Aug. 19, 1947. M. BINGENHEIMER 2,425,983

THERMAL AND MAGNETIC TRIP CIRCUIT BREAKER

Filed July 24, 1943

Fig. 4.

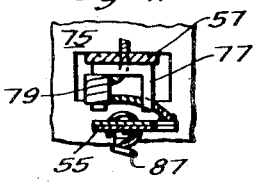


Fig. 1.

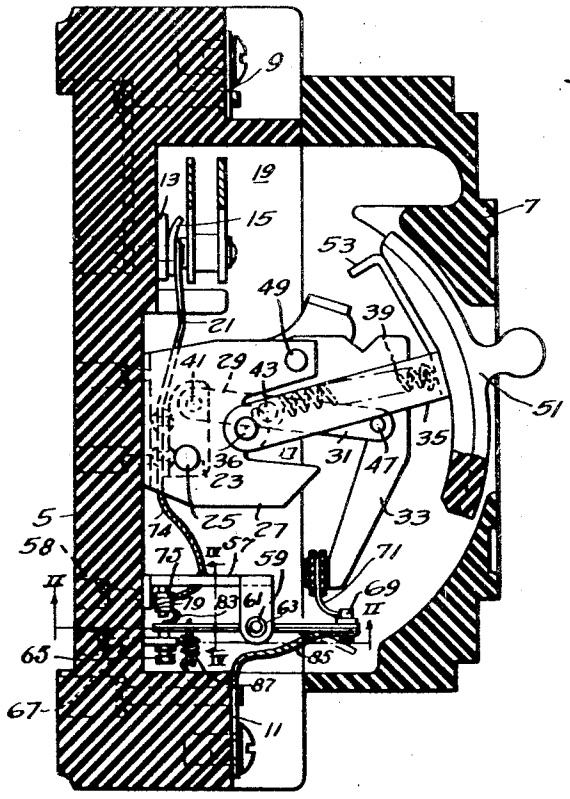


Fig. 2.

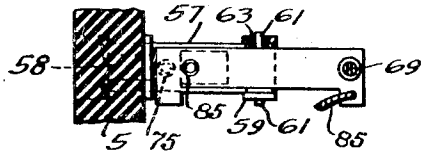
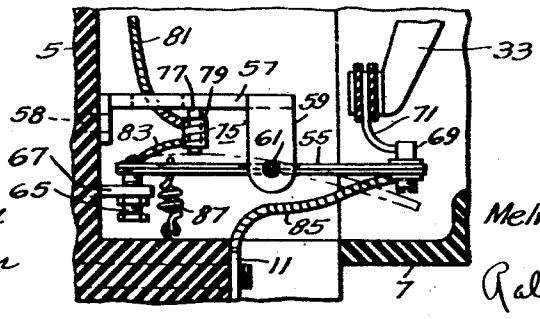


Fig. 3.



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THERMAL AND MAGNETIC TRIP CIRCUIT BREAKER

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8 Claims. (Cl. 200—88)

1

The invention relates to circuit interrupters and, more particularly, to electroresponsive trip devices for controlling automatic opening operation of a circuit breaker.

An object of the invention is the provision of a circuit breaker with an improved thermal-magnetic current responsive trip device of novel construction whereby it will not be falsely operated by or in response to shocks or vibration.

Another object of the invention is the provision of a circuit breaker with an improved thermal trip device comprising a current responsive bimetallic strip novelly arranged so that it will give the same deflection as conventional bimetal trip elements of the same dimension and yet which is capable of exerting a very much stronger tripping force than conventional bimetal elements of the same size.

Another object of the invention is the provision of a circuit breaker with an improved thermal-magnetic trip device comprising a current responsive bimetal element and a cooperating electromagnet for at times actuating the element, the parts being constructed and arranged so that the bimetal element is free to deflect even when the device is actuated magnetically. This maintains the accuracy of calibration of the bimetal element despite short circuit operations of the device.

