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Sitar

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[45] **Mar. 27, 1973**

[54] **BIMETALLIC CIRCUIT OVERLOAD PROTECTOR**

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[73] Assignee: **Furnas Electric Company,** Batavia, Ill.

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[21] Appl. No.: **242,091**

[52] **U.S. Cl.**.....**337/38,** 337/72

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

[58] **Field of Search**.....337/38, 36, 37, 50, 53, 59, 337/70, 72, 73, 74, 77, 78

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Primary Examiner—Harold Broome
Attorney—McDougall, Hersh & Scott

[57] **ABSTRACT**

A thermal overload protector for electrical circuits usable in single and multiphase circuits. A bimetallic element actuates a snap action switch in response to excess current in a heater connected in the circuit. An adjusting cam engages a switch element to permit adjustment of the operating value over a range while a reset cam can be actuated to provide for manual or automatic reset. Part of the switch operating linkage can be formed from a bimetal to provide an ambient compensating element. Also included are screws acting on the actuating linkage to permit precise adjustment during manufacture to compensate for such manufacturing tolerances as may exist. The protector may be constructed in either a normally closed or a transfer contact configuration.

25 Claims, 15 Drawing Figures

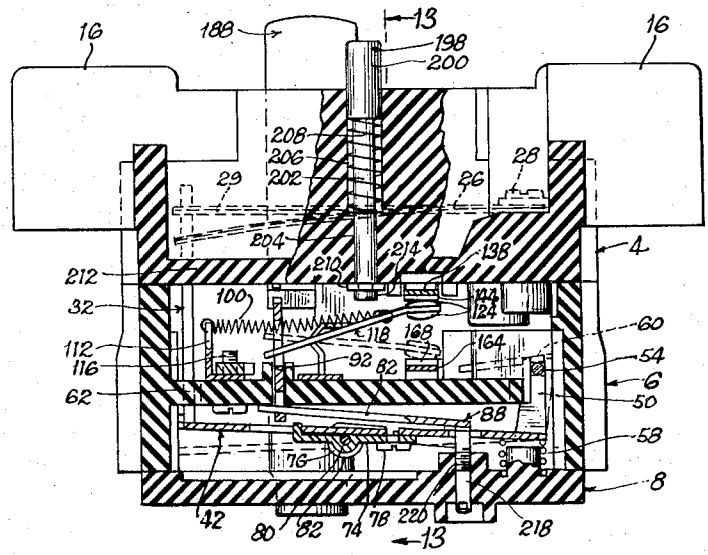


FIG. 1

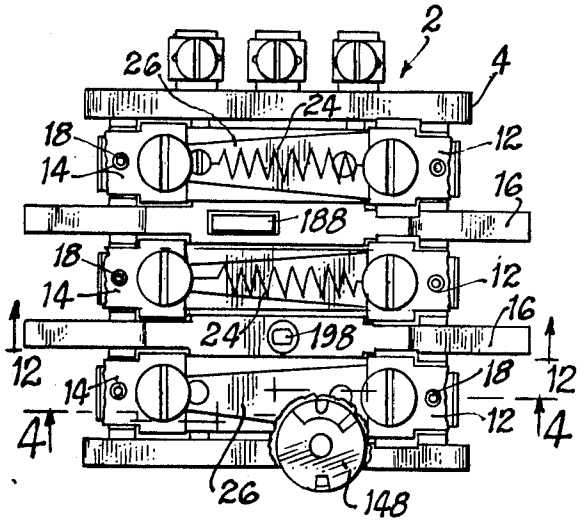


FIG. 4

