Feb. 22, 1966 G. N. LESTER 3,236,978

ARRANGEMENTS IN POLYPHASE MODULAR VACUUM SWITCHES HAVING COMMON OPERATING MEANS

Filed April 2, 1962

3 Sheets-Sheet 1

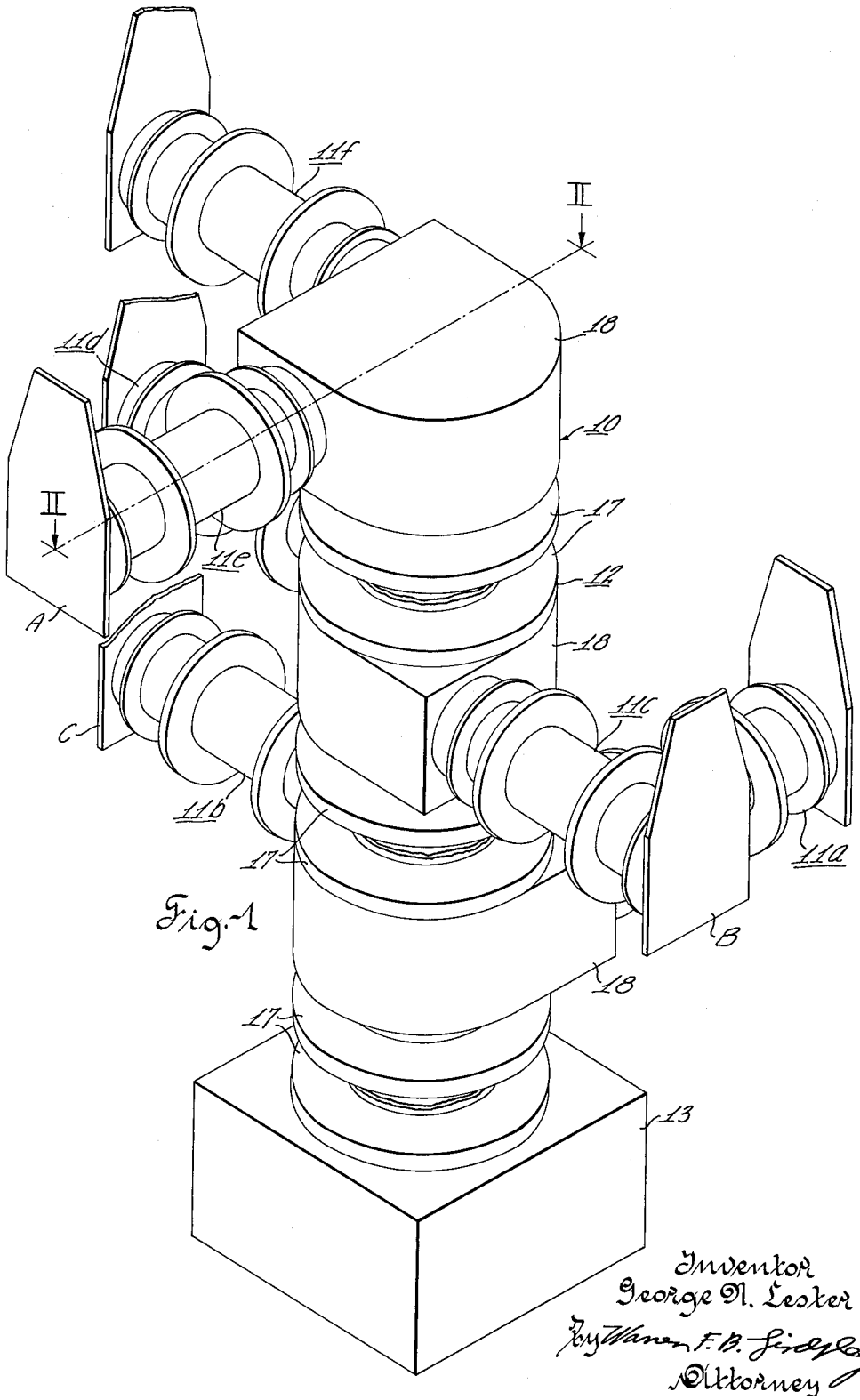

Fig. 1

