United States Patent [19] **Dickinson**

[11] **3,845,263**

[45] **Oct. 29, 1974**

[54] **CIRCUIT BREAKER WITH SPRING CHARGED OPERATING MECHANISM**

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[73] Assignee: **Westinghouse Electric Corporation**, Pittsburgh, Pa.

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[52] **U.S. Cl.** .... **200/153 SC,** 200/144 B, 335/190

[51] **Int. Cl.** **H01h 3/30,** H01h 3/28

[58] **Field of Search** ...... 200/153 SC, 153 H, 153 G, 200/78, 74, 144 B; 335/76, 77, 190

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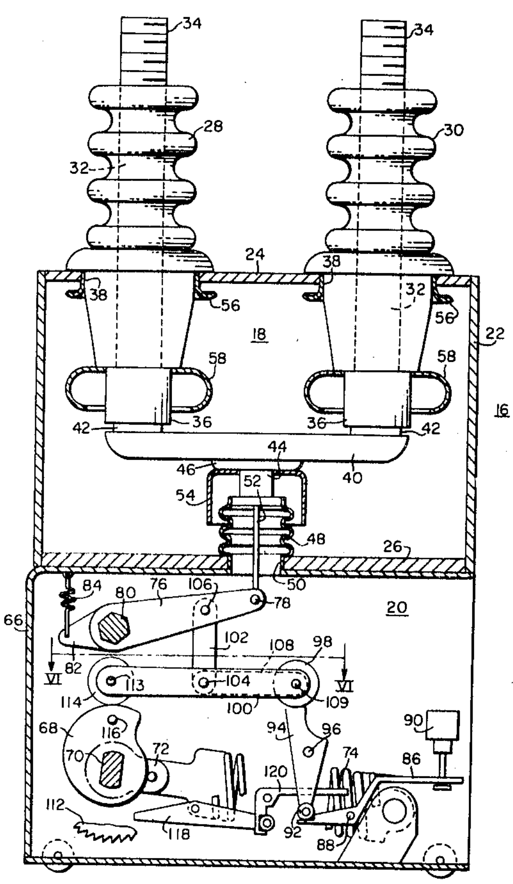
Assistant Examiner—William J. Smith
Attorney, Agent, or Firm—H. G. Massung

[57] **ABSTRACT**

An improved vacuum type circuit interrupter assembly having a vacuum breaker with a housing which is electrically insulated from the breaker contacts and an improved stored energy operating mechanism for opening and closing the vacuum circuit breaker. The contacts of the vacuum type circuit breaker are generally cup-shaped with one contact of smaller diameter than the other so that contact engagement is made by the smaller diameter contact sliding into the larger diameter contact.

