July 2, 1968 W. V. BRATKOWSKI ET AL 3,391,358

CIRCUIT BREAKER WITH IMPROVED MAGNETIC TRIP MEANS

Filed March 2, 1965 6 Sheets-Sheet 1

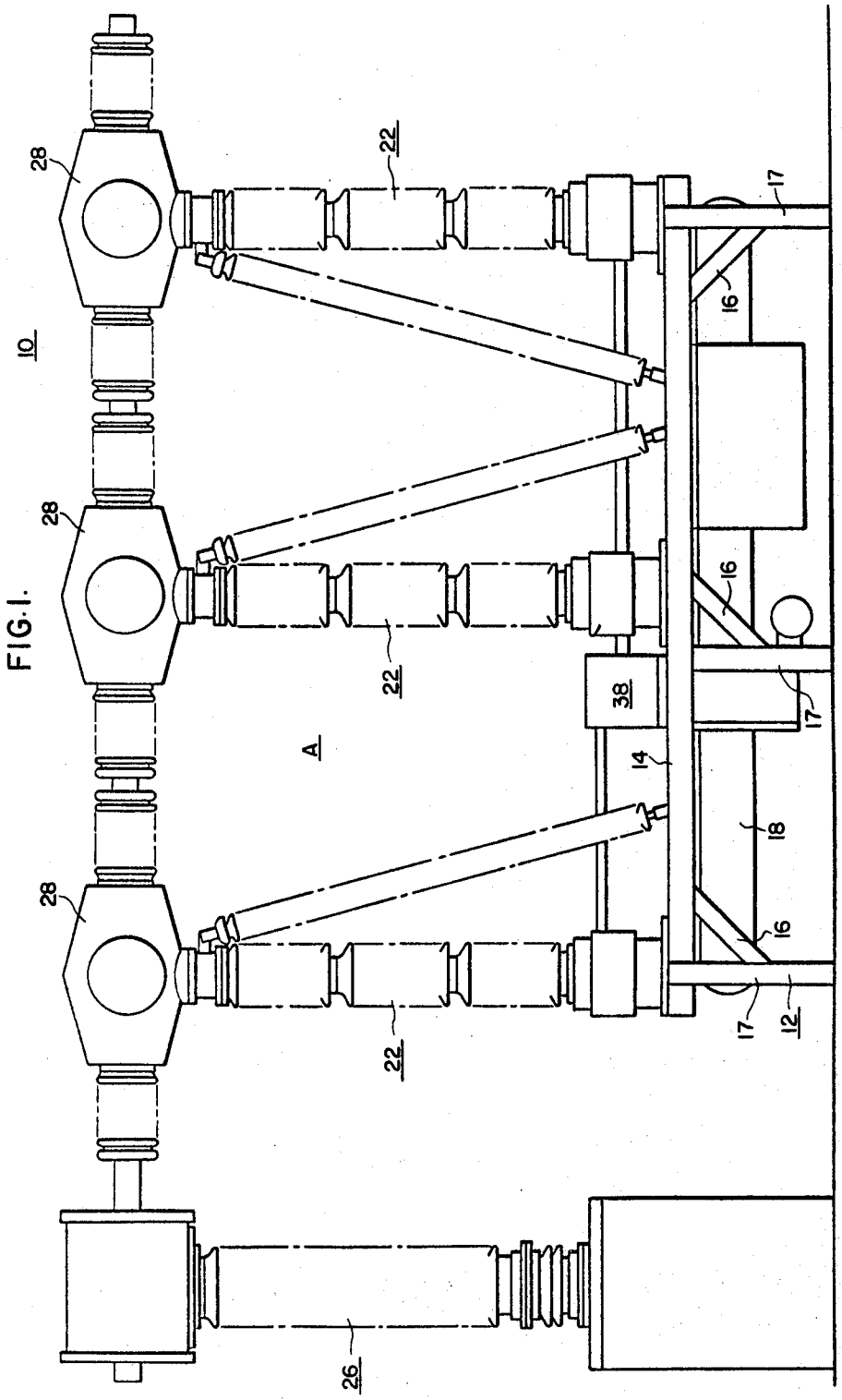

FIG. 1.

CIRCUIT BREAKER WITH IMPROVED MAGNETIC TRIP MEANS

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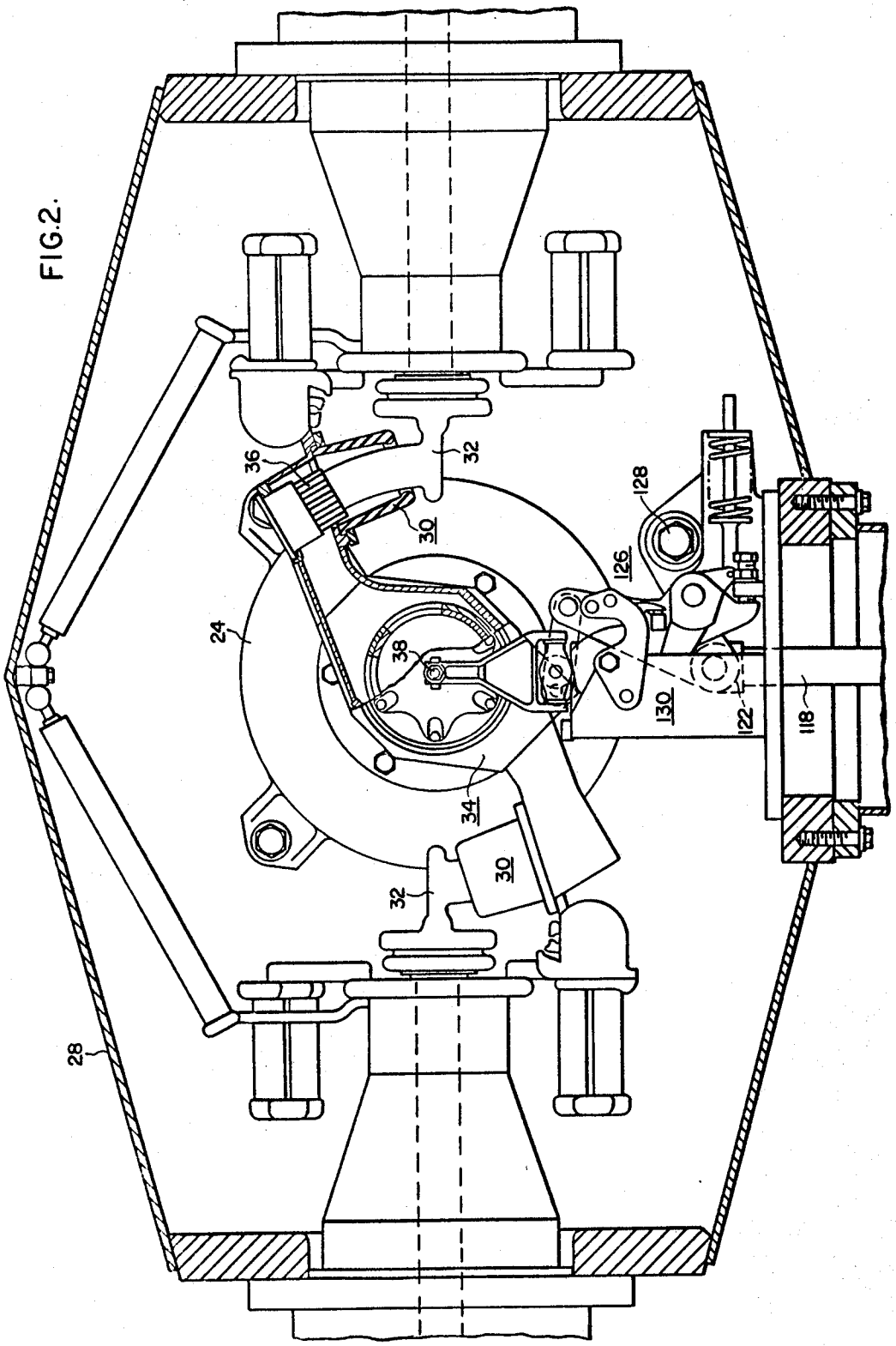
FIG.2.



