Oct. 29, 1968 F. E. MYERS 3,408,606

LOW AMPERE CIRCUIT BREAKER WITH INDIRECTLY HEATED THERMAL ELEMENT

Filed June 10, 1966

3 Sheets-Sheet 1

FIG. 1.

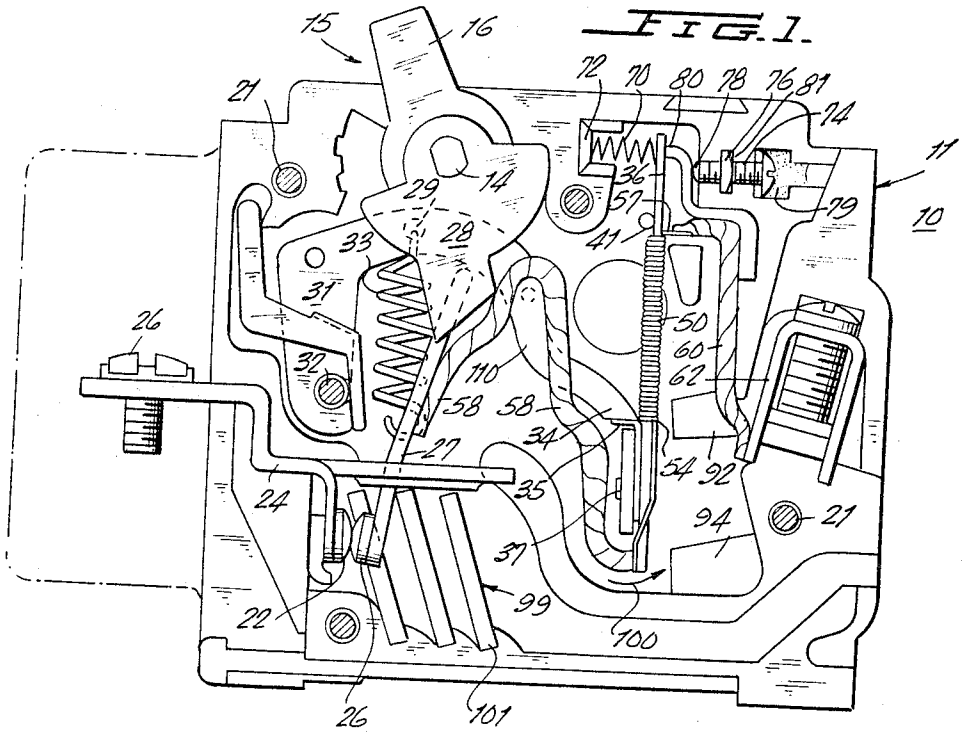
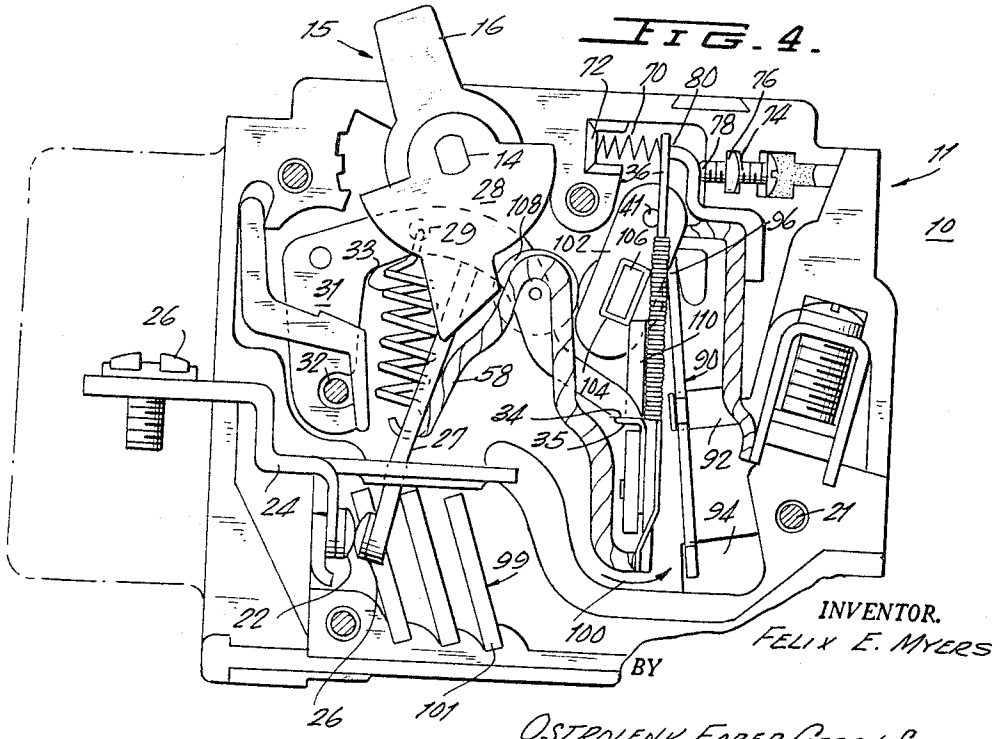


