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[54] **VACUUM INTERRUPTER WITH SHUNTING MAIN CONTACT STRUCTURE AND SERIES DISCONNECTING CONTACT STRUCTURE**
 9 Claims, 5 Drawing Figs.

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 200/146
 [51] Int. Cl. H01h 9/38,
 H01h 33/12
 [50] Field of Search. 200/144.2,
 146

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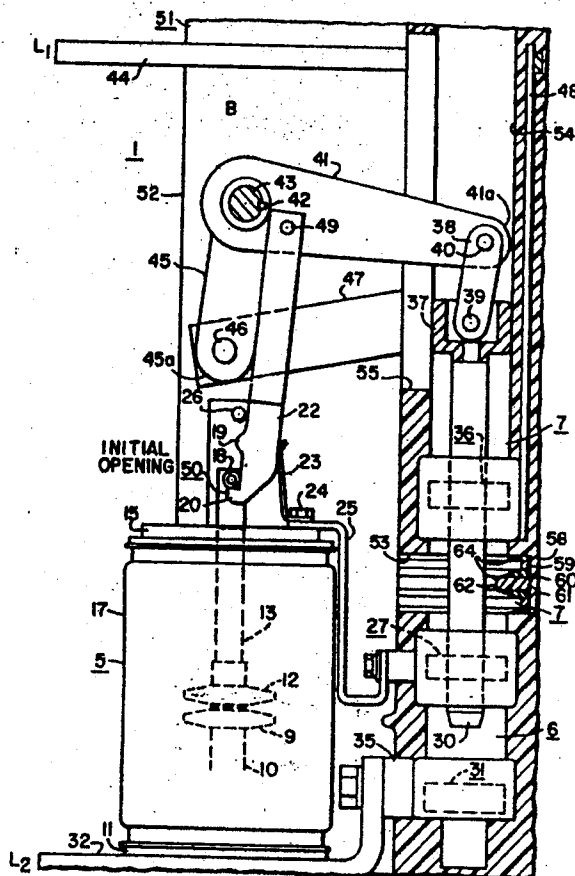
