Sept. 19, 1967 A. R. CELLERINI ETAL 3,343,042

SWITCHBOARD APPARATUS

Filed Nov. 5, 1964 6 Sheets-Sheet 1

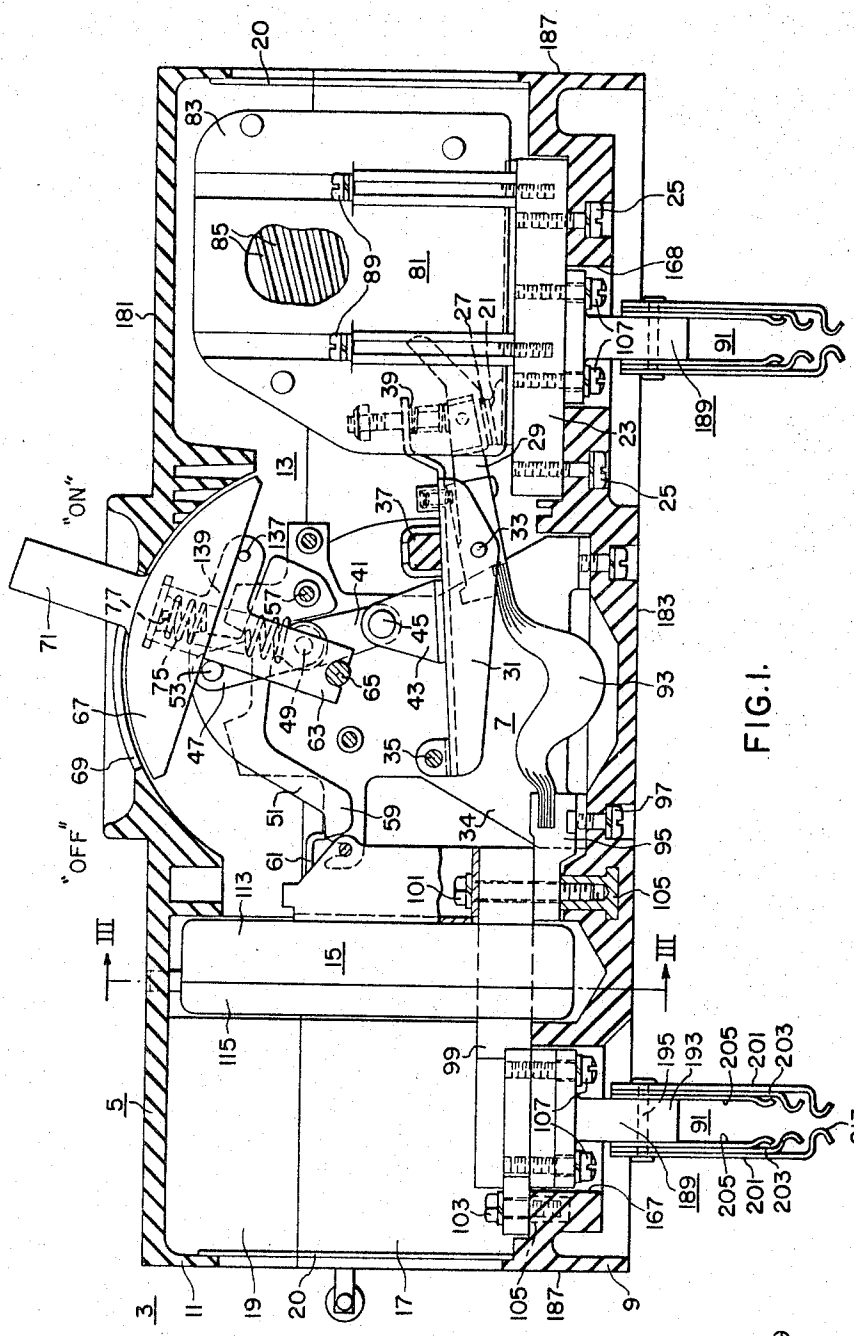

FIG. 1.

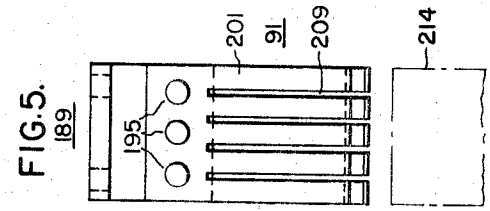

FIG. 5.

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SWITCHBOARD APPARATUS

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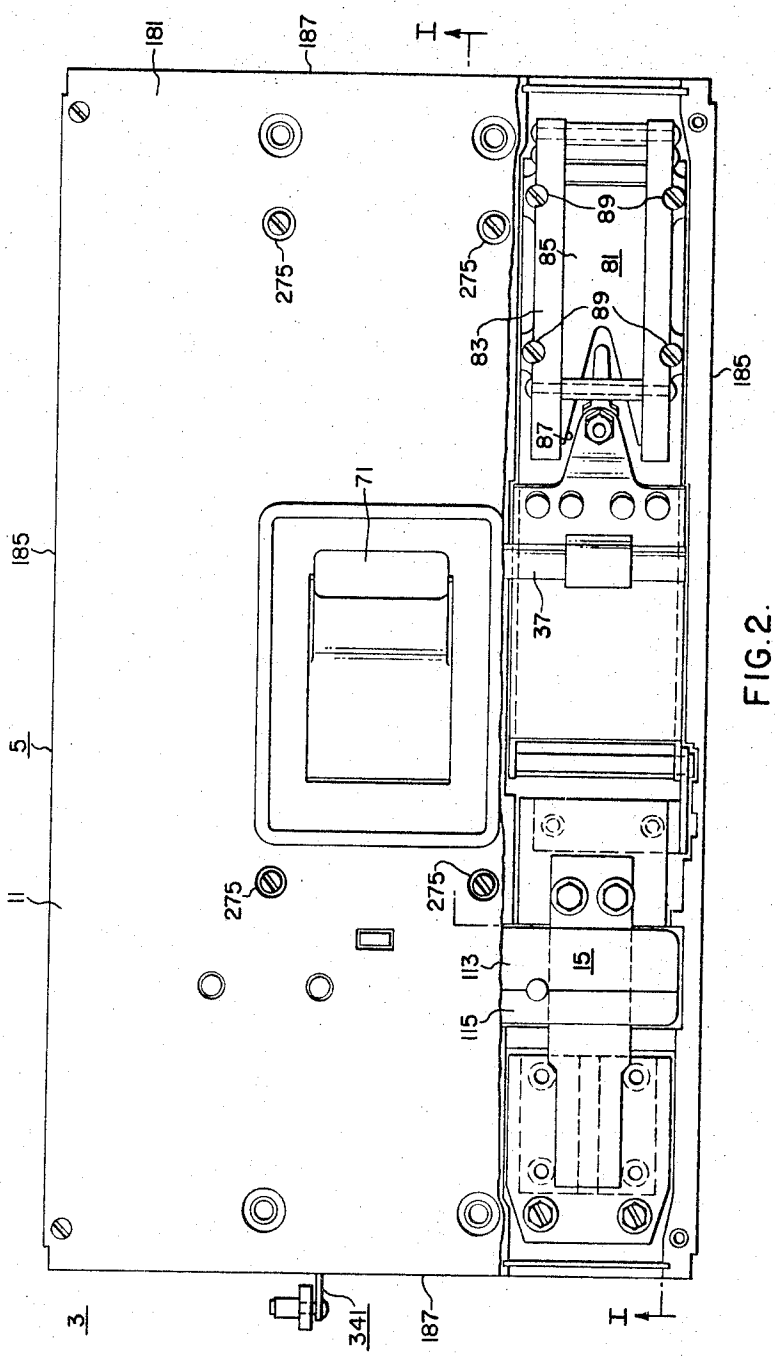

FIG. 2.

