Sept. 1, 1970 K. H. DATE 3,526,735

REPEATING CIRCUIT INTERRUPTER

Filed June 15, 1966 2 Sheets-Sheet 1

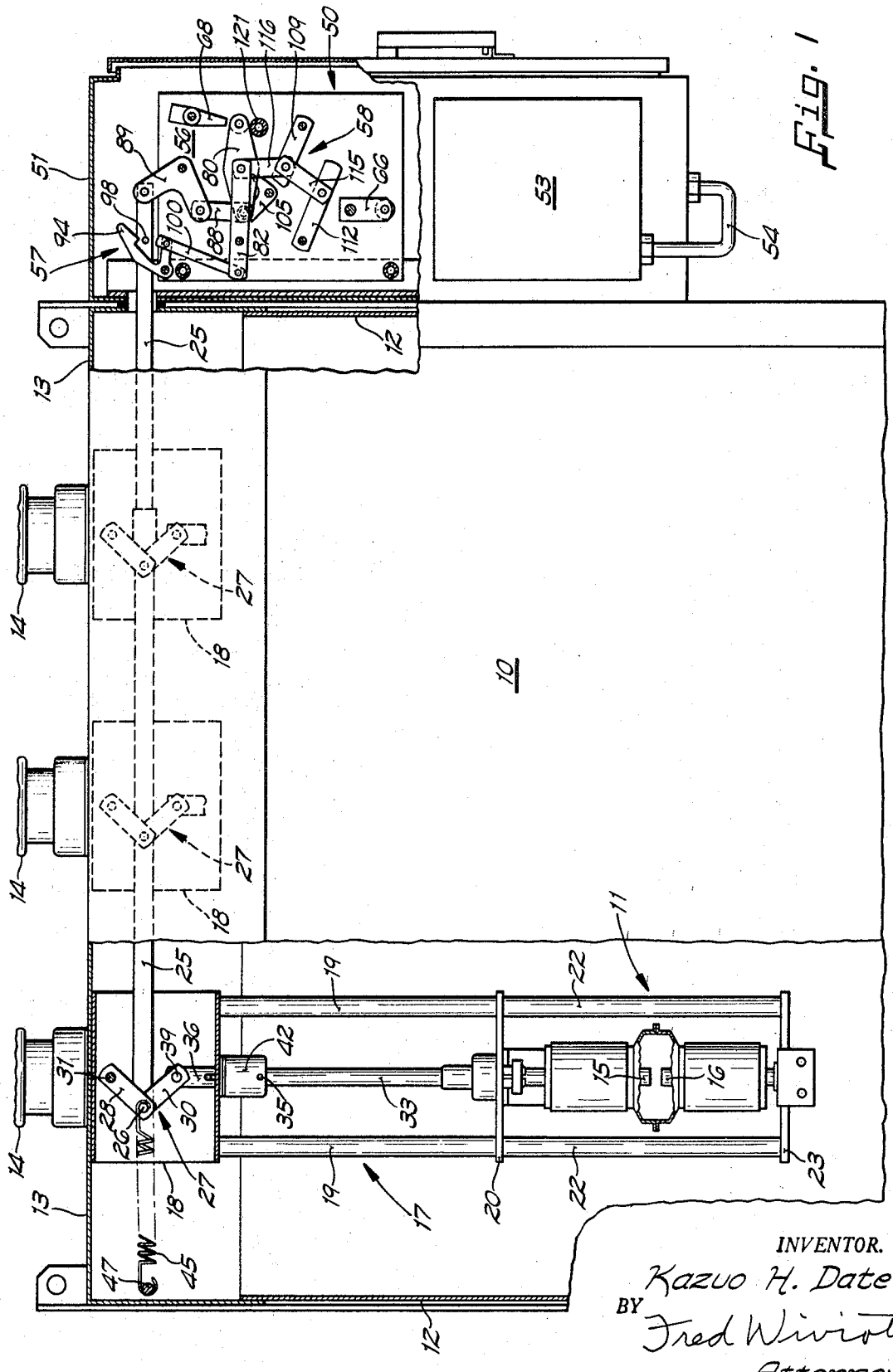

Fig. 1

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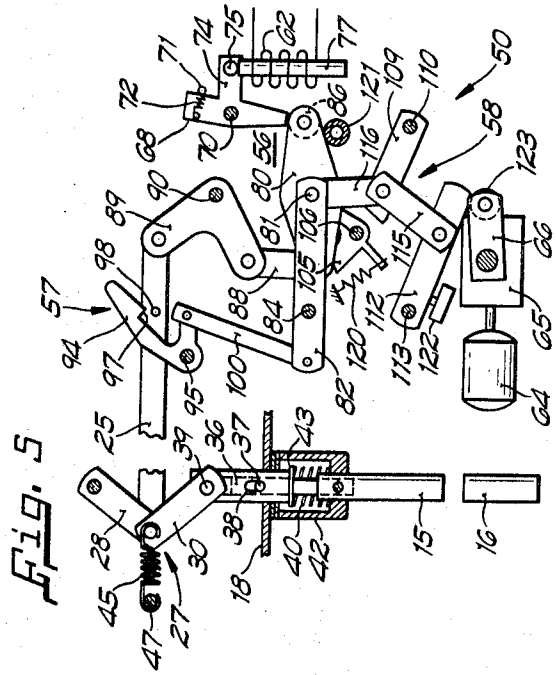