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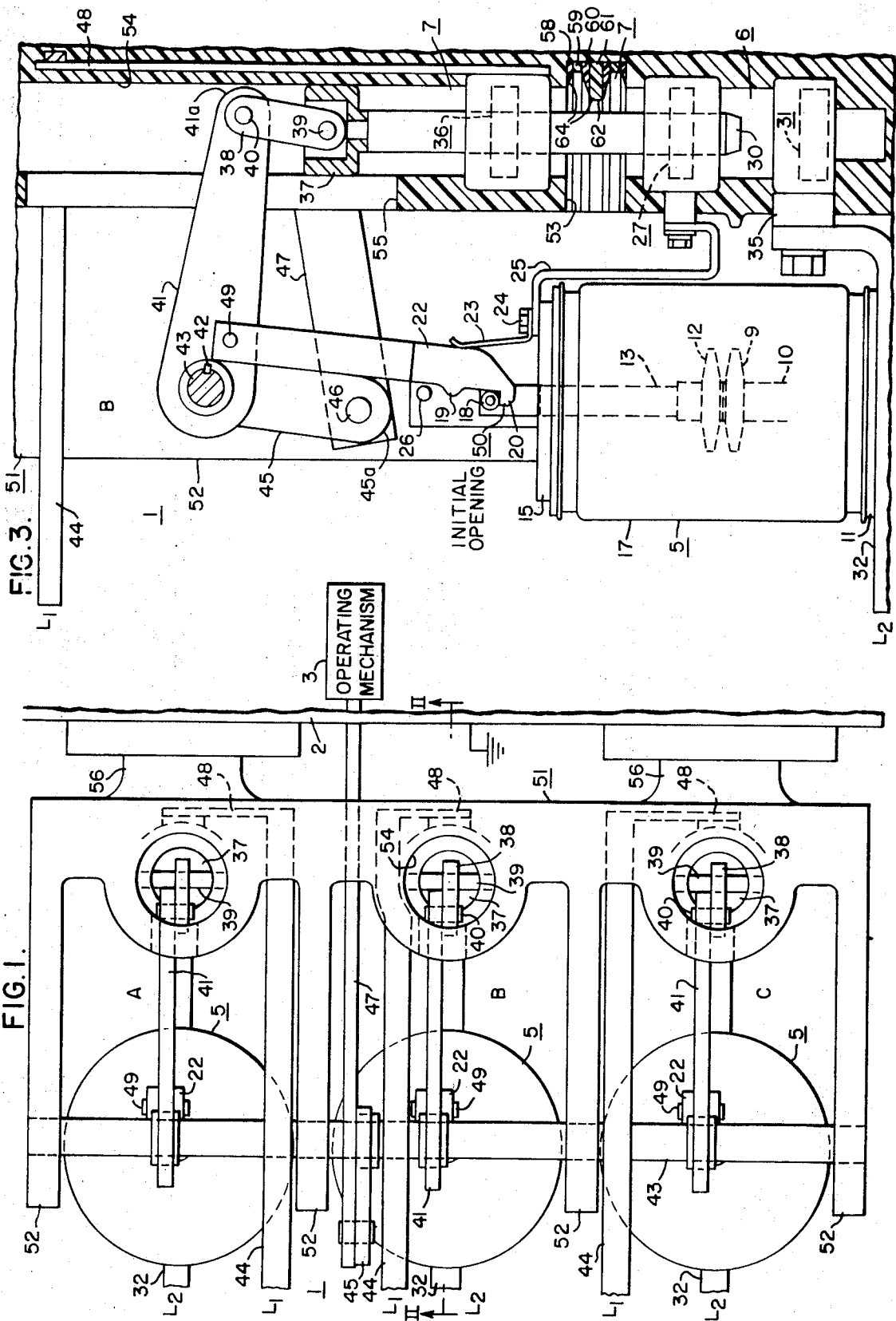
ABSTRACT: A vacuum-type circuit interrupter is provided having an electrically shunting main contact structure, comprising two spaced main stationary contacts associated therewith, and located externally of the vacuum envelope. The spaced main stationary contacts are electrically connected to the opposite terminals of the vacuum interrupter unit.