CIRCUIT BREAKER WITH IMPROVED MAGNETIC TRIP MEANS

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FIG.3.

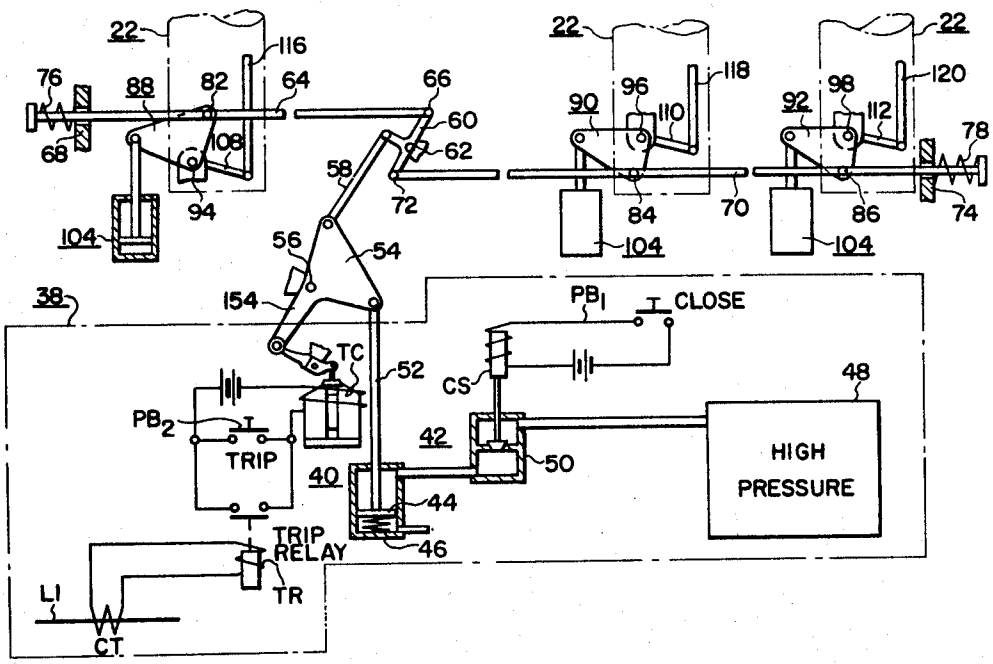
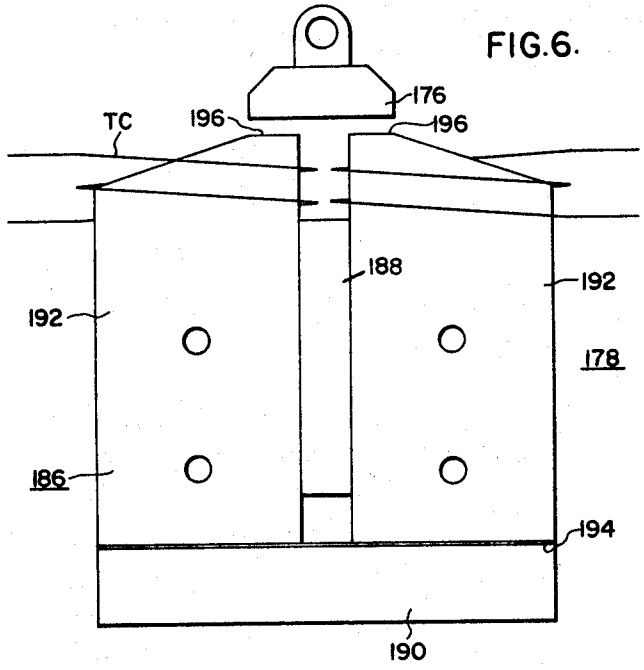
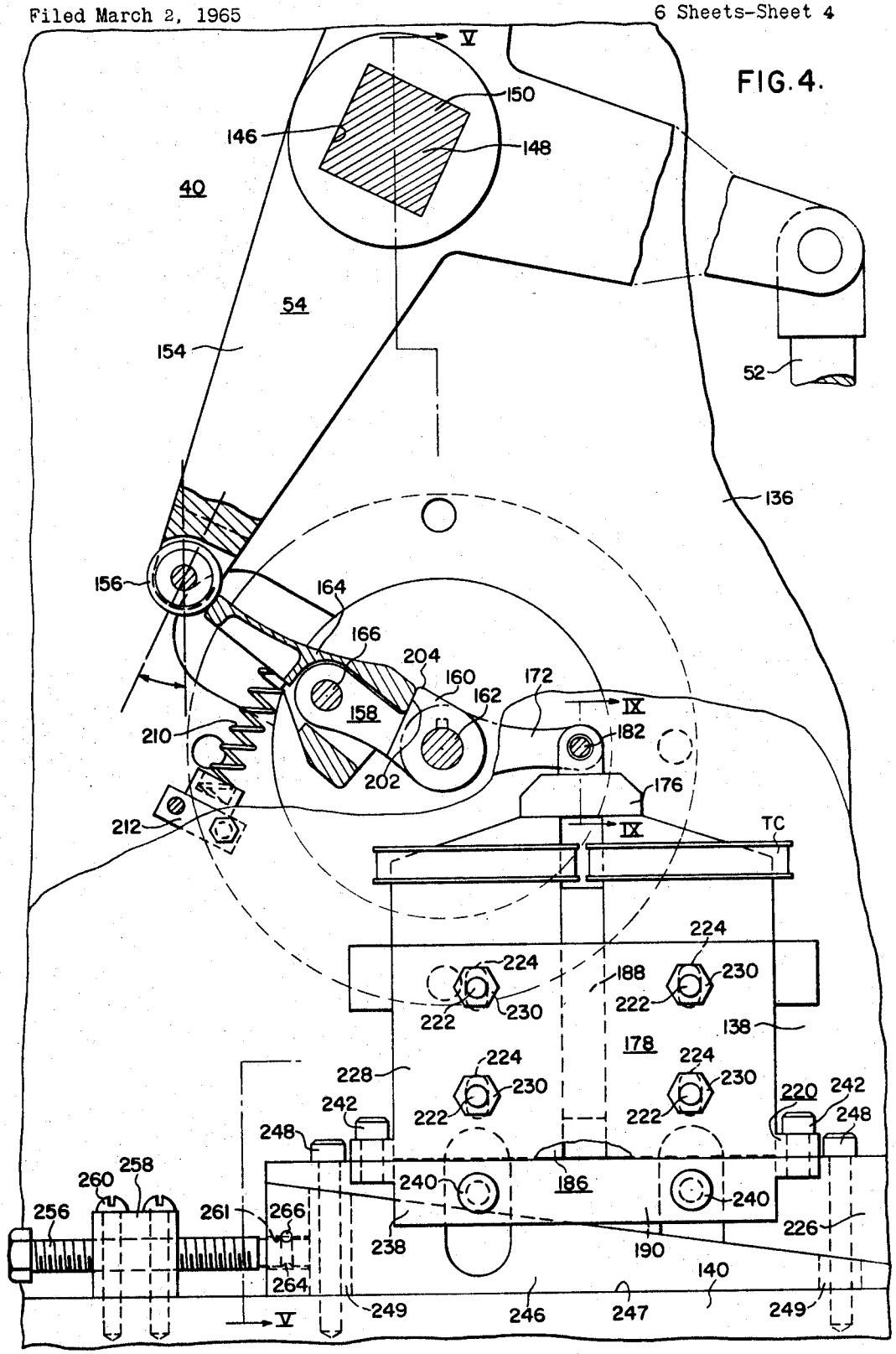


FIG.6.