Fig. 5

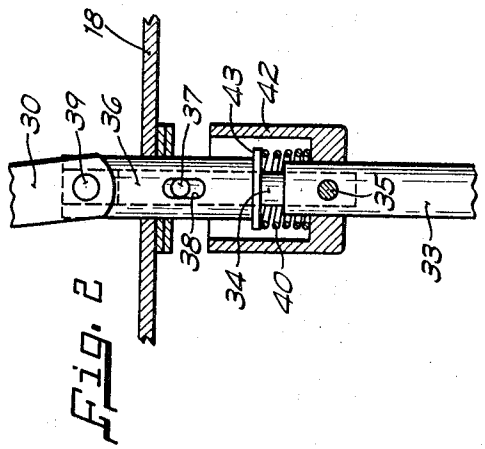

Fig. 2

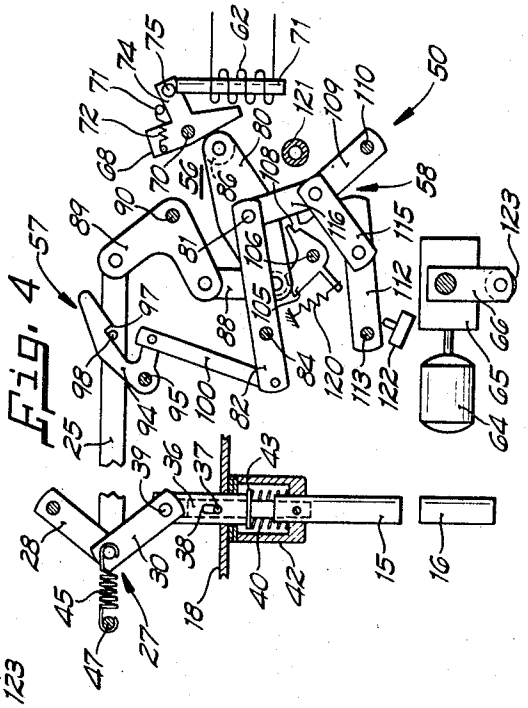

Fig. 4

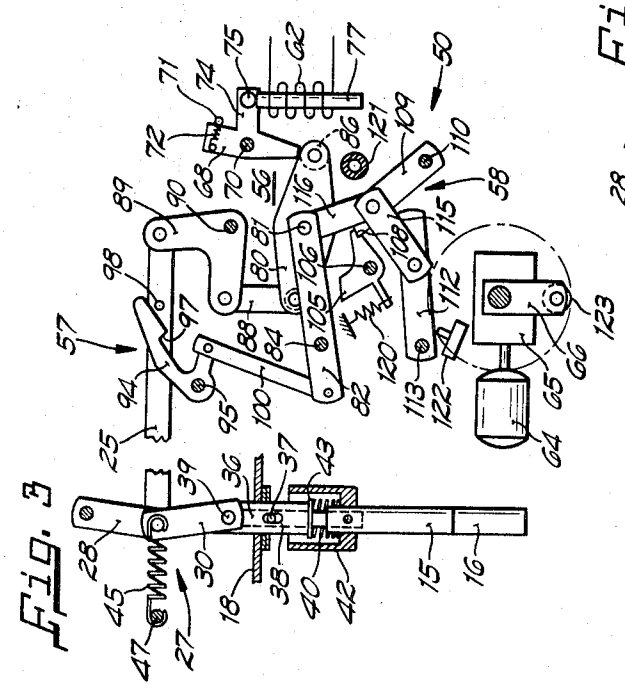

Fig. 3

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3,526,735

REPEATING CIRCUIT INTERRUPTER

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Int. Cl. H01h 3/00
U.S. Cl. 200—153 7 Claims

ABSTRACT OF THE DISCLOSURE

An operating mechanism for a vacuum circuit interrupter is provided in which an operating means moves between first and second positions in which the electrodes of the vacuum interrupter are respectively closed and open. The operating means is held in its second position by the operating mechanism to prevent reclosing of the electrodes until the operating mechanism releases the holding means. The operating mechanism and a closing means cooperate to reclose the electrodes and charge a resilient opening means through a toggle linkage means. The linkage means is connected to the resilient means and the operating means so that the mechanical lever advantage of the linkage means is utilized in charging the resilient means to thereby reduce the amount of force that must be applied to charge the resilient means.

This invention relates to repeating circuit interrupters and, more particularly, to an operating mechanism for repeating circuit interrupters having vacuum current interrupting devices.

Because of the many characteristic differences between interrupters of the vacuum type and those employing a dielectric medium, conventional operating mechanisms are not satisfactory in circuit breakers employing vacuum interrupters. For example, one such difference is the relatively short opening stroke characteristic of vacuum devices which introduces problems of rapid deceleration and contact bounce. In addition, there is a