United States Patent

[11] **3,571,543**

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[54] **MULTIPLE POSITION VACUUM INTERRUPTER SWITCHING DEVICE**
6 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **200/144,** 200/146
[51] **Int. Cl.** **H01h 33/66**
[50] **Field of Search** 200/144.2, 146

[56] **References Cited**

UNITED STATES PATENTS

2,773,154	12/1956	Williams	200/144(.2)
2,911,506	11/1959	Owens	200/146
3,023,290	2/1962	Jennings	200/144(.2)
3,025,375	3/1962	Frank	200/144(.2)
3,206,580	9/1965	McCarty	200/144(.2)
3,472,981	10/1969	McCarty et al.	200/144(.2)

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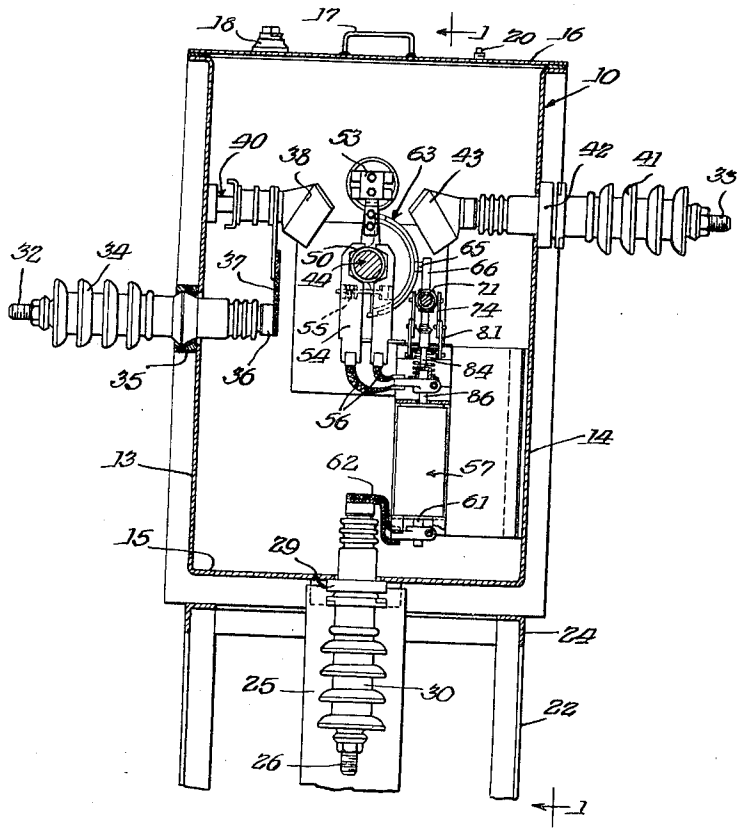
ABSTRACT: The operating and programming mechanism of the invention is designed to actuate the contacts of a vacuum switch and the contacts of a selector switch in a predetermined sequence. The vacuum switch contacts are connected in series with the contacts of the selector switch and a cam is provided as the programming means. The cam converts a portion of the operator output into linear motion so that the vacuum switch contacts are caused to close after the selector switch contacts close and are opened before the selector switch contacts open.



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SHEET 1 OF 3

Fig. 1.