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3 Sheets-Sheet 2

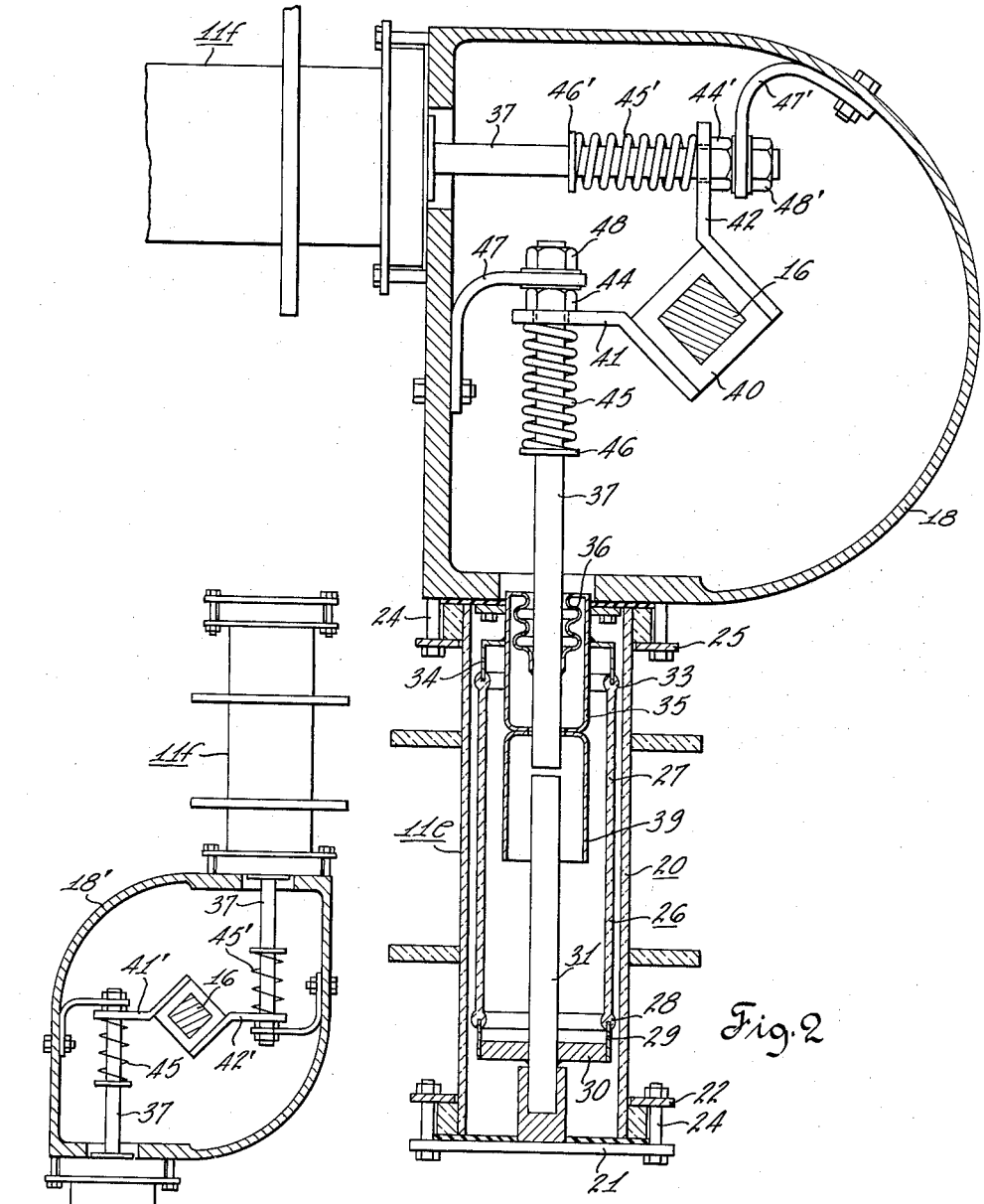

Fig. 2

Fig. 6

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Filed April 2, 1962 3 Sheets-Sheet 3

