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Mitchell

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[45] **May 28, 1974**

[54] **VACUUM-TYPE CIRCUIT BREAKER WITH IMPROVED ABILITY TO INTERRUPT CAPACITANCE CURRENTS**

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[52] **U.S. Cl.** .... **200/144 B,** 200/146 R

[51] **Int. Cl.** **H01h 33/66**

[58] **Field of Search** .... 200/144 B, 146 R

[56] **References Cited**

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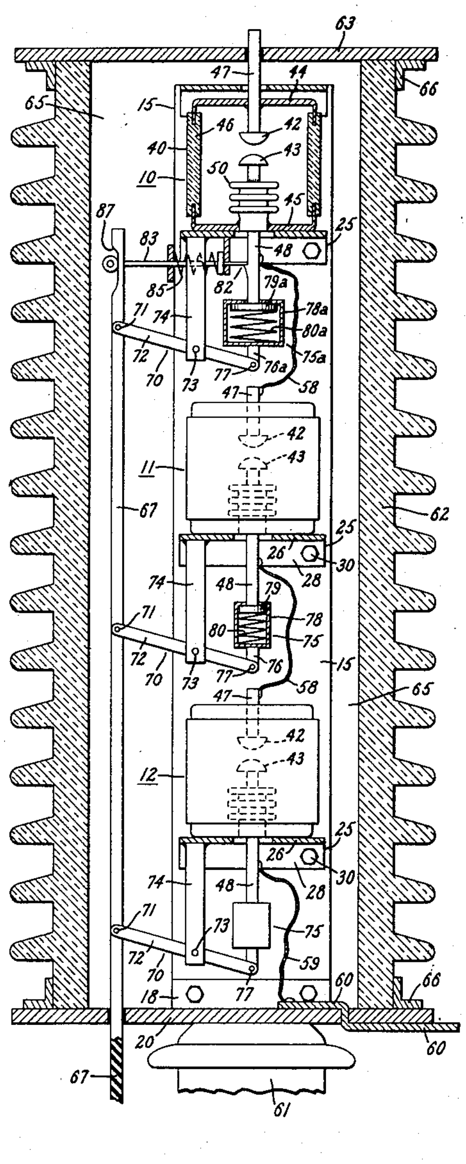
[57] **ABSTRACT**

A multi-break vacuum circuit breaker comprises a plurality of vacuum-type circuit interrupters electrically connected in series. Closing of the circuit breaker is controlled in such a manner that any prestriking that occurs during closing consistently occurs across the contacts of a preselected one or two of the interrupters and not across the contacts of the remaining interrupters, which constitute a majority of the total number of interrupters. This maintains the contacts of the remaining interrupters in good condition for a subsequent opening operation, thereby improving the ability of the circuit breaker to interrupt capacitance currents on such an opening operation.

11 Claims, 4 Drawing Figures



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SHEET 1 OF 2

Fig. 1.