15 Claims, 13 Drawing Figures



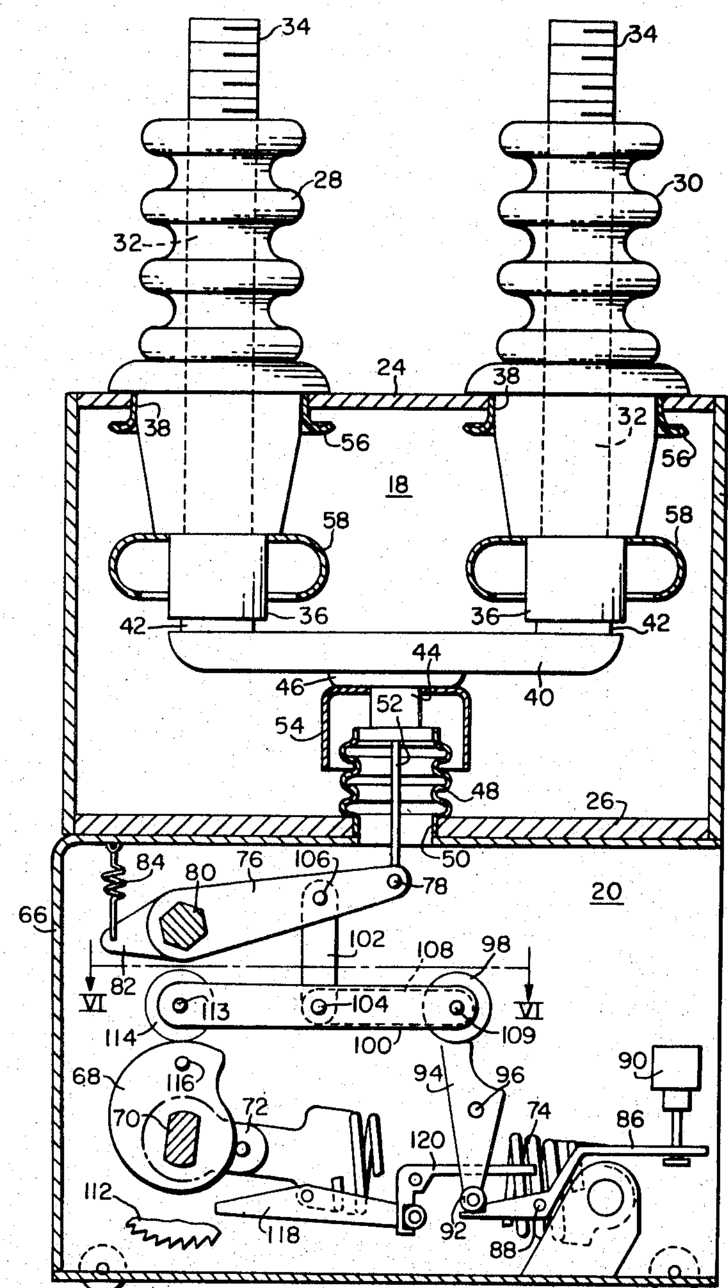

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FIG. I

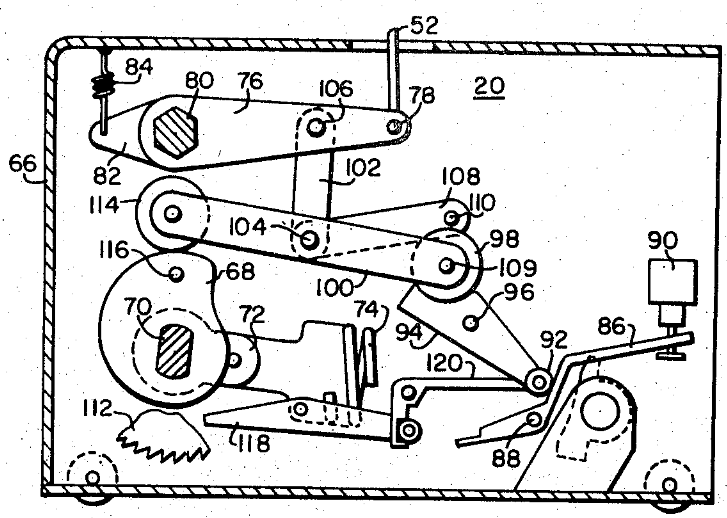

FIG. 2

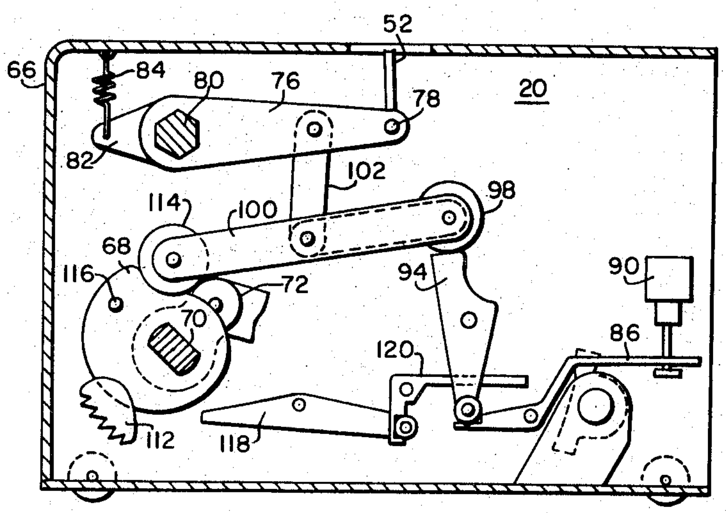

FIG. 3

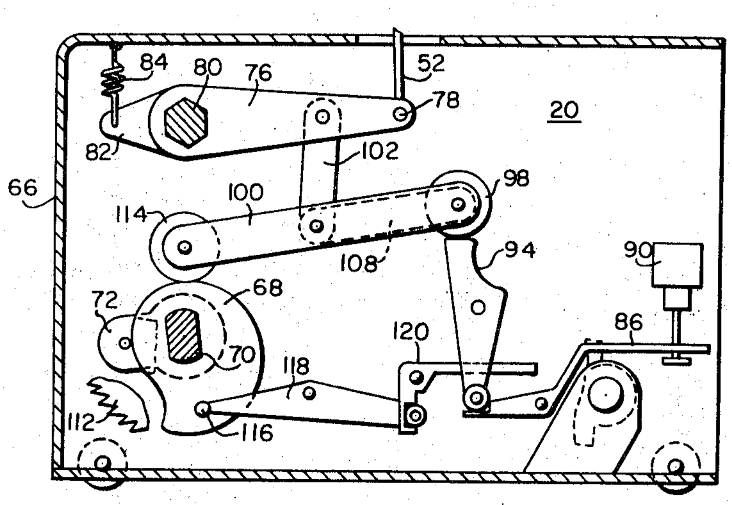

FIG. 4

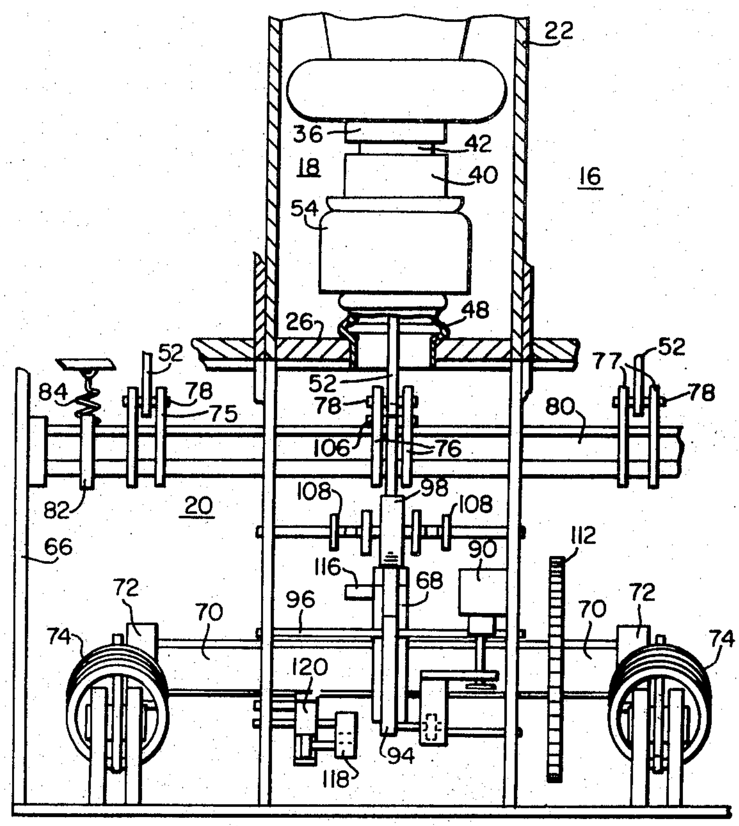
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FIG. 5

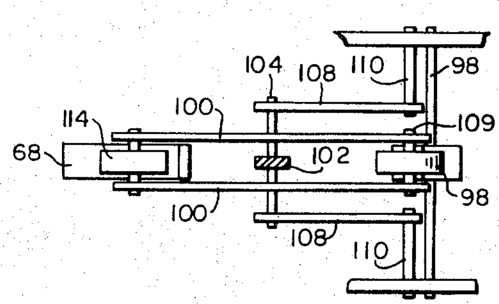
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FIG. 6