A movable main bridging contact electrically bridges the two spaced main stationary contacts in the closed-circuit position of the device to carry heavy current loads and to thereby relieve the duty imposed upon the separable contacts of the vacuum interrupter unit. Additionally, the movable main bridging contact separates from one of said two spaced stationary main contacts to provide a series disconnecting gap for more adequately withstanding high voltages in the open-circuit position of the device.

An operating mechanism is provided including a rotatable crank arm having the pivotal point of attachment of the moving contact of the vacuum interrupter unit positioned more closely to the axis of rotation of the crank arm than is the pivotal point of attachment of the movable main bridging contact. This varies the distance of opening travel between the two contacts. A lost-motion connection is provided between the operating link for the vacuum interrupter unit and a member secured to the movable operating rod of the vacuum-interrupter unit. This is released by camming at the end of the opening stroke to permit reclosure of the separable contacts of the vacuum interrupter unit by spring means.

The disconnecting gap may be provided with a plurality of contiguous insulating plates to provide a corrugated internal surface for a greater electrical creepage path across the series disconnecting gap in the open-circuit position of the interrupting device.





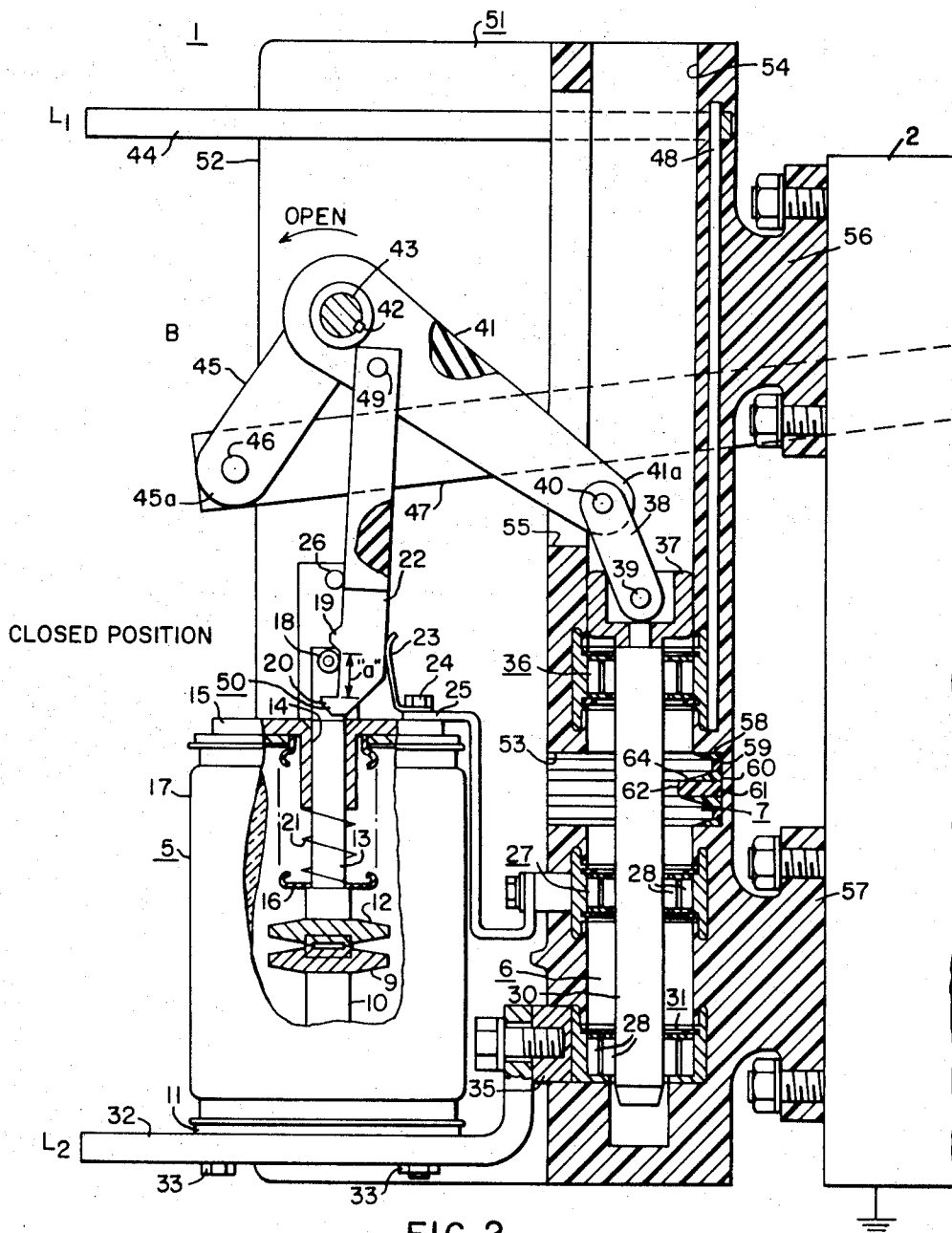


FIG. 2.

WITNESSES

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FIG. 5.