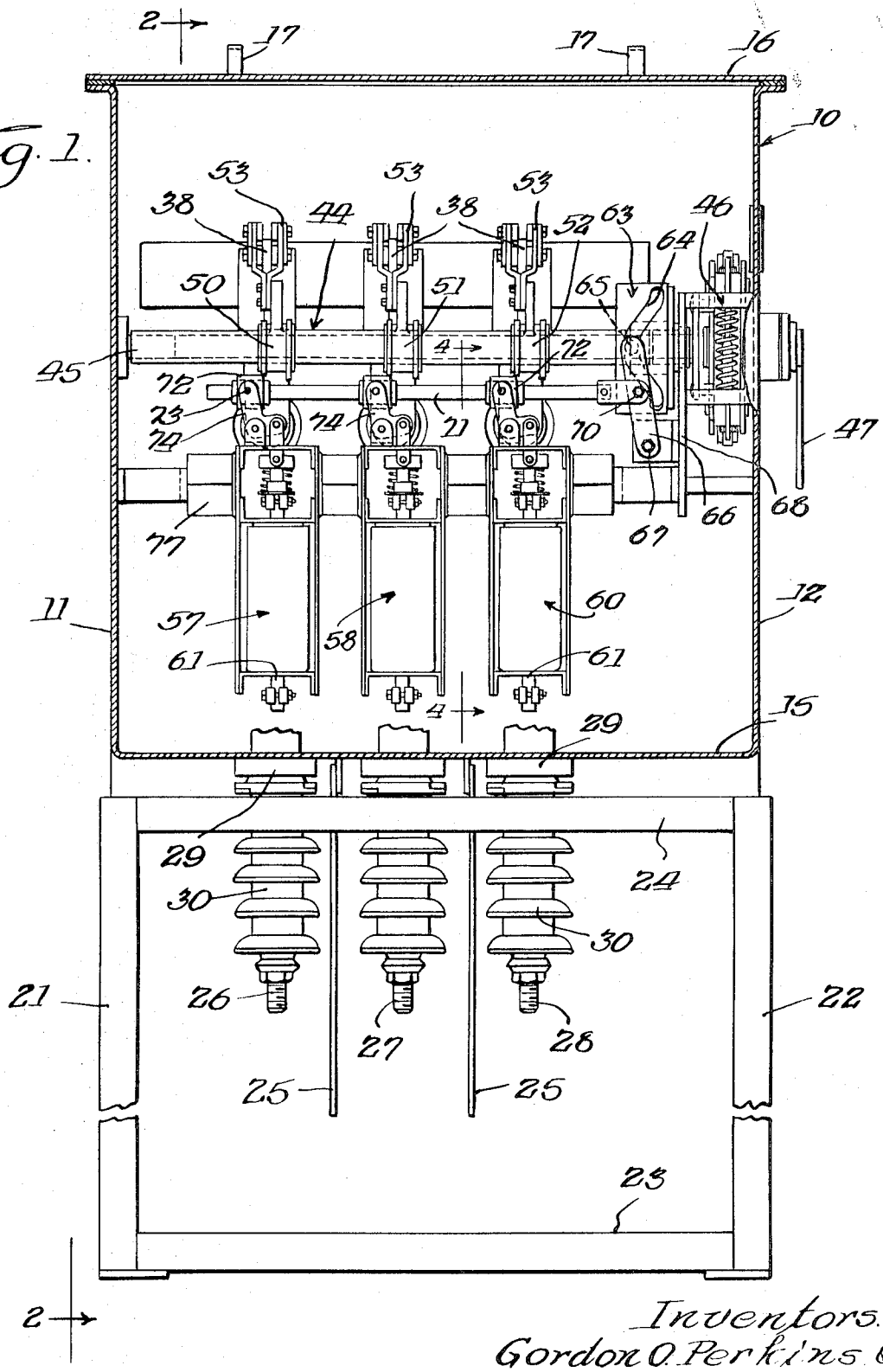

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Fig. 2.