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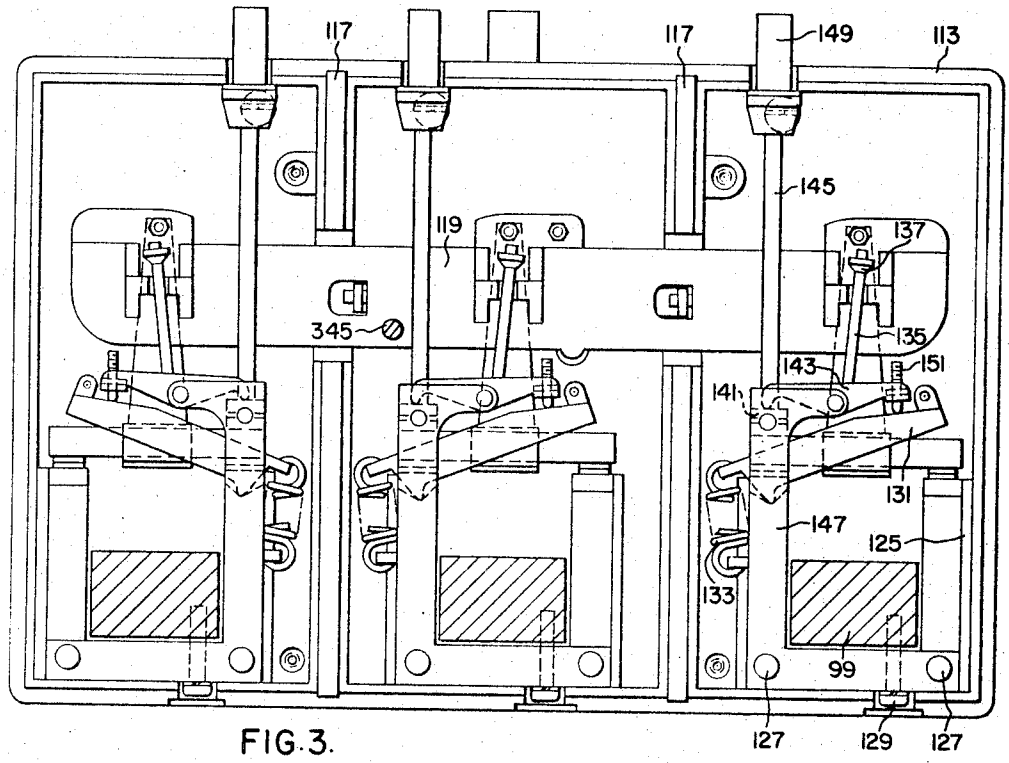

FIG.3.

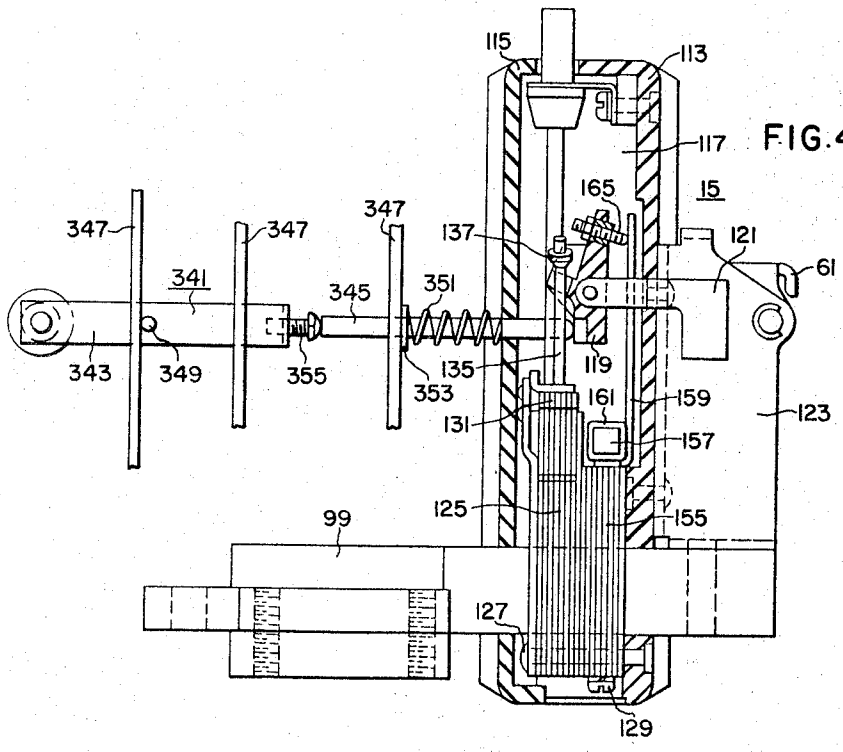

FIG.4.

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FIG.7.

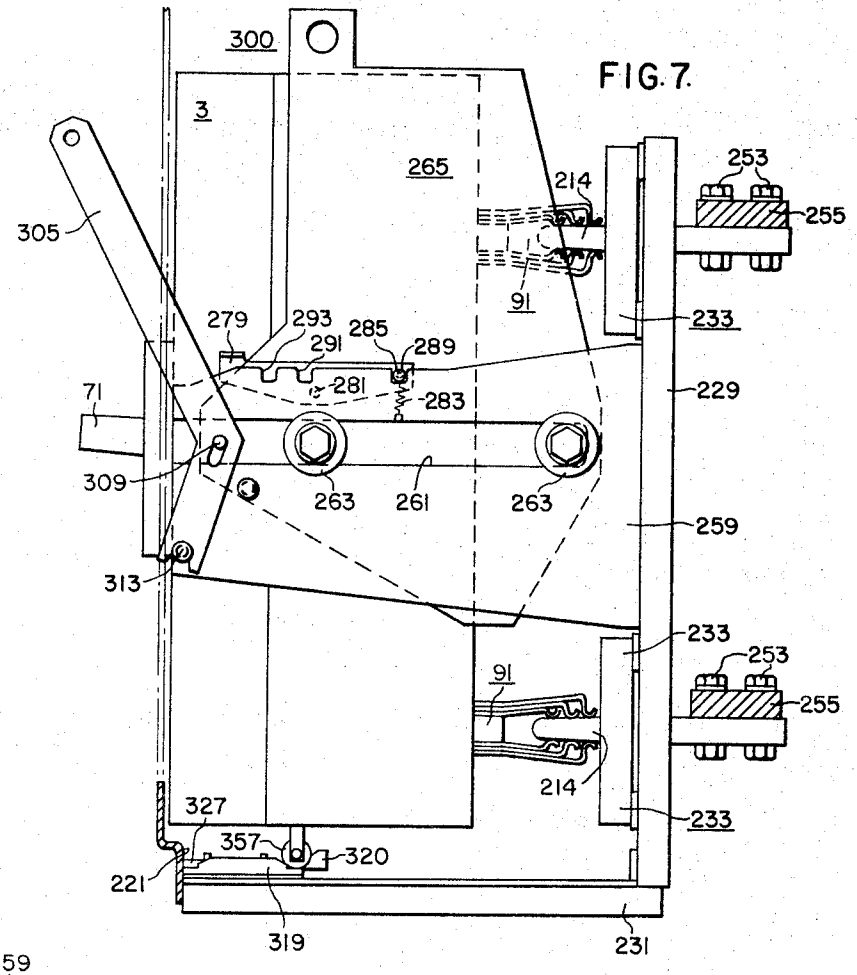
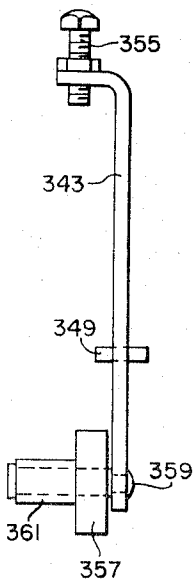


FIG.10.



