Feb. 8, 1955 A. W. KRIEGER 2,701,829

MANUALLY OPERABLE CIRCUIT BREAKER

Filed Aug. 3, 1951 4 Sheets-Sheet 1

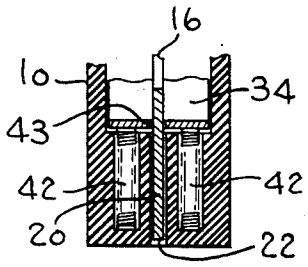


FIG. 5

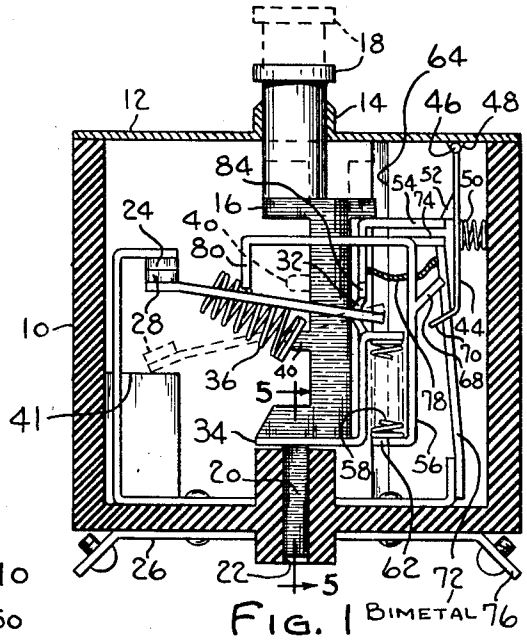


FIG. 1

FIG. 2

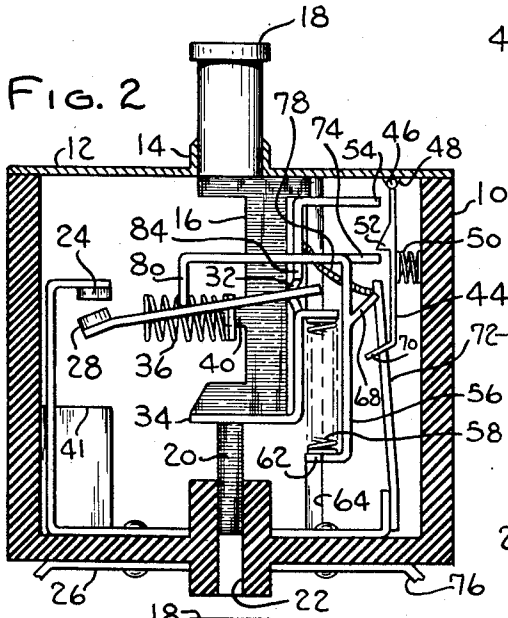
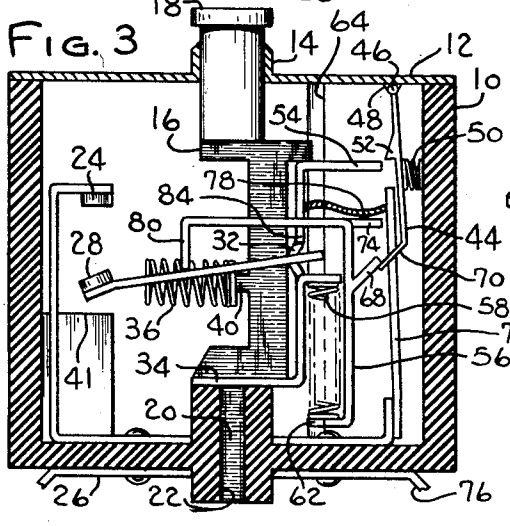