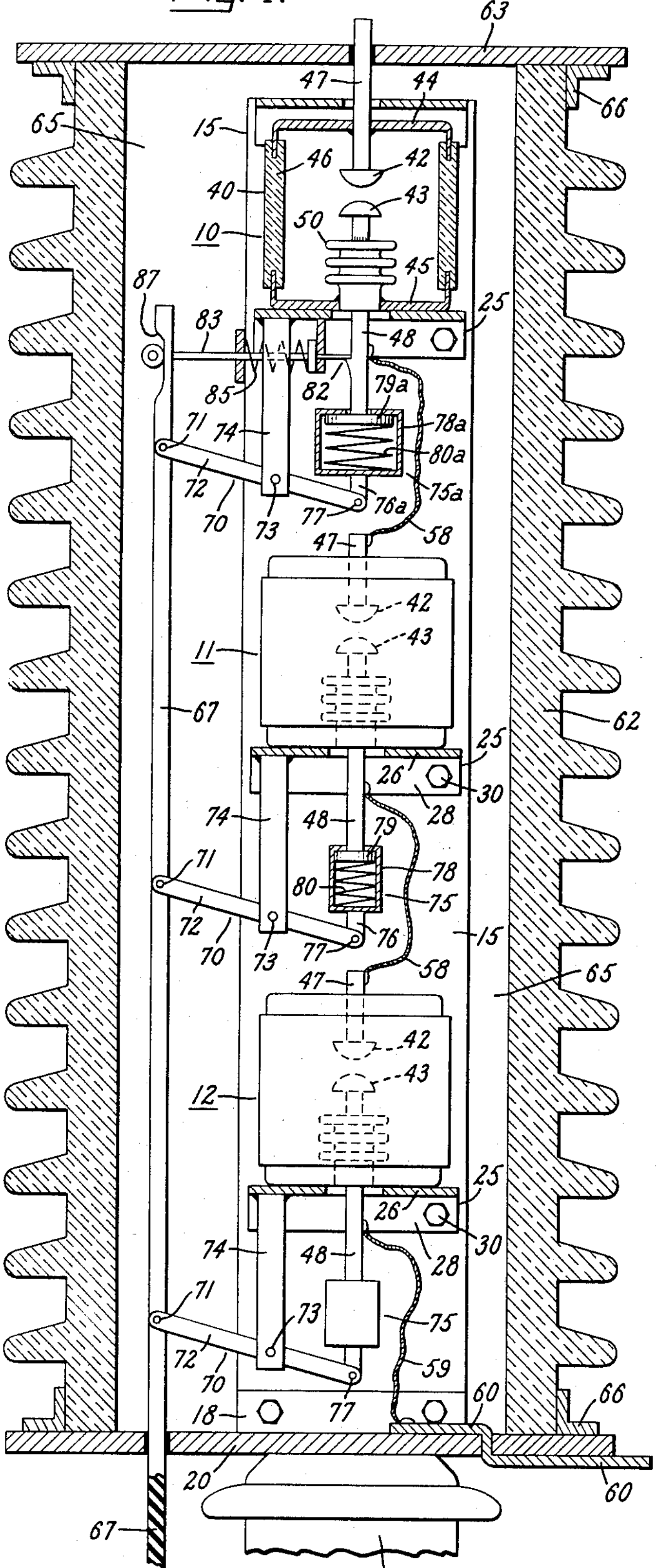


Fig. 2.

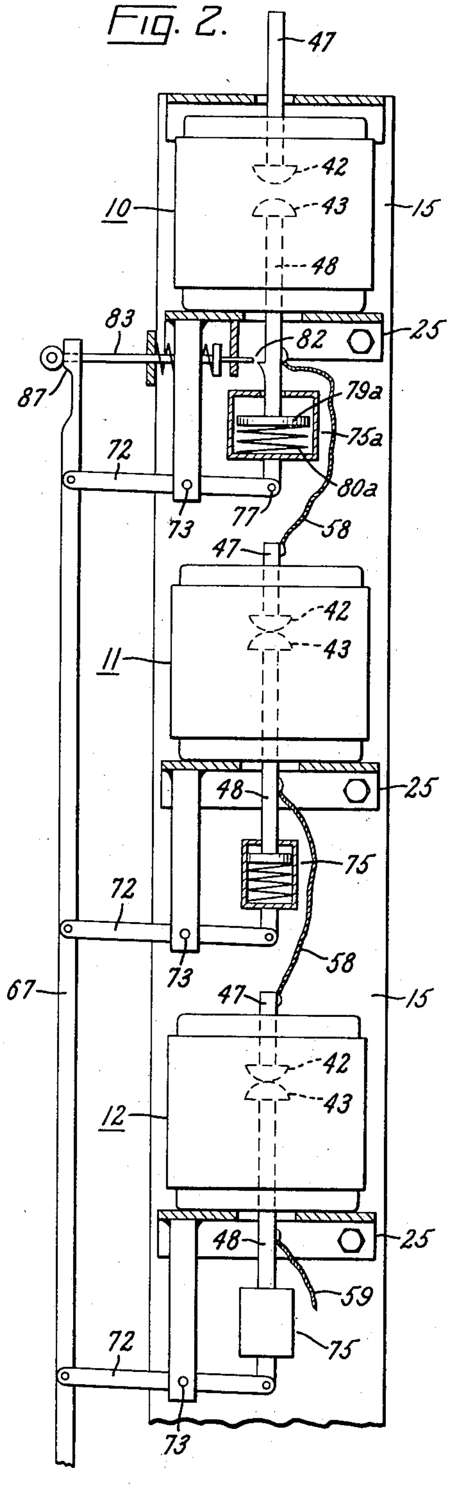


Fig. 3.