CIRCUIT BREAKER WITH IMPROVED MAGNETIC TRIP MEANS

FIG. 4.



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CIRCUIT BREAKER WITH IMPROVED MAGNETIC TRIP MEANS

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FIG.5.

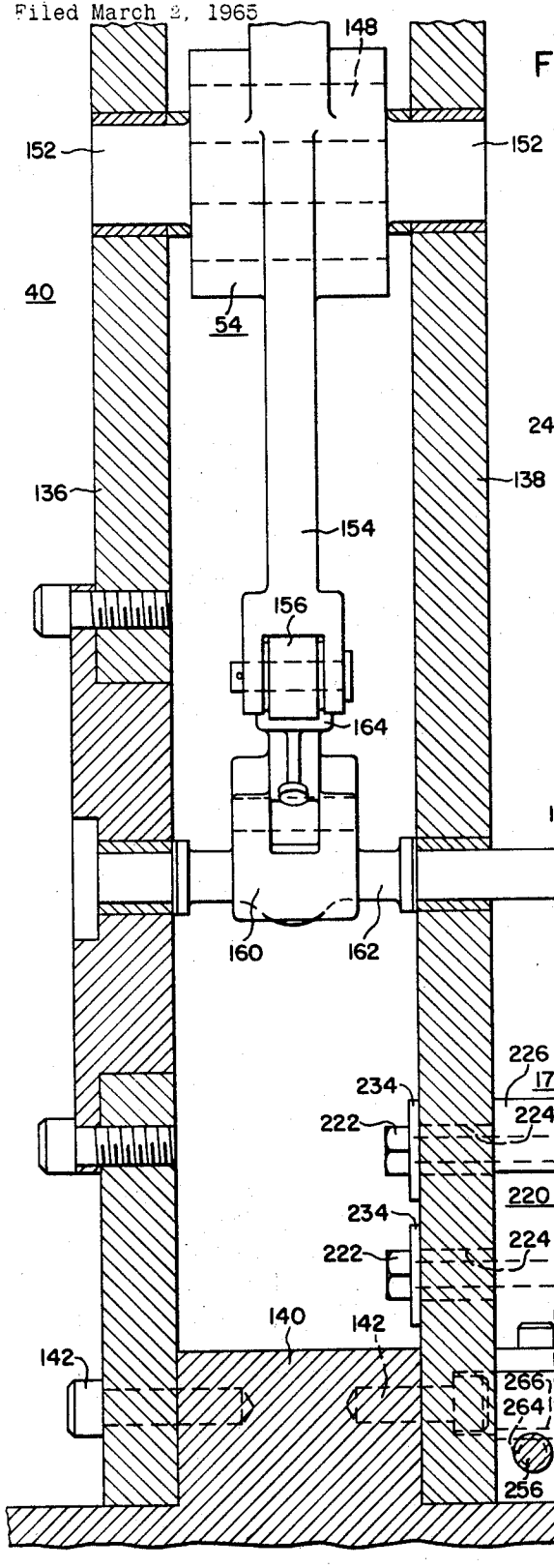


FIG.7.

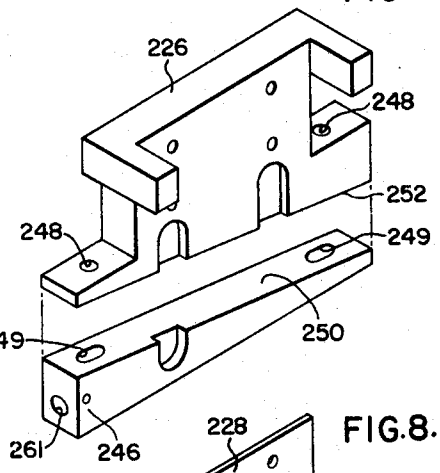


FIG.8.

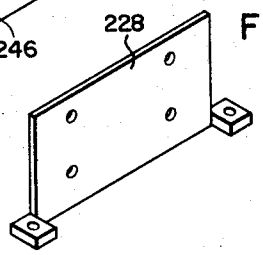
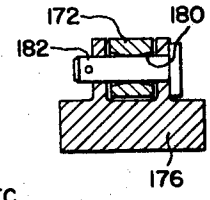


FIG.9.



CIRCUIT BREAKER WITH IMPROVED MAGNETIC TRIP MEANS

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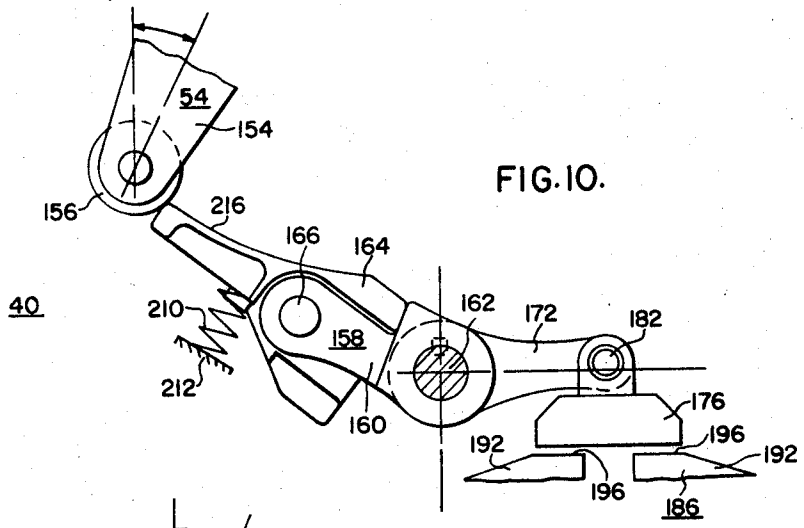

FIG.10.

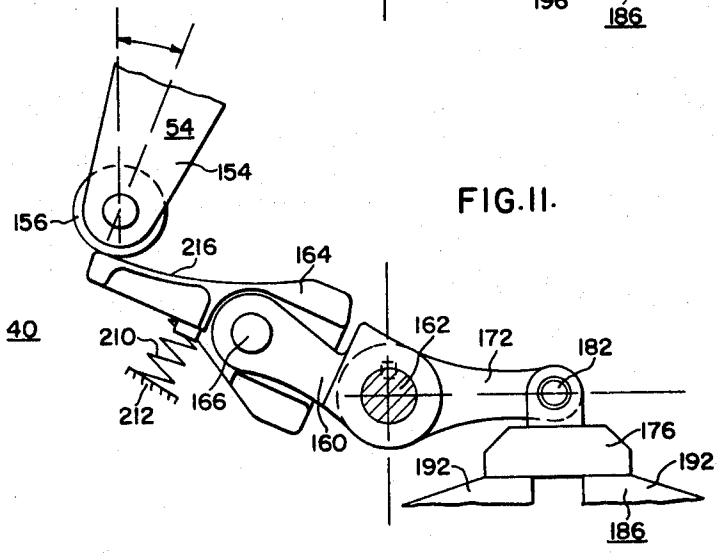

FIG.11.

