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Skreiner

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[54] **CIRCUIT BREAKER OPERATING MECHANISM WITH HIGH-SPEED LOW-ENERGY TRIPPING MEANS**

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[73] Assignee: **General Electric Company,** Philadelphia, Pa.

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[52] U.S. Cl. ..... **200/318,** 200/153 H, 335/171, 335/21

[51] **Int. Cl.** **H01h 9/20**

[58] **Field of Search**... 200/82 R, 82 B, 82 C, 148 F, 200/153 G, 153 H, 153 SC, 169 R, 169 C; 335/21, 165–168, 171

[56] **References Cited**

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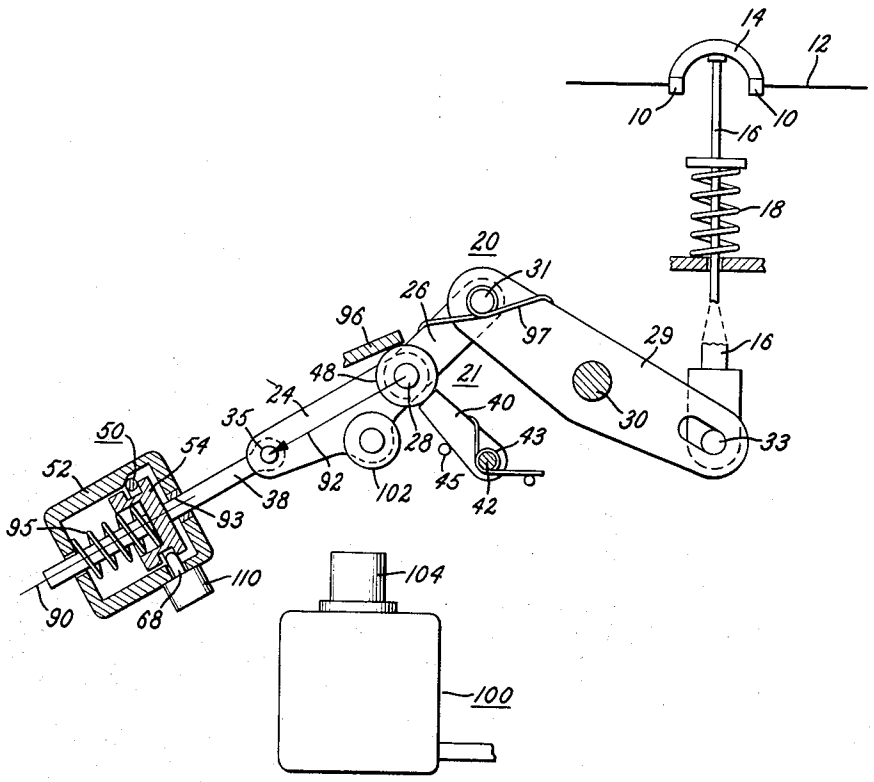
1,827,626	10/1931	Thumim	335/191
3,450,955	6/1969	Johnson	335/21
3,646,292	2/1972	Barkan	200/148 F
3,729,065	4/1973	Baskerville	200/153 SC

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[57] **ABSTRACT**

A circuit breaker operating mechanism comprises two toggle links pivotally interconnected at a knee. One of the toggle links is coupled to a contact-actuating member, and the other is pivotally supported on a pivot pin spaced from the knee. Latching means normally holds the pivot pin in a fixed position but is releasable to release said pivot pin and thus render the toggle links incapable of holding the contact-actuating member in its closed position. The latching means comprises a piston, a cylinder in which the piston is reciprocable, means for mounting said pivot pin on the piston, and a ring latch around the outer periphery of the piston normally latching the piston to the cylinder. The ring latch is operable to release the piston from latching relationship with the cylinder, thus releasing the pivot pin and initiating circuit-breaker opening.

4 Claims, 5 Drawing Figures



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SHEET 1 OF 2

Fig. 1.