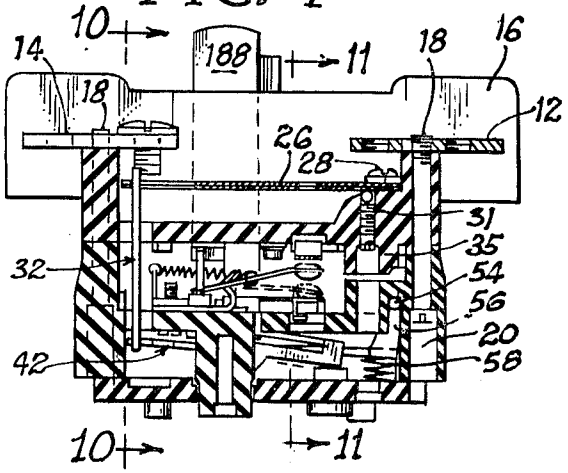


FIG. 2

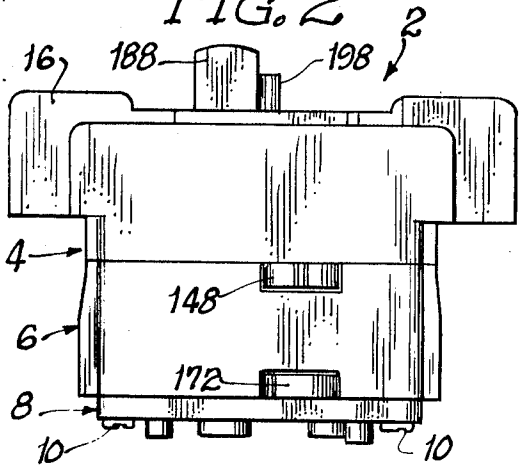


FIG. 5

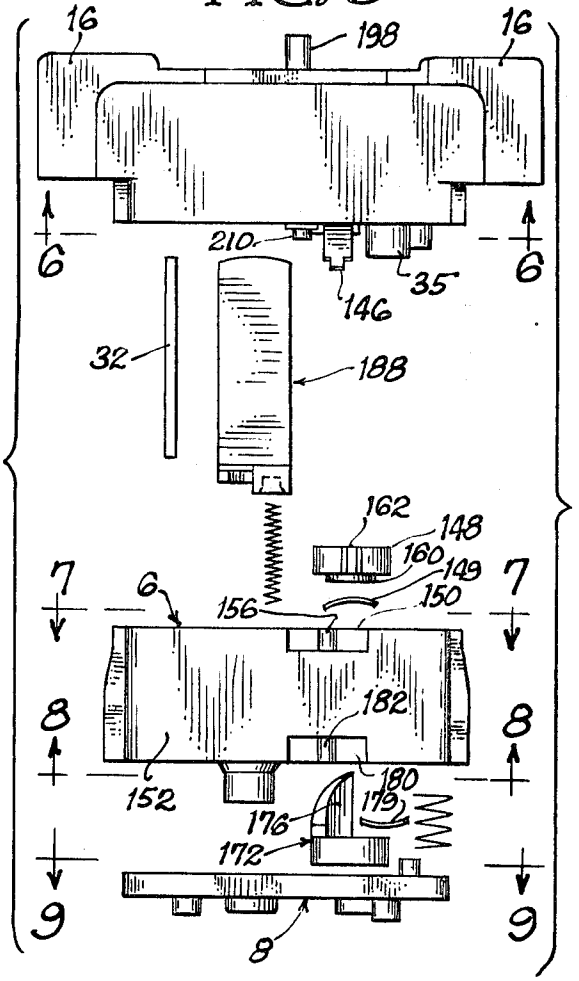


FIG. 3

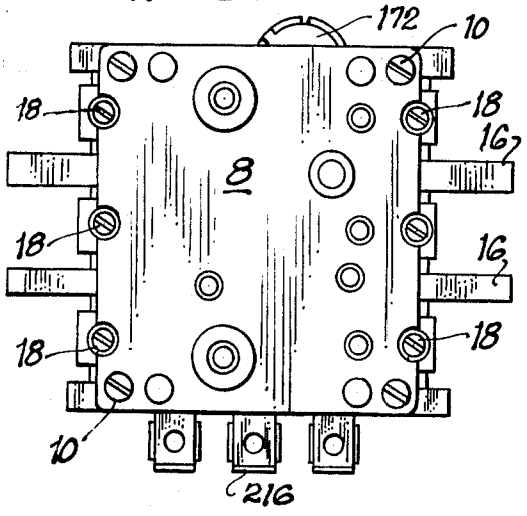


FIG. 6

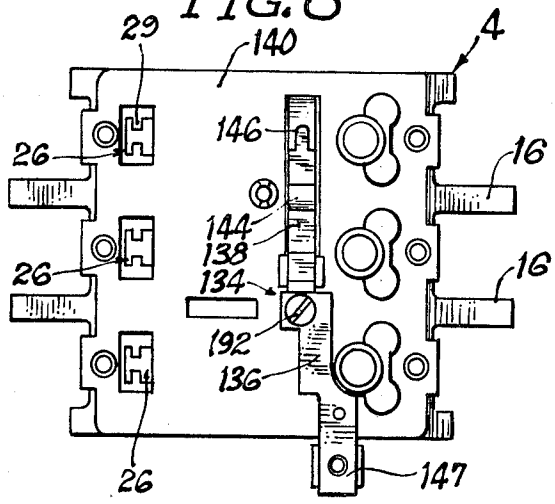


FIG. 9

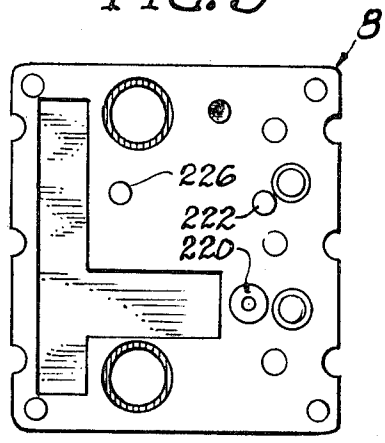


FIG. 7

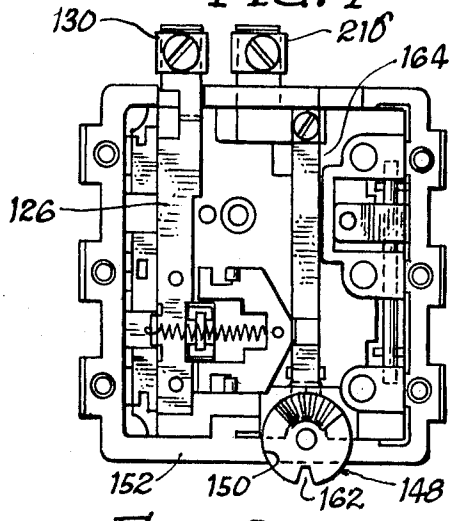


FIG. 10

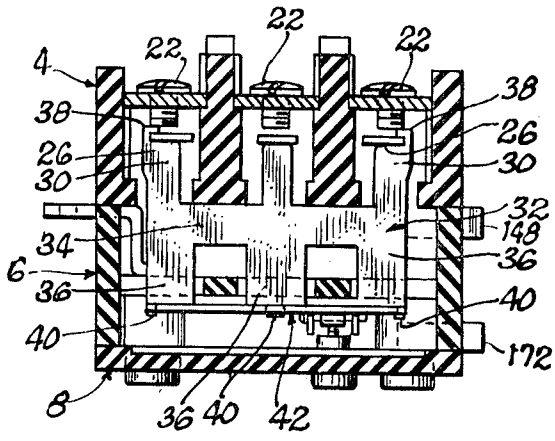


FIG. 8

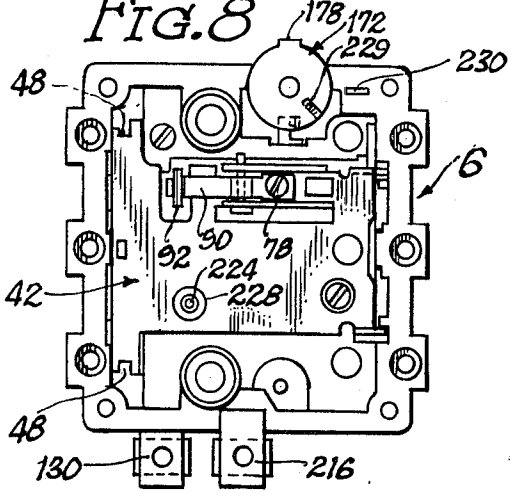


FIG. 11

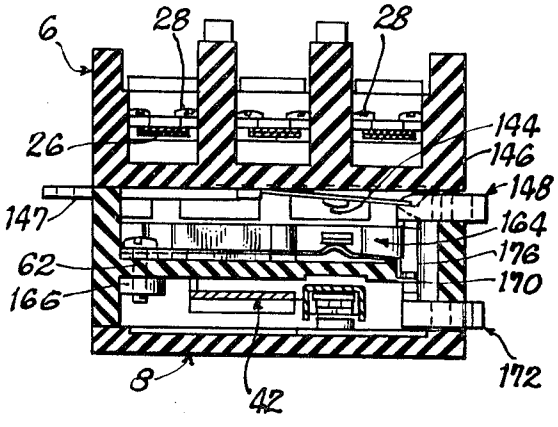


FIG. 12

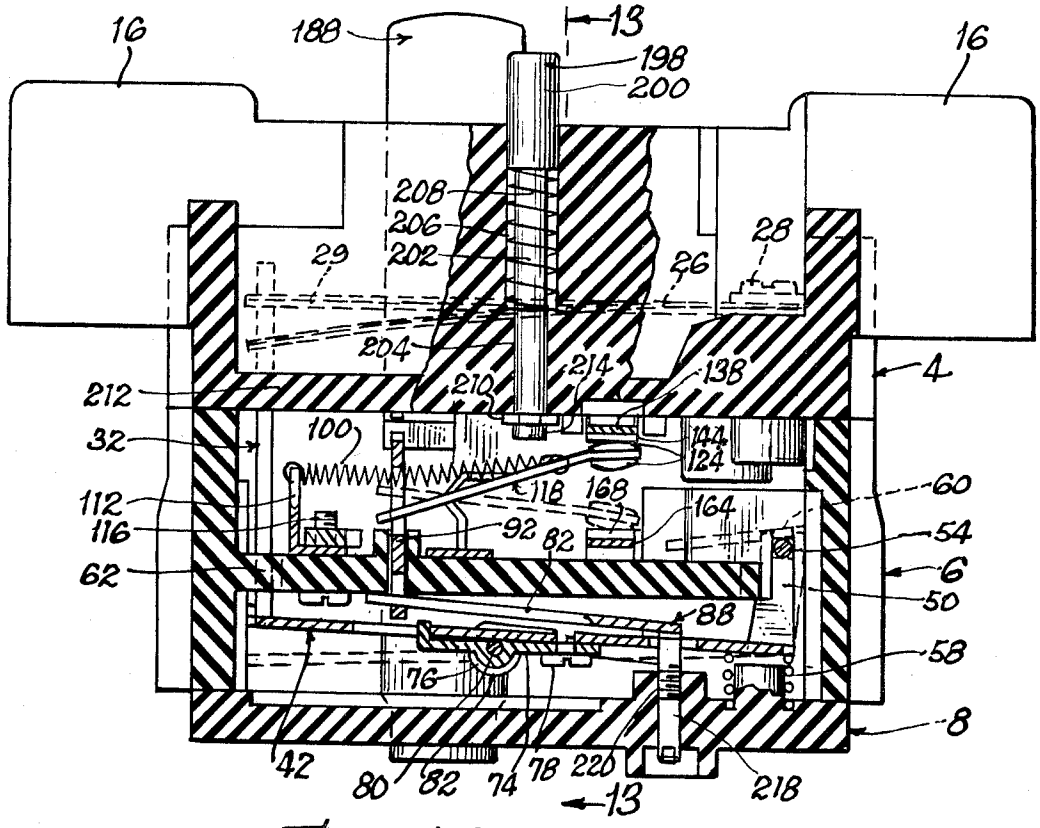

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FIG. 13

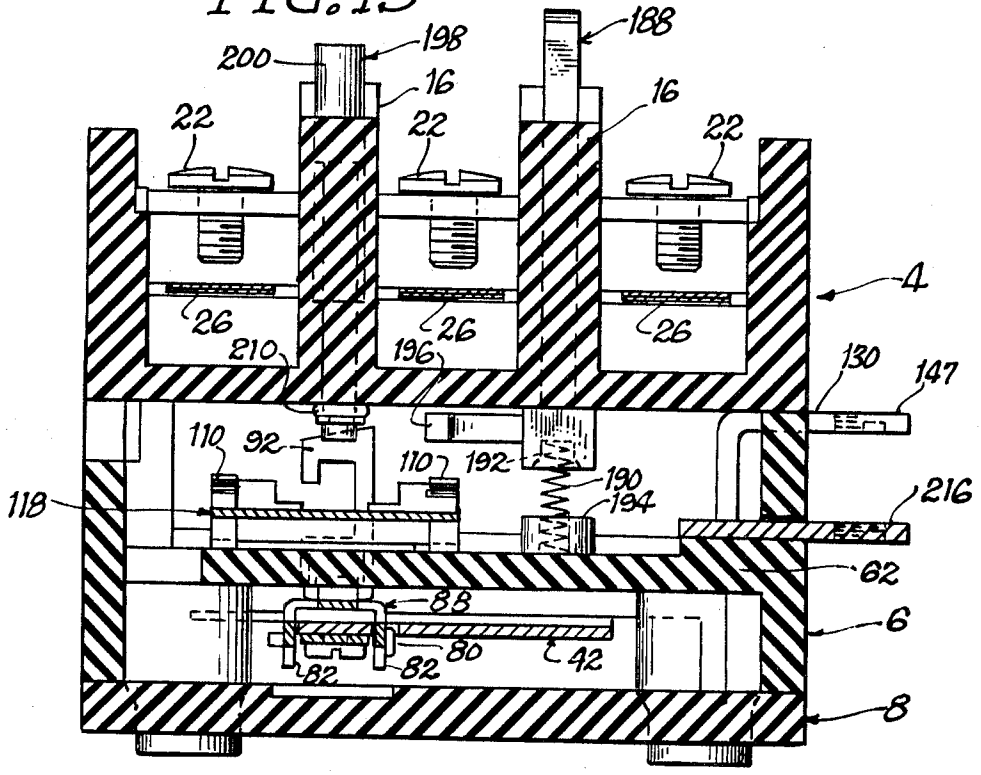

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FIG. 14

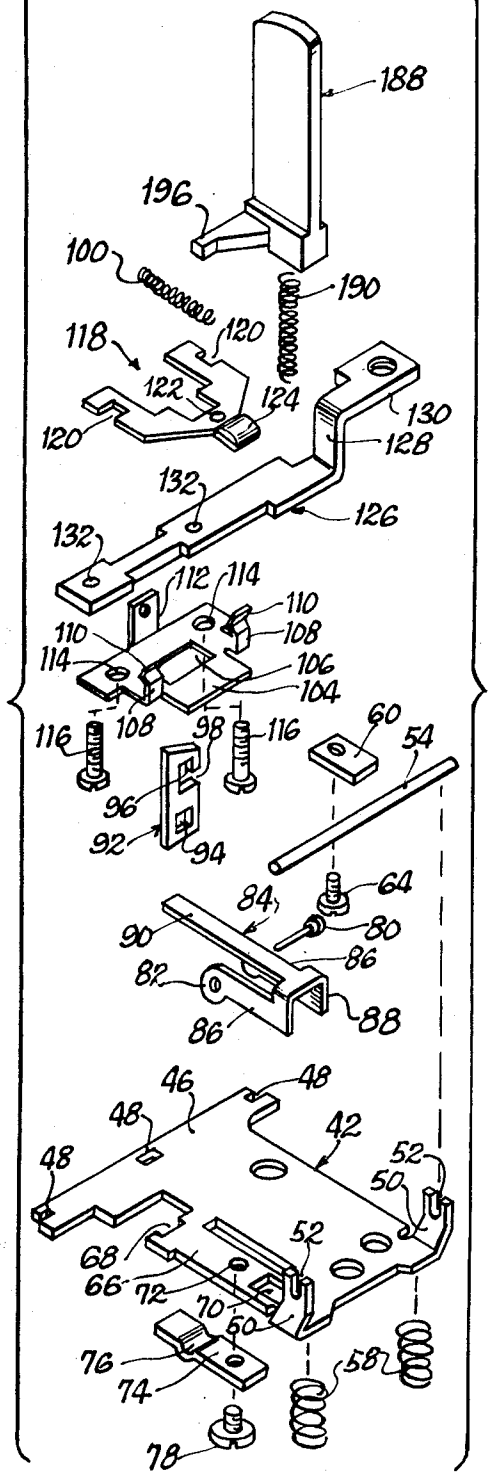
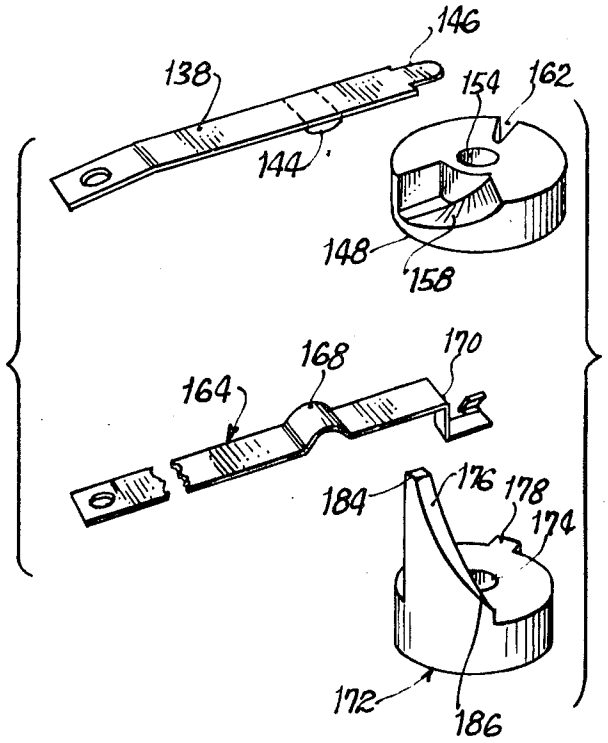

