United States Patent [19]

Burch

[11] **3,913,049**

[45] **Oct. 14, 1975**

[54] **THERMOSTATIC CIRCUIT BREAKER**

[75] Inventor: **Lyndon W. Burch,** Boston, Mass.

[73] Assignee: **B/K Patent Development, Inc.,** Highland Park, Ill.

[22] Filed: **Oct. 26, 1973**

[21] Appl. No.: **409,911**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 346,918, April 2, 1973.

[52] **U.S. Cl.** **337/75;** 337/72; 337/79; 337/112

[51] **Int. Cl.** **H01h 71/16**

[58] **Field of Search** 337/70, 72, 75, 76, 78, 337/79, 85, 112, 356, 358, 359, 362, 380

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Primary Examiner—Arthur T. Grimley
Attorney, Agent, or Firm—Kenway & Jenney

[57] **ABSTRACT**

A low cost thermally-actuated circuit breaker, adapted to be miniaturized. In one embodiment, the device has a spring arm on a base which combines as an integral unit the arm itself, an electrical contact, a manual reset member, and a terminal; a thermostat metal blade also mounted on the base and incorporating integrally an electrical contact and terminal structure; the blade engaging the end of the spring arm in such manner that the force of the arm is in a direction in which the thermal blade is relatively rigid, the spring arm and blade being held on the base by the cover for the assembly in operative position. In a second embodiment, a plurality of elements are arranged on a common base, with a common cover holding all of the elements attached to the base. In a third embodiment, indicating means are provided to indicate when one of the elements or more has tripped under overload conditions. In a fourth embodiment, the thermostat metal blade engages the spring arm by an edge portion of the blade, and the direction of the motion of the blade to open the circuit is such as to draw the edge portion in an edge-wise direction across the blade, thus reducing friction and thus stabilizing the circuit-opening characteristics of the device.

28 Claims, 32 Drawing Figures

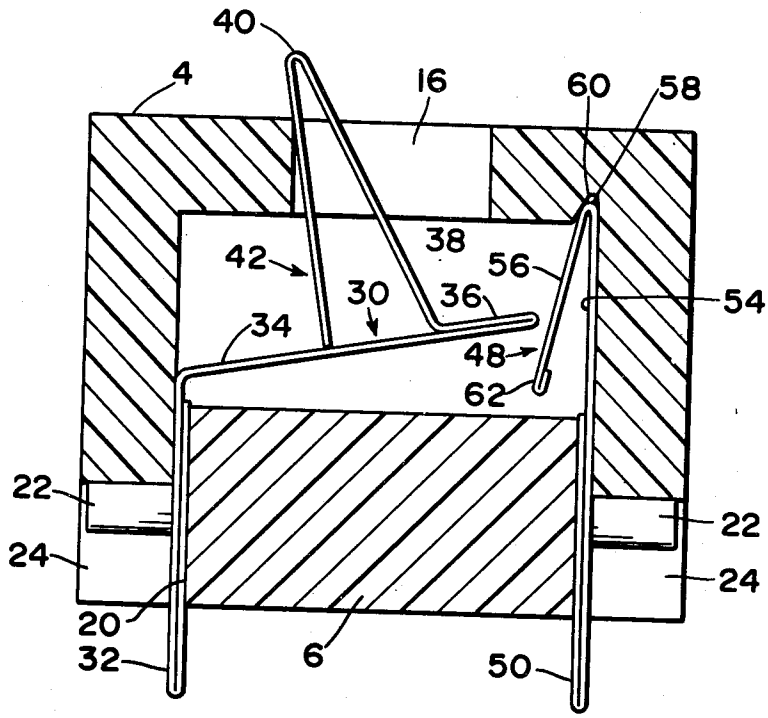


FIG. 1

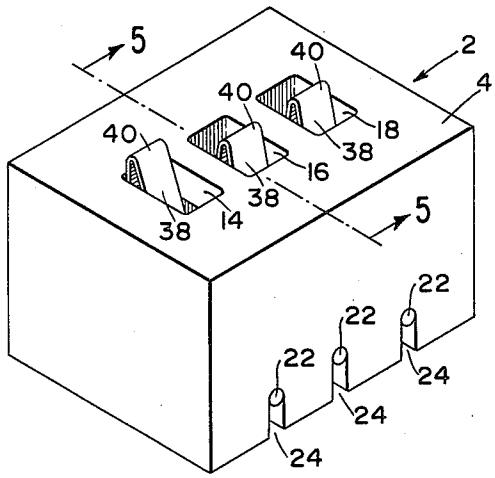


FIG. 2

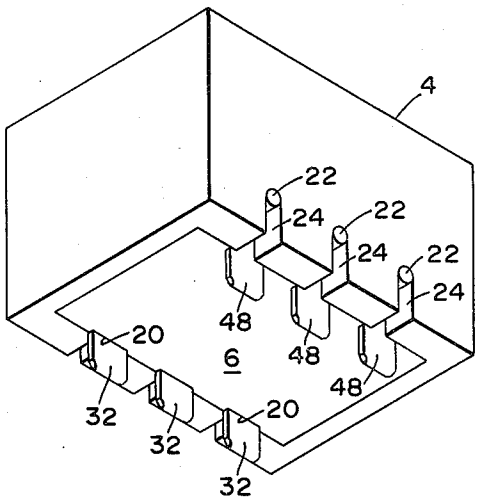
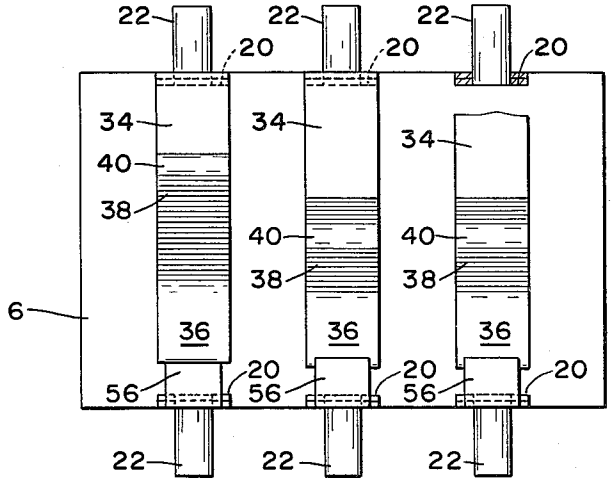


FIG. 3



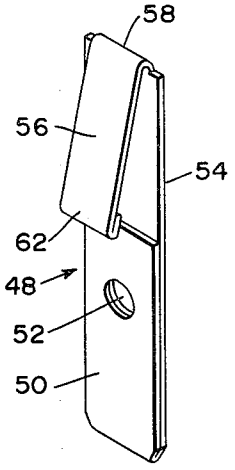


FIG. 4

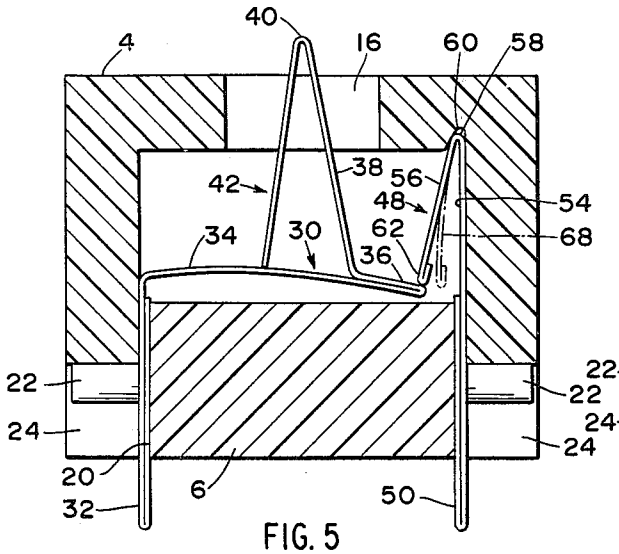


FIG. 5

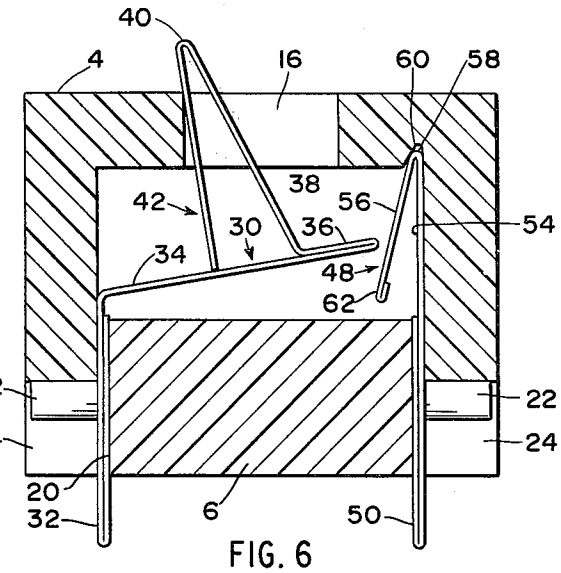
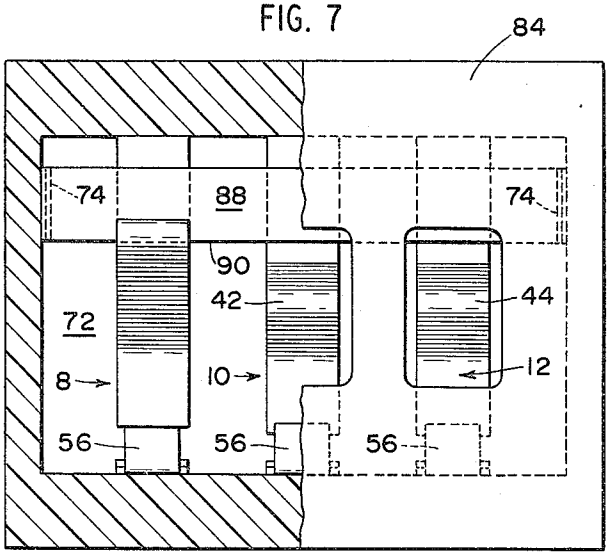