Another object of the invention is the provision of a circuit breaker with a very simple thermal magnetic trip device wherein the magnetic means acts to move the bimetal trip element for instantaneous tripping and the parts are so arranged that the air gap of the magnet is not changed upon heat deflection of the bimetal element.

Another object of the invention in accordance with a modification thereof is the provision of an improved thermal magnetic circuit breaker trip device wherein the bimetal element operates independently at times to trip the breaker and also operates jointly with the magnetic means at other times in tripping the breaker.

Another object of the invention is the provision of a circuit breaker with an improved thermal current responsive trip device which can readily be changed to give a short time operating characteristic or a longer time operating characteristic.

Another object of the invention is the provision of a circuit breaker with an improved current responsive trip device that is simple, accurate and reliable in operation and economical to manufacture.

The novel features that are considered characteristic of the invention are set forth in particular in the appended claims. The structure

2

and mode of operation of the invention together with additional objects and advantages thereof will be best understood from the following detailed description of several embodiments thereof when read in conjunction with the accompanying drawing, in which:

Figure 1 is a vertical sectional view of a circuit breaker embodying a trip device constructed in accordance with one embodiment of the invention;

Fig. 2 is a fragmentary sectional view of the trip device taken substantially along the line II—II of Fig. 1 and looking in the direction of the arrows;

Fig. 3 is a fragmentary sectional view on a larger scale showing another modification of the invention; and

Fig. 4 is a sectional view on an enlarged scale taken substantially along the line IV—IV of Fig. 1.

The present invention is illustrated in the drawing as applied to a circuit breaker mechanism similar to that disclosed in Patent 2,284,825, granted June 2, 1942, to O. S. Jennings and H. S. Gano and assigned to the assignee of the present invention. It is to be understood, however, that the improved trip device of the present invention may be applied to many other types of circuit breaker mechanisms.

Referring to the drawing, the circuit breaker to which the improved trip device is applied comprises a base 5 and cooperating removable cover 7 both of insulating material, a pair of end terminals 9 and 11 mounted in recesses in the ends of the base, a stationary contact 13, a cooperating movable contact 15 and an operating mechanism indicated generally at 17.

The stationary contact 13 is electrically connected to the upper terminal 9, and has associated therewith an arc extinguisher 19 of the slotted metal plate type for extinguishing arcs drawn between the contacts upon interruption of the circuit. The movable contact 15 is carried by a resilient spring contact arm 21 of conducting material secured at its lower end to a channel-shaped member 23 which is pivotally mounted by means of a pivot pin 25 on a U-shaped metal frame 27. The frame 27 is secured to the base 5 and has spaced side walls between which the channel-shaped contact supporting member 23 is disposed.

The operating mechanism 17 of the circuit breaker comprises a toggle consisting of links 29 and 31 connected to the movable contact arm, a releasable carrier lever 33 for releasably supporting the outer end of the toggle, a U-shaped

operating member 35 and a pair of overcenter springs 39 (only one being shown). The toggle link 29 is pivotally connected at 41 to the channel-shaped contact supporting member 23 and the outer end of this link is pivotally connected to the link 31 by a pivot pin 43. The link 31 is in turn pivotally connected to the releasable supporting lever by a pivot pin 47. The lever 33 is pivotally mounted on a pivot pin 49 extending transversely between the sides of the U-shaped frame 27. The legs of the U-shaped operating lever 35 are pivotally mounted at 36 on the sides of the frame 27, and this operating member has an operating handle 51 of insulating material secured to the outer end thereof. A knob portion of the operating handle projects through an elongated slot provided therefor in the cover 7. The pair of overcenter springs 39 are disposed on opposite sides of the lever 33 and link 31 and are connected at one end to the knee pivot pin 43 of the toggle and at the other end are connected to the outer end of the U-shaped operating lever 35. The carrier lever 33 is always biased in a counterclockwise direction by the operating springs 39 but is normally restrained or latched in the position shown in Fig. 1 by a latch of the trip device which will be hereinafter described. When the carrier lever is thus restrained in latching position, it forms a fixed support for the outer end of the operating toggle to permit manual operation of the breaker. When the breaker is in closed position, the contacts are restrained in this position by the carrier lever 33 as long as it is held in latched position, as shown in Fig. 1. To manually open the circuit breaker, the operating handle 51 is moved downwardly to the "off" position. This moves the line of action of the springs 39 below the pivot 47, causing the toggle 29—31 to collapse and the switch arm 21 to be moved to open position with a snap action. To manually close the circuit breaker, the operating handle 51 is moved upwardly to the "on" position shown. This movement of the handle moves the line of action of the springs 39 above the pivot 47 whereupon the toggle is actuated to the extended position shown and the switch arm 21 consequently moved to closed position with a snap action.