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FIG. 15


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BIMETALLIC CIRCUIT OVERLOAD PROTECTOR

BACKGROUND OF THE INVENTION

This invention relates generally to electrical circuit controlling means. More specifically, it relates to devices for protecting electrical loads from possible damage due to excessive current flowing in an electrical circuit.

Electrical circuit protective means designed to protect electrical loads against excessive current by utilizing elements which are temperature responsive and therefore responsive to the current flowing in the circuit are, of course, well known in the art. For instance, the use in such devices of actuating elements consisting of a lever-like element formed of two different metals having different coefficients of thermal expansion, known as bimetals, and positioned so as to be exposed to heat caused by current flowing in the circuit are well known. The utility, accuracy, reliability and versatility of such devices can be considerably enhanced in accordance with this invention by providing such a device wherein a number of important capabilities are available in a single device where heretofore such has not been the case.

Therefore, it is an object of this invention to provide a novel electrical circuit protection device which includes in a single device a number of different capabilities and features.

It is another object of this invention to provide a novel electrical circuit protection device which is capable of providing thermal or current protection in a single or a multiphase circuit as required by a user.

It is still another object of this invention to provide a novel electrical circuit protection device which may be adjusted by the user to adjust the nominal operating value of a given device.

It is a further object of this invention to provide a novel electrical circuit protection device which is capable of functioning at its rated operating parameter substantially independent of variations in the ambient temperature of its environment.

It is a still further object of this invention to provide a novel electrical circuit protection device which can be arranged to automatically restore the circuit or alternatively to require an operator to manually do the same.

It is another object of this invention to provide a novel electrical circuit protection device which may include means for providing an indication that the device has operated.

A further object of this invention is to provide a novel electrical circuit protection device in which various means for determining its mode of operation and its operating value are convenient and relatively accessible.

A still further object of this invention is to provide a novel electrical circuit protection device which includes a means whereby it may be tested as desired by a user to insure that it is capable of functioning as needed.

Another object of this invention is to provide a novel circuit protection device which includes adjustments means which may be used during manufacture to provide for a relatively accurate determination of rated operating values independent of variations in the tolerances of the materials used.

BRIEF SUMMARY OF THE INVENTION

The foregoing and other objects are achieved in an embodiment of the invention wherein bimetallic actuators are arranged to be exposed to heaters connected in an electrical circuit to be protected so as to respond to the heat created in such heaters by current flowing in the circuit and upon the movement of any one or more of the actuators to cause a switch means to operate to thereby provide an electrical signal effective to actuate a circuit interrupting device so as to prevent further current flow in the circuit and thereby protect the same. If desired, means may be provided to render the device substantially independent of variations in the ambient temperature of the environment in which it is used. Likewise, means may be provided to permit an automatic reclosure or to require a manual reclosure as desired.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention itself is set forth in the claims appended hereto and forming a part of the specification while an understanding of its structure and mode of operation may be derived from the detailed description taken in conjunction with the drawings in which:

FIG. **1** is a plan view partially in section of a circuit protective device in accordance with the invention;

FIG. **2** is a side view of the device of FIG. **1**;

FIG. **3** is a bottom view of the device of FIG. **1**;

FIG. **4** is a sectional view along the line **4—4** of FIG. **1**;

FIG. **5** is an exploded side view of the device in FIG. **1**;

FIG. **6** is a view along the line **6—6** of FIG. **5**;

FIG. **7** is a view along the line **7—7** of FIG. **5**;

FIG. **8** is a view along the line **8—8** of FIG. **5**;

FIG. **9** is a view along the line **9—9** of FIG. **5**;

FIG. **10** is a view along the line **10—10** of FIG. **4**;

FIG. **11** is a view along the line **11—11** of FIG. **4**;

FIG. **12** is a view along the line **12—12** of FIG. **1**;

FIG. **13** is a view along the line **13—13** of FIG. **12**;

FIG. **14** is an exploded view of the movable contact forming a part of the invention; and

FIG. **15** is an exploded view of the basic elements of two of the adjusting means forming a part of the invention.

DETAILED DESCRIPTION

As may best be seen in FIGS. **1**, **2**, **3** and **5**, there is provided a housing designated generally by the reference numeral **2**. The housing is constituted by an upper body **4** and a lower body **6**. The body is completed by a back plate **8** secured to the lower body **6** by a plurality of screws **10** as is best shown in FIG. **3**. The housing **2** is formed of any suitable plastic or similar insulating material and includes a plurality of ledges or supporting surfaces, openings and dividers for maintaining the various operating elements in their desired assembled position.

Supported on the upper body **4** are a plurality of terminals **12** and **14**. Each terminal **12** is physically separated from an adjoining terminal **12** and each terminal **14** is physically separated from an adjoining terminal **14** by dividers **16** molded integrally with the upper body **4** for the purpose of assuring good electri-

cal separation therebetween. The various terminals are attached to the housing by means of screws **18** passing through the lower body **6**, the upper body **4** and engaging in threaded openings provided in the terminals. The screws **18** are provided with heads which are accessible from the bottom of the housing by means of recesses **20** molded in the lower body **6** and in addition to retaining the terminals on the housing also function to hold the lower body **6** assembled to the upper body **4**.

Each terminal **12** and **14** includes headed screws **22** for connecting the terminals to heating elements **24** (only two of which are shown) extending between the terminals **14** and **12**. As may be seen, the device as disclosed includes three sets of terminals **12** and **14** whereby the device may be used to provide circuit protection in a three-phase circuit. If desired, only one set of terminals may be utilized if the circuit to be protected is a single-phase circuit.