FIG. 6

FIG. 7



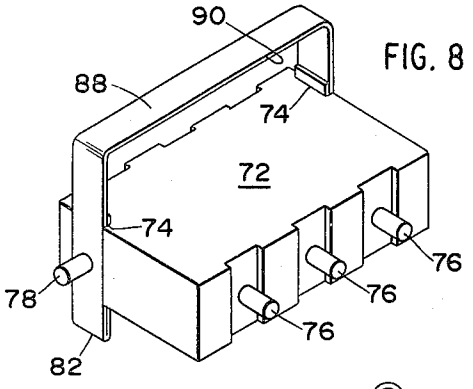


FIG. 8

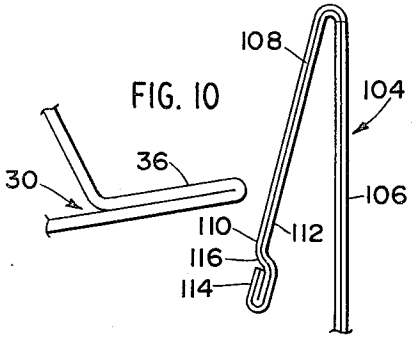


FIG. 10

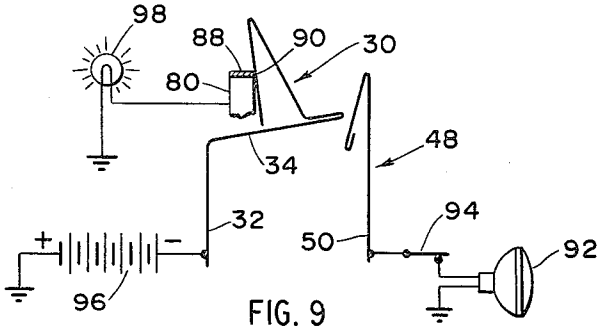


FIG. 9

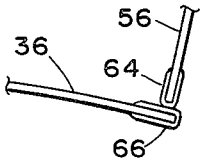


FIG. 17

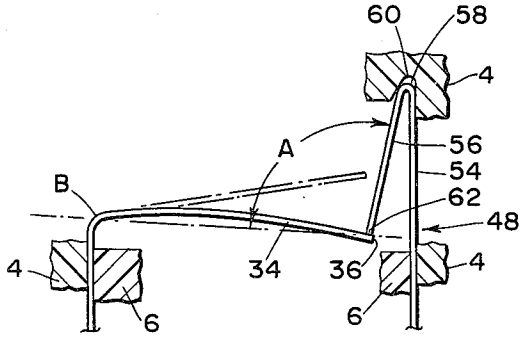


FIG. 11

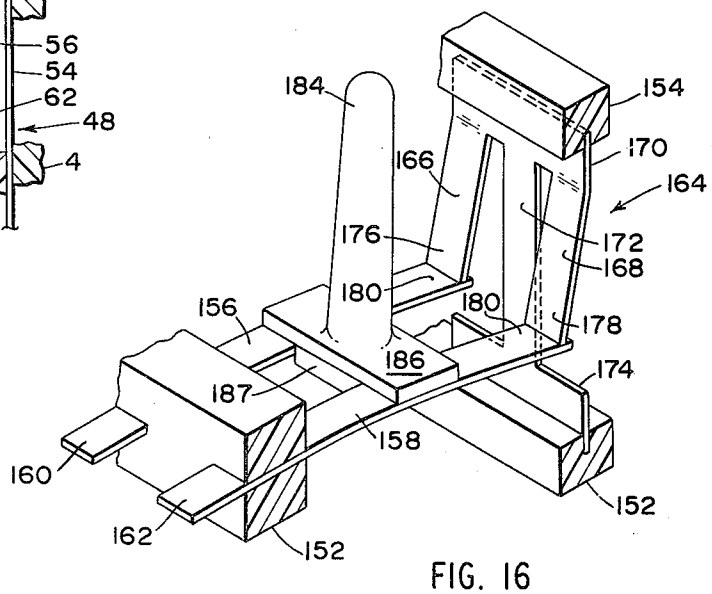


FIG. 16

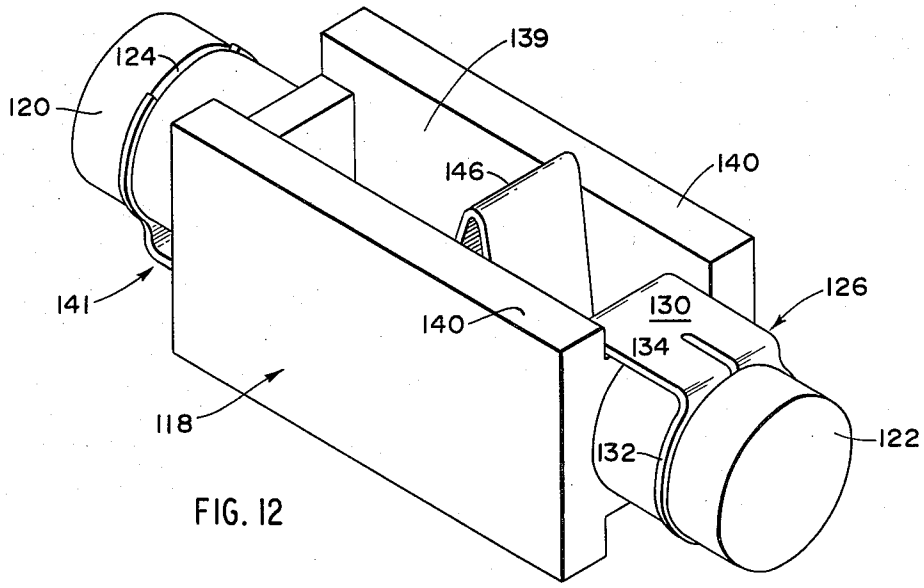


FIG. 12

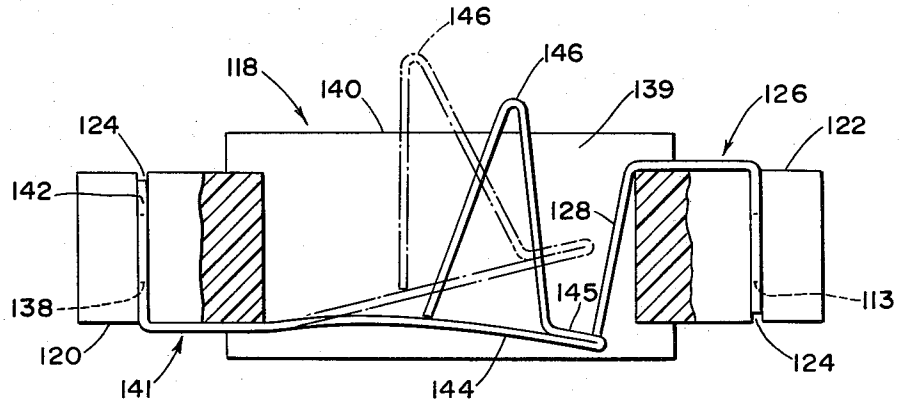


FIG. 14

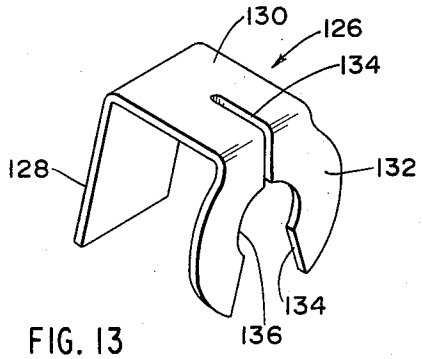


FIG. 13

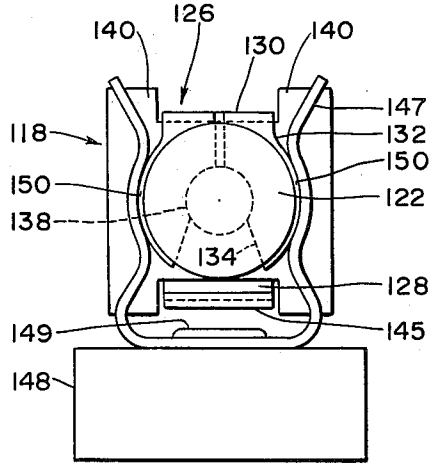
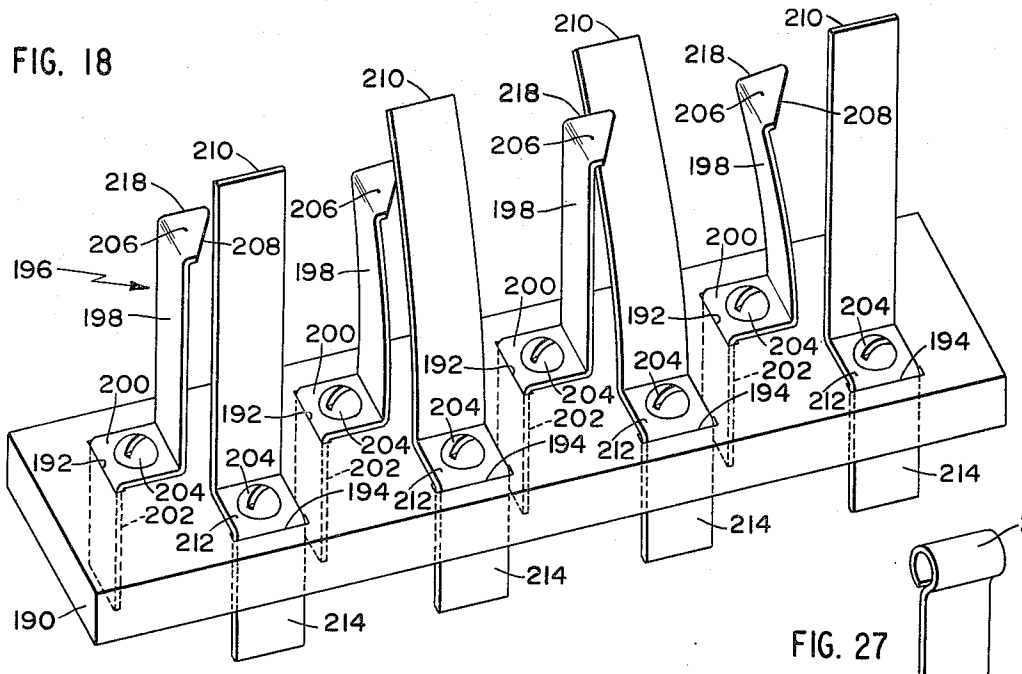


