

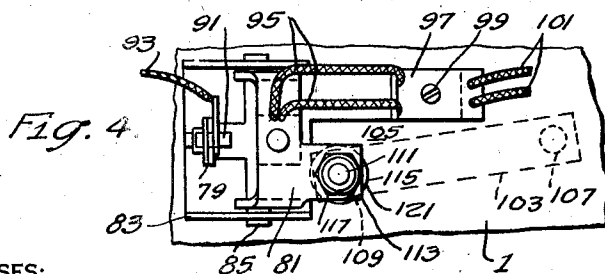
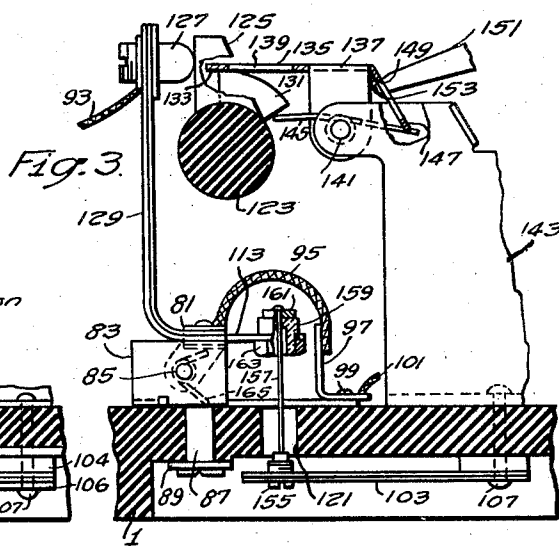
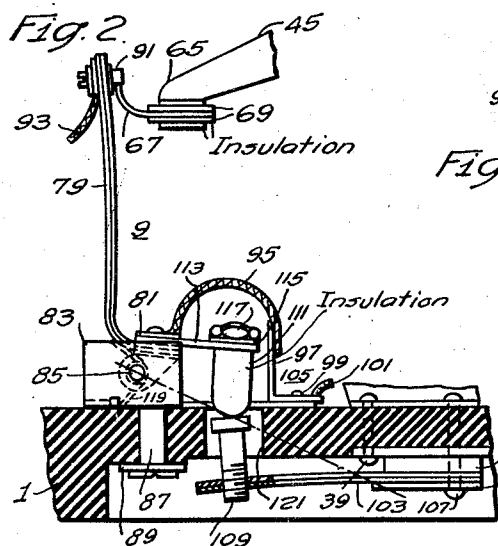
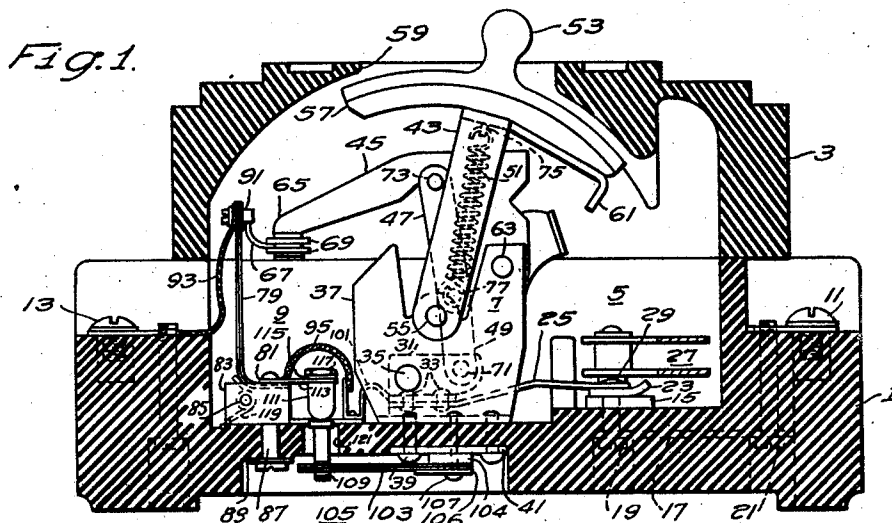
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2,340,050

CIRCUIT INTERRUPTER

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2,340,050

CIRCUIT INTERRUPTER

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17 Claims. (Cl. 200—116)

The invention relates, in general, to electrical switches or circuit breakers of the type having an electro-responsive or a thermal trip element for automatically causing the opening of the contacts of the switch or circuit breaker in response to predetermined overload conditions. In particular, the invention concerns circuit breakers of the above type which have a trip element compensated for changes in ambient temperature.

In the application for Letters Patent filed September 8, 1938, by Oliver S. Jennings and Harlan S. Gano, Serial No. 228,942, now Patent No. 2,284,825, granted June 2, 1942, there is described a novel method of mounting the thermal trip element of a circuit breaker and in compensating the same for changes in the ambient temperature of the medium surrounding the circuit breaker. The circuit breaker there described was designed specifically for oil-immersed applications; however, the novel method illustrated there for mounting and compensating the bimetallic trip element is suitable for circuit breakers operating in air also.

The present application concerns an important improvement in the means for mechanically connecting the free end of the compensating bimetal with the main bimetal which actually trips the breaker open. It is desirable to avoid any unnecessary lost motion, friction, or play in the connecting means between the two bimetals, and the present application is concerned specifically with a novel connection between these two bimetals. It has been found experimentally that any unnecessary free play, friction, or lost motion in the connecting means intermediate the two bimetals will result in varying characteristics of the main bimetal and successive tripping of the breaker on widely different overload currents. The present invention eliminates all unnecessary free play, friction, or lost motion in the connection between the tripping bimetal and the compensating bimetal and results in uniform tripping of the circuit breaker for every setting of the trip element of the breaker irrespective of changes in ambient temperature.