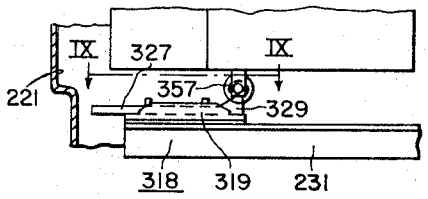
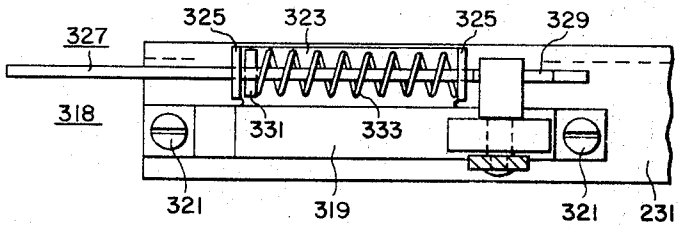


FIG.8.

FIG.9.



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SWITCHBOARD APPARATUS

Filed Nov. 5, 1964 6 Sheets-Sheet 5

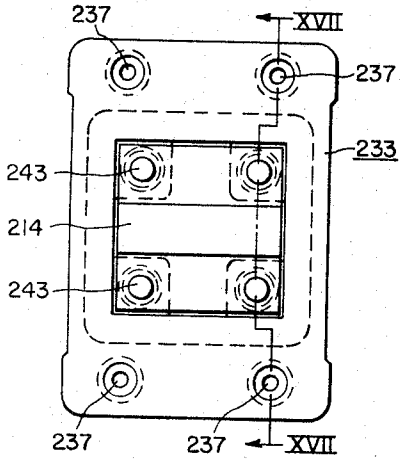

FIG.16.

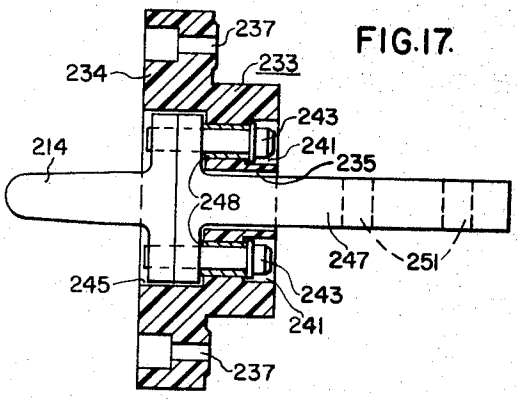

FIG.17.

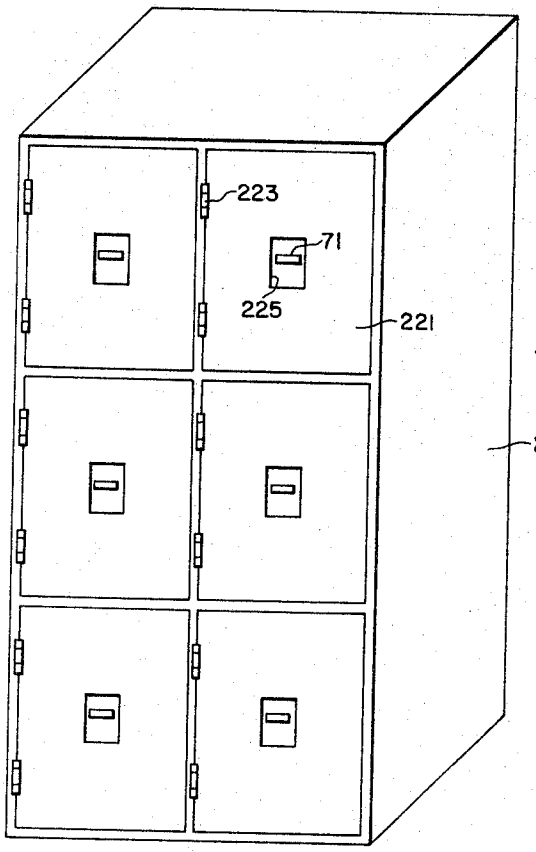

FIG.6.

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FIG.11.

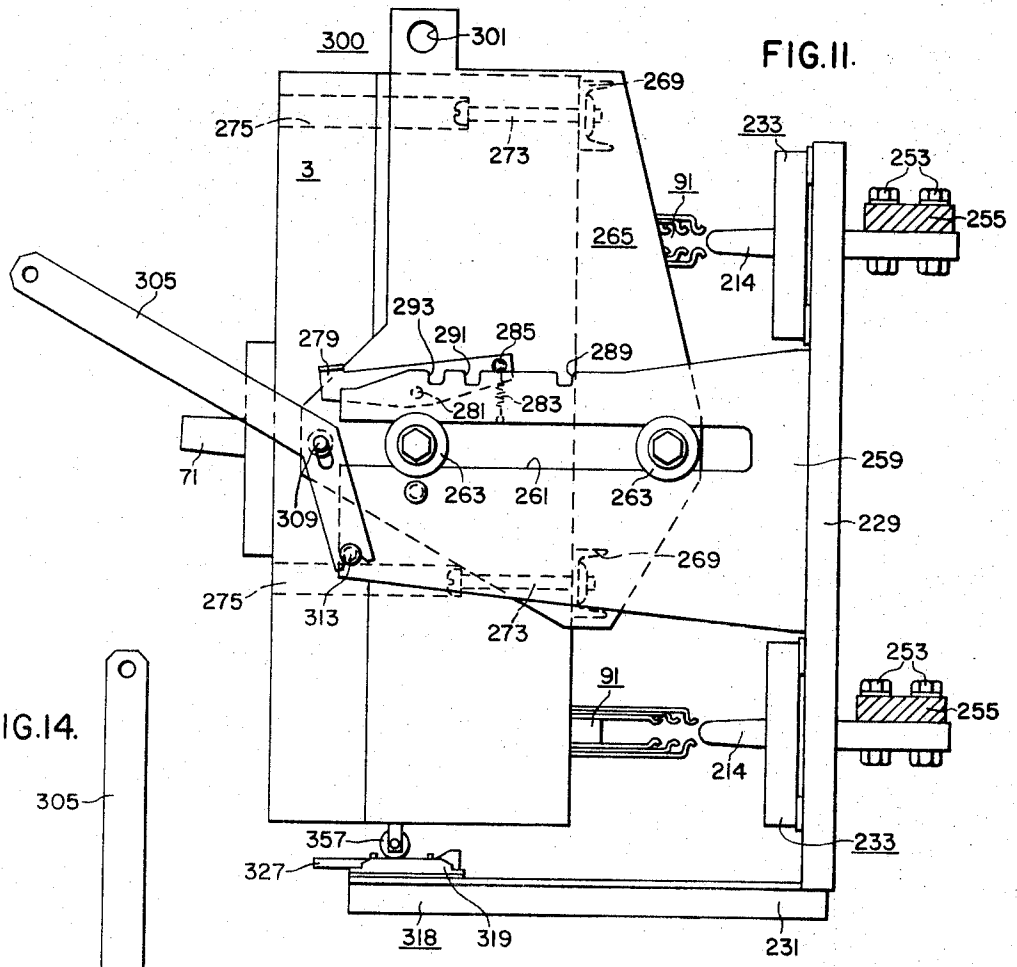

FIG.14.