FIG. 15

FIG. 18



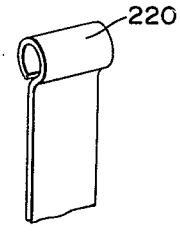


FIG. 27

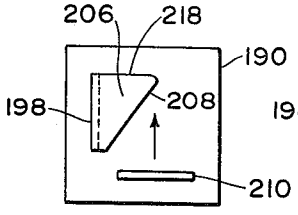


FIG. 19

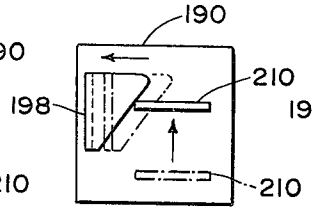


FIG. 20

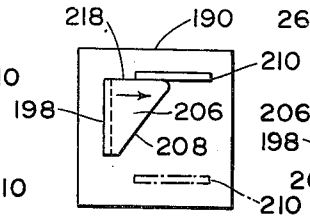


FIG. 21

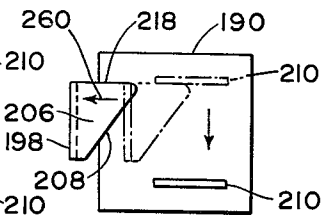


FIG. 22

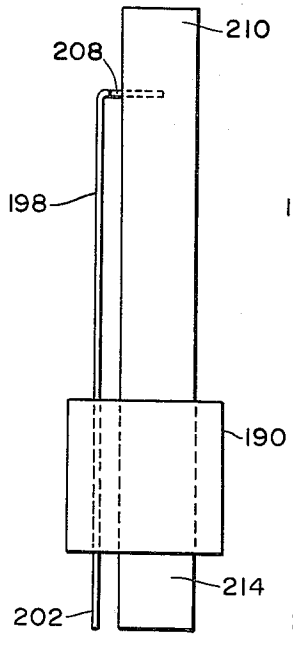


FIG. 23

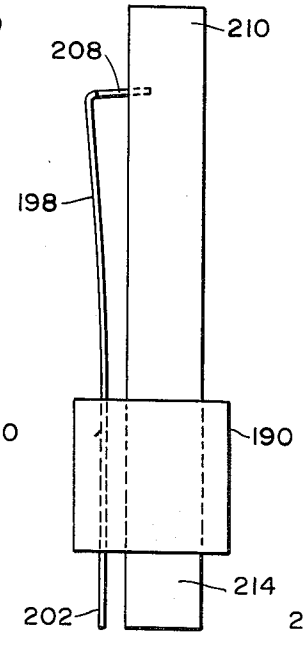


FIG. 24

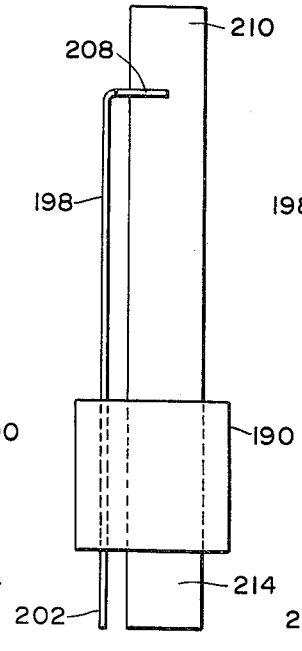


FIG. 25

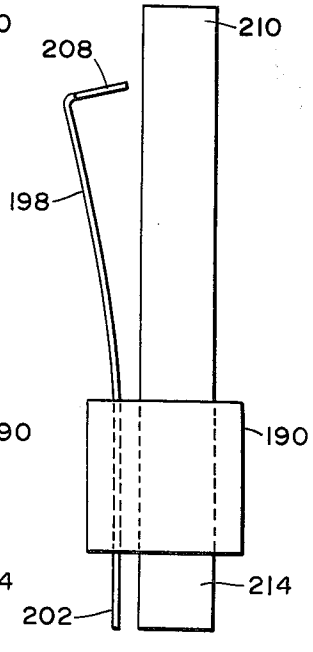


FIG. 26

FIG. 28

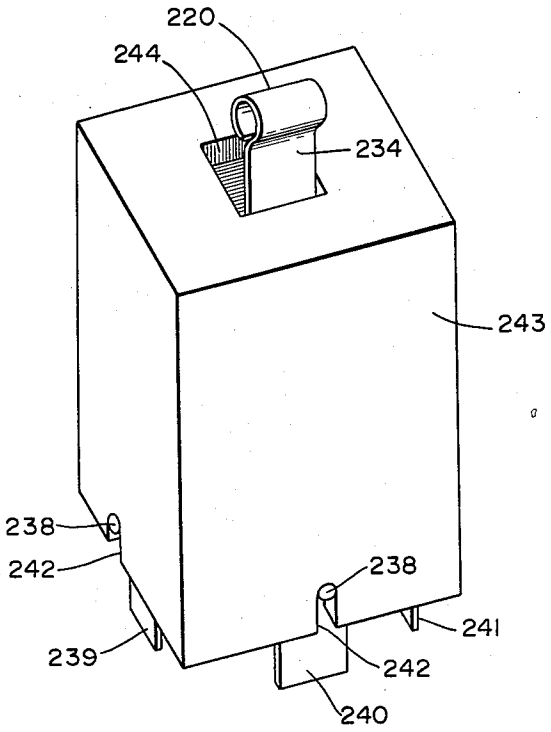


FIG. 29

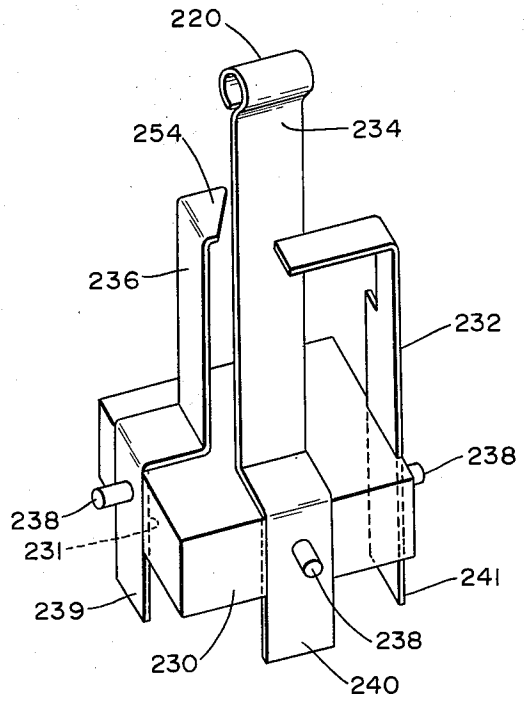


FIG. 30

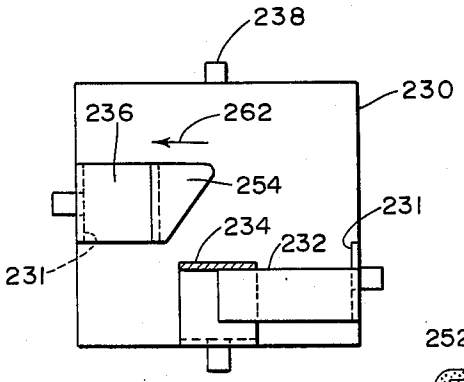
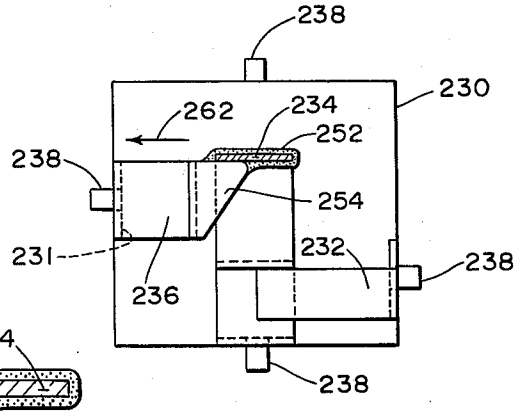


FIG. 31



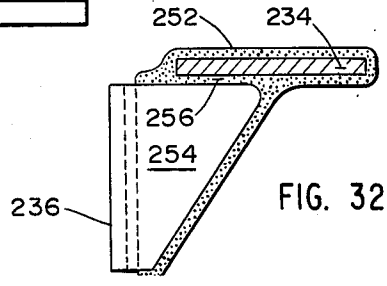


FIG. 32

THERMOSTATIC CIRCUIT BREAKER

This application is a continuation-in-part of U.S. patent application Ser. No. 346,918, filed Apr. 2, 1973, Lyndon W. Burch inventor.

BACKGROUND OF THE INVENTION

Many attempts have been made to manufacture very low cost, thermally-actuated small circuit breakers, with manual resetting means, as well as indication as to which of the plurality of circuit breakers has been opened. Almost invariably, the cost of such structures has been too high for wide acceptance by the mass markets, such as circuit breakers for the automobile market. The reasons for this are many, but among them are the high cost of labor (particularly in the United States) and the high cost of the materials of the circuit breaker. In addition, for some circuits it has been desired to provide a low cost double-break circuit breaker. However, even such devices must be low in cost if they are to sell in the automotive field.

In present day automobiles, for reasons of economy of installation and wiring, often a fuse panel will be installed which has on it many individual fuses. As to the panel, each fuse thereon requires two spring clips which must be riveted to the panel; and each fuse requires a body, end caps, and the fuse link itself. It takes many operations to assemble (from basic materials and parts) such a fuse and its clips. Again, labor costs for such steps tend to increase the cost of the finished panel and the fuses therefore. Thus, each fuse station requires its portion of the common base, the fuse body, the end caps thereon, the fuse wire, the two fuse-retaining clips, the rivets therefor, and the terminals extending from the clips.

It is known to use a thermostat metal blade to engage the end of an arm which is flexible or rigid. The blade, when heated by current flowing therethrough will bend in such manner as to release the arm so that the latter may move to open electrical contacts. However, in many such structures, the blade and the arm do not constitute electrical contacts per se. Instead, the motion of the arm itself may actuate remotely mounted contacts. Most of these designs in the prior art have been constructed in order to be serviceable on voltage circuits such as 110v. A.C. or 220v. A.C. Because of the requirements of the Underwriters Laboratory in respect to the performance of such devices, the prior art breakers are relatively expensive to construct and therefore costly to buy. As examples of these devices attention is drawn to the following U.S. Pat. Nos.: Jackson et al. 2,270,950; Frank et al. 2,320,355; Ingwersen 2,492,382; Millen 2,615,963; and Lombardo 2,844,690.

In addition, prior art devices in which a thermostatic blade must wipe across a spring arm during the circuit opening period, have the difficulty that the coefficient of friction between the spring arm and blade may vary from unit to unit, or may become variable during use. This gives rise to initial faulty calibration, or erratic calibration during use.

It is the general purpose of this invention to provide a low cost thermally actuable, manually-resettable circuit breaker having a minimum of parts, minimum of assembly costs, a minimum of calibration costs; and in which variations in calibration and current ratings are minimized.

SUMMARY OF THE INVENTION

Therefore, among the several objects and provisions of this invention may be noted the following:

One object of the invention is the provision of a low cost, simple, thermally actuable circuit breaker having no more than four parts in the total assembly.

A second object of the invention is the provision of a thermally actuable circuit breaker with means for assembling the operating parts thereof on a base involving a minimum of skill, labor and calibration costs.

Another object of the invention is the provision of a thermally actuable circuit breaker of either of the above kinds, in which manually resetting means are provided which indicate visually when the circuit breaker has opened its circuit.

A still further object of the invention is the provision of a circuit breaker of any of the above kinds, in which means are provided to obtain a remote electrical indication that the circuit breaker has opened.

Another object of the invention is the provision of a circuit breaker design of such nature that a plurality of individual circuit breakers may be economically mounted on a common base with the operative parts held on the base by means of a common cover.

Yet another object of the invention is the provision of a circuit breaker of the last named kind with indicating means for indicating when any one of the plurality of individual circuit breakers has opened its circuit.

Still another object of the invention is the provision of a circuit breaker of any of the above kinds in which simple but novel means are provided whereby accuracy of calibration is assured.

Other objects and advantages will be in a part obvious and in part pointed out hereinafter.

The invention accordingly comprises the elements and combinations of elements, features of construction, and arrangements of parts which will be exemplified in the structures hereinafter described, and the scope of the application of which will be indicated in the appended claims.

In the accompanying drawings, in which are illustrated several embodiments of the invention;

FIG. **1** is an illustration of one embodiment of the invention, which illustrates the overall general assembly.

FIG. **2** is a bottom view of the FIG. **1** embodiment, given to show certain features of construction and assembly.

FIG. **3** is a top plan view of the FIG. **1** embodiment, partly in section, and with the cover thereof removed.

FIG. **4** is an illustration of one of the thermallyactuable thermostat metal blades of the FIG. **1** embodiment.

FIG. **5** is a sectional elevation of the FIG. **1** embodiment, showing the assembly of one of the circuit breakers of the FIG. **1** embodiment on the base of the device with the parts in their circuit closed position, the view being taken in the direction of sight lines **5—5** on FIG. **1**.

FIG. **6** is a sectional elevation similar to FIG. **5**, but showing the operating parts in their circuit open position.

FIG. **7** is a plan view of the FIG. **1** embodiment, partly in section and with a portion of the cover thereof broken away, to show more clearly the inner assembly and construction of certain elements of the circuit breaker.

FIG. 8 illustrates a portion of a second embodiment of the invention, other elements of the FIG. 8 embodiment being the same as corresponding parts of the FIG. 1 embodiment; this view being given with the cover removed, in order to illustrate certain features of construction of the base and an indicating means.

FIG. 9 is a schematic diagram of an electrical circuit used in conjunction with the FIG. 8 embodiment in order to give electrical indication that any given circuit breaker, of a plurality thereof on a common base, has opened its circuit.

FIG. 10 is enlarged view of the thermostat metal blade element used in a third embodiment of the invention. Since the blade of FIG. 10 can be substituted in the FIG. 1 embodiment, the other elements of this third embodiment are those of the FIG. 1 embodiment.

FIG. 11 is a schematic view of portions of the FIG. 1 embodiment showing certain angular and mounting relationships of the operating parts.

FIG. 12 is an illustration of a fourth embodiment of the invention, the view being greatly enlarged.

FIG. 13 is an illustration of a thermally-actuable element of the fourth embodiment of the invention.

FIG. 14 is a sectional elevation showing the parts of the fourth embodiment assembled in operative relationship.

FIG. 15 is an end view of the fourth embodiment in a mounting clip.

FIG. 16 is an illustration in perspective showing a fifth embodiment of the invention, the working parts being in contact-closed position.

FIG. 17 is a view of the ends of operating portions of the various embodiments, given to show certain additional optional details of construction.

FIG. 18 is a view illustrating a sixth embodiment of the invention.

FIGS. 19—22 are plan views of the FIG. 18 embodiment, showing various stages and positions of the elements of the embodiment during operation thereof.

FIGS. 23—26 are views showing in elevation the respective positions of the elements in the plan views of FIGS. 19—22.

FIG. 27 is an illustration of an alternate end termination of the spring arms of FIG. 18.

FIGS. 28—30 are illustrations of a seventh embodiment of the invention, FIG. 28 showing the device with cover, FIG. 29 without cover, and FIG. 30 being a plan view of FIG. 29, the parts being in open position.

FIG. 31 is a plan view of an eighth embodiment of the invention, the parts being in contact-closed position.

FIG. 32 shows a greatly enlarged portion of the FIG. 31 embodiment.

Throughout the drawings, similar reference characters indicate corresponding parts, and the dimensions of certain of the parts as shown in the drawings may have been modified and/or exaggerated for the purposes of clarity of illustration and understanding the invention.

Referring now to FIGS. 1–6, the first embodiment is shown in a form that mounts a plurality of operating circuit breakers on a common base, with a common cover. However, it is to be noted that if desired, only one combination of circuit breaker elements can be mounted on a single base with its own individual cover.

The device is indicated generally by numeral 2 and has cover 4, base 6, and (mounted on the base) individual circuit breaker assemblies identified generally by numerals 8, 10 and 12 (see FIG. 3).

Cover 4 fits snugly around base 6, and when the cover is attached in proper position on the base, it holds the elements thereon in operating position. In the top of the cover are openings 14, 16 and 18 extending completely therethrough.