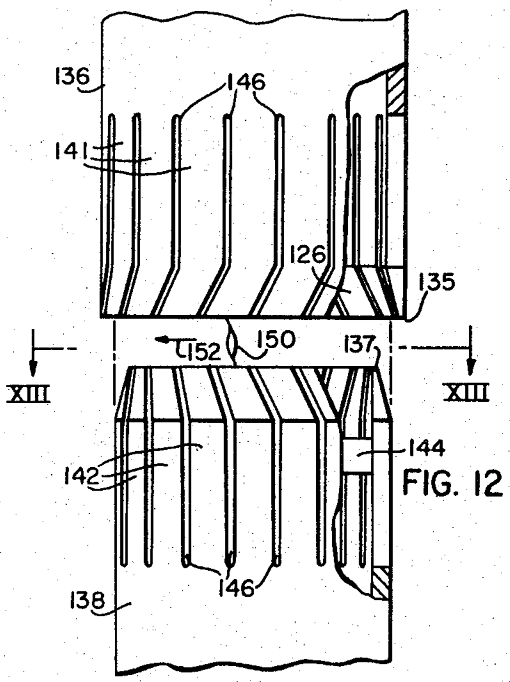


FIG. 12

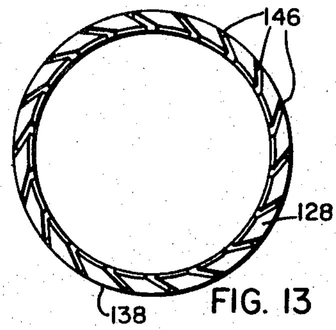


FIG. 13

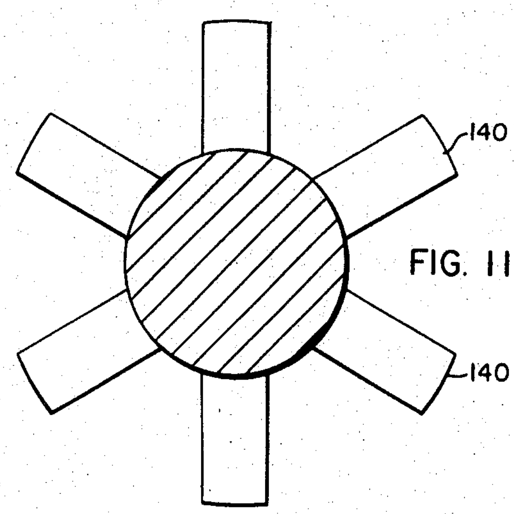


FIG. 11

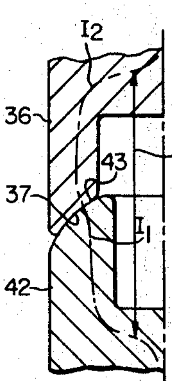


FIG. 9

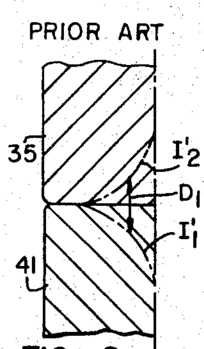
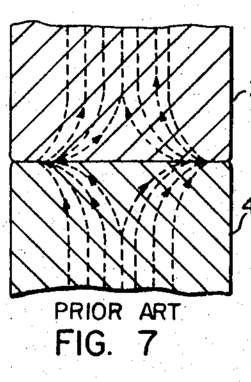


FIG. 8



PRIOR ART
FIG. 7

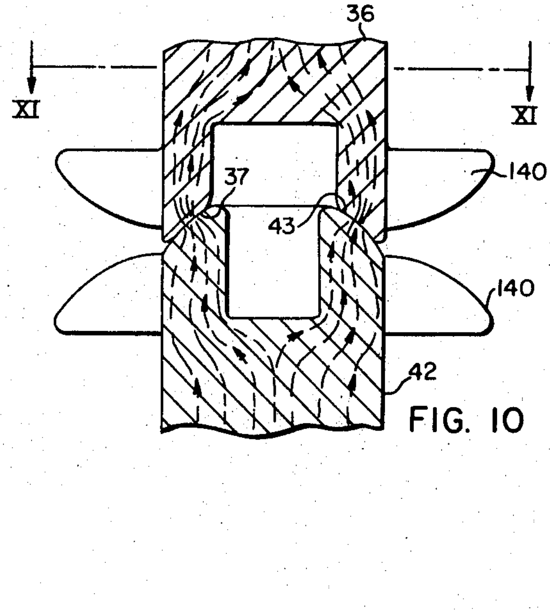


FIG. 10

CIRCUIT BREAKER WITH SPRING CHARGED OPERATING MECHANISM

BACKGROUND OF THE INVENTION

This invention relates to circuit interrupters and more particularly to vacuum type circuit interrupters and operating assembly therefor. The vacuum type circuit interrupter assembly disclosed utilizes an improved stored energy operating device for positioning a bridging member in a vacuum interrupter. The vacuum interrupter utilizes a contact configuration in which one contact of smaller diameter slides partially inside another contact of larger diameter to complete the electric circuit.

In a vacuum interrupter current flows through contacts located in an evacuated envelope. In the standard vacuum interrupter relatively movable contacts are disposed in the evacuated envelope. The contacts are relatively movable along the longitudinal axis of the vacuum interrupter, between a closed position in which they are engaged, and an open position in which they are separated to establish an arcing gap therebetween. In another variety of vacuum interrupter, as described in U.S. Pat. No. 3,283,101 issued Nov. 1, 1966 to J. D. Cobine et al., stationary butt type contacts, which are electrically connected to the vacuum interrupter terminals, are engaged by movable butt type contacts. The movable contacts are attached to a bridging member. When the vacuum interrupter is in the closed position, with the movable contacts in engagement with the stationary contacts, a completed electric circuit, between the stationary contacts exists through the bridging member.