greater tendency for the contacts in vacuum interrupters to weld shut, wherein means are required for impacting the contacts during an opening operation. Further, vacuum interrupters are generally provided with butt type contacts requiring greater contact pressure than circuit breakers having contacts with multiple points of engagement.

A primary object of the invention is to provide a circuit breaker operating mechanism having specific application to vacuum type circuit interrupters.

Another object of the invention is to provide means for decelerating the moving contact in vacuum circuit interrupters.

Yet another object of the invention is to provide means for preventing contact bounce in vacuum type circuit interrupters.

A further object of the invention is to provide means for breaking welds in the contact of a vacuum type circuit interrupter.

Yet another object of the invention is to provide a circuit breaker operating mechanism capable of supplying relatively high contact pressure to the butt contacts of a vacuum circuit interrupter.

Still another object of the invention is to provide a vacuum circuit interrupter having movable contact impacting means for weld breaking with means for supporting the vacuum envelope and terminal bushings independently of the movable contact.

These and other objects and advantages of the instant invention will become more apparent from the detailed description thereof, taken with the accompanying drawings in which:

FIG. 1 is a side elevational view, with parts broken away, of a circuit breaker incorporating the instant invention;

FIG. 2 is a fragmentary view of the circuit breaker illustrated in FIG. 1; and

FIGS. 3, 4 and 5 show the circuit breaker operating mechanism according to the instant invention in its various operative positions.