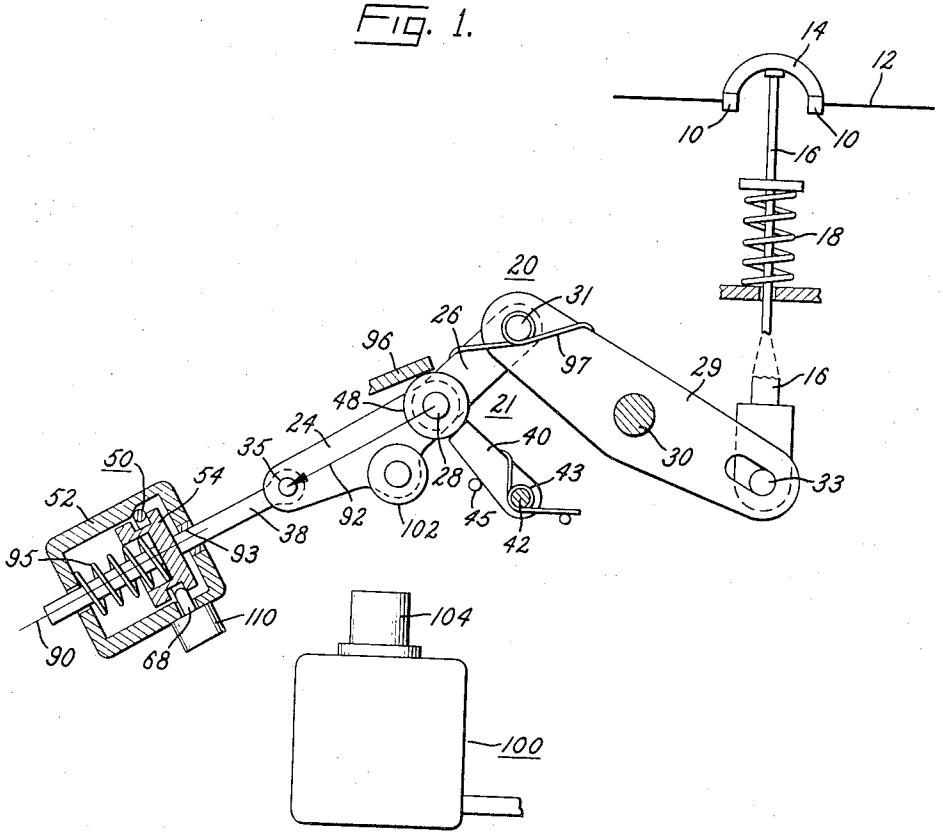


Fig. 2.

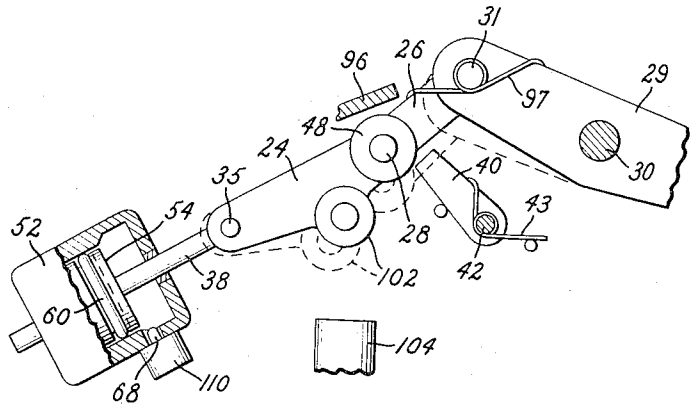


Fig. 3.

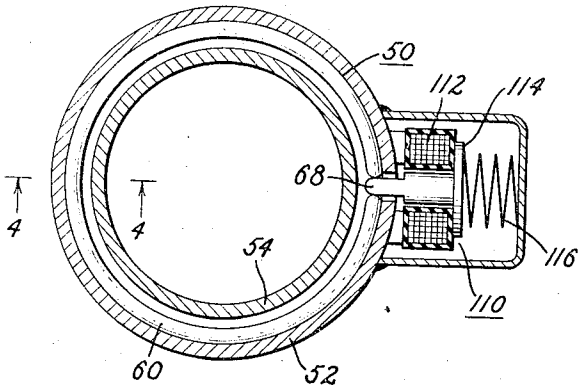


Fig. 4.