During the opening of vacuum circuit breakers, as the contacts are separated, arcing occurs between the contacts, and current will continue to flow through this arc until the arc is extinguished, which on an alternating current circuit will normally occur near the first current zero. When the contacts are closed, arcing and contact melting can occur. To minimize arcing and contact melting during a closing operation it is desirable that the contacts are closed rapidly. Rapid contact closing can best be achieved by using a stored energy type closing mechanism.

In prior art type butt contacts, it is well known that, actual contact is not made over an appreciable area of the contact surface. This occurs mostly because of the imperfections of the supposedly flat surfaces. Since contact is only made at a relatively few points on the contact surfaces a current flow may enter and leave the point of contact at an acute angle. This results in a relatively high force tending to separate or blow the contacts apart during high momentary fault currents. These butt type contacts require an operating and holding mechanism with a relatively high holding force to keep the contacts engaged during momentary high current conditions.

In some prior art vacuum interrupters as used in power switches and circuit breakers exposed portions of the evacuated envelope are electrically connected with the contacts. This means that external insulating supports must be provided for the vacuum interrupter, since the vacuum interrupter cannot be mounted directly on a grounded metallic structure. In prior art vacuum interrupters, it is also necessary to have an insulating operating rod external to the vacuum interrupter for connecting the vacuum interrupter to the operating mechanism, which may be at ground potential. Since the insulating operating rod is mounted external to the vacuum interrupter it does not have the advantage of being in a high dielectric environment, such as a vacuum, and since it is mounted in air must be of considerable longer length than if mounted inside the vacuum interrupter.

SUMMARY OF THE INVENTION

This invention discloses an improved vacuum type circuit interrupter construction. In the present invention, insulating bushings are mounted on a metallic vacuum envelope. A movable bridging member mounted inside the vacuum envelope is used for completing an electric circuit between the stationary insulating bushing. The movable bridging member is supported on an insulating rod, mounted internal of the metallic vacuum envelope. The metallic vacuum envelope is electrically insulated from the vacuum interrupter contacts by the insulating rod and the insulating bushings.

Since the metallic envelope is electrically insulated from the contacts, the metallic envelope can be mounted directly on a grounded operating mechanism. Having the operating mechanism grounded, and no energized parts of the vacuum interrupter exposed improves the safety environment for operating personnel. The operating mechanism is of the spring stored energy type which embodies a novel combination of features resulting in a relatively simple and compact assembly. Contacts used in the present invention are shaped so that a smaller diameter contact slides into a larger diameter contact during a vacuum interrupter closing. This type of contact construction as compared to a butt type contact requires a smaller holding force for a given momentary or continuous current. This type of contact also reduces the tendency of the contacts to bounce.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention, reference may be had to the preferred embodiment, exemplary of the invention, shown in the accompanying drawings in which:

FIG. 1 is a front view partially in section of a vacuum type circuit interrupter assembly embodying the teachings of the present invention with the vacuum interrupter in the closed position;

FIG. 2 is a view of a portion of the vacuum interrupter assembly shown in FIG. 1 showing a portion of the stored energy operating mechanism in the tripped open position;

FIG. 3 is a view of that portion of the operating mechanism shown in FIG. 2 but with the stored energy spring partially charged;

FIG. 4 is a view of that portion of the operating mechanism shown in FIG. 2 but with the stored energy spring completely charged and the operating mechanism in position to be tripped closed;

FIG. 5 is an end view of a portion of the vacuum interrupter assembly shown in FIG. 1;

FIG. 6 is a top view of a portion of the operating mechanism shown in FIG. 1 along the line VI—VI;

FIG. 7 is a sectional view of a prior art butt type contact;

FIG. 8 is a sectional view of a portion of a prior art butt type contact showing a possible current path;

FIG. 9 is a sectional view of a portion of a contact utilizing the teaching of the present invention;

FIG. 10 is a sectional view of a pair of contacts embodying the teachings of the present invention;

FIG. 11 is a top view of the contacts shown in FIG. 10 along the line XI—XI;

FIG. 12 is a side view partially in section of a pair of contacts illustrating another embodiment of the invention; and

FIG. 13 is a view of the lower contact shown in FIG. 12 along the line XII—XII.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, and more particularly to FIG. 1, there is shown a vacuum type circuit interrupter assembly 16 embodying the teaching of the present invention. The vacuum type circuit interrupter assembly 16 comprises a vacuum interrupter 18 and a stored energy operating mechanism 20. As can best be seen in FIG. 5, for a three phase system, three vacuum interrupters 18 would be mounted side by side on top of the operating mechanism 20.

The vacuum interrupter 18 comprises a metal vacuum chamber 22, which has an upper metal end cap 24 and a lower metal end cap 26. Two insulating terminal bushings 28 and 30 are mounted on the upper metal end cap 24. Conducting studs 32 pass through the insulating terminal bushings 28 and 30. Bushings 28 and 30 are mounted on the metal end cap 24 so that the conducting studs 32 pass through openings 38 in the end cap 24 substantially perpendicular to the end cap 24. The conducting studs 32 are electrically insulated from the metal end cap 24. The upper portion 34 of the conducting studs 32 which is external of the vacuum housing 22 are threaded to facilitate attachment of connector or terminal devices. The lower portion of the conducting studs 32 which extends from the bottom of bushings 28 and 30 are internal of the vacuum housing 22 and have a stationary contact 36 attached thereto. A movable bridging member 40 is mounted inside the vacuum housing 22. Movable contacts 42 are mounted on opposite ends of the bridging member 40. The movable contacts 42 are rigidly attached to bridging member 40, but are movable with respect to stationary contacts 36. The bridging member 40 is movable between a closed position where the movable contacts 42 are in engagement with the stationary contacts 36 and an open position where the movable contacts 42 are spaced from the stationary contacts 36 to establish an arcing gap therebetween. When the vacuum interrupter 18 is in the closed position, a continuous current path exists from the stud 32 of bushing 28 through the bridging member 40 to the stud 32 of bushing 30. The bridging member 40 is rigidly attached to an insulating rod 44. A stress grading shield 46 is located at the point where the insulating rod 44 attaches to the bridging member 40 so as to reduce the concentration of electrostatic stress in this area.