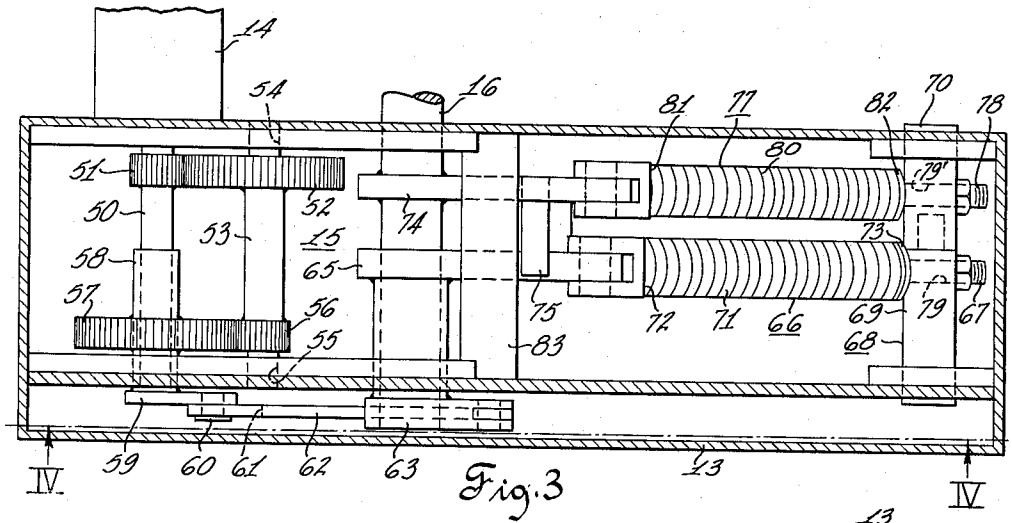

Fig. 3

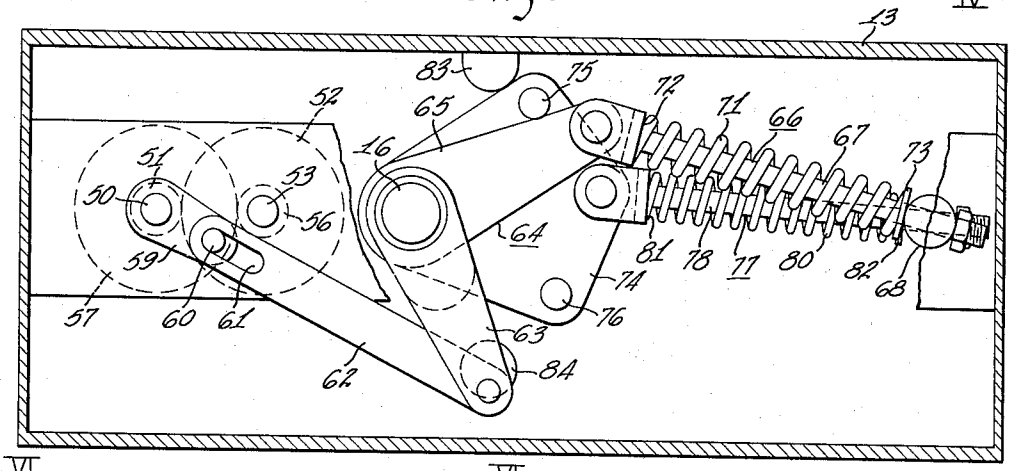

Fig. 4

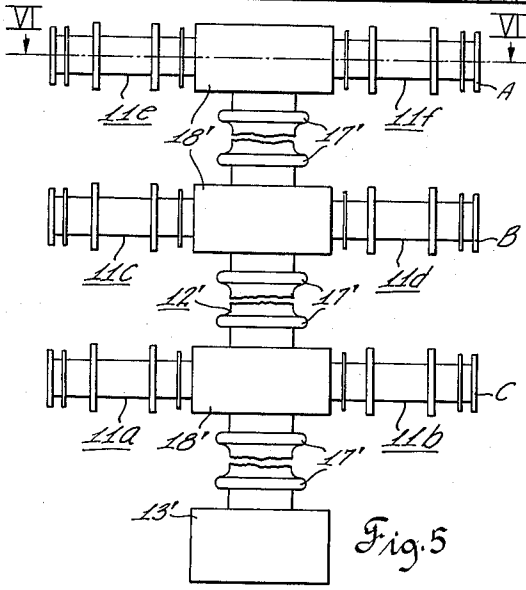

Fig. 5

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ARRANGEMENTS IN POLYPHASE MODULAR VACUUM SWITCHES HAVING COMMON OPERATING MEANS

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4 Claims. (Cl. 200—144)

This invention pertains to electric circuit breakers and more particularly to polyphase circuit breakers utilizing a plurality of vacuum switch modules arranged for actuation by a common operating means.