An object of the invention is the provision of a circuit breaker which will uniformly trip open on the same overload current for a single setting of the trip element irrespective of any variations in ambient temperature.

Another object of the invention is the provision of a connection between the tripping bimetal of a circuit breaker and its ambient temperature compensating bimetal which will eliminate all unnecessary lost motion, friction, and

free play in the connection between the two bimetals.

Another object of the invention is the provision of a circuit breaker with a compensating bimetal located outside the circuit breaker casing so as to be unaffected by the heat generated within the casing of the circuit breaker and a connection between the compensating bimetal and the tripping bimetal located within the casing to eliminate any lost motion, friction, or play between the two.

Another object of the invention is the provision of an oil-immersed circuit breaker with a compensating bimetal disposed away from the oil immediately surrounding the current carrying parts of the breaker and yet mechanically connected to the tripping bimetal within the region of circulation of such oil so that there will be no unnecessary lost motion, friction, or free play between the two bimetals.

Another object of the invention is the provision of a circuit breaker with a tripping bimetal which carries the full series current of its respective pole, said tripping bimetal being connected by insulated mechanical means to a compensating bimetal located outside the circuit breaker case in such manner that there is no unnecessary free play, friction, or lost motion in the connecting means.

Another object of the invention is the provision of an insulated mechanical connection between the tripping bimetal of a circuit breaker and its ambient temperature compensating bimetal which will eliminate all unnecessary lost motion, friction, and free play between the two, yet will still allow easy adjustment of one relative to the other.

The novel features that are considered characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to structure and operation, together with additional objects and advantages thereof, will be best understood from the following detailed description of two embodiments thereof when read in connection with the accompanying drawing, in which:

Figure 1 is a vertical sectional view of a circuit breaker constructed in accordance with the invention, the ambient temperature being normal.

Figure 2 is an enlarged fragmentary sectional view showing the details of the thermal trip device and the connecting means between the two bimetals, the bimetals being shown flexed in response to a high ambient temperature.

Figure 3 is an enlarged fragmentary sectional view of a modified form of connecting means between the two bimetals as applied to a multipole circuit breaker, the ambient temperature being normal; and,

Figure 4 is a plan view of the trip device shown in Figure 2, the ambient temperature being normal.

Referring to the drawing, particularly to Figure 1 thereof, the circuit breaker comprises, in general, a base 1, a cover 3, contact means indicated generally at 5, an operating mechanism indicated generally at 7, and a trip device indicated generally at 9.

The base 1 is constructed of molded insulating material and forms a support for the various elements of the circuit breaker. The cover 3, which is also constructed of molded insulating material, is secured to the base 1 by suitable means such as bolts (not shown) which pass through aligned openings formed in the base and cover. End terminals 11 and 13 are mounted in suitable openings provided in the ends of the base 1, and these end terminals 11 and 13 form the means for connecting the breaker in an electrical circuit.

The contact means indicated generally at 5 comprises a stationary contact 15 connected to a conductor strip 17 by means of a screw 19, which also secures the stationary contact 15 to the base 1. The conductor strip 17 is electrically connected to the end terminal 11 by means of a screw 21. The contact means indicated generally at 5 also comprises a movable contact 23 carried by a resilient switch arm 25, and an arc-extinguishing means indicated generally at 27. The arc-extinguishing means 27 is not an important part of the invention, and any suitable type may be used.

The movable contact 23 is secured to the free end of the resilient switch arm 25 by means of a rivet 29, and the opposite end of the switch arm 25 is secured to a channel-shaped movable contact supporting frame 31 by means of a pair of rivets 33. The channel-shaped movable contact supporting frame 31 is pivotally supported by means of a pivot pin 35 to the side walls of a metallic U-shaped main frame 37 secured to the base 1 by means of rivets 39 and a plate 41.

The operating mechanism indicated generally at 7 comprises, in general, a bifurcated operating member 43, a releasable cradle 45, a pair of toggle links 47 and 49, a pair of over-center springs 51, and an operating handle 53.

The bifurcated operating member 43 has the lower ends of its legs pivotally supported on the side walls of the main frame 37 by means of pivot studs 55. The upper end of the bifurcated operating member 43 has secured thereto an arcuate closure member 57 of molded insulating material, which acts to close an opening 59 provided in the cover 3 for any position of the bifurcated operating member 43. The handle 53 is formed integrally with the closure member 57 and projects through the opening 59 in the cover 3. A resetting member 61 projects from and is formed integrally with the bifurcated operating member 43, and this member serves to reset the releasable cradle 45 following a tripping operation, as will be described hereinafter.

The releasable cradle 45 is pivotally supported by means of a pivot pin 63 which extends between the side walls of the main frame 37. The releasable cradle 45 has a rearwardly extending portion 65 provided with a latch nose 67 which

is insulated from the releasable cradle 45 by a plurality of insulating plates 69. The releasable cradle 45 is adapted to be normally held in a latched position by means of the trip device 9.

The toggle links 47 and 49 pivotally connect the channel-shaped movable contact supporting frame 31 to the releasable cradle 45 in the manner shown in Figure 1 of the drawing, the lower end of the link 49 being pivotally mounted on the movable contact supporting frame 31 by means of the pivot pin 71, and the upper end of the link 47 being pivotally connected to the releasable cradle 45 by the pivot pin 73. The over-center springs 51 are connected between lugs 75 formed integrally with the bight portion of the operating member 43, and a knee pivot pin 77 which pivotally connects the toggle links together.

