shown in Fig. 10, cam elements of three different shapes designated as "A," "B" and "C" are provided for mounting upon the peripheries of cam wheels 27. Also as shown in this figure each of the cam wheels 27 has a rim 70 which is provided with twenty equally spaced openings 71 to enable mounting of said cam elements in selected operating positions upon the cam wheels by bolts 72. Each of the cam elements "A," "B" and "C" extends through an angle of 18 degrees and cam "A" has a V-shaped cam surface 73, cam "B" has an inclined cam surface 74 and a circular cam surface 75, and cam "C" has a circular cam surface 76.

The operation of the aforedescribed cam operating mechanism will now be more fully described in connection with Figs. 10 and 11. The cam wheel 27 is shown in its first operating position in Fig. 10, and as illustrated the same is provided with cam elements "A" in operating positions 12 and 16, cam elements "B" in operating positions 2, 3, 6 and 8, and a cam element "C" in operating position 7. With cam wheel 27 in its first operating position push rod 26 is located in its switch opening position, the stop projection 35 thereof being in engagement with the top surface of stop bar 29, and operating lever 28 is held in engagement with stop projection 36 under the action of spring 43.

Upon rotation of shaft 57 in a clockwise direction, cam wheel 27 is moved out of its first operating position toward its second operating position and the cam surface 74 on cam element B^1 engages roller 42 to move operating lever 28 upwardly out of the position shown in Fig. 10. Upon initial upward movement of operating lever 28 out of the position shown in Fig. 10 push rod 26 is moved upwardly through the medium of

spring 43 into a position wherein stop 35 thereof engages the surface 46 on latch bar 45 and the switch associated with said push rod is thus moved part way toward closed position, as indicated in dotted lines in Figs. 2 and 11. Upon continued upward movement of lever 28 toward the position shown in Fig. 11 push rod 26 is held stationary by the latch bar 45 and lever 28 is moved upwardly and away from stop projection 36 to compress spring 43 against the washer 44. As is apparent, push rod 26 is then adapted to be moved upwardly into switch closing position with a snap action by spring 43 upon tripping of latch 45 by cam 55. As will now be set forth, latch bar 45 is moved into the tripped position shown in Fig. 11 during final movement of cam wheel 27 into its second operating position.

With cam wheel 27 in its first operating position cam 55 is positioned as shown in Fig. 10 and shaft 57 is positioned so that its associated key 58 engages the hub projection 59 on said cam upon rotation of said shaft through an angle of substantially 90 degrees with respect to said cam. As hereinbefore set forth, the gears 68 and 69 act upon each half revolution of shaft 57 to effect rotation of cam wheels 27 through an angle corresponding to the angular spacing of the operating positions on said wheels. Thus during movement of cam wheel 27 from its first operating position to its second operating position shaft 57 is first rotated through an angle of 90 degrees with respect to cam 55 and then acts to drive said cam through an angle of 90 degrees to move the same from the position shown in Fig. 10 into the position shown in Fig. 11. During movement of cam 55 into the position shown in Fig. 11 the cam surface 55^a thereof engages roller 56 to move latch bar 45 into tripped position (Fig. 11) and push bar 26 is thus released to permit snap movement thereof into switch closing position under the action of spring 43. When cam 55 is driven in a clockwise direction slightly beyond the position shown in Fig. 11 springs 52 act through the medium of roller 56 to effect snap movement of said cam in a clockwise direction with respect to shaft 57 and latch bar 45 is thus returned quickly to the position shown in Fig. 10 without substantial movement of cam wheel 27 beyond its second operating position.