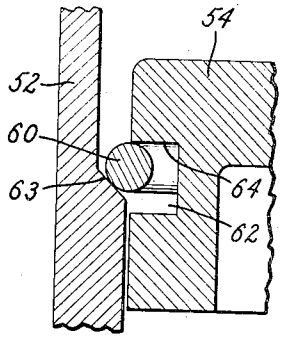
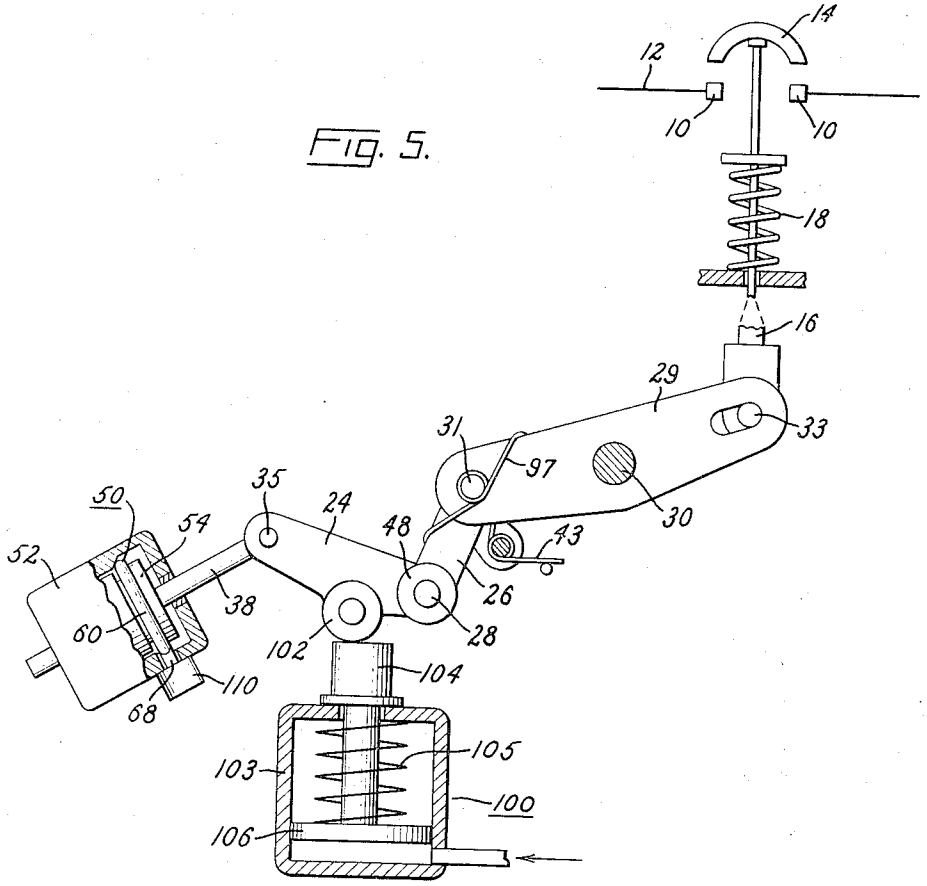


Fig. 5.



CIRCUIT BREAKER OPERATING MECHANISM WITH HIGH-SPEED LOW-ENERGY TRIPPING MEANS

BACKGROUND

This invention relates to an operating mechanism for an electric circuit breaker and, more particularly, relates to a mechanically trip-free operating mechanism which includes tripping means capable of being operated at exceptionally high speeds by small amounts of tripping energy.

A typical mechanically trip-free operating mechanism for a circuit breaker comprises a toggle linkage that has one end coupled to the movable contact-actuating member of the circuit breaker and its opposite end supported on a pivot pin which is normally latched in a fixed position by a trip latch. If the latch is tripped to release the pivot pin, the toggle becomes ineffective to transmit closing force or hold-closed force to the movable contact-actuating member, thus allowing the circuit breaker to open under the influence of its opening spring.

