United States Patent [19]

Cotton

[11] **3,883,781**

[45] **May 13, 1975**

[54] **REMOTE CONTROLLED CIRCUIT INTERRUPTER**

[75] Inventor: **John F. Cotton,** Athens, Ga.

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

[22] Filed: **Sept. 6, 1973**

[21] Appl. No.: **394,906**

[52] **U.S. Cl.** ..... **317/14 R;** 317/58; 337/3; 337/47; 335/17; 335/68

[51] **Int. Cl.** **H01h 37/00**

[58] **Field of Search** ..... 337/47, 3; 335/17, 68; 317/14 R, 58

[56] **References Cited**

UNITED STATES PATENTS

2,686,242 8/1954 Leonard et al. 337/47

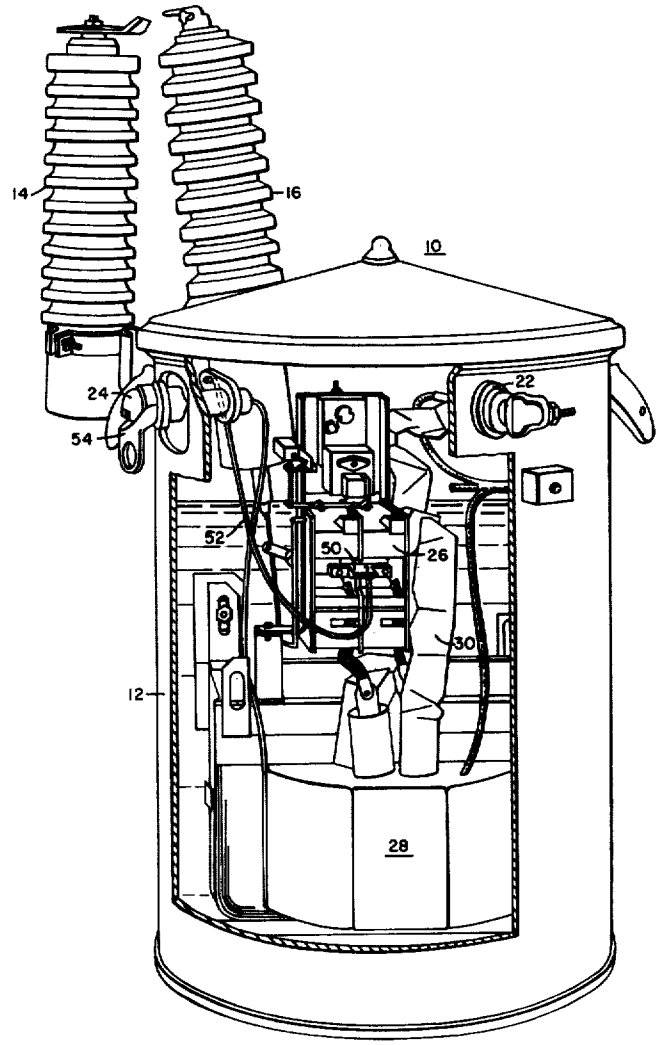
Primary Examiner—L. T. Hix

Attorney, Agent, or Firm—H. G. Massung

[57] **ABSTRACT**

A circuit breaker with a bimetal actuated latch, which controls both tripping and an overload indicator switch, is provided for emergency control the bimetal actuated latch is adjustable by a remotely controlled emergency control electric operator. An emergency control limit switch is provided so that the status of the emergency control electric operator can be remotely monitored. The circuit interrupter also has a remotely actuated motor operator which is controlled by a limit switch and cam arrangement to automatically shut off at the on and off positions of the circuit interrupter. A contact limit switch is provided to be actuated when the contacts of the circuit interrupter are open to indicate the status of the circuit interrupter. A remotely controlled reset solenoid is provided for resetting the overload indicator switch after it has been released by the bimetal actuated latch.