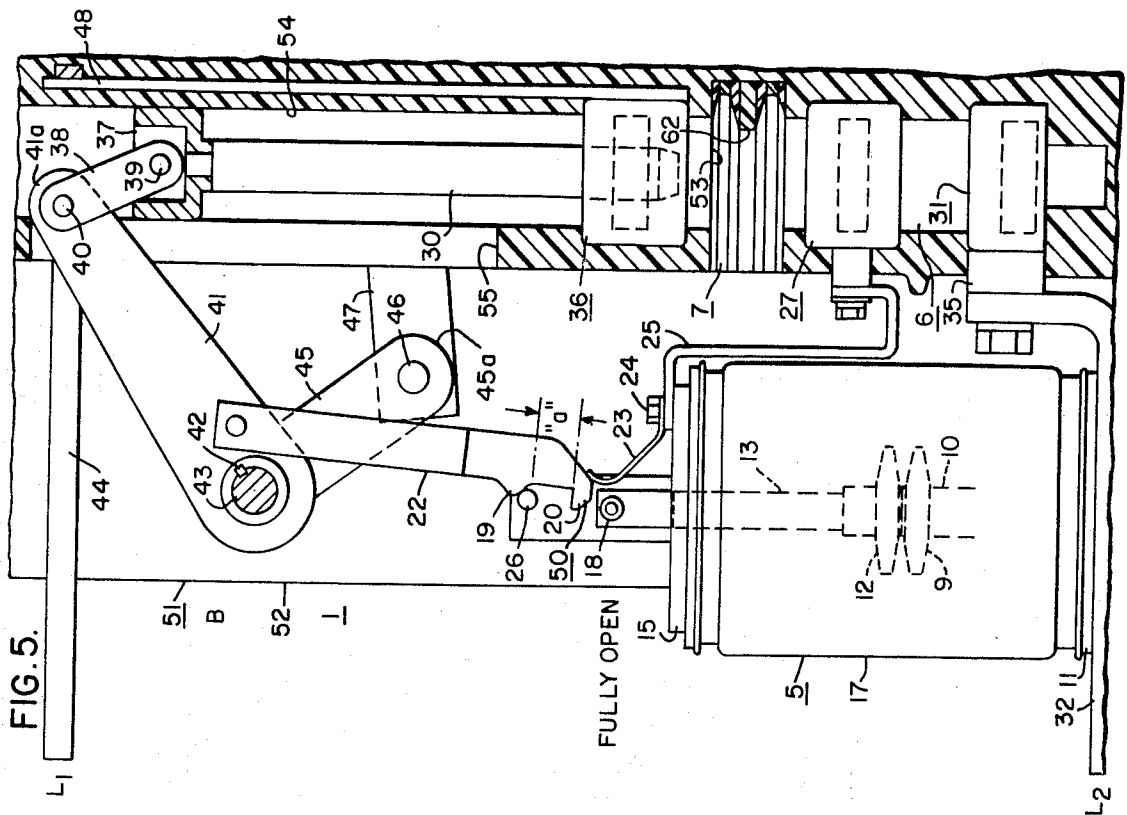
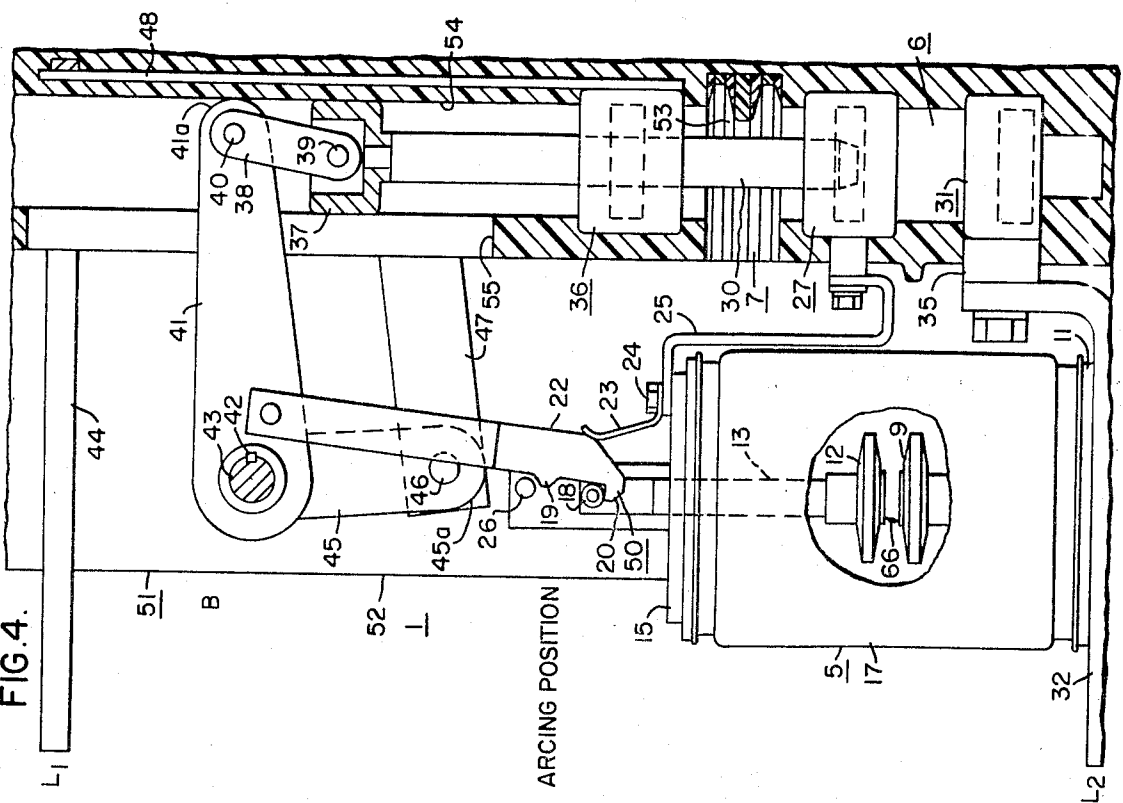


FIG. 4.