The bottom 6 is provided with the grooves or rabbets 20 in the opposite sides of the base 6 (see FIG. 8 for a clear illustration of this), and from each of the grooves there projects a pin 22 which, if the base 6 is molded from electrically-insulating synthetic plastic resin, may be molded integrally with the base.

Cover 4 fits snugly down over the base 6, and slots 24 are provided in the edges of the cover to fit down over the pins 22. The pins thus serve, as one of their functions, to determine how far the cover fits down over the base, the cover fitting down until the pins 22 strike against the upper ends of the grooves or slots 24.

Referring now to FIGS. 3, 4, 5 and 6 for enlarged details of the operating elements of the individual circuit breakers and their relationship, each breaker combination has a spring member indicated generally by numeral 30, this number being conveniently made on a four-slide machine. The member is made of spring material, preferably phosphor bronze of the composition generally used in electrical work, and has an end portion 32 folded back on itself as illustrated to provide a greater thickness at this end of the arm to facilitate mounting where the material of the spring arm is relatively thin, for example, 0.010 inches. The spring arm may be, for example, only 3/16 to ¼ inch wide. It will be noted that the grooves 20 along one side of the base 6 are so dimensioned that the depth of the groove is equal to the total thickness of the end portion 32 of the spring arm, and the width of the groove will be the width of the spring arm. These dimensions preferably are so produced and manufactured by the molding process which produces the base 6, that the spring arms are a sliding but snug fit in their respective grooves.

Each spring arm has a middle section 34, and the arm is then provided with a fold-back 36. Thereafter, the arm material 38 extends upwardly and then downwardly at bight 40 to form a manual resetting member indicated generally by numeral 42. Thus, the spring arm, terminal end, and resetting portion comprise an integral one piece member of metal. It is to be realized, however, that for certain sizes, it may be preferred to make the member 32–34 as one piece, and attach the manual resetting member 40 to the arm 34 by means such as suitable welding.

The end portion of each spring arm is provided with a hole therein which fits over one of the pins 22, thus (in combination with the grooves 20) positioning the spring arm accurately on the base 6. It will now be observed that when the cover 4 is placed down over the base, the conjunction of the side walls of the cover and the side of the base accurately and securely fastens each spring arm and resetting member in proper position on the base. When the cover is so positioned (see FIGS. 1, 5 and 6), it will be noted that the bight end 40 of the spring arm projects through the hole 16 in the cover, and extends outwardly thereof for a short distance. It is founded, by the construction, and thus provides a relatively smooth portion of the total assembly which can be manipulated by the finger of a person

using the circuit breaker, in order to reset the device as will be described below.

The description above of the spring arm assembly **30** which combines the terminal end **32,** the spring arm **34** per se, the manual reset member **42,** (and the electrical contact for the spring arm as will be described below) has been described for just one of the circuit breaker assemblies shown in FIGS. **1** and **2** and **3,** and in particular the one corresponding to sight lines **5–5.** However, the assembly for each of the circuit breaker combinations is the same regardless of whether the base is for a single circuit breaker assembly, or for a plurality, three such circuit breaker assemblies, such as shown in FIGS. **1** and **3** as an example.

Referring to FIGS. **3, 4, 5** and **6,** the thermally-actuable member of each circuit breaker combination is indicated generally by numeral **48,** and each comprises a strip or blade of thermoflexing metal having one end **50** folded back on itself, and provided with the hole **52.** The end **50** thus provides a thickened portion at the end of the blade just as in the case of the spring arms. The width and thickness of this end portion are such as to enable the latter to fit snugly in the respective grooves **20** provided at the other edge of the base **6,** just as the ends **32** of the flexible spring arms are fitted along their respective edge of the base. Holes **50** fit over the pins **22,** and thus serve to position the members **48** properly on the base **6.** Portion **50** serves as an electrical terminal.

Each thermostat metal member is provided with a body portion **54,** and with a tongue **56** of reduced width. The tongue is bent back on the body of the blade at bight **58** to provide the angular relationship shown. The end **62** of the tongue is folded back on itself as shown to provide a smooth end. The high expansion side of the thermostat metal of the tongue is to the left as drawn.

The individual thermo-metal blades **48** are assembled on the base at the same time that the spring arms **30** are assembled, and then the cover **4** is fitted down over the base, thus securely locking the blades and the spring arms in their correct operative positions. At this point, it is to be noted that the upper inside corner of the cover **4** is provided with an elongaged groove or rabbet **60** which is so positioned and deep enough so that when the cover **4** is in its proper position on the base **6,** the bight **58** of each thermostat blade fits securely and snugly within the groove. Thus, the body **54** of each thermostat metal blade is not permitted to bend when heated by the passage of current therethrough.

It is pointed out that the end **36** of the spring arm **34,** and the end **62** of the thermostat metal blade **48** by and of themselves constitute the electrical contacts of the circuit breaker of the instant invention. If desired, a wash of a precious metal such as silver or gold can be applied to these end portions, to make sure that particularly for low voltage circuits, the oxides which may be present on the surfaces of these metals will not result in an undesirable voltage drop across the contacts. However, this is not necessary in most cases. Or, if desired, a contact material **64** may be soldered to the end of the tongue **56** as shown in FIG. **17,** and in like manner a precious metal contact member **66** may be soldered to the end of the spring arm **36.** However, this will increase the cost of the device, and thus it is to be avoided except in cases of necessity. In the claims, the phrase "comprising an electrical contact" is to be taken as any one of the above constructions.

The construction given above has been described in terms of just one of the circuit breaker assemblies of the FIG. **1** embodiment. The constructions of the other thermally responsive members of the FIG. **1** embodiment are the same, if each circuit breaker is to have the same current rating. However, if it is desired to change the rating of an individual circuit breaker, all that is necessary is to change the thermostat metal itself to one of different resistance in accordance with conventional practice, or change the thickness or width of the tongue **56.**

FIG. **5** shows in sectional elevation the parts of one of the circuit breaker assemblies in their operative circuit-closed position. FIG. **6** shows the circuit breaker in the contact-open position. Referring to FIG. **1,** the left-hand circuit breaker is in contact-open position, and the other two are in contact-closed position.

Referring to a single circuit breaker, for example, the center one of FIG. **1** which has its parts positioned as shown in FIG. **5,** circuit connections are made to the terminals **32** and **50,** with the load in series with the breaker in the usual manner. Current will then pass through the terminal **32,** arm **34,** portion **36** thereof, the tongue **56** of the thermally-responsive member, body member **54** thereof, and out through the terminal **50.** So long as the current in the circuit does not exceed the rating of the circuit breaker, the end of the arm **34** and the end of the tongue **56** remain in electrical contact. It will be observed at this point, that the manual resetting member is positioned approximately in the center of the opening **16.**

However, if the value of the current exceeds the rated value, the tongue **56** will be heated thereby, and since the high expansion side **57** of the thermostat metal is at the left as viewed in FIGS. **4** and **5,** the tongue **56** will bend to the dotted line position **68** as shown in FIG. **5.** At the instant, the end **62** clears the end **36,** the flexible spring arm is released, and moves to the contact open position shown in FIG. **6.** This interrupts the current in the circuit. It will be observed that when the spring arm is released to move upwardly as shown, the bight portion of the spring arm is moved to the left-hand end of the hole opening **16** (as viewed), where it comes to rest. Thus, when the circuit breaker is in contact-open position, the position of the outwardly projecting end or bight of the particular manual reset means indicates that the circuit breaker has opened. This open position is shown in the FIG. **1** view, and it will be observed that when the circuits are closed, the bight portion of each manual resetting means is located approximately at the center of the opening **16.**

To reset the device, all that is necessary is that the user push the projecting end portion of the resetting means to the right (as viewed in FIGS. **5** and **6**) and in downwardly direction, which will cause the end **36** to slide down the tongue **56** until the end **62** of the tongue slides over the end **36** to latch the latter in contact-closed position.

Referring now to FIGS. **7** and **8,** a second embodiment of the invention is shown, in which electrical indicating means is provided to show that a circuit breaker has opened its contacts. A base **72** is provided which is like base **6** in all respects, except that a pair of additional edge grooves **74** are provided as shown. The pins

76 and the other grooves are as were previously provided in the FIG. 1 embodiment. Additional pins 78 are provided for each of the grooves 74 extending outwardly from the grooves 74 just as the pins 22 extend outwardly from their respective grooves in the FIG. 1 embodiment. The function of the pins and grooves of this embodiment is the same as the similar construction in the FIG. 1 embodiment.

A metallic strap 80 is provided which fits in the grooves 74, and preferably has its ends folded back on themselves as shown at numeral 82 to provide suitable electrical terminals. A cover 84 is provided, like the cover 4 in all respects as concerns the fit of the cover on the base 72, but including the provision of slots therein to ride over the pins 76. However, in this embodiment, a groove 86 is provided in the top inside surface of the cover, positioned and of sufficient depth so that when the cover is properly seated on the base 72, the groove will receive and hold the top bar 88 of the strap 80. Thus, by the fit of the cover on the base, the strap is held securely in its proper location.

The location of the bar 88 with respect to the openings 14, 16 and 18 is such that the edge 90 of the bars lies within the openings 14, 16, and 18 so that when a manual resetting member 40, for example, has moved to the postion shown in FIG. 6, the manual reset member will come in electrical contact with the bar 88.

Circuitry to give electrical indication for the above embodiment is shown in FIG. 9. A load, for example an electric light bulb 92, has one side connected to ground as shown, and the other side is connected to a conventional manual switch 94. The other side of the switch connects to the terminal 50 of member 48. The strap 80 is electrically connected to one side of a pilot or indicating lamp 98, and the other side of the latter is connected to ground. One side of battery 96 is connected to ground and the other side is connected to terminal 32 of the spring arm.

When the circuit breaker parts are in their contact making position as illustrated in FIG. 5, no current flows through the light 98, thus indicating that the respective parts are completing their circuit. However, when the spring arm is released by the thermal metal member or latch mechanism, and moves to the position shown in FIG. 6, the reset means contacts the bar 88, and a circuit is made to the lamp through the spring arm itself, manual reset member 30, bar 88 and the electrical connection to light 98. Thus, the light gives a remote indication that one of the circuit breakers has opened.

Referring now to FIG. 10, a portion of a third embodiment of the invention as shown, the change being in the fold occurring in the end of the thermal blade tongue. In this embodiment, the same enumeration has been maintained for clarity except as to the fold back portion. A thermally-actuable element 104 is shown like element 48, which has a body portion 106 and a tongue 108. The body portion 106, and 108 are the same as in the FIG. 1 embodiment, and the outer or electrical end terminal of the thermostat metal member is formed the same as in the FIG. 1 embodiment.

However, the end of the tongue 108 is formed differently. It will be noted that in the FIG. 1 embodiment (see FIG. 4) the end of the tongue is formed back against itself with the bending being to the right as drawn. In such case, since the high expansion side 110 of the bimetal element is to the left as viewed in both FIGS. 4 and 10, and the low expansion side is to the right, then in the FIG. 4 embodiment electrical contact is made between the end of the flexible spring arm and the end of the tongue through the high expansion side of the thermostat metal. It may not be desirable to do this, because sometimes the high expansion of thermostat metals has a relatively high resistance. Instead, it may be desirable to have contact made with the end of the flexible spring arm through the low expansion side of the thermostat metal. This is accomplished in the FIG. 10 embodiment by making the bend the reverse of what is shown in the FIG. 4 view. It will be observed that the bend curves toward the left and the end 114 is folded back upon itself, thus presenting the low expansion side of the thermostat metal to the arm 36. In order to keep the end 114 of the tongue 108 from constituting an abutment which would prevent the closing of the circuit breaker, a dog-leg 116 is provided in the tongue into which the fold-back portion 114 fits to provide a smooth transition point.

Referring now to FIG. 11, a feature in respect to the relationship of the contact arm 34 and the thermally actuable members of the above embodiments is illustrated schematically. Spring arm 34 is shown without the reset mechanism in order to simplify the drawing, and the thermally actuable member or tongue 56 is shown in simplified form. The parts are shown in their contact-closed position, and the flexible spring arm pivots about the point B. It is to be noted that the angle A between the end 62 of the tongue 56 and a straight line drawn from the flex point B and the place of engagement of the end of the tongue with the end 36 of the flexible spring arm must be greater than 90°. As a result of this, in the path of motion of the end 36 of the spring arm is an arc, and it will be noted that the arc and thus the path of the end 36 to its uppermost contact-open position, clears at all times the tongue 56. On the other hand, when the device is reset, the end 36 of the flexible arm may slide down smoothly along the lower portion of the tongue 56 until the members lock in contact-closed position as shown.