32 Claims, 10 Drawing Figures



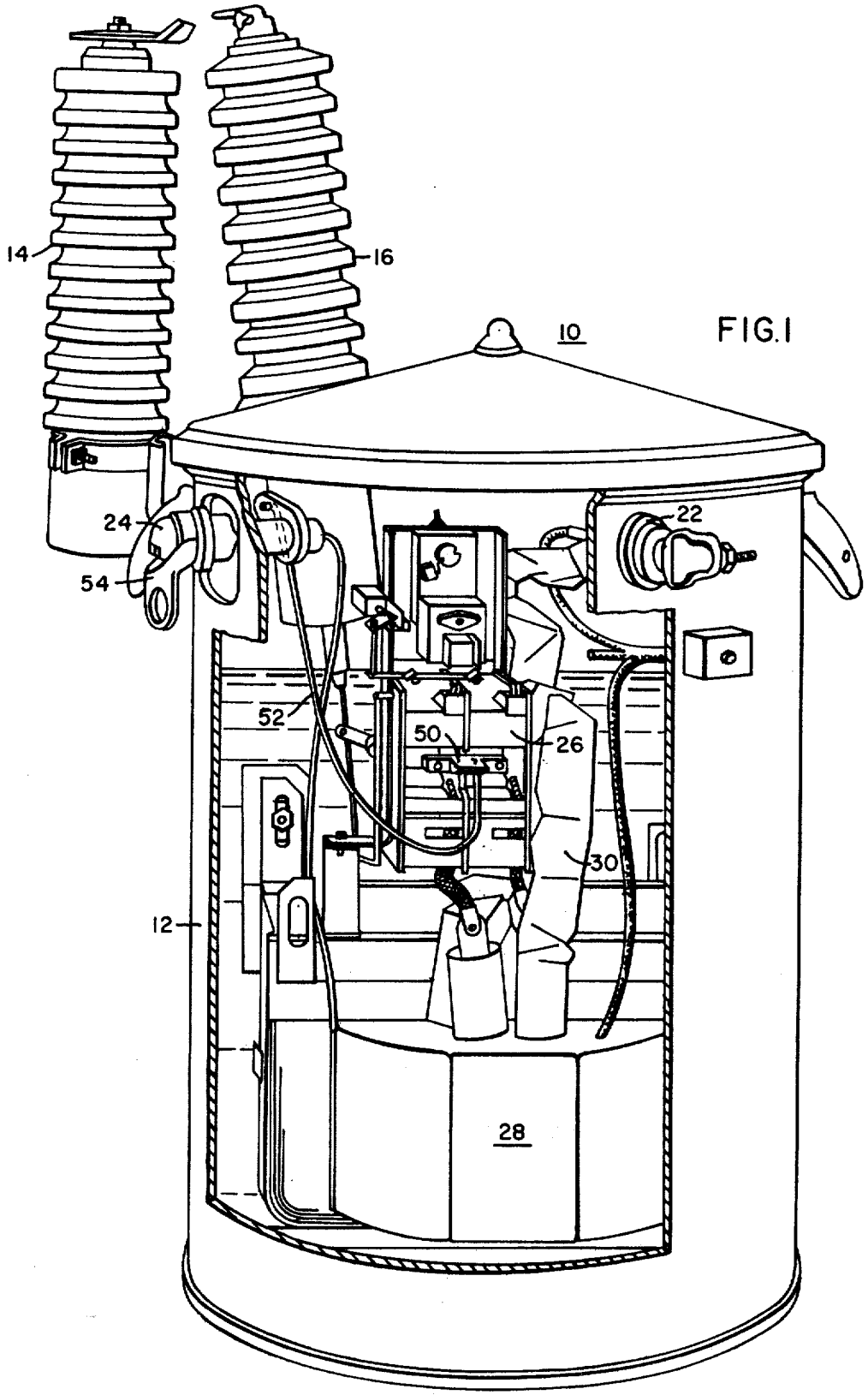


FIG.1

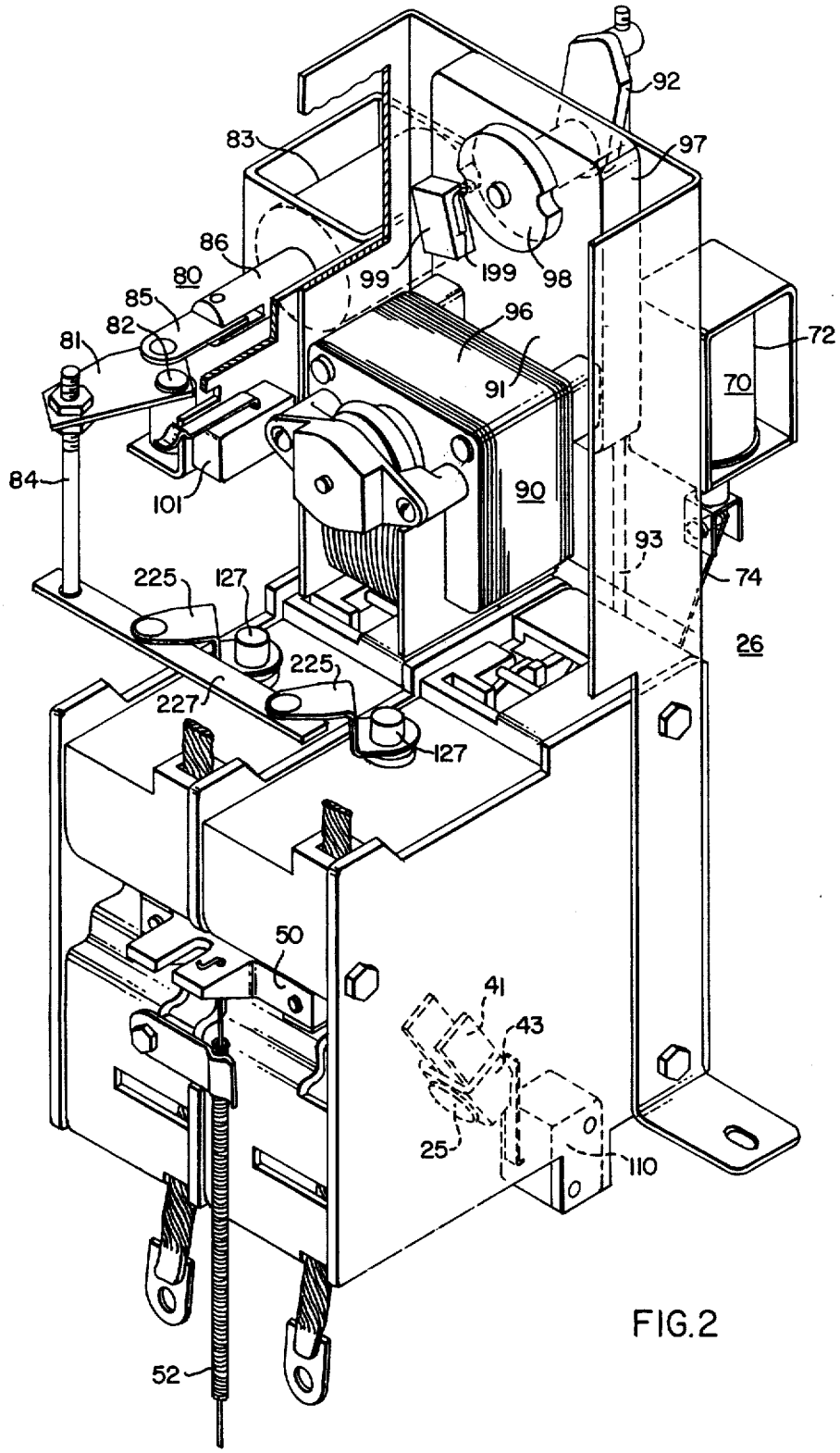

92
83
97
86
80
99
199
98
85
82
96
72
81
91
70
84
101
90
93
74
225
127
26
225
227
127
50
41
43
25
110
52

FIG.2

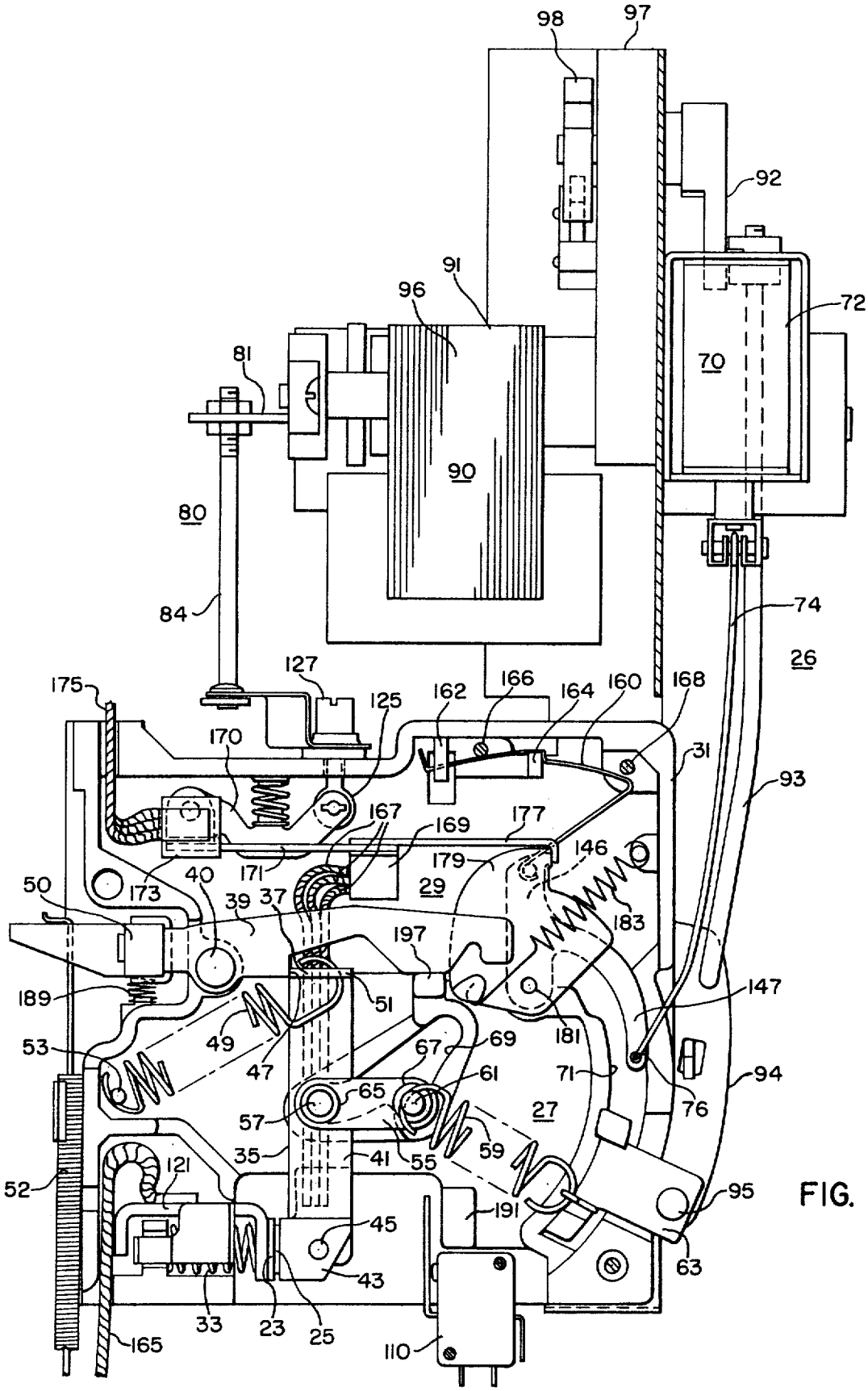

98
97
92
91
96
72
70
81
90
80
84
74
26
127
125
162
166
164
160
168
175
170
31
93
167
169
177
146
179
29
173
40
171
50
39
37
183
197
189
51
147
49
53
47
67
69
181
71
94
61
65
76
57
27
59
35
41
55
121
52
95
191
45
63
43
33
23
25
165
110

FIG. 3.

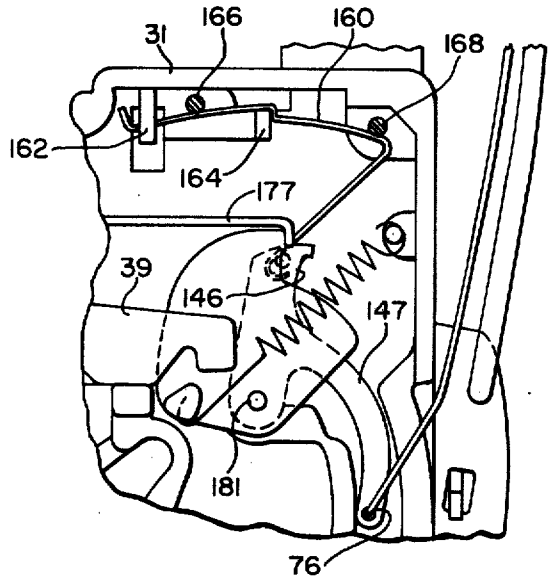

31
166
160
168
162
164
177
39
146
147
181
76

FIG. 4.