The operation of the circuit breaker as thus far described is, briefly, as follows. With the parts in the position shown in Fig. 1, that is, with the contact means in closed-circuit position and the releasable cradle 45 held in its normally latched position by the trip device 9, let it be assumed that it is desired to manually open the circuit controlled by the breaker. The operating handle 53 is moved from the closed position shown in Fig. 1 in a counter-clockwise direction to an open-circuit position at the opposite end of the opening 59. This movement of the operating handle 53 to open position moves also the operating member 43 in a counter-clockwise direction about its pivot axis 55. As soon as the line of action of the over-center springs 51 crosses the pivot pin 73, which connects the upper toggle link 47 to the releasable cradle 45, the force exerted by the springs 51 causes collapse of the toggle links 47 and 49. The collapse of the toggle links 47 and 49 causes movement of the switch arm 25 in a counter-clockwise direction to open-circuit position with a snap action.

In manually closing the circuit breaker, substantially the reverse action takes place. The operating handle, 53 is returned to the closed position shown in Figure 1. At a certain point in the closing movement of the operating handle 53 the line of action of the over-center springs 51 crosses the pivot pin 73, and the force of the over-center springs 51 causes the toggle links 47 and 49 to assume their extended or in-toggle position as shown in Fig. 1. Movement of the toggle links 47 and 49 to their extended position causes clockwise movement of the movable contact supporting frame 31 and switch arm 25 to a closed-circuit position with a snap action to effect engagement of the movable contact 23 with the stationary contact 15.

The releasable cradle 45 is always biased in a clockwise direction about its pivot axis 63 by a component of force exerted by the over-center springs 51, but the trip device 9 under normal conditions holds the releasable cradle 45 in its normally latched position, shown in Fig. 1, against the biasing action of the over-center springs 51. If an overload of predetermined magnitude and duration occurs in the circuit controlled by the breaker, the trip device 9 operates to effect release of the releasable cradle 45. The member 45, when released, is rotated in a clockwise direction about its pivot axis 63 by the springs 51, and at a predetermined point in its movement causes the line of action of the over-center springs 51 to cross the pivot pin 73 to effect a collapse of the toggle links 47 and 49. The collapse of the toggle links 47 and 49 causes

counter-clockwise movement of the switch arm 25 to open-circuit position with a snap action to interrupt the circuit controlled by the breaker.

After an overload tripping operation, the breaker cannot be reclosed without first moving the operating handle 53 to the full open-circuit position. The resetting movement of the operating handle 53 to the full open-circuit position causes the resetting member 61 to engage and move the releasable cradle 45 in a counter-clockwise direction to the position shown in Figure 1, in which it is relatched by the trip device 9.

The trip device 9 comprises a thermally responsive trip element in the form of a bimetallic strip 79, which is pivotally mounted at its lower end on the base 1. The lower end of the bimetallic element 79 is bent at a right angle and secured in any suitable manner to a U-shaped bracket 81. The bracket 81 is pivotally mounted on a U-shaped supporting bracket 83 by means of a pivot pin 85 which extends through the side legs of the brackets 81 and 83. The supporting bracket 83 is seated on the base 1 and is rigidly secured thereto by a pair of downwardly extending projections 87 (only one being shown) which pass through openings in the base 1 and have their lower ends clinched over against a plate 89 engaging the underside of the base 1.

The upper end of the bimetal trip element 79 is provided with an adjustable latch element 91 in the form of an adjusting screw, which is threaded through the free end of the trip element 79. The latch element 91 is normally adapted to overlap the latch nose 67 carried by the releasable cradle 45 to hold the releasable cradle in its normally latched position shown in Fig. 1. The bimetallic trip element 79 is connected in series with the contacts 15 and 23 of the circuit breaker by means of a pair of flexible series conductors 93 and 95, so as to be responsive to the current flowing in the controlled circuit. The flexible series conductor 93 has one end connected to the terminal 13, and its other end connected to the upper free end of the bimetallic trip element 79. The flexible series conductor 95 is secured to the bent foot of the bimetallic trip element 79 at one end, and the other end is secured to a terminal strip 97. The terminal strip 97 is secured to a horizontal extension of the mounting bracket 83 by means of a screw 99 (Figure 4). The other end of the terminal strip 97 is connected by flexible series conductors 101 to the resilient switch arm 25.

The circuit through the breaker extends from the left-hand terminal 13 through the flexible conductor 93, bimetallic trip element 79, flexible conductors 95, terminal strip 97, flexible conductors 101, resilient switch arm 25, through the contacts 23 and 15, conductor strip 17 to the opposite terminal 11.

The bimetallic trip element 79 is normally held against rotation about its pivot axis 85 in the position shown in Fig. 1, by means which will be hereinafter described. When an overload of predetermined magnitude and duration occurs in the circuit controlled by the breaker, the bimetallic trip element 79 is heated by the overload current and flexes in a direction away from the operating mechanism 7 to cause the latch element 91 to release the releasable cradle 45. The release of the cradle 45 effects opening of the circuit breaker in the manner previously described. After the circuit has been interrupted, the bimetallic trip element 79 cools and returns to its normal posi-

tion shown in Fig. 1, to permit resetting of the circuit breaker as previously described.