Automatic opening of the circuit breaker in response to an overload condition occurs when the trip device effects release of the carrier lever 33. When the carrier lever is thus released, it is moved in a counterclockwise direction by the operating springs 39 causing the toggle 29—31 to collapse and the switch arm 21 to move to open position with a snap action. During this operation, the operating handle is moved to an intermediate indicating position by shifting of the position of the operating springs 39. Before the breaker can again be closed, the releasable lever 33 must be reset to latched position to reset the mechanism. This is accomplished by moving the operating handle downwardly as far as it will go in the "off" direction. A resetting projection 53 on the operating member moves the carrier lever 33 back to its latched position upon resetting movement of the operating handle to the "off" position.

The trip device includes a flat straight strip or bar 55 of bimetallic material which may be formed by stamping the same from a stock sheet of bimetallic material. In accordance with the invention, the bimetal element is pivotally mounted intermediate its ends and at its center of gravity on a supporting bracket 57 or other suitable supporting means.

The bracket 57 is secured to the base by means of a screw 58 and has a pair of downwardly bent ears or projections 59 formed integral therewith at the outer end thereof. As a convenient means of pivoting the bimetal element, it is formed with a pair of projections 61 (Fig. 2) extending from the opposite side edges thereof. A pair of cylindrical sleeves or washers 63 preferably, although not necessarily, of insulating material are mounted on the pivot projections 61 of the bimetal element. The sleeves 63 are rotatably engaged in cylindrical bearing openings provided in the spaced depending projections 59 of the bracket 57. The bimetal element is thus mounted for pivotal movement on the supporting projections 59 of the bracket. In making the device the parts are so constructed that the pivot axis of the bimetal element will be located as closely as possible to the center of gravity of the bimetal element so that this element will as nearly as possible be statically and dynamically balanced with respect to its pivot. The bimetal element 55 is disposed with its high expansion side nearest the breaker mechanism. When the bimetal element is heated a predetermined amount, it will deflect in a direction to release the lever 33 of the circuit breaker mechanism. An adjusting screw 65 extending through a bracket 67 secured to the base 5 is disposed to engage the low expansion side of the bimetal element 55 adjacent the inner end of the element. This inner end of the bimetal element is maintained against the adjusting screw 65 by means of a helical tension spring 87 disposed between the inner end of the bimetal element and the base. A latch element 69 is carried by the outer free end of the bimetal element 55 for engaging a curved latch piece 71 secured to the lower end of the releasable carrier lever 33 to normally restrain the carrier member in the latched position shown in Fig. 1. The curved latch piece 71 is insulated from the carrier lever so that no current will flow through the carrier lever to the element 55. The latch element 69 is adjustable in order to adjust the amount of latch overlap between it and the latch piece 71 and for this purpose the latch element has a threaded portion which threads through a washer secured in an opening provided therefor in the outer end of the bimetal element 55. The lower threaded end of the latch element 69 is provided with a screwdriver slot to permit adjustment of the latch element.

The bimetal element 55 is adapted to be heated in response to the current of the circuit through the breaker and for this purpose a portion of the bimetal element is connected in series circuit with the contacts of the breaker. The outer end of the bimetal element is electrically connected by a flexible shunt conductor 85 to the lower terminal 11. Another flexible shunt conductor 74 connected at its upper end to the switch arm 21 has its lower end connected to the magnet 75 which is connected by flexible conductor 83 to the inner end of the bimetal element 55.