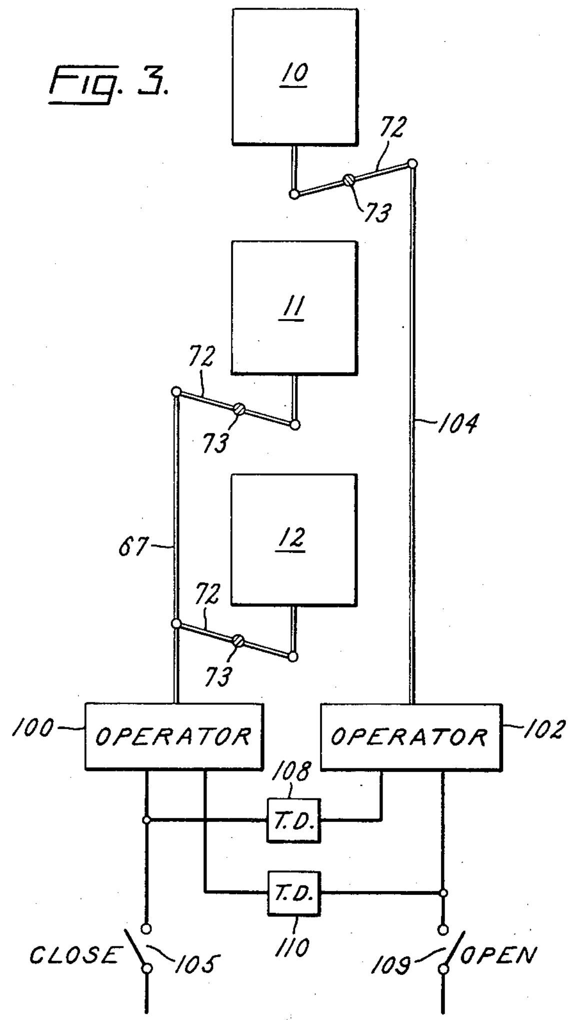
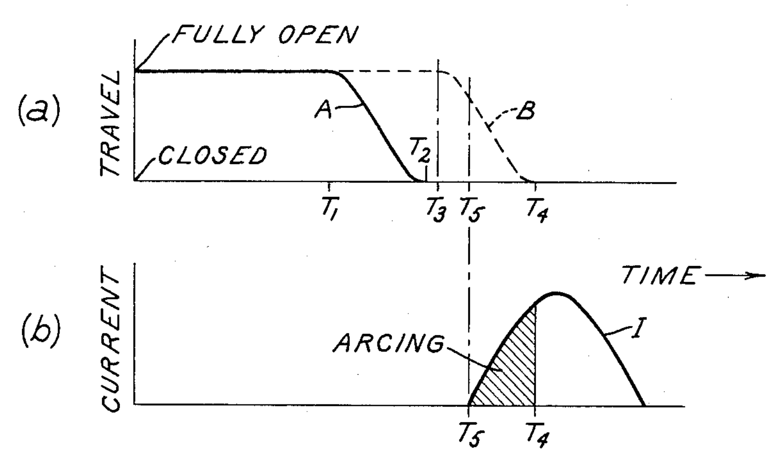

10
11
12
72
73
104
67
100
OPERATOR
OPERATOR
102
108
T.D.
T.D.
110
CLOSE
105
109
OPEN

Fig. 4.


FULLY OPEN
(a)
TRAVEL
A
B
CLOSED
T_2
T_1
T_3
T_5
T_4
TIME
(b)
CURRENT
ARCING
I
T_5
T_4

VACUUM-TYPE CIRCUIT BREAKER WITH IMPROVED ABILITY TO INTERRUPT CAPACITANCE CURRENTS

BACKGROUND

This invention relates to a vacuum-type circuit breaker comprising a plurality of vacuum-type circuit interrupters electrically connected in series and, more particularly, relates to a multi-break vacuum-type circuit breaker that has improved ability to interrupt capacitance currents.

The following references are of interest with respect to this invention: U.S. Pats. Nos. 3,268,696-Lindell; 3,300,609-Flurscheim et al.; 3,560,682-Kohler; 3,562,457-Peek; and 3,594,525-Miller et al.

The most difficult type of duty imposed upon a vacuum circuit breaker frequently turns out to be the interruption of capacitance currents. As is explained in U.S. Pat. No. 2,391,672-Boehne et al., such currents are usually very low compared to fault currents, and the recovery voltage during such interruptions builds up across the contacts rather slowly following clearance at a current zero; but this recovery voltage can rise to a relatively high value of twice normal peak voltage within 180° after such clearance. It is difficult for the inter-contact gap or gaps to withstand such high voltage without a restrike unless the contacts are in a good condition. Whether or not the contacts will be in a good condition during this period depends to a large extent upon the type of closing duty that the contacts had been exposed to immediately prior to the capacitance current interrupting operation. If the contacts had been closed against a high current, there is a good chance that a relatively large weld between the contacts was formed during closing. When the contacts are separated on a subsequent opening operation, this weld will be torn apart, leaving jagged edges or protuberances on the contact surfaces. The presence of these jagged edges and protuberances can materially impair the ability of the inter-contct gap or gaps to withstand the high recovery voltage. If the interrupting operation is a high-current interruption, the high-current arc can burn off the jagged edges and protuberances and prevent their impairing dielectric recovery; but the arc accompanying capacitance-current interruptions is usually a low-current arc that is not very effective in burning off the jagged edges and protuberances.