VACUUM INTERRUPTER WITH SHUNTING MAIN CONTACT STRUCTURE AND SERIES DISCONNECTING CONTACT STRUCTURE

This invention relates, generally, to vacuum-type circuit interrupters and, more particularly, to vacuum-type circuit interrupters having a shunting main contact structure with a series disconnecting contact structure for more adequately withstanding high voltages.

A general object of the present invention is to provide an improved vacuum-type circuit interrupter capable of carrying heavy currents during the normal operation of the device, and operating effectively to interrupt the circuit, with means for assisting in the withstanding of high voltages during the fully open-circuit position of the device.

In German Pat No. 1,133,785, there is illustrated a vacuum-type circuit interrupter, which includes, besides the main interrupting gap, a parallel interrupting device. The parallel interrupting device is opened in the closed, as well as in the open position of the vacuum interrupter. It is closed only during the switching operation, whereby there is formed a current path with a resistance in parallel to the main interrupting gap. The resistance has the function to prevent the premature interruption of the arc, which causes overvoltages to occur. The main and the parallel interrupting gaps are arranged in a common vacuum enclosure, and are operated by a common mechanism. Accordingly, it is a further purpose of the present invention to improve upon the vacuum-type circuit-interrupting device of the aforesaid German Pat. No. 1,133,785 rendering the same of improved construction, and more capable of carrying relatively heavy currents, while at the same time protecting the contacts of the vacuum device during the closing operation.

The present invention is concerned with a circuit-interrupting arrangement which operates with a vacuum-type device having a parallel interrupting gap, functioning as a main contact structure. However, the present invention is concerned with the problem of substantially increasing the dielectric strength and the current-carrying capacity, as compared with known circuit breakers, without increasing the cost in a corresponding degree. As a result, the parallel interrupting gap in the case of the present invention is not thought of as being provided either for switching of the resistance, or as a part of the vacuum-type circuit interrupter. Furthermore, the invention is distinguished in that the parallel interrupting gap is preferably under atmospheric pressure, as contrasted with being enclosed in a vacuum ambient, and it is structurally united with a series interrupting gap for the vacuum interrupter, the latter also preferably being under atmospheric pressure.

In the case of a circuit-breaker arrangement according to the present invention, the desired current-carrying capacity is obtained by means of the parallel interrupting gap, effectively acting as a main contact structure. The parallel interrupting gap consists, for example, of a stationary contact, which is connected with a terminal of the vacuum interrupter and of a movable contact, which is connected to the other terminal of the vacuum interrupter. Since the parallel interrupting gap is under at least atmospheric pressure, therefore, contrary to known-type circuit interrupters, it is not built into the vacuum interrupter and, therefore, can be operated by simpler means.

On the other hand, the series interrupting gap, functioning as a series disconnecting contact structure, takes care of the increase of the dielectric strength. This takes place in that one contact, for example, the stationary contact, is connected to the junction of the vacuum interrupter and the parallel interrupting gap, while the other, for example movable contact, leads to the line to be controlled by the circuit-breaker arrangement. Also, no considerable additional cost is required for this, because no gastight casing is needed for an interrupting gap under atmospheric pressure. In addition, due to the structural unification of both additional interrupting gaps, and independently of whether these are arranged in the atmosphere, or in a gas under elevated pressure, there is obtained a simple construction, with the result that the increase

of capacity, in comparison with the known vacuum-type circuit interrupters, considerably exceeds the additional complication in structure.

The structural unification can be obtained first by an operating mechanism common to the vacuum interrupting device, and also to the parallel and series interrupting gaps. It is suitable for a circuit-breaker arrangement with an operating crank common to all the interrupting gaps and to coupling the vacuum interrupter more closely to the line of rotation of the crank than the other interrupting gaps. In this way there is obtained advantageously a shorter switching stroke for the vacuum interrupting device, while there is also provided, advantageously, a larger stroke for the parallel and series interrupting gaps.

An especially advantageous realization of the invention has a movable contact common to the parallel and the series interrupting gaps. In this case, the sliding contact of the parallel interrupting gap associated with the movable contact at the same time represents also the stationary contact of the series interrupting gap. The control of the vacuum circuit-interrupting device in this case takes care such that the vacuum interrupting device is opened after the common movable contact has left the stationary contact of the parallel interrupting gap, and it is opened (the circuit interrupted) before the stationary contact of the series interrupting gap has been left by the sliding contact of the parallel interrupting gap.