FIG. 3



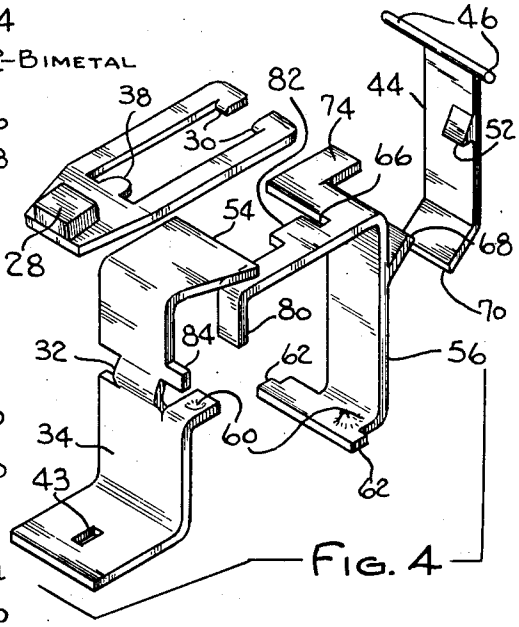


FIG. 4

INVENTOR.
ALVIN W. KRIEGER
BY
ATTORNEY

Feb. 8, 1955 A. W. KRIEGER 2,701,829

MANUALLY OPERABLE CIRCUIT BREAKER

Filed Aug. 3, 1951

4 Sheets-Sheet 2

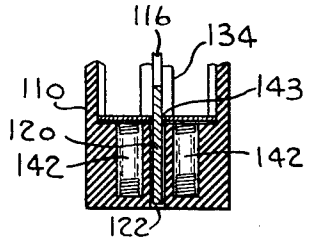


FIG. 10

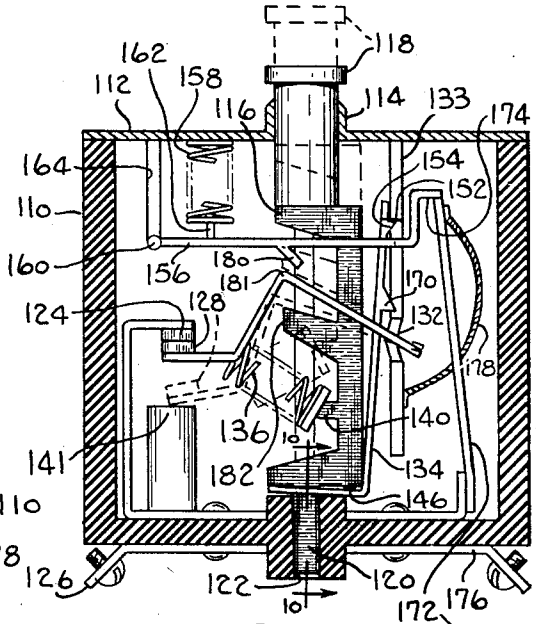


FIG. 6

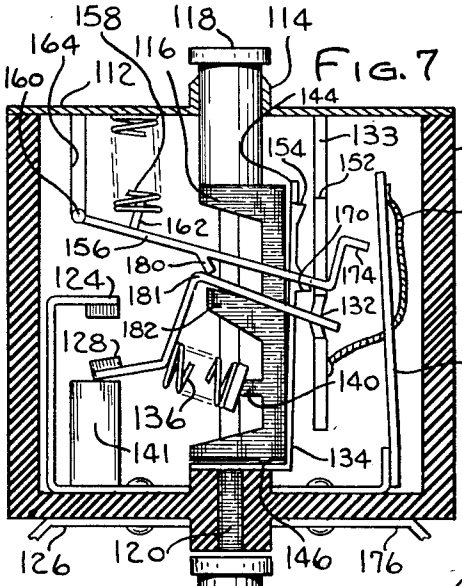


FIG. 7

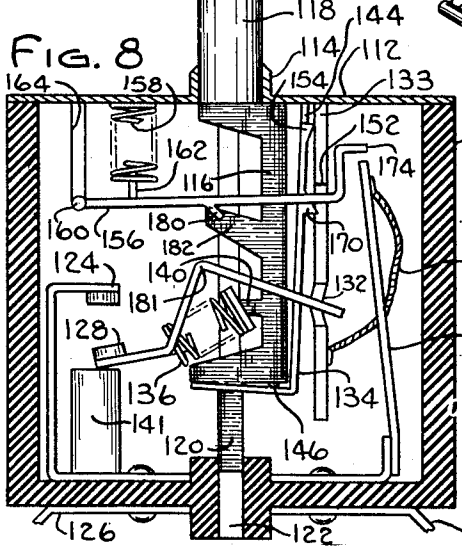


FIG. 8

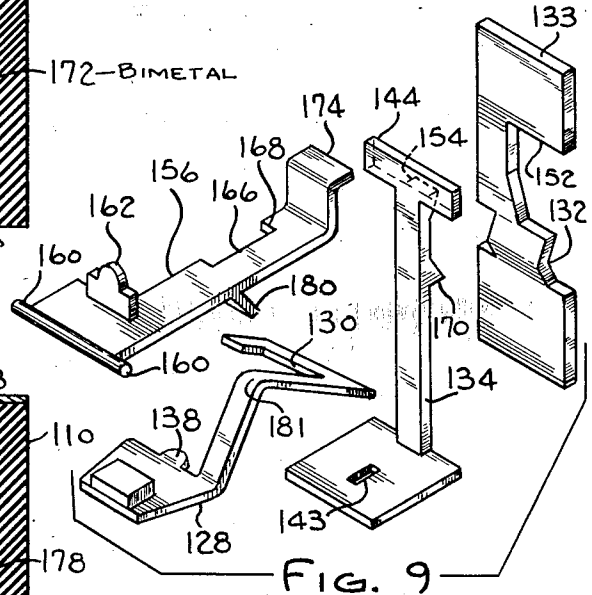


FIG. 9

INVENTOR.
ALVIN W. KRIEGER
BY W. B. Lyon
ATTORNEY

Feb. 8, 1955 A. W. KRIEGER 2,701,829

MANUALLY OPERABLE CIRCUIT BREAKER

Filed Aug. 3, 1951 4 Sheets-Sheet 3

FIG. 11

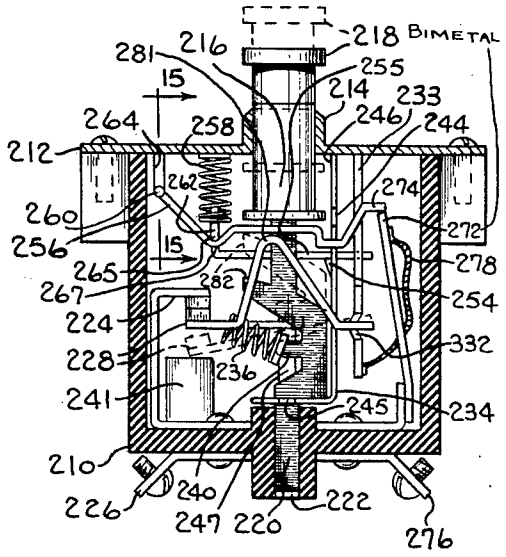
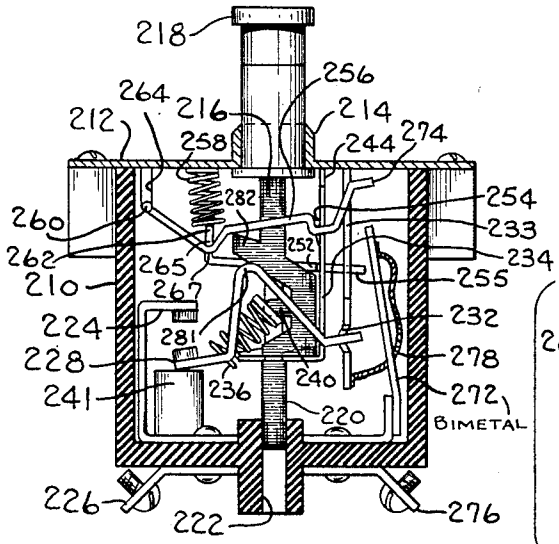


FIG. 12



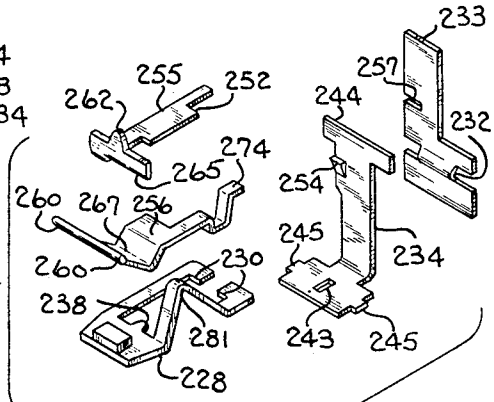
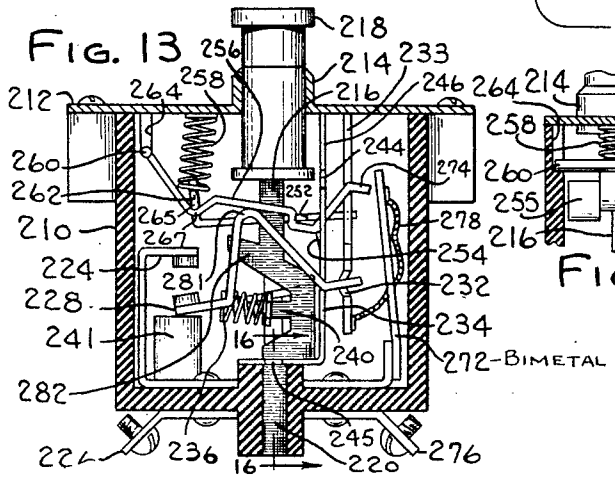


FIG. 14

FIG. 13



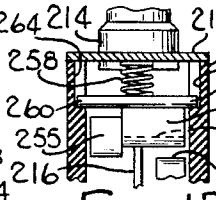


FIG. 15

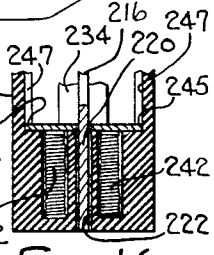


FIG. 16

INVENTOR.
ALVIN W. KRIEGER
BY W. C. Leyon
ATTORNEY

Feb. 8, 1955 A. W. KRIEGER 2,701,829

MANUALLY OPERABLE CIRCUIT BREAKER

Filed Aug. 3, 1951 4 Sheets-Sheet 4

FIG. 17

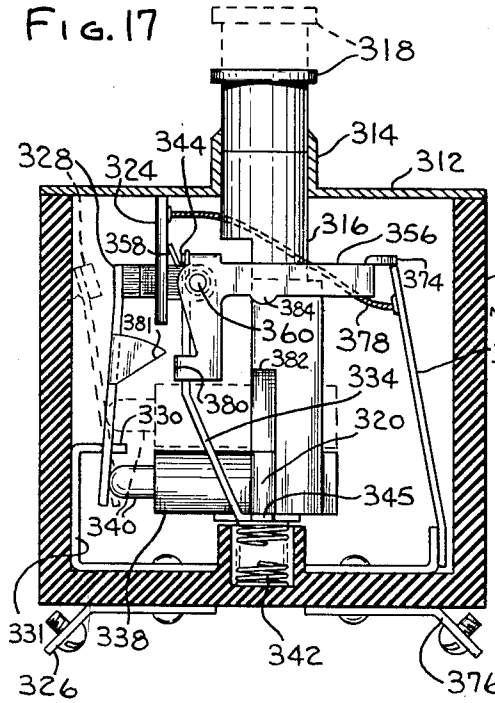
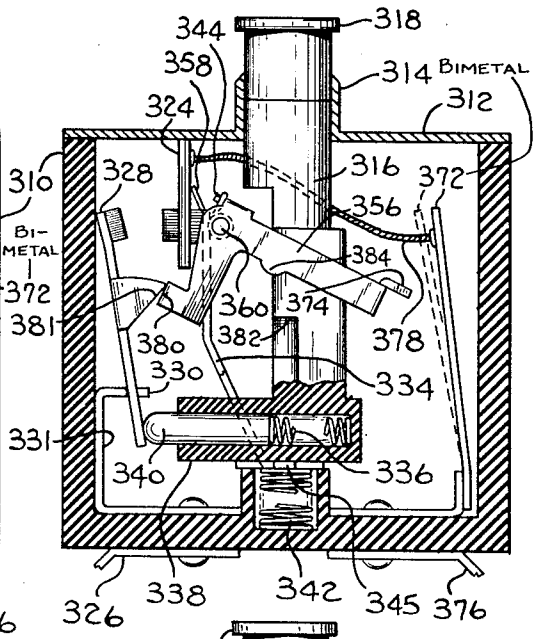