SUMMARY

An object of my invention is to construct a multi-break vacuum circuit breaker in such a manner that most of its breaks (i.e., inter-contact gaps) will be relatively free of jagged edges and protuberances that interfere with dielectric recovery during the build-up of recovery voltage while interrupting capacitance currents.

Another object is to avoid arcing during closing on a majority of the breaks of a multi-break vacuum circuit breaker and to consistently confine arcing on closing to the remaining break or breaks.

Another object is to provide a multi-break vacuum circuit breaker in which there is an increased opportunity during an interrupting operation to clean up the contact surfaces that had been exposed to arcing and resultant welding during a previous closing operation.

In carrying out my invention in one form, I provide a vacuum-type circuit breaker comprising first and second interrupter means, the first interrupter means comprising a plurality of vacuum circuit interrupters and the second interrupter means comprising at least one vacuum circuit interrupter but fewer than in said first interrupter means. The vacuum circuit interrupters are electrically connected in series with each other, and each comprises a highly-evacuated envelope and a pair of contacts located within the envelope that are relatively movable into and out of engagement with each other. Closing means is provided for driving the contacts of all of the interrupters into engagement to effect closing of the circuit breaker. The closing means is controlled in such a manner that, during closing: (a) all the contacts of the first interrupter means engage prior to the time at which any of the contacts of the second interrupter means engage, and (b) the gap length between the contacts of the second interrupter means at the time all of the contacts of said first interrupter means have reached engagement is sufficiently great as to consistently preclude a prestrike across the contacts of the first interrupter means during a closing operation.

BRIEF DESCRIPTION OF DRAWINGS

For a better understanding of the invention, reference may be had to the following description taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a side elevational view partly in section and partly schematic showing a vacuum-type circuit breaker embodying one form of the invention. The circuit breaker is shown in open position.

FIG. 2 is a side elevational view of a portion of the circuit breaker of FIG. 1, with the parts in a position through which they pass during an intermediate stage of a closing operation.

FIG. 3 is a schematic showing of a modified form of the invention.

FIG. 4 is a graphic representation of certain relationships occurring during a closing operation.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

General Construction

Referring now to FIG. 1, the vacuum circuit breaker shown therein is a multi-break type of circuit breaker comprising a plurality of vacuum-type circuit interrupters **10**, **11**, and **12** electrically connected in series and respectively defining the breaks of the circuit breaker. In the illustrated embodiment, these interrupters are supported in stacked, vertically spaced relationship by means of a pair of horizontally spaced channels **15**, each of a high strength electrical insulating material, such as glass-fibre-reinforced polyester resin. The channels **15**, only one of which is shown, are secured at their lower ends to lugs **18** integral with a metal base **20**. These channels and the soon-to-be described means for supporting the interrupters thereon are preferably of the construction disclosed and claimed in application Ser. No. 232,568-Sharp, filed Mar. 7, 1972, and assigned to the assignee of the present invention.

To describe this construction in more detail, at vertically spaced locations, interrupter-supporting plates **25** extending between the insulating channels **15** are provided. Each of these supporting plates **25** is preferably of metal and is detachably clamped to the channels. Each plate **25** comprises a flat body **26** extending between the channels **15** and flanges **28** at the edges of flat body which are bolted to the channels by bolts **30.**

Mounted atop each supporting plate **25** is one of the vacuum interrupters **10, 11,** and **12.** These vacuum interrupters are of a conventional design, and each comprises a highly evacuated envelope **40** and a pair of separable contacts **42** and **43** located within the envelope. Envelope **40** comprises a tubular casing **46** of a suitable insulating material, such as glass, and two metal end caps **44** and **45** at opposite ends of the casing joined to the casing by suitable glass-to-metal seals. Contact **42** is a stationary contact supported on a conductive rod **47** which extends in sealed relationship through upper end cap **44**; and the other contact **43** is a movable contact supported on a reciprocally movable contact rod **48** extending freely through the lower end cap **45.** A flexible metallic bellows **50** joined in sealed relationship at its opposite ends to rod **48** and end cap **45** provides a seal about rod **48** and permits it to be reciprocated without impairing the vacuum inside envelope **40.** In FIG. **1,** the contacts **42** and **43** of each interrupter are shown in their fully separated, or fully open position. When contact **43** is driven upwardly into engagement with its mating contact **42,** the interrupter is in a closed condition.

Each interrupter is secured to its supporting plate **25** by means of suitable mounting studs (not shown) fixed to the lower end cap **45** and extending through suitable openings in the supporting plate **25.** Each supporting plate **25** has a central opening through which freely extends the movable contact rod **48** of the interrupter supported thereon. Reference may be had to the aforesaid Sharp application for a more detailed description of this interrupter-supporting arrangement.