A flexible metallic bellows 48 is attached at one end to an opening 50 in the lower end cap 26 and at the other end to the insulating rod 44. The metal bellows 48 is attached in sealing relationship to the opening 50 and the insulating rod 44 so as to provide a vacuum tight seal for the vacuum chamber 22, while permitting movement of the insulating rod 44. The insulating rod 44 is attached to an operating rod 52 which controls the movement of the bridging member 40 between the opened and closed positions. Movement of the operating rod 52 is controlled by the stored energy operating mechanism 20 to be described in detail hereinafter.

A cup-shaped metal shield 54 is mounted around the insulating rod 44 and the metal bellows 48 to prevent the insulating rod 44 and the metal bellows 48 from being bombarded by metallic vapors and particles released during arcing between the movable contacts 42 and the stationary contacts 36. Stress grading shields 56 and 58 are located in appropriate relationship to insulating bushings 28 and 30 so as to reduce the concentration of electrostatic stress.

The insulating rod 44 is mounted internal of the vacuum housing 22 to take advantage of the high dielectric strength of the vacuum in housing 22. The housing 22, end caps 24 and 26, the bellows 48 and operating rod 52 are all electrically insulated from, the conducting stud 32 of bushing 28, the conducting stud 32 of bushing 30, and the bridging member 40 all of which may be at a high potential during operation of the vacuum interrupter 18. As shown in FIG. 1, since the housing 22, the end caps 24 and 26, and the operating rod 52 are electrically insulated from the circuit in the vacuum interrupter 18, the vacuum interrupter 18 can be mounted directly on the operating mechanism 20. No external insulating supports are required for the vacuum interrupter 18.

The stored energy operating mechanism 20 which can best be understood by referring to FIGS. 1 through 6 is of the spring stored energy type. The operating mechanism 20 has a metal housing 66 in which the vacuum interrupters 18 can be directly mounted. The closing operation is performed by the closing cam 68 being rotated in the counterclockwise direction. The closing cam 68 is rigidly attached to an operating shaft 70. Closing levers 72 are rigidly attached to the opposite ends of the closing shaft 70. Closing springs 74 are attached to the levers 72 to supply the energy for closing the vacuum interrupter 18.

For a three phase system three vacuum interrupters 18 are mounted side by side above the operating mechanism 20. An operating rod 52 extends from each of the vacuum interrupters 18 and is secured to a pair of pole unit or contact operating levers 75, 76 or 77 by a pin 78. Each pair of contact operating levers 75, 76 or 77 is rigidly attached to the operating shaft 80. An opening lever 82 is rigidly attached to the operating shaft 80 and opening spring 84 is connected to opening lever 82 to bias the operating shaft 80 in a clockwise direction. To open vacuum interrupter 18 the operating shaft 80 is permitted to rotate in a clockwise direction. To permit the operating mechanism 20 to move from the closed position shown in FIG. 1 to the open position shown in FIG. 2, latch 86 is rotated in a counterclockwise direction about pin 88. Latch 86 can be rotated counterclockwise by operating the plunger mechanism 90. Rotating latch 86 in a counterclockwise direction frees roller 92 attached to the end of lever 94, and lever 94 is then free to be rotated, by the transmitted force from opening spring 84, in a counterclockwise direction. Lever 94 rotates about a fixed pin 96. When lever 94 is forced to rotate in a counterclockwise direction, roller 98 which is attached to cross links 100 is free to move in a downward direction. When roller 98 and cross links 100 are free to move in a generally downward clockwise direction, link 102 which is attached at one end to cross links **100** by pin **104** and at its opposite end to the central contact operating levers **76** by pin **106**, is free to move in a generally downward direction. This permits the spring biased operating shaft **80** to move in a clockwise direction moving the operating rods **52** in a downward direction, and thus opening the vacuum interrupters **18.** FIG. **2** shows operating unit **20** in the open position with the closing spring **74** uncharged. Link **102** is also connected by pin **104** to guide links **108.** The guide links **108** are connected at one end to pin **104** and at the other end to stationary trunnion pins **110** which are on the same center as pin **109**, when the vacuum interrupter **18** is in the closed position. Pin **109** connects roller **98** to the cross links **100.** The guide links **108** operate to control the motion of the operating linkage comprising contact lever **76**, links **102**, and links **100.** The guide links **108** prevent sideward motion of link **102.**

During a closing operation, the closing spring **74** is charged by ratcheting the ratchet wheel **112** which is rigidly attached to the closing shaft **70** in a counterclockwise direction. Ratchet wheel **112** can be rotated in a counterclockwise direction either manually or automatically by means well known in the art. As a ratchet **112** is ratcheted in a counterclockwise direction cam **68** also moves in a counterclockwise direction. At an intermediate position as shown in FIG. **3**, a roller **114**, which is attached to links **100** at its ends opposite roller **98**, is permitted to move along cam **68** in a downward direction. Roller **114** is attached to links **100** by pin **113.** As roller **114** moves in a downward direction, to a position as shown in FIG. **3**, link **100** is pivoted about pin **104** and roller **98** is raised. As roller **98** moves upward, lever **94** which is slightly biased in a clockwise direction moves to an upright position and is again latched rigidly by latch **86.** The ratchet wheel **112** continues being moved in a counterclockwise direction until the closing spring **74** goes over horizontal dead center and biases the cam **68** in a counterclockwise direction. As the closing spring **74** is moved over dead center and starts to bias the cam **68** in a counterclockwise direction, a stop pin **116** which is attached to cam **68** comes to rest against the left-hand end of closing latch **118.** The operating mechanism **20** is now ready to close the vacuum interrupters **18.** This is accomplished by pressing downward on latch **120**, by hand or an electromagnet similar to **90** so as to rotate latch **120** in a clockwise direction. This allows latch **118** to rotate from the force of the closing springs **74** and allows the closing cam **68** to rotate approximately 180° moving the operating mechanism to the closed position as shown in FIG. **1.** As the closing cam **68** rotates in a counterclockwise direction, from the position shown in FIG. **4**, roller **114** and link **100** are moved in an upward clockwise direction. This raises link **102** which in turn rotates lever arm **76** in a counterclockwise direction raising operating rod **52** in an upward direction and forcing the movable contacts **42**, mounted on the bridging member **40**, into engagement with the stationary contacts **36.** Vacuum interrupter **18** is now in the fully closed position and can be tripped open by operating the tripping lever **86.**