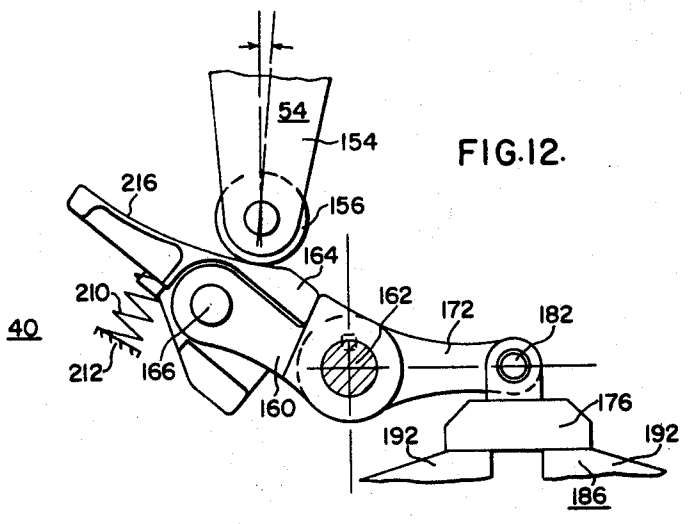

FIG.12.

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3,391,358

CIRCUIT BREAKER WITH IMPROVED MAGNETIC TRIP MEANS

Walter V. Bratkowski, McKeesport, Raymond J. Radus, Monroeville, and Erling Frisch, Pittsburgh, Pa., assignors to Westinghouse Electric Corporation, Pittsburgh, Pa., a corporation of Pennsylvania

Filed Mar. 2, 1965, Ser. No. 436,601
14 Claims. (Cl. 335—21)

ABSTRACT OF THE DISCLOSURE

An improved circuit breaker comprises an armature releasable to trip the breaker and a toggle structure that collapses to permit automatic resetting of the armature upon the occurrence of tripping operations. The armature is part of a magnetic latch structure that is adjustable to adjust the tripping action of the breaker.

An object of this invention is to provide a circuit breaker with improved means for effecting high speed tripping operations.

Another object of this invention is to provide a circuit breaker comprising a magnetic type trip device.

Another object of this invention is to provide a circuit breaker comprising an armature releasable from a magnetic structure to trip the breaker, which breaker comprises improved means providing for a fast reset of the armature during tripping operations.

A further object of this invention is to provide a circuit breaker comprising an improved adjustable tripping system.

Other objects of this invention will be explained fully hereinafter or will be apparent to those skilled in the art.

The novel features that are considered characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to structure and operation, together with additional objects and advantages thereof, will be best understood from the following detailed description when read in conjunction with the accompanying drawings.

In said drawings:

FIGURE 1 is a side elevational view of one pole or phase of a three-phase high-voltage circuit interrupter embodying principles of the present invention;

FIG. 2 is a sectional view through one of the modulai interrupting heads illustrated in FIG. 1, with the separable contact structure being illustrated in the closed-circuit position;

FIG. 3 is a simplified diagrammatic view of the operating linkage, closing system and tripping system of one of the pole-units of the present invention;

FIG. 4 is a side elevational view, with parts broken away, of one of the tripping systems of the present invention;

FIG. 5 is a sectional view taken generally along the line V—V of FIG. 4;

FIG. 6 is an elevational view, with parts broken away, of the part of the magnetic latch structure seen in FIGS. 4 and 5;

FIG. 7 is a perspective view of part of the support-and-adjusting means disclosed in FIGS. 4 and 5;

FIG. 8 is a perspective view of one of the support plates seen in FIGS. 4 and 5;

FIG. 9 is a partial sectional view illustrating certain parts of the armature supporting means; and

FIGS. 10–12 are partial diagrammatic views illustrating positions of certain parts during tripping operations.

Referring to the drawings, there is disclosed in FIG. 1

a high-voltage three-phase compressed-gas circuit interrupter or circuit breaker **10**. The three pole units are alike except for the interpole electrical control wiring, gas lines and air lines; and except for the house at the middle pole which contains the common parts of the air and gas systems. Only one pole unit A of the circuit breaker **10** is seen in FIG. 1. The circuit breaker is more specifically described in the copending patent application of Roswell C. Van Sickle, Ser. No. 374,708, filed June 12, 1964, and also in the copending patent application of Roswell C. Van Sickle et al., Ser. No. 374,709, filed June 12, 1964, both of which applications have been assigned to the assignee of the instant application. Thus, only a brief description of the circuit breaker is given in the instant application.

Each pole unit of the circuit breaker is mounted upon a heavy grounded supporting frame **12** comprising longitudinally extending beam members **14** and brace supports **16** supported on upright leg portions **17**. In each pole unit, a high-pressure main reservoir tank **18** is supported on the associated supporting frame **12**. In each pole unit, there are three supply pipes (not shown) which extend from the high-pressure reservoir tank **18** through three upstanding tubular insulating column structures **22** into three auxiliary high-pressure reservoir chambers **24** (only one of which reservoir chambers is seen in FIG. 2) that are at high potential.

There is associated with each pole unit an upstanding current-transformer structure **26** which is utilized to measure the current flow through the pole unit. Since the current-transformer structure **26** constitutes no part of the present invention, and because the internal structure thereof is well understood by those skilled in the art, the structure will not be described. Reference, however, may be had to U.S. Patent No. 2,504,647 for a description of a typical gas-filled type of current-transformer structure that could be used.

On each of the insulating column structures **22**, there is mounted a live metallic exhaust housing, or interrupting head unit **28** which is at high potential. In each of the interrupting head units **28** there is disposed a pair of serially related arc-extinguishing units **30** (FIG. 2) comprising a pair of spaced stationary contacts **32**. A bridging contact structure **34** comprising a pair of movable contacts **36** (only one of the movable contacts being seen in FIG. 2) is supported for rotation about an axis **38**. In operation, the bridging contact structure **34** is rotated to move the movable contacts **36** into and out of bridging engagement with the spaced stationary contacts **32**. In each pole unit, the spaced stationary contacts **32** in the three interrupting head units **28** are connected in electrical series to provide six breaks (two in each of the interrupting head units **28**) during an opening operation of the circuit interrupter **10**.

As is disclosed schematically in FIG. 3, each of the pole units is provided with a tripping and closing system compartment **38** comprising a tripping system **40** and a closing structure **42**. The closing structure **42** constitutes no part of the present invention, and it may be either a hydraulic type, pneumatic type or solenoid mechanism, as desired. The closing structure **42** is illustrated as a pneumatic type comprising a pneumatic piston **44** supported for reciprocal movement within an operating cylinder **46**. A reservoir tank **48** is provided for supplying high-pressure gas, such as compressed air, through a valve **50** into the cylinder **46** to effect downward closing movement of the piston **44** to thereby move an operating rod **52** downward. Downward movement of the operating rod **52** rotates an operating lever or trip member **54** in a clockwise (FIG. 3) direction about a fixed pivot **56** to simultaneously close the contacts within the three interrupting head units **28**. Clockwise movement of the operating lever

or trip member 54 operates through the link 58 to rotate a crank arm structure 60 clockwise about a pivot 62. An elongated operating rod 64 is supported at one end thereof to one end of the crank arm 60 by means of a pivot pin 66. The rod 64 is supported at the other end thereof, for generally horizontal movement, by being disposed in an opening in a suitable supporting plate 68. An elongated operating rod 70 is pivotally connected at one end thereof to the crank arm 60 by means of a pivot pin 72. The rod 70 is supported at the other end thereof for generally horizontal movement by being disposed in an opening in a suitable supporting plate 74. Accelerating springs 76 and 78 are provided at the outer ends of the operating rods 64 and 70 respectively to bias the operating rods 64, 70 toward the open position. The horizontal operating rods 64, 70 are pivotally connected as at 82, 84, 86, to three crank arms 88, 90 and 92 which are affixed to three horizontal shafts 94, 96 and 98. The shafts 94, 96 and 98, are rotatable members that pass through gas tight seals into lower column housing portions of the three tubular insulating column structures 22 (FIG. 1). A separate dash-pot structure 104 (FIG. 3) is operatively connected to each of the crank arms 88, 90 and 92.