For electrically connecting the interrupters in series, I provide a plurality of flexible conductive braids **58.** These braids connect the movable contact rod **48** of each interrupter to the stationary contact rod **47** of the interrupter immediately therebelow. In the case of the bottom interrupter, another flexible braid **59** connects movable contact rod **48** of this interrupter to a lower terminal **60** of the circuit breaker. The contact rod **47** of the upper interrupter **10** serves as the upper terminal of the illustrated circuit breaker.

For supporting the base plate **20** and electrically isolating it from ground, a vertically extending porcelain insulating column **61** is provided. Only the top portion of this column **61** is shown in the drawings. Base plate **20** is secured to the top of column **61** in a conventional manner.

For enclosing the vacuum interrupters **10, 11,** and **12,** so as to protect them from the elements and so as to provide a housing for insulating fluid, I provide a tubular shell **62** surrounding the interrupters and the channels **15.** This shell **62,** which is preferably of porcelain, has an annular metal flange **67** at its lower end sealed to the porcelain and projecting radially therefrom and suitably bolted to base plate **20.** At its upper end, shell **62** carries a metal end cap **63** that is suitably sealed to the porcelain of shell **62.** The contact rod **47** of the top interrupter projects through a hole in the metal end cap **63,** and a suitable seal surrounds this contact rod to prevent any leakage between the rod and the cap **63.**

The chamber **65** within the cylindrical shell **60** is filled with a suitable insulating fluid, such as sulphur hexafluoride at a pressure of about 50 p.s.i. gage. This insulating fluid acts in a known manner to increase the dielectric strength, or breakdown voltage, of each interrupter along all paths within the chamber **65** that are located external to the interrupter envelope **40.** The level of this breakdown voltage will be discussed in more detail hereinafter.

Operating Mechanism

For operating the vacuum interrupters **10, 11,** and **12,** I provide an elongated operating rod **67** of electrical insulating material that extends generally parallel to the longitudinal axis of the interrupters in a position laterally spaced from the interrupter-supporting plates **25.** This operating rod **67** extends downwardly through the base **20** to a suitable operator (not shown), which, when energized, applies downward closing force to rod **67.** A suitable seal is provided about the operating rod where it extends through base **20.** Operating rod **67** is mechanically connected to each of the interrupters **10, 11,** and **12** by linkages **70** respectively associated with the individual interrupters.

Each linkage **70** comprises a pivotally mounted operating lever **72** pivotally connected at one end through a pivot **71** to the operating rod **67** and at its opposite end to movable contact rod **48** of the associated interrupter. Intermediate its ends, operating lever **72** is pivotally supported on a pivot **73** carried by spaced-apart arms **74** fixed to supporting plate **25** and projecting downwardly therefrom.

In the linkages associated with the lower two interrupters **11** and **12,** the pivotal connection of operating lever **72** to contact rod **48** comprises a conventional contact-wipe mechanism **75,** which includes a downwardly projecting rod **76** and a pivot pin **77** connecting lever **72** to rod **76.** The wipe mechanism **75** serves in a conventional manner to maintain pressure on the contacts of its associated interrupter when they are engaged and to permit some over-travel at the end of a closing operation to assure that all the contacts are properly engaged. Reference may be had to FIG. 5 of U.S. Pat. No. 3,025,375-Frank, assigned to the assignee of the present invention, for a more detailed showing of such a wipe mechanism. In general, each wipe mechanism **75** comprises a tubular cage **78,** a piston-like member **79** freely slidable therein, and a compression-type wipe spring **80** between piston member 79 and the lower wall of the cage.

During a closing operation, the operating rod **67** is driven downwardly from its position of FIG. **1** through its position of FIG. **2.** Considering first the lower two interrupters **11** and **12,** this downward motion of operating rod **67,** acting through linkages **70,** drives each of the cages **78** upwardly driving the wipe spring **80** and piston **79** upwardly therewith until the contacts **43, 42** of the associated interrupter engage. When this contact-engagement occurs, upward movement of the piston **79** is terminated, but the cage **78** continues to move upwardly for a limited additional distance into the position shown in FIG. **2,** thus compressing the wipe springs

80 and increasing the contact pressure on the engaged contacts 42, 43.

The wipe mechanism 75a of the upper interrupter 10 is similar to those of the lower interrupters, and corresponding parts of the upper wipe mechanism have therefore been assigned corresponding reference numerals except with the suffix *a*. As will soon appear more clearly, the upper wipe mechanism 75*a* serves also to provide closing power for the upper interrupter, and, for this reason, is considerably larger than the other wipe mechanisms 75 and contains a considerably heavier spring 80*a*.