FIG. 4.



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FIG. 2.

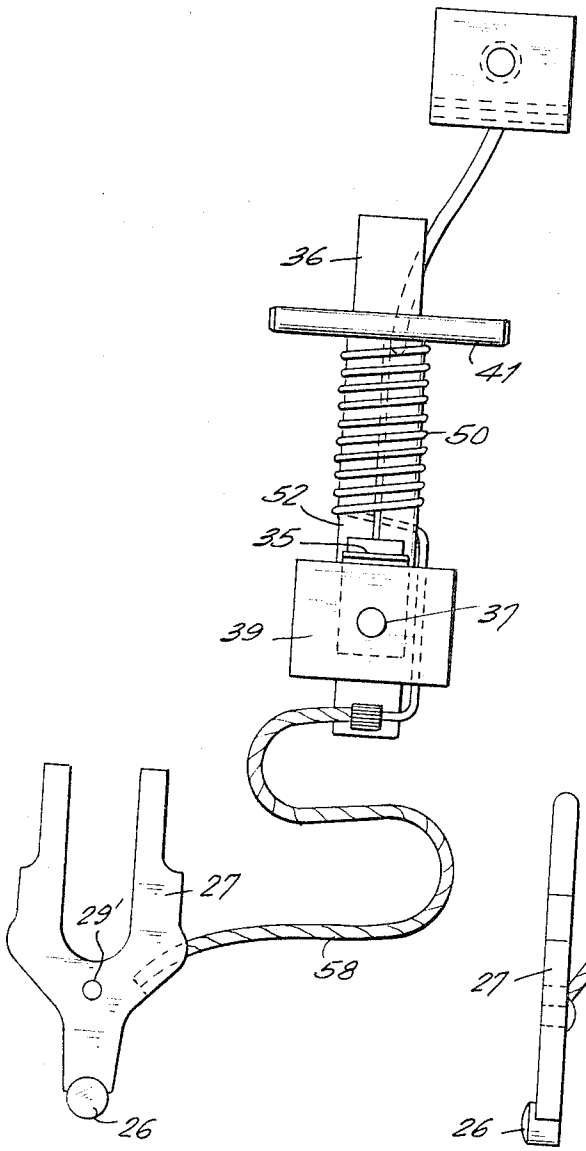
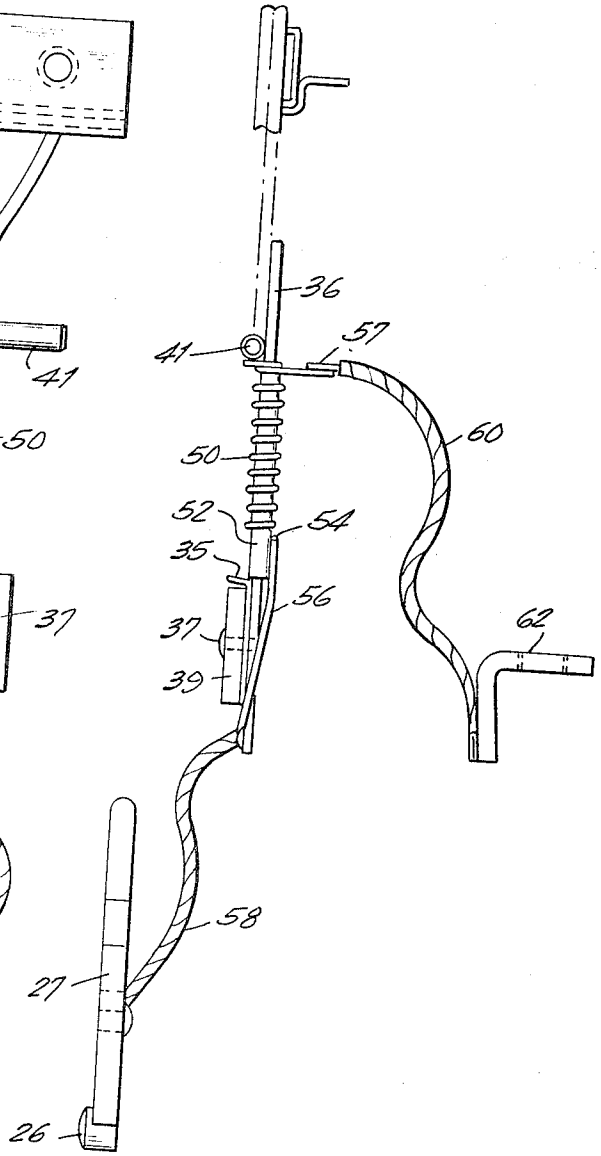