As is apparent from the foregoing, upon continued rotation of shaft 57 in a clockwise direction the cam surfaces 55^b and 55^a of cam 55 act alternately to effect tripping and quick return of latch bar 45 to latching position in each operating position of cam wheel 27. During rotation of cam wheel 27 from its second operating position into its third operating position push rod 26 is held in switch closing position by the circular cam surfaces 75 on cam elements B^1 and B^2. Upon movement of cam wheel 27 out of its third operating position toward its fourth operating position the cam surface 75 on cam element B^2 is moved out of engagement with roller 42 to permit a slight downward movement of push rod 26 into a position wherein the under surface of stop projection 35 engages the upper surface of latch bar 45. However, such slight downward movement of push rod 26 is insufficient to effect opening of the contacts of its associated switch. When cam wheel 27 is moved into its fourth operating position the cam surface 74 on cam element B^2 is moved out of the path of roller 42 and cam 55 then acts to effect momentary tripping of latch bar 45 for return of push rod 26 to switch opening position under the action of gravity.

Assuming now that the cam wheel is in its fourth operating position and shaft 57 is started in a counterclockwise direction to move said cam wheel toward its first operating position. The above described lost motion driving connection between shaft 57 and cam 55 provides for rotation of said cam by said shaft through an angle of 90 degrees into the position shown in Fig. 11 during rotation of cam wheel 27 from its fourth operating position into its third operating position. Thus during movement of cam wheel 27 from its fourth operating position toward its third operating position push rod 26 is held in switch opening position by latch bar 45 and spring 43 is compressed by the cam surface 74 on cam element B^2. When cam wheel 27 moves into its third operating position, latch bar 45 is momentarily tripped by the surface 55^a of cam 55 to permit snap movement of push rod 26 into switch closing position. During movement of cam wheel 27 from its third operating position to its second operating position push rod 26 is maintained in switch closing position by the surfaces 75 of cam elements B^1 and B^2. Upon return of cam wheel 27 to its first operating position cam element B^1 is moved out of the path of roller 42, and as is apparent latch bar 45 is then tripped to permit return of said push rod 26 to switch opening position.

As is apparent from the foregoing, the cam elements B^3, C, B^4, A^1 and A^2 act in the order named upon counterclockwise rotation of cam wheel 27 to effect movement of push rod 26 into switch closing position in operating positions 6, 12 and 16, and to permit dropping out of said push rods into switch opening position in operating positions 9, 13 and 17. Also as is apparent from the foregoing, said cam elements act in reverse order upon clockwise rotation of cam wheel 27 to effect movement of push rod 26 into switch closing position in operating positions 16, 12 and 8 and to permit dropping out of said push rod into switch opening position in operating positions 15, 11 and 5. Obviously the cam elements A, B and C may be mounted upon the several cam wheels 27 to provide for operation of switches 3 to 7 in any desired sequence.

As will now be set forth, when the cam arrangement is such that a switch is to be opened and another switch is to be closed in a given operating position of the controller, the former switch is opened prior to closure of the latter. As hereinbefore set forth, when a push rod 26 is to be moved into switch opening position upon movement of its associated cam wheel 27 into a given operating position the same is held in switch closing position pending movement of said cam wheel into said operating position by engagement of its associated stop projection 35 with the upper surface of latch bar 45. Also as hereinbefore set forth, when a push rod 26 is to be moved into switch closing position upon movement of its associated cam wheel 27 into a given operating position the same is moved part way toward circuit closing position and is held pending movement of said cam wheel into said operating position by engagement of its associated stop 35 with a surface 46 on the under side of latch bar 45. The stop projections 35 of push rods 26 are of cone frustum shape, as hereinbefore set forth, and as is apparent during movement of latch bar 45 out of the position shown in Fig. 10 toward tripped position the upper sur-

face of said latch bar is moved out of engagement with the under surface of the stop projection 35 of the push rod which is being held in switch closing position prior to disengagement of surface 46 with the upper surface of the cam projection 35 of the push rod which is to be moved into switch closing position. When the upper surface of latch bar 45 is moved out of engagement with the under surface of the stop projection 35 which is associated with the switch to be opened the cone surface on said projection engages the beveled surface 47 on latch bar 45 and as shown in full lines in Fig. 12 upon continued movement of said latch bar toward tripped position said stop projection moves downwardly into a position to effect opening of its associated switch prior to release of the stop projection shown in dotted lines which is associated with the switch to be closed. Upon movement of latch bar 45 into tripped position the stop projections 35 shown in full and dotted lines are released simultaneously and the push bar associated with the former stop is moved downwardly into its extreme switch opening position while the push bar associated with the latter stop is moved with a snap action into its upper extreme switch closing position.