The circuit breaker is calibrated at the factory by means of the adjustable latch element 91 so that it will trip open in response to overload currents of definite predetermined magnitude and duration. After the breaker has been calibrated, the adjusting screw 91 is sealed by a suitable sealing material to maintain the calibration permanent.

The bimetallic trip element 79 is affected by changes in ambient temperature. If the ambient temperature rises, the bimetallic trip element 79 deflects in a direction away from the operating mechanism 7 an amount proportional to the rise in ambient temperature. This decreases the amount of latch overlap between the latch element 91 and the latch nose 67, with the result that the breaker will be tripped open either at a lower current than that for which it was calibrated, or at a given overload current in a shorter period of time. Conversely, if the ambient temperature decreases, the bimetallic trip element 79 will deflect in a direction toward the mechanism 7 and will tend to increase the amount of latch overlap between the elements 91 and 67, with the result that the breaker will be tripped open either at a higher current than that for which it was calibrated, or at a given overload current after a longer period of time.

In order to prevent changes in ambient temperature from affecting the trip characteristic of the trip element 79, and to insure that the breaker will be tripped open in response to definite predetermined overload conditions, irrespective of changes in ambient temperature, there is provided an ambient temperature compensating means comprising a bimetallic strip 103, and a mechanical connecting means indicated generally at 105 interposed between the bimetallic strip 103 and the bimetallic trip element 79. The bimetallic strip 103 is rigidly secured at one end to the base 1 by means of a rivet 107 and the two metal plates 106 and 104. A metallic adjusting screw 109 is threaded through the free end of the bimetallic strip 103 to engage under compression an insulator 111 which passes through an opening in an offset horizontal projection 113 of the U-shaped bracket 81. The insulator 111 is rigidly secured to the horizontal projection 113 by means of a lockwasher 115 and a nut 117. A spring 119 which is coiled around the pivot pin 85 biases the U-shaped bracket 81 in a clockwise direction around the pivot pin 85 so that the point of contact between the adjusting screw 109 and the insulator 111 is always under compression.

An opening 121 in the base 1 is provided to permit engagement between the elements comprising the mechanical connecting means 105, but this opening 121 is made as small as possible to minimize any heat transfer from the interior of the circuit breaker casing to the bimetallic strip 103. The insulation effect of the insulator 111 further helps to minimize heat transfer between the elements in the interior of the circuit breaker casing and the bimetallic strip 103.

An important feature of the invention is the location of elements 111 and 109 so that their point of contact is as close as possible on a center line connecting the pivot pin 85 with the fixed part of the bimetallic strip 103 nearest the free end, as shown in Fig. 2. By so locating the elements 111 and 109 the relative motion of the ele-

ments comprising the mechanical means 105 is greatly reduced, thus reducing friction and resulting in more uniform breaker performance.

The operation of the ambient temperature compensating means is briefly as follows. If the ambient temperature rises, the bimetallic trip element 79 flexes toward the left away from the operating mechanism 7. However, the bimetallic strip 103 is arranged so that it flexes downwardly away from the base 1, thus permitting the coil spring 119 to rotate the U-shaped bracket 81 clockwise around its pivoting axis 85 and hence to compensate for the ambient temperature deflection of the bimetallic trip element 79. Fig. 2 illustrates the position of the elements when the ambient temperature is high. Similarly, if the ambient temperature decreases, the bimetallic trip element 79 deflects toward the operating mechanism 7, but at the same time the bimetallic strip 103 deflects upwardly toward the base 1 and rotates the U-shaped bracket 81, and element 79 which it supports, about its pivoting axis 85 in a counter-clockwise direction against the biasing action of spring 119, to compensate for the decrease of ambient temperature. It will thus be seen that the bimetallic strip 103 always maintains the same amount of latch overlap between the latch element 91 and the latch nose 67 irrespective of any change in ambient temperature, so that the breaker will always be tripped open in response to definite predetermined overloads, independently of any change in ambient temperature.

The circuit breaker described above was specifically designed for oil-immersed applications, but the invention is not limited to such applications and may be applied to circuit breakers operating in other mediums or in air. In oil-immersed applications, however, it is essential that the compensating bimetal 103 be placed in a region away from the vicinity of the warm current-carrying parts of the breaker, and be maintained at the ambient temperature of the oil surrounding the breaker. The particular mounting arrangement of the bimetallic strip 103 fulfills this condition, and also prevents hot oil in the vicinity of the current-carrying parts of the breaker from coming in contact with the compensating bimetallic strip 103. The bimetallic strip 103 is, therefore, constantly maintained at the ambient temperature of the oil surrounding the circuit breaker casing and is not greatly affected by the heat of the hot oil in the interior of the casing or by the circulation of such hot oil. The opening 121 in the base 1 is made as small as possible, and the insulator 111 helps to insulate any heat transfer. The physical size of the insulator 111 and the adjusting screw 109 also helps to prevent any circulation of oil through the opening 121 in the base 1. Consequently, heat generated within the circuit breaker casing does not affect the bimetallic strip 103, and there is practically no circulation of hot oil through the opening 121.

The adjusting screw 109 is adjustable from outside of the circuit breaker casing and serves to adjust the trip characteristic of the bimetallic trip element 79. Turning the screw in towards the base 1, serves to decrease the amount of latch overlap between the latch element 91 and the latch nose 67, and to result in the breaker tripping open more quickly than before for the same current, and also tripping open at a lower steadily maintained overload current. Turning the screw 109 out away from the base 1, serves

to increase the amount of latch overlap between the latch element 91 and the latch nose 67, and to result in the breaker tripping open more slowly than before for the same current, and also tripping open at a higher steadily maintained overload current than before.