FIG. 3.



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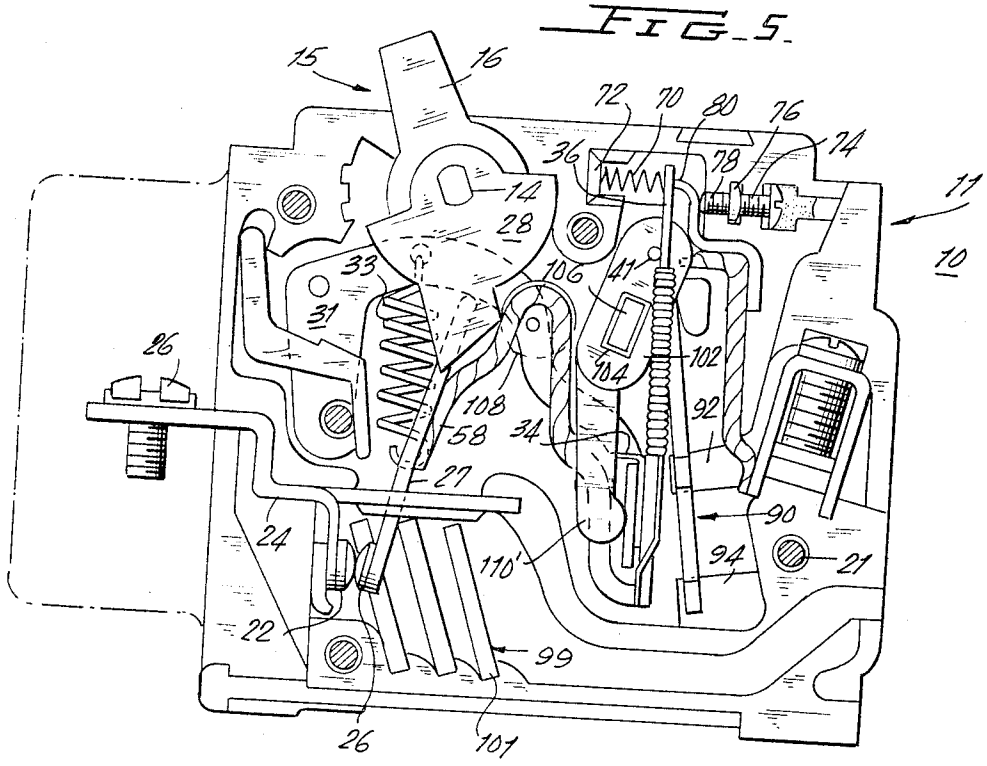
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FIG. 5.