Mounted within the upper body **4** are bimetallic elements **26**. The bimetallic elements **26**, as may be best seen in FIGS. **4** and **11**, are mounted in the upper body by screws **28** anchoring one of their ends to a ledge or shoulder molded in the upper body and are positioned so that their lengths extend to the opposite side of the housing and are disposed beneath the heating elements **24** with their opposite ends **29** therefore free to move downwardly in response to heat generated in the heating elements caused by current flow therein. Means for adjusting each bimetal **26** (See FIG. **4**) are provided in the form of a screw **31** threaded into the upper body **4**. A ball **33** rests on the upper end of the screw and bears against the lower surface of each bimetal whereby it may be adjusted to a desired operating point. A hollow boss **35** on the underside of the upper body **4** provides access to the screw **31** during the assembly process.

As may best be seen in FIGS. **4** and **10**, the movable ends **29** of the bimetallic elements **26** are in physical contact with the spaced extensions **30** of a coupler **32**. The coupler **32** is formed from an electrically insulating material such as a phenolic resin and consists of the upper extensions **30**, a cross bar **34** and lower extensions **36**. As shown in FIG. **10**, the two outer upper extensions **30** are formed with upwardly extending portions **38** engaging the outer sides of the two outer bimetallic elements **26** so as to be held against transverse movement with respect to those elements. Also, as shown in FIG. **10**, the lower extensions **36** of the coupler **32** are provided with downwardly depending projections **40** for a similar purpose, as will be described.

At its bottom the coupler **32** engages a lever **42**. The lever **42**, referring to FIG. **14**, may be seen to be constituted as a roughly T-shaped element having a stem **44** and a cross bar **46**. Provided in the cross bar **46** are three spaced notches **48** which are engaged by the projections **40** on the coupler **32** so that when assembled the coupler is held in position between the bimetallic elements **26** and the lever **42** and is effective to transfer the downward motion of the bimetallic elements to the lever to cause the cross bar **46** and consequently the lever **42** to move downwardly. On the opposite end of the stem **44** from the cross bar **46** the lever is provided with a pair of upstanding lugs **50**, each having a notch **52** provided in its free end. The notches **52** engage a pivot pin **54** held in a recess **56** molded into the lower body **6**. The pivot pin is held in position by virtue of its engagement in the notches **52** of the lever which in turn is biased upwardly by a pair of coil springs **58** engaging between the back plate **8** and the bottom of the lever. A holding plate **60** overlies the pin to hold it against upward movement while the holding plate itself is attached to a supporting surface **62** in the lower body **6** by a screw **64**.

Extending to one side of the stem **44** is an arm **66** having a small notch **68** and a larger notch **70**. Also provided in the arm **66** is a threaded opening **72**. A clamp plate **74** provided with a semicircular depression **76** is attached to the arm **66** by means of a screw **78** engaging in the threaded opening **72**. When attached to the arm **66**, the clamp plate holds a pivot pin **80** in position between the arm and the depression **76**. When assembled, the pivot pin **80** engages in holes in the ears **82** of an actuating lever **84**. The actuating lever is formed with a pair of arms **86** carrying the ears **82** and a U-shaped portion **88** joining the arms **86**. Coextensive with the arms **86** is an actuating arm **90**.

The actuating lever **84** may be formed of any suitable material preferably metallic on one embodiment of the invention. In another embodiment thereof, the actuating lever **84** may be formed of a bimetallic material. When arm **90** is formed from a bimetallic material, a means is provided to compensate for variations in the ambient temperature, as the bimetallic construction of the element **26** is such that its free end tends to move downwardly as the temperature increases. If there should be a substantial increase in the ambient temperature, the device may operate or trip even though the desired thermal value is not reached by a heater **24**. To prevent such "nuisance tripping" the actuating arm **90** may be formed of a bimetal arranged to cause it to move upwardly as the ambient temperature increases and thereby permit the actuator **92** to be moved upward by the force of the coil spring **100**. Under such a condition a greater downward movement of the actuating arm will be required to cause the device to trip.

Engaging the free end of the actuating arm **90** is an actuator **92**. The actuator is formed with a completely enclosed opening **94** on its bottom and at its top it is formed with an opening **96** having an access slot **98**. As may be best seen in FIG. **12**, the free end of the actuator arm **90** engages in the opening **94** and the actuator **92** passes through an opening provided in the supporting surface **62** of the lower body **6**. Engaging in the opening **96** of the actuator **92** is a coil spring **100** which passes through the opening **96** in such a way so that the actuator **92** engages the spring at approximately its center. The spring **100** has one end secured to a contact assembly **102** as constructed as follows. The contact assembly is formed with a base section **104** having an opening **106** in the center thereof through which the actuator **92** passes when the device is assembled. Also provided on the contact assembly **102** are a pair of lugs **108** each formed with an upper portion **110** bent to form generally V-shaped elements. Extending upwardly from the rear of the base section **104** is a single bracket **112** provided with a hole therein which is used to anchor one end of the coil spring **100**. A pair of spaced holes **114** are provided in the base section on either side of the bracket **112** to accommodate a pair of

screws **116** which secure the contact assembly **102** to the supporting surface **62**.

The contact assembly **102** supports a movable contact **118** formed generally as a U-shaped element with a pair of notches **120** in each leg thereof. The movable contact **118** is assembled to the contact assembly **102** by engaging the notches **120** in the generally V-shaped portions **110** of the upstanding lugs **108**. The assembly is completed by connecting the other end of the coil spring **100** in a hole **122** provided in the cross leg of the movable contact **118**. Provided on that same cross leg is a contact element **124**. An electrical circuit for the movable contact **118** is completed by a terminal assembly **126** formed as a generally elongated bar having an upwardly bent portion **128** and an outwardly bent portion **130** at one end. A pair of threaded openings **132** are provided in the terminal assembly **126** to receive and hold the screws **116** after they have passed through the supporting surface **62** and, the holes **114** of the contact assembly **102** whereby the contact assembly and the terminal assembly **126** may be held in assembled position in the device, this being best seen in FIG. **13**. The portion **130** of the terminal assembly extends through an opening provided in a side of the lower body **6** to provide an external means whereby an electrical connection may be made.

In the normal or quiescent state, the movable contact **118** is held in an upward position using the engagement of the walls of the notches **120** with the V-shaped elements **110** of the lugs **108** as pivot points. The coil spring **100** is engaged in the opening **96** of the actuator **92** and inasmuch as this places the spring in tension the movable contact **118** is maintained in an uppermost position. The structure permitting this may be understood by reference to FIG. **12**.