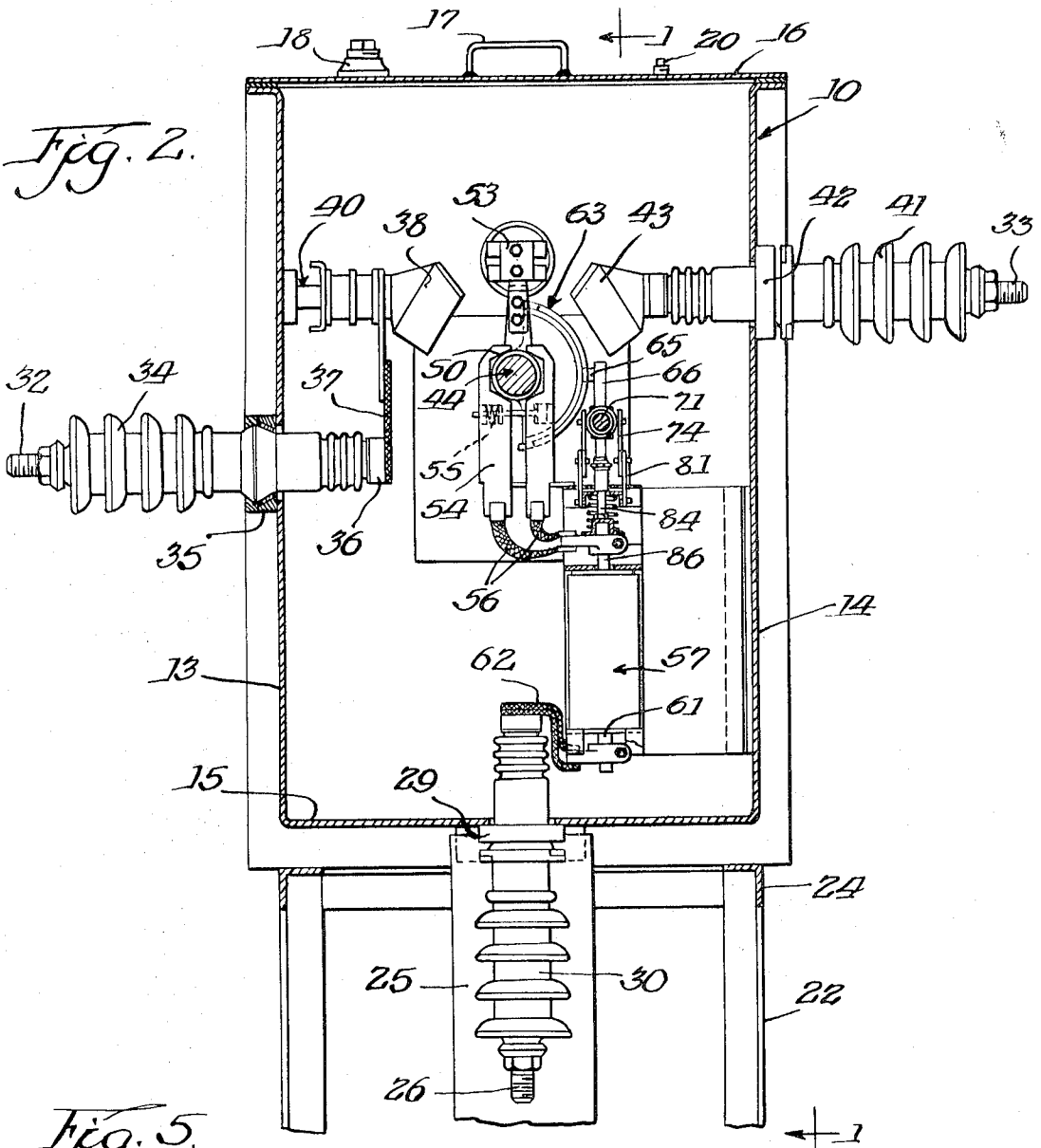

Fig. 5.

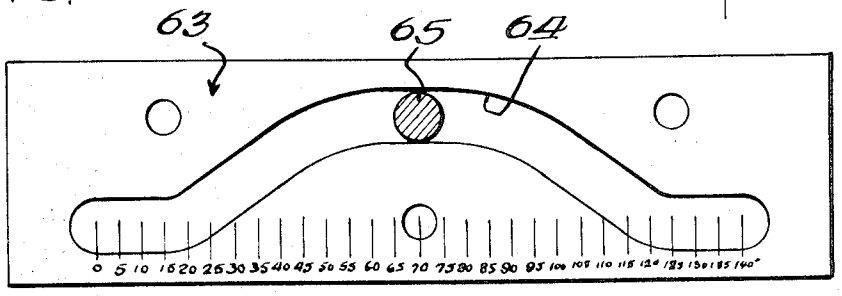

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Fig. 3.