In accordance with the invention claimed, a new and improved polyphase circuit breaker structure is provided comprising a plurality of circuit interrupting devices wherein at least one of the devices is employed in each phase of the circuit. Each of the devices is mounted within a vacuumized envelope and comprises a pair of cooperating separable contacts. One of the contacts of each of the pairs of contacts is supported for movement in directions inwardly and outwardly of the envelope. Means common to all of the phases of the polyphase circuit breaker structure is provided for operating the movable contacts.

The principal object of this invention is the provision of an improved multiphase circuit breaker structure for effecting synchronous operation of all of the contacts of all of the interrupting devices in all of the phases of the electric circuit.

Another object of this invention is to provide a new and improved vacuum type circuit breaker structure comprising a plurality of pairs of cooperating arcing contacts arranged in electrical and spatial arrangement on a common insulating column.

A further object of this invention is to provide a new and improved vacuum type circuit breaker structure comprising a plurality of pairs of cooperating contacts wherein the modules of each phase of the polyphase circuit are separately but simultaneously interrupted by a common actuating means.

A still further object of this invention is to provide a new and improved circuit interrupting structure including in electrical and spatial relation one or more movable contacts in one or more vacuumized envelopes wherein the movable contacts of each phase of a polyphase circuit are adapted to be operated through the intermediary of a common rotating insulating structure.

A still further object of this invention is to provide a new and improved vacuum type circuit interrupting device employing a plurality of modules in spatial series relationship for each phase of a polyphase circuit breaker structure wherein the contacts of the devices of each phase are supported for movement in opposed directions.

A still further object of this invention is to provide a new and improved polyphase circuit breaker structure wherein a plurality of circuit interrupting devices each operable within a vacuum are mounted on a common insulating column and each of the devices in each phase are mounted at the same distance from the base of the column.

A still further object of this invention is to provide a new and improved polyphase circuit breaker structure employing a plurality of vacuum switch interrupting devices arranged on a single column wherein the devices are arranged to extend transversely from the insulating column.

A still further object of this invention is to provide a polyphase circuit breaker structure employing a plurality of vacuum type circuit interrupting devices wherein the devices of each phase have their longitudinal axes arranged transversely to each other.

A still further object of this invention is to provide a new and improved polyphase circuit breaker structure employing a plurality of vacuum type circuit interrupting devices mounted on a single insulating column wherein the devices of each phase are arranged with their longitudinal axes in parallel planes.

A still further object of this invention is to provide an improved vacuum type circuit breaker structure for interrupting circuits having a very high operating voltage which is simple, reliable in operation and relatively inexpensive to manufacture.

Objects and advantages other than those described above will be apparent from the following description when read in connection with the accompanying drawings in which:

FIG. 1 is an isometric view of a vacuumized polyphase circuit breaker structure mounted on a common insulating column and operated by a rotary actuating mechanism and embodying the invention;

FIG. 2 is a partial cross sectional view of one phase of the polyphase circuit breaker structure shown in FIG. 1 taken along the line II—II;

FIG. 3 is a side view of the rotary actuating mechanism shown in the base of the column of the structure illustrated in FIG. 1;

FIG. 4 is a bottom view of FIG. 3 taken along the line IV—IV;

FIG. 5 is a modification of the structure shown in FIGS. 1 through 4 wherein the longitudinal axes of the vacuumized circuit interrupting devices of each phase are arranged parallel to each other and at a common distance from the base of the structure; and

FIG. 6 is a cross sectional view of FIG. 5 taken along the line VI—VI.