The above described cam operating mechanism is provided with an indicating mechanism which will now be described. Said indicating mechanism comprises an indicator wheel 80 (Fig. 13), a latch 81 for controlling the operation of said wheel and a pointer 82 which is operatively connected to said wheel and is associated with a dial plate 83 mounted upon the outside of the right side wall of cabinet 1 as shown in Figs. 1 and 2.

As shown in Figs. 7, the right hand end of shaft 38 projects beyond end plate 20 and indicator wheel 80 is rotatably supported upon the projecting end of said shaft and is operatively connected thereto through the medium of a coil spring 85 and a stop member 86. Spring 85 is provided with outwardly extending end portions 87 and 88 which engage on opposite sides of a projection 89 on wheel 80 and the stop member 86 is fixed to the right hand end of shaft 38 and is provided with a projection 90 which extends through an opening in said wheel for engagement between the end portions of said spring. As is apparent, spring 85 acts through the medium of projections 89 and 90 to normally hold indicator wheel 80 in a given angular position with respect to shaft 38. As shown in Fig. 13 the periphery of wheel 80 is provided with equally spaced notches 91 corresponding to the operating positions of cam wheels 27. Latch 81 is disposed vertically and the lower end thereof is rotatably supported upon the right hand end of shaft 51. The upper end of latch 81 is adapted to engage within the notches 91 in indicator wheel 80 and said latch is biased to move toward said wheel by a spring 93 which is connected at opposite ends to a pin 94 secured to said latch and a pin 95 secured to end plate 20. The upper end of latch 81 is provided with an adjustable screw stop 96 for engaging the front side of a pin 97 fixed to the side arm 50 of latch bar supporting member 48.

As shown in Figs. 2, 3 and 4, dial plate 83 is provided with equally spaced indicating numerals 1 to 20 corresponding to the operating positions of cam wheels 27 and the pointer 82 is secured to a shaft 98 which is axially aligned with shaft 38 and is rotatably supported within a bearing projection on the inner face of said dial plate. The inner end of shaft 98 has a radially disposed arm 99 fixed thereto which engages within a notch 100 in a circular flange projection 101 on the right hand face of indicator wheel 80.

The operation of the aforedescribed indicating mechanism will now be fore fully set forth. Upon location of cam wheels 27 in any one of the several operating positions thereof, pointer 82 is located opposite the dial plate numeral corresponding to such operating position and latch 81 is located within a notch 91 in indicator wheel 80, as shown in Fig. 13. Upon movement of the latch bar supporting member 48 out of the latching position shown in Fig. 10 into the tripped position shown in Fig. 11 latch 81 is moved through the medium of pin 97 and stop 96 into a tripped position wherein the same clears the notches 91 in indicator wheel 80. As hereinbefore set forth, latch bar supporting member 48 is momentarily tripped and returned to latching position during movement of the cam wheels 27 into each of the several operating positions thereof. Thus upon rotation of cam wheels 27 in either direction out of any one of the operating positions thereof latch 81 is maintained in the position shown in Fig. 13 to lock indicator wheel 80 against rotation pending movement of the cam wheels into the next operating position, and shaft 38 is rotated with respect to indicator wheel 80 against the action of spring 85. Upon movement of the cam wheels 27 into the next operating position latch 81 is moved into tripped position by the latch bar supporting member 48 and said indicator wheel is then moved with a snap action under the action of spring 85 into a position corresponding to the position of the cam wheels. Pointer 82 is thus operated in a step by step manner upon operation of the cam wheels in either direction to provide for accurate indication of the position of said cam wheels at all times. In connection with the foregoing it should be noted that spring 85 permits over-travel of the cam wheels beyond the operating positions thereof without operation of the pointer 82. Also it should be noted that the pin and stop operating connection 97, 96 between latch bar operating member 48 and latch 81 permits return movement of said latch bar operating member to the position shown in Fig. 13 without interference by the latch 81.