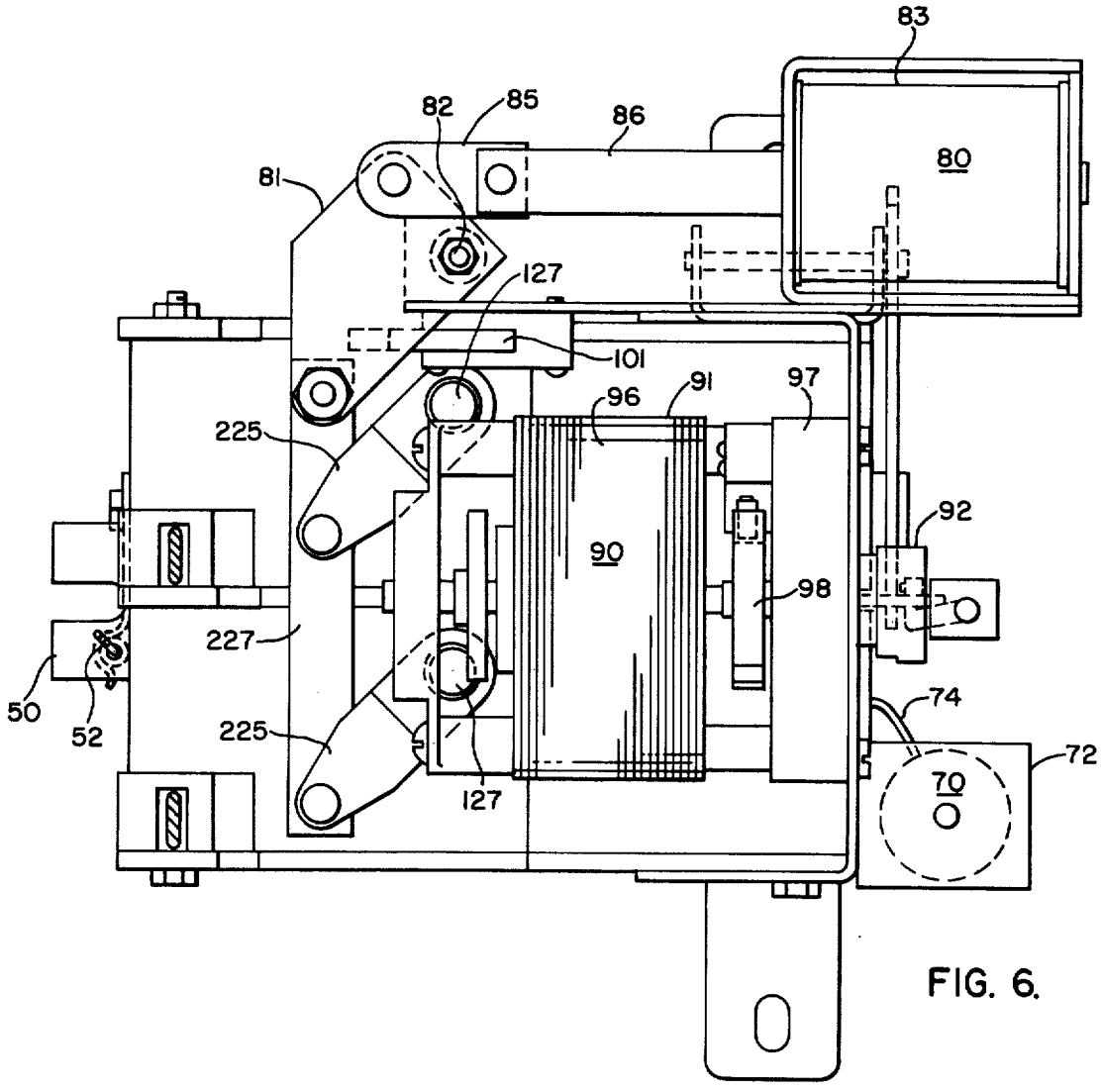

83
82
85
86
81
80
127
101
91
96
97
225
92
90
98
227
74
50
52
225
72
70
127

FIG. 6.