In that figure, it may be seen that the coil springs **58** exert an upward force on the bottom of the lever **42**. Consequently, the actuating lever **84** which is attached thereto by virtue of the engagement of the pivot pin **80** with its arms **86** is maintained with its free end in an uppermost position and is held in that position by the vertical component of the spring force of the coil spring **100** acting through the actuator **92**. In the event excess current should flow in the circuit being protected in any one of the conductors forming a part of that circuit, to the point that any one of the heaters **24** produces enough heat to cause its associated bimetallic actuator to deflect downwardly, the coupler **32** will transmit the downward movement of any such bimetallic actuator **26** to the free end of the lever **42**. The lever will then pivot downwardly about the pin **54** causing the actuator lever **84** and its actuating arm to move downwardly pulling the actuator **92** likewise downwardly. The downward pulling force of the actuator is exerted at approximately the center of the coil spring secured at one end to the fixed bracket **112** and at its other end to the outer portion of the movable contact **118**. When the downward force exerted by the actuator is sufficient to overcome the vertical force component of the coil spring the movable contact will pivot as described above with a snap or toggle action and in so doing will move from the solid line position shown in FIG. **12** to the dotted line position of that figure.

Associated with the movable contact **118** is a relatively fixed contact **134** (see particularly FIGS. **6** and **15**). The contact assembly **134** includes a terminal portion **136** and a spring contact portion **138**. The spring contact portion is attached to the terminal portion **136** and the bottom **140** of the upper body **4** by means of a screw **142** holding these elements to that bottom. The spring portion **138** carries a contact element **144** and is biased downwardly, that is, out of the plane of the drawing as shown in FIG. **6**. At its free end there is provided a projection **146** for a purpose to be described. The terminal portion **136** extends outwardly of the housing to provide an exposed terminal **147** for connection to an actuating means in a circuit controller.

In one application of the invention, the actuating means may be the coil of a magnetic contactor which would normally be energized through a circuit including one terminal connected to ground and the other connected to the terminal **147** through the terminal portion **136**, spring contact portion **138**, contact element **144**, contact element **124**, movable contact assembly **118**, contact assembly **102** and the terminal assembly **126** to the terminal **130** and back to the terminal of a source of potential. As described above, in the event of a thermal overload in the circuit being controlled by the contactor, the movable contact assembly **118** will operate so as to move the contact element **124** away from the contact element **144** interrupting the circuit to the magnetic contactor operating coil causing the contactor to drop out and interrupt the protected circuit so as to prevent any damage to the load being supplied.

As is best seen in FIGS. **7** and **15**, an adjusting element **148** for determining operating value of the device is mounted in an opening **150** in a side wall **152** of the lower body **6**. The adjusting element is constituted by a circular body having a hold **154** in the center thereof whereby it may be mounted on a pin or stud **156** molded on the lower body **6** and extending into the opening **150**. Formed on the adjusting element **148** is a camming surface **158** extending partially around the periphery thereof. As is best seen in FIG. **5**, also formed on the bottom of the actuating element **148** is an arcuate projection **160** substantially coextensive with the camming element.

When assembled, the projection **146** of the contact assembly **134** bears against the camming surface **158** so that as the actuating element **148** is rotated, the spring contact portion will move upwardly or downwardly as shown in FIG. **15**. By rotating the adjusting element **148** the pressure or degree of engagement between the contact elements **144** and **124** may be varied and by this means the device adjusted by a user to vary its operating point. To increase the adjusting elements **148** resistance to rotation due to shock and vibration a wave washer **149** is placed on pin **156** and then the adjusting element **148** is assembled. The wave washer is compressed when the upper body **4** and lower body **6** is assembled and exerts additional pressure on the adjusting element **148**. It should be noted that the slope of the camming surface **158** is such that if the adjusting element **148** should become loose the downward force exerted by the spring contact portion **138** will be effective to cause the element to rotate in the direction wherein less current in the circuit being protected will be required to cause the device to trip.

In order to provide a visual indication of the operating point the arcuate projection **160** is provided. Thus, when the adjusting element is assembled, the arcuate projection is disposed inside the lower body and one end or the other thereof will engage the interior of the side wall **152** to limit the movement of the adjusting element. For convenience and visual indication of the operating point, a notch **162** is provided in the adjusting element to receive the end of a pointed tool such as a screw driver whereby the desired adjustment may be made.

As described thus far, the apparatus may include means for compensating the variations in the ambient temperature and means for adjusting the operating value of the circuit protector whereby to vary it to values equal to or greater than a nominal rated value. In further accordance with the invention, there is provided means for permitting an automatic reset or reclosure after a cessation of current flow in the circuit being protected and the heating element cools down or in providing for a means requiring an operator to manually reset the device. The basic elements permitting this are best shown in FIGS. **11** and **15**. These elements are constituted by an automatic reset spring **164**. The contact spring assembly is formed as an elongated conducting member secured by threaded fastening means **166** to the supporting surface **62** in the lower body **6**. It is, as may best be seen in FIG. **7**, mounted substantially parallel to but spaced from the terminal assembly **126**. Formed intermediate its length is a hump or raised portion **168** while its free end **170** is bent, as is best shown in FIG. **15**, first downwardly and then laterally outwardly in the direction of the outside of the housing **2**.

The means whereby automatic or manual operation may be provided includes a reset cam **172** provided with a hold **174** in the center thereof, a raised camming surface **176** and an actuating projection **178**. A wave washer **179** is provided to restrain movement of the reset cam **172**. An opening **180** in the bottom of the side wall **152** of the lower body **6** is provided with a pin or stud **182** which may be inserted into the hole **174** of the reset cam **172** for mounting and permitting rotation of the same. When so mounted, the camming surface **176** is positioned within the lower body and is engaged by the free end **170** of the automatic reset spring **164**.

When it is desired to provide for automatic reset of the circuit protector, the actuating projection **178** of the reset cam **172** is engaged to rotate the reset cam to its maximum clockwise position as shown in FIG. **8**. The limit of this position is determined by the engagement of that projection with the side wall **152**. When so rotated, a highermost point **184** of the camming surface **176** is in engagement with the free end **170** of the automatic reset spring **164** causing the automatic reset spring to be bent upwardly about its point of attachment **166** with the supporting surface **62**. When the automatic reset spring is so elevated and the apparatus operates in response to a thermal overload in the circuit, the movable contact **118** will operate as previously described. However, the downward movement of its contact **124** will continue only until it engages the elevated automatic reset spring **164**. Under these circumstances, the movable contact assembly will not be able to rotate far enough so as to assume an overcenter position, that is, a position wherein the force then being exerted by the coil spring **100** would be effective to maintain it in a downward position. Consequently, the movable contact **118** will only remain in its downward position in engagement with the elevated automatic reset spring **164** only as long as any one of the bimetal elements **26** is bending downwardly as the result of being heated by excess current flowing in one of the heater elements **24**. As before, the contact **124** will have moved away from the contact **144** causing operation of a magnetic contractor of the like but with the interruption of the circuit as the result of the actuation of the contactor. The responsible heating element **24** will cool permitting the bimetal actuator **26** to restore itself to its original position. When this happens, the movable contact **118** will no longer be subjected to any force exerted by the actuator **92** and the coil spring **100** will be effective to cause the movable contact assembly to rotate upwardly as shown in FIG. **12** and the contact **124** will reengage the contact **144** causing the magnetic contactor to operate and restore the circuit.