A further means for the simple structural design utilizing the principles of the invention is obtained by utilizing an insulating body, which contains the parallel and series interrupting gaps, and which, additionally, supports the vacuum circuit-interrupting device. Preferably, the insulating body is made from a casting resin, such as epoxy resin, and thereby relatively complicated forms may be cast at a small cost. In the insulating body can also be located, for example, the rotatable operating shaft common to all three interrupting gaps, so that no large tolerances between the drive, such as the operating mechanism, and the driven parts contained in the insulating body need be considered. The insulating body also can take care of the insulation of the three interrupting gaps to ground. For circuit-breaker arrangements with several poles, it is recommended to provide the insulating body with lateral extensions, which serve as separating shielding walls between the individual pole units.

In accordance with a preferred embodiment of the invention, there is provided a vacuum-type circuit-interrupting device having the end plates thereof electrically connected to the spaced stationary contacts of a shunting main contact structure. The movable main contact of the shunting main contact structure additionally provides the moving contact of a series disconnecting contact structure by a suitable crank arrangement having a linkage provided with a lost-motion connection with the movable contact of the vacuum-type circuit-interrupting device. The arrangement functions such that the main contact structure is first separated while the separable contacts of the vacuum-type device remain closed. Subsequently, following a takeup of the lost motion in the linkage structure, the vacuum circuit-interrupting device opens to interrupt the entire current, and this action takes place prior to the separation of the movable common contact from the stationary contact structure of the series disconnecting contact structure. Finally, the series disconnecting contact structure opens to withstand any voltage surges, and the contacts of the vacuum-type circuit-interrupting device reclose, so that during the closing operation, the closing of the circuit occurs entirely across the contacts of the series disconnecting contact structure.

Further objects and advantages will readily become apparent upon reading the following specification, taken in conjunction with the drawings, in which:

FIG. 1 is a plan view illustrating a three-phase circuit interrupter having three pole units embodying the principles of the present invention, the contact structure being illustrated in the closed-circuit position;

FIG. 2 is a vertical sectional view taken along the line II-II of FIG. 1, the contact structure being illustrated in the closed-circuit position;

FIG. 3 is a view similar to that of FIG. 2, but illustrating the disposition of the several parts during the initial portion of the opening operation;

FIG. 4 is a view similar to FIGS. 2 and 3, but showing a later position of the several parts during the opening operation; and

FIG. 5 is a view similar to FIGS. 2-4, but illustrating the fully open-circuit position of the device, with the vacuum interrupter contacts reclosed, preparatory to a closing operation.

Referring to the drawings, and more particularly to FIG. 1 thereof, the reference numeral 1 generally designates a three-phase circuit interrupter comprising, generally, a mechanism compartment 2 enclosing a suitable operating mechanism 3, not shown. In addition, the circuit interrupter 1 comprises interrupting structure including three individual pole units A, B and C. Each pole unit, for instance pole unit A, includes a vacuum interrupting device 5, an adjacently disposed main contact structure 6 and a series disconnecting switch structure 7. With reference to FIG. 2, it will be noted that the vacuum-type device 5 includes a stationary contact 9 supported on the stationary conducting support 10 electrically and mechanically connect to an end plate 11. Cooperable with the stationary contact 9 is a movable contact 12 actuated by a movable contact-operating rod 13 movable through an aperture 14 in the upper end plate 15 of the vacuum device 5. Preferably, a bellows 16 provides a seal to maintain the vacuum within the evacuated envelope, or casing 17, as well understood by those skilled in the art. It will be noted that the upper end of the movable contact-operating rod 13 has a roller 18 affixed thereto, which may be engaged by abutments 19, 20 integrally formed on a floating operating link 22, which is biased toward the left, as viewed in FIG. 2, by a leaf spring 23 secured by a mounting bolt 24. In more detail, the operating link 22 is biased by the leaf spring 23 to the left, as viewed in FIG. 2 against the roller 18 and at the same time also against a stationary pin 26. As a result, a lost-motion connection 50 of travel distance (FIG 2) is provided.

The mounting bolt 24, in addition, electrically secures a connector 25, such as a strap connection, from the end plate 15 to a sliding stationary contact structure 27 comprising a plurality of circumferential sliding contact fingers 28. As well known by those skilled in the art, the circumferentially disposed contact fingers 28 may be biased radially inwardly by a suitable biasing means, such as by a garter spring, not shown.