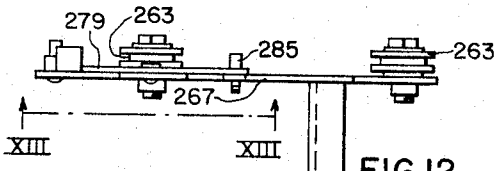

FIG.12.

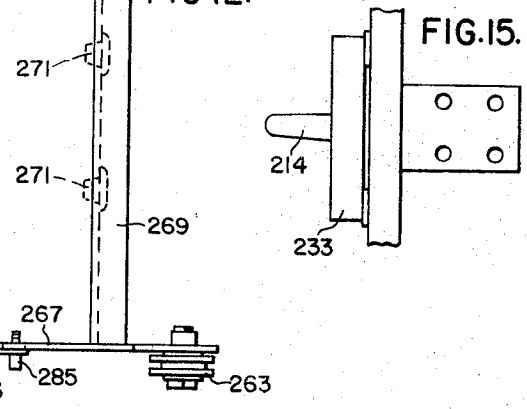

FIG.15.

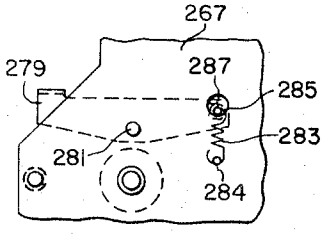

FIG.13.

United States Patent Office 3,343,042
Patented Sept. 19, 1967

3,343,042

SWITCHBOARD APPARATUS

Albert R. Cellerini, Beaver, and Louis N. Ricci, Chippewa Township, Pa., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Filed Nov. 5, 1964, Ser. No. 409,244
8 Claims. (Cl. 317—112)

This invention relates generally to switchboard apparatus and more particularly to switchboards of the type comprising plug-on type circuit breakers. This invention also relates to plug-on type terminal connectors.

A general object of this invention is to provide an improved switchboard.

Another object of this invention is to provide an improved switchboard comprising a circuit breaker with means automatically tripping the circuit breaker under certain predetermined conditions.

Another object of this invention is to provide an improved switchboard comprising a plug-on type circuit breaker which improved means for moving the circuit breaker into and out of operating position on the switchboard.

Another object of this invention is to provide an improved circuit breaker.

Another object of this invention is to provide an improved compactly constructed molded-case type circuit breaker.

Another object of this invention is to provide an improved plug-on type circuit breaker that can carry increased current with a minimum of heating.

A further object of this invention is to provide an improved plug-on type terminal connector.

The invention, both as to structure and operation, together with additional objects and advantages thereof, will be best understood from the following detailed description when read in conjunction with the accompanying drawings.

In said drawings:

FIGURE 1 is a side sectional view, taken generally along the line I—I of FIG. 2, illustrating a circuit breaker constructed in accordance with principles of this invention;

FIG. 2 is a top plan view, with parts broken away, of the circuit breaker seen in FIG. 1;

FIG. 3 is a sectional view of the separately enclosed trip unit of the circuit breaker taken generally along the line III—III of FIG. 1;

FIG. 4 is a side sectional view through the center pole unit of the trip device of FIG. 3 with the circuit-breaker safety tripping structure being shown in cooperating relationship with the trip unit;

FIG. 5 is a side view of one of the contact plug-on type terminal connectors seen in FIG. 1;

FIG. 6 is an isometric view, on a substantially smaller scale relative to the scale of FIGS. 1–5, of a switchboard or control center comprising at least one circuit breaker of the type disclosed in FIGS. 1 and 2, and embodying principles of this invention;

FIG. 7 is a side sectional view with parts broken away illustrating a circuit breaker in operating position in one of the compartments of the switchboard unit seen in FIG. 6;

FIG. 8 is a partial view similar to FIG. 7 illustrating the position of certain parts of the structure seen in FIG. 7 when the switchboard door is in the open position;

FIG. 9 is a sectional view, taken generally along the line IX—IX of FIG. 8 and illustrated on an enlarged scale relative to FIG. 8;

FIG. 10 is an end view, on an enlarged scale relative to FIG. 4 of part of the tripping structure seen in FIG. 4;

FIG. 11 is a view similar to FIG. 7 with the circuit breaker being shown in a disconnected position;

FIG. 12 is a top plan view of the carriage structure seen in FIGS. 7 and 11;

FIG. 13 is an elevational view of part of the structure seen in FIG. 12 which part is identified by the line XIII—XIII in FIG. 12;

FIG. 14 is an elevational view of the bell-crank lever member disclosed in FIGS. 7 and 11;

FIG. 15 is a side view of part of the structure seen in FIGS. 7 and 11 with part of the disclosed terminal being rotated 90° to a different position from that seen in FIGS. 7 and 11;

FIG. 16 is a plan view of one of the terminal structures seen in FIGS. 7 and 11; and

FIG. 17 is a sectional view taken generally along the line XVII—XVII of FIG. 16.

Referring to the drawings, there is shown in FIGS. 1 and 2 a circuit breaker **3** comprising an insulating housing **5** and a three-pole circuit breaker mechanism supported within the housing. The housing **5** comprises a base **9** and a cover **11** both of molded insulating material.

The circuit-breaker mechanism **7** comprises an operating mechanism **13** and a trip unit **15**. The circuit breaker is a three-pole circuit breaker comprising three compartments disposed in a side-by-side relationship. The center compartment is separated from each of the two outer compartments by means of a separate pair of cooperating insulating barriers **17** and **19** molded integrally with the circuit breaker base **9** and cover **11** respectively. At the two opposite ends of the circuit breaker each compartment is closed off by means of two insulating barriers **20** that are suitably secured to the housing base and cover **11**. The removable three-pole trip unit **15**, which extends transversely across the internal width of the circuit breaker will be hereinafter specifically described. The operating mechanism **13**, that is disposed in the circuit breaker center pole unit or compartment, is a single operating mechanism for operating the contacts of all three pole units.

Each pole unit comprises a stationary contact **21** that is fixedly secured to a rigid main conductor **23** that is secured to the base **9** by means of bolts **25**. In each pole unit, a movable contact **27** is welded or brazed to a contact arm **29** that is pivotally mounted on a switch arm **31** by means of a pivot pin **33**. Each of the switch arms **31** is pivotally supported at one end thereof on a separate support bracket **34** by means of a separate pivot pin **35**. The switch arms **31** for all three of the pole units are connected to move in unison by means of a common tie bar **37** that is rigidly connected to all three of the switch arms. Each of the contact arms **29** is biased about the associated pivot **33** by means of a separate spring **39** to provide contact pressure in the closed position of the contacts.

The switch arms **31** are operated to the open and closed positions by means of the common operating mechanism **13**. The operating mechanism **13** comprises a toggle link **41** that is pivotally connected to an extension **43** of the center pole switch arm **31** by means of a pivot pin **45**. The toggle link **41** is pivotally connected to the lower end of another toggle link **47** by means of a knee pivot pin **49**. The upper end of the toggle link **47** is pivotally connected to a cradle or releasable member **51** by means of a pivot pin **53**. The cradle **51** is pivotally supported at one end thereof on the supporting bracket **34** by means of a pivot pin **57**. The other end **59** of the releasable member **51** is held in a latched position by means of a latch member **61**. The operating

mechanism **13** also comprises an inverted generally U-shaped operating lever **63** that is pivotally supported on th bracket **34** by means of pins **65** that engage the inner ends of the legs of the operating lever **63**. An actuating insulating shield **67**, for substantially closing an opening **69** in the cover **11**, is secured to the upper end of the operating lever **63**. An insulating handle portion **71** extends from the shield **67** out through the opening **69** to permit manual operation of the breaker. Two overcenter springs **75** (only one being shown in FIG. 1) are connected under tension between the knee pin **49** of the toggle **41, 47** and the upper end of the operating lever **63**. Pin means **77** are secured to the upper end of the lever **63** in order to support the upper ends of the springs **75**.