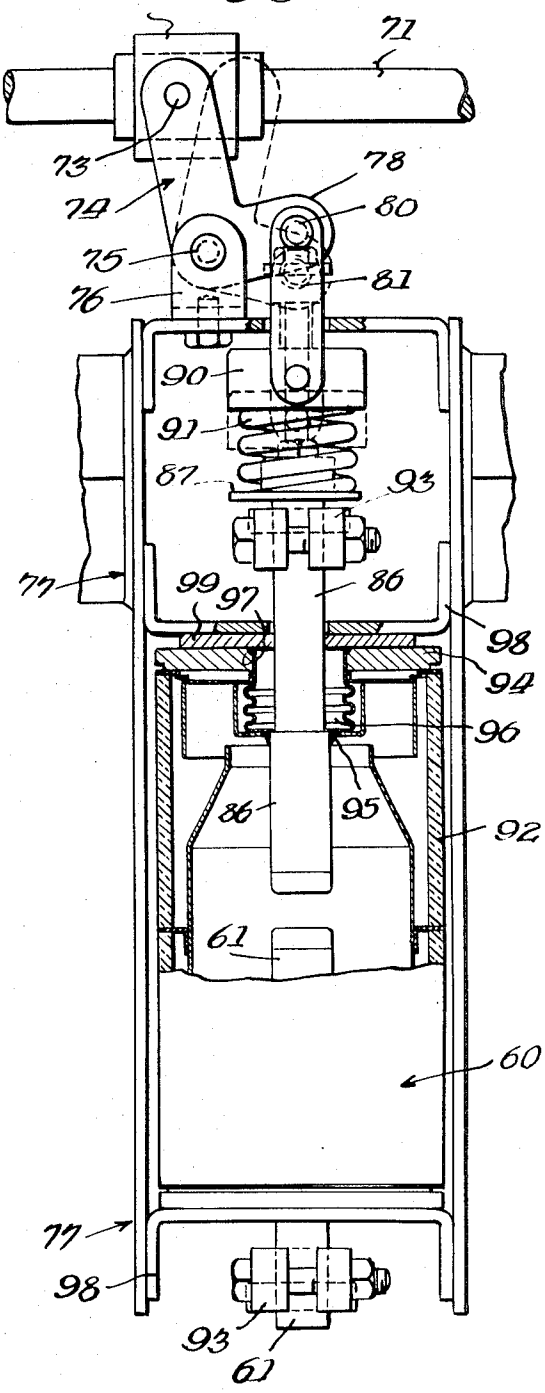
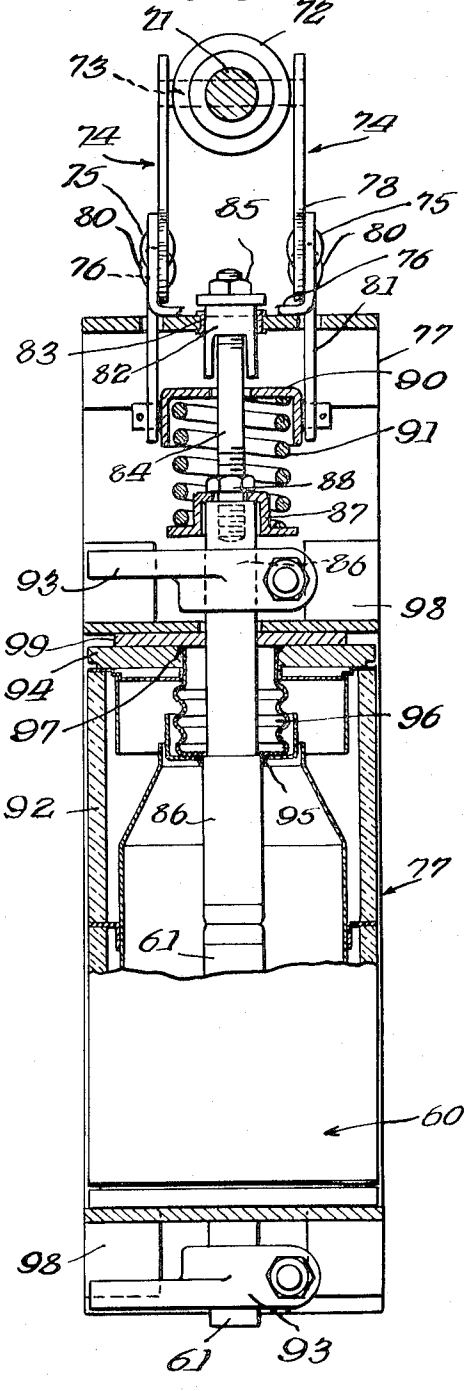


Fig. 4.



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MULTIPLE POSITION VACUUM INTERRUPTER SWITCHING DEVICE

The invention relates to actuating mechanism for electric switch structure and has reference more particularly to vacuum switches and to operating mechanism for the movable contacts of said vacuum switches and which will be programmed with respect to a selector switch having opening and closing movement in an insulating medium.

The operating and programming mechanism of the invention is designed to actuate the contacts of a vacuum switch and the contacts of a selector switch in a predetermined sequence. When opening, the vacuum switch will open first so as to interrupt its specified load. The selector switch will then open an amount which will give a second insulating gap in series with the vacuum switch contacts. When closing, the selector switch will close before the vacuum switch so that the actual completion of the circuit is accomplished by the vacuum switch.

The above programmed operation results in all the arcing associated with the interruption and closing of the various switch contacts being accomplished in a vacuum rather than in an insulating fluid. Arcing in a fluid is undesirable since the arcing causes thermal expansion of the surrounding insulating medium which in turn causes pressure surges and a pressure buildup in the tank. Also arcing in an insulating fluid is further undesirable because of the breakdown of the insulating medium, the components may be conductive, poisonous or flammable. A majority of the insulating dielectric fluids in which the interruptions are made are themselves flammable. Confining and restricting the arcing to a sealed vacuum space permits the use of flammable fluids without the danger of said fluids igniting, as well as the use of nonflammable fluids and air.