Referring now to the drawings in greater detail, FIG. 1 shows a polyphase repeating circuit breaker **10** having current interrupters **11** of the vacuum type. The circuit breaker **10** is provided with a metallic enclosure **12** having a cover **13** which supports porcelain terminal bushings **14** for connection to conductors (not shown). In addition conductors (also not shown) extend from the lower ends of bushings **14** to connect with the movable and stationary electrodes or contacts **15** and **16**, respectively, of the vacuum circuit interrupters **11**.

The details of the vacuum circuit interrupter **11** form no part of the instant invention and, accordingly, will not be discussed in detail for the sake of brevity. For a more complete description of the vacuum circuit interrupter, reference is made to co-pending application U.S. Pat. No. 3,280,286, issued to John W. Ranheim on Oct. 18, 1966, and assigned to the assignee of the instant invention.

A suspension assembly **17** rigidly supports each of the vacuum interrupter assemblies **11** below the cover **13**, and each assembly **17** includes an open-ended rectangular bracket **18** which is suitably affixed at its top to the cover **13**. A pair of insulating support rods **19** are secured to the lower surface of bracket **18** and extend downwardly therefrom. In addition a first support plate **20** is secured to the lower end of the insulating rods **19** and in turn supports a second plurality of insulating rods **22** which carry a second support plate **23** at their lower ends. The upper and lower ends of the vacuum interrupter **11** are rigidly affixed to the support plates **20** and **23**, respectively. Because of the rigid manner in which the interrupters **11** are supported, it is possible during an opening operation, as will be discussed in greater detail hereinafter, to impact the movable electrodes **15** with a great deal of force to break any welding that may exist with the stationary electrodes **16**. This is in contrast to certain prior art circuit breakers where the vacuum interrupters are part of or suspended from the porcelain insulators wherein such impacting of the stationary contacts or electrodes is not possible.

An operating rod **25** extends lengthwise of the housing **12** and beneath the cover **13** and is connected by pins **26** to the knee of a toggle linkage **27** associated with each phase, and each of which comprises a first link **28** and a second link **30**. Each of the first links **28** is pivotally connected at their other ends to fixed pins **31** and the other ends of the second links **30** are pivotally connected to the upper end of an insulating contact rod **33** which extends downwardly into the interrupting assembly **11** of each phase to engage the movable electrodes **15** so that said contacts in each phase may be simultaneously opened.

FIG. 2 shows in greater detail the connection between each toggle link **30** and its contact rod **33** to include a stem **34** affixed by a pin **35** in a telescoping relation to the upper end of the rod **33**. Each stem **34** extends upwardly from its rod **33** and into a sleeve **36** to which it is connected by a pin **37** which extends through the stem **34** and into slots **38** formed in the opposite side of sleeve **36**. In addition, the upper end of each sleeve **36** is pivotally connected to its associated toggle link **30** by a pin **39**. A contact pressure spring **40** surrounds each stem **34** and extends between a cup-shaped member **42** mounted in an inverted relation at the upper end of the rod **33** and a washer **43** mounted at the lower end of the sleeve **36**.

Switch opening energy for each of the movable electrodes **15** is provided by an opening spring **45** affixed at one end by a pin **46** to the operating rod **25** and at its other end to a pin **47** fixed to the casing **12**. It will be appreciated that movement of the rod **25** towards the right, as viewed in FIG. 1, would charge the opening spring **45** and straighten the toggle linkages **27** to thereby move the contact rods **33** downwardly to close the movable electrodes **15**. On the other hand, when the rod **25** is released for movement toward the left in FIG. 1 and under the influence of spring **45**, the toggle linkages **27** will collapse to raise the rods **33** and thereby open the movable electrodes **15**.