When it is desired to provide for manual operation of the apparatus, the actuating projection **178** of the reset cam **172** is rotated to its maximum counterclockwise (as viewed from FIG. **8**) position as shown in FIG. **8** and this in turn will bring the free end **170** of the automatic reset spring **164** into engagement with the lowermost portion **186** of the cam **176**. Under these circumstances, the automatic reset spring **164** is permitted to be lowered close to the supporting surface **62** and when the device operates the movable contact **118** is permitted to rotate to the dotted line position shown in FIG. **12** wherein the coil spring **100** is now effective to exert a force tending to maintain it in that position.

When the device is so adjusted, it is necessary to use the manual reset means provided. This means comprises a manual reset actuator **188** formed as a plunger-like element out of a non-conducting material such as a suitable plastic. The upper end of the reset actuator is mounted vertically in the apparatus extending through an opening molded in divider **16** (see FIG. **13**). The reset actuator **188** is maintained in an upward position by a coil spring **190** engaging between a recess **192** in the reset actuator and an opening in a hollow boss **194** formed on the supporting surface **62**. Extending laterally from the bottom of the reset actuator is a reset arm **196** which in the assembled position overlies a portion of one of the legs of the movable contact **118** to the left hand side of the means for mounting and pivoting of that movable contact assembly as illustrated in FIG. **12**. Thus, when the reset actuator **188** is depressed downwardly against the force of the spring **190**, the actuating arm **196** engages the leg of the U-shaped movable contact **118** to exert a force thereon causing it to move in a counterclockwise direction. Therefore, when the apparatus has operated in response to a thermal overload in the circuit and the movable contact **118** has moved downwardly or rotated clockwise as shown in FIG. **12**, when the reset actuator is operated, the actuating arm **196** is effective to cause the movable contact assembly to move upwardly or rotate in a counterclockwise direction and to reestablish engagement of the contact **124** with the contact **144**.

In addition to the foregoing features, the apparatus also includes a manual means whereby a user may

periodically check the operation of the device. This means is provided by a manual trip plunger **198**. The manual trip plunger **198** is formed as a substantially cylindrical element passing through an opening provided in a divider **16** (see FIG. **1**). Referring to FIG. **12**, it may be seen that the manual trip plunger includes an upper enlarged portion **200** and a reduced lower portion **202**. The opening in the divider **16** is molded to have a lower portion **204** of a first diameter and an upper portion **206** of a second and greater diameter. Encompassing the manual reset plunger is a coil spring **208** extending between the bottom of the portion **206** of the opening in the divider **16** and the bottom of the upper enlarged portion **200** so as to exert a force biasing the trip plunger upwardly. A collar **210** is passed over the reduced portion **204** of the trip plunger **198** encompassing the bottom of the reduced portion and bearing against the bottom **212** of the upper body **4** so as to maintain the trip plunger in assembled position in the device. The bottom **214** of the trip plunger is positioned to overlie the forward or contact end of the movable contact **118** so that when the trip plunger is moved downwardly against the force of the spring **208** the movable contact assembly will be rotated downwardly or clockwise interrupting the circuit between the contacts **124** and **144**. By this means an operator can test the apparatus and the circuit controlling element controlled thereby periodically as desired.

The apparatus as described thus far is one in a normally closed configuration, that is, the contact **124** is normally engaged with the contact **144** so as to normally energize a holding element in the circuit to be protected. In an alternative embodiment, the device could be constructed in a transfer contact configuration. Thus, in this embodiment the automatic reset spring **164** may be provided with a contact element and a terminal such as shown at **216** in FIG. **3** extending outwardly of the housing. In this arrangement, the movable contact assembly **118** with an additional contact on it would, during the normal or quiescent state, be maintained in its upward position as shown in FIG. **12** and upon actuation in response to excess current flow in the circuit being protected would be actuated to engage the contact on the automatic reset spring **164** to close a circuit effective to energize a circuit controlling device.

This same arrangement, that is, the provision of a contact element on the automatic reset spring **164** together with an external terminal **216** may also be used to complete a circuit to a single light or some other kind of indicator to advise a user that the device has tripped and that there is or was a thermal overload in the circuit.

Also included in the device are convenient means which may be utilized during the manufacture of the device to make adjustments whereby the effect of tolerances in the various components thereof, such as the thermal coefficients of expansion of the bimetals or dimensional tolerances in the parts, may be substantially eliminated.

FIG. **12** illustrates one such adjusting means. This includes a member **218** threaded into a boss **220** molded on the upper surface of the back plate **8** and engaging U-shaped portion **88** of the actuating lever **84**. The threaded element **218** may be utilized after the device has been assembled and connected in a test circuit with known values and moved inwardly or outwardly to cause the actuating lever **84** to pivot about the pin **80** until a setting is found at which the device will operate at its rated value. In this manner, any tolerances in the materials may be compensated for by adjusting the device once assembled to a precise operating value.

Another adjusting means is provided by the screw **64** which by engaging in the holding plate **60** maintains the holding plate in position so that it bears on the pivot pin **54** about which the lever **42** pivots. Access to this screw is provided through an opening **222** in the back plate **8** whereby the balance adjustment of the lever may be achieved.

In addition to the foregoing features, the device also includes an additional adjustment and safety feature. This is provided by a threaded element **224** to which access may be had by an opening **226** in the bottom of the back plate and aligned with an opening **228** in the lever **42**. The upper end of this threaded element engages a bottom surface of the reset plunger **188** to limit its downward movement. In this fashion, if the device has tripped and a user manually resets the device so as to reclose the circuit but the condition causing the thermal overload still exists causing any one of the bimetal actuators to be deflected downwardly that bimetal actuator will still be effective to maintain the movable contact assembly **118** in its downward position interrupting the circuit. In this fashion, an operator cannot reset a circuit wherein a fault or other condition causing a thermal overload still exists.

Another safety feature to be used at the option of a user includes a slot **229** formed in the bottom of the reset cam **172** (see FIG. **8**). This slot cooperates with a slot **230** formed in the bottom of the lower body **6**. When the reset cam **172** is rotated counterclockwise to the manual reset position, the slots **229** and **230** are aligned with each other and a metal strip can be inserted to engage in these slots so as to prevent rotation of the reset cam away from the manual reset position. Such an arrangement would require in the event of the device tripping out that an operator manually reset it and at the same time he would investigate and ascertain the reason why the device operated. Similarly slots (not shown) are provided on the adjusting element **148** and the top of the side wall **152** to permit the insertion of a holding element in those slots to prevent rotation of the adjusting element if such is not desired.

Beyond those modifications and variations which have been described above, there are others which may occur to those skilled in the art and it is intended by the claims appended hereto to cover all such modifications as fall within their scope.