FIG. 18



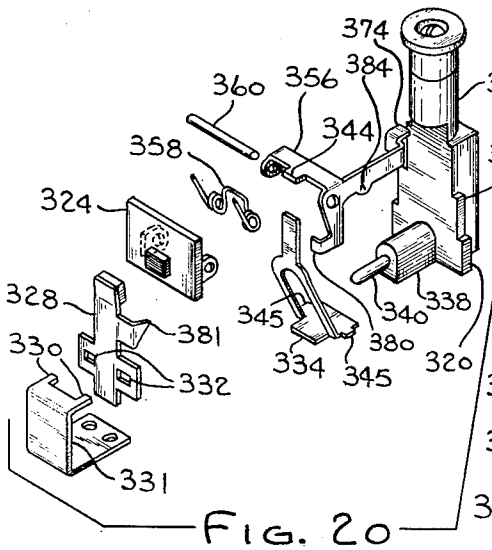


FIG. 20

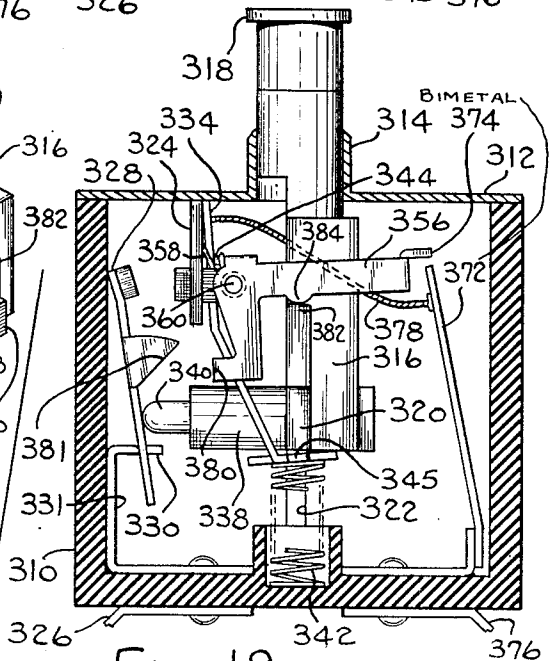


FIG. 19

INVENTOR.
ALVIN W. KRIEGER

BY

ATTORNEY

United States Patent Office 2,701,829 Patented Feb. 8, 1955

2,701,829

MANUALLY OPERABLE CIRCUIT BREAKER

Alvin W. Krieger, Milwaukee, Wis., assignor to Cutler-Hammer, Inc., Milwaukee, Wis., a corporation of Delaware

Application August 3, 1951, Serial No. 240,138

24 Claims. (Cl. 200—116)

This invention relates to manually operable circuit breakers having automatic overload tripping mechanisms, and particularly to such circuit breakers which are opened and closed with a snap action by a push-pull type of operating button.

Circuit breakers of this type have heretofore used current-responsive latches which directly contact the movable contact carrying member to hold the switch "on" during normal operation. Because of the extreme work required of such latches the time limits and current values are relatively high and such breakers cannot be used where low, close limits are required. In the normal operation of such breakers it is necessary to mechanically deflect the current-responsive latch for each opening and closing. This shortens the effective life of the latch. In addition, such breakers may be manually held "on" even when the latch has tripped.

The objects of this invention, therefore, are to provide a circuit breaker which: will trip automatically within close limits of time and current values; may be normally manually operated operated with double snap action without disturbing the current-tripping mechanism; is reset after automatic tripping by the same manual operation used to close the circuit breaker; will be free tripping, that is it will automatically trip even though normally manually held closed, and will not close when tripping conditions exist; will have relatively high current rupturing capacity; and will not be a fire hazard.

In obtaining these objects a double snap-action switch is operated by moving its over-center spring under the control of a manually movable member. Such member may be of the push-pull type and is manually moved to and from "on" and "off" positions.

An overload release spring acting through a slider urges the manually movable member toward "off." However, the slider is normally latched with the overload release spring loaded as the manually movable member is moved to "on" position. When the slider is latched the manually movable member may move from "on" and "off" positions in the normal operation of the switch without disturing the latched condition of the slider.

The latch for the slider consists of an engagement between the slider and a suitable relatively fixed abutment. This engagement is relatively hard to overcome because of the friction created by the force of the release spring. Hence a spring-biased trigger is used to supply the force for unlatching the slider. The trigger is held in cocked position by a current-responsive element. The spring for operating the trigger is weaker than the release spring and hence the frictional engagement between the current-responsive element and the trigger is much lower. It is preferable to use a long trigger with the place of engagement with the current-responsive element remote from the trigger spring. This also lessens the frictional engagement between such element and the trigger and permits the element to release the trigger within close limits of time and current values. When released, the trigger develops enough momentum or multiplied force to readily overcome the frictional resistance between the latch and slider and disengage the latter. Upon such disengagement the release spring will move the manually movable member to "off" position.

An abutment is provided on the manually movable member to engage and automatically reset the trigger in cocked position as the manually movable member is moved to "off" position. As the manually movable member is manually moved to "on" position the snap action switch will be closed unless the current-responsive member is still in overload position. In such event the trigger will not stay in cocked position and will engage

the movable switch contact and hold the switch open as the manually movable member moves into "on" position. To accomplish this there is a finger on the trigger to engage and hold the movable contact open even though the manually operable member is moved to fully "on" position. The trigger spring supplies a greater force than the over-center spring. Thus there is accomplished a free tripping action so that the switch cannot be closed when tripping conditions exist.

The novel features, which are considered characteristic of the invention, are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 is a view in side elevation of the first modification of the circuit breaker embodying the present invention with the side of the base cut away and shown in section for clarity in illustration, the parts being shown in "on" position for normal operation;

Fig. 2 is a view similar to Fig. 1 with the circuit breaker "off" and the parts shown in the position assumed after the overload release has functioned;

Fig. 3 is a view similar to Fig. 1 with the circuit breaker "off" and the parts shown in the position assumed during the first step following the release of the overload mechanism, such position being the same as in the case where the push-pull bar has been manually moved to or held in the "on" position during overload conditions;

Fig. 4 is an exploded view of the slider and trigger mechanism constituting part of the overload release mechanism;

Fig. 5 is a sectional view taken on line **5—5** of Fig. 1;

Fig. 6 is a view in side elevation of the second modification of the circuit breaker embodying the present invention with the side of the base cut away and shown in section for clarity in illustration, the parts being shown in "on" position for normal operation;

Fig. 7 is a view similar to Fig. 6 with the circuit breaker "off" and the parts shown in the position assumed during the first step following the release of the overload mechanism, such position being the same as in the case where the push-pull bar has been manually moved to or held in the "on" position during overload conditions;

Fig. 8 is a view similar to Fig. 6 with the circuit breaker "off" and the parts shown in the position assumed after the overload release has functioned;

Fig. 9 is an exploded view of the slider and trigger mechanism constituting part of the overload release mechanism;

Fig. 10 is a sectional view taken on line **10—10** of Fig. 6;

Fig. 11 is a view in side elevation of the third modification of the circuit breaker embodying the present invention with the side of the base cut away and shown in section for clarity in illustration, the parts being shown in "on" position for normal operation;

Fig. 12 is a view similar to Fig. 11 with the circuit breaker "off" and the parts shown in the position assumed after the overload release has functioned;

Fig. 13 is a view similar to Fig. 11 with the circuit breaker "off" and the parts shown in the position assumed during the first step following the release of the overload mechanism, such position being the same as in the case where the push-pull bar has been manually moved to or held in the "on" position during overload conditions;

Fig. 14 is an exploded view of the slider and trigger mechanism constituting part of the overload release mechanism;

Fig. 15 is a sectional view taken on line **15—15** of Fig. 11;

Fig. 16 is a sectional view taken on line **16—16** of Fig. 13;

Fig. 17 is a view in side elevation of the fourth modification of the circuit breaker embodying the present invention with the side of the base cut away and shown in section for clarity in illustration, the parts being shown in "on" position for normal operation;

Fig. 18 is a view similar to Fig. 17 with the circuit breaker "off" and the parts shown in the position assumed during the first step following the release of the overload mechanism, such position being the same as in the case where the push-pull bar has been manually moved to or held in the "on" position during overload conditions;

Fig. 19 is a view similar to Fig. 17 with the circuit breaker "off" and the parts shown in the position assumed after the overload release has functioned; and

Fig. 20 is an exploded view of the slider and trigger mechanism constituting part of the overload release mechanism.