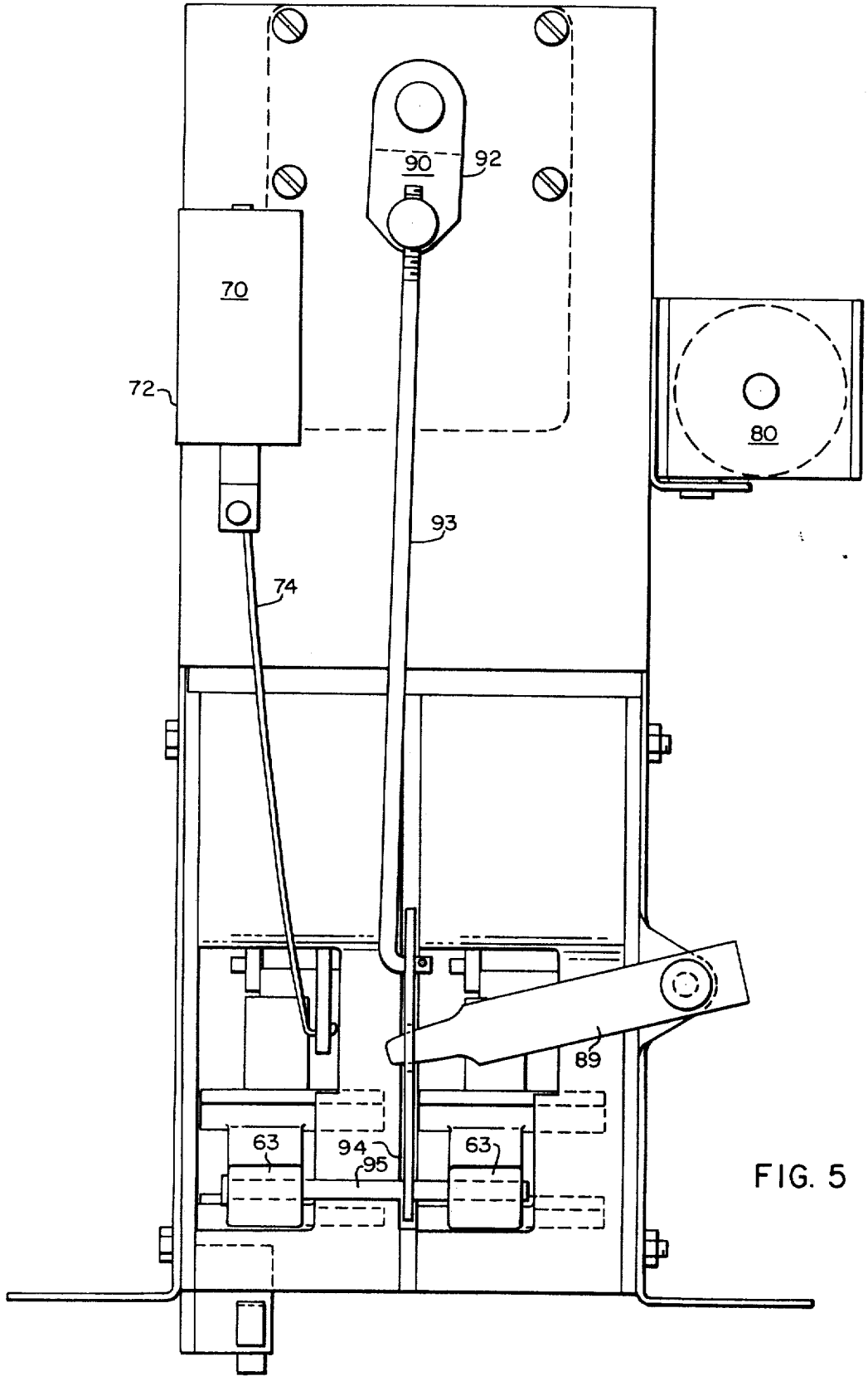


FIG. 5

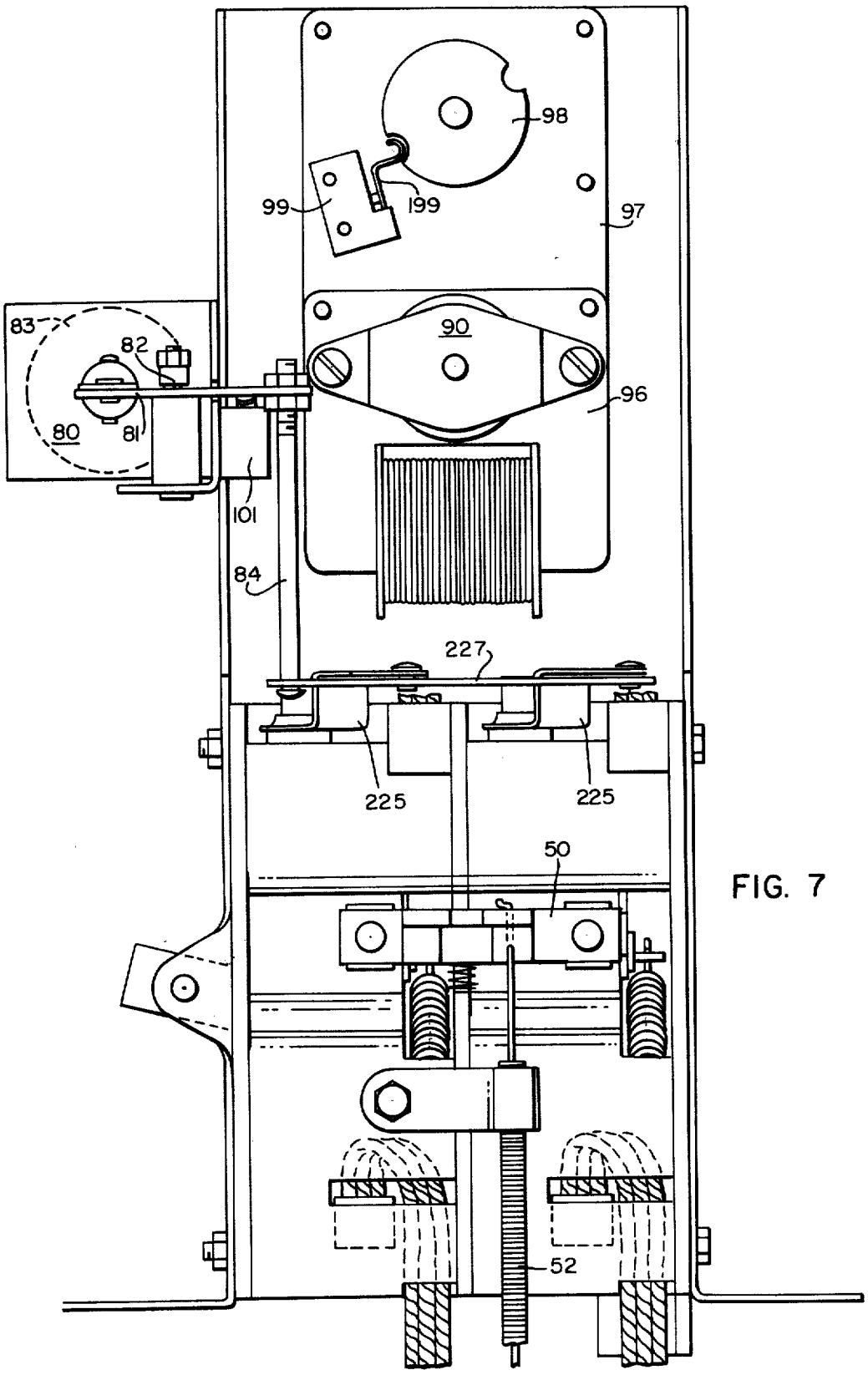


FIG. 7

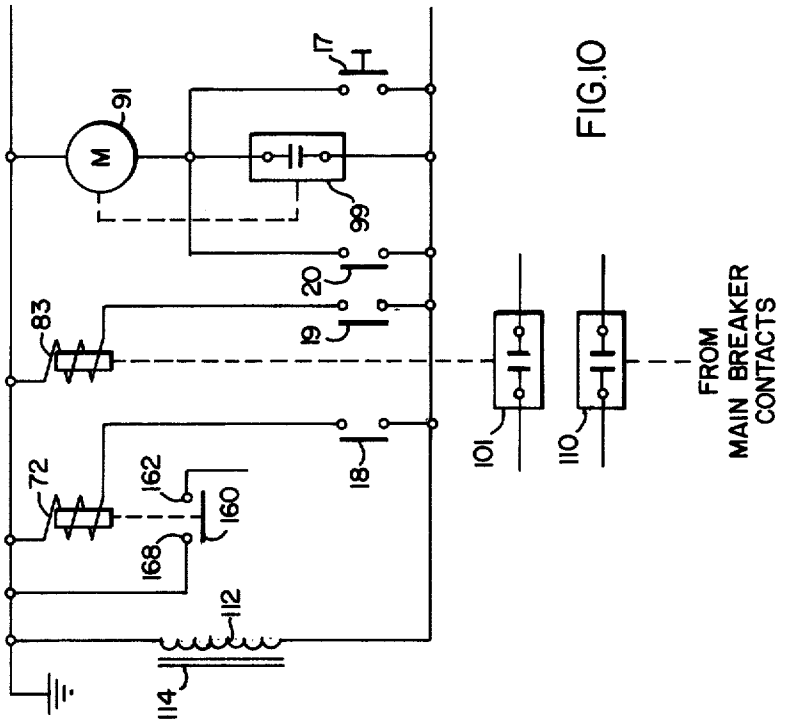


FIG.10

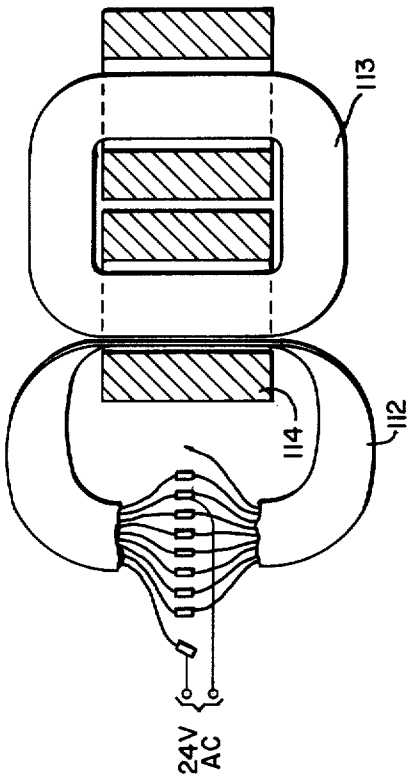


FIG.8

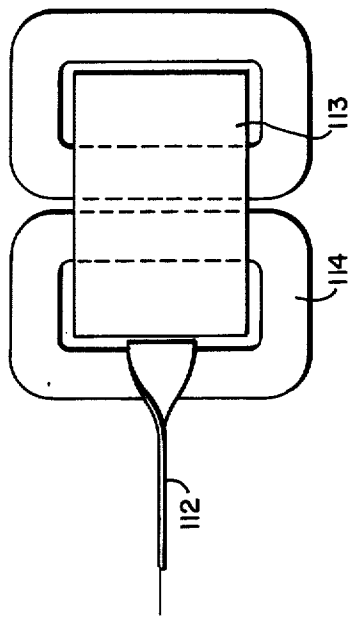


FIG.9

REMOTE CONTROLLED CIRCUIT INTERRUPTER

CROSS REFERENCE TO RELATED APPLICATIONS

This invention is closely related to pending U.S. applications Patent Office Ser. No. 279,567 and Patent Office Ser. No. 279,565.

BACKGROUND OF THE INVENTION

This invention relates to circuit breakers of the type having a bimetallic thermal trip element, and more particularly, to circuit breakers for distribution transformers to control moderate power distribution on feeder circuits.

In the patent to Leonard et al., U.S. Pat. No. 2,686,242, there is disclosed a circuit breaker similar to the circuit breaker herein disclosed, except that the circuit breaker in the Leonard et al patent does not include the remote monitoring and control features provided by the breaker disclosed in the present application. This invention is an improvement over the circuit breaker disclosed in the above-mentioned Leonard et al patent in that provisions for remote control and monitoring of the circuit breaker contacts, the overload signal switch and the emergency control adjustment is provided.

The disclosed circuit breaker is particularly adaptable for use with distribution transformers. Transformers used in power distribution systems are generally associated with protective devices which prevent or limit current overload damage to the transformer and its associated apparatus. The completely self-protected transformer includes a circuit breaker on the secondary or low voltage side to protect against damage due to overload currents. The secondary breaker disconnects the transformer from its load if the current becomes dangerously high.

Commonly used circuit breakers incorporate three basic features: (1) a low overload signal device, (2) an incremental load increase adjustment and (3) a tripping device to open the contacts of the circuit breaker upon a predetermined overload. As the load increases through the circuit breaker an overload point is reached at which the overload indicator switch closes and energizes a signal light on the outside of the transformer housing. The signal light, which is mounted on the transformer enclosure provides visual indication of when the secondary circuit breaker is about to trip. That is, the signal light is turned on at a lower overload current than that required to trip the breaker. The signal light remains on until reset even though the load current is later reduced to a satisfactory level. When line crews see an illuminated signal light, they are thereby given notice that a moderate overload condition has occurred. Repeated observations of an illuminated signal light usually indicate that the transformer should be replaced with a higher capacity transformer. The signal light also gives a quick and accurate visual indication of where a tripped breaker is located when a power outage occurs. As the load current continues to increase, a second overload point is reached where the circuit breaker trips open. The circuit breaker tripping protects the transformer against severe damage due to the flow of excessive overload currents.

To add extra loadability and minimize customer outage until transformer changeover can be implemented, an incremental load increase adjustment or emergency control device is included in the circuit breaker. It is desirable in many applications to change the overload capacity of a distribution transformer. In these applications, reducing the transformer life somewhat by sustaining a moderate overload is better than interrupting the load current and causing a power outage. As stated the completely self-protected transformer includes an emergency control device which effectively changes the rating of the contained circuit breaker. The emergency control mechanism may be moved from its normal position to an overload position to allow the resetting of a tripped circuit breaker or the overload indicator. The rating of the circuit breaker may be increased by the emergency control mechanism for a short period of time until the bimetal actuated latch in the circuit breaker has cooled sufficiently to allow setting of the rating of the circuit breaker at its normal position.