The contacts **42** and **36** are of such a construction as to require a low holding force to keep the contacts **42** and **36** in engagement while the vacuum interrupter **18** is closed. In some prior art constructions, as shown in FIG. **7** and FIG. **8**, the vacuum circuit interrupter contacts are of the butt type or disc type. It is well known that when these types of contacts are closed, actual contact is not made over an appreciable area of the contact surface due to the imperfection of the flat surfaces. Actual contact is made at only a few points on the contact surfaces and these points will vary as the contact is used during operation. The result is that current tends to pass from one contact member to another at a few small points as indicated in FIGS. **7** and **8.** As shown in FIG. **8**, the current may enter and leave a point of contact at a sharp angle. The result is that these contacts require relatively high force to hold them in engagement during the making and carrying of high momentary currents. Typically at 25,000 amperes interrupting capacity contact must carry 40,000 amperes momentarily during making or while closed to meet the rating requirements. Existing contact designs require approximately **400** lbs of pressure to meet this requirement. This pressure is high in comparison with contact pressure required for other types of breakers and thus imposes heavy duties on the closing mechanism of vacuum breakers as presently designed. As still higher momentary current interrupting capacities are required even high holding forces will be required. With the type of contact as shown in FIG. **9**, the required holding force can be reduced. Contacts **36** and **42** as shown in FIG. **9** are substantially cup-shaped with a smaller diameter portion of contact **36.** With this shape actual contact will still be limited to a few points. However, current enters and leaves the points of contact in a more nearly straight line and the repulsive force, due to the current in the two contacts, is considerably reduced. Therefore, less holding force is required for this shape of contact for a given momentary current rating. Referring now to FIG. **8**, there is shown an idealized current path for prior art butt type contacts **35** and **41.** An idealized current path for the disclosed cup-shaped contacts is shown in FIG. **9.** I_1' represents the current flowing through contact **41** and I_2' represents the current flowing through contact **35.** D_1 represents a distance separation of the idealized currents I_1' and I_2'. The repulsive force F_1 between current I_1' and I_2' in FIG. **8**, is $F_1 = 2I_1'I_2/D_1$. For the contacts shown in FIG. **9**, I_1 is current through contact **42**, I_2 is current through contact **36**, D_2 is a distance where a major portion of the idealized current paths I_1 and I_2 are parallel and currents I_1 and I_2 are flowing in opposite directions. Repulsion force with the contacts shown in FIG. **9** is $F_2 = 2I_1I_2/D_2$. With $I_1 = I_1'$, and $I_2 = I_2'$ since D_2 is much greater than D_1 it follows that F_2 is proportionally less than F_1.

In the disclosed cup-shaped contacts **36** and **42** contact is made between the inward sloping lip portion **37** of contact **36** and outward sloping lip portion **43** of contact **42.** The lip portion **43** of contact **42** is of a smaller diameter than the lip portion **37** of contact **36.** When contacts **36** and **42** are closed portion **43** moves into and engages portion **37.** If there is any misalignment between contacts **36** and **42**, as they close contacts **36** and **42** are forced into the desired alignment.

In another embodiment of the invention, as shown in FIGS. **10** and **11**, radial fins **140** are added to contacts **36** and **42.** The fins **140** provide an easy pathway for the arc to get away from the point of origin and to provide rapid lengthening of the arc. The fins **140** result in two beneficial results. One, the melting of metals at the point of origin of the arc is reduced and two, the interrupting ability of the single break is increased because of the more rapid dispersion of the metallic vapors and particles at current zero, due to increased arc length and open area.

Referring now to FIGS. **12** and **13**, there is shown a contact construction used with another embodiment of the invention. The construction of the contacts **136** and **138** as shown in FIG. **12**, substantially reduces contact bounce upon closing, reduces the required holding force on the contacts while they are closed, and during interrupter opening, rapidly moves the arc **150** until it is extinguished. As shown in FIG. **12**, the contacts **136** and **138** are of a generally cup-shaped configuration, with each contact **136** and **138** being divided into segments **141** and **142**, respectively, so as to form a cylindrical or circular cluster of fingers **141** and **142**. The multiple contact fingers **141** have an inward sloping contact portion **126** which engages an outward sloping contact portion **128** of contact fingers **142** when the vacuum interrupter **18** is closed. During engagement portion **128** of contact **138** is generally forced within the confines of contact **136**, and fingers **141** are forced outward. Contact **138** is of a smaller outside diameter than contact **136** so that contact engagement is obtained by a portion of the smaller contact **138** sliding into the larger contact **136**. The fingers **142** of the smaller diameter contact **138** deflecting inward and the fingers **141** of the larger diameter contacts **136** deflecting outward. The result is that each finger **141** bears upon a finger **142** of the opposite contact with a definite pressure. The fingers **142** of the smaller diameter contact **138** may be made relatively stiff so that most of the deflection occurs in the fingers **141** of contact **136**. A disc **144** is mounted internal of the smaller diameter contact **138** to limit the inward deflection of the fingers **142** of contact **138**. Contacts **136** and **138** are disposed in the vacuum interrupter **18**, so that when the vacuum interrupter **18** is closed, each finger **141** of contact **136** overlaps a corresponding finger **142** of contact **138**.