By varying the deflection characteristics of the bimetallic strips 103 and 79 with respect to each other, the bimetallic trip element 79 may be under, fully, or overcompensated for changes in the ambient temperature, or arranged to give any other desired characteristic of compensation.

Fig. 3 is a modification of the invention as applied to a multi-pole breaker similar in mechanism to the breaker described in connection with Fig. 1, but having a common trip bar which may be actuated by the individual trip mechanism of any pole. Each pole of the multi-pole breaker has its individual tripping mechanism, which upon an overload occurring in that pole will slightly rotate the common trip bar to trip the breaker open. The view is cut away to show only one pole with its associated trip mechanism, since the multi-pole structure may be as shown in my Patent No. 2,162,577, issued June 13, 1939.

In the form of the invention illustrated in Fig. 3 there is a cylindrically shaped common trip bar 123, made of molded insulating material, which is pivotally mounted and rotatable about its longitudinal axis. This common trip bar 123 extends across all the poles of the breaker and may be actuated by the tripping mechanism associated with any pole to trip the breaker open upon an overload occurring in that pole of the breaker. The common trip bar 123 has a number of horn-shaped upwardly extending projections 125 formed integrally with the trip bar, one for each pole, each of which engages an adjustable screw 127 threaded through the free end of the bimetallic trip element 129 for that pole. The bimetallic trip element 129, as before, carries the full current of its respective pole, the flexible conductor 93 serving to carry the full current of the pole to the free end of the bimetallic trip element 129, whence the current passes through the bimetallic trip element 129 to be finally carried off by the flexible conductors 95 to the terminal strip 97, and thence to the switch arm 25 by means of the flexible conductors 101.

When an overload occurs in the pole, the overload current, passing as it does through the bimetallic trip element 129, serves to heat the same and to flex the bimetallic trip element 129 to the right. This flexing causes the adjustable screw 127, engaging the horn-shaped projection 125 for its pole, to partially rotate the common trip bar 123 in a clockwise direction about its longitudinal axis. The partial clockwise rotation of the common trip bar 123 also rotates in a clockwise direction a fin-shaped metallic insert 131 rigidly embedded in the trip bar 123 adjacent the center of the bar. The left-hand end portion of the arcuate edge of the fin-shaped metallic insert 131 normally supports the end 133 of the horizontal extension 135 of a pivotally mounted U-shaped bracket or latch 137, as shown in Fig. 3. The horizontal extension 135 of the pivotally mounted U-shaped bracket 137 has a slot 139 therein, which is slightly wider than the fin-shaped metallic insert 131 and disposed directly over the insert 131. A pivot pin 141, supported between the two side walls of a U-shaped main frame 143 of the breaker (the

frame 143 being similar to the main frame 37 described in connection with Fig. 1), serves to pivotally mount the U-shaped bracket 137. Coiled about the pivot pin 141 is a spring 145, one end of which biases the fin-shaped metallic insert 131 and the common trip bar 123 in a counter-clockwise direction about the longitudinal axis of the common trip bar 123. The other end of the spring 145 engages a rearwardly extending portion 147 of the U-shaped bracket 137, and, as a result, this end of the spring 145 biases the U-shaped bracket 137 in a counter-clockwise direction about the pivot pin 141. The rearwardly extending portion 147 of the U-shaped bracket 137 has a slot 149 therein, which is slightly wider than the width of a releasable cradle 151 of the circuit breaker mechanism. The releasable cradle 151 is similar in structure and in operation to the releasable cradle 45 already described in connection with Fig. 1, and is always biased in a clockwise direction about its pivot axis (not shown). The upper end of the slot 149 normally engages and latches a latch nose 153 of the releasable cradle 151 to permit the breaker to be normally operated.

When an overload current passes through any pole of the multi-pole breaker, the overload current passing through the bimetallic trip element 129 flexes the same to the right. This flexing of the bimetallic trip element 129 to the right serves to partially rotate the common trip bar 123 in a clockwise direction about its longitudinal axis. This partial rotation of the trip bar 123 also rotates the fin-shaped metallic insert 131, and permits the horizontal extension 135 of the U-shaped bracket 137 (the U-shaped bracket 137 being biased in a counter-clockwise direction about the pivot pin 141 by the spring 145), to drop down, the fin-shaped metallic insert 131 then projecting up through the slot 149. The counter-clockwise rotation of the U-shaped bracket 137 serves to disengage the latch nose 153 of the releasable cradle 151 from the upper end of the slot 149, and to permit the releasable cradle 151 to fly upward and to trip the breaker open in a manner identical to that described in connection with Fig. 1.

When it is desired to reset the breaker, the operating handle (not shown) of the breaker is moved to the full open position, and in a manner identical to that already described in connection with Fig. 1, the releasable cradle 151 is moved in a counter-clockwise direction about its pivot axis (not shown). Near the end of its counter-clockwise travel the lower end of the nose 153 engages the lower end of the slot 149 and forces the U-shaped bracket 137 in a clockwise direction about its pivot axis 141 against the biasing action of the spring 145. This clockwise rotation of the U-shaped bracket 137 raises the horizontal portion 135; and the spring 145, biasing the fin-shaped metallic insert 131 in a counter-clockwise direction about the longitudinal axis of the common trip bar 123, forces the fin-shaped metallic insert 131 under the end 133 of the horizontal portion 135 of the latch 137. The clockwise rotation of the U-shaped bracket or latch 137 brings the upper edge of the slot 149 over the line of action of the latch nose 153 of the releasable cradle 151, so that when the operating handle (not shown) is released or is moved to the closed-circuit position the releasable cradle will again have its nose 153 engaged by the upper end of the slot 149

to latch the releasable cradle 151 until the next overload operation occurs.