As hereinbefore stated, the cam operating shaft 57 of the controller is adapted to be driven either manually or by means of the motor 64. As shown in Fig. 1, the manual operating means comprises a removable crank 103 having a shaft 104 which is insertable into an opening in a bearing projection 105 on the inner face of dial plate 83 for engagement with the right hand end of the cam operating shaft 57. Crank shaft 104 is adapted to be locked in engagement with cam shaft 57 by a locking member 106 mounted within cabinet 1. As shown in Fig. 3, locking member 106 is pivotally supported at one end upon a bolt fixed to the right hand wall of cabinet 1, and as shown in Fig. 4 the under side of said locking member engages within a groove 107 in shaft 104. Locking member 106 is accessible upon opening of the door 2 of cabinet 1 and is movable upwardly out of the full line position shown in Fig. 3 to permit removal of crank 103. Upon removal of the crank, locking member 106 is adapted to drop into the position shown in dotted lines in Fig. 3 under the action of gravity to cover the shaft opening in bearing projection 105.

As shown in Fig. 7, the right hand end of cam shaft 57 is provided with a slot 108 and as shown in Fig. 4 the inner end of shaft 104 is bored to

receive shaft 57 and is provided with a pin 109 for engaging within said slot. Cam shaft 57 is movable axially toward the left out of the position shown in Fig. 7 against the action of a coil spring 110 which is held under compression between end bracket 19 and a collar 111 fixed to said shaft. When shaft 104 of the crank 103 is inserted into the bearing projection 105 and locked in the position shown in Fig. 4 shaft 57 is moved toward the left (Fig. 7) against the action of spring 110 into a position wherein gear 67 is held out of mesh with pinion 66 to disconnect said shaft from motor 64. However, as is apparent from Fig. 5, upon axial movement of shaft 57 into this position pinion 68 remains in mesh with gear 69 and roller 56 is engageable by the cam 55. Thus upon rotation of shaft 57 by crank 103 the controller will operate as hereinbefore described. When crank 103 is removed shaft 57 is returned to the position shown in Fig. 7 under the action of spring 110 to provide for operation of the controller by pilot motor 64.

A braking mechanism shown in Fig. 5 is provided to prevent excessive coasting of the controller upon deenergization of motor 64. Said braking mechanism comprises a gear 113 which meshes with the motor pinion 66 and a pair of friction plates 114 for engaging the side faces of said gear. Gear 113 and friction plates 114 are mounted upon a pin 115 which is slidably supported within an opening in end bracket 19. Gear 113 and friction plates 114 are clamped together between bracket 19 and a nut 116 on pin 115 by a spring 117 mounted upon said pin. Friction plates 114 are held against rotation by a pin 118 secured to end bracket 19. Gear 113 and friction plates 114 provide a frictional drag for effecting quick stopping of the controller upon deenergization of motor 64.

The control means for motor 64 includes a limit switch 119 associated with the latch bar operating member 48 and a plurality of limit switches generally indicated by reference numeral 120 (Fig. 5) which are controlled by a drum operating element 121 fixed to the cam wheel shaft 38.