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3,408,606

LOW AMPERE CIRCUIT BREAKER WITH INDIRECTLY HEATED THERMAL ELEMENT

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ABSTRACT OF THE DISCLOSURE

A circuit breaker construction intended for low ampere applications, typically below 4 amperes, which includes the basic operational components of a higher rated circuit breaker, with an additional heater means being series wound about the overload responsive bimetal to suitably modify the tripped characteristics.

My invention relates, in general, to circuit breaker devices intended for low ampere applications, and more particularly to such devices which are constructed by suitably modifying a presently available higher rated circuit breaker type, which has demonstrated extreme reliability and safety of operation.

My U.S. Patent No. 2,996,589, issued Aug. 15, 1961, entitled "Pivoted Bimetal" and assigned to the assignee of the instant invention, shows a presently available circuit breaker device for home and light industrial use which has achieved wide-scale utilization in the protection of circuits having a normal load rating in the order of 15–60 amperes. The design of such circuit breakers has advanced to the point where they are extremely reliable and efficient in operation, and may be rapidly and economically manufactured and calibrated.

The overload responsive trip means of such circuit breaker devices includes a thermally responsive elongated element, which is in the series-circuit path of current flow. This element is appropriately calibrated such that it will be distortively deflected responsive to a predetermined inverse time characteristic of the overload current flow therethrough, with such deflective movement of the thermally responsive element serving to automatically trip the circuit breaker mechanism. Such previously existing circuit breaker devices, because of the inherent characteristics of their directly heated thermal elements, could not be used at appreciably lower ratings, as for example in the order of 1 to 4 amperes. The protective circuit interrupting devices used in such lower-rated circuits generally include structures which do not offer the same degree of reliability, safety of operation, or ease of manufacture and calibration provided by the higher rating commercial type circuit breakers.

My invention solves the aforementioned problems by suitably modiyfing the well known higher capacity circuit breaker of the type shown in aforementioned U.S. Patent No. 2,996,589, to provide reliable operation at a nominal rating in the order of 1–4 amperes.

More particularly, the directly heated thermal element of the bimetallic variety which is shown in that patent has now been replaced by an indirectly heated bimetal, having a suitable heater means to generate sufficient heat for deflecting the latch tip end of the bimetal responsive to a moderate overload condition at these appreciably lower ratings. The heater means may take the form of a series of windings disposed along an intermediate longitudinal portion of the bimetal and electrically insulated therefrom. In accordance with a particularly advantageous aspect of my invention, the same thermally responsive element may be used for those circuit breakers having a nominal load rating of 1, 2, 3 and 4 amperes, with modification of the overload tripping characteristic being achieved by varying the heater means.

In order to provide a sufficiently active thermal element to deflect when subjected to the heat at such relatively low current magnitudes. A very thin element is required. If the element were rigidly fastened at one of its ends, it would undergo deflective deformation, each time the circuit breaker were relatched. Thus, inasmuch as such lower ampere rating circuit breakers are particularly susceptible to permanent deflection of their elongated thermal elements, it is particularly advantageous that a pivoted thermal element be utilized. Further, the incorporation of such a pivoted element lends itself to instantaneous tripping, inter-pole tripping, and multi-pole construction, in a particularly convenient manner.

In addition to the thermally responsive moderate overload trip, an instantaneous, or magnetically actuated trip, may also be provided to provide more rapid tripping in the event of a fault condition appreciably in excess of the normal load rating. The magnetic trip may preferably take the form of a magnet member, located within the circuit breaker housing and defining a V-shaped air gap for the flux field generated by the heater windings.

It is therefore seen that the contribution of the instant invention resides in the recognition of the manner in which an existing higher capacity circuit breaker device may be modified to provide reliable and safe operation at appreciably lower current ratings, e.g., in the order of 1 to 4 amperes. Because of limitations in the characteristics of thermally responsive bimetallic elements as used in such previous breakers, it has not previously been thought feasible to modify such existing circuit breaker devices to provide suitable operation at such appreciably lower ratings. Further, the previously available lower rated circuit breaker devices could not be readily used together with the installation of higher capacity circuit breakers. My invention advantageously permits a single installation wherein the system panelboard may include circuit breakers of the higher capacity ratings, as well as the instant circuit breaker of significantly lower current ratings.