As inward deflection of the fingers **142** of contact **138** are angled in a generally inward and clockwise direction. The slots **146** in contact **136** are also angled in the same direction as the slot **146** of contact **138** so as to move an arc **150** in a circular direction around the contacts **136** and **138**, as shown by the arrow **152** in FIG. **12**. The contacts **136** and **138**, shown in FIG. **12**, will require a low engagement force as compared to a butt type contact for a given momentary or continuous current rating. The tendency of contacts **136** and **138** to bounce upon engagement will be very low and any bounce will be substantially damped out by the sliding friction of engagement. Due to the flexible nature of the fingers **141** and **142** of contacts **136** and **138** multiple contact points will be established and less contact material will be required than in prior art butt type contacts that make contact at only a few points. The tendency of the finger clusters **141** and **142** to contract when carrying current enhances the contacts **136** and **138** momentary current carrying ability. Contacts **136** and **138** are made from a material having a good spring and low resistivity characteristics such as zirconium-copper, cadmium-copper or chromium-copper. To improve anti-welding characteristics, and decreased tendency to chop on low current each finger can be tipped with a material having the desired characteristics. When contacts **136** and **138** are in engagement the passage of current through the contact fingers **141** and **142** will tend to cause the contact to contract in diameter. Disc **144** inside of contact **138** limits the contraction of contact **138** and as the fingers **141** of contact **136** tend to contract contact pressure is increased while current increases. This increased contact pressure during operation greatly reduces the required holding force for contacts **136** and **138** constructed as shown in FIG. **12**.

When the contacts **136** and **138** are separated during circuit interruption an arc **150** will be formed therebetween. The arc **150** will rotate rapidly around the contacts **136** and **138** in a direction generally as indicated by arrow **152** in FIG. **12**. The arc **150** will continue to rotate until extinction, which on an alternating current system occurs near the first current zero. The arc **150** will rapidly rotate around the inner circumferential surface **137** of contact **138** and outer circumferential surface **135** of contact **136** until it is extinguished.

It is to be understood that the vacuum interrupter **16** can be operated by any suitable type of mechanism other than that described under **20**. Also, three interrupters **18** could be enclosed in one vacuum envelope if that is desired.

A vacuum type circuit interrupter assembly **16** constructed in accordance with the teaching of the present invention has several advantages over existing prior art interrupter assemblies. For example, the insulating operating rod **46** being inside the vacuum chamber **22** can be considerably shorter than insulating operating rods mounted externally in air. For 95 KV basic insulation impulse level BIL it would need to be only ½ to 1 inch long as compared to 7 to 9 inches in air. This reduces the overall sides of the interrupter assembly **16** at the expense of only a small increase in the size of the vacuum chamber **22**. Another advantage of the disclosed vacuum interrupter assembly **16** is the use of a housing **22** which is electrically insulated from the vacuum interrupter **18** contacts. This permits the mounting of the vacuum interrupter directly on a grounded metal structure such as the chassis **66** of the operator assembly **20**. This simplifies the construction and use in that the only external insulation for the interrupter is in the main stud and bushings **28** and **30**. Another advantage of the present construction is that the two break contact operation permits a higher voltage interrupting capacity than possible in a single break construction. This results in a reduction in cost and size as compared to single break units. Still another advantage is that the interrupter **18** terminals **34** are stationary. Another advantage of the shown construction is that operating assembly **20** is simple, compact and easier to construct than prior art spring stored energy mechanisms. Yet another advantage of the present vacuum interrupter assembly **16** is that the contacts **36** and **42** or **136** and **138** require little holding force and momentary current carrying capacity and closing capability will be greatly increased over prior art.

What I claim is:

1. A vacuum type circuit interrupter assembly comprising, a vacuum interrupter having contacts movable between open and closed positions and a spring stored energy operating mechanism comprising: a frame; a closing spring; operating rod means connected to said vacuum interrupter; a rotatably mounted crankshaft;

means for driving the crankshaft to load said closing spring; closing latch means for releasably retaining said closing spring in the loaded condition; cam means rigidly attached to said crankshaft; a contact operating lever attached to said operating rod means; a tripping latch means; a cross link means having two free ends, one end supported by said tripping latch means and having the other end supported by said cam means; a vertical link pinned at one end to said contact operating lever and pinned at its other end to said cross link means remote from said cross link means ends; said cam means being driven by said crankshaft when said closing latch means is released, to release said closing spring, and raise said cross link means and said vertical link and said contact operating lever and said operating rod; whereby said vacuum interrupter contacts are moved to their closed position.

2. A vacuum type circuit interrupter assembly as claimed in claim 1 wherein, said vacuum interrupter is mounted directly on said frame of said operating mechanism, and said vacuum interrupter comprises a vacuum chamber, stationary contact means, movable contact means, being movable between a first closed position where said stationary contact means are in engagement with said movable contact means and a second open position where said movable contact means are spaced from said stationary contact means, said operating rod means being connected to said movable contact means, said operating rod means extending external of said vacuum housing.

3. A vacuum type circuit interrupter assembly as claimed in claim 2 including a plurality of vacuum interrupters mounted side by side on said frame of said operating mechanism.

4. A vacuum type circuit interrupter assembly as claimed in claim 2 including multiple vacuum interrupters mounted on said frame, an operating shaft rotatably mounted on the frame of said operating mechanism, multiple contact unit operating levers, each of said pole unit operating levers being mounted beneath an associated vacuum interrupter, one end of each of said contact operating levers rigidly attached to said operating shaft and the other end of each of said contact unit operating levers being attached to said operating rod from said associated vacuum interrupter.

5. A vacuum type circuit interrupter assembly as claimed in claim 1 wherein said tripping means comprises; a tripping plunger; a tripping lever; and a tripping latch member; with the vacuum interrupter in said first closed position, said tripping lever is held in a generally vertical alignment by said tripping latch; said tripping lever when in the vertical position supporting one end of said cross link means; said tripping plunger when activated interacts with said tripping latch to release said vertical tripping lever to permit said vertical tripping lever to rotate and allow the end of said cross link means supported by said vertical tripping member, when said vacuum interrupter is in said closed position, to move in a generally downward direction; as said cross link means moves in a downward direction said vacuum interrupter moves from said first closed position to said second opened position.