When the breaker is in the closed position, the current of the circuit flows therethrough from the upper terminal 9, through the contacts 13 and 15, switch arm 21, flexible shunt conductor 74, magnet 75, flexible conductor 83, through the bimetal element 55, and through the flexible shunt conductor 85 to the lower terminal 11 of the circuit breaker. The flow of normal rated current through the breaker does not produce sufficient heating of the bimetal element to cause

a substantial amount of bending thereof. When an overload occurs in the circuit, however, the overload current heats the bimetal element and when heated a predetermined amount by the overload current, the bimetal element bends or deflects to the position indicated by the dotted lines in Fig. 1, thereby causing the latch element 69 to disengage the latch piece 71 and effect release of the carrier lever 33. The circuit breaker mechanism is thereupon tripped and the contacts automatically opened in the manner previously described.

In operating to trip the breaker as just described, when the bimetal element reaches the temperature at which it begins to warp or bend, the inner end of the element presses against the adjusting screw 65 with a force proportional to the latch load. Since the pivot of the bimetal is fixed, the bending motion of the portion of the bimetal between its pivot 61 and its inner end is transmitted to the outer half of the bimetal as rotary motion about the pivot, and this motion plus the bending or deflecting movement of the outer half of the bimetal element between the pivot and the latch end effects movement of the latch 69 downwardly to released position. As a result of this mounting of the bimetal at its midpoint the bimetal element is capable of exerting a much larger tripping force than conventional bimetal trip elements which are fixedly mounted at one end.

The time required for heating the bimetal element a predetermined amount by the overload current introduces a time delay prior to tripping of the breaker. This time delay varies inversely as the magnitude of the overload current so that the breaker will be tripped more quickly in response to heavy overload currents than in response to lower overload currents.

By pivotally mounting the bimetal element 55 at its center of gravity, the trip device is made substantially shock proof, that is, the bimetal element will not be falsely operated to trip the breaker in response to shocks or vibration. The mounting arrangement of the bimetal element possesses another important advantage as explained above, namely that due to the leverage obtained, the bimetal element is capable of exerting a tripping force many times larger than conventional bimetal trip elements of the same size which are fixedly mounted at one end.

One feature of the invention is that an electromagnet is provided for moving the bimetal element about its pivot to trip the breaker instantaneously upon the occurrence of heavy overloads or short circuits. The electromagnet 75 is mounted on the bracket 57 adjacent the inner end of the bimetal element 55 on the side thereof opposite the adjusting screw 65. The electromagnet comprises a U-shaped core 77 (Fig. 4) of magnetic material and a coil or energizing winding 79 wound upon one leg of the core. The ends of the legs of the core 77 are disposed in spaced relation to the inner end of the bimetal element 55 so that an air gap is provided between this end of the bimetal element and the two pole faces of the core 77. Since the bimetal element is at least partly of magnetic material, the inner end thereof adjacent the core 77 forms the armature of the electromagnet and is adapted to be attracted against the pole faces of the electromagnet when the coil 79 is energized a predetermined amount.

With the connection shown in Fig. 1, substantially the whole length of the bimetal element is

directly heated by current flow. If longer time delay operation of the bimetal is desired, the conductor 85 may be connected to an intermediate point of the bimetal element 55 so that only a portion of the bimetal element is directly heated by current flow, the remaining portion being heated indirectly by conduction.

The electromagnet 75 is not energized a sufficient amount to move the bimetal element 55 against the force of the spring 87 by normal rated current or by overload currents up to a predetermined value. However, when an overload above a predetermined value, for example, an overload current above 8 to 10 times the normal rated current, occurs in the circuit, the electromagnet 75 is sufficiently energized thereby to strongly attract the inner end of the bimetal element 55 and move the element about its pivot 61 in a releasing direction, thereby releasing the latch 69—71 and tripping the circuit breaker. The bimetal element 55 is actuated substantially instantaneously by the electromagnet so that tripping of the breaker takes place substantially instantaneously upon the occurrence of an overload above the predetermined magnitude.