In certain circuit breakers, the latch that holds the above-described pivot pin in place can be a simple latch member acting directly on the pivot pin (as shown, for example, at 31 in U.S. Pat. No. 2,794,181-Frank), but release of such a latch member requires a large amount of tripping energy, particularly if the circuit breaker is a large one. To reduce the energy required for tripping, it has been customary to provide a latching toggle or a series of latching toggles for normally holding the pivot pin in its latched position. (An example of such a latching toggle appears in U.S. Pat. No. 1,827,626—Thumim,) While the presence of such a latching toggle or series of latching toggles reduces the energy required for tripping, it also results in a relatively complex tripping mechanism which is still not as fast as sometimes required. A factor detracting from the speed of a latching toggle is that its effective mass is high when in or near its usual latching position near toggle-center.

The mechanisms illustrated in the above noted Frank and Thumim patents contain still another toggle which must be moved out of a position near center to effect tripping. This toggle (25, 24, 23, 15 in Frank and 18, 17, 7, 6 in Thumim) is one constituted by the usual guide link for the above-described pivot pin, one of the links of the main toggle, and the connecting pivot pin acting as the knee of this toggle. While the presence of this toggle contributes to reduced tripping force requirements, it also reduces the speed of opening because of the time required for moving this relatively massive toggle out of its latching position near center.

SUMMARY

A general object of my invention is to provide tripping means for a mechanically trip-free operating mechanism which can be operated at exceptionally high speed by small amounts of tripping energy.

Another object is to construct the operating mechanism in such a way that circuit-breaker opening can be effected with small amounts of tripping energy without the need for moving any toggles out of a position near toggle-center during tripping or initial opening movement.

In carrying out the invention in one form, I provide latching means that comprises a piston, a cylinder in which said piston is reciprocable, and a ring latch around the outer periphery of the piston normally latching the piston to the cylinder. The above-described pivot pin that supports one link of the main operating toggle is mounted on the piston and is carried thereby. The ring latch comprises a split ring seated in a groove in the periphery of the piston and a latching element normally fitting between the ends of the split ring for holding the ring in an expanded condition for blocking movement of the piston with respect to the cylinder. This latching element can be withdrawn from its normal position to allow the ring to contract into a disabled position where the ring is ineffective to continue blocking movement of the piston with respect to the cylinder, thus releasing the piston and the pivot pin carried thereby and initiating circuit-breaker opening.

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 schematic view of a circuit-breaker operating mechanism embodying one form of the invention. The operating mechanism is depicted in its circuit-breaker closed position.

FIG. **2** shows the operating mechanism in two separate positions through which it passes during opening. One position is depicted in solid lines, and a later position is depicted in dotted lines.

FIG. **3** is a detailed view of a ring latch constituting a part of the operating mechanism of FIG. **1.**

FIG. **4** is a sectional view along the line **4—4** of FIG. **3.**

FIG. **5** shows the operating mechanism of FIG. **1** in its fully-open position.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Referring now to FIG. **1,** the circuit breaker depicted therein comprises a set of spaced-apart stationary contacts **10** connected in a power line **12.** Bridging the stationary contacts **10** is a movable bridging contact **14** shown in its closed position. For actuating the bridging contact, an actuating rod **16** of insulating material is connected thereto. Opening of a circuit breaker is effected by driving rod **16** upwardly from its position of FIG. **1,** and closing is effected by returning the rod in a downward direction to its position of FIG. **1.** Opening force is derived from a compression-type opening spring **18** which, upon release, drives the rod **16** upwardly.