Making contacting engagement with the stationary contact structure 27 is a movable main rod-shaped contact 30, which, in the closed position, as shown in FIG. 2, makes contacting engagement with a second stationary contact structure 31, likewise comprising a plurality of circumferentially disposed contact fingers 28. A line-conducting strap 32 may be bolted, as at 33, to the lower end plate 11 of the vacuum device 5, and is connected to a terminal portion 35 of the stationary contact structure 31.

Spaced upwardly from the stationary contact structure 27 is a third stationary contact structure 36, likewise comprising a plurality of circumferentially disposed fingers 28 also making sliding contacting engagement with the movable rod-shaped contact 30. An upper line terminal strap 44 may be secured by any suitable means to a vertical connector strap 48, the latter being electrically connected to the upper stationary contact structure 36.

It will be noted that the upper end of the movable contact 30 has a cylindrical guide 37 affixed thereto, and movable therewith. A floating link 38, preferably of insulating material, is pivotally connected, as at 39, to the upper cylindrical guide 37 and, additionally, makes pivotal connection, as at 40, to the free end 41a of a rotatable crank arm 41 keyed at 42 to a rotatable main drive shaft 43. As shown in FIGS. 1 and 2, the main drive shaft 43 extends across the three pole units A, B and C, and has an actuating crank 45 fixedly secured thereto

to cause the rotation thereof. The free end 45a of the actuating crank arm 45 is pivotally connected, as at 46, to a generally horizontally movable operating link 47, which is connected to the mechanism 3 disposed interiorly of the mechanism compartment 2. The operating mechanism 3 may be of any suitable type, the only requirement being that it effects counterclockwise rotation of the drive shaft 43 during the opening operation, and clockwise rotation of the operating drive shaft 43 during the closing operation.

It will be observed that the floating operation link 22 is pivotally secured to a point 49 more closely positioned with respect to the line of rotation of the main drive shaft 43 than is the point of pivotal connection 40 of the link 38, so that the movable rod-shaped contact 30 moves a greater distance because of the ratio of the pivotal connections 40, 49 on the operating crank arm 41. As a result, the contacts 9, 12 of the vacuum circuit-interrupting device 5 have less travel than the movable rod-shaped contact 30, the purpose for which will appear more fully hereinafter.

A convenient and inexpensive supporting structure for the several parts may be supplied by an insulating body 51 having suitable projections and openings 53 provided therein. Preferably, a suitable casting resin, such as epoxy resin, may be utilized to provide the guide bore 54, the operating slot 55, and the interpole shield plates 52. In addition, the body structure 51 may be suitably configured to provide the supporting legs 56, 57 and the opening 53, in which may be suitably inserted plates 58-61 forming a corrugated, or sinuous internal surface 62 to provide a greater electrical creepage path across the series disconnecting contact structure 7. These ribs are designated by the reference numeral 64, and serve to increase the electrical creepage path when the device 1 is applied on high-voltage circuits.

OPENING OPERATION

During the opening operation, the operating mechanism 3 disposed internally of the mechanism compartment 2, functions to effect counterclockwise rotation of the main drive shaft 43. This movement is effected by the operating link 47 and the crank arm 45. The rotation of the main drive shaft 43 causes simultaneous upward movement of the floating links 22, 38. FIG. 3 indicates the position of the contacts 9, 12 at the point of time in which the lower abutment 20 picks up the roller 18 attached to the upper end of the contact-operating rod 13 of the vacuum interrupting device 5. At this time it will be noted that the contacts 30, 31 have separated within the main contact structure 6, so that the entire burden of opening the circuit is imposed upon the vacuum interrupting device 5. Since this type of device is capable of efficiently opening heavy currents at considerable voltage, the arc 66 (FIG. 4) established is soon extinguished in the evacuated enclosure 17 in a manner well understood by those skilled in the art.

The arrangement is such that the arc 66 is extinguished within the vacuum circuit-interrupting device 5 before the movable contact rod 30 separates from the stationary contact structure 27 of the shunting main contact structure 6. Continued upward movement of the contact rod 30 inserts an isolating gap in the circuit, as shown in FIG. 5, and additionally permits the link 22 to be cammed out of engagement with the roller 18, so that the latter may be free and thereby effect contact reclosure within the vacuum circuit-interrupting device 5. FIG. 5 shows this more clearly. In more detail the shoulder 19 is cammed by the stationary stop pin 26 so that the insulating rod 22 is deflected to the right, as viewed in FIG. 4, against the pressure exerted by the leaf spring 23, and the shoulder or cam surface 20 moves out of the way of the roller 18 so that the vacuum device 5 may reclose under the action of a reclosing spring 21 (FIG. 2) and the bellows 16.