The electromagnet 75 in this modification of the invention is located adjacent the inner end of the bimetal element 55 substantially directly opposite the stop screw 65, and since this end of the bimetal element is maintained in engagement with the screw during bending or warping of the bimetal element in response to overloads, the air gap of the electromagnet remains substantially constant and is not changed to any substantial degree by such warping or bending of the bimetal element. Consequently, the instantaneous tripping point provided by the electromagnet 75 remains constant and is not changed by thermal deflection of the bimetal element.

It will be noted that the bimetal element 55 is free to deflect or bend as far as it wants to when the element is heated in response to overload current, and heat deflection or bending of the element is not obstructed by the electromagnet 75 even when the inner end of the bimetal element has been moved into engagement with the poles of the electromagnet during magnetic tripping. Consequently, the calibration and accuracy of thermal operation of the bimetal trip element remains constant and is not changed after tripping of the breaker on heavy overloads or short circuits. This is because the bimetal element is free to bend in response to heating thereof and is not subjected to stresses which might change its calibration.

Another modification of the invention is shown in Fig. 3. This modification is similar in structure to the embodiment shown in Fig. 1 except that the electromagnet 75' in this instance is mounted adjacent a portion of the bimetal element 55 which deflects or materially changes its position when the bimetal element bends or warps when heated by overload current. This results in a cooperative thermal and magnetic trip action wherein tripping of the breaker is at times effected as a result of the joint action of both thermal bending of the bimetal element and the magnetic attraction of the instantaneous tripping electromagnet.

Except for the change in location of the electromagnet, the parts and structure of this modification are identical to the embodiment shown in Fig. 1 and previously described, and it is therefore unnecessary to describe the structure again.

Parts identical to those shown in Fig. 1 are identified by the same reference character.

Referring to Fig. 3, the electromagnet 75' is mounted on the bracket 57 in a position such that its pole faces are disposed opposite a portion of the bimetal element substantially midway between the pivot 61 and the inner end of the bimetal element. This portion of the bimetal element opposite the pole faces of the magnet is deflected a substantial amount toward the magnet poles when the bimetal element bends in response to overload currents. Consequently, as the bimetal element starts to bend in response to heating thereof by overload current, the portion thereof opposite the pole faces of the electromagnet 75' move closer to the magnet shortening the air gap therebetween. The reluctance of the magnetic circuit is thus decreased so that the pull of the electromagnet on the bimetal element increases considerably until a point is reached at which the electromagnet suddenly actuates the bimetal element 55 about its pivot 61 thereby releasing the latch and tripping the circuit breaker. With this construction, the circuit breaker will be tripped with shorter time delay action on overloads of intermediate value than in the case of the embodiment shown in Fig. 1.

The electromagnet 75' in Fig. 3 is also operable to effect instantaneous tripping of the circuit breaker upon the occurrence of an overload current above a predetermined value, for example, above 8 to 10 times the normal rated current. When an overload above the predetermined magnitude occurs, the pull of the electromagnet 75' on the bimetal element 55 becomes sufficient to move the bimetal element 55 about its pivot 61 thereby releasing the latch and tripping the breaker. The instantaneous magnetic tripping operation takes place independently of any heat deflection of the bimetal element.

In the Fig. 3 modification, the major portion of the bimetal element is free to deflect when heated without obstruction by the electromagnet, even though the inner portion of the bimetal element has been moved to attracted position against the magnet.

In each of the embodiments of the invention, the trip device can be calibrated or adjusted by means of the screw 65 or the adjustable latch 69. In the Fig. 3 embodiment, thermal trip calibration or adjustment may be obtained by means of the adjustable latch 69 and the magnetic or instantaneous tripping point adjusted by means of the screw 65.