A problem exists in that the versatility of present completely self-protected transformers is somewhat limited since visual observation of the protected transformer is necessary to determine the overload condition; and, the breaker and overload signal switch must be manually reset. It is desirable to have a circuit breaker for use in distribution transformers which provided remote signals to indicate if the overload signal switch has operated, if the contacts of the circuit breaker are open, or if the emergency control mechanism is in the overload position. It is also desirable to have a circuit breaker which provides for remote control of the circuit breaker contact mechanism, resetting of the overload indicator switch, or positioning of the emergency control mechanism.

SUMMARY OF THE INVENTION

An improved circuit breaker providing for remote control and monitoring of contact position, overload signal indication, and emergency control setting is disclosed. In one embodiment the circuit breaker comprises an elongated movable contact arm that is pivotally connected intermediate the ends thereof to an operating link of a spring-type operating mechanism. The elongated movable contact arm is provided with a contact at one end for cooperating with a stationary contact. The contact arm is latched at the other end thereof by means of an elongated primary latch that is pivotally supported intermediate the ends thereof. The spring-type operating mechanism is operable between open and closed positions to pivot the contact arm about the latched end between open and closed positions, with a snap action. A bimetallic current actuated trip latch is provided. The bimetal latch comprises a second latch member that is latched by a bimetal activated latch and that is spring biased towards a tripping position. Upon the occurrence of a sustained overload above a predetermined value, the bimetal flexes with a time delay to release the second latch. The second latch then moves to strike the primary latch pivoting the primary latch to a position releasing the latched end of the contact arm. Thus, allowing spring means to bias the contact arm about the pivot of the operating link to a tripped open position.

The bimetal latch also latches a signal latch which is spring biased to close a pair of signal contacts when released. The signal latch is held to be released at an overload value which is less than that which releases the second latch and trips open the circuit breaker. Therefore, the signal latch is released prior to tripping

open of the circuit breaker. A signal latch reset means is also provided to reset the signal latch in response to a remote control signal. In one embodiment of the invention, the signal reset means comprises an electric solenoid which is connected by a wire formed link to the signal reset latch. The signal latch has a C-shaped portion with one end being linked by the wire formed linking member to the signal reset solenoid.

In one embodiment of the invention, an electric operator is provided to switch the circuit breaker between the open and closed positions. The electric operator comprises an electric motor which is linked to the spring operating mechanism to open and close the contacts of the circuit breaker. After activation power is fed to the electric operator through a limit switch which is cam controlled shut off only when the circuit breaker is in the "on" or "off" position. That is, if the electric operator is energized momentarily by a remote signal, it will continue to run until the circuit breaker is switched to either the "on" or "off" position. In one embodiment the electric operator comprises an electric motor which operates in one direction only. The electric motor is connected to a gear reducer which rotates a cam linked to the operating handle which forms part of the spring operating mechanism. Rotation of the operating cam switches the circuit breaker between the open and closed positions.

In one embodiment of the invention, a solenoid is provided for remote operation of the emergency control activator which essentially changes the rating of the circuit breaker. The solenoid can be activated from a remote signal to switch the emergency control mechanism to the higher overload position. A limit switch is provided for remotely indicating the position of the emergency control mechanism. Another limit switch is provided to be contacted by the movable contact when in the open position for remote indication of the position of the movable contact.

Power for operation of the disclosed circuit breaker can be provided for by placing a multiple conductor flat ribbon cable between the transformer coil and one loop of the core. The ends of the flat cable conductor are offset one conductor and spliced together to provide the desired operating voltage.

It is an object of this invention to provide a circuit breaker which can be remotely controlled to switch between the "on" and "off" positions, to reset the overload indicator, and to position the emergency control.

It is a further object of this invention to provide a circuit breaker which can remotely indicate the status of the overload indicated, the emergency control and the main contacts.

BRIEF DESCRIPTION OF THE DRAWINGS

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

FIG. **1** is a cutaway of a distribution transformer including a circuit breaker utilizing the teachings of the present invention;

FIG. **2** is a rear perspective view of a circuit breaker utilizing the teachings of the present invention;

FIG. **3** is a right side view of the circuit breaker shown in FIG. **2**, with portions removed to show the circuit breaker operating mechanism more clearly;

FIG. **4** is a side view of a portion of the circuit breaker as shown in FIG. **3**, with the overload signal latch in tripped position;

FIG. **5** is a front view of the circuit breaker shown in FIG. **2**;

FIG. **6** is a top view of the circuit breaker shown in FIG. **2**;

FIG. **7** is a rear view of the circuit breaker shown in FIG. **2**;

FIG. **8** is a top schematic view of a transformer core showing the flat ribbon conductor connector to supply power to operate the circuit breaker shown in FIG. **2**;

FIG. **9** is a side view of FIG. **9**; and

FIG. **10** is a schematic view showing electrical connection for the remote control features of the circuit breaker shown in FIG. **2**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, and FIG. **1** in particular, there is shown a pole-type completely self-protected distribution transformer **10** including a circuit breaker **26** utilizing the teaching of the present invention. The transformer **10** includes an enclosure **12** with a lightning arrester **14** and a primary bushing **16** mounted thereon. Secondary bushings such as the bushing **22** are attached to the enclosure **12**. A signal light **24** is mounted on the enclosure **12** and is electrically connected to circuit breaker **26** to be activated at predetermined overloads. A core and coil assembly **28** is secured inside the enclosure **12** with the circuit breaker **26** attached thereto. Required winding leads **30** extend from the coil assembly to the appropriate bushings.

Referring now to FIGS. **2** through **8**, the circuit breaker **26** comprises an insulating base or housing member **31** on which are mounted some parts of the breaker mechanism. The breaker operating mechanism comprises a stationary contact **23**, a movable contact **25**, a spring operating assembly indicated generally at **27** and a trip device indicated generally at **29**. A spring **33** provides contact pressure in the closed position of contacts **23** and **25**. A motor operator assembly **90**, a signal reset assembly **70** and an emergency control assembly **80**, all of which will be described in more detail hereinafter, are also provided.

The movable contact **25** is fixedly mounted on one end of an elongated arm structure **35** that is latched at the one end **37** thereof in the operating position, as seen in FIG. **3**, by means of an elongated primary latch member **39**. The primary latch member **39** is mounted for pivotal movement intermediate the ends thereof, on a fixed pivot **40**. The contact arm structure **35** comprises an elongated arm portion **41** and a U-shaped member **43** that carries the contact **25**. U-shaped member **43** is mounted on portion **41** by means of a pivot pin **45** for limited movement relative to the arm portion **41**, to provide contact alignment in the closed contact position. The movable contact **25** is fixedly mounted on the U-shaped member **43**. The contact arm structure **35** is supported at **37** on a latch surface **47** of the primary latch **39**. The contact arm **35** pivots on the latch surface **47** during manual operation of the circuit breaker in a manner to be described hereinafter. A tension spring **49** is connected at one end thereof to an extension **51** of the contact arm structure **35** and at the other end thereof to a stationary spring support pin **53**.

The contact arm structure **35** is pivotally connected intermediate the ends thereof to an operating link **55** by means of a pivot pin **57**. A pair of operating springs **59** are connected at one end to a pin **61** on the upper end of the operating link **55** and at the other end to an insulating operating handle **63**. The operating link **55** comprises twin members connected by means of the pin **61**. A roller **65** is mounted on the pin **57** between the twin members of the link **55**. A roller **67** is mounted on the pin **61** between the twin members of the link **55**. The rollers **65, 67** are positioned in a generally triangular shaped opening **69** in the insulating housing **31**. Rollers **65** and **67** engage the surfaces defining the opening **69** to guide movement of the operating link **55** in a manner to be described. The insulating handle **63** which is biased inward by means of the tension spring **59** rides on the arcuate surface **71** which guides the handle **63** for movement between the on and off positions.

In the closed position of the circuit breaker **26**, the line of action of the operating spring **59** is below the point about which the handle **63** moves so that the springs **59** bias the handle **63** to the on position. The line of action of the springs **59** is also below the center about which the roller **67** travels on the surface **69** so that the roller **67** is biased to the right in the opening **69** to maintain the operating link **55** in the closed position. When the operating handle **63** is moved from the on position seen in full lines to the off positon (not shown), the line of action of the operating springs **59** moves to the left over the center about **61**. When this occurs, a component of the force of the springs **59** biases the roller **67**, causing the roller **67** together with the link **55** to move from the closed position seen in full lines to the open position (not shown), to pivot the movable contact arm structure **35** about the latch surface **47**. This movement of the operating link **55** and movable contact arm structure **35** occurs with a snap action.