FIG. 1 illustrates an isometric view of a polyphase circuit breaker structure **10**. Structure **10** comprises a plurality of identical vacuumized circuit interrupting devices **11***a*, **11***b*, **11***c*, **11***d*, **11***e* and **11***f*, wherein like parts are provided with similar reference characters and wherein the vacuum switches or interrupters are mounted on a structural column **12**. Each of the vacuum interrupters of each phase are arranged in series spatial arrangement with their longitudinal axes arranged transversely to each other and to column **12**. The circuit breakers in each of phase A, B and C, as shown in FIG. 1 are arranged in common horizontal planes but different vertical planes. Column **12** is mounted on a base **13** which supports or houses a motor **14** and crank arrangement **15** for actuating an insulating shaft **16** which is mounted for rotation in column **12** as shown in FIGS. 2, 3 and 4. Column **12** comprises a plurality of hollow insulators **17** which are separated from each other by hollow spacers forming metallic casing **18**. The insulators **17** and casings **18** are all mounted in axial alignment for receiving and supporting shaft **16**.

Casing **18** is arranged to have bolted thereto a plurality of interrupting structures in module form. One of the interrupters is shown in FIG. 2 in cross section. Each interrupter may comprise a cylindrical casing **20** closed at one end by a cover **21** bolted by suitable means such as bolts **24** to a flange **22** surrounding cylinder **20** and secured to casing **18** by suitable means such as bolts **24** attaching flange **25** surrounding the other end of cylinder **20** to casing **18**. Cover **21** serves as a means for receiving and positioning one end of a vacuum interrupter structure **26** in cylinder **20** as well as an electrical contact for interconnecting the vacuum interrupters of a given pole structure.

As shown in FIG. 2 the vacuum interrupter structure **26** comprises a cylindrical envelope **27** which may be formed, for example, of a suitable vitreous material. One end of envelope **27** is provided with an annular rim **28** to which is fixedly secured in vacuum tight connection thereto one end of a ring or flange **29**. A metallic cap **30** is sealed throughout its edge to the other

end of flange 29 in the manner shown in FIG. 2. Cap 30 supports a relatively fixed contact 31 which is arranged to extend along the longitudinal axis of envelope 27 and is substantially rigidly supported so as to restrict longitudinal or lateral movement thereof. Cap 30 may support a tubular venting passage (not shown) through which envelope 27 is evacuated and sealed off in the usual way. The opposite end of envelope 27 is provided with an annular rim 33 to which is fixedly secured in a vacuum tight connection one end of a ring or flange 34. A tube or retainer 35 is sealed throughout its rim in a vacuum tight connection to flange 34 in the manner shown. A metallic cylindrically shaped bellows 36 is fixedly secured in a vacuum tight connection at one end thereof to retainer 35. The other end of bellows 36 surrounds and is fixedly attached in a vacuum tight connection to a movable contact 37 which is arranged to extend through retainer 35 into envelope 27 and in cooperating relationship with contact 31.

The relatively movable cooperating contacts 31 and 37 may be made of any suitable material which, for example, may be but is not limited to tungsten or tungsten alloys. As shown in FIG. 2 contact 37 is arranged for longitudinal movement a limited predetermined distance by the contact actuating mechanism comprising motor 14 and the crank arrangement 15 shown in FIG. 3 while being restrained from lateral displacement.

In order to control the arcing products emitted upon separation of the engaging surfaces of contacts 31 and 37 shown in FIG. 2 a cylindrical cup shaped tube or shield 39 is provided around and spaced from contact 37. Shield 39 is arranged to extend beyond the adjacent ends of the contacts so as to surround at least a part of contact 31 when in contact engaging position. Shield 39 may be formed of glass or any suitable metallic or nonmetallic material.

Upon actuation of movable contact 37 in axial contact engaging or contact disengaging direction, bellows 36 deflects, allowing restricted longitudinal movement of contact 37. The required range of movement of contact 37 is very small. With only 3/16 of an inch separation between engaging surfaces of contacts 31 and 37 a current of several thousand amperes at an A.C. voltage of 18,000 can be safely interrupted by each vacuum interrupter element of a pole structure. The interrupter can continuously conduct current of several hundred amperes. Since normal atmospheric pressure tends to expand the bellows into envelope 27, the atmospheric pressure may be utilized to help hold or assist in holding the contacts together in normally closed position or to speedily close the gap between them upon release of an externally applied contact separating force.