Limit switch 119 is mounted in a stationary position upon end bracket 19 and is operated by an adjustable stop 122 carried by a bracket 123 fixed to the side arm 49 of the latch bar operating member 48. As shown in Fig. 6, limit switch 119 is provided with an insulating base 124 which carries a pair of stationary contacts 125 and a cooperating bridging contact 126. Bridging contact 126 is biased to move into engagement with its associated stationary contacts by a spring 127 and is mounted upon a push rod 127a located opposite the stop 122. Bridging contact 126 is normally held in circuit closing position by its associated spring 127 and is moved into circuit opening position by stop 122 during final movement of latch bar operating member 48 into the tripped position shown in Fig. 11.

Drum 121 is arranged to operate three normally closed limit switches 128, 129 and 130, shown diagrammatically in Fig. 14. These limit switches are of a conventional type and are mounted upon a stationary insulating base 131 (Fig. 5) which is located to the rear of said drum. Drum 121 has a notched flange projection 132 on one end thereof, and as shown in Fig. 14 limit switch 128 is controlled by said flange projection to provide for closure thereof in the first operating position of the cam wheels and for opening thereof in all other operating positions of said wheels. Limit switches 129 and 130 are controlled by pins 133 and 134 (Fig. 7) which are adjustably mounted upon the drum 121. Limit switch 129 is opened in the first operating position of cam wheels 27 and limit switch 130 is opened in the twentieth operating position of said wheels.

Referring now to Fig. 14, the same illustrates a normally open electromagnetic line switch F which provides for operation of motor 64 in a forward direction to move cam wheels 27 toward their twentieth operating position, and a normally open electromagnetic line switch R which provides for operation of said motor in a reverse direction. Switch F is provided with normally open auxiliary contacts *f* and is controlled by a normally open push button 135. Switch R is provided with normally open auxiliary contacts *r* and is controlled by a normally open push button 136. Upon depression of push button 135 the operating winding of switch F is connected across lines L^1, L^2 through the medium of limit switch 130 to provide for forward operation of motor 64. Upon movement of cam wheels 27 into their twentieth operating position switch F is deenergized by opening of limit switch 130 to stop forward operation of motor 64. Upon depression of push button 136 the operating winding of switch R is connected across lines L^1, L^2 through the medium of limit switch 129 for reverse operation of motor 64. Upon movement of cam wheels 27 into their first operating position switch R is deenergized by opening of limit switch 129 to stop reverse operation of motor 64.

As hereinbefore set forth, switch 119 is momentarily opened upon movement of cam wheels 27 into each of the operating positions thereof. Thus if push button 135 is released during movement of cam wheels 27 into a selected operating position switch F is maintained energized through the medium of switch 119, auxiliary contacts *f* and limit switch 130, and upon movement of the cam wheels into the selected operating position switch 119 is opened to deenergize switch F for stopping of motor 64. Also if push button 136 is released during movement of cam wheels 27 into a selected operating position switch R is maintained energized through the medium of switch 119, auxiliary contacts *r* and limit switch 129, and upon movement of the cam wheels into the selected operating position switch 119 is opened to deenergize switch R for stopping of motor 64. As is apparent from the foregoing, momentary depression of either of the push buttons 135 or 136 effects one step of operation of the cam wheels 27.

The aforedescribed controller may be used in connection with an alternating current motor to effect speed regulation by control of resistance sections connected in the secondary circuit of the motor. In such installations a main line switch M is employed for controlling the primary circuit of the motor. As shown in Fig. 14, line switch M is provided with auxiliary contacts *m* and is controlled by a normally open start push button 137, a normally closed stop push button 138, and also by the aforedescribed limit switch 128. As hereinbefore set forth, limit switch 128 is closed in the first operating position of cam wheels 27 and is open in all other operating positions of said wheels. Main switch M is adapted to be energized upon depression of start push button 133 through the medium of stop push button 134 and limit switch 128, and said main switch can therefore be closed only in the first operating position of cam wheels 27. Upon movement of cam wheels 27 out of their first operating position main switch

M is maintained energized through the medium of its associated auxiliary contacts *m* and stop push button 134.