Associated with the upper wipe mechanism 75*a* is a latch 82 that serves, when in the position shown in FIG. 1, to prevent th movable contact rod 48 from moving upwardly to close the interrupter. This latch 82 comprises a movable latching member 83 biased into a latching position by a compression spring 85. The latching member 83 is controlled by a cam 87 carried by operating rod 67. When the operating rod 67 is driven downwardly during a closing operation, as above described, the latch 82 prevents the contact rod 48 of the upper interrupter from moving in a closing direction until the cam 87 on operating rod 67 has moved downwardly sufficiently to release the latch 82, as shown in FIG. 2. When this latch-release occurs, the then-compressed spring 80*a* responds by driving the movable contact rod 48 upwardly through an interrupter-closing stroke. In FIG. 2, the spring 80*a* is just beginning upward motion of the contact rod 48 in response to release of latch 82. Compression of spring 80*a* prior to latch release is effected by force supplied by the downwardly-moving operating rod 67 through parts 72 and 76*a* during the earlier part of the closing operation.

Closing Operation

It will be apparent from the above description that my operating mechanism acts to effect substantially simultaneous closing of the contacts of the lower two interrupters 11 and 12 at a time prior to closing of the upper interrupter 10. This closing sequence is utilized to relieve the lower interrupters 11 and 12 from arcing duty during a closing operation. This will be apparent from FIG. 4, wherein the upper graph (a) illustrates the travel of the contacts between open and closed position and the lower graph (b) illustrates the current through the circuit breaker. Referring first to the upper graph of FIG. 4, the contacts of all of the interrupters are fully open until an instant T_1, at which instant the movable contacts 43 of the two lower interrupters are started toward closed position, as indicated by curve A. They reach engagement with their mating contacts 42 at an instant T_2. Immediately following T_2, at an instant T_3, the contacts 42, 43 of the upper interrupter are started toward closed position, as indicated by dotted-line curve B, reaching engagement at instant T_4. Referring now to FIG. 4*b*, when the contacts of all of the interrupters are fully-open, no current ordinarily flows through the circuit breaker since the total gap length is sufficient to withstand the voltage then present across the circuit breaker. At T_2 the total gap length has been reduced to one-third of its original value by the closing of the two lower interrupters 11 and 12, but the inter-contact gap of the remaining interrupter 10 is able by itself to withstand the full voltage across the circuit breaker. When the contacts of the remaining interrupter 10 are driven toward closed position, as indicated by curve B of FIG. 4*a*, its gap shortens and at an instant T_5 can no longer withstand the voltage then present across it. Thus, an arc-over across this last gap occurs at T_5, and the current I depicted in FIG. 4*b* flows through the circuit breaker. Arcing across the gap of the upper interrupter occurs between T_5 and the instant T_4, when the contacts of the upper interrupter reach engagement and thus complete a metallic path through the circuit breaker for carrying the current. It will be apparent from the above that all of the arcing during closing occurred across the contacts of the upper interrupter. An important factor making this possible is that the gap of the upper interrupter at the instant T_2 has a sufficient length to consistently withstand the full voltage across the circuit breaker, thus precluding any arc-over, or prestrike, across the gaps of the lower interrupters during closing.

Another factor that contributes to the substantial elimination of prestrikes across the contacts of the lower interrupters 11 and 12 during a closing operation is that the dielectric strength of the upper interrupter 10, not only across its inter-contact gap, but also along paths external to the interrupter, is sufficiently high to withstand the full circuit-breaker voltage without breakdown. Such an external breakdown would, of course, transfer the full voltage to any gaps then present between the contacts of the lower interrupters and could cause a prestrike across these gaps since they would have then been shortened by the closing operation then in progress. My circuit breaker is designed in such a manner that the breakdown voltage externally of any of the interrupters is greater than that across the interrupter's fully-open inter-contact gap, thus forcing any breakdowns that do occur to occur internally instead of externally of the interrupter. This internal preference relationship is deliberately avoided in most non-vacuum type circuit breakers because such circuit breakers frequently cannot clear the current following a breakdown if they are standing in a fully-open position at the time of the breakdown. But a vacuum circuit breaker is not subject to this disability; it is usually just as effective in clearing the current initiated while it is standing fully open as it is in clearing current during a normal opening operation.

The desired high dielectric strength external to the interrupter is obtained in my circuit breaker by using a high-quality, pressurized dielectric fluid within the chamber 62 (e.g., the pressurized sulphur hexafluoride gas referred to hereinabove) and also by using a unitary porcelain shell for enclosing the entire stack of interrupters. This latter feature makes available the entire length of the porcelain shell to discourage a flashover external to the shell.