An operating mechanism **50**, according to the instant invention, is disposed in a metallic housing **51** suitably affixed adjacent one end of the enclosure **12**. As seen in FIG. 1, the operating rod **25** extends from the enclosure **12** and into the housing **51** where it is coupled to the operating mechanism **50**. A control **53** for initiating the various opening and closing operations of the circuit breaker **10**, is disposed within a separate metallic housing and is electrically connected to the mechanism **50** by a cable **54**. As will be understood by those skilled in the art, many types of controls which are suitable for use with the circuit breaker **10** are well known, and accordingly, control **53** will not be discussed in detail. For a complete description of a control capable of use with the disclosed circuit breaker, reference is made to U.S. Pat. No. 3,100,854, issued to Richard E. Riebs on Aug. 13, 1963, and assigned to the assignee of the instant invention.

As seen in FIGS. 3–5, the operating mechanism **50** includes a first latch assembly **56** for holding the electrodes **15, 16** in a closed position against the opening spring **45**, a second latch assembly **57** for holding the contacts **15, 16** in an open position to prevent contact rebound and a reset assembly **58** for resetting the first latch assembly **56** and for releasing the second latch assembly **57**.

A trip solenoid **62** is provided for releasing the first latch assembly **56** so that the operating rod **25** is freed for movement to a switch open position under the influence of opening spring **45**. After a switch opening operation, a motor **64** is operative through a gear mechanism **65** and a reclosing lever **66** to actuate the reset assembly **58**.

The first latch assembly **56** includes a latch member **68** which is pivotally mounted about a fixed pin **70** and which is urged toward clockwise rotation and against a stop pin **71** by a small spring **72**. An integral arm **74** extends outwardly from the latch member **68** and carries a pin **75** at its outer end which normally lies in the path of the trip solenoid's plunger **77**.

The first latch assembly **56** also includes a latch lever **80** pivotally mounted intermediate its ends about a pin **81** carried by one end of a link **82** which in turn is pivotally mounted intermediate its ends on a fixed shaft **84**. A roller **86** is mounted at one end of latch lever **80** and cooperatively engages the latch **68** while the other end of lever **80** is pivotally connected to one end of a link **88**. The other end of link **88** is pivotally connected to one arm of a bell crank **89** which is pivotally mounted about a fixed shaft **90** and whose other arm is pivotally connected to the operating rod **25**.

It will be appreciated from the description thus far that when the electrodes **15, 16** are in their closed position, as shown in FIG. 3, the opening spring **45** will be extended and will urge the operating rod **25** toward the left to rotate the bell crank **89** and the latch lever **80** counterclockwise. Such movement is prevented, however, by the latch **68** which lies in the path of roller **86** to prevent rotation of the latch lever **80**.

The second latch assembly **57** includes a latch crank **94** pivotally mounted on a fixed shaft **95** and having a latch surface **97** for cooperatively engaging a pin **98** carried by the operating rod **25**. A long link **100** is provided for interconnecting the other arm of the latch crank **94** with the other end of the link **82**.

The reset assembly **58** includes a reset latch **105** pivotally mounted about fixed shaft **106** and having a latch tip **108** engageable with a latch arm **109** pivotally mounted on a second fixed shaft **110**. In addition, the assembly **58** includes a reset lever **112** carried on a fixed shaft **113** and a first link **115** which couples the lever **112** to the free end of the latch arm **109** and a second link **116** which couples the arm **109** and the link **115** to the pin **81** carried by the latch lever **80**.

When the operating assembly **50** is in its position shown in FIG. 3 the electrodes **15, 16** are in their closed position and the opening spring **45** is extended. Should the control assembly **53** sense the necessity for a switch opening operation, it will cause the energization of the trip coil **62** in a manner well known in the art. This causes the solenoid plunger **77** to move upwardly and impact the pin **75** carried by the latch **68** and thereby to rotate the latch counterclockwise from its position shown in FIG. 3 to its position shown in FIG. 4. This frees the latch lever **80** and the bell crank **89** for counterclockwise rotation about the pin **81** and shaft **90**, respectively, as the opening spring **45** moves the operating rod **25** toward the left, as viewed in FIGS. 3 and 4. In addition, this movement collapses the toggle links **27** associated with each phase to move the sleeves **36** upwardly.