Three operating cranks 108, 110 and 112 are disposed within the insulating column structures 22 where they are operatively connected to the horizontal shafts 94, 96 and 98. Three insulating operating rods 116, 118 and 120 are pivotally connected to the cranks 108, 110 and 112. Each of the insulating operating rods 116, 118 and 120 extends upward through the associated tubular insulating column structure 22. The upper ends of the three insulating operating rods 116, 118 and 120 are provided with metallic rod-ends 122 (FIG. 2). Each of the rods 116, 118 and 120 is connected to the associated bridging contact structure 34 by means of a contact-operating structure 126 comprising a torsion bar 128 and a linkage structure 130.

In order to close the circuit breaker, the push button PB1 (FIG. 3) is operated to operate the closing solenoid CS to thereby operate the valve 50. Gas, under high pressure, is then admitted through the valve 50 into the cylinder 46 to force the piston 44 and rod 52 downward to a closed position. This movement operates through the crank 54, link 58, crank 60, rods 64, 70, cranks 88, 90, 92 and cranks 108, 110, 112 to move the rods 116, 118, 120 down to the closed position.

In each of the interrupting head units, the rod 116, 118 or 120 down to the closed position operates through the contact-operating structure 126 (FIG. 2) to move the movable bridging contact structure 34 into the closed position bridging the stationary contacts 32. In each of the interrupting head units, movement of the rod 116, 118 or 120 to the closed position operates through the linkage structure 130 to charge the torsion bar 128. The three bridging contact structures 34 of the pole unit A are latched in the closed position by means of the trip system or structure 40 (FIG. 3) which operates to latch the crank 54 in the closed position. The trip structure 40 will be hereinafter more specifically described.

In order to effect an opening operation of the pole unit A, the trip structure 40 is released, in a manner to be hereinafter more specifically described, to release the lever 54 whereupon the three charged torsion bars 128 (FIG. 2) of the three interrupting head units 28 (FIG. 1) and the opening springs 76, 78 (FIG. 3) operate to rotate the three bridging contacts 34 (FIG. 2) to the open position during which operation the rod 52 and piston 44 (FIG. 3) are operated back up to an open position in preparation for another closing operation.

As each of the movable bridging contact structures 34 is rotated to the open position, an arc is established between each pair of contacts 36 and 32. These arcs are extinguished by means of a suitable arc-extinguishing gas that is automatically released from the associated high-pressure reservoir chamber 24 through the tubular gas conducting arms of the bridging contact structure 34.

The circuit breaker 10 comprises three pole units similar to the pole unit A (FIG. 1) which pole units are electrically interlocked for simultaneous operation. The opening and closing operations of the circuit breaker are more specifically described in the aforementioned patent application of Roswell C. Van Sickle, Ser. No. 374,708 and in the aforementioned patent application of Roswell C. Van Sickle et al., Ser. No. 374,709.

As is disclosed in FIG. 3, the trip structure 40 is operated to release the lever 54 by energization of the tripping coil TC. The tripping coil TC may be energized by operation of a trip relay TR by means of a manually operable tripping push-button PB2. The tripping coil TC may also be energized automatically through a current transformer CT that operates in response to overload currents through the circuit of the breaker to operate the trip relay TR.

The tripping system or trip structure 40 will be specifically described with reference to FIGS. 4–12. Referring to FIGS. 4 and 5, two side-plate supporting structures 136 and 138 are fixedly supported on a base supporting structure 140 by means of a plurality of bolts 142. The lever or trip member 54 is provided with an opening 146 (FIG. 4) therein that is generally rectangular in cross section, and a supporting pin structure 148, comprising a center part 150 (FIG. 4) that is rectangular in cross section and keyed in the opening 146 and two supporting pin parts 152 (FIG. 5), is rotatably supported in suitable openings in the side plate structures 136, 138 to thereby rotatably support the lever structure 54. The lever or trip member 54 comprises a lever arm 154 having a roller member 156 rotatably secured thereto at the outer end thereof. The lever arm 154 is latched in the closed position by means of a toggle-latch 158 comprising a first link 160 that is supported on a fixed pivot 162 and a second link 164 that is pivotally connected to the first link 160 by means of a knee pivot pin 166. As is seen in FIG. 5, the pin 162 is supported for rotation in suitable openings in the side plate structures 136 and 138. The pivot pin 162 (FIG. 5) is provided with an extension 170 that extends outside of the side plate structure 138. An armature link 172 (FIG. 4) is fixedly connected to the pivot pin extension 170 (FIG. 5). The armature link 172 connects the toggle-latch 158 with an armature 176 that is part of a magnetic device indicated generally at 178. As is seen in FIG. 9, the member 172 is provided with an opening 180 therein which opening flares out at both ends. The opening 180 is circular in cross section throughout the length thereof with the circles being larger at the flared-out ends than at the middle. A support pin 182 passes through openings in spaced ear-parts of the armature 176 and also through the opening 180 to support the armature 176 on the link member 172. The armature is supported for rotation in the plane of the paper as seen in FIG. 4. Because of the flaring end parts of the opening 180, the armature 176 may also rotate or wobble, for example, in the plane of the paper as seen in FIG. 9. This mounting arrangement provides for a limited universal-type movement of the armature 176 on the member 172.

In addition to the armature 176, the magnetic structure 178 comprises a generally U-shaped magnet structure 186 (FIGS. 4–6) and a permanent magnet member 188. The U-shaped magnetic structure 186 comprises a base part 190 and two pole pieces or leg parts 192 supported on the base part 190 with a thin layer of non-magnetic material 194 separating the pole pieces 192 from the base part 190. Each of the pole pieces 192 is provided with a generally flat pole face 196 (FIG. 6) against which the armature 176 seats in the closed position. The universal type of mounting of the armature 176 on the member 172 permits the flat engaging face of the armature to seat properly against the flat pole faces 196 of the

pole pieces **192**. The U-shaped magnet structure **186** is fixedly supported on the side plate structure **138** in a manner to be hereinafter more specifically described. The pole pieces **192**, base part **190** and armature **176** are made of a suitable magnetically permeable material such as soft iron.

Referring to FIG. 6, when the armature **176** is in the tripped or open position, the magnetic flux generated by the permanent magnet member **188** passes through a magnetic circuit comprising the member **188**, the lower parts of the pole pieces **192** and the lower base part **190**. When the armature **176** is moved into the position disclosed in FIG. 4 wherein the armature **176** engages the pole faces of the U-shaped structure **186**, a lower-reluctance path is provided through the upper parts of the pole pieces **192** and the armature **176** because of the high-reluctance gap **194** (FIG. 6) in the lower magnetic circuit. Thus magnetic flux shifts from the lower magnetic circuit to an upper magnetic circuit which comprises the permanent magnet member **188**, the upper parts of the pole pieces **192** and the armature **176**. Thus, when the parts are in the position shown in FIG. 4, about 90% or more of the magnetic flux generated by the magnet member **188** will work to maintain the armature **176** in the closed position shown to thereby maintain the toggle latch **158** in the latching position shown in FIG. 4.