It is therefore seen that a principal object of my invention is to provide a low ampere rating circuit breaker of improved reliability and safety of operation.

Another object of my invention is to provide a circuit breaker device for low ampere applications, which is constructed by suitably modifying a presently available commercial type circuit breaker previously limited to higher ratings.

A further object of my invention is to provide a circuit breaker device particularly adapted for utilization in the range of 1–4 amperes, and having a pivotally mounted thermal element which is indirectly heated by a heater coil wrapped about an intermediate portion thereof.

An additional object of my invention is to provide a plurality of such circuit breaker devices, having nominal ratings of 1, 2, 3 and 4 amperes, which are identically constructed except for their respective heater means.

Still another object of my invention is to provide a circuit breaker device employing a quick make-quick break overcenter operating mechanism of the type shown in U.S. Patent No. 2,996,589, but incorporating an indirectly heated bimetal trip unit calibrated to provide desired operation at a load rating in the order of 1–4 amperes.

These as well as other objects of my invention will become readily apparent upon a consideration of the following descriptions and drawings, in which:

FIG. 1 is a side elevation view of a circuit breaker constructed in accordance with my invention, with the cover removed, and shown in the ON condition.

FIG. 2 is a side elevation view of the thermally re-

sponsive element, contact arm and load terminal sub-assembly portion of the circuit breaker shown in FIG. 1.

FIG. 3 is an end view of FIG. 2.

FIG. 4 is a modification of the circuit breaker shown in FIG. 1, to include an instantaneous magnetically actuated trip, in addition to the bimetallic thermally actuated trip shown therein, as well as an inter-pole trip member.

FIG. 5 corresponds essentially to FIG. 4, but shows a modified arrangement for interconnecting the inter-pole trip member to the individual circuit breaker trip means.

Circuit breaker **10** is housed within a molded insulative casing **11**, which includes a plurality of recesses for receiving and locating the various operating components thereof. The open side of casing **11** is capped by a removable cover (not shown), which is also constructed of a molded insulating material, and which is secured to base **11** by rivets **21**, which pass through aligned apertures of the base and cover. Located within housing **11** is a stationary contact **22** which is electrically connected via conductor member **24** to line terminal **26**, which is illustratively shown as a screw type terminal. It should, however, be understood that a plug-in type terminal may be substituted therefor in the well-known conventional manner. Cooperating with stationary contact **22** is a movable contact **26**, which is mounted at the lower end of movable contact arm **27**. Parallel plate slotted arc extinguishing means **99** may be provided within recesses **101** of the circuit breaker molded housing. The upper bifurcated end of contact arm **27** abuts a suitable pivot formation in internally extended portion **28** of manual operating member **15**. Manual operating member **15** is pivoted about protrusion **14** thereof, which is entered into suitable recesses of the base **11** and cover, and includes an outwardly extending portion **16** to provide a handle operator for manually moving the circuit breaker between its manual OFF and manual ON positions, in the manner more fully discussed in my aforementioned U.S. Patent No. 2,996,589.

The operating mechanism for bringing about the engagement and disengagement of the cooperating contacts **22**, **26** further comprises a latchable cradle **31**, which is pivotally mounted at one end thereof to base protrusion **32**, and forms a latch tip **34** at its opposite end. One end of an operating spring **33** is tied to cradle **31** at aperture **29** intermediate the ends thereof, while the other end of spring **33** is tied to contact arm **27** at aperture **29'**. Operating spring **33** is always in tension, thereby urging contact arm **27** upward into engagement with its pivotal mounting to manual operating member **15**.