It may be thought that instead of having the angular relationship as shown, a simple right angled bend or extension at the end of the tongue toward the spring arm, which extension will then engage the end of arm 36, would be sufficient so that the above angular relationship would not have to be made. However, while this may be true in the sense that the arc of travel of the end of the flexible arm would then clear the thermostat metal blade on contact-open operation, nevertheless, when it is attempted to reclose the parts with such a construction, it will be found that the extending portion of the end of the tongue will constitute a hook or catch which will make a relatching operation difficult if not impossible.

Referring to FIGS. 12–15, a greatly enlarged view of a fourth embodiment of the invention is shown, which may be, for example, not more than 1 ½ inches long. It utilizes the same principles as the above embodiments, but is adapted to fit in a conventional spring clip for small cartridge fuses, such as are used in automobiles and other places.

A hollow body 118 is provided of electrically insulating moldable synthetic resin, the body terminating in the two solid cylindrical ends 120 and 122. Body 118 is preferably square, so that when the fuse is clipped into the fuse terminal clips, its base will lie close to the

base of the fuse clip assembly, thus insuring that the circuit breaker will be positioned so that the manually resettable means is reachable. Each of the cylindrical ends **120** and **122** is provided with a circular groove **124** therein, the purpose for which is to mount the two operating parts of the device.

The thermally actuable member of this embodiment is shown in FIG. **14,** and comprises a strip of thermostat metal indicated generally by numeral **126** and having a leg **128** bent downwardly from the central portion **130** of the strip, and a mounting tab **132** is also bent downwardly from the portion **130.** The tab **132** is made in the form of a C-ring having arcuate legs formed by cutting a slot **134** in the tab, and by providing a hole **136** in the center. A slot **138** is provided in order to render the legs of the C-ring more flexible radially. The diameter of the central hole **136** should be such as to fit snugly about the neck **138** formed in end **120** by the groove **124.** The high expansion side of the member **126** is uppermost as drawn in FIG. **14.**

FIG. **15** is a sectional elevation of the embodiment, showing the thermally actuable member **126** snapped into place at this end of the body, with the leg **128** projecting downwardly into the hollow central portion **139** of the body, the C-ring **132** having been inserted in groove **124** and snapped into place about the neck **138.** By this construction, it will be noted that the thermally actuable member is firmly clamped in its proper position by the simple means of snapping it over the neck. No rivets or other fastening means are needed. The control portion **130** is thus automatically held against the flat top of the body **118** which assists in preventing the element from rotating. However, if desired, the body **118** may be provided with a pair of upstanding side edges or wing portions **140** at each end, which form side abutments engaging central part **130** of the thermal member to assist in keeping the latter in proper place and orientation.

The diameter formed by the C-ring legs **132** is made greater than the diameter of the end portions **120.** Then, when the device is snapped into a fuse clip, the edges **150** of these legs engage the clip to make electrical contact therewith as shown in FIG. **15.**

At the other end of the device, a spring arm **141** is provided comprising a single strip of metal having one end bent to form a C-ring mounting tab **142** which is like the C-ring mounting tab **132** of the thermally actuable member. C-ring **142** fits in the groove **124** formed in the other cylindrical end of the body **118** with the legs gripping the neck **143** formed by the groove. The central portion of the spring lies flat against the flat bottom of the body **118** at this end. Integrally formed with the central portion is a spring arm leg **144** which is first folded back upon itself at its end to provide the fold-back end **145** and then, just as in the FIG. **1** embodiment, continues upwardly and then downwardly at the bight **146** (as viewed) to form a manually resetting member, all as shown in the FIG. **1** embodiment.

The diameter of the legs of the C-ring **142** are larger than the diameter of the cylindrical end portion **122,** so when this end of the circuit breaker is mounted into its fuse clip, the edges of the C-ring will engage the clip in order to make electrical connection therewith as described for the tab of the thermal element.

In FIG. **14,** the contact-closed position of the device as shown, with the lower end of the thermally actuable tab or member **128** engaging the left-hand end of the spring arm **144,** that is, engaging the fold-back portion **145.** Contact-closed position is indicated by the bight **146** of the resetting mechanism being toward the left as shown.

In dotted lines, the contact-open position of the device is shown, and it will be observed that the spring arm has moved to its upward position after being released by bending of the arm **128** to the left, the respective positions being shown by dotted lines. That such action has occurred is indicated by the movement of the bight **146** of the resetting mechanism toward the right as shown in FIG. **14.**

To reset the device, all that is necessary is to manually push the upper end (the bight **146**) of the resetting member toward the left and downwardly, to bring the end of the spring arm back underneath the end of the tongue **128** of the thermally actuable member, and thus into latching position.

As is the other embodiments, no extraneous contacts are required in this device. The end of the member **128** and the end **145** of the spring arm constitute the electrical contacts.

It will also be observed that in this particular embodiment, only three parts are needed: the body **118,** the thermally responsive member **126,** and spring arm **141.** No rivets are needed for assembly. The body is molded by mass production means, and the metal elements can be made by mass production stamping and forming devices. The assembly of the device is by a simple snap operation. Therefore, it can be realized that by this construction, the assembly and manufacturing costs are made very low, while at the same time the device provides a manually resettable indicating type of circuit breaker for, particularly, automotive use.

Referring now to FIG. **15,** an end view is shown of the device of FIG. **12** mounted in its terminal clips, just as an ordinary fuse would be mounted. One of the spring clips **147** of the fuse holder is shown, this being attached to one end of the base **148** by means of a conventional rivet **149.** (The other clip for the fuse holder will be similarly formed and attached to the other end of base **148.**)

The device of FIGS. **12–14** is snapped into the fuse clips just as if it were a fuse. The end **120** is shown, and projecting from the surface thereof are the edges **150** of the arcuate legs **132** which form the C-ring of the tab. It will be noted that these projecting edges engage the spring clip **147** and are in direct electrical contact therewith. In like manner, the projecting edges of the tab for the spring arm engage the spring clip into which that end of the circuit breaker device is pressed.

Referring now to FIG. **16,** a fifth embodiment of the invention is shown, the embodiment constituting a double break circuit breaker. The construction illustrated is schematic in part, but the mechanical details of incorporating the structure shown into completed devices will be apparent to persons skilled in the art in view of the teaching above as to the previous embodiments.

Portions **152** of a base are shown, and also a portion **154** of a cover is shown. Mounted securedly in one end of the base by conventional means such as molded-in slots, are a pair of spring arms **156** and **158** which, of course, pivot at their point of mounting in the base. (If desired, instead of the mounting shown, each of the spring arms may be bent in a downwardly direction as shown in the FIG. **1** embodiment, and held to the base

by the grooves, pins and slots described therein.) Each of the arms **156** and **158** has the external terminal ends **160** and **162** respectively.

A thermostat metal member indicated generally by numeral **164** is provided, this member comprising the two outer thermal blades **166** and **168** which are integrally joined to a cross bar **170.** A central support leg **172** is provided, terminating in the bottom cross bar **174.** The element is supported between the cover and the base **150** by the cross-bars **170** and **174** engaging slots in the cover and base to hold it firmly in position. Preferably, leg **172** of the element **164** is made wider than the tongues **166** and **168** so that it will not heat appreciably during the passage of current therethrough. The high expansion side of the thermostatic metal is toward the spring arms.

Just as in the previous embodiments, the end portions **176** and **178** of legs or tongues **166** and **168** respectively act as contact members and as latching members for the end portions **180** and **182** of the spring arms **156** and **158.** If desired, at the ends of the spring arms fold backs like those of the first embodiment may be provided, and folded backs at the ends of tongues **166** and **168.**

A manual reset member or lever **184** is provided which may be made economically of electrical insulating material, and which has at its lower end the cross bar or portion **186.** Cross **186** is provided with a shouldered portion **187** which extends between the contact arms **156** and **158.** The member **184** rests on the spring arms, so that if either spring arm is released by its thermal latch, it may move to contact-open position, carrying the member **184** with it to indicate an opening of the contacts.

The operation of the device is that of the previous embodiments. The electrical circuit which is desired to be protected is connected to the terminals **160** and **162** with the power supply and load in series, so that the current in the circuit flows through the spring arm **156,** tongue **166,** bar **170,** tongue **168,** spring arm **158,** and out terminal **162.** When excess current is passed through the device, each of the tongues **166** and **168** move away from the spring arms in such manner as to disengage from the ends **180** and **182** thereof. The spring arms then move upwardly (as viewed) to the contact-open position such as, for example, shown in FIG. **6.** The manual reset member **184** is moved upwardly by the spring arm to indicate a contact-opening operation. After the thermal members **166** and **168** have cooled, then the device is reset by pushing downwardly on the reset member **184** until the end portions **180** and **182** of the spring arm relatch under the end portions **176** and **178** of the legs **166** and **168.** It will be noted that if either one of the thermally actuable legs **166** or **168** operates to release its spring arm, or if both thermally-actuable legs so operate, the resetting member **184** will be moved to indicate a contact-open circuit.

Referring now to FIGS. **18–26,** a sixth embodiment of the invention is shown, as well as drawings illustrating several operating positions of the embodiment.

Base **190** is provided, the base being long enough to support several of the individual circuit breaker combinations. Of course, from the construction shown as well as the following description, it will be apparent that a base just long enough to take one pair of operating parts can be utilized.

Base **190** is provided with the slots **192** and **194** which extend through the thickness of the base. A plurality of thermal elements indicated generally by **196** is provided, each of which comprises a flat elongated blade portion **198,** a base portion **200** bent generally at right angles to the blade portion **198,** and an integral terminal portion **202.** The terminal portions **202** of the pairs of elements extend through the respective slots **192** and extend beyond the other bottom side of the base. Slots **192** are just large enough to receive the terminal portions **202** with a sliding fit. Each of elements **196** may be fastened to the base by means of conventional threaded screws **204,** or rivets may be conveniently used.

The upper end of the thermal element is bent to form a portion **206** extending preferably at right angles to the blade portion **198.** The edge **208** of each of portions **206** is at an angle of about 60° to the main body of the element for the purpose to be described below.

A plurality of spring arms **210** is provided, each having a base portion **212** bent generally at right angles to the upstanding length of the spring arm, and having an integral terminal portion **214** bent at right angles to the base portion **212.** The terminal portions **214** of the spring arms extend downwardly through the respective slots **194** in the base, the slots being sized to receive the terminals **214** with a sliding fit. The spring arms may be attached to the base by means of the screws **204,** or by rivets if desired.

In FIG. **18,** the left-hand pair of elements is shown with the circuit breaker in the contact-open position. In the next position (toward the right of FIG. **18** as viewed), the spring arm is shown as being bent backwardly (as viewed) and is about half-way towards the position in which the spring arm and its respective thermal member **198** will become locked in contact-closed position. The third pair of elements of FIG. **18** shows a spring arm locked in position by the thermal element, in contact-closed or "reset" position. The right hand set (as viewed) of elements of FIG. **18** shows the position of the particular pair, when the thermal blade has been heated by the passage of the current therethrough and has moved backwardly in order to release its respective spring arm and thus open the respective contact portions.

The above positions are represented in FIGS. **19–22** and FIGS. **23–26.** FIGS. **19** and **23** show plan and elevation views of a left-hand pair of spring arm and thermal blade of the device of FIG. **18.** The drawings are schematic in nature, and each element is shown on an individual base. Referring to FIG. **19,** the spring arm **210** is shown in its open position, and the thermal blade **198** is shown cold, that is, it has been cooled down from a heated position. The spring arm **210,** to reclose the circuit controlled by this pair of elements, is pushed in the direction of the arrow of FIG. **19.** Pushing may be done by moving the top portion **214** of the spring arm.