The circuit breaker is tripped open by momentary energization of the tripping coil TC either by means of the push-button PB2 (FIG. 3) or by means of energization of the trip relay TR upon the occurrence of an overload current through the line L1 which overload energizes the current transformer CT to operate the trip relay. When the trip coil TC is energized, the magnetic forces generated by the current through the trip coil operate to buck the magnetic flux through the upper magnetic circuit (FIG. 4) whereupon the magnetic flux is transferred from the upper magnetic circuit to the lower magnetic circuit to release the armature **176**.

When the armature **176** is released, the force of the charged torsion bar (**128** FIG. 2) and charged opening springs **76**, **78** (FIG. 3) operate to move the circuit breaker parts to the tripped or open-circuit position. As is seen in FIG. 4, the force tending to rotate the lever or trip member **54** in a counterclockwise direction operates through the pivot **166** to tend to rotate the toggle link **164** in a clockwise direction about the pivot **166** which movement is prevented by engagement of the stop portion **202** on the link **164** with a stop portion **204** on the link **160**. This force tending to rotate the operating lever **54** in a counterclockwise direction, therefore, operates through the erected toggle **164**, **160** to bias the erected toggle **164**, **160** in a counterclockwise direction to thereby bias the pin structure **162**, **170** (FIG. 5) in a counterclockwise (FIG. 4) direction, which force operates through the link **172** to tend to lift the armature **176**. So long as the armature **176** is held in the closed position shown in FIG. 4, the circuit breaker will be maintained in the closed position. Upon release of the armature **176**, however, the force tending to move the lever **54** in a counterclockwise direction will rotate the erected toggle **164**, **160** and the toggle link **172** in a counterclockwise (FIG. 4) direction lifting the armature **176** away from the U-shaped magnetic structure **186**. This tripping movement starts easily because of the roll-off type latch engagement between the roller **156** and the toggle link **164**. During the initial part of this tripping movement the toggle links **164**, **160** and the link **172** rotate as a unit to the position shown in FIG. 10 wherein the armature **176** is separated from the U-shaped magnetic structure **186**. During the tripping movement of the erected toggle **164**, **160** and link **172** along with the armature **176**, the toggle **164**, **160** and lever **54** reach a position wherein the force operating to rotate the lever **54** in a counterclockwise direction operates to collapse the toggle **164**, **160** about the knee pivot **166** against the bias of a compression spring **210** that is supported between the toggle link **164** and the stationary support **212**. The toggle **164**, **160** collapses when the line of action of the force operating to rotate the lever **154** in a counterclockwise direction passes over a line drawn between the point of engagement between the roller **156** and the link **164** and the center of the knee pivot **166**. When the toggle **164**, **160** collapses, the roller **156** moves onto an upper cam surface **216** on the toggle link **164** (FIG. 11) and the spring **210** biasing against the toggle link **164** operates to move the knee pivot pin **166** in a clockwise direction about the pivot **162**. This movement is effected because the roller **156** engages the cam surface **216** restraining clockwise movement of the link **164** about the knee pivot **166** and because the members **160**, **164** are connected for relatively pivotal movement whereby the spring **210** can freely operate to move the pivot pin **166** and link **160** in a clockwise direction about the pivot **162**. Because the link **160**, pivot **162**, link **172** and armature **176** operate to rotate as a unit about the pivot **162**, this action of the spring **210** serves to reset the armature **176** in the position shown in FIG. 11.

As was previously described, as soon as the armature **176** resets against the pole faces **196** of the pole pieces **192**, the magnetic flux is automatically transferred back up through the armature **176** to work to maintain the armature **176** in the attracted position.

With the toggle **164**, **160** collapsed and the armature **176** in the attracted reset position seen in FIG. 11, the lever or trip member **54** is free to rotate in a counterclockwise direction to the open position seen in FIG. 12 during which movement the roller **156** rides along the cam surface **216**. During the opening movement of the lever **54** to the open or tripped position seen in FIG. 12, the three bridging contact members **34** (FIG. 2) of the three interrupter heads **28** of the pole unit A (FIG. 1) will be simultaneously moved to the open circuit position in the same manner as was hereinbefore described. Thereafter, the circuit breaker can be closed in the same manner as was hereinbefore described. As was hereinbefore set forth, the three pole units are interlocked to be tripped and closed simultaneously.

When the circuit breaker is operated to the closed position in the manner previously described, the lever or trip member **54** moves along the cam surface **216** (FIG. 12) of the toggle link **164** to the fully closed position, and near the end of this closing movement of the lever **54** the roller **156** rides off of the cam surface **216** whereupon the spring **210** biases the link **164** in a clockwise direction about the knee pivot **166** to reset the toggle link **164** with a snap action back in the closed and latching position seen in FIG. 4. When the toggle link **164** is reset, the lever **54** is latched and the movable contact structures **34** (FIG. 2) of the three interrupter head units **28** of the pole unit A are latched in the closed position in the same manner as was hereinbefore described. As was hereinbefore described during the closing operation, the opening springs **76**, **78** (FIG. 3) and the torsion bar **128** (FIG. 2) are charged thereby preparing the pole unit for another tripping or opening operation.

The U-shaped magnetic structure **186** of the electromagnetic device **178** is fixedly supported on the side wall structure **138** by means of a supporting structure indicated generally at **220** (FIGS. 4 and 5). Four bolts **222** pass through four openings **224** in the side plate structure **138**; through suitable openings in an upper support plate **226**; through openings in a first support plate **228** (FIG. 8); through openings in the two pole pieces **192**; and through openings in a second support plate **228**. Nuts **230** (FIG. 5) are secured to the outer threaded ends of the bolts **222** to fasten the U-shaped magnetic structure **186**, support plates **228** and upper support plate **226** to the side plate structure **138**. The openings in the parts **228**, **186**, **226** receive the bolts **222** with a close fit, and the opening **224** comprises a slot that is elongated

in a vertical direction for a reason to be hereinafter specifically set forth. Washers 234 (FIG. 5) are provided between the bolt heads and the supporting plate 138. In addition to the upper support plates 228, lower support plates 238 are provided on opposite sides of the U-shaped magnetic structure. The lower support plates 238 are riveted to the U-shaped magnetic structure 186 by means of rivets 240. As is seen in FIGS. 4, 5 and 8, the plates 228, 238 are provided with ear portions that receive bolt members 242 that secure these parts together.

In addition to the upper supporting plate 226, there is provided a lower supporting plate 246 that rests on a flat surface 247 of the lower support 140. Bolts 247 extend through openings 248 in the upper support plate 226 and through openings 249 in the lower support plate 246 to secure these members fixedly together. The bolts 248 are threaded into suitable openings in the support plate 140.