Referring to the first modification disclosed in Figs. 1 to 5, the switch or circuit breaker is housed and mounted within a base **10** of moulded insulating material. A cover plate **12** provided with a bearing **14** is suitably secured to the base **10** and cooperates with such base in operably supporting the mechanism. A push-pull bar or manually movable member **16** has an outer end extending through the bearing **14** and provided with a knob **18** by which the bar may be manually moved inwardly to "on" position or outwardly to "off" position. The inner end **20** of such bar is guided in a bearing **22** provided by the base **10**.

A single throw snap action switch is operated by the reciprocal movement of the push-pull bar **16**. A fixed contact **24** for such switch is secured within the base **10** as shown and is electrically connected to an external terminal **26**. A movable contactor **28** for such switch has spaced pivots **30** at its inner end resting in a depression **32** formed in a slider **34**. An over-center compression spring **36** has its outer end engaged by a lug **38** on such movable contactor and its inner end engaged by a lug **40** on such push-pull bar. The spring **36** thus holds the contactor **28** for pivoting action toward and away from the fixed contact **24**. When the push-pull bar is in the "on" position shown in full lines of Fig. 1, the over-center spring snaps the contacts closed. When the push-pull bar is pulled outwardly to the "off" position (shown in broken lines in such figure), the over-center spring snaps the contactor **28** to the open position also shown in the broken lines of such figure where it rests against an internal abutment **41** formed on the base **10**. The lower end of the slider **34** is offset and has an opening **43** within which the inner end **20** is slidable to permit the push-pull bar **16** to move in normal operation without disturbing the slider **34** while the center spring **36** resiliently holds such slider, the contactor **28**, and the push-pull bar **16** in relative operative positions shown in the drawings.

An automatic overload release normally holds the slider **34** inactive and releases such slider to force the push-pull bar to the "off" position when predetermined overload conditions exist. Compression type release springs **42** positioned adjacent the inner end **20** bear against the base **10** and the slider **34** and resiliently urge such slider upwardly to the position shown in Fig. 2. In this position the push-pull bar is in its "off" position and the circuit breaker open. However, under normal conditions the slider **34** is latched in the cocked position shown in Fig. 1 by a latch **44** swingable on pins **46** mounted in notches **48** at the upper end of the base **10** and there held by cover plate **12**. The latch is biased toward the slider **34** by a latch spring **50** so that a tooth **52** on the latch will engage the top of a lateral projection **54** on the slider **34**. Because of the excessive frictional engagement between the tooth **52** and the projection **54** a current responsive member, operating within close limits of time and current values, cannot be used to directly break such engagement. Hence, there is provided a trigger mechanism which is easily held in cocked position and yet when released will develop sufficient force to break open the slider latch. A trigger **56** is normally biased downwardly with respect to the slider **34** by a compression type trigger spring **58** which extends between lateral projections on such slider and trigger, being held in a suitable manner by dimples **60** or the like. The lower end of the trigger has lugs **62** which are guided in grooves **64** in the base **10** and the upper end has a slot **66** which engages the peripheral edge of slider **34** for the purpose of movably guiding these parts. A sloping tooth **68** on the trigger is positioned relative to a sloping tooth **70** on the latch **44** so that when the trigger is uncocked and it snaps toward the lower position shown in Fig. 3, these teeth will engage with sufficient force to move the latch **44** out of engagement with the slider **34**.

The trigger **56** is held in cocked position by a current responsive element **72** such as a bimetal thermal element which normally underlies and engages a lip **74** on the trigger **56**. Because the trigger gains some velocity before the teeth **68** and **70** engage and because of the mechanical advantage derived from the camming action of such teeth, the spring **58** is relatively light in strength and only a small frictional resistance is created between the end of the element **72** and the lip **74**. Thus such element will warp away from such lip to uncock the trigger upon a small increase of predetermined current value for a relatively short time. The element **72** is electrically connected to an external terminal **76** and may be adjusted (by mechanism not shown) to control the range of its responsive operation. A pigtail type connector **78** extends from the upper end of the element **72** to the slider **34**. It is long enough so as not to interfere with the relative motion between these elements. Thus the flow of current through the circuit breaker passes from the terminal **76** through the bimetallic element to the slider **34** to the contactor **28** to the fixed contact **24** and thence to the terminal **26**. As excessive current passes through the element **72** for a predetermined period of time the heat generated will be sufficient to warp such element to the position shown in Fig. 3 thereby uncocking the trigger as described.

It is desirable to prevent the circuit breaker from becoming closed by the manual operation of the push-pull bar when abnormal current conditions cause the element **72** to be warped from latching position. To accomplish this, the trigger **56** is provided with an upper arm terminating in a depending finger **80** which engages the contactor **28** to hold it spaced from the fixed contact **24** whenever the push-pull bar is moved toward "on" position while the element **72** is out of alinement with the lip **74** as is illustrated by the relationship of the parts shown in Fig. 3. With this arrangement even though the manually operable member **16** be held in "on" position, the circuit breaker will open if overload conditions arise.

In order to automatically reset the trigger **56** it is provided with an abutment **82** which normally overlies another abutment **84** on the slider **34**. The abutment **84** will strike against the abutment **82** while the slider **34** is moving upwardly by the release springs **42** and carry the trigger **56** to the cocked position with the lip **74** spaced above the top of the element **72**, as is shown in Fig. 2.

The operation of this modification of the circuit breaker will now be described. Starting with the circuit breaker closed and the parts shown in the full line position of Fig. 1, it is only necessary to manually pull the push-pull bar **16** outwardly to the position shown in the broken line in order to cause the circuit breaker to be opened and the contactor **28** to assume the position shown in the broken line. The over-center spring **36** functions to open and close the contactor **28** with a snap action and to resiliently hold the push-pull bar **16** in either its "on" or "off" position. Such normal operation does not disturb the overload release mechanism. With the circuit breaker in the "on" position, a predetermined overload condition causes the current responsive element **72** to warp out of engagement with the lip **74**. The trigger **56** will first move downwardly toward the position shown in Fig. 3 moving the contactor **28** out of engagement with the fixed contact **24** and tripping the latch **44**. As soon as the latch **44** is tripped, the slider **34** then being uncocked will move upwardly to the position shown in Fig. 2. This forces the push-pull bar **16** to "off" position and at the same time resets the trigger **56** with respect to the element **72**. Provided the element **72** has warped back to normal, the next time the push-pull bar is moved to "on" position, the slider **34** will be carried to its cocked position and automatically latched. If the element **72** is not back to normal position, the trigger **56** will not be engaged thereby. As a result, the finger **80** will hold the contactor **28** out of engagement even in the "on" position of the bar.

Referring to the second modification disclosed in Figs. 6 to 10, the switch or circuit breaker is housed and mounted within a base **110** of moulded insulating material. A cover plate **112** provided with a bearing **114** is

suitably secured to the base **110** and cooperates with such base in operably supporting the mechanism. A push-pull bar or manually movable member **116** has an outer end extending through the bearing **114** and provided with a knob **118** by which the bar may be manually moved inwardly to "on" position or outwardly to "off" position. The inner end **120** of such bar is guided in a bearing **122** provided by the base **110**.

A single throw snap action switch is operated by the reciprocal movement of the push-pull bar **116**. A fixed contact **124** for such switch is secured within the base **110** as shown and is electrically connected to an external terminal **126**. A movable contactor **128** for such switch has a fulcrum **130** at its inner end resting in a depression **132** formed in a plate **133**. An over-center compression spring **136** has its outer end engaged by a lug **138** on such movable contactor and its inner end engaged by a lug **140** on such push-pull bar. The spring **136** thus holds the contactor **128** for pivoting action toward and away from the fixed contact **124**. When the push-pull bar is in the "on" position shown in the full lines of Fig. 6, the over-center spring snaps the contacts closed. When the push-pull bar is pulled outwardly to the "off" position (shown in broken line in such figure), the over-center spring snaps the contactor **128** to the open position also shown in the broken lines of such figure where it rests against an internal abutment **141** formed on the base **110**.