The breaker **26** is closed by reverse movement of the handle **63** from the off position to the on position. During this movement, the line of action of the operating springs **59** crosses over the center about pin **61**, whereupon the springs **59** bias the roller **67** to move the operating link **55** and movable contact arm structure **35** to the closed position with a snap action.

Referring to FIG. **3**, it will be seen that in the closed position of the circuit breaker **26**, the circuit extends from a conductor **165** through a conductor **121**, stationary contact **23**, the movable contact **25**, the U-shaped member **43**, flexible conductors **167** that are attached at one end to the member **43** and at the other end to a conductor **169**, the conductor **169**, a bimetal **171** that is connected at one end to the conductor **169** and at the other end to a conductor **173**, the conductor **173** to a flexible conductor **175** that is connected to the conductor **173**. The bimetal **171** is fixedly secured at the upper side thereof to an adjusting arm **170** that is suitably pivotally secured to the housing **31** in a manner more specifically described in the above-mentioned U.S. Pat. No. 2,686,242. A latch member **177** which is fixedly secured at one end thereof to the free end of bimetal **171** latches a second latching member **179** that is pivotally mounted on a stationary pivot **181** and that is biased in a clockwise direction by means of a tension spring **183**.

When a persistent relatively low overload current above a predetermined value occurs in the circuit, the bimetal **171** becomes heated and flexes with a time delay upward, whereupon the latch **177** releases the second latch member **179**. Upon release of the second latch member **179**, the spring **183** snaps the second latch member **179** clockwise about the pivot **181** causing the second latch member **179** to engage the end of the primary latch member **39** to pivot the primary latch member **39** in a counterclockwise direction about the fixed pivot **40** against the bias of spring **189**. This moves the latch surface **47** to release the latched end **37** of the contact arm **35** whereupon the tension spring **49** moves the contact arm **35** about the pivot **57** to a tripped open position, with a snap action.

The operating mechanism is relatched and rrelatched following an automatic opening operation by moving the handle **63** to a position slightly past the off position. During this movement, one end of contact arm **35** engages a surface **191** on the insulating housing **31**. This occurs when the operating link **55** is moved to the open position. The latching end **37** of the contact arm **35** is moved up over the latch surface **47** of the primary latch member **39**, and as the handle **63** approaches the off position, a projection thereon engages the second latch member **179** to rotate the second latch member **179** counterclockwise about the pivot **181** whereupon the latch member **179** is again relatched by latch **177**. When the second latch member **179** is moved to the latch position, a projection on latch member **179** moves away from the end of the primary latch member **39** and the spring **189** returns the primary latch member **39** to the latching position. This latches the contact arm **35** in the operating position. The movement of the primary latch member **39** to the latching position is stopped when the one end of the primary latch member **39** engages the projection **197** on the base **11**.

Means is also provided for indicating an over load condition that is not of sufficient magnitude to trip the breaker **26** open, but which indicates that the current in the circuit is approaching a dangerous overload condition or that a dangerous overload condition has existed and has cleared itself without tripping the breaker. The signal indicating means also indicates that the breaker **26** has been tripped open in response to an overload current.

The signal indicating means comprises releasable signal member **146** pivotally supported by pivot pin **181**. Member **146** is held by latch portion **177** carried by the bimetal element **171**. Signal latch member **146** is biased in a clockwise direction by flat-formed spring **160**. Flat formed spring **160** is held in position by projections **162** and **164** formed in housing **31**. Spring **160** is in contact with a conducting rod **166** which passes through housing **31**. When signal latch member **146** is released by the bimetal actuated latch **177**, flat spring **160** moves so as to contact support bolt **168**. As can best be seen in FIG. **4**, this completes circuit between conducting rod **166** and support bolt **168** through spring **160**. Bolt **168** and flat spring **160** form the contacts which close the circuit, indicating that signal latch **146** has been released due to an overload condition. The releasable signal **146** is reset following an operation thereof by opration of the signal reset assembly **70** or switching the circuit breaker handle **63** to the off position. The releasable signal member **146** is provided with a curved downwardly extending C-shaped arm **147** having a cam surface on the lower end thereof which is disposed in the path of the opening movement

of the operating handle **63**. Upon movement of the handle **63** to the off position, a portion of the handle **63** engages the cam surface on latch member **146** and rotates the releasable latch member **146** in a counterclockwise direction to permit reengagement of the latch member **146** with the latch **177**. This action also moves the flat spring **160** out of engagement with mounting bolt **168** and opens the signal circuit.

The signal latch **146** can also be reset with the signal reset assembly **70**. The signal reset assembly **70** comprises a signal sheet solenoid **72** and a reset linkage **74**. An opening **76** is formed in the bottom of the C-shaped portion **147** of the signal latch **146**. Opening **76** is engaged by reset linkage **74** which is connected to reset solenoid **72**. By energizing signal sheet solenoid **72**, signal latch **146** can be rotated in a counterclockwise direction and thus be reset to the latched position. The signal reset solenoid **72** permits the signal latch **146** to be reset from a remote location, and the signal circuit formed by flat formed spring **160** between conducting rod **166** and bolt **168** permits the status of the signal latch **146** to be remotely monitored.

An operator assembly **90** is also provided to switch the circuit breaker contacts **23** and **25** between the open and closed positions. A limit switch **110** is attached to the base of breaker **26** and is disposed so that when contact **25** is in the open position, limit switch **110** is engaged. Thus, a circuit formed through limit switch **110** can be used to remotely determine the status of the contacts **23** and **25**. The operator assembly **90** is constructed so as to facilitate activation from a remote location. When operator assembly **90** is activated, it will stay energized until circuit breaker **26** is switched either from the on position to the off position or from the off position to the on position. Operator assembly **90** comprises a gear motor **91**, a crank **92**, a connecting rod **93** and a lifter link **94**. Lifter link **94** is connected to operating rod **95** which is connected to the handle **63** of a circuit **26**. Lever **89** which engages lifter link **94** is provided to guide lifter link **94** and to hold lifter link **94** in position. Gear motor **91** comprises an electric motor **96** and a gear box **97**. The output shaft of electric motor **96** is connected to the input shaft of gear reducer **97**. Crank **92** is attached to the output shaft of gear box **97**. A crank **92** is rotated due to activation of drive motor **96**, handle **63** of circuit breaker **26** is moved between the on and off positions. Operating handle **63** is moved between the on and off positions without changing the direction of rotation of electric motor **96**. A cam **98** is also attached to the output shaft of gear motor **91**. Cam **98** is constructed so as to engage a limit switch **99** during predetermined cam rotation. Electric motor **96** is fed power through limit switch **99** so that, by proper construction of cam **98**, operation of electric motor **96** can be controlled. In a normal cycle, as crank **92** is rotated 360°, operating handle **63** is switched from the on position to the off position after a 180° rotation and then is switched from the off position back to the on position after a full 360° rotation. By constructing cam **98** with indentations at 180° spacing and having limit switch **99** disposed so as to be open when the operating lever **199** is released in one of the indentations, the electric motor **96** once activated will continue to operate until crank **92** is rotated 180° and circuit breaker **26** is switched. That is, a remote signal can activate gear motor **91** and gear motor **91** will continue to operate even after removal of the remote activation signal until crank **92** is rotated 180°, changing the state of circuit breaker contacts **23** and **25**. Thus, means are provided by limit switch **110** and operator assembly **90** for remotely monitoring and controlling the status of the main contacts **23** and **25** in circuit **26**.

Two or more of the circuit breakers **26** may be assembled and tied together for unitary operation to control a circuit. While only a single pole circuit breaker **26** has been described in detail it is to be understoood that operation of multipole units will be similar. When two or more breakers **26** are assembled together a single cover plate is disposed between adjacent breakers **26** and a coverplate is mounted on the outsides of the breaker unit. The breaker operating handles are joined together by a rod **95**.