A further object of the invention is to provide operating mechanism for the contacts of a vacuum switch which are connected in series with the contacts of a selector switch, wherein a multiposition operator causes rotation of the selector switch contacts and wherein a cam converts a portion of the operator output into linear motion to operate the contacts of the vacuum switch.

With these and various other objects in view, the invention may consist of certain novel features of construction and operation, as will be more fully described and particularly pointed out in the specification, drawings and claims appended thereto.

In the drawings which illustrate an embodiment of the device and wherein like reference characters are used to designate like parts:

FIG. 1 is a front elevational view of switch structure for a three phase alternating current circuit and which embodies the improvements of the invention;

FIG. 2 is a side elevational view of the switch structure shown in FIG. 1 taken substantially along line 2–2 of FIG. 1;

FIG. 3 is a fragmentary front elevational view, parts being shown in section, of the actuating mechanism for the movable contact of the vacuum switches;

FIG. 4 is a fragmentary side elevational view taken substantially along line 4–4 of FIG. 1 and showing the actuating mechanism of FIG. 3; and

FIG. 5 shows a developed view of the cam which controls the programming of the contacts of the vacuum switches.

The switch structure which has been selected for illustrating the invention is shown in FIGS. 1 and 2 as suitably located within a container or housing 10, the same essentially consisting of end members 11 and 12, side members 13 and 14, a bottom supporting member 15 and a top member 16. The top member is provided with a handle 17, a plug 18 which closes the opening for filling the container and a second smaller plug 20 for closing a vent opening. The container 10 is supported by a built-up supporting frame which includes the front and rear standards 21 and 22, the bottom frame members 23 and the top frame member 24. The baffle plates 25 depend downwardly from the bottom wall 15 and the said plates have

a location between adjacent terminals 26, 27 and 27 and 28 which in turn are adapted for electrical connection to the three phases respectively of an alternating circuit to be controlled by the present switch structure. The terminals extend through the bottom wall 15 and into the container being held in place by the member 29. Also the terminals are insulated in the usual manner by the insulators 30 which, of course, insulate the current carrying terminals from the container walls.

Additional terminals are also associated with the container 10 such as the terminals 32 for electrical connection to one feeder line and the terminals 33 for electrical connection to a second feeder line. The terminals 32 are insulated by the insulators 34, the said insulators and terminals passing through the sidewall 13 and into the container. The gasket device 35 serves to seal the insulated terminals in place. Within the container the terminals 32 are provided with a contact block 36 in electrical connection with the conductor 37 which thus connects the terminals 32 with the stationary switch contacts 38. The contacts 38 are fixed to the sidewall 13 by the member 40 and thus the stationary contacts extend inwardly of the container for coaction with the movable contacts to be presently described.

The terminals 33 are insulated by the insulators 41 and the units are fixed to the sidewall 14 and sealed by the members 42. Accordingly the insulated terminals 33 pass through wall 14 to extend within the container and provide the stationary contacts 43.

The main operating shaft of the switch structure is indicated by the numeral 44 as best shown in FIG. 1, and said shaft extends longitudinally of the container 10 being journaled for rotation in the end walls 11 and 12. The member 45 at the left hand end of FIG. 1 functions to journal this end of the main operating shaft. At the right hand end the shaft is operatively connected to a spring energized switch operator 46 wherein energy is stored in a spring system and released at a point where the stored energy is sufficient to satisfactorily rotate the main operating shaft 44. A type of spring energized switch operator which has been found to be highly successful is disclosed and claimed in the pending application of William S. Kovats, Ser. No. 538,851, filed Mar. 30, 1966 and entitled Spring Energized Switch Operator with Roller Type Stop and Release Elements. By actuation of the handle 47 the operator can store energy in the spring operator in either a clockwise or a counterclockwise direction of rotation and which is automatically released for rotating the shaft 44 for closing or opening the switch contacts.