What is claimed as new and desired to be secured by Letters Patent is:

1. An improved electrical circuit protection device comprising: a housing; a plurality of pairs of terminals mounted on said housing for connection in an electrical circuit to be protected; an electrical heating element extending between each terminal in a pair of terminals; a bimetallic strip, anchored at one end so as to have flexing movement toward the interior of said housing at its opposite free end in response to increased temperature, mounted on said housing beneath each heating

element; a pivoted lever assembly mounted in said housing spaced from said terminals; a coupler having a plurality of first extensions, each engaging a free end of one of said bimetallic strips; said coupler also having a plurality of second extensions extending oppositely from said first extensions and engaging the free end of said pivoted lever assembly to cause it to move in response to movement of any one of said bimetallic strips; an actuating lever pivotally mounted on said lever assembly and substantially coextensive therewith; a switch supporting bracket mounted in said housing between said bimetallic strips and said lever assembly; a movable contact mounted on said switch supporting bracket; a coil spring extending between said switch supporting bracket and said movable contact tending to urge said movable contact in one direction; an actuator engaging said spring and said actuating lever to exert a force on said spring when said actuating lever moves downwardly in response to downward movement of said pivoted lever assembly; a first terminal disposed externally of said housing and means electrically connecting said first terminal to said movable contact; a second terminal disposed externally of said housing; a first relatively fixed contact in said housing; and means electrically connecting said second terminal to said first relatively fixed contact.

2. An improved electrical circuit protection device as set forth in claim 1 including an adjustable element mounted beneath said movable contact assembly to limit its downward movement.

3. An improved electrical circuit protection device as set forth in claim 2 wherein said adjustable means comprises an elongated spring member fixed at one end and free to move at its other end and an intermediate portion thereof is positioned in the path of movement of said movable contact so that when said elongated spring member is moved to one position it will be engaged by and limit the movement of said movable contact as it is operated and when moved to another position it will permit greater movement of said movable contact and said coil spring will tend to urge said movable contact in another direction.

4. An improved electrical circuit protection device as set forth in claim 3 having a rotatable element with a portion extending externally of said housing and engaging the free end of said elongated spring member whereby it may be adjusted.

5. An improved electrical circuit protection device as set forth in claim 4 including a third terminal on the exterior of said housing, a second relatively fixed contact on said adjustable element and means electrically connecting said third terminal to said second relatively fixed contact.

6. An improved electrical circuit protection device as set forth in claim 4 wherein said rotatable element includes a cam portion and one end of said elongated spring member engages said cam portion.

7. An improved electrical circuit protection device as set forth in claim 6 including means formed on said housing and in said rotatable element for receiving means to prevent the rotation of said rotatable element.

8. An improved electrical circuit protection device as set forth in claim 1 wherein said movable contact is normally urged by said coil spring toward engagement with said first relatively fixed contact and upon movement of said coupler lever assembly, actuating lever and actuator in response to the movement of any one of said bimetal strips caused by the heat developed in an associated heating element as the result of excess current flow in a circuit being protected said movable contact will move away from said relatively fixed contact.

9. An improved electrical protection device as set forth in claim 8 wherein said means connecting said second terminal to said first relatively fixed contact includes a leaf spring secured at one end free to move at its other end.

10. An improved electrical circuit protection device as set forth in claim 9 including a rotatable adjusting element having a portion extending externally of said housing and having a portion engaging the free end of said leaf spring whereby the leaf spring may be moved upward or downwardly in response to movement of said adjusting element.

11. An improved electrical circuit protection device as set forth in claim 10 wherein said adjusting element is provided with a cam surface interiorly of said housing and the free end of said leaf spring is in contact with said cam surface.

12. An improved electrical circuit protection device as set forth in claim 1 including a reset actuator mounted in said housing and having a portion disposed exteriorly thereof, spring means engaging said reset actuator to urge it outwardly of said housing and means on said reset actuator overlying a portion of said movable contact whereby when said reset actuator is moved inwardly against the force of the spring and said movable contact assembly is in one position the movement of said manual reset actuator will be effective to cause it to move to another position.

13. An improved electrical circuit protection device as set forth in claim 12 including adjustable means positioned beneath said manual reset actuator to limit its movement inwardly of said housing.

14. An improved electrical circuit protection device as set forth in claim 13 wherein said housing is provided with an opening therein to provide access to said adjustable means whereby it may be adjusted.

15. An improved electrical circuit protection device as set forth in claim 1 including a manual trip plunger having a portion extending externally of said housing, spring means engaging said manual trip plunger to urge it outwardly of said housing, said manual trip plunger being disposed above said movable contact whereby when said manual trip plunger is depressed inwardly of said housing against the force of said spring it will engage said movable contact assembly and cause it to move from a first position to a second position.

16. An improved electrical circuit protection device as set forth in claim 1 wherein said actuating lever is formed of a bimetallic material arranged so that its free end moves in a direction opposite to the direction of movement of said bimetallic strips so as to provide compensation for variations in the ambient temperature.

17. An improved electrical circuit protection device as set forth in claim 16 including an adjusting screw threaded into said housing and having an end engaging said actuating lever to permit adjustment of the device to a desired operating value and wherein an opening is provided in said housing for access to said adjusting screw.

18. An improved electrical circuit protection device as set forth in claim 4 wherein said movable contact is normally urged by said coil spring toward engagement with said first relatively fixed contact and upon movement of said coupler lever assembly, actuating lever and actuator in response to the movement of any one of said bimetal strips caused by the heat developed in an associated heating element as the result of excess current flow in a circuit being protected said movable contact will move away from said relatively fixed contact.

19. An improved electrical circuit protection device as set forth in claim 19 wherein said means connecting said second terminal to said first relatively fixed contact includes a leaf spring secured to one end free to move at its outer end.

20. An improved electrical circuit protection device as set forth in claim 19 including a rotatable adjusting element having a portion extending externally of said housing and having a portion engaging the free end of said leaf spring whereby the leaf spring may be moved upward or downwardly in response to movement of said adjusting element.

21. An improved electrical circuit protection device as set forth in claim 20 wherein said adjusting element is provided with a cam surface interiorly of said housing and the free end of said leaf spring is in contact with said cam surface.

22. An improved electrical circuit protection device as set forth in claim 21 including a reset actuator mounted in said housing and having a portion disposed exteriorly thereof, spring means engaging said reset actuator to urge it outwardly of said housing and means on said reset actuator overlying a portion of said movable contact whereby when said reset actuator is moved inwardly against the force of the spring and said movable contact assembly is in one position the movement of said manual reset actuator will be effective to cause it to move to another position.

23. An improved electrical circuit protection device as set forth in claim 22 including a manual trip plunger having a portion extending externally of said housing, spring means engaging said manual trip plunger to urge it outwardly of said housing, said manual trip plunger being disposed above said movable contact whereby when said manual trip plunger is depressed inwardly of said housing against the force of said spring it will engage said movable contact assembly and cause it to move from a first position to a second position.

24. An improved electrical circuit protection device as set forth in claim 23 including a third terminal on the exterior of said housing, a second relatively fixed contact on said adjustable element and means electrically connecting said third terminal to said second relatively fixed contact.

25. An improved electrical circuit protection device as set forth in claim 24 wherein said actuating lever is formed of a bimetallic material arranged so that its free end moves in a direction opposite to the direction of movement of said bimetallic strips so as to provide compensation for variations in the ambient temperature.

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