It will be observed from FIG. **19** that the positions of the right angled top **206** of the thermal blade (with its slanting face **208**) and the spring arm **210,** is such that when the spring arm is pushed in the direction of the arrow, its top position encounters the edge **208.** As the spring arm is pushed further upwardly (as viewed in FIG. **19**), the thermal blade is forced to the left by the camming action of the edge **208.** This behavior is shown in FIG. **20** and **24,** where the spring arm has been pushed from the dotted line of FIG. **20** to the full

line, and the thermal blade has moved from the dotted line thereof to the full line position. The solid line arrow pointed to the left, as shown in FIG. **20**, indicates the direction of motion of the upper end of the thermal blade.

Eventually, the spring arm will be pushed far enough to move beyond the back edge **218** of portion **206** of the thermal blade, and the latter is enabled to move to the right (see FIG. **21**) to overlap the spring arm. The spring arm then will be engaged by only the edge **218** of the thermal blade. This is the closed position of the circuit breaker.

Referring to FIG. **22**, when current is passed through the thermal blade and the spring arm, the thermal blade heats. Consequently, the latter (which has its high expansion side to the right of the upstanding portion **198** as viewed in FIG. **22**) will move to the left under the influence of the heat engendered therein in the direction of the solid-line arrow, until it frees the spring arm **210.** The spring arm will then move from the dotted line position in FIG. **22** to the solid line position under the influence of its own spring bias. This breaks the electrical circuit into which the circuit breaker is connected, and current ceases to flow in the circuit and in blade **198.**

Thereafter, after the thermal blade **198** has cooled to the position shown in FIG. **19**, the device may be reset as described above.

In relation to the figures, FIG. **23** is the elevation of FIG. **19**, FIG. **24** is the elevation of FIG. **20**, FIG. **20** is the elevation of FIG. **21**, and FIG. **26** is the elevation of FIG. **22.**

As in the previous embodiments, it is to be noted that in this embodiment the force of the spring arm is exerted in a direction in which the thermal blade is relatively rigid. In the FIG. **18** embodiment, the thermal blade is rigid edgewise, and thus the force of the spring arm, while the particular pair of elements is locked in contact closing position, is against the edgewise direction of the thermal blade. That is, the thermal blade is in a condition of shear stress.

Another important feature of the FIG. **18** embodiment is as follows: When thermal blade **198** is heated and moves from the FIG. **21** position to the FIG. **22** position, it is only the edge **218** of the portion **206** of the thermal blade that is moved across the width of the spring arm, and this motion is in a direction along the edge **218.** In view of the fact that the thermal blade can be, for example, only 0.020 inches thick, there will be relatively little friction between the edge **218** and the face of the spring arm **210.** As a result, there is little hindrance to the motion of the thermal blade to the left in order to open the contacts. Because the edge **218** has little contact area, the contact pressure exerted between it and the face of the spring arm **210** contacted thereby, is relatively high, thus leading to a low contact potential drop across these engaging surfaces. Additionally, because of the "narrow" engagement of the face **218** with the spring arm, any roughness on either of the engaging surfaces will have little effect in preventing the motion of the thermal blade toward a contact opening position, thus maintaining calibration of the device.

As has been indicated, the top end portion of the spring arm may be used as a "handle" in which to move the spring arm into a contact closing position. If desired, as shown in FIG. **27**, the top portion may be curled or bent to form a cylindrical end portion **220.** Also, if desired, a cover can be utilized for the FIG. **18** embodiment, in which an opening is provided in the top of the cover in order to have the end portions of the spring arms project therefrom, and thus the curled end portions will be available for resetting purposes without exposing other electrically alive portions of the circuit breaker assembly.

It is also to be noted that just as in the FIG. **1** embodiment, the arrangement of elements **198** and **210** may be such to utilize the cover of the assembly by providing suitable edge grooves in the manner shown in FIG. **1.**

Referring now to FIGS. **28–30**, a seventh embodiment of the invention is shown, FIG. **28** showing the device with its enclosing cover **243** which holds the three contact elements of the device in place on the base when the cover is in position. FIG. **29** shows the device with the cover removed and the parts assembled on the base prepartory to receiving the cover, and FIG. **30** is an plan view of FIG. **29** with the cover removed, showing the parts in contact-open position.

A base **230** is provided having slots **231** along the edges of the base such as in the FIG. **1** embodiment. Into these slots are fitted a rigid, back-contact arm **232,** a spring arm **234,** and the thermostat metal arm **236.** The spring arm **234** corresponds to the spring arm **210** of the embodiment of FIG. **18,** and preferably has at its upper end the curled terminus **220.** Thermostat metal blade **236** is like thermostat metal blade **198** of the FIG. **18** embodiment, and has an upper end portion **154** bent at right angles to the blade itself, portion **254** being provided with the angled edge **255** which is like, and serves the same purpose, the edge **208** of the FIG. **18** embodiment. Arm **234** and blade **236** are positioned on the base by means of the dog-legs illustrated so that they are located approximately as shown. In this position, when the spring arm has been released by the thermostat metal blade **236,** it rests against the contact arm **232.** Therefore, just as shown in FIG. **9** in respect to the FIG. **1** embodiment, by suitable circuit connections the open position of the circuit breaker can be indicated by, for example, a light. This open position of the contacts is also shown in FIG. **30,** and such engagement of parts **232** and **234** is shown.

In order to hold and locate the elements on the base, pins **238** are provided central of slots **231** and projecting from the base, suitable holes being provided in the downwardly extending terminal tabs **239, 240** and **241** of the element to slip over the pins **238.** Cover **243** of the device, when the parts are in position as shown in FIG. **29,** is slid over the base, suitable slots **242** being provided in the rim of the cover to receive the pins **238,** just as in the FIG. **1** embodiment. An opening **244** is provided in the top of the cover in order to receive the projecting end **220** of the spring arm **234.**

The operation of the device is the same as shown in the FIG. **18** embodiment. With the parts locked into position as shown, for example, by the position of the parts in the third pair of elements from the left as shown in FIG. **18,** contact is made to complete a desired circuit. If a current overload occurs in the circuit being protected, thermostat metal blade **236** will heat and bend to the left as drawn in FIG. **29** far enough to pull end portion **254** to the left far enough to release the spring arm **234.** The latter moves, under its own resilience, away from blade **236** until it comes to rest against the top bent over portion of the contact arm

232, thus making contact with this position. (At this point, by suitable indicating circuit connections, a light or other visible indicating means will illustrate that the circuit is open. See FIG. 9.) In order to close the circuit, all that is necessary is to move end 220 of the spring arm past cam portion 254, thus bending blade 236 against its own resilience, until the latter snaps back over the spring arm to hold the latter in contact-closed position, thus closing the circuit.

In this embodiment, the advantages experienced in the FIG. 1 embodiment will be realized, in that there is provided a base and three functional elements which are mounted on the base, these elements being held on the base by means of a cover. Portions of the thermostat metal blade and the spring arm act as the electrical contacts. Thus, in the assembly, there is a total of just five parts. Assembly is speedy and economical. The downwardly extending tabs 239, 240 and 241 of the switch elements preferably will constitute quick make and detach contact tabs.

Referring now to FIG. 31 for an eighth embodiment of the invention, the structure is the same as in the FIGS. 28–30 embodiment in that base 230, pins 238, the slots 231 are provided to hold the elements on the base in cooperation with the cover. Contact arm 232 is the same as in the FIGS. 28–30 embodiment and has the same function. Thermostat metal blade 236 and spring arm 234 are the same.

In this embodiment, however, a solder layer 252 is provided on at least portions of the right-angled cam portion 254 of the thermostat metal blade, and a mating portion of the spring arm. The solder has a low melting temperature such that it will be melted by the heat of the thermostat metal blade when the current at which the device is designed to open its contacts, passes through the thermostat blade. After the parts are first provided with this film (such as by a conventional dipping process), the parts are then assembled on the base and arm 234 and the bimetal blade 236 are placed in contact-closed position. At this point, two portions of the respective arms covered with solder will be in engagement. Heat is then applied to the solder which will melt. As a result, the edge of the portion 254 of the thermostat metal arm will come into engagement with the spring arm 234; at the most, only an extremely thin film of solder will still reside between these engaging portions. Upon removal of the heat, the solder solidifies and thus a solder joint is formed between the parts, this joint being adapted, upon current overload, to melt and permit a contact opening. Thus, there is obtained an electrical contact joint which has very low voltage drop across it, and which will not corrode. At the same time, because it is a solder joint, vibration of the device will not affect the contacts and they will stay in a firmly united position until an overload current occurs. At that point, the temperature of the thermostat metal blade (which is heated by the overcurrent) will be sufficient to melt the solder, and the blade 236 can unlatch the spring arm 234. Once it has done so, then of course the solder immediately cools and solidifies again while the parts are in contact-open position. The closing operation of the device then will be the same as before: that is, the parts are engaged, localized heat is applied to the mating solder faces which will immediately melt at the low temperature, and when the heat is removed these engaged faces will now cool to their solid state, thus again completing the solder joint between the bimetal arm and the spring arm. After this is done, then the cover 243 can be replaced.

It is believed that when the solder has thus frozen to complete the joint, there will remain a residual extremely thin layer of solder between the abutting edge of the bent over portion 254 and the contacting portion of the spring arm 234. When the solder is heated by an overflow of current in blade 236, this solder melts and becomes a "lubricant" which facilitates the sliding of portion 254 across the spring arm, thus rendering an almost frictionless motion or, at the very least, a motion in which the friction is always constant. As a result, the calibration retention of the device is enhanced. A reference to FIG. 32, which is a greatly enlarged portion of the solder joint when the device is in its closed position, illustrates this thin layer of solder 256 (greatly exaggerated).

A model has been constructed and tested in which the dimensions of the vertical portion of the thermostat metal arm are as follows: height 7/8 inches, width 3/16 inches, thickness 0.010 inches. The material was Type No. 6650 thermostat metal manufactured and sold by W. M. Chace Company, 1600 Beard Avenue, Detroit, Michigan. The dimensions of the spring arm are as follows: Vertical height 1 inch, width 3/16 inches, and thickness 0.010 inches. The material was hardened beryllium copper, No. 25 alloy. The parts were so mounted that when the spring arm was freed by the thermostat metal blade and therefore was in a vertical position (not bent over in engagement with the blade), there was about 3/16 inch separation between the spring arm and the forward edge of the thermostat metal blade.

When tested, with four amperes flowing through the thermostat blade, the circuit breaker opened within a time interval of onee minute to one minute 10 seconds. When the device was placed directly across a 100 ampere-hour battery, 6 volts, using two 1 foot long leads of No. 14 copper wire, the opening of the breaker was almost instantaneous to the eye. (The actual opening time on this type of short was not actually measured.) However, no damage or overheating of the thermostat metal blade was seen.

In the embodiment shown in FIG. 32, the dimensions of the parts are the same, their mounting is the same, and the solder used had a melting point of 275°F. Such a solder may be purchased from Brookstone Company, Peterborough, N. H., under the tradename "Tix Solder" and having a melting temperature of 275°F. As an indication of another solder that can be used, the National Bureau of Standards Circular No. 492 gives a solder of the following composition: Lead 25%, tin 25%, bismuth 50% (all by weight), having a liquidus temperature of 266°F.

In the embodiments of FIGS. 18–31, it will be observed that when the blades 198 and 236 are heated so that they bend to release the latching engagement with the spring arms, the motion draws the portions (respectively) 206 and 254 in a direction parallel to the direction in which contacting edges of these portions lie. That is, in the direction of the arrows 260 (FIG. 22) and 262 (FIGS. 30 and 32). Therefore, the result is to reduce the sliding friction of the edges with respect to the spring arms' faces, which enhances calibration constancy.

The embodiments of this invention can be manufactured and made singly at a price competitive with the fuse and its clips, or even less. As to the first four em-

bodiments above, this reduction in manufacturer's price is due to the fact that each circuit breaker element combination of this invention basically consists of a base, a cover, a spring arm and a thermally-actuated member. These constitute four parts, as to which manufacture is simple, assembly as a circuit breaker is simple, calibration is simple, and the holding of the parts together in an operative position as well as the indication of circuit-open position, are also facilitated by the constructions of this invention. The simplicity of the fifth and sixth embodiments speak for themselves.

It will be noted that one of the factors that leads to the reduction in cost of manufacture of the device of this invention to the extreme extent that it is, is the fact that within the spring arm the following elements are contained as integral parts thereof: the terminal through which electrical connection is made, the spring arm itself, the use of the end of the arm as a contact member, and the manual reset member. As indicated above, these devices can be very economically made on machines such as a four slide machine.