Movable contacts 37 of the module comprising vacuum interrupters 11*f* and 11*e* as shown in FIG. 2, extend into casing 18 and are attached to shaft 16. If the module is arranged in a common plane a clamping means 40 having a pair of laterally extending arms 41 and 42 is provided for attaching the movable contacts 37 to shaft 16. Each of the arms 41 and 42 is loosely mounted on contacts 37 and is biased away from the arcing tip end thereof against nuts 44, 44', threadedly mounted on shafts 37, by springs 45, 45'. Springs 45, 45' are axially mounted on shafts 37 and extend between collars 46, 46' on shafts 37 and the arms of clamp 40. Spring type conductor members 47, 47' are attached at one end to shafts 37 between nuts 44 and 48 and between nuts 44' and 48', respectively, and at the other end to casing 18. Members 47, 47' form a dual function of an electrical contact and a spring biasing means acting to aid the atmospheric pressure in normally holding contacts 31 and 37 of the vacuum interrupters in engagement.

Clamp 40 which is fixedly attached to shaft 16 is rotated clockwise as shown in FIG. 2 upon rotation of shaft 16. Rotation of clamp 40 causes arms 41, 42 thereof to press against nuts 44, 44' on the ends of contacts 37 thereby actuating them longitudinally of envelopes 27 to separate the contacts 31 and 37. With the structure shown in FIGS. 1 and 2 the movable contacts of all of the modules comprising vacuum interrupters 11*a* through 11*f* are actuated substantially simultaneously in opposed directions inwardly and outwardly of envelopes 27. The inward and outward movements of the movable contacts of the modules are provided by rotation of shaft 16 by the crank arrangement 15 as shown in FIG. 3.

Shaft 16 is rotated through a sector of a circle. This motion is clockwise with reference to FIG. 4 in order to close the arcing contacts of the modules comprising interrupters 11*a* through 11*f* and counterclockwise in order to open these arcing contacts. The rotation of shaft 16 is accomplished by motor 14 through the crank arrangement 15 shown in FIGS. 3 and 4. Shaft 50 of motor 14 is provided with a gear 51 which is in meshing engagement with a gear 52 mounted on shaft 53. Shaft 53 is parallelly arranged with shaft 50 and is rotatably mounted in fixed bearing surfaces 54 and 55. A gear 56 fixedly mounted on shaft 53 is in meshing engagement with a gear 57 which is keyed to a sleeve 58 which is rotatably mounted on shaft 50. Sleeve 58 has attached thereto a crank arm 59. Crank arm 59 has mounted thereon a pin 60 which engages a slot 61 forming a lost motion connection in a link 62. Link 62 is pivotally attached to a crank arm 63 of crank 64 which is rotatably mounted on shaft 16, as shown. Crank arm 65 forming a part of crank 64 is pivotally attached to a rotatably mounted spring biasing means 66. Spring biasing means 66 comprises a shaft 67 pivotally attached at one end to crank arm 65 and reciprocally mounted at the other end in an aperture 79 in a shaft structure 68.

As shown in FIG. 3 shaft structure 68 comprises shaft portions 69 and 70 which are relatively movable one to the other. The shaft structure 68 is rotatably mounted at its ends on base 13 of the circuit breaker structure 10. A spring 71 is mounted around shaft 67 and bears against a collar 72 at one end of shaft 67 and a collar 73 slidably mounted on shaft 67 at the other end thereof.

Shaft 16 has fixedly mounted thereon adjacent to crank arm 65 a plate 74 for rotation therewith. Plate 74 is provided with pins 75 and 76 extending transversely therefrom which form limit stops for crank arm 65. A spring biasing means 77 similar to the spring biasing means 66 is attached to plate 74 and shaft structure 68. The spring biasing means 77 comprises a shaft 78 pivotally attached at one end to plate 74 and reciprocally mounted at the other end in an aperture 79' in shaft portion 70 of shaft structure 68. A spring 80 is mounted around shaft 78 and bears against a collar 81 at one end of shaft 78 and a collar 82 slidably mounted on shaft 78 at the other end thereof.

FIG. 4 shows the crank arrangement 15 in the contact open position. Plate 74 is biased by crank arm 65 acting against pin 75 against a stop 83 on the circuit breaker frame structure. As pin 60 is rotated clockwise about its center of rotation by motor 14 link 62 travels to the left and crank 64 rotates clockwise until it engages pin 76. At this point spring 71 is slightly over center with respect to a line between its support at shaft structure 68 and the axis of shaft 16.