For closing the circuit breaker and also for holding it closed, an operating mechanism **20** is provided. This operating mechanism **20** comprises a toggle **21** which comprises two toggle links **24** and **26** having their adjacent ends pivotally interconnected by a connecting pin **28** that forms a knee for the toggle. One of the toggle links **26** is coupled to the actuating rod **16** by means of an operating crank **29** that is pivotally mounted on a fixed pivot **30.** The right hand end of toggle link **26** is pivotally connected to crank **29** by a pivot pin **31,** and the right hand end of crank **29** is connected to the actu-

ating rod **16** through a suitable pivotal connection **33.**

For pivotally supporting the left hand end of the other toggle link **24,** a pivot pin **35** is provided. This pivot pin **35** is mounted on a piston rod **38** which is normally held in its position of FIG. **1,** as will soon be described. When the circuit breaker is in its closed position, as shown in FIG. **1,** the toggle **21** occupies a slightly undercenter position and has a tendency to collapse downwardly at its knee **28.** For preventing such collapse, a conventional prop **40** is provided. This prop is pivotally supported on a stationary pivot **42** and is biased into its position of FIG. **1** against a stop **45** by a torsion spring **43.** A roller **48** on the knee pin **28** bears against the upper surface of the prop **40** and thus prevents the toggle from collapsing downwardly while in its position of FIG. **1.**

So long as the toggle-supporting pivot pin **35** is held in its position of FIG. **1,** the circuit breaker is prevented from opening. Thus, in its condition of FIG. **1,** the toggle is able to transmit closing or hold-closed force to the actuating rod **16.** When, however, the pivot pin **35** is released, the opening spring **18,** acting through output crank **29,** drives toggle **21** bodily to the left, thus allowing circuit-breaker opening to proceed. After an initial amount of opening has occurred and the parts have entered their solid line position of FIG. **2,** the knee roller **48** has moved off the prop **40** and the toggle **21** is free to collapse downwardly at its knee toward its position of FIG. **5** to permit further opening travel of the operating rod **16.** The dotted lines of FIG. **2** illustrate the parts shortly after such collapse has begun.

For releasably holding the pivot pin **35** in its position of FIG. **1,** I rely upon a ring latch **50** similar to that shown and described in U.S. Pat. No. 3,646,292—Barkan. This ring latch cooperates with a cylinder **52** and a piston **54** to effect the desired holding or latching action. Cylinder **52** is a stationary element, and piston **54** is reciprocable within the cylinder. The previously-mentioned piston rod **38** is fixed to piston **54.**

The ring latch **50,** which is shown in more detail in FIGS. **3** and **4,** comprises a split ring **60** of circular cross section that is carried in an annular groove **62** in the piston **54.** This piston ring **60** is a resilient member that has a tendency to expand in diameter, but its expansion is limited by the internal wall of cylinder **52** and specifically by a conical shoulder **63** on the internal wall of cylinder **52.** Referring to FIGS. **1** and **4,** a leftward force on piston **54** is transmitted to the piston ring through groove surface **64** and urges the piston ring against conical shoulder **63.** The reaction force developed on the ring by the conical shoulder tends to contract the ring. The ring is normally prevented from contracting beyond the position shown in FIG. **4** by a latching member **68,** shown in FIGS. **1** and **3,** that fits between the ends of the split ring. When latching member **68** is withdrawn radially outward from this position, the reaction force from conical shoulder **63** on the cylinder forces the ring to contract completely into groove **62,** thus releasing the piston for leftward movement. When the piston is so released, it allows piston rod **38** and the entire toggle **21** to move rapidly to the left under the bias of opening spring **18,** thereby allowing the output crank **29** to pivot at high speed about point **30** in a counterclockwise circuit-breaker opening direction.

In a ring latch such as shown at **50,** the latching force on the piston is well distributed around the periphery of the piston, which is a very large area compared to the active area in most latches; and, partially as a result of this, a relatively small releasing force can be used to release a very large force on the piston. In a typical ring latch such as illustrated, the force being released may be 100 or more times the releasing force, as compared to a typical maximum of about five times with a simple prop type latch. (The ratio of the force being released to the releasing force is referred to herein as the mechanical advantage of the latch.)