The main operating shaft 44 is formed of any suitable insulating material and has mounted thereon in spaced relation a group of three metal collars such as 50, 51 and 52, each metal collar providing a movable contact 53 for coaction respectively with its stationary contacts 38 and 43 which extend inwardly from the sidewalls 13 and 14 in alignment therewith. The collars are fixedly mounted on the shaft 44 and each collar is in electrical connection with a current transfer clamp 54 which is spring energized at 55 and has the conductors 56 extending from its lower end. The conductors 56 electrically connect the clamp and thus its respective movable contacts 53 to a vacuum switch such as 57, 58 and 60, FIG. 1. The fixed stationary electrode 61 of each vacuum switch is connected by the conductors 62 to one of the terminals 26, 27 or 28. Accordingly it will be understood that for the three phase switch of FIG. 1, the terminal 26 is electrically connected to the vacuum switch 57 and which is in turn connected by the conductors 56 and a current transfer clamp 54 to its respective collar 50 and to a movable contact 53. The terminals 27 and 28 are connected in a similar manner through the vacuum switches 58 and 60 respectively.

When the spring energized switch operator 46 is actuated in the required direction the movable contacts 53 will be given snap action to contact the stationary contacts 38 whereby the respective phase terminals 26, 27 and 28 are connected through the vacuum switches with the terminals 32 comprising one of the feeder lines controlled by the present switch struc-

ture. When the spring energized switch operator is actuated in a reverse direction the movable contacts 53 can be closed on the stationary contacts 43 which comprise another feeder line that can be controlled by the switch structure. As an alternative these fixed terminals 43 can be used for grounding terminals 26, 27 and 28.

It will be understood that the switch structure within the container 10 is immersed in an insulating medium such as insulating oil. Since it is not desirable to have arcing take place in the insulating medium the invention provides the vacuum switches and also provides a cam system for converting the rotary motion of the shaft 44 into linear motion for actuating the movable contacts of the vacuum switches. As a result, the selector switch contacts such as 53 and 38 will close before the contacts of the vacuum switches close. Also on opening, the vacuum switches will open first and then the movable contacts 53 will open with respect to the stationary contacts 38. The selector switch performs the function of placing a visible break in the circuit as evidence of an open circuit.

The cam system essentially comprises the cam member 63 having the cam groove 64 as clearly shown in FIG. 5. The cam member 63 is suitably mounted on the operating shaft 44 so as to rotate with the shaft. A cam roller 65 is adapted to ride in the groove 64 and said roller is carried by the lever 66 pivoted at 67 to supporting structure 68. The cam groove 64 is symmetrical about a central high point and when the cam roller 65 is located at the high point the movable contacts 53 are open, being disposed vertically midway between the stationary contacts 38 and 43.

The lever 66 is pivotally connected at 70 to an auxiliary shaft 71 which extends substantially parallel to the main operating shaft 44 and is adapted to move in an axial direction as the lever 66 is oscillated by the cam member 63. The shaft carries a series of three collars 72 which are suitably fixed to the shaft 71 in spaced relation. The pins 73 which project diametrically from the collars serve to pivotally connect each collar to the bell cranks 74. See FIGS. 3 and 4. Each pair of bell cranks are pivotally connected at 75 to the spaced ears 76 which are fixed to and project upwardly from the supporting structure 77. The said supporting structure 77 in turn supports the vacuum switches 57, 58 and 60 from the sidewalls 11 and 12. The ends 78 of the bell cranks are pivotally connected at 80 to the depending metal links 81. When the main operating shaft 44 is rotated in either direction from the open position shown in FIG. 2, the cam member 63 is rotated to cause oscillating movement of the lever 66 and reciprocating movement of the auxiliary shaft 71. The initial movement of the auxiliary shaft will be a reciprocation of the shaft in a direction towards the right and thus the bell crank levers 74 are oscillated in a clockwise direction to cause a lowering of the links 81. This lowering movement of the links and their subsequent lifting is employed to effect closing and opening of the movable electrode of the vacuum switches all in a manner which will now be described.

The supporting frame structure 77 for the vacuum switches 57, 58 and 60 is apertured in its top wall so that the links 81 will pass through to depend below as shown in FIGS. 3 and 4. Additional openings are provided for the stud guides 82 and which are free to move vertically by reason of the bearing 83. The metal stud 84 is received by a guide and the lower end of the stud is threaded or otherwise fixedly secured to the movable contact 86 of one of the vacuum switches and which coacts with a stationary contact 61 previously referred to. The lower spring seat 87 has telescoping relation on the stud 84 and the spring seat rests on the contact 86, being retained in place by the nut 88. The depending ends of the links 81 engage the ears of the top spring seat 90 and the coil spring 91 is confined under compression between the top spring seat 90 and the lower spring seat 87.