In each pole unit, an arc-extinguishing unit **81** is provided to extinguish the arc drawn between the associated contacts **21, 27**. Each arc-extinguishing unit comprises an insulating housing **83** and a plurality of magnetic steel plates **85** supported within the housing **83**. The moving contact **27** moves within a generally V-shaped opening **87** (FIG. 2) in the stacked plates **85**, and the arc drawn between the contacts **21, 27** is magnetically moved to the right (FIGS. 1 and 2) into the plates **85** to be extinguished during a circuit interrupting operation. Each of the arc-extinguishing units **81** is secured to the associated main conductor **23** (FIG. 1) by means of four bolts **89** that are threaded into tapped openings in the conductor **23**.

At each of the three-pole units, the circuit breaker **3** is provided with two plug-on type terminal connectors **91** that are suitably secured at opposite ends of the circuit breaker. The plug-on type terminal connectors **91** will be hereinafter more specifically described.

The circuit through each pole unit of the circuit breaker **3** extends from the right-hand (FIG. 1) terminal **91** through the conductor **23**, the contacts **21, 27**, the contact arm **29**, flexible conductors **93** that are secured at one end to the contact arm **29** and at the other end to a terminal conductor **95**, through the terminal conductor **95** that is secured to the base by means of a screw **97**, a unitary rigid main conductor **99** that is connected to the terminal conductor **95** and is secured to the base by means of bolts **101** and **103**, to the other terminal connector **91**. The bolts **101** and **103** are threaded into inserts **105** in the base **9** to secure the main conductor **99** to the base. Each of the rear-type plug-on terminal connectors **91** is connected to the associated internal conductor (**23** or **99**), by means of four bolts **107** that are disposed at the four corners of an imaginary square. Only two bolts for each of the connectors **91** are disclosed in FIG. 1. As can be seen in FIG. 2, the section in FIG. 1 is shown at the left in the outer pole unit and it jogs into the center pole unit in order to more clearly disclose the operating mechanism which is a single mechanism only in the center pole unit of the circuit breaker. It is to be understood that each of the circuits through each of the three pole units comprises the same kind of structure as that hereinbefore described with respect to the parts that are illustrated in FIG. 1.

The circuit breaker **3** is disclosed in FIG. 1 in the closed or "on" position. The circuit breaker is manually operated to the open or "off" position by movement of the handle **71** in a counterclockwise direction to the off position. During this movement, the line of action of the overcenter spring means **75** is moved to the left to an overcenter position to effect a collapse of the toggle **41, 47** to pivot the switch arm **31** for the centerpole in a counterclockwise direction about the associated pivot **35** to an open position. This movement of the center pole switch arm **31**, because of a rigid connection of all of the switch arms **31** by means of a rigid common tie bar **37**, simultaneously moves all of the three switch arms **31** to the open position.

The circuit breaker is manually closed by reverse movement of the handle **71** from the off to the on position.

This movement moves the operating lever **63** to move the line of action of the overcenter spring means **75** to the right to thereby straighten the toggle **41, 47** moving all three of the switch arms **31** simultaneously to the closed position seen in FIG. 1.

Referring to FIGS. 1–4, the trip device **15** comprises a molded insulating base **113** and a molded insulating cover **115** cooperable with the base to enclose three thermal magnetic tripping means which are disposed within three compartments in the housing **113, 115**. The compartments are separated by means of insulating barriers **117**. The trip device **15** includes a molded insulating trip bar **119** that passes through suitable openings in the barriers **117** and is common to all three of the pole units. The trip bar **119** is pivotally supported on a bracket **121** that extends out of the base **113** and is supported on a suitable supporting bracket **123**. A separate laminated U-shaped magnetic core **125** for each pole unit is suitably mounted in the associated compartment of the trip device **15** by means of bolts **127** that secure the core to the trip-unit base **113**. As can be seen in FIGS. 3 and 4, each of the main conductors **99** passes through the opening in the U-shaped magnet **125** and is held in place by means of a bolt **129**. A separate movable armature **131** is pivotally supported on one leg of each of the cores **125**. Each armature is biased to an opened position by means of a separate spring **133**. A rod **135** is pivotally connected to each armature **131** and a head portion **137** on each rod **135** is adapted to engage and operate the trip bar **119** upon sufficient energization of the electromagnet **125, 131**. Each tripping electromagnet is energized by current flowing in the associated main conductor **99**.

The circuit breaker is tripped open instantaneously by operation of any one of the tripping electromagnets. When one of the tripping electromagnets is energized by an overload current above a predetermined value or by means of a short circuit, the armature **131** is attracted and the free end thereof is moved into engagement with the other leg of the magnet yoke **125** during which movement the rod **135** is pulled down, whereupon the head **137** of the rod **135** engages the trip bar **119** causing the trip bar to rotate in a counterclockwise (FIG. 4) direction. This movement effects a releasing movement of the latch **61** to disengage the latch **61** from the cradle **51** (FIG. 1). Upon release of the cradle **51**, the springs **75** act to rotate the cradle in a clockwise direction about the pivot **57** and to collapse the toggle **41, 47** to thereby pivotally move the three switch arms **31** in a counterclockwise (FIG. 1) direction to the open position.

During the automatic opening operation the line of force of the spring means **75** operates to move the operating lever **63** and handle **71** to an intermediate position between the on and off positions in a well known manner to thereby provide a visual indictaion that the circuit breaker has been automatically tripped.

Following an automatic opening operation, it is necessary to reset and relatch the circuit breaker mechanism before the contacts can be closed. This is effected by movement of the handle **71** to the full off position. During this movement, a pin **137** that is supported on the operating lever **63**, engages a shoulder **139** on the cradle **51** moving the cradle in a counterclockwise direction about the pivot **57**. Near the end of this movement, the free or latching end **59** of the cradle **51** cams the latch **61** to the left against the bias of spring means (not shown) and moves below the latching end of the latch **61** whereupon the latch **61** is biased back to the latching position seen in FIG. 1 to relatch the cradle **51** in a well known manner. The breaker contacts are then closed in the previously described manner by movement of the handle to the on position.

An adjusting mechanism is provided for adjusting the position of each armature **131** to provide for selection of the minimum overload current that will be required

to instantaneously trip the circuit breaker. The adjusting mechanism is of the type that is specifically described in the patent to Glenn R. Thomas et al., Pat. No. 3,073,925. Thus, only a brief description of the adjusting mechanism is given herein. The adjusting mechanism comprises a cam member **141** having an upper cam surface that is engaged by one end of a lever **143**. The lever **143** is pivotally supported intermediate its ends on a supporting bracket **147** that is attached to the yoke **125** and housing **113** by means of rivets **127**. A rod **145** extends from the cam **141** to an adjusting knob **149** that passes out through a suitable opening in the trip unit housing **113, 115**. Rotation of the adjusting knob **149** rotates the cam **141** to thereby pivot the lever **143** whereupon an adjusting screw **151** on one end of the lever **143** moves against the associated armature **131** to pivot the armature **131** varying the magnetic air gap and therefore the minimum overload current that will magnetically trip the circuit breaker.