By substantially eliminating arcing in the lower interrupters 11 and 12 during a closing operation, I can assure that the contacts of these interrupters 11 and 12 will be in a good condition at the time of a subsequent opening operation. More specifically, since there is no significant arcing on these particular contacts during closing, any welds which are formed by closing thereof are relatively small and can be broken on a subsequent opening without producing large protuberances. By maintaining the contacts of interrupters 11 and 12 in such a relatively smooth condition, I am able on a subsequent opening operation to develop a substantially higher dielectric strength between these contacts, which materially aids these interrupters in interrupting capacitance currents. While it is true that protuberances can be developed on the contacts of the last-to-close interrupter 10 during an opening operation, in view of the arcing and welding in this particular interrupter that accompanied the prior closing operation, it should be noted that it is the dielectric strength of only this one interrupter 10 which is affected by the protuberances. The improvements in dielectric strength in the other interrupters 11 and 12 more than offset any reduction in dielectric strength resulting from the added arcing duty imposed on interrupter 10 during closing.

To limit the extent to which the contacts of interrupter 10 are eroded by the arcing that occurs thereon during a closing operation, I drive the contacts of the interrupter 10 into engagement as soon as feasible after the instant T_2 when the contacts of interrupters 11 and 12 have engaged. In this regard, the contacts of interrupter 10 should reach engagement within about one-half cycle of power frequency current after T_2. In some cases, closing motion of interrupter 10 can be initiated even slightly before the instant T_2, but sufficient delay should still be present between T_2 and T_4 to assure that the start-of-arcing instant T_5 is consistently postponed to a time following T_2.

Opening Operation

An opening operation is performed simply by driving the operating rod 67 in an upward direction from its depressed, open position. Typically, this is done by a suitable opening spring (not shown) coupled to operating rod 67 near its upper end. In one embodiment of my invention, this upward opening movement of the operating rod 67 causes the contacts of all of the interrupters to part substantially simultaneously. More specifically, when operating rod 67 moves in an upward direction, it acts through levers 72 to drive the wipe cages 78 and 78*a* downwardly, causing them to impact against their corresponding piston members 79 and 79*a* substantially simultaneously, thus parting all of the contacts substantially simultaneously.

In a modification of my invention, I adjust the wipe mechanisms in such a manner that they cause the contacts of the upper interrupter 10 to part substantially ahead of the instant at which the contacts of the other interrupters 11 and 12 part. By parting the contacts of interrupter 10 first, I cause arcing to occur for a longer period across these particular contacts than across the contacts of the other interrupters. This added arcing on the contacts of interrupter 10 is desirable in providing more opportunity for clean-up of these contacts. More specifically, the longer duration arcing in interrupter 10 has more time to burn off the protuberances formed during the prior closing operation.

If this opening operation is a low-current capacitance switching operation, the arc in interrupter 10 prior to the first current zero may not be able to burn off the protuberances on the contacts of the interrupter. As a result, a restrike may occur across this single interrupter while the remaining interrupters have still not parted contact. This restrike is unlikely to be detrimental because its occurrence is unlikely to lead to the build-up of excessively high voltages since with only one gap present and subject to the entire circuit-breaker voltage, another breakdown of the gap is likely

to occur before an excessively high voltage can be built up.

In the interruption of fault currents, any protuberance on the contacts of interrupter 10 when the contacts first part are less detrimental than in capacitance-current interruptions because the fault-current arc, typically being a very high current arc, can easily burn off the protuberances at an early stage in the interrupting operation. Thus, the fault-current interrupting ability of the circuit breaker imposes no obstacle to increasing the voltage rating of the circuit breaker commensurate with its improved ability to interrupt capacitance currents at higher voltages.

Modified Embodiment

In the circuit breaker of FIGS. 1 and 2 only a single main operator and a single operating rod 67 are used for operating the three interrupters. It is to be understood, however, that my invention in its broader aspects also comprehends an arrangement such as depicted in FIG. 3 where one operator (100) is used for the interrupters 11 and 12 and a separate operator (102) is used for the interrupter 10. The first operator 100 is coupled to interrupters 11 and 12 through an operating rod 67 corresponding to the operating rod 67 of FIGS. 1 and 2. The other operator 102 is coupled to interrupter 10 through a second operating rod 104. Closing is effected by closing a closing-control switch 105 to energize operator 100, which responds by acting through operating rod 67 to close the interrupters 11 and 12. A short time after the main operator 100 is energized, the secondary operator 102 is energized to close the interrupter 10 by supplying a closing force via operating rod 104. The duration of the time delay is determined by a suitable time-delay device schematically shown at 108. This time delay is preferably set so that the contacts of interrupter 10 will still be fully open when the contacts of interrupters 11 and 12 have reached engagement, as was the case in the example illustrated in FIG. 4.