As to the thermal latch mechanism of each embodiment, it will be observed that the single thermally actuated member comprises integrally the mounting member by which it is fastened to the case in proper position, the terminal to which electrical connections are made, the thermally-actuable blade portion which acts to latch and unlatch the contacts, and the use of the end portion of the thermally actuable blade as a contact member.

Thus, the two movable parts in the device of this invention combine each within itself a plurality of functions, thus eliminating the need to include separate members to perform each of these functions as separate elements in the breaker itself. This, of course, leads to a high degree of economy in the manufacture of the device.

Another point to note is that the thermostat metal blades and spring arms of the above embodiments of the invention are so related that the force of the spring arm is always in a direction in which the thermostat blades are relatively rigid. In the embodiments of FIGS. **1–17**, the force is directed so as to place the thermostat metal blade in compression. In the FIG. **18** embodiment, the force of the spring arm is in a direction parallel to the width of the thermostat blade and thus is met by the edgewise rigidity of the latter.

As a result of this, the effect of vibration on the engagement of the thermostat metal blade and its spring arm is lessened, as compared to what would be the case if the force of the spring arm were to be in a direction in which the thermostat blade is flexible. On the contrary, in view of the manner of use of the thermal arm in the present invention, it reacts against the spring arm in such a direction to rigidly oppose the force of the spring arm as well as to prevent the spring arm forces to materially affect its calibration.

As noted above, for ordinary use it is not necessary to add extraneous contact material to the ends of the spring arm and the thermally actuable thermostat metal arm. It will be found that sufficient contact and a low enough contact-resistance will be obtained.

However, if desired, a simple "wash" may be used, of silver or gold. This is relatively inexpensive because of the thinness of the coating. For example, such a wash can be applied on a mass production basis by dip plating only the ends of the thermally actuable bimetal blade and spring arm.

Another feature is that the integral ends of the spring arm and the thermostat metal blade are external to the case, and each of these ends can be readily formed to be one terminal of a quick-disconnect terminal structure. This simplifies not only the installation of the circuit breaker where desired, but also lessens the manufacturing cost of the circuit breaker itself.

In view of the fact that the device is so easily assembled, it is a simple matter to make the base of a length sufficient to mount a plurality of individual circuit breaker members. The number to be mounted will depend on the wishes of the user. The common cover fastens all the elements of the circuit breakers in their proper positions on the base. The use of a common base and common cover simplifies the cost of each circuit breaker, as compared to the total cost of the same number of circuit breakers, each mounted on its own base with its own cover. Also, if it is found, during manufacture, that one circuit breaker is not operating properly or according to its desired rating, it is a simple matter to remove the cover, change the particular thermally actuable element, and then put the cover back on in place to hold all the parts together. This again reduces manufacturing costs.

A further point is that the mechanism of this device can be miniaturized to the extent that a circuit breaker of this invention can be substituted for a fuse in the clips used to hold the fuse. It is to be noted that a conventional fuse has four parts: the body, two end caps, and the fusible wire. In the embodiment of this invention which is to replace a fuse, only three parts are needed.

Also, as pointed out above and emphasized here, the extreme simplicity by which a plurality of circuit breaker mechanisms are mounted on a common base, with the cover thereof forming a part of the mounting means, combined with the simple indicating mechanism involving no extra parts for indication and a minimum of parts for resetting, leads to an economy of manufacture not possible with the prior art devices.

Another feature is that in the embodiments of FIGS. **1–16** of the instant invention as compared with the prior art, the angular relationship between the moving end of the thermally actuable blade and the end of the spring arm as the blade moves, initially tends to move the end of the spring arm against its own bias in a direction opposite to the opening direction. The result is that as the thermal blade heats and moves toward the unlatching position, the contact pressure between the ends of the spring arm and blade increases. In many devices of the thermally actuable latch type, the action of the thermostat blade itself tends to decrease the contact pressure rather than increase it.

As mentioned above, the construction of the thermally actuable blade itself is important in reducing cost. In the instant invention, the support for the thermally actuable blade constitutes an integral part of the blade itself; and is so made that when that part is fastened to the base by the cover for the device, the thermally actuable blade is properly positioned with respect to the spring arm of the device.

In view of the above it will be seen that the several objects of the invention are achieved and other advantageous results attained.

It is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

As many changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings, shall be interpreted as illustrative and not in a limiting sense, and it is also intended that the appended claims shall cover all such equivalent variations as come within the true spirit and scope of the invention.

Having described the invention, what is claimed is:

1. A two-break circuit breaker comprising:

a base;

a pair of spring arms mounted on the base and adapted to occupy a first contact-closed position and a second contact-open position, the arms each being resiliently biased toward contact-open position, and one end portion of each spring arm constituting an electrical contact, and the other end portion constituting an electrical terminal;

thermal latch means mounted on the base and comprising a thermostat metal element, the element having a mounting leg and at least two first legs attached by one end of each to the mounting leg, each first leg being adapted to be in a first position when at one position and in a second position when at another temperature, the other end of each of the first legs being adapted respectively to engage said one end of a spring arm when at the first temperature, thereby to make electrical contact therewith; and each of said first legs when in said second position being disengaged from the respective spring arm;

manually actuable means for imparting relative motion between the spring arms and said first legs thereby to cause reengagement with the ends of the spring arms and the ends of said first legs in contact-closed position.

2. A circuit breaker comprising:

an elongated body having a hollow center and first and second end portions, each end portion having a circumferential groove therein defining a neck of reduced diameter;

a thermally actuable member comprising a length of thermostat metal having an intermediate portion and a tab at one end thereof shaped as a flat C-ring having arcuate legs, the tab being bent at an angle to said intermediate portion, said legs defining a central hole which fits snugly around said neck in the first end portion, the legs fitting snugly in the groove in said first end portion, and the width of the C-ring as defined by the external diameter of said arcuate legs being greater than the width of said first end portion;

said member being provided at the other end of its intermediate portion with a first arm bent at an angle to said intermediate portion, said arm extending into the hollow center of the body;

a spring member comprising a length of spring metal having an intermediate portion and a tab at one end thereof shaped as a second C-ring having arcuate legs, the tab being bent at an angle to said intermediate portion, said legs defining a center hole which fits snugly around said neck in the second end portion, the legs fitting snugly in the groove in the second end portion, and the width of the second C-ring as defined by the external diameter of said arcuate legs being greater than the width of said second end portion;

said member being provided at the other end of its intermediate portion with a first arm bent at an angle to said intermediate portion, said arm extending into the hollow center of the body;

a spring member comprising a length of spring metal having an intermediate portion and a tab at one end thereof shaped as a second C-ring having arcuate legs, the tab being bent at an angle to said intermediate portion, said legs defining a center hole which fits snugly around said neck in the second end portion, the legs fitting snugly in the groove in the second end portion, and the width of the second C-ring as defined by the external diameter of said arcuate legs being greater than the width of said second end portion;

the spring member being provided at its other end with a spring arm bent at an angle to said intermediate portion, the spring arm extending into the hollow center of the body and lying in a direction toward said first arm, with the end of the spring arm adapted to be latched under the end of the first arm, and with the spring arm resiliently biased against said first arm; and

manual resetting means attached to the spring arm and extending outwardly thereof, the outer end of the resetting means being adapted to move the spring arm from a position in which it does not engage the first arm to a position in which it does.

3. The circuit breaker of claim **2** including means integral with said body for preventing said thermally actuable member and said spring member from rotating on the base with respect to said end portions.

4. The circuit breaker of claim **3** in which said means comprises first side portions projecting from the body and laterally abutting the intermediate portion of the thermally actuable member; and second side portions projecting from the body and laterally abutting the intermediate portion of the spring member.

5. A circuit breaker adapted to be connected in an electrical circuit, comprising:

a base;

a resilient metal spring arm mounted on the base, one portion of a face of the arm comprising a first electrical contact, and an end portion including an electrical terminal;

an elongated thermostat metal blade mounted on the base and adapted to occupy one position when at one temperature, and another position when at another temperature, one end portion of the blade comprising a second electrical contact adapted, when the blade is in said one position, to make a line engagement with said first electrical contact to close said circuit, the other end of the blade comprising an electrical terminal;

said one end portion of the blade when in said one position constituting a latch to hold the blade and arm in contact-making position with the arm in a flexed condition when so held and resiliently biased to move away from said blade when released

thereby, the resilient force of said arm being exerted in a direction lying in a plane substantially parallel to the plane of the thermostat metal blade and being applied directly against said second electrical contact, the electrical contact portions of the arm and blade constituting the latch engaging members, and the blade being adapted when at said other temperature to move to said other position to unlatch the arm and to permit relative motion between the blade and arm in planes at approximately right angles to each other with the motion of the second electrical contact being in a direction parallel to the direction of said line engagement, thereby to disengage said electrical contacts and thereby to directly open said circuit, the contact portions of the arm and blade remaining in the circuit open position until the circuit breaker is reset and the contact pressure between electrical contact portions increasing during motion of said blade toward unlatching position; and

manually actuable means for moving at least one of the spring arm and blade into position to cause engagement of said contact, and to latch the blade and the spring arm in contact making position.

6. The circuit breaker of claim **5** in which the thermostat metal blade and the spring arm are each made of strip metal; the circuit breaker includes a cover; and the fixed ends of the thermostat metal blade and spring arm are held on the base in their respective positions by being clamped between the cover and the base.

7. The circuit breaker of claim **5** in which the one end portion of said arm and said one end of the blade remain spaced apart from each other after said latch has released the spring arm and until the latter has been moved into contact making position.

8. The circuit breaker of claim **5** including a cover, the said end portion of the thermostatic blade and said one end portion being held on the base by being clamped between the base and cover.

9. The circuit breaker of claim **5** including a plurality of said spring arms and a plurality of said thermostat metal blades, the arms when disengaged from the thermostat blades lying approximately in a common plane, and the blades when engaged with said arms lying each in a plane perpendicular to said common plane.

10. A circuit breaker comprising:

a base;

a spring arm mounted on the base, one portion of the arm comprising a first electrical contact and an end portion including an electrical terminal;

a thermostat metal blade mounted on the base and adapted to occupy one position when at one temperature, and another position when at another temperature, one end portion of the blade comprising a second electrical contact adapted, when the blade is in said one position, to be in electrical engagement with said first electrical contact, the force exerted by said arm being in a direction in which said blade is relatively rigid and is substantially in lengthwise compression;

the thermostat metal blade comprising a thermostat metal element having two legs joined by one end of each at a bight, the legs being oriented in a generally V-shape or U-shape; a first of said legs being shorter than the second of said legs and having a free end; the other end of said second leg extending outwardly of said base and constituting an electrical terminal; means holding the bight end of the second leg relatively immovable with respect to the base; the first leg being directed toward said base; the spring arm being mounted on the base with one end thereof extending outwardly of the base and constituting an electrical terminal; and the other end of the spring arm being adapted to be in engagement with the free end of said first leg to make an electrical contact therewith and to be latched thereby in contact-making engagement therewith;

the blade when in said one position constituting a latch to hold the blade and arm in contact-making position with the arm in a flexed condition when so held and resiliently biased to move away from said blade when released thereby, the resilient force of said arm being exerted in a direction in which the thermostat metal blade is relatively rigid, the electrical contact portions of the arm and blade constituting the latch engaging members, and the blade being adapted when at said other temperature to move to said other position to unlatch the arm and to permit relative motion between the blade and arm thereby to disengage said electrical contacts; and

manually actuable means for moving at least one of the spring arm and blade into position to cause engagement of said contact, and to latch the blade and the spring arm in contact making position.

11. The circuit breaker of claim **10** including a plurality of said thermostat metal elements mounted on a common base, each having said first and second legs; a plurality of said spring arms on the base, each spring arm being adapted to be in said engagement respectively with the free end of one of said first legs and to be latched thereby in contact-making engagement therewith; each of said spring arms including a manually actuated resetting means, each resetting means being actuable to reset only its respective spring arm; and a common cover for the base and the spring arms and the thermostat metal elements, the cover being provided with a plurality of openings therein through each of which projects a portion of one of said manual resetting means.

12. The circuit breaker of claim **11** in which the spring arms and thermostat metal elements are affixed to the base at least in part by the conjunction of the cover and base.