The tripping system 40 can be adjusted by adjustment of the support device 220. As is seen in FIG. 7, the lower support plate 246 is provided with a flat cam surface 250 and the upper support plate 226 is provided with a flat cam surface 252. These cam surfaces 250, 252 engage and mate along a slanted plane in the manner shown in FIG. 4 when the parts are secured in the mounted position. If it is desirable to adjust the tripping system 40 in order to adjust the relative closed positions of the toggle link 164 and roller 156, the bolts 248 are removed and the nuts 230 are loosened on the bolts 222. Thereafter, an adjusting screw 256 (FIG. 4) can be operated to adjust the trip structure. The adjusting screw 256 is threadedly supported in a suitable tapped opening in a screw support 258 that is fixed to the support 140 by means of bolts 260. The screw 256 is rotated to move the lower support plate 246 on the flat supporting surface 247 in a horizontal direction (FIG. 4) either toward or away from the screw support 258. The screw 256 is disposed loosely in an opening 261. The screw 256 is provided with an end that is notched at 264. After the screw 256 is placed in the opening 261, a pin 266 (FIGS. 4 and 5) is placed in a suitable opening in the lower support 246. The pin 266 is positioned in the notch 264 to connect the screw 256 and plate 246 for unitary rectilinear back-and-forth horizontal (FIG. 4) movement while permitting the screw 256 to rotate relative to the plate 246. As the lower support plate 246 moves relative to the upper support plate 226, the cam surfaces 250, 252 cooperate and the upper spring support 226 will be moved in a vertical direction moving the bolts 222 and U-shaped magnetic structure 186 in a vertical direction. The bolts 222, which fit closely in openings in the members 226, 228 and 186, are constrained for rectilinear vertical movement in the slots 224. Thus, the bolts 222 and members 226, 228, 186 are moved vertically when the support 246 is moved horizontally.

As the vertical position of the U-shaped magnetic structure 186 is adjusted, the armature 176 is moved therewith whereupon the members 172, 160, 164 are rotated about the pivot 162. This movement adjusts the relative positions of the toggle link 164 and roller 156 to thereby provide an effective adjustment of the slip-off or, more particularly, roll-off type latching engagement between the roller 156 and 164. Thus, the tripping system 40 can be effectively adjusted by adjustment of the supporting structure 220.

From the foregoing, it will be understood that there is provided by this invention a circuit breaker having an improved tripping system for effecting high-speed opening operations of the breaker. The tripping system comprises a magnetic structure and an armature releasably secured to the magnetic structure by means of a magnetic flux that works in a first magnetic circuit to maintain the armature in a latching position. The armature is connected to a toggle-latch structure that is erected in a thrust-transmitting position when the breaker is latched closed, which toggle-latch structure latches a lever or trip member in order to maintain the circuit breaker in the closed position. When the armature is released, by either a manual or automatic releasing operation, the erected toggle-latch structure moves in an erected position as the trip member forces the toggle-latch structure and armature toward a tripped position. After the initial unitary releasing movement of the toggle-latch structure during which movement the armature moves away from the magnetic structure and during which movement the trip member has started toward the fully tripped position, the toggle-latch structure collapses whereupon spring means immediately biases the armature and part of the collapsed toggle-latch structure back to the reset position which armature-resetting operation occurs before the trip member has moved to the fully open position. Thus, there is a fast reset of the armature during trip member operation of the breaker. As the trip member moves to the fully tripped position, it moves along a cam surface of one of the toggle links of the collapsed toggle-latch structure. When the trip member is moved back to the fully latched position, spring means automatically operates to reset the aforesaid one toggle link thereby resetting the toggle-latch structure in the initial erected thrust-transmitting and latching position. Only the one toggle link need be reset during this operation because, as was hereinbefore set forth, the armature and part of the toggle-latch structure were reset during the tripping operation of the circuit breaker. Improved means is also provided for supporting the magnetic latching structure and for adjusting the tripping system in order to provide an adjustment of a slip-off latch engagement between the toggle-latch structure and the trip member.

While the invention has been disclosed in accordance with the provisions of the patent statutes, it is to be understood that various charges in the structural details and arrangement of parts thereof may be made without departing from the spirit of the invention.

We claim as our invention:

1. A circuit breaker comprising a pair of contacts, a trip structure for effecting opening of said contacts, said trip structure comprising a magnetic core member and an armature in an engaged position engaging said core member, a toggle-latch structure comprising a pair of toggle members pivotally connected together and positioned in an erected thrust-transmitting position, a trip member in a closed position, biasing means biasing said trip member to operate through said erected toggle members to bias said armature toward an open position, means for releasing said armature, upon release of said armature said biasing means operating through said erected toggle members to move said trip member and armature toward an open position to effect opening of said contacts, and means operating during said opening operation to collapse said toggle members and reset said armature in said engaged position.

2. A circuit breaker comprising a pair of contacts, a trip structure for effecting opening of said contacts, said trip structure comprising a magnetic core member and an armature in an engaged position engaging said core member, a toggle-latch structure comprising a pair of toggle members pivotally connected together and positioned in an erected thrust-transmitting position, a trip member in a closed position, biasing means biasing said trip member to operate through said erected toggle members to bias said armature toward an open position, means for releasing said armature, upon release of said armature said biasing means operating through said erected toggle members to move said trip member and armature toward an open position to effect opening of said contacts, means for resetting said trip member in said closed position, said toggle members collapsing before said trip member is reset in said closed position, means operating to reset said armature in said engaged position upon collapse of said toggle members, and means resetting said toggle members in said erected position when said trip member is reset in said closed position whereupon said armature in said engaged position operates through said erected toggle mem-

bers to maintain said trip member in the closed position.

3. A circuit breaker comprising a pair of contacts, a trip member latched in a first position to maintain said contacts closed, means biasing said trip member toward a second position, said trip member being movable from said first position to said second position to effect opening of said contacts, toggle means comprising a first toggle link and a second toggle link pivotally connected to said first toggle link, said first and second toggle links being in an erected position, latch means comprising a magnetic structure and an armature engaging said magnetic structure in a latched position, said armature in said latched position operating through said erected toggle links to maintain said trip member in said first position, a roll-off type latch engagement between said erected toggle links and said trip member, means operable to effect release of said armature, upon release of said armature said erected toggle links moving initially as a unit in the erected position permitting said trip member to move toward the second position, during movement of said trip member to said second position said erected toggle links collapsing, and means resetting said armature in said latched position upon collapse of said toggle links.

4. A circuit breaker comprising a pair of contacts, a trip member latched in a first position to maintain said contacts closed, a first biasing means biasing said trip member toward a second position, toggle means comprising a first toggle link and a second toggle link pivotally connected to said first toggle link, said first and second toggle links being in an erected position, a magnetic core member, an armature engaging said core member in a latching position to operate through said erected toggle links to maintain said trip member in said first position, a slip-off type latch engagement between said trip member and said first toggle link, said first toggle link having a cam surface thereon, means operable to effect release of said armature, upon release of said armature said first biasing means moving said trip member toward a second position during which movement said released armature is moved away from said core member and said erected toggle links move initially as a unit in an erected position, said trip member moving to said second position to effect opening of said contacts, as said trip member moves to said second position said toggle links collapsing, upon collapse of said toggle links means moving said second toggle link and said armature to move said armature to said latched position, means operable to move said trip member back to said first position, a second biasing means biasing said first toggle link toward the erected position which movement of said first toggle link is restrained by engagement of said trip member with said cam surface, and when said trip member reaches said first position said second biasing means moving said first toggle link to the erected position to again provide said slip-off type latch engagement between said trip member and said first toggle link whereupon said armature in said latching position again operates through said erected toggle links to maintain said trip member in said first position.