A stop mechanism shown in Figs. 7 and 8 is provided for preventing excessive coasting of cam wheels 27 upon deenergization of motor 64 in the first and twentieth operating positions of said wheels. Said stop mechanism comprises a stop pin 140 fixed to the end bracket 20 and a cooperating arm 141 mounted upon the cam wheel shaft 38 and having a tip 142 for engaging said pin. As shown at 143 in Fig. 8, shaft 38 is loosely keyed to arm 141 to permit a slight degree of rotation of said shaft with respect to said arm. Upon coasting of cam wheels 27 beyond their twentieth operating position arm 141 engages stop pin 140 as shown in full lines in Fig. 8 to stop said cam wheels in a position short of the first operating position of said wheels. Upon coasting of cam wheels 27 beyond their first operating position arm 141 engages stop pin 140 as shown in dotted lines in Fig. 8 to stop said cam wheels in a position short of the twentieth operating position of said wheels.

What I claim as new and desire to secure by Letters Patent is:

1. In combination, a movable switch member biased toward one position, a spring for moving said switch member against its bias into another position, a rotatable cam operating element movable into a predetermined position to effect movement of said switch member into its latter position through the medium of said spring, a latch for locking said switch member against movement into its latter position under the action of said spring during movement of said cam element into said predetermined position, and means for tripping said latch upon movement of said cam operating element into said predetermined position to permit snap movement of said switch member into its latter position under the action of said spring.

2. In combination, a control switch biased toward open position, a spring for moving said switch against its bias into closed position, a rotatable cam element movable into a predetermined position to effect movement of said switch into closed position through the medium of said spring, a latch normally positioned to stop said switch in an intermediate position during movement of said cam element into said predetermined position, and means for tripping said latch upon movement of said cam element into said predetermined position to permit snap movement of said switch into closed position under the action of said spring.

3. In combination, a control switch biased toward open position, a spring for moving said switch against its bias into closed position, a rotatable cam element having a plurality of switch operating positions, certain for effecting closure of said switch through the medium of said spring, and certain for permitting opening of said switch, a latch associated with said switch, said latch being normally positioned to lock said switch against movement into closed position when the same is in open position and against movement into open position when the same is in closed position, and means for tripping said latch to permit operation of said switch upon movement of said cam element into each of its switch operating positions.

4. In combination, a control switch biased toward open position, a spring for moving said switch against its bias into closed position, a rotatable cam wheel having a plurality of switch operating positions, certain for effecting closure of said switch through the medium of said spring, and certain for permitting opening of said switch, a latch biased toward a given normal position to lock said switch against movement into closed position when the same is in open position and against movement into open position when the same is in closed position, a rotatable cam geared to said cam wheel for momentarily tripping said latch to permit operation of said switch upon movement of said cam wheel through each of its switch operating positions.

5. In combination, a plurality of separately operable control switches each biased toward open position and each having a spring associated therewith for moving the same into closed position, a rotatable cam mechanism for operating said switches through the medium of their associated springs, said cam operating mechanism having a plurality of equally spaced switch operating positions for effecting opening and closure of said switches in a predetermined sequence, a single latch element biased toward a given normal position to lock said switches against movement into closed position when the same are in open position and against movement into open position when the same are in closed position, and a cam element operatively connected to said cam mechanism for momentarily tripping said latch element during movement of said cam mechanism in either direction through each of its switch operating positions.

6. In combination, a plurality of separately operable control switches each biased toward open position and each having a spring associated therewith for moving the same into closed position, a rotatable cam mechanism for operating said switches through the medium of their associated springs, said cam mechanism having a plurality of equally spaced operating positions for effecting opening and closure of said switches in a given sequence upon rotation of said cam mechanism in one direction, and in a reverse sequence upon rotation of said cam mechanism in an opposite direction, a single latch element biased toward a given normal position to lock said switches against movement into closed position when the same are in open position, and against movement into open position when the same are in closed position, a rotatable cam element operatively connected to said cam mechanism for momentarily tripping said latch element during movement of said cam mechanism in either direction through each of its switch operating positions, said cam element acting during movement into tripped position to permit opening of any one of said control switches prior to closure of another.