An automatic overload release normally held in inactive position is effective upon its release to force the push-pull bar to its "off" position. One of the elements of this automatic overload release is a slider **134** having its lower end offset and provided with an opening **143** within which the inner end **120** of the push-pull bar is slidable to effectively guide the lower end of such slider. Compression-type release springs **142** positioned on opposite sides of the inner end **120** bear against the base **110** and the offset end of the slider **134** and resiliently urge such slider upwardly to the position shown in Fig. 8. In this position the push-pull bar is in its "off" position and the circuit breaker open. The upper end of the slider has a cross bar **144** the ends of which slidably engage the inner surfaces of the side walls of the base **110** to laterally guide the upper end of the slider. Under normal operating conditions the slider **134** is latched in the cocked position shown in Fig. 6 by the engagement of a tooth **154** on the slider with an internal edge **152** on the plate **133**. The tooth **154** is resiliently urged toward the plate **133** by the action of the compression springs **142** in cooperation with a fulcrum **146** on the lower end of the bar **116**. Because of the excessive frictional engagement between the tooth **154** and the edge **152** a current responsive member, operating within close limits of time and current values, cannot be used to directly break such engagement. Hence, there is provided a trigger mechanism which is easily held in cocked position and yet when released will develop sufficient force to break open such latching engagement. A trigger **156** pivotally mounted within the base **110** by pins **160** held at the bottom of grooves **164** is normally biased downwardly by a compression type trigger spring **158** operable between a spring seat **162** on the trigger and the cover plate **112**. The trigger **156** has a notch **166** for accommodating the slider **134**. The right-hand edge of this notch forms a striker **168** which engages with a downwardly sloping surface of a tooth **170** on the slider **134** to cam the upper end of such slider away from the plate **133** and disengage the latching engagement between the slider and such plate whenever the trigger is uncocked or released from its cocked position.

The trigger **156** is held in its cocked position by a current responsive element **172** such as a bimetallic thermal element, the upper end of which normally underlies and engages a lip **174** on the trigger **156**. Because of the velocity gained by the trigger, after it is uncocked and before the striker **168** engages the tooth **170**, and because of the mechanical advantage derived from the camming action between such striker and tooth, the spring **158** is made relatively light in strength and only a small frictional resistance is created between the end of the element **172** and the lip **174**. Thus such current responsive element will warp away from such lip to uncock the trigger upon a small increase of predetermined current value for a relatively short time. The element **172** is electrically connected to an external terminal **176** and may be adjusted (by mechanism not shown) to control the range of its responsive operation. A pigtail type connector **178** extends from the upper end of the element **172** to the plate **133** and is long enough so as not to interfere with the relative movement of such parts. Thus the flow of current through the circuit breaker passes from the terminal **176** through the bimetallic element to the plate **133** to the contactor **128** to the fixed contact **124** and thence to the terminal **126**. As excessive current passes through the element **172** for a predetermined period of time the excess heat generated will be sufficient to warp such element to the position shown in Fig. 7 thereby uncocking the trigger as described.

It is desirable to prevent the circuit breaker from being closed by the manual operation of the push-pull bar when overload current conditions cause the element **172** to be warped from latching position. To accomplish this the trigger **156** is provided with a depending finger **180** which engages a raised knob **181** on the contactor **128** to hold the latter spaced from the fixed contact **124** whenever the push-pull bar is moved toward or held in "on" position while the element **172** is out of alinement with the lip **174** as illustrated by the relationship of the parts shown in Fig. 7. With this arrangement even though the manually operable member **116** be held in "on" position, the circuit breaker will open if overload conditions arise.

In order to automatically reset the trigger **156** the push-pull bar **116** is provided with an abutment **182** which will engage the underside of the trigger **156** as the push-pull bar is being moved upwardly by the release springs **142** after the slider **134** has been unlatched. The force of springs **142** is sufficient to overcome the force in spring **158** and hence the trigger **156** is automatically reset in position as shown in Fig. 8 where it will be held on the subsequent downward movement of the bar **116** provided normal operating conditions exist.

The operation of this modification of the circuit breaker will now be described. Starting with the circuit breaker closed and the parts shown in the full line position of Fig. 6, it is only necessary to manually pull the push-pull bar **116** outwardly to the position shown in the broken line in order to cause the circuit breaker to be opened and the contactor **128** to assume the position shown in the broken line. The over-center spring **136** functions to open and close the contactor **128** with a snap action and to resiliently hold the push-pull bar **116** in either its "on" or "off" position. Such normal operation does not disturb the overload release mechanism. With the circuit breaker in the "on" position, a predetermined overload condition causes the current-responsive element **172** to warp out of engagement with the lip **174**. The trigger **156** will first move downwardly toward the position shown in Fig. 7 moving the contactor **128** out of engagement with the fixed contact **124** and unlatching the slider **134**. As soon as the slider is unlatched it will move upwardly to the position shown in Fig. 8. This forces the push-pull bar **116** to "off" position and at the same time resets the trigger **156** with respect to the element **172**. Provided the element **172** has warped back to normal, the next time the push-pull bar is moved to "on" position, the slider **134** will be carried to its cocked position and automatically latched. If the element **172** is not back to normal position the trigger **156** will not be engaged thereby. As a result, the finger **180** will hold the contactor **128** out of engagement with the fixed contact **124** even in the "on" position of the bar.

Referring to the third modification disclosed in Figs. 11 to 16, the switch or circuit breaker is housed and mounted within a base **210** of moulded insulating material. A cover plate **212** provided with a bearing **214** is suitably secured to the base **210** and cooperates with such base in operably supporting the mechanism. A push-pull bar or manually movable member **216** has an outer end extending through the bearing **214** and provided with a knob **218** by which the bar may be manually moved inwardly to "on" position or outwardly to "off" position. The inner end **220** of such bar is guided in a bearing **222** provided by the base **210**.

A single throw snap action switch is operated by the reciprocal movement of the push-pull bar **216**. A fixed contact **224** for such switch is secured within the base **210** as shown and is electrically connected to an external terminal **226**. A movable contactor **228** for such switch has spaced fulcrums **230** at its right-hand end pivotally resting in a depression **232** formed in a fixed plate **233**. An over-center compression spring **236** has its left end

engaged by a lug **238** on such movable contactor and its right end engaged by a lug **240** on such push-pull bar. The spring **236** thus holds the contactor **228** for pivoting action toward and away from the fixed contact **224**. When the push-pull bar is in the "on" position shown in the full lines of Fig. 11, the over-center spring snaps the contacts closed. When the push-pull bar is pulled outwardly to the "off" position (shown in broken line in such figure), the over-center spring snaps the contactor **228** to the open position also shown in the broken lines of such figure where it rests against an internal abutment **241** formed on the base **210**.

An automatic overload release normally held in inactive position is effective upon its release to force the push-pull bar to its "off" position. One of the elements of this automatic overload release is a slider **234** having its lower end offset and provided with an opening **243** within which the inner end **220** of the push-pull bar is slidable. Such lower end also has lugs **245** which are slidably mounted in grooves **247** in the walls of the base **210**. The top of such slider has a cross bar **244**, the ends of which are slidably guided in a groove **246** also formed in the interior of such base. By this means the slider is restrained to rectilinear motion relative to the base **210** and the push-pull bar **216**. Compression-type release springs **242** positioned on opposite sides of the inner end **220** bear against the base **210** and the slider **234** and resiliently urge such slider upwardly to the "off" position of Fig. 12. Under normal operating conditions the slider **234** is latched in the cocked position shown in Fig. 11 by the engagement of a tooth **254** on the slider with an edge **252** on a bolt **255**. This bolt has one end slidably mounted in a slot **257** in the plate **233** and its other end carried by a spring-biased trigger so that such edge may be moved into and out of locking alinement with the tooth **254**. Because of the excessive frictional engagement between the tooth **254** and the edge **252**, a current responsive member, operating within close limits of time and current values, cannot be used to directly break such engagement. Hence there is provided a trigger mechanism which is easily held in cocked position and yet when released will develop sufficient power to break open such latching engagement. A trigger **256** pivotally mounted within the base **210** by pins **260** resting at the bottom of grooves **264** is normally biased downwardly by a compression type trigger spring **258** operable between the cover plate **212** and a spring seat **262** on the bolt **255**. The bolt **255** has a fulcrum edge **265** pivotally supported in a depression **267** formed in the trigger **256** and held there by the action of such trigger spring. When the trigger pivots clockwise about the axes of the pins **260**, the bolt **255** will be moved to the left and drawn away from the slider **234**. When the trigger is moved in a counter-clockwise direction about such axes, the bolt **255** will be moved to the right toward the slider **234**. By this means the edge **252** is brought into and out of latching alinement with the tooth **254**. By reason of the sloping wall of the depression **267**, the bolt **255** may be forcibly moved with respect to such trigger a sufficient distance to permit the bolt to slide up the sloping surface of the tooth **254** during resetting of the trigger. The mechanical advantage derived from this trigger and bolt arrangement is sufficient to readily break the frictional engagement between the edge **252** and tooth **254** under the power supplied by the relatively low strength compression spring **258**.