5. A circuit breaker comprising a pair of contacts, a trip member mounted on a fixed pivot and latched in a first position to maintain said contacts closed, a first biasing means biasing said trip member toward a second position, toggle means comprising a first toggle link and a second toggle link pivotally connected to said first toggle link, means pivotally mounting said second toggle link on a fixed pivot, said first and second toggle links being in an erected position, a magnetic core member, an armature engaging said magnetic core member in a latching position, an armature link connected to said armature and movable with said second toggle link about the fixed pivot of said second toggle link, said first toggle link engaging said trip member, said armature operating through said armature link and said erected first and second toggle links to maintain said trip member in said first position, means operable to effect release of said armature, upon release of said armature said first biasing means moving said trip member toward said second position during which movement said armature is moved away from said core member and said erected toggle links move initially as a unit in an erected position about the fixed pivot of said second toggle link, said trip member moving to said second position to effect opening of said contacts, as said trip member moves to said second position said toggle links collapsing, upon collapse of said toggle links means moving said second toggle link said armature link and said armature about the fixed pivot of said second toggle link to move said armature to said latched position, means operable to move said trip member back to said first position, a second biasing means biasing said first toggle link toward the erected position which movement of said first toggle link is restrained by engagement thereof with said trip member, and said second biasing means operating when said trip member reaches said first position to move said first toggle link to the erected position whereupon said first toggle link engages said trip member in latching engagement and whereupon said armature in said latching position operates through said armature link and said erected toggle links to maintain said trip member in said first position.

6. A circuit breaker comprising a pair of contacts, latch means latching said contacts and releasable to effect opening of said contacts, a magnetic latch structure supported in a first position latching said latch means, said magnetic latch structure being releasable to release said latch means to effect opening of said contacts, and means for adjusting said supported first position of said magnetic latch structure to thereby adjust the releasing action of said latch means.

7. A circuit breaker comprising a pair of contacts, a first member movable from a first position to a second position to effect opening of said contacts, a second member in a latching position engaging said first member to maintain said first member in said first position, a magnetic latch supported in a first position to latch said second member in said latching position, said magnetic latch being releasable to effect release of said second member to thereby effect release of said first member, and means for adjusting the supported first position of said magnetic latch to thereby adjust the engagement between said second member and first member.

8. A circuit breaker comprising a pair of contacts, a first member in a first position and being movable to a second position to effect opening of said contacts, a second member in a latching position maintaining said first member in said first position, a roll-off type latching engagement between said first and second members, a magnetic latch comprising a core member and an armature engaging said core member to latch said second member in said latching position, said armature being releasable to release said second member to thereby effect release of said first member, and means for adjusting the supported position of said core member and armature to thereby adjust the position of the roll-off type latching engagement between said first and second members.

9. A circuit breaker comprising a pair of contacts, latch means latching said contacts and being releasable to effect opening of said contacts, a magnetic latch supported in a first position latching said latch means, during a tripping operation said magnetic latch being releasable to release said latch means to effect opening of said contacts, support means supporting said magnetic latch in said first position and comprising a base member, a first cam member supported on said base member, a second cam cooperating with said first cam member, said second cam being adjustable to adjust the supported position of said magnetic latch, and adjusting means operable to move said first cam member on said base to thereby move said second cam member to adjust the supported position of said magnetic latch to thereby adjust said tripping operation.

10. A circuit breaker comprising a pair of contacts, a first member in a first position and movable to a second position to effect opening of said contacts, a second member in a latching position maintaining said first member in said first position, a slip-off type latching engagement between said first and second members, a magnetic latch comprising a core member and an armature, means operatively connecting said second member with said armature, means supporting said magnetic latch in a first supported position, said armature engaging said core member to latch said second member in said latching position, said armature being releasable to release said second member to thereby effect release of said first member, means for adjusting the supported position of said magnetic latch to thereby adjust the slip-off type latching engagement between said first and second members which means comprises a base member, a cam member supported on said base member, said cam member comprising a first cam surface, a second cam surface engaging said first cam surface, said second cam surface being movable to move said magnetic latch, adjusting means operable to move said cam member in a first direction during which movement said first cam surface operates against said second cam surface to move said second cam surface in a second direction to thereby move said second member to adjust the slip-off type latch engagement between said first and second members.

11. A circuit breaker comprising a pair of contacts, a lever member latched in a first position to maintain said contacts closed, biasing means biasing said lever member toward a second position, said lever member being movable from said first position to said second position to effect opening of said contacts, a latch structure comprising a magnetic core and an armature engaging said magnetic core in a latched position, a linkage structure connected to said armature, said linkage structure engaging said lever member at a slip-off type latch engagement, said armature in said latched position operating through said linkage structure to maintain said lever member in said first position, means operable to release said armature, upon release of said armature said linkage structure being released to release said lever member whereupon said lever member moves to said second position to effect opening of said contacts, means for adjusting the position of said latch structure and comprising a support, a first cam member supported on said support and comprising a first cam surface, a second cam member comprising a second cam surface engaging said first cam surface, means connecting said latch structure with said second cam member, adjusting means operable to move said first cam member on said support, upon movement of said first cam member on said support said first cam surface operating against said second cam surface to move said second cam member to thereby move said latch structure to an adjusted position during which movement of said latch structure said linkage structure is moved to adjust the slip-off type latch engagement between said linkage structure and said lever member, and securing means operable to secure said latch structure in said adjusted position.

12. A circuit breaker according to claim 4, said second toggle link comprising an elongated member pivotally mounted intermediate the ends thereof on a fixed pivot, said first toggle link being pivotally connected to said second toggle link on one side of said fixed pivot, and said armature being operatively connected to said second toggle link on the other side of said fixed pivot.

13. A circuit breaker according to claim 5, said second toggle link comprising an elongated member pivotally mounted intermediate the ends thereof on said fixed pivot, said second toggle link comprising a first leg extending from said fixed pivot and being pivotally connected to said first toggle link, said second toggle link comprising a second leg extending from said fixed pivot and being connected to said armature link.

14. A circuit breaker comprising a pair of contacts, a trip member mounted on a fixed pivot and latched in a first position to maintain said contacts closed, a first biasing means biasing said trip member toward a second position, toggle means comprising a first toggle link, a second toggle link comprising an elongated member pivotally mounted intermediate the ends thereof on a fixed pivot and comprising a first leg on one side of said fixed pivot and a second leg on the other side of said fixed pivot, means pivotally connecting said first toggle link with said first leg of said second toggle link, said first toggle link and said first leg of said second toggle link being in an erected position, a magnetic core member, an armature structure engaging said magnetic core member in a latching position, means connecting said armature structure with said second leg of said second toggle link, said first toggle link engaging said trip member, said armature structure operating through said second and first toggle links when said first toggle link and said first leg of said second toggle link are in an erected position to maintain said trip member in said first position, means operable to effect release of said armature structure, upon release of said armature structure said first biasing means moving said trip member toward said second position during which movement said armature structure is moved away from said core member and said first and second toggle links move initially as a unit in said erected position about the fixed pivot of said second toggle link, said trip member moving to said second position to effect opening of said contacts, as said trip member moves to said second position said first toggle link and said first leg of said second toggle link collapsing, upon collapse of said first toggle link and said first leg of said second toggle link means moving said second toggle link and said armature structure about the fixed pivot of said second toggle link to move said armature structure to said latched position, means operable to move said trip member back to said first position, a second biasing means biasing said first toggle link toward the erected position which movement of said first toggle link is restrained by engagement thereof with said trip member, and said second biasing means operating when said trip member reaches said first position to move said first toggle link to the erected position whereupon said first toggle link engages said trip member in latching engagement and whereupon said armature structure in said latching position operates through said second toggle link and said first toggle link to maintain said trip member in said first position.

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ROBERT S. MACON, *Primary Examiner.*