7. In combination, a plurality of separately operable control switches each biased toward open position and each having an operating spring associated therewith for moving the same into closed position, an operating member for each of said switches movable in one direction out of a given normal position to effect closure of its associated switch through the medium of its spring and returnable to normal position to permit opening of its associated switch, a rotatable cam shaft having a plurality of cam wheels fixed thereto for controlling said switches through the medium of their associated operating members, said cam wheels having a plurality of equally spaced operating positions for effecting opening and closure of said switches in a given sequence upon

rotation of said cam shaft in one direction and in a reverse sequence upon rotation of said cam shaft in an opposite direction, a single latch element biased toward a given normal position to lock said switches against movement into closed position when the same are in open position, and against movement into open position when the same are in closed position, a drive shaft geared to said cam shaft and a cam element associated with said drive shaft for momentarily tripping said latch element during movement of said cam wheels through each of the operating positions thereof.

8. In combination, a plurality of separately operable control switches each biased toward open position and each having a spring associated therewith for moving the same into closed position, a rotatable cam mechanism for operating said switches through the medium of their associated springs, said cam operating mechanism having a plurality of equally spaced switch operating positions for effecting opening and closure of said switches in a given sequence upon rotation of said cam mechanism in one direction, and in a reverse sequence upon rotation of said cam mechanism in an opposite direction, a single latch element biased toward a given normal position to lock said switches against movement into closed position when the same are in open position and against movement into open position when the same are in closed position, a rotatable cam element operatively connected to said cam mechanism for momentarily tripping said latch element during movement of said cam mechanism through each of its switch operating positions, an indicating mechanism yieldingly connected to said cam operating mechanism to rotate therewith, and means associated with said latch element for effecting step by step operation of said indicating mechanism upon rotation of said cam mechanism through its several switch operating positions.

9. In combination, a plurality of separately operable control switches each biased toward open position and each having a spring associated therewith for moving the same into closed position, a rotatable cam mechanism for operating said switches through the medium of their associated springs, said cam mechanism being rotatable in opposite directions between given limits and having a plurality of equally spaced switch operating positions between said limits for effecting opening and closure of said switches in a given sequence upon rotation of said cam mechanism in one direction between said limits, and in a reverse sequence upon rotation of said cam mechanism in an opposite direction between said limits, a driving motor for said cam mechanism, and means associated with said cam mechanism for stopping said driving motor upon movement of said cam mechanism into said limits.

10. In combination, a plurality of separately operable control switches each biased toward open position and each having a spring associated therewith for moving the same into closed position, a rotatable cam mechanism for operating said switches through the medium of their associated springs, said cam mechanism being rotatable in opposite directions between given limits and acting upon rotation in one direction between said limits to effect opening and closure of said switches in a given sequence, and upon rotation in an opposite direction between said limits to effect opening and closure of said switches in a reverse sequence, a driving motor normally connected to said cam operating mechanism, and a detachable manual operating member for said cam mechanism, said manual operating member when placed in operating position upon said cam mechanism providing for disconnection of said motor from said mechanism.

11. In combination, a control switch biased toward open position, a latch normally positioned to lock said switch against movement into closed position when the same is in open position and against opening when the same is in closed position, spring means operable to move said switch against its bias into closed position, an operating element rotatable in opposite directions and having a plurality of equally spaced operating positions, means associated with said operating element for momentarily tripping said latch during movement of said element in either direction into each of its operating positions, and cam means associated with said operating element for operating said spring means to effect closure of said switch in certain of said operating positions upon tripping of said latch and for releasing said spring means to permit opening of said switch in certain other of said operating positions upon tripping of said latch.