The adjustable screw 127 permits the circuit breaker to be calibrated at the factory so that the breaker will trip open in response to overload currents of definite predetermined magnitude and duration. After the breaker has been calibrated, the adjusting screw 127 is sealed by a suitable sealing material to maintain the calibration permanent.

The mechanical connection between the bimetallic trip element 129 and the ambient temperature compensating bimetallic strip 103 comprises a metallic adjusting screw 155 threaded through the free end of the bimetallic strip 103, through the center of which is rigidly soldered or otherwise suitably fastened a piece of steel piano wire 157, which passes loosely through an insulating bushing 159 and is soldered or otherwise suitably secured at its other end to a washer 161. The insulating bushing 159 passes through an opening provided in the offset horizontal portion 113 of the U-shaped bracket 31. A nut 163 is threaded on to the lower end of the insulating bushing 159 to secure it to the offset horizontal portion 113 of the U-shaped bracket 31. A spring 165 is coiled about the pivot pin 85 to bias the U-shaped bracket 31 in a counter-clockwise direction about its pivot axis 85.

The operation of the compensating bimetallic strip 103 in Fig. 3 is as follows. When the ambient temperature rises, the bimetallic trip element 129 will be affected and will flex slightly in the same direction it would flex if an overload current passed through it, namely, to the right toward the operating mechanism of the breaker. However, at the same time the bimetallic strip 103 will also be affected by the rising ambient temperature and will consequently flex in an upward direction toward the base 1. Since the spring 165 biases the U-shaped bracket 31 in a counter-clockwise direction about its pivot axis 85, the movement of the free end of the bimetallic strip 103 upward will permit a slight counter-clockwise rotation of the U-shaped bracket 31. Thus the flexing toward the right of the free end of the bimetallic trip element 129 is compensated by a counter-clockwise rotation of the U-shaped bracket 31, which supports the bimetallic trip element 129. The two movements hence neutralize each other insofar as they concern the position of adjusting screw 127 relative to the horn-shaped projection 125; and the amount of latch overlap, or more particularly, the length of the end 133 engaged by the fin-shaped metallic insert 131 remains constant irrespective of changes in ambient temperature.

Conversely, when the ambient temperature decreases, the bimetallic trip element 129 will be affected and will bend toward the left away from the operating mechanism of the circuit breaker. However, at the same time the bimetallic strip 103 will also be affected by the decreasing ambient temperature, and will bend downward away from the base 1. This movement of the free end of the bimetallic strip 103 downward will pull the U-shaped bracket 31 about its pivot pin 85 in a clockwise direction against the biasing action of the spring 165. Consequently, the bending to the left of the free end of the bimetallic trip element 129 is compensated by the clockwise rotation of the U-shaped bracket 31, which supports the bimetallic trip element 129, and the position of the adjusting screw 127 relative to the horn-shaped projection 125 remains unchanged ir-

respective of the decreasing ambient temperature.

Instead of using a steel wire in the connection between the two bimetallic elements 129 and 103, a flexible metallic ribbon or any other flexible connection could be used since the element is always under tension.

The use in Fig. 1 of the spring 119 to bias the bracket 81, causes the adjusting screw 109 to be engaged at all times by insulator 111, and in Fig. 3 the spring 165 biases the insulating bushing 159 into engagement with the washer 161 on the steel wire 157 and in each case eliminates all lost motion or free play between the bimetallic trip element and the compensating bimetal. This causes the bimetals 79 and 129 to follow exactly every movement of the compensating bimetals 103. The result of such a novel connection between these two vital elements of the circuit breaker is uniform breaker tripping irrespective of changes in ambient temperature.

In Fig. 3 it will be noticed that the hole 121 in the base 1 is made relatively small to insulate the compensating bimetallic strip 103 from heat in the interior of the circuit breaker casing, and also to minimize the circulation of oil through this opening when the circuit breaker is used in oil-immersed applications.

It will be noticed in both embodiments of the invention that as a consequence of bracket 83 being rigidly secured to the base 1 by the clinched over ends of members 87 and the main supporting brackets 37 and 143 being riveted to the base 1 by means of the rivets 39 and 107 there cannot possibly be a relative displacement between brackets 83 and 37 or 143 along the base 1 to change the amount of latch travel in the breaker.

While the invention has been disclosed in accordance with the provisions of the patent statutes, it is to be understood that various changes in the structural details thereof may be made without departing from the spirit of the invention. It is desired, therefore, that the appended claims be given the broadest reasonable interpretation permissible in the light of the prior art.

I claim as my invention:

1. In a circuit interrupter, relatively movable contacts for opening and closing the circuit, a bodily movable thermal control element heated in response to the current in the circuit and movable in response to predetermined overload conditions in the circuit to effect actuation of said contacts, and a thermally responsive member having one portion rigidly secured to a fixed support and having a free portion connected to said control element to bodily displace the same in compensating for changes in ambient temperature, said connection comprising a laterally flexible member which transmits the motion of the free portion of the thermally responsive member to said control element to bodily displace the same.