The crank arrangement 15 is now ready to snap contacts 31 and 37 closed through actuation of shaft 16, clamp 40 and arms 41 and 42. In the ready to close position spring 71 is fully charged. Since link 62 is provided with a lost motion slot 61, crank 64 is not retarded by pin 60 in its sudden motion to the left. This motion is caused by crank 64 which is driven by spring 71 in the clockwise direction. As crank 64 snaps toward the closed contact position, it is forced against pin 76. Plate 74 in turn is then forced against stop 84 on the circuit breaker structure. Shaft 16, which is fastened to plate

74, on being rotated clockwise transmits the closing stroke to the movable circuit breaker contact **37**. By suitable control switches the control circuit for motor **14** is cut off at or near the end of the crank arrangement's stroke.

As pin **60** is rotated by motor **14** further in the clockwise direction crank **64** rotates counterclockwise. Since the crank arrangement is symmetrical about a line through the support of spring **71** and the axis of shaft **16**, the opening operation is the image of the closing carried out in the counterclockwise direction by crank **64**, plate **74** and shaft **16**.

FIGS. 5 and 6 illustrate a modification of the structure shown in FIGS. 1 through 4 wherein the vacuum interrupters **11***a* through **11***f* are mounted on a column **12'** comprising hollow insulators **17'** separated by casings **18'**. The longitudinal axes of the vacuumized interrupters of each of the phases A, B and C are arranged parallel to each other and at a common distance from the base **13'** of the structural column **12'**. The vacuum interrupters **11***a* through **11***f* are identical to those shown and described for FIGS. 1 through 4 except that they are all arranged in parallel vertical planes. FIG. 6 illustrates a cross sectional view of the structure shown in FIG. 5 wherein the arms **41'** and **42'** are bent from the form shown in FIG. 2 to actuate contacts **37** of the module comprising vacuum interrupters **11***e* and **11***f* in parallel spaced directions longitudinally of vacuum interrupters **11***e* and **11***f*.

Although but a few embodiments of the present invention have been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

Having now particularly described and ascertained the nature of my said invention and the manner in which it is to be performed, I declare that what I claim is:

1. A polyphase circuit breaker comprising at least a pair of interconnected circuit interrupting devices for each phase, each of said devices being mounted within a vacuumized envelope and comprising a pair of cooperating separable contacts, one of said contacts of each of said pairs of contacts being supported for movement in directions inwardly and outwardly of said envelope, a single column insulating means for supporting each of said devices of each of said phases, said devices of each of said phases having their longitudinal axes arranged transversely to each other, and means common to all of said devices for operating said movable contacts.

2. A polyphase circuit breaker comprising at least a pair of interconnected circuit interrupting devices for each phase, each of said devices being mounted within a vacuumized envelope and comprising a pair of cooperating separable contacts, one of said contacts of each of said pairs of contacts being supported for movement in directions inwardly and outwardly of said envelope, a single column insulating means for supporting each of said devices, said devices of each phase having their longitudinal axes arranged in parallel planes, said planes being transverse to the axis of said column, and means common to all of said phases for operating said movable contacts.

3. A polyphase circuit breaker comprising a plurality of interconnected circuit interrupting devices for each phase, each of said devices being mounted within a vacumized envelope and comprising a pair of cooperating separable contacts, one of said contacts of each of said pairs of contacts being supported for movement in directions inwardly and outwardly of said envelope, a single insulating means for supporting said devices of each of said phases in a column, said devices of each of said phases being mounted transversely to each other in a common plane, and means common to all of said devices arranged within said column for operating said movable contacts.

4. A polyphase circuit breaker comprising a plurality of interconnected circuit interrupting devices for each phase, each of said devices being mounted within a vacuumized envelope and comprising a pair of cooperating separable contacts, one of said contacts of each of said pairs of contacts being supported for movement in directions inwardly and outwardly of said envelope, a single insulating means for supporting said devices of each of said phases in a column, said devices of each of said phases being mounted in different vertical planes, and means common to all of said devices arranged within said column for operating said movable contacts.

References Cited by the Examiner

UNITED STATES PATENTS

1,801,736	4/1931	Greenwood	200—144
2,906,841	9/1959	Jennings	200—144
2,917,596	12/1959	Jennings et al.	200—144
3,159,731	12/1964	Luehring	200—144

FOREIGN PATENTS

356,221	9/1931	Great Britain.
599,970	3/1948	Great Britain.

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