In the illustrated operating mechanism, I capitalize on the high mechanical advantage of the ring latch by having it act directly on the pivot pin **35** without any intermediate toggle or series of toggles. In some prior mechanisms, prop latches have been provided acting directly on the pivot pin **35,** but because of the low mechanical advantage of such a latch, large amounts of tripping energy, too high for many applications, have been needed.

To reduce the amount of tripping energy required, it has been customary to provide a single latching toggle or a series of latching toggles between the latching member and the pivot pin. While such an arrangement does have reduced tripping energy requirements, it has the disadvantage of being complex and not as fast as sometimes required. As already pointed out hereinabove, a factor detracting from the operating speed of a latching toggle is that its effective mass is high when in its normal latching position near toggle center. By using a ring latch such as **50** with its high mechanical advantage, I am able to dispense with the heretofore-used latching toggles and still trip rapidly with only a small amount of tripping energy.

Another feature which many prior mechanisms have relied upon to reduce the tripping energy requirements is to mount the toggle-supporting pivot pin (e.g., my pin **35**) on a guide link which is pivotally mounted so as to form a latching toggle with an adjacent link of the main toggle. Such a latching toggle is illustrated at **25, 24, 23, 15** in the aforesaid Frank U.S. Pat. No. 2,794,881. The presence of such a toggle detracts from opening speed because when the circuit breaker is closed, such toggle is typically latched in a position near dead center, where it has a high effective mass opposing initial opening movement of the toggle away from dead center. I am able to dispense with this additional toggle and its retarding effect inasmuch as my high mechanical-advantage latch does not require the assistance of such a toggle to reduce tripping energy. The absence of this toggle effect will be apparent from FIG. **1,** where it can be seen that the reference line **90** along which the piston **54** is movable is substantially in line with the line of action **92** of the opening force applied by opening spring **18.** Initial opening motion of both the toggle link **24** and piston rod **38** occurs along this line **90, 92,** with no toggle effect being present between these parts to delay such opening movement. Although I prefer to arrange the parts so that reference lines **90** and **92** are substantially in line or parallel, a moderate degree of angularity between them is permissible. In neither case is any significant toggle effect present between the parts **38** and **24.** The more in-line or parallel these lines are, the more reduced will be the transverse force on piston **54** and piston rod **38,** thus reducing any tendency for them to bind within their surrounding guide surfaces, such as **93.**

After the opening movement has proceeded beyond its initial stage, the knee roller **48** has moved off the prop **40,** thus allowing the toggle **21** to collapse downwardly at its knee in a conventional manner. FIG. **2,** in solid lines, shows the mechanism at the instant when such initial movement has occurred and at the point where the toggle **21** is starting to collapse. In dotted lines, FIG. **2** shows the parts at a later stage after the toggle has partially collapsed and additional leftward motion of piston **54** has occurred.

In FIG. **5** the piston **54** has been reset and toggle **21** has fully collapsed so that the breaker is fully open. Resetting of the piston **54** to its position of FIG. **5** is effected by a compression type resetting spring **95** (FIG. **1**) located between the piston and the left hand end wall of cylinder **52.** This resetting spring **95** is weak compared to the opening spring **18** and cannot effectively oppose initial opening.

For assuring that the toggle **21** will not enter an overcenter position and collapse in an upward direction, a suitable buffer indicated schematically at **96** (FIG. **1**) is provided. This buffer is positioned to prevent entry of the knee roller **48** into an overcenter position. To assure prompt collapse of the toggle **21** during an opening operation, a torsion spring **97** is provided about pivot **31.** This torsion spring biases the toggle link **26** in a counterclockwise direction about pivot **31.**

Closing of the circuit breaker is effected by driving the operating mechanism from its position of FIG. **5** back into its position of FIG. **1.** In the illustrated embodiment, this is done with a suitable fluid-actuated closing operator **100** comprising a cylinder **103** and a piston **106** reciprocable therein. Piston **106** carries an upwardly projecting plunger **104.** When the operator is energized, the piston **106** and plunger **104** move upwardly, driving a roller **102** on the toggle link **24** in an upward direction to extend the toggle **21.** At the end of this closing operation, the closing operator **100** is deenergized, and its driving parts **106, 104** rapidly return to their reset position of FIG. **5** under the bias of a suitable reset spring **105.** It is to be understood that other conventional types of closing operators, e.g., spring-type or solenoid-type, can equally well be used with my mechanism.