2. In a circuit interrupter, relatively movable contacts for opening and closing the circuit, a thermal control element movable in response to predetermined overload conditions in the circuit to effect actuation of said contacts, a laterally flexible rod-shaped member secured at one end to said control element and insulated therefrom, and a thermally responsive member having one portion rigidly secured to a fixed support and having a free portion connected to said control element to bodily displace the same in compensating for changes in ambient temperature, said connection comprising an adjusting screw

threaded through the free portion of said thermally responsive member, said screw being secured to one end of said laterally flexible rod-shaped member.

3. In a circuit interrupter, relatively movable contacts for opening and closing the circuit, a pivotally mounted thermal control element heated in response to the current in the circuit and bendable in response to predetermined overload conditions in the circuit to effect actuation of said contacts, a member secured to said thermal control element, a thermally responsive member having one portion rigidly secured to a fixed support and having a free portion connected to said control element to bodily displace the same about its pivot to compensate for changes in ambient temperature, and a biasing spring acting at all times to take up any lost motion in said connection, said connection comprising a thrust member which engages the member secured to the bodily movable control element to transmit the motion of the free end of said thermally responsive member to said control element, the point of engagement of said engaging members being disposed substantially on a center line between the pivot axis of the control element and the fixed portion of said thermally responsive member.

4. In a circuit interrupter, relatively movable contacts for opening and closing the circuit, a pivotally mounted thermal control element heated in response to the current in the circuit and bendable in response to predetermined overload conditions in the circuit to effect actuation of said contacts, an insulation thrust receiving member rigidly secured to said thermal control element, a thermally responsive member having one portion rigidly secured to a fixed support and having a free portion connected to said control element to move the same about its pivot to compensate for changes in ambient temperature, and a biasing spring acting at all times to take up any lost motion in said connection, said connection comprising an adjustable thrust member adjustably secured to the free end of the thermally responsive member and at all times engaging under compression said insulation member, the point of engagement of said thrust members being located substantially on a center line between the pivot axis of the control element and the fixed portion of said thermally responsive member.

5. In a circuit interrupter, relatively movable contacts for opening and closing the circuit, a pivotally mounted bimetallic trip element heated in response to the current in the circuit and movable in response to predetermined overload conditions to cause opening of said contacts, and a bimetallic member having one end rigidly secured to a fixed support and having the other end connected to said pivotally mounted bimetallic trip element by a laterally flexible member to rotate said pivotally mounted bimetallic trip element in compensating the same for changes in ambient temperature.

6. In a circuit interrupter, relatively movable contacts for opening and closing the circuit, a pivotally mounted bimetallic trip element heated in response to the current in the circuit and movable a predetermined amount in response to predetermined overload conditions to cause opening of said contacts, a member secured to said pivotally mounted bimetallic trip element, a bimetallic member having one end rigidly secured to a fixed support and having the other end connected to said pivotally mounted bimetallic trip element to rotate the same in compensating for changes in ambient temperature, and a biasing spring acting

at all times to take up any lost motion in said connection, said connection comprising a thrust member which engages the member secured to the pivotally mounted bimetallic trip element to transmit the motion of the free end of the bimetallic member to rotate said pivotally mounted bimetallic trip element, the point of engagement of said engaging members being disposed substantially on a center line between the pivot axis of the trip element and the fixed end of said bimetallic member.

7. In a circuit interrupter, relatively movable contacts for opening and closing the circuit, a pivotally mounted bimetallic trip element heated in response to the current in the circuit and movable in response to predetermined overload conditions in the circuit to cause opening of said contacts, a laterally flexible member secured at one end to said trip element and insulated therefrom, and a bimetallic member having one end rigidly secured to a fixed support and having the other end connected to said pivotally mounted bimetallic trip element to rotate the same in compensating for changes in ambient temperature, said connection comprising an adjusting screw threaded through the free end of said bimetallic member, said screw being secured to one end of said laterally flexible member.

8. In a circuit interrupter, relatively movable contacts for opening and closing the circuit, a pivotally mounted bimetallic trip element heated in response to the current in the circuit and movable in response to predetermined overload conditions in the circuit to cause opening of said contacts, an insulation thrust receiving member rigidly secured to said pivotally mounted bimetallic trip element, a bimetallic member having one end rigidly secured to a fixed support and having the other end connected to said pivotally mounted bimetallic trip element to rotate the same in compensating for changes in ambient temperature, and a biasing spring acting at all times to take up any lost motion in said connection, said connection comprising an adjustable thrust member threaded through the free end of said bimetallic member which engages said insulation member, one of said engaging thrust members having a rounded surface for engaging the other member, and the point of engagement of said rounded surface with said insulation member being disposed substantially on a center line between the pivot axis of said trip element and the fixed end of said bimetallic member.

9. In a circuit interrupter, relatively movable contacts for opening and closing the circuit, a pivotally mounted thermal control element heated in response to the current in the circuit and movable in response to predetermined overload conditions in the circuit to effect actuation of said contacts, and a bimetallic member having one end rigidly secured to a fixed support and having the other end connected to said pivotally mounted control element to rotate the same in compensating for changes in ambient temperature, said connection comprising a thrust member responsive to movement of the free end of said bimetallic member, said thrust member engaging a rounded surface that is movable with said control element, the point of engagement being near a center line drawn between the pivot axis of said pivotally mounted thermal control element and the fixed end of said bimetallic member.

10. In an electrical switch, a casing, a switch member mounted in said casing for movement to open and to closed circuit position, a thermal

control element mounted in said casing heated by the current in the circuit and movable when heated a predetermined amount by the passage of currents of predetermined magnitude and duration to cause movement of said switch member to one of its circuit controlling positions, and a thermally responsive member mounted on the outside of said casing and connected to said thermal control element for compensating the same for changes in ambient temperature, said connection comprising a laterally flexible member which transmits the motion of said thermally responsive member to said thermal control element.