In the ON position of the circuit breaker, as shown in FIG. 1, the operating spring is in over-center relationship to the left relative to the pivotal mounting of contact arm **27**, and serves to urge the movable contact **26** into firm engagement with stationary contact **22**. The latch tip **34** of the latchable cradle **31** seats upon latch means **35** carried by the lower end of an elongated thermally responsive element **36**, which may typically be of the bimetallic variety. Latch means **35** is shown secured to the thermal element **36** by a rivet member **37**, extending through an aperture at the lower end thereof, with an insulative plate **39** preferably also being provided. A bearing pin **41** is suitably secured to the upper end of the element **36**, as by welding, and enters suitable circular recesses of the circuit breaker base and cover for pivotally mounting the bimetal element **36** thereto.

Thermally responsive element **36** is biased in a clockwise direction by spring **70**, which is disposed in recess **72** of base **11**, with one end of spring **70** abutting the internal wall of the recess and the other end of spring **70** abutting a portion of elongated thermal element **36** above its pivotal mounting **41**. Accurate calibration of thermal element **36** is set by adjusting screw **74**, which extends through an opening **79** in base **11** and is received by nut **76**, disposed in a suitable recess **81** of base **11**. The end **78** of screw **74** opposite its head abuts one leg of tensioning member **80**, thereby forcing tensioning member **80** against thermal element **36** to calibratingly move the thermal element about its pivot **41**.

In order to provide appropriate overload responsive movement of elongated thermally responsive element **36** at the appreciably lower magnitudes to which the instant invention is directed, I provide an indirect heater means **50** in the form of a plurality of windings, coiled about an intermediate longitudinal portion of the elongated thermal element **36**, and suitably insulated therefrom, such as by insulative sleeve **52**, intermediate the surface of the thermal element **36** and the individual windings of the heater means **50**. One end **54** of the heater means is connected via conductor **56** to braid **58**, which in turn is connected to the movable contact arm **27**. The other end **57** of the heater means is connected to braid member **60**, which in turn is connected to the load terminal **62**.

Thus, the current carrying path through circuit breaker **10** beginning at the line side thereof proceeds from line terminal **26**, through conductive member **24**, to stationary contact **22**, to complementary moving contact **26**, contact arm **27**, and braid **58**, through conductor **56** to end **54** of the heater means, serially through the heater means **50** to its opposed end **57**, and through conductor braid **60** to load terminal **62**. Thus, it is seen that the heater means **50** is in the series path of current flow through the circuit breaker **10**, with thermally responsive element **36** being electrically insulated therefrom.

When circuit breaker **10** is subjected to a moderate overload condition, in accordance with the prescribed inverse time current characteristics thereof, the heat generated with heater **50** will deflectively move the latched end of elongated thermal element **36** in the direction of arrow **100**, so as to defeat the latched engagement of cradle latch tip **34** and latch means **35**. This will permit cradle **31** to rotate clockwise about its pivot **32**, so as to change the over-center relationship of operating spring **33** to the right with respect to the pivotally mounted end of contact arm **27** and impart a quick-break movement of cooperating contacts **22**, **26** to the TRIP condition.

Heater means **50** is designed in conjunction with the characteristics of thermal element **36**, such that sufficient deflective movement will be imparted thereto to satisfy the prescribed inverse-time tripping characteristics, which may typically be a maximum of two minutes at 200% of rated current and one hour at 135% of rated current. Further, in order to provide sufficiently active operation, thermal element **36** must be relatively thin, and hence the pivotal mounting **41** thereof rather than a fixed or rigid mounting of the bimetal end serves to prevent permanent deflection of its weak cross-section during relatching of the circuit breaker.

In accordance with a particularly advantageous feature of my invention, the thermal element **36** of individually rated circuit breakers in the range of 1–4 amperes may be made identical with the differing ratings being achieved by suitable modification of heater means **50**. This may be accomplished by changing the number of turns and/or gauge of the wire, to progressively increase the resistance of the heater at the lower ampere rating capacities of the breaker. Alternatively, the heater construction may remain unchanged, with different thermal elements being used for the different circuit breaker ratings.