For tripping the ring latch **50** to initiate an opening operation, I provide a suitable solenoid **110** preferably of the repulsion type. This solenoid, which is best shown in FIG. **3,** has its stationary coil structure **112** mounted on the stationary cylinder **52** and an armature **114** coupled to the latching element **68.** When the coil structure is appropriately energized, the armature **114** is repelled therefrom, and it moves at high speed to rapidly withdraw the latching element **68** from between the ends of the piston ring **60** to release the ring latch. A suitable compression spring **116** resets the armature to its normal position of FIG. **3** after such a releasing operation.

Another advantage of the ring latch in a circuit-breaker operating mechanism is that the ring latch can readily be made insensitive to the mechanical shocks typically encountered in such an application. Such shocks have a tendency to jar the armature of a tripping solenoid out of its normal position, thereby producing unintentional tripping on certain rare occasions. Such shocks usually act in the plane of movement of the parts of the operating mechanism or parallel to this plane. By positioning the latching element **68** in a plane that is disposed at a substantial angle to the plane of movement of the parts of the operating mechanism such as pivot pin **35,** I can materially reduce the sensitivity of the ring latch to these shocks, thereby decreasing the chances for such unintentional tripping. In a ring type latch, the split in the latching ring and, hence, the latching element **68** can be located at any circumferential point about the piston periphery. Although the drawing shows the latching element **68** in the same plane as the plane of movement of the operating mechanism, this has been done merely to simplify the drawing. In a preferred form of the invention, the latching element **68** is disposed in a plane approximately perpendicular to the plane of movement of the operating mechanism.

While I have shown and described a particular embodiment 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 U.S. Letters Patent is:

1. In an operating mechanism for a circuit breaker comprising a movable contact-actuating member,

a. a toggle comprising first and second toggle links and a connecting pin pivotally interconnecting said toggle links to form a knee for the toggle,

b. means for coupling said first toggle link to said movable contact-actuating member,

c. a pivot pin on which said second toggle link is pivotally supported at a point spaced from said knee,

d. latching means for normally holding said pivot pin in a fixed position so that hold-closed force for said circuit breaker can be transmitted through said toggle to said contact-actuating member to hold said circuit breaker closed, said latching means being releasable to release said pivot pin and thus render said toggle incapable of continuing to transmit hold-closed force to said contact-actuating member,

e. said latching means comprising a piston member, a cylinder member in which said piston member is reciprocable, means for mounting said pivot pin on one of said piston or cylinder members, and a ring latch around the outer periphery of said piston member normally latching said piston member to said cylinder member,

f. said ring latch comprising a split ring seated in a groove in the periphery of said piston member and a latching element normally fitting between the ends of said split ring for holding said ring in an expanded condition for blocking movement of said piston member with respect to said cylinger member, said latching element being withdrawable from its position between said ends to allow said ring to contract into a disabled position where the ring is ineffective to continue to block movement of said piston member with respect to said cylinder member.

2. The operating mechanism of claim **1** in which:

a. said piston member is a movable member, and

b. said latching means comprises a movable element carried by said piston member, said pivot pin being mounted on said movable element.

3. The circuit breaker operating mechanism of claim **1** in which:

a. circuit-breaker opening means is provided for applying opening force through said toggle to said pivot pin,

b. said opening force acts in a predetermined direction on said pivot pin when the circuit breaker is closed,

c. the path of movement of said piston member with respect to said cylinder member is generally parallel to said predetermined direction.

4. The circuit breaker of claim **1** in which:

a. said pivot pin is movable in a predetermined first plane when released, and

b. said latching element is movable in a predetermined second plane that is disposed at a substantial angle to said first plane, thereby decreasing the sensitivity of said latching means to mechanical shocks acting in said first plane.

* * * * *