11. In an electrical switch, a casing, a switch member mounted in said casing for movement to open and to closed circuit position, a pivotally mounted electro-responsive control element mounted in said casing, said element being movable in response to predetermined current conditions to cause movement of said switch member to one of its circuit controlling positions, a member secured to said electro-responsive control element, a thermally responsive member mounted outside of said casing so as to be responsive only to temperatures adjacent the outside of the casing, said thermally responsive member being connected to said control element to compensate said control element for changes in ambient temperature, said thermally responsive member having one portion rigidly secured to the casing of the electrical switch and having a free portion from which said connection is made, and a biasing spring acting at all times to take up any lost motion in said connection, said connection comprising a thrust member which engages said member secured to said control element to transmit the motion of the free portion of said thermally responsive member to said control element, the point of engagement of said engaging thrust members being disposed substantially on a center line between the pivot axis of said control element and the fixed portion of said thermally responsive member.

12. In an electrical switch, a casing, a switch member mounted in said casing for movement to open and to closed circuit position, an electro-responsive control element mounted in said casing, said element being movable in response to predetermined current conditions to cause movement of said switch member to one of its circuit controlling positions, and a thermally responsive member mounted outside of said casing so as to be responsive only to temperatures adjacent the outside of the casing, said thermally responsive member being connected to said control element to compensate said control element for changes in ambient temperature, said thermally responsive member having one portion rigidly secured to the casing of the electrical switch and having a free portion from which said connection is made, said connection comprising a flexible cord member which transmits the motion of the free portion of said thermally responsive member to said control element.

13. In a circuit interrupter, a casing, relatively movable contacts mounted in said casing, a bimetallic trip element pivotally mounted in said casing and heated in response to the current flowing in the circuit, said trip element flexing a predetermined amount in response to predetermined overload conditions to cause opening of said contacts, an insulation member rigidly secured to said bimetallic trip element, a bimetallic member mounted outside of said casing

so as to be responsive only to temperatures adjacent the outside of the casing and connected to said trip element to move said trip element about its pivot to compensate for changes in ambient temperature, said bimetallic member having one portion rigidly secured to the casing of the circuit interrupter and having a free portion from which said connection is made, and a biasing spring acting at all times to take up any lost motion in said connection, said connection comprising an adjustable thrust member threaded through the free portion of said bimetallic member which engages the insulating member secured to said trip element to transmit the motion of the free portion of said bimetallic member to said trip element to bodily displace the same, the point of engagement of said engaging thrust members being disposed substantially on a center line between the pivot axis of said trip element and the fixed portion of the compensating member.

14. In a circuit interrupter, a casing, relatively movable contacts mounted in said casing, a bimetallic trip element bodily movable in said casing and heated in response to the current flowing in the circuit, said trip element flexing a predetermined amount in response to predetermined overload conditions to cause opening of said contacts, a laterally flexible rod-shaped member secured at one end to said trip element and insulated therefrom, and a bimetallic member mounted outside of said casing so as to be responsive only to temperatures adjacent the outside of the casing and connected to said trip element to bodily displace said trip element for changes in ambient temperature, said bimetallic member having one portion rigidly secured to the casing of the circuit interrupter and having a free portion from which said connection is made, said connection comprising an adjusting screw threaded through the free portion of said bimetallic member, said screw being secured to one end of said laterally flexible rod-shaped member.

15. A circuit controlling means comprising a base, a bimetallic control element pivotally mounted on said base and heated in response to the current flow in the controlled circuit, said bimetallic element flexing in response to predetermined overload conditions and also flexing in response to changes in ambient temperature, a member secured to said bimetallic control element, a thermally responsive member rigidly secured at one end to said base on the opposite side thereof from said control element and hav-

ing its free end connected to said control element to move the same in compensating for ambient temperature movement of said control element, and a biasing spring acting at all times to take up any lost motion in said connection, said connection comprising a thrust member which engages the member secured to said control element to transmit the motion of the free end of said thermally responsive member to said control element to bodily move the same, and the point of engagement of said engaging thrust members being disposed substantially on a center line between the pivot axis of said control element and the fixed end of said thermally responsive member.

16. A circuit controlling means comprising a base, a bimetallic control element bodily movably mounted on said base and heated in response to the current flow in the controlled circuit, said bimetallic element flexing in response to predetermined overload conditions and also flexing in response to changes in ambient temperature, and a thermally responsive member rigidly secured at one end to said base on the opposite side thereof from said control element and having its free end connected to said control element to bodily move the same in compensating for ambient temperature movement of said control element, said connection comprising a flexible cord which transmits the motion of the free end of said thermally responsive member to said bimetallic control element to bodily move the same.

17. In a circuit breaker having relatively movable contacts, a pivotally mounted bimetal control element heated in response to the current of the circuit and operable in response to predetermined overload conditions to cause actuation of said contacts, an ambient temperature compensating bimetal element fixedly mounted at one end, means operatively connecting the free end portion of said compensating bimetal element to said control element said connecting means including a connection which permits movement of said elements relative to each other without binding as the compensating bimetal element moves the control element about its pivot in compensating for changes in ambient temperature, at least a part of the said connection being disposed on a center line between the pivot axis of the control element and the fixed end of the compensating element, and spring means for taking up play in said connection.

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