It is at times essential that the service of a transformer be restored at least temporarily immediately after a circuit has been opened by operation of the transformer breaker in response to an overload condition. However, there are occasions where it is difficult or impossible to reclose the breaker **26**, especially if the oil has been heated by a long continued overload current or due to a high ambient temperature, because the hot oil maintains the bimetal element **171** deflected to its tripped position and the spring mechanism **27** cannot be relatched. Emergency control **80** is provided for emergency adjustment of the bimetallic element **171**, from a remote location, to permit the circuit breaker to be closed and latched immediately upon a tripping operation. Emergency control **80** permit the breaker **26** to temporarily carry a certain percentage of overload current for a predetermined time. The emergency control assembly **80** essentially permits remote changing of the circuit breaker **26** rating. Emergency control adjustment **80** of circuit breaker **26** comprises the pivoted mounting of the bimetal element **171** and the adjusting screw **127**. Mounted on the adjusting screw **127** for each of the breaker units is an arm **225**. The arms **225** are placed over the adjusting screws **127** after the adjusting screws **127** have been adjusted to give proper tripping. The arms **225** are securely connected to the adjusting screws **127** so as to provide a fixed connection. When more than one circuit breaker **26** unit is used, the arms **225** of the circuit breaker unit are connected by means of a link **227** for unitary movement. A lever **81** pivoted about point **82** is connected at one end to emergency control solenoid **83** and at the other end to link **227**. A relatively long bolt **84** is used to connect the one end of lever **81** to link **227**. Bolt **84** is connected so as to provide some degree of flexibility or movement between the end of lever **81** and connecting link **227**. The other end of lever **81** is connected by link **85** to the operating rod **86** extending from solenoid **83**. In operation emergency control solenoid **83** acts through linkage members **81**, **85**, **84** and **227** to simultaneously rotate the arms **225** and adjusting screws **127** a predetermined distance in a clockwise direction as viewed in FIG. **6**. This movement of adjusting screws **127**, each of which threadedly engages a corresponding adjusting rod **125** causes clockwise rotation of the arm **170** upon which the bimetal element **171** is mounted. This moves the latch portion **177** to the latching position even though the bimetal remains in a deflected condition and permits relatching of the spring operating mechanism **27** of the breaker **26**. Operating the emergency control assembly **80** also permits the signal

latch **146** to be reset even though an overload condition exists. Operating the emergency control solenoid **83** increases the trip temperature setting of the bimetal element **171** and requires a greater overload to trip the second breaker latch **179** or the overload signal latch **146.** By this emergency adjustment, the breaker **26** will carry a given overload for a predetermined time, but will still trip out in response to higher overload or short circuit currents. After the overload has cleared, the emergency adjusting means may be restored to its original position by deenergizing solenoid **83** and placing the transformer back in normal use. Emergency control limit switch **101** is mounted on the breaker so as to be engaged by link **81** when in the deenergized position. A circuit through emergency control limit switch **101** can thus indicate the status of the emergency control assembly **80.** That is, the switch **101** can be used to provide a remote indication of whether or not the emergency control assembly **80** is activated and the breaker is in an increased overload mode.

A trip bar **50** extends across the back of the circuit breaker unit **26.** This is mechanically linked by a push-pull cable **52** to an operating handle **54** located on the exterior of the transformer tank **12.** This trip mechanism can be used in the event of primary power failure and thus loss of the control voltage to open the breaker before restoring power. This handle **50** is held positively in the trip position to insure safety for lineman while servicing the secondary side of the tranformer **10.** This manual device prevents remote closure of the circuit breaker **26** by activation of the operator assembly **90** during the service procedures.

It can be seen that this invention provides a circuit breaker **26** especially adaptable for remote operation and control. The status and position of the main contacts **23** and **25** can be determined and controlled by operator assembly **90** and limit switch **110.** The emergency control can be positioned and monitored remotely through the emergency control assembly **80** and limit switch **101.** The overload signal circuit can be monitored and controlled remotely through use of the signal reset assembly **70.**

Pushbuttons can be supplied at the transformer **10** to provide for on-site operation or control of the above-described features. A typical electric schematic for remote surveillance and control of circuit breaker **26** is shown in FIG. **10.** In this schematic, one push-button **17** is provided for on-site operation of the breaker operator control motor **91.** The signal reset solenoid **72** can be remotely operated by closing contacts **18.** Emergency control advance solenoid **83** can be operated by remotely closing contacts **19.** The circuit breaker **26** can be switched on and off by remotely closing contacts **20** which activates the operator motor **91.** Motor **91** then continues to run through limit switch **99** until a predetermined position is reached. Closing of limit switch **101** indicates the emergency control **80** status. Closing of limit switch **110** indicates main breaker contacts **23** and **25** status.

Power for operation of the above-described electric circuit breaker **26** is provided for by placing a multiple conductor flat ribbon cable **112** between the transformer coil **113** and one loop of the core **114.** The ends of the flat cable conductor are offset one conductor and spliced together as seen in drawings **8** and **9.** To achieve a normal 24 volt AC as required, the **24** volts is divided by the working voltage per turn of the core and rounded to the nearest whole number. This then is the number of conductors at the splice that are bridged to achieve the approximate **24** volt AC required. For example, on a transformer core designed for 7 volts per turn, each conductor of the flat multiple ribbon cable picks up 3.5 volts when it passes through one core loop. If the control voltage required is **24** volts, **24** is divided by 3.5, yielding **6,85,** rounding this to the nearest whole number **7,** indicates that **7** strands must be bridged at the splice to obtain a supply voltage of approximately 24 volts. Using multiple conductor ribbon conductors **112** to provide the control voltage to operate circuit breaker **26** allows circuit breaker **26** to be easily installed in transformers **10** accommodating various working voltage coil designs. Use of multiple conductor ribbon conductors facilitates installation of control windings.

In the disclosed invention, a circuit breaker **26** is provided having a solenoid actuated signal latch reset assembly **70,** a solenoid actuated emergency control advance linkage and bell crank assembly **80,** an operator assembly **90** having a unidirectional gear motor driven crank and crank rod breaker open and breaker closed and reset assembly. The gear motor driven crank assembly is provided with an internal cam to actuate limit switches for self-deenergization at predetermined points where the breaker is in the open position and/or in the closed position.

I claim:

1. A circuit breaker comprising:

a stationary contact;

a movable contact;

an elongated contact arm carrying said movable contact at one end thereof;

a primary latch supported for movement about a first axis and being in a latching position, latching the other end of said elongated contact arm;

a second latch in a latched position;

biasing means biasing said second latch toward a tripping position;

a bimetal actuated latch latching said second latch in the latched position;

a spring operating mechanism pivotally connected to said contact arm intermediate the end of said contact arm and being operable to pivot said contact arm about said other end on said primary latch between open and closed positions with a snap action;

a signal latch in a latched position;

said bimetal actuated latch latching said signal latch in the latched position;

a pair of signal contacts associated with said signal latch and being movable from an open to a closed position when said signal latch is released;

said bimetal actuated latch being responsive to current flowing through the circuit breaker so upon the occurrence of lesser overloads above a predetermined value, said bimetal actuated latch releases said signal latch, whereupon said pair of signal contacts moves to a closed position and upon the occurrence of a greater overload above a predetermined value, said bimetal actuated latch also releases said second latch, whereupon said biasing means moves said second latch to effect movement of said primary latch to unlatch said elongated contact arm, whereupon said spring operating

mechanism moves said contact arm to a tripped open position; and,

signal reset means being responsive to an electric signal to reset said signal latch in a latch position.

2. A circuit breaker as claimed in claim **1**, comprising:

a spring biasing means for biasing said signal latch towards an unlatched position; and

said spring biasing means forming one of said pair of signal contacts.

3. A circuit breaker as claimed in claim **1**, wherein:

said signal reset means comprises an electric solenoid linked to said signal latch to reset said signal latch when activated.

4. A circuit breaker as claimed in claim **3**, comprising:

a handle mechanism movable between an on and an off position connected to said spring operating mechanism;

said signal latch having a C-shaped portion with one end being linked by a wire-formed member to said signal reset means; and

said signal latch being disposed so as to contact and be reset by said handle when said handle is moved to the off position.

5. A circuit breaker as claimed in claim **4**, comprising:

a flat-formed spring biasing said signal latch towards an unlatched position; and

said flat-formed spring forming one of said pair of signal contacts.

6. A circuit breaker as claimed in claim **4**, comprising:

an electric motor;

said electric motor being connected to said spring operating mechanism to move said primary latch between open and closed positions in response to a remote signal.

7. A circuit breaker as claimed in claim **1**, including:

an electric operator;

said electric operator being responsive to a remote electric signal to move said movable contact between open and closed position.

8. A circuit breaker as claimed in claim **6**, comprising:

a handle movable between an on and off position connected to said spring operating mechanism to operate said spring operating mechanism;

a gear reducer connected to the output shaft of said motor;

a cam connected to the output shaft of said gear reducer;

linkage means connecting said cam to said handle of said circuit breaker so that said handle mechanism is moved between the on and off positions while said electric motor is run in one direction.

9. A circuit breaker as claimed in claim **8**, including:

means for stopping said electric motor with said handle located at predetermined positions.

10. A circuit breaker as claimed in claim **9**, wherein said means to stop said motor comprises:

a limit switch through which power flows to said electric motor;

a cam attached to the output shaft of said gear reducer;

said cam and said limit switch being cooperatively associated to interrupt electric power to said motor at predetermined positions of said cam.

11. A circuit breaker as claimed in claim **6**, including:

an emergency control activator;

connecting means connecting said emergency control activator to said bimetal actuated latch so that when said emergency control activator is moved, the value of the current required to cause said bimetal actuated latch to release said signal latch and said second latch is varied.

12. A circuit breaker as claimed in claim **11**, comprising:

an electric operator assembly remotely controlled for positioning said emergency control activator.