Thermal tripping means is provided to effect automatic tripping of the circuit breaker with a time delay upon the occurrence of lower overload current conditions. The thermal tripping means comprises another U-shaped laminated magnet yoke **155** (FIG. 4) through which the conductor **99** passes. An unlaminated magnetic bar **157** connects the upper legs of the magnet yoke **155**. A bimetal member **159** is supported on a conducting coil **161** that is disposed over the bar **157**. Upon the occurrence of an overload current below a predetermined value, the hysteresis losses in the bar **157**, which occur in the form of heat, will be conducted to the bimetal **159** and heat generated by eddy currents in the coil **161** will be conducted to the bimetal **159** whereupon the heated bimetal will bend to the left (FIG. 4) to engage an adjusting screw **165** that is supported on the trip bar **119** to thereby rotate the trip bar **119** to effect a tripping operation of the circuit breaker in the same general manner as was hereinbefore described.

As can be seen in FIG. 1, the trip device **15** is secured to the circuit breaker by means of bolts **101** and **103** that secure the three rigid conductors **99** for the three pole units to the base **9**. The trip device **15** and conductors **99** comprise a unitary removable structure whereby the trip units are interchangeable so that the breaker can accommodate other trip units having different current carrying capacities. It can be seen in FIG. 3 that there are three conductors **99** extending through the trip device **15** for the three pole units of the trip device. Each of the conductors **99** conducts the current in the associated pole unit along the length of the circuit breaker. In each pole unit a rear-type and plug-on type terminal connector **91** is supported on and directly connected to the associated conductor **99** by means of four bolts **107** (only two of which are seen in FIG. 1). In each pole unit an opening **167** is provided in the housing base **9** to receive the terminal connector **91** that is connected to the conductor **99**. In each pole unit, the terminal connector **91** on the right (FIG. 1) passes through a separate opening **168** in the housing base **9** and is connected directly to the rigid internal conductor **23** by means of four bolts **107** (only two of the bolts **107** being seen in FIG. 1).

As can be seen in FIGS. 1 and 2, the circuit breaker housing **5** comprises a front or top **181**, a back or bottom **183**, and side wall means comprising two side walls **185** and two end walls **187**. The handle **71** extends through the opening **69** in the front of the housing. The openings **167** and **168** in the back of the housing permit connections between the terminal connectors **91** and the conductors **23** and **99**. The arc-extinguishing units **81** extend substantially to the adjacent end wall **187**.

As can be seen in FIGS. 1 and 5, each of the terminal connectors **91** comprises a generally T-shaped rigid conducting support part **189**. The arm parts of the support part **189** have openings therein for receiving the bolts **107** that are screwed into tapped openings in the conductor **99** or **23** to mount the terminal structure **91** on the conductor **99** or **23** with a generally flat upper face of the terminal connector support part **189** engaging a generally flat lower face of the conductor **99** or **23**. The leg portion **193** of the support part **189** of the terminal connector **91** extends in a direction generally normal to the upper flat connecting surface of the support part **189** and this leg portion is provided with openings therein for receiving three bolts or rivets **195** that secure a plurality of contact members to the leg portion **193**. The openings in the arm parts of the support **189** are disposed at the four corners of an imaginary square and the tapped openings in the conductors **99** and **23** are disposed at the four corners of an imaginary square. Thus, each of the terminal connector structures **91** can be rotated 90° and secured to the associated main conductor **99** or **23** in the same general manner as that hereinbefore described.

As can be seen in FIGS. 1 and 5, a contact structure comprising two outer contact members **201**, two intermediate contact members **203** and two inner contact members **205** is supported on the support part **193** of the conducting support **189** by means of the three rivets **195**. Each of the contact members **201**, **203** and **205** comprises an elongated sheet metal conducting member having a plurality of slot portions **209** (FIG. 5) therein to form a plurality of contact fingers. As can be seen in FIG. 5, each of the contact members of the specifically described contact structure is split to provide five separate contact fingers. Each of the contact fingers is bent over at the outer end thereof to provide a generally rounded portion forming a contact surface **213** (FIG. 1). There are thirty contacts or contact surfaces **213** on each of the connectors **91**.

The contact members **201, 203** and **205** comprise members of good conducting material having good spring characteristics or resiliency. Copper and silver are examples of good basic conducting materials, and when anyone of these materials is alloyed in order to provide the desirable resiliency, the alloyed material can be effectively utilized as the material forming the contact fingers of this invention. For example, the contact members can be formed from a beryllium copper alloy, a zirconium copper alloy or a cadmium copper alloy. A specific example of a suitable contact member is a contact member formed from a beryllium copper alloy having the composition of about 98% copper, 1% beryllium and 0.2% nickel. The contact members may be formed by any suitable method.

The circuit breaker is shown in FIG. 11 in the disconnected position and in FIG. 7 in the connected position. In the connected position the terminal connectors **91** are connected to conducting stabs **214**. It can be understood that as the circuit breaker is moved into the connected position the contact members **201** are the first to engage the stabs **214** and these contact members are spread apart as they move into further engagement with the stabs **214**; then the intermediate contact members **203** engage the stabs **214** and are biased apart by the stabs and finally the inner contact **205** engage the stabs **214** to be biased apart by the stabs. The resiliency of the contact members provides a spring bias against the stabs **214** to provide good contact pressure in the connected position seen in FIG. 7. As can be seen in FIG. 7, although the stabs **209** are progressively wider from left to right, the contact pressure between the different pairs of contact members is substantially the same because the contact members **201** which are spread furthest apart in the connected position are the longest contact members and the contact members **205** which are spread apart the least are the shortest contact members.

With the provision of three pairs of contact members each of which contact members comprises five resilient contact fingers, each of the contact structures **91** will make contact with the associated stab **214** at thirty different contact points **213**. Thus, the circuit breaker will be able to carry increased currents with less heat rise. An

advantage of the provision of three different pairs of contact members that progressively engage the associated stab conductor is that the force required to initially and then progressively make contact can be less for the same amount of effective contact engagement, than that required if, for example, only one row or pair of contact arms were used.

Referring to FIG. 6, there is shown therein a control center or switchboard **217** comprising a cabinet structure **219** having six compartments therein each of which compartments is provided with an opening at the front of the cabinet that is covered by means of an openable door **221**. Each of the doors **221** is pivotally mounted on the cabinet structure **219** by means of hinges **223**. Each of the doors **221** is provided with a suitable opening **225** therein for receiving the operating handle **71** of an enclosed circuit interrupter when the door is moved to the closed position. Thus, the enclosed circuit interrupter or circuit breaker **3** can be manually operated when the door **221** is in the closed position. The switchboard **217** may have more or less than six compartments therein and it may be constructed in any of a number of ways that are well known in the art.

Referring to FIGS. 7 and 11, within each of the compartments of the control center there is supported a back supporting plate **229** and a bottom support member **231** that is suitably secured to the back plate **229**. The back plate **229** is a generally flat plate member having six openings therein for receiving six terminal structures **233** (FIGS. 16 and 17). As is seen in FIGS. 16 and 17, each of the terminal structures **233** comprises an insulating block **234** having an opening **235** therein. Each of the insulating blocks **234** is provided with four openings **237** at the four corners thereof for receiving four screw members that are threaded into tapped openings in the back plate **229** to mount the terminal structure on the back plate **229**. The insulating block **234** is also provided with four openings **241** therein for receiving four bolts **243**. The stab member **214** is a generally T-shaped (FIG. 17) rigid conducting member that is positioned in a cavity **245** in the support **233** with the flat rear surface thereof engaging the flat rear surface of a rigid generally T-shaped conductor **247**. The bolts **243** rigidly secure the members **214** and **247** together and support these members on the insulating block **234** which is in turn supported on the back plate **229** by means of the bolts that fix into the openings **237** (FIG. 16). Metallic inserts **248** are provided in the openings **241** to prevent damage to the insulating block **234** upon operation of the bolts **243**. The conductor **247** is provided with openings **251** (FIG. 17) therein for receiving bolts **253** (FIGS. 7 and 11) that are used to connect the conductor **247** to one of the bus bars **255** that are suitably supported in the switchboard enclosure (FIG. 6) in a manner well known in the art. As can be seen in FIG. 16, the bolts **243** are disposed at the four corners of an imaginary square so that the members **247** and **214** can be rotated 90° and still be connectable to the support **233** in the same manner described. Moreover, with the openings in the members **214** and **247** being disposed at the four corners of an imaginary square, either of these members **214** or **247** can be rotated 90° relative to the other member and still be connectable to the other member in the same manner hereinbefore described.