Reference is now made to FIG. 4, which shows the added provision of an instantaneous, or magnetically actuated, trip, which includes a magnetic member **90**, mounted at one end thereof, within suitable recesses **92**, **94** of the circuit breaker housing **11**, and the other end **96** thereof being closely adjacent the pivot end of the thermal element **36**. If desired, an armature member (not shown) may be secured to the lower end of the thermal element. Thus, magnetic flux generated by heater means **50** extends across the V-shaped air gap intermediate magnetic member **90** and the lower end of thermal element **36**. Upon the occurrence of a severe fault condition, the free end of thermal element **36** is rotated towards mag-

netic member **90**, closing the air gap, and thereby defeating the latched engagement of cradle latch tip **34** and latch tip **35** so as to provide instantaneous tripping of the circuit breaker.

The modifications of the circuit breaker shown in FIG. 4 include provisions for inter-pole tripping, in the general manner shown in my above-mentioned U.S. Patent No. 2,996,589. A trip member **102** is pivotally mounted to the common pivot **41** of elongated bimetallic element **36**. Trip member **102** includes a rectangular aperture **104**, which receives elongated tie bar **106**, extending outside of the circuit breaker housing for connecting trip member **102** to the trip members of additional similarly constructed circuit breakers adjacent thereto, with reference being made to the aforementioned U.S. Patent No. 2,996,589, for the details of this inter-connection. A roller member **108** carried by cradle **31** engages trip member **102** upon operation of cradle **31** between its latched, circuit breaker ON position to the TRIP position. Engagement of trip member **102** by roller **108** forces trip member **102** counter-clockwise about pivot **41**. This counter-clockwise movement is sufficient to engage upwardly extending thermally insulative member **110**, secured to the elongated thermal element **36**, so as to move it in the trip direction of arrow **100** a sufficient amount, to defeat the latched engagement of members **34**, **35**. That is, should circuit breaker unit **10** move to its tripped condition, it will move member **102** counter-clockwise, with such movement being transmitted via tie bar **106** to the trip members of the adjacently aligned similar circuit breakers trip, the trip member **102** of the circuit Conversely, should one of such adjacently aligned circuit breakers trip, the trip member **102** of the circuit breaker shown will be moved counter-clockwise to engage member **110** and thereby move circuit breaker **10** to its trip condition.

It is noted that the heater windings **50** are advantageously limited to an intermediate portion along the length of thermal element **36**, intermediate pivotal mounting **41** and displaced from latch means **35**. Should the windings be placed close to the latch, it might interfere with its operation. Further, by not having the heater coils **50** at the lowermost end of the element **36**, an armature member may be conveniently added.

Reference is made to FIG. 5, which shows a modification of the manner in which trip member **102** engages elongated bimetallic element **36**. Upwardly extending member **110**, secured to the bimetallic element of FIG. 4, has now been replaced with an extension **110'** of trip member **102**, and serves the same function of moving latch means **35** in the direction of arrow **100** upon the counter-clockwise movement of trip means **102**. In both the embodiments of FIGS. 4 and 5, I advantageously avoid having trip member **102** directly contact heater **50**. If such contact were permitted, member **102** might blister or swell from the heat of the heater coils, adversely affecting the operation of the inter-pole trip.

It is therefore seen that my invention enables the construction of a circuit breaker device for low current magnitude, in the order of 1–4 amperes, which has the ruggedness, reliability and safety of operation of circuit breaker devices previously limited to appreciably higher current magnitudes. Further, it is seen that I achieve these advantages by a relatively simple modification of such prior art devices, which utilize a maximum of the previous components and does not require any re-work of the housing.

Although in the foregoing, my invention has been described in conjunction with preferred embodiments, many variations and modifications will now become apparent to those skilled in the art, and I prefer, therefore, that the instant invention be limited not by the disclosure contained herein but only by the appended claims.