The trigger **256** is held in cocked position by a current responsive element **272**, such as a bimetallic thermal element, the upper end of which normally underlies and engages a lip **274** on the trigger **256**. A small increase of predetermined current value for a relatively short time will cause such element to warp away from such lip and uncock the trigger **256**. The element **272** is electrically connected to an external terminal **276** and may be adjusted (by mechanism not shown) to control the range of its responsive operation. A pigtail type connector **278** extends from the upper end of the element **272** to the plate **233** and is long enough so as not to interfere with the relative movement of such parts. Thus the flow of current through the circuit breaker passes from the terminal **276** through the bimetallic element to the plate **233** to the contactor **228** to the fixed contact **224** and thence to the terminal **226**. As excessive current passes through the element **272** for a predetermined period of time the heat generated will be sufficient to warp such element to the position shown in Fig. 13 thereby uncocking the trigger as described.

It is desirable to prevent the circuit breaker from being closed by manual operation when overload conditions exist. To accomplish this, the contactor **228** is provided with a raised knob **281** which is engaged by the trigger **256** whenever such trigger is uncocked to hold the contactor **228** out of engagement with the fixed contact **224** even though the push-pull bar be moved toward or held in the "on" position as is illustrated by the relationship of the parts shown in Fig. 13. With this arrangement the circuit breaker will open when overload conditions arise even though the manually operable member **216** be held in "on" position at the time.

In order to automatically reset the trigger **256**, the push-pull bar **216** is provided with an abutment **282** which will engage the underside of the trigger **256** as the push-pull bar is being moved upwardly by the release springs **242** after the slider **234** has been unlatched. The force of springs **242** is sufficient to overcome the force in spring **258** in the accomplishment of this function. With the trigger so reset, the slider **234** will be latched as the bar is again moved to "on" position.

The operation of this modification of the circuit breaker will now be described. Starting with the circuit breaker closed and the parts shown in the full line posiiton of Fig. 11, it is only necessary to manually pull the push-pull bar **216** outwardly to the position shown in the broken line in order to cause the circuit breaker to be opened and the contactor **228** to assume the position shown in the broken line. The over-center spring **236** functions to open and close the contactor **228** with a snap action and to resiliently hold the push-pull bar **216** in either its "on" or "off" position. Such normal operation does not disturb the overload release mechanism. With the circuit breaker in the "on" position a predetermined overload condition causes the current responsive element **272** to warp out of engagement with the lip **274**. The trigger **256** will first move downwardly toward the position shown in Fig. 13 moving the contactor **228** out of engagement with the fixed contact **224** and unlatching the slider **234** by withdrawing the bolt **255** so that the edge **252** is withdrawn from the tooth **254**. As soon as the slider is unlatched it will move upwardly to the position shown in Fig. 12. This forces the push-pull bar **216** to "off" position and at the same time resets the trigger **256** with respect to the element **272**. Provided the element **272** has warped back to normal, the next time the push-pull bar is moved to "on" position, the slider **234** will be carried to its cocked position and automatically latched. If the element **272** is not back to normal position, the trigger **256** will not be engaged thereby and as a result will hold the contactor **228** out of engagement with the fixed contact **224** even in the "on" position of the bar.

Referring to the fourth modification disclosed in Figs. 17 to 20, the switch or circuit breaker is housed and mounted within a base **310** of moulded insulating material. A cover plate **312** provided with a bearing **314** is suitably secured to such base and cooperates therewith in supporting the mechanism. A push-pull bar or manually movable member **316** has an outer end extending through the bearing **314** and provided with a knob **318** by which such bar may be manually moved inwardly to "on" position or pulled outwardly to "off" position (shown in broken lines in Fig. 17). For the purpose of guiding it, the inner end of such bar is provided with lugs **320** slidable in grooves **322** formed in the inner walls of such base.

A single-throw snap action switch is operated by the reciprocal movement of the push-pull bar **316**. A plate **324** with a fixed contact for such switch is held in grooves in such base. A movable contactor **328** is pivotally mounted on a bracket **331** by projections **330** loosely fitting in openings **332** in such contactor. Such bracket is electrically connected to an external terminal **326**. The push-pull bar **316** carries a laterally projecting barrel **338** within which is mounted a compression spring **336** for urging a round-headed pin **340** into sliding engagement with the surface of the movable contactor **328**. The pin **340** performs the double function of holding the contactor **328** in operating relationship and snapping the contactor to "on" or "off" positons (see broken lines of Fig. 17) as such rounded head passes the fulcrum point in its travel.

An automatic overload release normally held in inactive or cocked position is effective upon its release to force the push-pull bar **316** to its "off" position. One element of such release is a slider **334** having a lower offset underlying and engaging the bottom of the push-pull bar **316**. Such offset is provided with lugs **345** which are slidably guided in the grooves **322**. A compression-type release spring **342** normally urges the slider **334** upwardly with sufficient force to carry the push-pull bar **316** to its "off" position as shown in Fig. 19. Under normal operating conditions the slider **334** is latched in the cocked position shown in Fig. 17 by the engagement of the upper end thereof with a lip **344** on a pivoted trigger **356**. The trigger **356** is pivoted by a shaft **360** to the plate **324** and is resiliently urged in a clockwise direction by a coil-type trigger spring **358** encircling such shaft. In normal conditions the trigger is held in cocked position by a current responsive element **372**, such as a bimetallic thermal element, the upper end of which underlies and engages a lip **374** on the right end of the trigger **356**. Because the upper end of the slider **334** engages the lip **344** immediately adjacent the shaft **360**, the moment of force created by the compression in release spring **342** and tending to turn the trigger in a clockwise direction is relatively small. In opposition to this, the engagement between the current responsive member **372** and the lip **374** is spaced a considerable distance from and on the opposite side of the shaft **360**. Thus the moment of force tending to resist the clockwise rotation of the trigger under influence of both springs **342** and **358** is created by a relatively small force acting on a relatively long lever arm. Hence the frictional engagement at such point is so small that upon little increase of predetermined current values for a short time the current responsive element will warp away from the trigger and permit it to uncock. The element **372** is electrically connected to an external terminal **376** and may be adjusted (by mechanism not shown) to control the range of its responsive operation. A pigtail type connector **378** extends from the upper part of the element **372** to the plate **324** and is long enough so as not to interfere with the relative movement of such element. Thus the flow of current through the circuit breaker passes from the terminal **276** through the bimetallic element **372** to the plate **324** to the movable contactor **328** to the bracket **331** and hence to the external terminal **326**. As excessive current passes through the element **372** for a predetermined period of time the heat generated will be sufficient to warp such element to the position shown in full line in Fig. 18 thereby uncocking the trigger as described.

It is desirable to prevent the circuit breaker from being closed by manual operation when overload conditions exist. To accomplish this the trigger **356** is provided with a finger **380** which engages a projection **381** on the movable contactor **328** to hold such contactor out of engagement with the fixed contact whenever such trigger is released from engagement with the current responsive element **372**. The force in trigger spring **358** is sufficient to overcome the force in spring **336** and hold said contactor open even though the push-pull bar **316** be in its "on" position as is illustrated in Fig. 18. With this arrangement the circuit breaker will open when overload conditions arise even though the push-pull bar **316** be then held in "on" position.