Opening of the interuppters 10, 11, 12 is effected by closing an opening-control switch 109 to energize the operators 100 and 102 in an opening direction. In one form of the invention, operator 102 parts the contacts of interrupter 10 prior to the instant at which operator 100 parts the contacts of interrupters 11 and 12. The length of time elapsing between these contact-partings is controlled by a time delay device schematically shown at 110. If it is desired to effect substantially simultaneous opening of the interrupters, this can be done by shunting-out the time delay device 110 so that closing of the switch 109 effects substantially simultaneous operation of the two operators 100 and 102.

Other Modifications

In the above description, I have been concerned with a multi-break circuit breaker that comprises only three series-connected vacuum interrupters. It should be recognized that the invention can equally well be applied to a circuit breaker comprising a greater number of series-connected interrupters, such as would be used in a higher voltage circuit breaker. Where a substantially greater number of interrupters are used, e.g., six or more interrupters, it will often be desirable to delay closing of more than one interrupter so as to provide the dielectric strength across the last-to-close interrupters needed to prevent a prestrike in the interrupters of the first-to-close group. In such a high-voltage circuit breaker application, as well as in the illustrated application, the interrupters that first close can be thought of as constituting first interrupter means and the one or more interrupters that close last can be thought of as constituting second interrupter means. The contacts of the first interrupter means need not reach engagement precisely simultaneously, but the last of these contacts to engage should engage sufficiently ahead of the point at which any of the contacts of the second interrupter means reach engagement as to preclude a prestrike across the contacts of the first interrupter means. Preferably, the contacts of the second interrupter means will still be in a substantially fully separated position at the time all the contacts of the first interrupter means have reached engagement. The number of interrupters present in the second interrupter means will depend upon the total circuit breaker voltage, but this number should be less than the number of interrupters present in the first interrupter means so as to confine prestriking on closing to less than a majority of the interrupters.

While I have shown and described particular embodiments of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention in its broader aspects; and I, therefore, intend in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a vacuum-type circuit breaker for interrupting fault currents and capacitance currents:

a. first and second interrupter means,
b. said first interrupter means comprising a plurality of vacuum circuit interrupters,
c. said second interrupter means comprising at least one vacuum circuit interrupter but fewer vacuum circuit interrupters than in said first interrupter means,
d. means for electrically connecting all of said vacuum circuit interrupters in series with each other,
e. each of said vacuum circuit interrupters comprising a highly evacuated envelope and a pair of contacts located within said envelope that are relatively movable into and out of engagement with each other,
f. closing means for driving the contacts of all of said interrupters into engagement to effect closing of said vacuum circuit breaker,
g. and means for controlling said closing means in such a manner that, during closing, all the contacts of said first interrupter means engage prior to the time at which any of the contacts of said second interrupter means engage, the gap length between the contacts of said second interrupter means at the time all of the contacts of said first interrupter means have reached engagement being sufficiently great as to consistently preclude a prestrike across the contacts of said first interrupter means during a closing operation,
h. and opening means for driving the contacts of all of said interrupters out of engagement during a current-interrupting operation to provide gaps between the contacts of all of said interrupters for withstanding the recovery voltage that builds up across the circuit breaker after clearance at a current zero.

2. The vacuum type circuit breaker of claim 1 in which any prestrikes that occur during closing consistently occur across the contacts of said second interrupter means and not across the contacts of said first interrupter means.

3. The vacuum type circuit breaker of claim 1 in which the contacts of said second interrupter means are substantially fully open at the time that all the contacts of said first interrupter means have reached engagement.

4. The vacuum type circuit breaker of claim 1 in which said closing means causes all the contacts of said first interrupter means to engage substantially simultaneously during each closing operation.

5. The vacuum type circuit breaker of claim 1 in which the breakdown voltage external to any vacuum interrupter of said second interrupter means is greater than the breakdown voltage across the gap between the contacts of said interrupter when said contacts are fully separated.

6. The vacuum type circuit breaker of claim 1 in which electrical insulating means is provided around the second interrupter means having a sufficiently high dielectric strength to consistently force any breakdown across said second interrupting means to occur internally, rather than externally, of the vacuum circuit interrupter or interrupters constituting said second interrupting means.

7. The vacuum type circuit breaker of claim 1 in which during closing the contacts of said second interrupter means are all engaged within about one-half cycle of power frequency current after all the contacts of said first interrupter means have engaged.

8. The vacuum circuit breaker of claim 1 in which only a single vacuum interrupter is present in said second interrupter means.

9. The vacuum type circuit breaker of claim 1 in which only two interrupters are present in said second interrupter means.

10. A vacuum type circuit breaker as defined in claim 1 in which, during an opening operation, said opening means causes the contacts of said second interrupter means to disengage prior to disengagement of the contacts of said first interrupter means.

11. A vaccum type circuit breaker as defined in claim 1 in which said opening means drives the contacts of all of said interrupters out of engagement substantially simultaneously during an opening operation.

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