The ceramic or glass envelope of vacuum switches 57, 58 and 60 is indicated by numeral 92, and is sealed at respective ends by end headers. At the base end the stationary contact 61 extends through the bottom end header, being sealed by a metal to metal brazed joint, and the contact is electrically connected to a power conductor 62 by the clamp 93. At the top end the envelope is sealed by the top end header 94. The movable contact 86 enters the vacuum bottle and is sealed via a brazed joint 95 to the lower end of the bellows 96. The bellows are sealed at their top end to the top end header at 97. The top and bottom end headers are fixed to the top and bottom supporting brackets 98 via stud fasteners which are fixed to the end headers. Insulating supporting members 77 offer mechanical support between the top and bottom end headers and supporting brackets, augmenting, and thereby protecting, the mechanical support of the ceramic to metal seals. Without this extra support the ceramic to metal seals could be overstressed by the forces necessary between contacts 86 and 61.

At the top end of the vacuum bottle the bearing plate 99 retained between the top end header and the top supporting bracket has relief holes to permit the free flow of fluid into and out of the non-evacuated bellows cavity during closing and opening of contact 86. The contact 86 is accordingly movable with respect to the stationary contact 61 and the contact is electrically connected in circuit by the power conductor 56 which is fixed to the contact by the clamp 93. The required vacuum is maintained within the glass container 92 by the metal bellows 96.

It will be understood that the shape of the cam groove 64 is such as to give the desired programming to the movable contacts of the vacuum switches. As shown in FIGS. 1 and 2, the selector switches contacts 53 are in open position and the movable contacts of the vacuum switches are also in open position, the bell cranks 74 having been oscillated to lift the links 81 and thus the contacts 86 of the vacuum switches are elevated and out of engagement with the stationary contacts 61.

When the main operating shaft 44 is rotated in a counterclockwise direction, FIG. 2, the movable contacts 53 of the selector switch are first caused to engage the stationary contacts 38. Continued rotation of the operating shaft will produce such oscillating movement of the lever 66 as to reciprocate the auxiliary shaft 71 and effect a closing of the vacuum switches. In other words, the links 81 are lowered from their position in FIG 3 until the vacuum switch contacts 86 and 61 meet. Further lowering of the links 81 depresses the upper spring seat 90 causing the full load of the spring to be transferred to the vacuum switch contacts. This load is sufficient to prevent the contacts from "blowing-open" due to electromagnetic force generated when current starts to flow. At the final closed position of FIG. 4, a gap exists between the upper spring seat 9 and the stud guide 82. During continued opening and closing operations of the switch, some contact material is lost from the butt contacts 86 and 61. The movable contacts 86 which are biased downward by spring 91 are permitted to move to reestablish contact by this gap. Closing of the vacuum switches thus takes place after a closing of the selector switches and if any arcing occurs it will take place within the vacuum switches. During counterclockwise rotation starting at 70° of the cam in FIG. 5, the selector switch contacts 53 start rotating immediately, but for the first 5° of travel there is no movement of the vacuum switch contacts. At 65° curvature of cam slot 64 starts and lever 66, driven by pin 65, starts to move the vacuum switch contacts. At 42½ the selector switch contacts 53 first make physical contact with contacts 38. The vacuum switch contacts at this time are still gapped sufficiently so that they will not arc over and conduct current. At approximately 20° the vacuum switch contacts 86 and 61 just make contact. Up to this time spring 91 has been preloaded between restraining members including the upper spring seat 90 which is biased against the stud guide 82, and the lower spring seat 87. At 15° the upper spring seat has moved downward, further compressing the spring and changing its nature from a preloaded cartridge, transferring its force to the vacuum switch contacts. From approximately 20° to 0° the coil spring is compressed and this represents lost motion in

the connection permitting overtravel and a pressure engagement of the contact **86** with contact **61**. The electric circuit from the terminals **26**, **27** and **28** is now closed through the series connected switches to the feeder terminals **32**.

In the opening action of the switch structure a reverse operation takes place. Initial rotation of the main operating shaft will rotate the cam member and through the connecting linkage the links **81** will be elevated. At each end of the cam member **63**, the travel from 0° to 10° on one end and 130° to 140° on the other end represents overtravel which will occur due to the momentum of moving components and flexure of supporting members, and for normal misalignment. Start of rotation, therefore, begins at 10° on the cam. Movement of selector switch contacts commences immediately with initial rotation of the main operating shaft, with contacts **53** sliding along contacts **38**. At 15° the auxiliary shaft **71** and the connecting linkage will start to move, moving the upper spring seat upwards towards the stud guide **82**, reducing the separation between them shown in FIG. **4**. At approximately 20° the gap disappears and the oscillating auxiliary shaft system becomes directly coupled to the moving vacuum switch contact **86**, which subsequently will begin to open.