In order to automatically reset the trigger **356**, the push-pull bar **316** is provided with an abutment **382** which will engage a semi-circular projection **384** on the underside of the trigger **356** as the push-pull bar is moved upwardly by the release spring **342** after the slider **334** has been unlatched. The force of spring **342** is sufficient to overcome the force in trigger spring **358** and any sliding friction between the end of lip **374** and the side of element **372** in the accomplishment of this function. Under normal conditions the element **372** will underlie the lip **374** upon reset. The angle of the lower offset of the slider **334** is such that spring **342** acts to resiliently urge the upper end toward the right into sliding engagement with the end of lip **344**. Hence the upper end of the slider **334** will snap under the lip **344** as the push-pull bar **316** is moved to "on" position from the "off" position of Fig. 19 to again lock the slider **334** in cocked position.

The operation of this modification of the circuit breaker will now be described. Starting with the circuit breaker closed and the parts shown in the full line position of Fig. 17, it is only necessary to manually pull the push-pull bar **316** upwardly to the position shown in the broken line in order to cause the circuit breaker to be opened and the movable contactor **328** to assume the position shown in the broken line. The spring **336** functions to open and close the contactor **328** with a snap action as the end of such pin passes the fulcrum point of such contactor. Because of the slope of the contactor to the vertical in both "on" and "off" positions the pin **340** under pressure of spring **336** will also resiliently hold the push-pull bar **316** in either its "on" or "off" position. Such normal operation does not disturb the overload release mechanism. With the circuit breaker in the "on" position, a predetermined overload condition causes the current responsive element **372** to warp out of engagement with the lip **374**. The trigger **356** will first move clockwise toward the position shown in Fig. 18 moving the contactor **328** out of engagement with the fixed contact **324** and unlatching the slider **334** by tipping the lip **344** upwardly. As soon as the slider is unlatched it will move upwardly to the position shown in Fig. 19. This forces the push-pull bar **326** to "off" position and at the same time resets the trigger **356** with respect to the element **372**. Provided the element **372** has warped back to normal, the next time the push-pull bar is moved to "on" position the slider **334** will be carried to its cocked position and automatically latched. If the element **372** is not back to normal position the trigger **356** will not become cocked and as a result will swing clockwise as the bar **316** is pushed downwardly and the finger **380** will engage the knob **381** to hold the contactor **328** out of engagement with fixed contact **324** before the pin **340** reaches the fulcrum point of such contactor. As previously explained, even after the pin **340** passes below such fulcrum the trigger so released will still hold the contacts disengaged.

Although only several embodiments of the invention are shown and described herein, it will be understood that this application is intended to cover such other changes or modifications as come within the spirit of the invention or scope of the following claims.

I claim:

1. In an "on" and "off" snap action push-pull operated switch, overload responsive means comprising spring means loaded by a push-pull bar as said bar is moved into "on" position, means for locking said last mentioned means when so loaded, a spring-biased trigger normally urged to unlatched position to unlock said means, and an element normally engaging said trigger in latched position and effective in response to currents of predetermined values to effect unlatching of said trigger, said engagement of the element and the trigger being effected as said bar is moved into "on" position.

2. In a switch as claimed in claim 1, an abutment on said trigger operable in unlatched position of said trigger to prevent said switch from being placed in "on" position by said push-pull bar.

3. A free-tripping overload switch comprising relatively movable engageable contacts, a manually movable member supported for movement relative to said contacts to and from "off" and "on" positions, resilient means operable between said member and one of said contacts to urge said contacts into engagement when said member is in "on" position and to urge said contacts out of engagement when said member is in "off" position, an overload release spring operative when released to force said member to "off" position, said spring being loaded as said member is moved to "on" position, means for locking said spring in loaded condition in a position permitting said member to move to and from "off" and "on" positions without actuation of said spring, and trigger mechanism including a current responsive element for tripping said means.

4. A switch as claimed in claim 3, in which said trigger mechanism has an abutment holding said contacts disengaged in the sprung condition of said trigger mechanism.

5. A switch as claimed in claim 3, in which said means for locking comprises: a slider having a portion interposed between said overload release spring and said manually movable member and a latch portion; and a latch plate with which said latch portion engages to hold said slider with said spring so loaded.

6. A switch as claimed in claim 5, in which said slider has an abutment to engage said trigger mechanism in the sprung condition of said overload release spring to reset said trigger mechanism with respect to said current responsive element.

7. A snap action circuit breaker having a manually operable member reciprocatably movable to and from "on" and "off" positions, means including spring means operable by said member to operate said circuit breaker in each direction with a snap action under normal conditions, automatic means released from a cocked position under overload conditions to open said circuit breaker and move said member to "off" position, and second means for cocking said automatic means as said member is moved to "on" position after previous release of said automatic means.

8. A snap action circuit breaker having a manually operable member movable to and from "on" and "off" positions to operate said circuit breaker under normal conditions, automatic means released from a cocked position under overload conditions to open said circuit breaker and move said member to "off" position, and second means for cocking said automatic means as said member is moved to "on" position after previous release of said automatic means, said automatic means comprising a spring-biased slider operable when released to move said member to "off" position, a latch for holding said slider in cocked position, a slider-charged trigger operable when released from charged position to open said circuit breaker and trip said latch, and a current responsive element subject to overload conditions and normally biased to hold said trigger in charged position.

9. A free-tripping overload switch comprising in combination an element rectilinearly movable to "on" and "off" positions and being biased in one direction, an overload release spring operative when released to force said element to "off" position, said spring being loaded as said element is moved to "on" position, cooperating contacts including a contactor pivotally supported on said element, a latch biased into engagement with said element to restrain said element against the bias of said element, a rectilinearly movable trigger, spring means operable between said trigger and said element to urge said trigger in a direction to disengage said latch, a thermally responsive means normally restraining said trigger against said spring means, operating means for said contactor to resiliently engage and disengage said contacts at will while said element is latched and to relatch said element, and a part on said trigger engageable with said contactor to maintain said contacts disengaged when said thermally responsive means no longer restrains said trigger and while said operating means is in position to engage said contacts.

10. A free-tripping overload switch comprising in combination an element rectilinearly movable to "on" and "off" positions and being biased in two directions, an overload release spring operative when released to force said element to "off" position, said spring being loaded as said element is moved to "off" position, cooperating contacts including a contactor pivotally supported adjacent said element, a fixed edge adjacent said element, a tooth on said element engageable with said edge under the influence of the bias of said element in one of said directions to latch said element against the bias of said element in the other of said directions, a pivotally mounted trigger biased in one direction and having a striker to engage said element and disengage said tooth and said fixed edge, a thermally responsive means normally restraining said trigger against its bias, operating means for said contactor to resiliently engage and disengage said contacts at will while said element is latched and to relatch said element, and a part on said trigger engageable with said contactor to maintain said contacts disengaged when said thermally responsive means no longer restrains said trigger and while said operating means is in position to engage said contacts.

11. A free-tripping overload switch comprising in combination an element rectilinearly movable to and from "off" and "on" positions, an overload release spring operative when released to force said element to "off" position, means for locking said spring in loaded condition in a position permitting said element to move to and from "off" and "on" positions without actuation of said spring, cooperating contacts including a contactor pivotally supported adjacent said element, a tooth on said element, a bar having longitudinal movement for engagement with said tooth, a pivotally mounted trigger biased in one direction and interconnected with said bar to impart longitudinal movement thereto to cause said bar to disengage from said tooth, a thermally responsive means normally restraining said trigger against its bias, operating means for said contactor to resiliently engage and disengage said contacts at will while said element is latched and to relatch said element, and a part on said contactor engageable by said trigger to maintain said contacts disengaged when said thermally responsive means no longer restrains said trigger and while said operating means is in position to engage said contacts.

12. In an "on" and "off" spring-biased snap action push-pull bar operated switch, relatively movable engageable contacts, a manual push-pull bar supported for movement relative to said contacts to and from "off" and "on" positions, resilient means operable between said bar and one of said contacts to urge said contacts into engagement when said bar is in "on" position and to urge said contacts out of engagement when said bar is in "off" position, free-tripping overload protection comprising a slider movable relative to said bar and having a cocked position, a release spring loaded by said slider in the cocked position of said slider and operable to move said bar to "off" position when said slider is uncocked, said spring being loaded as said bar is moved to "on" position, a tooth on said slider, a bolt to engage said tooth and hold said slider in said cocked position, a pivoted member associated with said bolt and biased in one direction to withdraw said bolt from engagement with said tooth, and a current responsive element normally holding said pivoted member in the untripped position thereof.