During the closing operation, it will be observed that the circuit is closed between the movable rod-shaped contact 30 and the stationary contact structure 27, so that the contacts 9, 12 provided interiorly of the vacuum device 5 have no closing

duty imposed thereon. Consequently, any shock or shattering is not imposed upon the vacuum circuit-interrupting contacts 9, 12 which were reclosed at the end of the circuit opening operation.

As shown in FIG. 1, the three interrupting gaps A, B and C of the breaker arrangement 1 are structurally connected, not only by the common mechanism 3, 43, but also by the insulating housing 51, so that a compact structure results. Due to the greater resistance across the vacuum circuit interrupter contacts 9, 12, it will be obvious that the current flow in the closed-circuit position of the device will be carried substantially entirely by the shunting main contact structure 6. As a result, the vacuum circuit interrupter contacts 9, 12 do not become unduly warm due to the relatively small current flowing through the vacuum interrupter 5 even at considerable operating current values passing through the circuit-breaker structure 1.

It will be noted during the closing operation that the floating operating link 22 is cammed by the roller 18 and again assumes an operative position, as illustrated in FIG. 2 of the drawings. Any prestriking, therefore, always occurs between the movable contact 30 and the stationary contact structure 27 during the closing operation, since the vacuum contacts 9, 12 have already been closed.

Although there has been illustrated and described a specific structure, it is to be clearly understood that the same was merely for the purpose of illustration, and that changes and modifications may readily be made therein by those skilled in the art without departing from the spirit and scope of the invention.

We claim:

1. A circuit-interrupting device including a vacuum-type circuit-breaker unit having a pair of spaced first terminals and a pair of separable interiorly disposed contacts one of which is movable, a main shunting contact structure shunting said unit and having a pair of spaced stationary main shunting contacts respectively connected at all times to said first terminals of said unit and a movable main bridging contact member electrically bridging said spaced stationary main shunting contacts in the closed position of the device, a series disconnecting contact structure in series with said unit and having one of said spaced stationary shunting contacts which is connected to said one movable contact of the vacuum-type circuit-breaker unit as one of its disconnecting terminals and said movable bridging contact member as another movable disconnecting terminal, and means involving a continuous progressive open-

ing movement of said movable bridging contact member for first opening the main shunting contact structure prior to opening of the vacuum-type circuit-breaker unit and subsequently opening said series disconnecting contact structure.

2. The combination according to claim 1, wherein said last-mentioned means effects reclosure of the contacts of the vacuum-type circuit-breaker unit in the fully open-circuit position of the device.

3. The combination according to claim 1, wherein said last-mentioned means includes a rotatable crank arm, first linkage means connected to said rotatable crank arm and vacuum contacts, second linkage means connected to said movable contact, and the pivotal point of the first linkage means to the axis of rotation being more close than the pivotal point of the second linkage means.

4. The combination according to claim 3 wherein the first linkage means comprises a lost-motion connection.

5. The combination according to claim 1, wherein a cast resin insulating body is used to support the vacuum-type circuit-breaker unit and the main contact structure and the series disconnecting contact structure.

6. In combination, a vacuum breaker unit including separable contacts electrically connected at all times to a pair of stationary main shunting contacts disposed in atmosphere, a movable shunting bridging contact member separable from one of said stationary main shunting contacts and sliding on a second stationary main shunting contact, a disconnecting contact structure in atmosphere in series with said unit and including said movable shunting bridging contact member as one terminal and said second stationary main shunting contact as another terminal, and operating means effecting a continuous opening movement of said main contact member for first providing a gap between said main stationary shunting contacts and then opening the separable contacts of said unit and finally opening said series disconnecting contact structure.

7. The combination according to claim 6, wherein said operating means includes a lost-motion linkage connected to the vacuum-breaker unit to obtain the right sequence of contact opening.

8. The combination according to claim 7, wherein the lost-motion linkage is freed to obtain contact reclosure of the vacuum breaker unit at the end of the opening operation.

9. The combination according to claim 8, wherein a rotatable crank-arm is used having the vacuum breaker linkage closer to the axis of rotation than the movable contact connection.

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