It will be recalled that when the electrodes **15, 16** are in their closed position and the opening spring is extended, as seen in FIG. 3, the pin **37** in the stem **34** is initially intermediate the ends of the slot **38** formed in the sleeve **36**. As a result, therefore, when the sleeve **36** initially begins moving upwardly during a switch opening operation, the contact rod **33** will remain in its switch closed position. After the sleeve **36** has moved upwardly a short distance, however, the slots **38** will impact the pins **37** at a relatively high speed so that the impact force will be sufficient to break any welding which may exist in the electrodes **15, 16**. It will be appreciated, too, that this initial opening movement of the sleeve **36** under the influence of opening spring **45** will be aided by the contact pressure springs **40**.

The operating mechanism **50** is able to impact the movable electrodes **15** with a high opening force because each of the interrupters **11** is relatively rigidly mounted between the plates **20** and **23** and by the insulating support rods **19** and **22**. This rigid mounting insures that the refractory portions of the interrupter **11** will not be unduly stressed by the impacting force. Also because the movable electrodes **15** are mounted independently of the terminal bushings **14**, the latter will not be subjected to the impacting force.

As seen in FIGS. 3 and 4, the engagement between the latch arm **109** and the reset latch **105** will hold the lever **82** inactive during the initial rotational movement of the latch lever **80** and the bell crank **89**. As a result, the latch crank **94** will also remain inactive so that the pin **98** will engage the latch surface **97** when the operating rod **25** reaches its full switch-open position shown in FIG. 4. As a result, return movement of the operating rod **25** is prevented so that the movable electrodes **15** are prevented from rebounding toward their closed positions.

After the operating rod **25** reaches its fully open position to rotate the bell crank **89** and the latch lever **80** counterclockwise, the left end of the latch lever **80** will engage the reset latch **105** to rotate the latter counterclockwise against a small reset spring **120** as seen in FIG. 4. This releases the latch arm **109** so that the levers **82** and **112** are free to pivot clockwise about their respective shafts **84** and **113** from their positions shown in FIG. 4 to their positions shown in FIG. 5. This rotational movement of the levers **82** and **112** may be brought about either as a result of their own weight or a small spring (not shown) may be provided for this purpose.

As the lever **82** pivots, the pin **81**, which rotatably supports the latch lever **80**, will move the lever **80** downwardly and against a stop **121**, whereupon the roller **86** will again be positioned below the latch **68**. In addition,

clockwise pivotal movement of the lever **82** will elevate the link **100** to rotate the latch crank **94** counterclockwise to move the latch surface away from the pin **98**. This places the mechanism **50** in a reset position in preparation for a reclosing operation.

Reclosing of the electrodes **15**, **16** may be initiated in any manner well known in the art, such as, for example, by means of a limit switch **122** positioned below the reset lever **112**. When the mechanism **50** reaches its reset position, shown in FIG. 5, the reset lever **112** will engage the limit switch **122**, thereby completing an energizing circuit to the reclosing motor **64** which, in turn, rotates the reclosing lever **66** counterclockwise. As the reset lever **66** rotates, a roller **123** on its free end will engage the underside of the reset lever **112** to rotate the latter counterclockwise, thereby producing clockwise rotation in the latch arm **109** to move it into engagement with the latch **105**. Also, because the roller **86** carried by the latch lever **80** is disposed below the latch member **68**, the lever **80** will rotate clockwise about its point of engagement with latch **68** to rotate the bell crank **89** clockwise thereby to extend the opening spring **45** and to reclose the movable electrodes **15**. In addition, as the latch lever **80** rotates, it will move the pin **81** in a generally upward direction to produce counterclockwise rotation in lever **82** to thereby return the latch crank **94** to its initial position shown in FIG. 3. In this manner the mechanism **50** is reset in preparation for subsequent switch opening operation.