Referring to FIGS. 7 and 11, two side plates **259** are suitably secured to and supported on the back plate **229**. The side plates **259** are spaced to receive the circuit breaker **3** in a manner to be hereinafter described. Only one of the side plates **259** is visible in FIGS. 7 and 11; but it can be understood that a pair of these identical side plates **259** are used to support the associated circuit breaker. Each of the side plates **259** is provided with an elongated slot **261** therein that is opened at the outer end of the plate **259**. The slots **261** cooperate to form a track to receive rollers **263**. The circuit breaker **3** is supported on a carriage **265** (FIG. 12) that comprises two side plates **267** and two back braces **269** (FIGS. 11 and 12). Each of the back braces **269** is provided with two openings **271** (FIG. 12) therein. Four bolts **273** (FIG. 11) that are disposed in four openings **275** (FIGS. 11 and 12) in the insulating housing **5** of the circuit breaker **3** are threaded into the tapped openings **271** to secure the circuit breaker **3** to the carriage **265**. As can be seen in FIG. 2, the openings **275** in the housing **5** are provided in the insulation between the pole units of the circuit breaker **3**. The four rollers **263** (FIG. 12) are suitably secured to the side plates **267**.

A locking member **279** (FIG. 13) is pivotally supported intermediate the ends thereof on one of the side plates **267** by means of a pivot pin **281**. A spring member **283** is supported under tension between one end of the locking member **279** and a stationary pin **284** on the side plate **267** to bias the locking member in a clockwise direction (FIGS. 7, 11 and 13) about the pivot **281**. The member **279** is provided with a pin **285** that passes through a suitable opening **287** (FIG. 13) in the side plate **267** to limit movement of the lever **279** in both directions. The pin **285** is provided to cooperate with three notches **289**, **291** and **293** in the side plate **259** in a manner to be hereinafter described.

When it is desired to mount the circuit breaker **3** in the desired position on the switchboard, the circuit breaker structure **300**, which comprises the molded-case circuit breaker **3** and the carriage **265**, is moved into the position seen in FIG. 11 wherein the rollers **263** are engaged in the tracks **261** in the opposite side supporting plates **259**. As the circuit breaker structure is moved to the FIG. 11 position the members **279**, unless manually held in the unlocking position, will be automatically moved to locking positions with the pins **285** being biased first into the notches **293** and then into the notches **291**. The members **279** are manually operable out of the locking positions by counterclockwise (FIG. 11) movement about the pivots **281**. Each of the side plates **267** of the carriage **265** is provided with an opening **301** at the upper end thereof to receive a hook part of a crane that may be used to move the circuit breaker structure **300** into the position seen in FIG. 11. With the circuit breaker structure **300** in the position seen in FIG. 11, a bell-crank lever **305** (FIG. 14) is placed in the position seen in FIG. 11 wherein an elongated slot **307** thereof receives a pin **309** that is fixedly supported on one side plate **267** and wherein a slot portion **311** at one end thereof receives a pin **313** that is fixedly supported on the supporting side plate **259**. If desired, a similar bell-crank lever **305** can be simultaneously utilized at the other side of the circuit breaker structure **300**. With the bell-crank **305** in the position seen in FIG. 11, an operator manually rotates this member in a clockwise (FIG. 11) direction whereupon the circuit breaker structure **300** is moved into the connected position seen in FIG. 7. When the circuit breaker structure **300** reaches the fully connected position seen in FIG. 7, the spring member **283** will bias the lever **279** to move the pin **285** into the slot **289** to thereby lock the circuit breaker structure **300** in the fully connected position.

When it is desired to move the circuit breaker structure **300** to a disconnected position on the switchboard, the locking lever **279** is depressed to release the pin **285** from the slot **289**. The bell crank lever **305** is then rotated in a counterclockwise direction to cam the circuit breaker structure **300** out to a fully disconnected position, and at the end of this movement, the locking pin **285** of the locking lever **279** will snap into the slot **291** to automatically lock the circuit breaker structure **300**, in the disconnected position. The slots **293** are provided to be used as an additional locking slot when extensions (not shown) are used to elongate the tracks **261**.

As can be seen in FIGS. 7, 8, 9, and 11, there is supported on the support **231** a safety trip structure **318** comprising a cam plate member **319** that is secured to the support **231** by means of two screws **321** (FIG. 9). The cam plate **319** is provided with an offset portion **323** hav-

ing two bent-over portions **325** that extend upward from the support **231**. Each of the parts **325** is provided with an opening therein, and a cam member **327** is movably supported in these openings. The cam member **327** is provided with a cam part **329** at one end thereof (FIG. 8). A spring support **331** is fixedly secured to the member **327**, and a compression spring **333** is disposed over the member **327** and biased between the member **331** and the one support part **325** to bias the cam member **327** to the left as seen in FIGS. 7, 8 and 9.

Referring to FIGS. 4 and 10, there is shown therein a tripping device **341** comprising a first part **343** and a second part **345**. Three insulating supports **347** are supported in one end of the center pole compartment of the circuit breaker **3**. The supports **347** are supported in suitable slots in the insulating housing parts **9** and **11**. Each of the supports **347** is provided with an opening therein, and the members **345** and **343** are disposed within the openings to be supported on the circuit breaker. The part **343** has a pin member **349** thereon that engages one barrier **347** to limit outward movement of the tripping device **341** to retain the tripping device **341** in position on the circuit breaker. The part **345** passes through a suitable opening in the housing part **115** of the trip device **15** and the inner end of the part **345** is disposed adjacent the lower side of the trip bar **119**. A compression spring **351** is disposed over the part **345** and it engages the housing part **115** and a spring support **353** to bias the part **345** and therefore the entire tripping device **341** outward to the position wherein the pin **349** engages the barrier **347**. An adjusting screw **355** engages the part **345** at one end thereof and threadedly engages the part **343** at the other end thereof to enable adjustment of the length of the tripping device **341** to thereby enable adjustment of the tripping function that will be hereinafter described. As can be seen in FIG. 10, a roller **357** is rotatably supported at the outer end of the part **343** on a pin **359**. Another roller **361** is rotatably supported on the pin **359** adjacent the roller **357**. Referring to FIG. 7, it will be seen that when the door **221** of the switchboard (FIG. 6) is in the closed position seen in FIG. 7, the door engages the outer end of the cam member **327** biasing the cam member to the right to the position seen in FIG. 7. The spring **351** (FIG. 4) biases the tripping device **341** outward to the position seen in FIG. 7. When the door **221** is moved to the open position, the cam member **327** is released and the spring **333** (FIG. 9) biases the cam member **327** to the left whereupon the cam part **329** of the member **327** engages the roller **361** (FIG. 10) camming the tripping device **341** (FIG. 4) inward against the bias of the spring **351** during which movement the part **345** engages the trip bar **119** to rotate the trip bar to a tripping position to thereby trip the circuit breaker in the same general manner hereinbefore described. Thus, it can be understood that the circuit breaker **3** is automatically tripped by operation of the cam member **327** when the cabinet door **221** is moved to the open position. If for any reason the spring **333** should fail, the circuit breaker would not be tripped by operation of the cam **227** when the door **221** is opened. Means is provided to trip the breaker if an attempt is then made to move the breaker to the disconnected position. As can be seen in FIG. 11, when the circuit breaker structure **300** is moved from the connected position seen in FIG. 7 toward the disconnected position seen in FIG. 11, the roller **357** will engage the stationary cam member **319** moving to the top surface of the cam member **319** which camming action moves the tripping device **341** inward against the bias of the spring **351** (FIG. 4) to effect an automatic tripping operation in the same manner hereinbefore described. The cam member **319** is so positioned that the breaker will be tripped before the terminal connectors **91** are moved to the disconnected position seen in FIG. 11.