6. A vacuum type circuit interrupter assembly comprising, a vacuum interrupter having contacts movable between open and closed positions and a spring stored energy operating mechanism comprising: a frame; a closing spring; operating rod means connected to said vacuum interrupter; a rotatably mounted crankshaft; means for driving the crankshaft to load said closing spring; closing latch means for releasably retaining said closing spring in the loaded condition; cam means rigidly attached to said crankshaft, a contact operating lever attached to said operating rod means; a tripping latch means; a cross link means having two free ends, one end supported by said tripping latch means and having the other end supported by said cam means; a vertical link pinned at one end to said contact operating lever and pinned at its other end to said cross link means remote from said cross link means ends; said cam means being driven by said crankshaft when said closing latch means is released, to release said closing spring, and raise said cross link means and said vertical link and said contact operating lever and said operating rod; and including a pair of guide links, a first pin means attaching said vertical link to said cross linked means, a second pin means, said second pin means being fixed with respect to said frame, one set of ends of said pair of guide links being pivotally attached to said second fixed pin means, the other ends of said pair of guide links being pivotally attached to said first pin means to guide said cross link means and said vertical link in a predetermined direction.

7. A vacuum type circuit interrupter assembly as claimed in claim 2 wherein said vacuum interrupter comprises a bridging member, a first bushing mounted on said vacuum chamber generally perpendicular to said bridging member, a second bushing mounted on said vacuum chamber generally parallel to said first bushing, said stationary contact means being mounted on said first bushing and said second bushing, said movable contact means being mounted on said bridging member, said bridging member being movable to move said movable contacts from said first position in engagement with said stationary contact means to said second position separated from said stationary contact means, mounting means for connecting said operating rod to said bridging member.

8. A combination as claimed in claim 7 wherein said connecting means comprises an insulating member, said insulating member being mounted between said bridging member and said operating rod to electrically insulate said operating rod and said vacuum chamber from said bridging member.

9. A vacuum type circuit interrupter assembly as claimed in claim 2, wherein, said stationary contact means comprises at least one stationary contact being generally cup-shaped, a first contact surface formed at the inner lip of said stationary cup-shaped contact, said first contact surface sloping generally inward, said movable contact means comprising at least one movable contact, said movable contact being generally cup-shaped, a second contact surface formed at the outer lip of said movable contact, said second contact surface sloping generally outward from said movable cup-shaped contact, said movable contact and said stationary contacts being disposed in said vacuum interrupter so that when said movable contact means engages said stationary contact means, a portion of said second contact surface of said movable contact engages said first contact surface of said stationary contact and a portion of said second contact surface moves inside the confines of said stationary cup-shaped contact.

10. The combination as claimed in claim 9 including, a first plurality of fins extending from said stationary

contact, and a second plurality of fins extending from said movable contact.

11. The combination as claimed in claim **9** wherein; said stationary contact has multiple slots formed in the side thereof, the slots in said stationary contact being formed in a generally circumferential and radial direction; said movable contact has multiple slots formed in the side thereof, the slots in said movable contact being formed in a generally radial and circumferential direction; said stationary contact and said movable contact being disposed in said vacuum interrupter with the slots of said stationary contact and the slots of said movable contact pointing in the same direction, so that when said movable contact separates from said stationary contacts and an arc is formed therebetween the arc rotates around the outer circumference of said stationary contact and the inner circumference of said movable contact.

12. A vacuum type circuit interrupter assembly as claimed in claim **2** wherein said stationary contact means comprises a generally first cup-shaped stationary contact, said cup-shaped stationary contact comprises multiple contact fingers, said multiple contact fingers being arranged in a generally annular ring and forming the side of said cup-shaped stationary contact, a first contact surface formed at the free ends of said contact fingers sloping towards the center of said cup-shaped stationary contact, said movable contact means comprises a second generally cup-shaped contact, said cup-shaped contact comprising multiple contact fingers, said contact fingers being arranged in a generally annular ring and forming the side of said cup-shaped movable contact, a second contact surface formed on the free ends of said contact fingers and sloping generally away from the center of said cup-shaped movable contact, said stationary contact and said movable contact disposed in said vacuum interrupter so that when said stationary contact is engaged by said movable contact said first contact surface engages said second contact surface with a portion of said second contact surface passing inside the confines of said stationary contact, the fingers of said stationary contact being deflected outward and the fingers of said movable contact being deflected inward to give multiple contact points under high contact pressure.

13. The combination as claimed in claim **12** including a disc mounted internal of said movable contact, said disc limiting the amount of possible inward deflection of said contact fingers forming the side of said movable cup-shaped contacts.

14. A vacuum type circuit interrupter as claimed in claim **12** wherein said stationary contact and said movable contact have an equal number of contact fingers, and said stationary contact and said movable contacts are disposed in said vacuum interrupter so that when said vacuum interrupter is in said first closed position each finger of said movable contact engages a mating finger on said stationary contact.

15. A circuit breaker spring stored energy operating assembly for a circuit breaker having contacts movable between open and closed positions, comprising:

a frame;

a closing spring;

operating means connected to the circuit breaker, and contacts for moving the contacts;

a rotatably mounted crankshaft supported from said frame;

means for driving the crankshaft to load said closing spring;

closing latch means for releasably retaining said closing spring in the loaded condition;

cam means rigidly attached to said rotatably mounted crankshaft;

a tripping latch means;

a cross link means having two free ends, one end supported by said tripping latch means and having the other end supported by said cam means;

a vertical link pinned at one end to said contact operating lever and pinned at its other end to said cross link means intermediate the two free ends; and,

said cam means driven by said crankshaft when said closing latch means is released, to release said closing spring, raise said cross link means, said vertical link and said operating means whereby said circuit breaker contacts are moved to their closed position.

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