13. In an "on" and "off" spring-biased snap action push-pull bar operated switch, relatively movable engageable contacts, a manually movable push-pull bar supported for movement relative to said contacts to and from "off" and "on" positions, resilient means operable between said bar and one of said contacts to urge said contacts into engagement when said bar is in "on" position and to urge said contacts out of engagement when said bar is in "off" position, free-tripping overload protection comprising a slider movable relative to said bar and having a cocked position, a release spring loaded by said slider in the cocked position of said slider and operable to move said bar to said "off" position when said slider is uncocked, said spring being loaded as said bar is moved to "on" position, a lateral projection on said slider, a pivoted latch spring-biased into engagement with said projection to hold said slider in said cocked position, a slidable member spring-biased from an untripped position in a direction to disengage said latch from said projection, and a current responsive element normally holding said slidable member in the untripped position thereof.

14. In an "on" and "off" snap action push-pull bar operated switch, relatively movable engageable contacts, a push-pull bar supported for movement relative to said contacts to and from "off" and "on" positions, resilient means operable between said bar and one of said contacts to urge said contacts into engagement when said bar is in "on" position and to urge said contacts out of engagement when said bar is in "off" position, free-tripping overload protection comprising a slider movable relative to said bar and having a cocked position, a release spring loaded by said slider in the cocked position of said slider and operative to move said bar to "off" position when said slider is uncocked, said release spring being loaded as said bar is moved to "on" position, a tooth on said slider, a fixed edge engageable by said tooth to hold said slider in said cocked position, a pivoted member spring-biased from an untripped position in one direction to contact said slider and disengage said tooth from said edge, and a current responsive element normally holding said pivoted member in the untripped position thereof.

15. In an "on" and "off" snap action push-pull bar operated switch, overload protection comprising a slider movable relative to said bar and having a cocked position, a release spring loaded by said slider in said cocked position and operable to move said bar to "off" position when said slider is uncocked, an elongated trigger, a pivot for said trigger close to one end thereof to permit said trigger to swing from a latched to an unlatched position, a first

lip on said trigger at said end to hold said slider in cocked position when said trigger is in latched position, a second lip on the other end of said trigger, and a current responsive element positioned to engage said second lip and hold said trigger in latched position.

16. A free-tripping overload switch comprising in combination a rectilinearly movable member biased in one direction from a cocked position, cooperating contacts including a contactor pivotally mounted intermediate its ends, a latch pivoted intermediate its ends and swingable to and from latched and unlatched positions, said latch having a lip on one side of its pivot engageable with said member in said latched position to restrain said member in said cocked position, a thermally responsive element positioned to engage said latch on the opposite side of its pivotal connection to hold said latch in latched position, and operating means for said contactor including a spring-biased pin slidably engageable with said contactor to engage and disengage said contacts at will while said member is cocked and to recock said member.

17. A switch as claimed in claim 16 in which said latch carries a finger adapted to engage said contactor to disengage said contacts when said latch is uncocked, and spring means to urge said latch to said uncocked position with enough force to hold said contacts disengaged independently of the position of said operating means whenever said thermally responsive element is out of engagement with said latch.

18. A switch as claimed in claim 17 in which there is an abutment on said operating means to engage and relatch said latch as said operating means is moved to disengage said contacts under influence of said member.

19. A free-tripping overload switch comprising cooperating contacts including a movable contactor pivoted intermediate its ends, a push-pull bar supported for longitudinal movement between "off" and "on" positions, a spring-biased pin carried by said bar and resiliently slidably engaged with said movable contactor to engage and disengage said contacts as said bar is moved to and from "on" and "off" positions, a slider having a cocked position and movable to an uncocked position to engage and move said bar to "off" position, a release spring normally urging said slider to said uncocked position, a member having a pivotal mounting, a portion on said member near one side of said pivotal mounting engageable with said slider to hold said slider in said cocked position with said release spring compressed, a thermal-responsive element having an end underlyingly engaging said member on the opposite side of said pivotal mounting at a place spaced from said pivotal mounting a distance in excess of the distance between said portion and said pivotal mounting whereby frictional engagement between said thermal-responsive element and said member caused by the pressure of said release spring is sufficiently low to permit said thermal-responsive element to move out of underlying engagement with said member upon a small change for a short time in the thermal condition to which said element is subjected.

20. A free-tripping overload switch comprising cooperating contacts including a contactor having a pivotal support intermediate its ends, a push-pull element movable to and from "off" and "on" positions, a resiliently biased member carried by said element and slidably engaged with said contactor to engage and disengage said contacts as said element is moved to "on" and "off" positions, a release spring for moving said element to "off" position, a latch having a cocked position for holding said spring compressed and out of operative engagement with said element, a trigger having a latch-engaging portion operable in the locked position of said trigger to hold said latch in said cocked position, and a current responsive device engageable with said trigger under normal operating conditions to hold said trigger in said locked position and disengageable from said trigger under abnormal operating conditions.

21. A free-tripping overload switch comprising cooperating contacts including a contactor having a pivotal support intermediate its ends, a push-pull element movable to and from "off" and "on" positions, a resiliently biased member carried by said element and slidably engaged with said contactor to engage and disengage said contacts as said element is moved to "on" and "off" positions, a release spring for moving said element to "off" position, a latch having a cocked position for holding said spring compressed and out of operative engagement with said element, a trigger having a latch-engaging portion operable in the locked position of said trigger to hold said latch in said cocked position, a current responsive device engageable with said trigger under normal operating conditions to hold said trigger in said locked position and disengageable from said trigger under abnormal operating conditions, spring means urging said trigger from said locked position to a sprung position, and abutment means between said trigger and said contactor operable in said sprung position to disengage said contacts in either position of said element.

22. A free-tripping overload switch comprising cooperating contacts including a contactor having a pivotal support intermediate its ends, a push-pull element movable to and from "off" and "on" positions, a resiliently biased member carried by said element and slidably engaged with said contactor to engage and disengage said contacts as said element is moved to "on" and "off" positions, a release spring for moving said element to "off" position, a latch having a cocked position for holding said spring compressed and out of operative engagement with said element, a trigger having a latch-engaging portion operable in the locked position of said trigger to hold said latch in said cocked position, a current responsive device engageable with said trigger under normal operating conditions to hold said trigger in said locked position and disengageable from said trigger under abnormal operating conditions, spring means urging said trigger from said locked position to a sprung position, abutment means between said trigger and said contactor operable in said sprung position to disengage said contacts in either position of said element, and abutment means between said trigger and said element to reset said trigger in said locked position as said element is moved to "off" position.

23. A snap action circuit breaker having a manually operable member movable to and from "on" and "off" positions to operate said circuit breaker under normal conditions, automatic means released from a cocked position under overload conditions to open said circuit breaker and move said member to "off" position, said automatic means comprising a spring-biased slider operable when released to move said member to "off" position, a latch for holding said slider in cocked position, a spring-charged trigger operable when released from charged position to open said circuit breaker and trip said latch, a current responsive element subject to overload conditions and normally biased to hold said trigger in charged position, second means for cocking said automatic means as said member is moved to "on" position after previous release of said automatic means, said second means comprising a first abutment movable with said member as said member is moved toward "off" position by said slider and a second abutment carried by said trigger and contacted by said first abutment to move said trigger to charged position as said member is moved into "off" position, and a one way engagement between said member and said slider to move said slider into cocked and latched position when said member is moved to "on" position.

24. A snap action circuit breaker having a manually operable member movable to and from "on" and "off" positions to operate said circuit breaker under normal condition, automatic means released from a cocked position under overload conditions to open said circuit breaker and move said member to "off" position, second means for cocking said automatic means as said member is moved to "on" position after previous release of said automatic means, said second means comprising a first abutment movable with said member as said member is moved toward "off" position by said slider and a second abutment carried by said trigger and contacted by said first abutment to move said trigger to charged position as said member is moved into "off" position, and means providing a one way engagement between said member and said slider to move said slider into cocked and latched position when said member is moved to "on" position.

References Cited in the file of this patent

UNITED STATES PATENTS

1,967,122	Horst	July 17, 1934
2,233,187	Von Hoorn	Feb. 25, 1941
2,381,294	Langstroth	Aug. 7, 1945
2,447,137	Runke	Aug. 17, 1948
2,485,736	Ingwersen	Oct. 25, 1949
2,625,625	Ingwersen	Jan. 13, 1953