It is to be understood that at certain installations only one of the improved tripping cam structures **319** or **327** may be used without the other in a switchboard.

Referring to FIGS. 7, 11 and 13, it will be noted that the circuit interrupter structure **300** will be effectively retained in the connected and disconnected positions by automatic operation of the manually releasable locking member **279**. The slot **291** serves to maintain the circuit interrupting structure **300** in the disconnected position and also to stop the circuit interrupting structure in the disconnected position to prevent accidental displacement off of the tracks **261**, of this structure when the structure is being moved out of the connected position.

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

We claim as our invention:

1. A switchboard structure comprising a cabinet having a cabinet opening therein, bus bar means supported in said cabinet, terminal means electrically connected to said bus bar means, a cricuit interrupting device supported in said cabinet and comprising a terminal structure automatically connected to said terminal means by the positioning of said circuit interrupting device in said cabinet, said circuit interrupting device comprising an insulating housing having a first opening therein and a pair of contacts supported within said housing, an operating member extending through said first opening and being manually movable to open and close said contacts, said insulating housing having a second opening therein, a tripping device supported in said insulating housing and extending outward from said second opening, a trip bar supported within said insulating housing and being movable to effect automatic opening of said contacts, said cabinet comprising a stationary cam member, and upon movement of said circuit interrupting device outward from said cabinet said tripping device engaging said stationary cam member and being cammed to a position to move said trip bar to effect automatic opening of said contacts.

2. A switchboard srtucture comprising a cabinet having a cabinet opening therein, bus bar means supported in said cabinet, terminal means electrically connected to said bus bar means, a circuit interrupting structure supported in said cabinet and comprising a terminal structure automatically connected to said terminal means by the positioning of said circuit interrupting structure in the connected position, said circuit interrupting structure comprising an insulating housing having a first opening therein and a pair of contacts supported within said housing, an operating member extending through said first opening and being manually movable to open and close said contacts, said insulating housing having a second opening therein, a tripping device supported in said insulating housing and extending outward from said second opening, a trip bar supported within said housing and being movable to a tripping position to effect automatic opening of said contacts, said cabinet comprising a stationary cam member, upon movement of said circuit interrupting structure away from said connected position toward a disconnected position wherein said terminal structure is disconnected from said terminal means said tripping device engaging said stationary cam member and being cammed to a position to move said trip bar to said tripping position, and upon movement of said circuit interrupting structure from said disconnected position toward said connected position said tripping device engaging said stationary cam member and being cammed to a position to move said trip bar to said tripping position.

3. A switchboard structure comprising a cabinet having a cabinet opening therein, bus bar means supported in said cabinet, a circuit interrupter supported in said cabinet in a connected position connected to said bus

bar means, said circuit interrupter comprising an insulating housing having a first opening means therein and a second opening means therein, a pair of contacts supported in said insulating housing, an operating member supported in said insulating housing and extending out through said first opening means, said operating member being manually operable to open and close said contacts, trip means supported within said insulating housing, said trip means comprising a latched releasable member releasable to effect automatic opening of said contacts and a trip bar movable to effect release of said latched releasable member, a spring biased movable cam means supported in said cabinet, said circuit interrupter comprising a tripping device supported in said insulating housing and extending out through said opening means, a cover in a closed position closing said cabinet opening and engaging said spring biased movable cam means to maintain said spring biased movable cam means in an inoperative position, and upon opening of said cover said spring biased movable cam means moving automatically to engage said tripping device to move said tripping device to a tripping position, said tripping device in moving to said tripping position moving said trip bar to effect release of said latched releasable means to effect opening of said contacts.

4. A switchboard structure according to claim 3, and said tripping device comprising an elongated member supported on said circuit interrupter for rectilinear movement.

5. A switchboard structure comprising a cabinet having a cabinet opening therein, bus bar means supported in said cabinet, terminal means electrically connected to said bus bar means, a circuit interrupter supported in said cabinet and comprising a terminal structure automatically connected to said terminal means when said circuit interrupter is positioned in said cabinet in a connected position, said terminal structure being automatically disconnected from said terminal means when said circuit interrupter is moved from said connected to a disconnected position toward said cabinet opening, said circuit interrupter comprising an insulating housing having a first opening means therein and a second opening means therein, a pair of contacts supported in said insulating housing, an operating member extending out from said first opening means and being manually movable to open and close said contacts, said circuit interrupter comprising trip means supported within said insulating housing, said trip means comprising a latched releasable member releasable to effect automatic opening of said contacts and a trip bar movable to effect release of said latched releasable member, a tripping device supported in said insulating housing and extending out through said second opening means, said tripping device being movable to a tripping position to move said trip bar to effect release of said latched releasable member to thereby effect automatic opening of said contacts, a cam structure supported on said cabinet and combrising a stationary cam member and a movable cam member, said cabinet comprising a door closing said cabinet opening and movable to an open position to open said cabinet opening, said door in the closed position thereof maintaining said movable cam member in an inoperative position, when said door is moved to the open position with said circuit interrupter in the connected position said movable cam member being automatically released and moving to move said tripping device to said tripping position, said stationary cam member being stationarily positioned such that when said circuit interrupter is moved from the connected position toward the disconnected position said stationary cam member is in the path of movement of said tripping device, whereby when said door is opened and said movable cam member fails to move said tripping device to said tripping position and said circuit interrupter is moved from the connected position toward the disconnected position said tripping device will engage said stationary cam member and be automatically moved to said tripping position.

6. A switchboard structure according to claim 5, and said triping device comprising an elongated member supported on said circuit interrupter for rectilinear movement into and out of said tripping position.

7. A switchboard structure comprising a cabinet having a cabinet opening therein, bus bar means supported in said cabinet, stationary terminal means supported in said cabinet and electrically connected to said bus bar means, track means supported in said cabinet in proximity to said stationary terminal means, a circuit interrupting device supported in said cabinet and comprising support means engaging said track means, said circuit interrupting device comprising a terminal structure, said circuit interrupting device being movable on said track means between a connected position wherein said terminal structure is automatically connected to said terminal means and a disconnected position wherein said terminal structure is automatically disconnected from said terminal means, positioning means operable to move said circuit interrupting device on said track means into and out of said connected position, said circuit interrupting device comprising an insulating housing having a first opening therein and a pair of contacts supported within said insulating housing, an operating member extending through said first opening and being movable to open and close said contacts, said insulating housing having a second opening therein, a tripping device supported in said insulating housing and extending outward from said second opening, a trip bar supported within said insulating housing and being movable to effect automatic opening of said contacts, a stationary cam member supported on said cabinet in the path of movement of said tripping device which path is determined by the movement of said circuit interrupting device on said track means from said connected position toward said disconnected position, and upon movement of said circuit interrupting device on said track means outward from said cabinet from said connected position to said disconnected position said tripping device engaging said cam member and being cammed automatically to a position to move said trip bar to effect automatic opening of said contacts before said circuit interrupting device reaches said disconnected position.

8. A switchboard structure according to claim 7, and said positioning means comprising a bell-crank lever member manually operable to move said circuit interrupting device on said track means into and out of said connected position.

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