The embodiments of the invention in which an exclusive privilege or property is claimed are defined as follows:

1. A circuit breaker comprising:

a housing containing a stationary contact, a cooperating movable contact and an operating mechanism for moving said contacts between contact engaged and contact disengaged conditions;

said operating mechanism including a manual operating member pivotally mounted to said housing, and having a first portion projecting outward of said housing, and a second portion internal of said housing, said first portion providing a handle operator for manually moving said operating mechanism between manual ON and manual OFF positions;

a contact arm having a first and second end, said first end carrying said movable contact and said second end pivotally mounted to said second portion of the manual operating member;

a latchable cradle having a first and second end, said first end pivotally mounted to said housing and said second end forming a latch tip;

an operating spring having a first and second end, said first end connected to an intermediate portion of said latchable cradle and said second end connected to an intermediate portion of said contact arm;

an overload responsive trip means having a current rating of not more than four amperes, and including an elongated thermally responsive element having a first and second end, pivot means at said second end for pivotally mounting said thermally responsive element to said housing and latch means carried at said second end for latching engagement with said latchable cradle latch tip;

said circuit breaker ON position corresponding to said latch tip being in engagement with said latch means, and said operating spring being in overcenter relationship relative to the pivotal mounting of said contact arm for urging said movable contact into engagement with said stationary contact;

predetermined heating of said thermally responsive element deflectively moving the second end thereof in a direction to defeat the latching engagement with said cradle latch tip, such that said operating spring moves said cradle in a direction to alter the overcenter relationship of said operating spring relative to said contact arm and rapidly moves said movable contact out of engagement with said stationary contact, to the circuit breaker TRIP condition;

a heater means for said thermally responsive element in the circuit path of current flow through said circuit breaker;

said heater means including a plurality of windings wrapped about said thermally responsive element longitudinally positioned intermediate said pivot means and latch means;

insulating means for electrically insulating said thermally responsive element from the current flow through said circuit breaker and heater means;

such that said heater means indirectly heats said thermally responsive element for the deflective movement thereof responsive to predetermined overload conditions.

2. A circuit breaker as set forth in claim **1**:

said trip means operatively constructed to move said circuit breaker to the TRIP condition responsive to the indirect heating of said thermally responsive element upon the occurrence of an overload condition satisfying predetermined inverse-time characteristics in excess of the normal load rating.

3. A circuit breaker as set forth in claim **1**:

said trip means operatively constructed to move said circuit breaker to the TRIP condition responsive to the indirect heating of said thermally responsive element upon the occurrence of a moderate overload condition satisfying predetermined inverse-time

characteristics in excess of the normal load rating; said trip means further including an instantaneous, magnetically actuated trip, said instantaneous trip having a magnetic member including a first and second end, said first end positioned closely adjacent said thermally responsive element first end, and said magnet second end spaced from said thermally responsive element second end to define therewith a V-shaped air gap having an apex at said first ends and open at said second ends;

said housing including seating means for said magnet second end, such that upon the establishment of a sufficient flux path across said air gap, the second end of said thermally responsive element moves towards said magnet second end to close the V, with such movement serving to defeat the latching engagement of said latch means and said cradle latch tip.

4. A circuit breaker as set forth in claim **1**, further including:

a trip member movable by said latchable cradle upon the movement thereof from the circuit breaker ON condition to the circuit breaker TRIP condition, said trip member when moved by said latchable cradle engaging a portion of said trip means, which is carried by said thermally responsive element and is thermally insulated from said heater means, means connected to said trip member and extending outside of said housing for connecting said trip member to the trip member of at least one additional similarly constructed circuit breaker, such that the occurrence

of an overload in any of the connected circuit breakers will move the trip members of all the circuit breakers to effect simultaneous tripping thereof.

5. A circuit breaker as set forth in claim **2**, further including:

a trip member movable by said latchable cradle upon the movement thereof from the circuit breaker ON condition to the circuit breaker TRIP condition, said trip member when moved by said latchable cradle engaging a portion of said trip means, which is carried by said thermally responsive element and is thermally insulated from said heater means, means connected to said trip member and extending outside of said housing for connecting said trip member to the trip member of at least one additional similarly constructed circuit breaker, such that the occurrence of an overload in any of the connected circuit breakers will move the trip members of all the circuit breakers to effect simultaneous tripping thereof.

6. A circuit breaker as set forth in claim **1**:

said thermally responsive element being a bimetal.

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