13. A circuit breaker as claimed in claim **12**, wherein said electric operator comprises:

an electric solenoid;

emergency control linkage means for connecting said electric solenoid to said emergency control activator so that when said electric solenoid is activated, the position of said emergency control activator is correspondingly changed; and including,

emergency control limit switch disposed so as to indicate the status of said emergency control activator.

14. A circuit breaker as claimed in claim **11**, comprising a contact limit switch;

said contact limit switch being disposed so as to engage said elongated contact arm when said movable contact is separated from said stationary contact so as to be activated when said circuit breaker is open.

15. A circuit breaker comprising:

a stationary contact;

a movable contact, movable between a closed position in engagement with said stationary contact and an open position spaced from said stationary contact;

an elongated contact arm carrying said movable contact at one end thereof;

a primary latch supported for movement about a first axis and being in a latching position to latch the other end of said elongated contact arm;

a second latch held in a latched position;

biasing means biasing said second latch toward a tripping position;

a bimetal activated latch latching said second latch in the latched position;

a spring operated mechanism pivotally connected to said contact arm intermediate the ends of said contact arm and being operable to pivot said contact arm about said other end on said primary latch between open and closed positions with a snap action;

said bimetal actuated latch being responsive to current flow through the circuit breaker so upon the occurrence of a selected overload above a predetermined value, said bimetal actuated latch release said second latch, whereupon said biasing means moves said second latch to effect movement of said primary latch to unlatch said contact arm, whereupon said spring operating mechanism moves said contact arm to a tripped open position;

an emergency control activator being connected to said bimetal actuated latch so as to change the selected overload above which said bimetal actuated latch releases said second latch; and

an emergency control solenoid connected to said emergency control activator to move said emergency control activator in response to a remote signal so as to change the selected overload current at which said circuit breaker is tripped open.

16. A circuit breaker as claimed in claim **15**, including:

an emergency control limit switch positioned so as to be activated when said emergency control solenoid is operated to indicate the status of said emergency control activator.

17. A circuit breaker as claimed in claim **16**, comprising:

a contact position switch;

said contact position switch being located so as to be closed by said elongated contact arm when said movable contact is separated from said stationary contact and the circuit breaker is opened.

18. A circuit breaker comprising:

a stationary contact;

a movable contact;

an elongated contact arm carrying said movable contact at one end thereof;

a primary latch supported for movement about a fixed axis and being in a latching position, latching the other end of said elongated contact arm;

a second latch in a latched position;

biasing means biasing said second latch toward a tripping position;

a bimetal actuated latch latching said second latch in the latched position;

a spring operating mechanism pivotally connected to said connected arm intermediate the ends of said contact arm and being operable to pivot said contact arm about the other end on said primary latch between open and closed positions with a snap action;

said bimetal actuated latch being responsive to current flow through the circuit breaker so upon the occurrence of overload above a predetermined value, said bimetal actuated latch releases said second latch whereupon said biasing means moves said second latch to effect movement of said primary latch to unlatch said contact arm whereupon said spring operating mechanism moves said contact arm to a tripped open position; and

operating control means connected to said spring operating mechanism for operating said spring operating mechanism in response to a remote signal.

19. A circuit breaker as claimed in claim **18**, wherein said operating control means comprises:

an electric motor having an output shaft;

a gear reducer having an input shaft connected to the output shaft of said electric motor and having an output shaft;

an operating cam attached to the output shaft of said gear reducer;

a handle mechanism connected to said spring operating mechanism and being movable between an on and an off position to move said movable contact from the closed position to the open position;

linkage means connecting said handle mechanism to said operating cam mechanism so that said operating handle mechanism is moved between the on and off positions as said operating cam is rotated by said electric motor.

20. A circuit breaker as claimed in claim **19**, wherein said electric motor is operable in one direction only.

21. A circuit breaker as claimed in claim **19**, including means for stopping said electric motor when said operating handle mechanism is in a predetermined position, comprising:

a control cam attached to the output shaft of said gear reducer;

a limit switch completing an electric circuit to said electric motor and being disposed so as to be activated by said control cam at discrete positions to control operation of said electric motor.

22. A circuit interrupter including a motor operator for remote control, comprising:

a stationary contact;

a movable contact, being movable between a closed position in engagement with said stationary contact and an open position spaced from said stationary contact;

an operating means connected to said movable contact to move said movable contact between the open and closed positions with a snap action;

an electric motor having an output shaft;

a gear reducer having an input shaft, connected to the output shaft of said motor, and an output shaft;

an operating cam connected to the gear reducer output shaft;

a linkage connecting said operating cam to said operating means so that said movable contact is moved between the open and closed positions as said cam is rotated by said electric motor.

23. A circuit interrupter as claimed in claim **22** including:

an electric supply line feeding power to said electric motor;

a motor operator limit switch having a pair of contacts inserted in series with said electric supply line;

a control cam attached to the output shaft of said gear reducer and being cooperatively associated with said motor operator limit switch to open said electric supply line when the circuit interrupter is in the open position and also when the circuit interrupter is in the closed position.

24. A circuit interrupter comprising:

a stationary contact;

a movable contact being movable between a closed position in engagement with the said stationary contact and an open position spaced from said stationary contact;

an operating means connected to said movable contact to move said movable contact between the open and closed positions with a snap action;

a bimetal actuated latch latching said movable contact in the closed position;

spring biasing means connected to said movable contact to bias said movable contact towards the open position;

said bimetal actuated latch being responsive to current flow through the circuit interrupter so upon the occurrence of a tripping overload current above a predetermined value, said bimetal actuated latch releases said movable contact whereupon said circuit interrupter opens;

an emergency control actuator connected to said bimetal actuated latch and being movable between a normal position in which said bimetal actuated

latch releases at predetermined current overload and an overload position wherein said bimetal actuated latch trips at a current level greater than the predetermined overload current; and

an electric solenoid connected to said emergency control activator to move said emergency control activator between the normal position and the overload position in response to a remote signal.

25. A circuit interrupter as claimed in claim **24,** including:

an emergency control limit switch;

linkage means connecting said emergency control activator to said electric solenoid;

said emergency control limit switch being cooperatively associated with said emergency control linkage means so as to indicate the status of said emergency control activator.

26. A circuit breaker as claimed in claim **25,** including a electric operator being remotely controlled and connected to said operating means to activate said operating means in response to a remote control signal.

27. A circuit interrupter as claimed in claim **26,** including a limit switch disposed so as to contact said movable contact when said movable contact is in the open position, to thereby indicate the position of said movable contact.

28. A distribution transformer including:

a housing;

a core disposed within said housing;

a circuit interrupted disposed within said housing and being switchable between an open position, wherein the electrical connections through said transformer are open, and a closed position, wherein the electrical connections through said transformer are closed, in response to a remote signal;

an electric operator connected to said circuit interrupter and disposed within said housing for switching said circuit interrupter between an open and closed position in response to the remote signal; and

a control winding surrounding a portion of said core for supplying electric power to energize said electric operator.

29. A transformer as claimed in claim **28** wherein said control winding comprises;

a flat multiconductor cable disposed around a portion of said core; and

said flat multiconductor cable being connected with the ends of said flat multiconductor cable offset one conductor and spliced together to provide the desired operating voltage.

30. A distribution transformer as claimed in claim **29,** wherein said circuit interrupter comprises:

a stationary contact;

a movable contact;

an elongated contact arm carrying said movable contact at one end thereof;

a primary latch supported for movement about a fixed axis and being in a latching position, latching the other end of said elongated contact arm;

a second latch in a latched position;

biasing means biasing said second latch toward a tripping position;

a bimetal actuated latch latching said second latch in the latched position;

a spring operating mechanism pivotally connected to said contact arm intermediate the ends of said contact arm and being operable to pivot said contact arm about the other end of said primary latch between open and closed positions with a snap action;

said bimetal actuated latch being responsive to current flow through the circuit breaker so upon the occurrence of overload above a predetermined value, said bimetal actuated latch releases said second latch whereupon said biasing means moves said second latch to effect movement of said primary larch to unlatch said contact arm whereupon said spring operating mechanism moves said contact arm to a tripped open position; and,

said electric operator being connected to said spring operating mechanism for operating said spring operating mechanism in response to a remote signal.

31. A distribution transformer as claimed in claim **30,** wherein said electric operator comprises:

an electric motor having an output shaft;

a gear reducer having an input shaft connected to the output shaft of said electric motor and having an output shaft;

an operating cam attached to the output shaft of said gear reducer;

a handle mechanism connected to said spring operating mechanism and being movable between an on and an off position to move said movable contact from the closed position to the open position;

linkage means connecting said handle mechanism to said operating cam mechanism so that said operating handle mechanism is moved between the on and off positions as said operating cam is rotated by said electric motor.

32. A distribution transformer as claimed in claim **31,** comprising:

a contact position switch;

said contact position switch being located so as to be closed by said elongated contact arm when said movable contact is separated from said stationary contact and said circuit interrupter is opened.

* * * * *