Should a tripping operation become necessary while the main electrodes **15**, **16** are being reclosed, solenoid coil **62** may be energized to rotate the latch **68** and release the latch lever **80** for counterclockwise rotation to allow a switch opening operation even though the reclosing lever **66** is in its reclosing position.

Those skilled in the art will appreciate that the force necessary to extend the opening spring **45** and to compress the contact pressure spring **40** will increase as the charging of these springs proceeds. In order to eliminate the necessity for providing an inordinately large motor **64**, the springs **40** and **45** are coupled to the operating rod **25** through the toggle linkage mechanism **27**. Since the leverage expected by the toggle links **28** and **30** increases as they approach their straight line position, a greater spring charging force will be available at the time when the springs **40** and **45** require a greater force for charging. In this manner, a relatively smaller reclosing motor **64** may be employed than would normally be necessary.

While only a single embodiment of the invention has been shown and described, it is not intended to be limited thereby.

I claim:

1. In a circuit interrupter having a vacuum envelope and switch means including a pair of electrodes having adjacent ends enclosed within said envelope, one of said electrodes being movable between open and closed positions with the other electrodes, the combination comprising:

resilient switch opening means coupled to said movable electrode;

an operating mechanism including,

an operating means connected to said movable electrode and said resilient switch opening means and having a first position wherein said movable electrode is in its closed position and said resilient switch opening means is charged and being movable to a second position by said resilient means wherein said movable electrode is in its open position,

first means engaging said operating means for holding the operating means in its first position,

release means operable to free said operating means for movement from its first to its second position,

second means maintained in a normal position when said operating means is in its first and second positions for engaging and holding the operating means when the latter is in its second position,

third means coupled to said second means for moving the second means out of its normal position after the operating means and movable electrodes have respectively moved to their second and open positions; and

switch closing means engaging said operating mechanism for returning said operating means and movable electrode to their respective first and closed positions and returning said second means to its normal position.

2. The circuit interrupter set forth in claim **1** wherein said second means is disengaged from said operating means when said operating means is in its first position and engaged with said operating means when it is in its second position and the second means is in its normal position.

3. The circuit interrupter set forth in claim **1** wherein said second means comprises second latch means having a position in latched engagement with said operating means when said operating means is in its second position and said second means is in its normal position.

4. The circuit interrupter set forth in claim **1** wherein:

said third means includes linkage means having a rigid condition and being connected to said second means for holding the second means in its normal position and for moving said second means out of its normal position upon release of the linkage means from said rigid condition; and

fourth means having a position in engagement with said linkage means to hold the linkage means in its rigid condition and being disengageable from said linkage means by said operating mechanism to release said linkage means from its rigid condition after said movable electrode moves to its open position.

5. The circuit interrupter set forth in claim **4** wherein said first means is movable to a position in engagement with said fourth means to disengage the fourth means from said linkage means.

6. The circuit interrupter set forth in claim **1** wherein:

said third means includes linkage means connected to said second means for moving said second means out of its normal position; and

said second means comprises second latch means connected to said linkage means and being in latched engagement with said operating means when said operating means is in its second position and said second means is in its normal position, said second latch means being movable out of latched engagement with said operating means when said second means is moved out of its normal position by said linkage means.

7. The circuit interrupter set forth in claim **6** wherein:

said switch closing means has a position in engagement with said linkage means;

said operating mechanism includes fourth means having engaged and disengaged positions with the linkage means for releasably holding said linkage means; and

said linkage means is movable to a rigid condition in engagement with the fourth means by said switch closing means, said linkage means holding the second means in said normal position when in said rigid condition, said linkage means being movable to a collapsed condition when disengaged with the fourth means to move said second means out of its normal position, said linkage means remaining in said collapsed condition until returned to said rigid condition by the switch closing means.

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U.S. Cl. X.R.

200—144; 335—9