13. The circuit breaker of claim **11,** including an electrical conducting member mounted on the base in position to be engaged electrically by each of the manual resetting means when the spring arm is in contact-open position.

14. A circuit breaker comprising:

a base;

a spring arm mounted on the base, one portion of the arm comprising a first electrical contact and an end portion including an electrical terminal;

a thermostat metal blade mounted on the base and adapted to occupy one position when at one temperature, and another position when at another termperature, one end portion of the blade comprising a second electrical contact adapted, when the blade is in said one position, to be in electrical engagement with said first electrical contact, the force exerted by said arm being in a direction in which said blade is relatively rigid;

the blade when in said one position constituting a latch to hold the blade and arm in contact-making position with the arm in a flexed condition when so held and resiliently biased to move away from said blade when released thereby, the resilient force of said arm being exerted in a direction in which the thermostat metal blade is relatively rigid, the electrical contact portions of the arm and blade constituting the latch engaging members, and the blade being adapted when at said other temperature to move to said other position to unlatch the arm and to permit relative motion between the blade and arm thereby to disengage said electrical contacts;

manually actuable means for moving at least one of the spring arm and blade into position to cause engagement of said contact, and to latch the blade and the spring arm in contact making position; and

a third electrical conductor positioned on said base and adapted to be electrically engaged by the spring arm when the latter is in contact-open position.

15. A circuit breaker comprising:

a base;

a spring arm mounted on the base, one portion of the arm comprising a first electrical contact and an end portion including an electrical terminal;

a thermostat metal blade mounted on the base and adapted to occupy one position when at one temperature, and another position when at another temperature, an edge portion of the blade comprising a second electrical contact adapted, when the blade is in said one position, to be in electrical engagement with said first electrical contact, the force exerted by said arm being in a direction in which said blade is relatively rigid;

the blade when in said one position constituting a latch to hold the blade and arm in contact-making position with the arm in a flexed condition when so held and resiliently biased to move away from said blade when released thereby, the resilient force of said arm being exerted in a direction in which the thermostat metal blade is relatively rigid, the electrical contact portions of the arm and blade constituting the latch engaging members, and the blade being adapted when at said other temperature to move to said other position while drawing said edge portion across the arm in a direction lengthwise of said edge portion to unlatch the arm and to permit relative motion between the blade and arm thereby to disengage said electrical contacts; and

manually actuable means for moving at least one of the spring arm and blade into position to cause engagement of said contact, and to latch the blade and the spring arm in contact making position, said one portion of the spring arm engaging, during resetting the latter into contact closed position, with a portion of said blade, thereby to move the blade outwardly with respect to the said one portion of the arm until latch position of the latter is attained.

16. A circuit breaker comprising:

a base;

a spring arm mounted on the base, one portion of the arm comprising a first electrical contact and an end portion including an electrical terminal;

a thermostat metal blade mounted on the base and adapted to occupy one position when at one temperature, and another position when at another temperature, one end portion of the blade comprising a second electrical contact adapted, when the blade is in said one position, to be in electrical engagement with said first electrical contact, the force exerted by said arm being in a direction in which said blade is relatively rigid;

the blade when in said one position constituting a latch to hold the blade and arm in contact-making position with the arm in a flexed condition when so held and resiliently biased to move away from said blade when released thereby, the resilient force of said arm being exerted in a direction in which the thermostat metal blade is relatively rigid, the electrical contact portions of the arm and blade constituting the latch engaging members, and the blade being adapted when at said other temperature to move to said other position to unlatch the arm and to permit relative motion between the blade and arm thereby to disengage said electrical contacts;

each of one end portion of the thermally actuable blade and said end portion of the spring arm being fixed to the base with an integral portion thereof extending outwardly therefrom, said integral portion of each constituting one terminal of a quick-disconnect electrical connection; and

manually actuable means for moving at least one of the spring arm and blade into position to cause engagement of said contact, and to latch the blade and the spring arm in contact making position, said manually actuable means comprising a metal member attached to said spring arm and extending away therefrom, the circuit breaker including a cover having a hole therein, and a portion of the strip of metal extending through the hole and outwardly of the cover when the spring arm is in its second position, whereby said metal member is adapted, when manually actuated, to push the spring arm into engagement with said blade.

17. A circuit breaker comprising:

a base;

a spring arm mounted on the base, one portion of the arm comprising a first electrical contact and an end portion including an electrical terminal;

a thermostat metal blade mounted on the base and adapted to occupy one position when at one temperature, and another position when at another temperature, one end portion of the blade comprising a second electrical contact adapted, when the blade is in said one position, to be in electrical engagement with said first electrical contact, the force exerted by said arm being in a direction in which said blade is relatively rigid;

the blade when in said one position constituting a latch to hold the blade and arm in contact-making position with the arm in a flexed condition when so held and resiliently biased to move away from said blade when released thereby, the resilient force of said arm being exerted in a direction in which the thermostat metal blade is relatively rigid, the electrical contact portions of the arm and blade constituting the latch engaging members, and the blade being adapted when at said other temperature to move to said other position to unlatch the arm and to permit relative motion between the blade and arm thereby to disengage said electrical contacts;

manually actuable means for moving at least one of the spring arm and blade into position to cause en-

gagement of said contact, and to latch the blade and the spring arm in contact making position, said manually actuable means comprising a strip of metal integral with said spring arm and extending away therefrom, both the spring arm and the manually actuable means being formed of a single length of spring metal the circuit breaker including a cover having a hole therein, and a portion of the strip of metal extending through the hole and outwardly of the cover when the spring arm is in its second position, whereby said metal member is adapted, when manually actuated, to push the spring arm into engagement with said blade.

18. A circuit breaker adapted to be connected in an electrical circuit, comprising:

a base;

a spring arm mounted on the base, one portion of the arm comprising a first electrical contact and an end portion including an electrical terminal;

a thermostat metal blade mounted on the base and adapted to occupy one position when at one temperature, and another position when at another temperature, one end portion of the blade comprising a second electrical contact adapted, when the blade is in said one position, to be in electrical engagement with said first electrical contact to close said circuit, the force exerted by said arm being in a direction in which said blade is relatively rigid, said blade being made of strip metal;

said one end portion of the blade when in said one position constituting a latch to hold the blade and arm in contact-making position with the arm in a flexed condition when so held and resiliently biased to move away from said blade when released thereby, the resilient force of said arm being exerted in a direction lying in a plane substantially parallel to the plane of the thermostat metal blade and edgewise of the latter, the electrical contact portions of the arm and blade constituting the latch engaging members, and the blade being adapted when at said other temperature to move to said other position to unlatch the arm and to permit relative motion between the blade and arm thereby to disengage said electrical contacts and thereby to directly open said circuit, the contact portions of the arm and blade remaining in the circuit open position until the circuit breaker is reset; and

manually actuable means for moving at least one of the spring arm and blade into position to cause engagement of said contact, and to latch the blade and the spring arm in contact making position, the manually actuable means comprising a strip of metal attached to said spring and extending away therefrom, the circuit breaker including a cover having a hole therein, and a portion of the strip of metal extending through the hole and outwardly of the cover when the spring arm is in its second position, whereby the strip is adapted, when manually actuated, to push the spring arm into engagement with said blade.

19. The circuit breaker of claim **18** in which each of the other end portions of the thermally actuable blade and the spring arm is fixed to the base with a portion thereof extending outwardly therefrom, said latter portions each constituting one terminal of a quick-disconnect electrical connection.

20. The circuit breaker of claim **18** in which the spring arm and said strip are integral with each other and are formed from a single length of spring metal.

21. A circuit breaker adapted to be connected in an electrical circuit, comprising:

a base;

a spring arm mounted on the base, one portion of the arm comprising a first electrical contact and an end portion including an electrical terminal;

a thermostat metal blade mounted on the base and adapted to occupy one position when at one temperature, and another position when at another temperature, one end portion of the blade comprising a second electrical contact adapted, when the blade is in said one position, to be in electrical engagement with said first electrical contact to close said circuit, the force exerted by said arm being in a direction in which said blade is relatively rigid, said blade being made of strip metal;

said one end portion of the blade when in said one position constituting a latch to hold the blade and arm in contact-making position with the arm in a flexed condition when so held and resiliently biased to move away from said blade when released thereby, the resilient force of said arm being exerted in a direction lying in a plane substantially parallel to the plane of the thermostat metal blade and edgewise of the latter, the electrical contact portions of the arm and blade constituting the latch engaging members, and the blade being adapted when at said other temperature to move to said other position to unlatch the arm and to permit relative motion between the blade and arm thereby to disengage said electrical contacts and thereby to directly open said circuit, the contact portions of the arm and blade remaining in the circuit open position until the circuit breaker is reset;

manually actuable means for moving at least one of the spring arm and blade into position to cause engagement of said contact, and to latch the blade and the spring arm in contact making position; and

a third electrical conductor positioned on said base and adapted to be electrically engaged by the spring arm when the latter is in contact-open position.

22. A circuit breaker adapted to be connected in an electrical circuit, comprising:

a base;

a spring arm mounted on the base, one portion of the arm comprising a first electrical contact and an end portion including an electrical terminal;

a thermostat metal blade mounted on the base and adapted to occupy one position when at one temperature, and another position when at another temperature, one end portion of the blade comprising a second electrical contact adapted, when the blade is in said one position, to be in electrical engagement with said first electrical contact to close said circuit, the force exerted by said arm being in a direction in which said blade is relatively rigid;

said arm and said thermostat metal blade being elongated strips having length and width, the length being greater than the width; the arm and the thermostat metal blade being mounted so as to extend in the same direction with respect to the base by said end portion of the arm and by the other end portion of the blade with the planes of the arm and

blade at approximately right-angles to each other; said one end portion of said blade being provided with a cam surface adapted to be engaged by said arm when the latter is moved in a first direction from contact-open position to contact-closed position of the circuit breaker, thereby to move said blade against the resilience thereof in a direction at right angles to the direction of motion of said arm and into said other position; said arm being adapted to be moved to a position beyond said first portion of said blade far enough so that said blade is enabled to move into its said one position wherein an edge portion thereof engages and holds said arm in its contact-closed position; said second electrical contact constituting an edge portion of said one end portion of the blade adapted to engage said one portion of the arm; the direction of motion of said arm during motion thereof caused by heating being such as to draw said edge across said arm in a direction parallel to the length of said edge, thereby to minimize friction between said one end portion of the blade and said arm when the blade moves to said other position to open the contacts;

said one end portion of the blade when in said one position constituting a latch to hold the blade and arm in contact-making position with the arm in a flexed condition when so held and resiliently biased to move away from said blade when released thereby, the resilient force of said arm being exerted in a direction lying in a plane substantially parallel to the plane of the thermostat metal blade and edgewise of the latter, the electrical contact portions of the arm and blade constituting the latch engaging members, and the blade being adapted when at said other temperature to move to said other position to unlatch the arm and to permit relative motion between the blade and arm thereby to disengage said electrical contacts and thereby to directly open said circuit, the contact portions of the arm and blade remaining in the circuit open position until the circuit breaker is reset; and

manually actuable means for moving at least one of the spring arm and blade into position to cause engagement of said contact, and to latch the blade and the spring arm in contact making position.

23. The circuit breaker of claim **22** in which said one end portion of the blade comprises a section of the blade bent at right angles thereto and extending laterally a distance sufficient to overlap the path of motion of said arm, said cam surface constituting a first edge of said section at an angle to the direction of motion of said arm when the latter is moved into contact-closed position.

24. The circuit breaker of claim **23** in which the other edge of said section lies approximately parallel to the plane of said second portion of the arm, whereby when the blade and arm are in contact-closed position, said other edge lies against said second portion and constitutes an abutment therefor preventing motion thereof from contact-closed position to contact-open position.

25. The circuit breaker of claim **23** including when said arm and blade are in engagement, a continuous layer of solder surrounding each of said one portion of the arm and said one end portion of the blade when the arm and blade are in latched position.

26. The circuit breaker of claim **25** which includes a layer of solder between said edge and said arm.

27. The circuit breaker of claim **25** in which the solder surrounding one of said portions is fused with the solder surrounding the other of said portions.

28. The circuit breaker of claim **25** in which the solder surrounding one of said portions is not fused with the solder surrounding the other of said portions.

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