12. In combination, a control switch biased toward open position, a latch normally positioned to lock said switch against movement into closed position when the same is in open position and against opening when the same is in closed position, a spring operable to move said switch against its bias into closed position, an operating element rotatable in opposite directions and having a plurality of equally spaced operating positions, means associated with said operating element for momentarily tripping said latch during movement of said element in either direction into each of its operating positions, and cam means associated with said operating member for effecting operation of said switch through the medium of said spring, said cam means being adjustable upon said operating member to provide for closure and opening of said switch upon tripping of said latch in selected operating positions of said member.

13. In combination, a plurality of separately operable control switches each biased toward open position, a single latch member associated with said switches normally positioned to lock any one of said switches against movement into closed position when the same is in open position and against opening when the same is in closed position, a spring associated with each of said control switches for moving the same against its bias into closed position, a rotatable operating element for said switches having a plurality of equally spaced operating positions, means for momentarily tripping said latch during movement of said operating element in either direction into each of said operating positions, and cam means associated with said operating element for operating said springs to effect closure of each of said switches upon tripping of said latch in certain operating positions of said element and for releasing said springs to permit opening of each of said switches upon tripping of said latch in certain other operating positions of said element.

14. In combination, a control switch biased toward open position, an operating push rod therefor, a latch associated with said push rod for locking said switch against movement into closed position when the same is in open position, and against opening when the same is in closed position, a spring associated with said push rod and adapted to be compressed to bias said push rod

in a direction to effect closure of said control switch, a rotatable operating element having a plurality of equally spaced operating positions, means associated with said operating element for momentarily tripping asid latch during movement of said element in either direction into each of said operating positions, and cam means associated with said operating element for compressing said spring to effect closure of said switch in certain of said operating positions upon tripping of said latch and for releasing said spring to permit opening of said switch in certain other of said operating positions upon tripping of said latch.

15. In a circuit controller, in combination, a vertically disposed support having a plurality of normally open separately operable control switches mounted thereon, said switches being arranged one above the other in spaced relation, and each having a vertically arranged push rod associated therewith for operating the same, and a unitary cam operating device for said switches arranged below the same and including a spring associated with each of said push rods for moving the same in a direction to close its associated switch, a rotatable cam mechanism for operating said push rods through the medium of their associated springs, said cam mechanism having a plurality of equally spaced operating positions for effecting operation of said switches in a predetermined sequence, a latching mechanism associated with said push rods for normally locking said switches against movement into closed position when the same are in open position and against opening when the same are in closed position, and means for momentarily tripping said latching mechanism in each of the operating positions of said cam mechanism.

16. In a multiswitch controller, in combination, an enclosing casing, a plurality of normally open separately operable control switches mounted within said casing, a unitary cam operating mechanism for said switches also mounted within said casing including a cam mechanism rotatable in opposite directions between given limits and having a plurality of equally spaced operating positions for effecting operation of said switches in a given sequence upon rotation in one direction between said limits and in a reverse sequence upon rotation in an opposite direction between said limits, an indicating mechanism including an indicating part associated with said casing and yieldingly connected to said cam operating mechanism to rotate therewith, and means associated with said cam operating mechanism for effecting step by step operation of said indicating part upon rotation of said cam mechanism in opposite directions through its several operating positions.

17. In a multiswitch controller, in combination, an enclosing casing, a plurality of normally open separately operable control switches mounted within said casing, a unitary cam operating mechanism for said switches also mounted within said casing and including a cam mechanism rotatable in opposite directions between given limits and acting upon rotation in one direction between said limits to effect opening and closure of said switches in a given sequence and upon rotation in an opposite direction between said limits to effect opening and closure of said switches in a reverse sequence, a driving motor normally connected to said cam operating mechanism, and a detachable manual operating member for said cam mechanism insertable through an opening in said casing for driving engagement with said cam mechanism, said manual operating member when placed in driving engagement with said cam mechanism providing for disconnection of said motor from said mechanism.

CLYDE F. ROBBINS.