At 35° the vacuum switch has opened sufficiently to have extinguished the current and establish a vacuum gap between contacts **86** and **61**, sufficient to withstand normal operating and transient switching voltages.

At 42½ the selector switch contacts **53** and **38** start to physically separate causing a visible gap. At 65° both the vacuum switch and selector switch contacts have achieved maximum opening, each able by itself alone to withstand all normal and transient voltages which may appear across the switch. The remaining full travel to 70° moves the contacts **53** to their normal open position. Overtravel from 70° to 75° will not further move the vacuum switch contacts since **65** is in a straight section of cam slot **64**. Thus in the opening action, the electric circuit is first opened in the vacuum switches and then the visible opening takes place in the selector switches.

The invention is not be to be limited to or by details of construction of the particular embodiment thereof illustrated by the drawings, as various other forms of the device will, of course, be apparent to those skilled in the art without departing from the spirit of the invention of the scope or the claims.

We claim:

1. In combination with a source, a first load and at least one selector switch, a vacuum switch for providing a single series circuit between said source, said selector switch and said first load, said selector switch being immersed in an insulating fluid, said selector switch including a main operating shaft having a movable contact for coaction with a first stationary contact when the main operating shaft is rotated, said vacuum switch having a stationary contact within an evacuated hermetically sealed container, said container being immersed in said insulating fluid, and said vacuum switch additionally including a movable contact extending from the exterior to within the sealed container through a bellows for sealing the container against the entrance of atmospheric air, cam means on the main operating shaft, and linkage means including a lost motion connection and a coil spring for resiliently biasing the lost motion connection into extended relation operatively connecting the said cam means with the movable contact of the vacuum switch, said cam means having a configuration for programming the opening and closing of the vacuum switch with respect to the opening and closing of the selector switch whereby the vacuum switch contacts are caused to close after the selector switch contacts close and are opened before the selector switch contacts open.

2. The combination of claim 1 wherein said linkage which operatively connects the cam means with the movable contact of the vacuum switch includes a pivoted lever which is oscillated by the cam means and an auxiliary shaft which is reciprocated by the oscillating movement of the lever.

3. The combination of claim 2 wherein said lost motion connection is connected between said auxiliary shaft and said movable contact of said vacuum switch and wherein said coil spring resiliently biases said elements of said lost motion connection into said extended relation.

4. The combination of claim 1 wherein said selector switch includes a second stationary contact wherein said movable contact is adapted to alternatively coact with said first stationary contact and said second stationary contact when said main operating shaft is rotated.

5. The combination of claim 4 wherein said cam means is programmed whereby said vacuum switch contacts are opened before said movable contact of said selector switch disengages from said first stationary contact and whereby said vacuum switch contacts are close before said selector switch movable contact engages said second stationary contact thereby disengaging said series connection of said source, said first stationary contact and said first load connected thereto and establishing a series connection between said source, said second stationary contact and a second load connected thereto.

6. In combination with a source, a load and a selector switch, a vacuum switch for providing a single series circuit between said source, said selector switch and said load, said vacuum switch and said selector switch each having a movable contact for coaction with a stationary contact respectively for closing and opening the said switches, operating means for actuating the switches individually and in a predetermined sequence, said operating means including a main operating shaft mounted for rotation and having the movable contact of the selector switch fixed thereto, an auxiliary shaft supported for reciprocating movements in a direction substantially parallel to the axis of rotation of the main operating shaft, cam means on the main operating shaft, a connecting lever between the cam means and auxiliary shaft for reciprocating the auxiliary shaft as the main operating shaft is rotated, and linkage connecting the auxiliary shaft with the movable contact of the vacuum switch, said cam means having a configuration for obtaining said predetermined sequence in the actuation of the said switches, whereby the movable contact of the vacuum switch is caused to close after the movable selector switch contact closes and is opened before the movable contact of the selector switch is caused to open.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,571,543 Dated March 23, 1971

Inventor(s) GORDON O. PERKINS and HOWARD E. SWANSON

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 30, "switches" should read --switch--:

Column 4, line 50, "9" should read --90--.

Column 6, line 29, "close" should read --closed--.

Signed and sealed this 2nd day of November 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patents