It will be understood that a separate armature for the electromagnet may be attached to the bimetal element 55 instead of relying on the magnetic material in the bimetal element itself for the armature.

The element 55 need not be entirely of bimetallic material throughout its entire length. A portion of the length of the element may be of a single metal. If a longer delay is desired, a part of the element 55 may be constructed of heating resistance material and serve as the heater to heat the remaining portion of bimetallic material.

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

I claim as my invention:

1. In a circuit breaker, a trip device comprising a bimetal trip element heated in response to current of the circuit and having a high expansion side and a low expansion side, means pivotally mounting said bimetal element adjacent its mid-portion, stop means engaging the low expansion side of said element adjacent one end thereof and permitting pivotal movement of said end away from the stop means, said bimetal element bending when heated a predetermined amount in response to overload current to cause tripping of the circuit breaker, and electromagnetic means energized in response to the current of the circuit and acting on said bimetal element on the same side of its pivot as does said stop means for moving said bimetal element about its pivot to instantaneously cause tripping of the breaker upon the occurrence of an overload current above a predetermined magnitude.

2. In a circuit breaker, a trip device for tripping the breaker comprising a bimetal trip element heated in response to the current of the circuit and having a high expansion side and a low expansion side, means pivotally mounting said bimetal element adjacent its mid portion, stop means engaging the low expansion side of said element adjacent one end thereof, said bimetal element bending when heated a predetermined amount in response to overload current to cause tripping of the circuit breaker, an electromagnet energized in response to the current of the circuit operable to move said bimetal element about its pivot to cause tripping of the breaker upon the occurrence of an overload current in the circuit above a predetermined magnitude, and said electromagnet acting on said bimetal element adjacent said stop means so that the major portion of said bimetal element can bend its maximum amount free of restraint by said electromagnet.

3. In a circuit breaker, a trip device for tripping the breaker comprising a bimetal trip element heated in response to the current of the circuit and having a high expansion side and a low expansion side, means pivotally mounting said bimetal element intermediate its ends, stop means engaging the low expansion side of said element adjacent one end thereof, spring means acting on said one end to bias it in engagement with said stop means, said bimetal element bending when heated a predetermined amount by overload current to cause tripping of the circuit breaker, an electromagnet energized in response to the current and mounted adjacent said one end of said bimetal element on which said spring acts and on the high expansion side thereof, said electromagnet being operable to move said bimetal element about its pivot to cause tripping of the circuit breaker upon the occurrence of an overload current above a predetermined magnitude in the circuit.

4. In a circuit breaker, a trip device therefor comprising a bimetal trip element heated in response to the current of the circuit and having a high expansion side and a low expansion side, means pivotally mounting said element intermediate its ends, stop means engaging the low expansion side of said element adjacent one end thereof, spring means biasing said one end of said element in engagement with said stop means, said bimetal element bending when heated a predetermined amount in response to overload current to cause tripping of the circuit breaker, and

an electromagnet energized in response to the current of the circuit and mounted between said stop means and the pivot and adjacent a portion of the bimetal element that substantially deflects when the bimetal element is heated a predetermined amount by overload current, said electromagnet being operable to move said bimetal element about its pivot to cause tripping of the breaker upon the occurrence of an overload current above a predetermined magnitude.

5. In a circuit breaker, a trip device therefor comprising a bimetal trip element heated in response to the current of the circuit and having a high expansion side and a low expansion side, means pivotally mounting said element intermediate its ends, stop means engaging the low expansion side of said element adjacent one end thereof, spring means biasing said one end of said element in engagement with said stop means, said bimetal element bending when heated a predetermined amount in response to overload current to cause tripping of the circuit breaker, and an electromagnet energized in response to the current of the circuit mounted adjacent said bimetal element on the high expansion side at a position along the length of the bimetal element intermediate the pivot and the said one end of the bimetal element, said electromagnet being operable to move said bimetal element about its pivot to trip the circuit breaker upon the occurrence of an overload in the circuit above a predetermined magnitude.

6. In a circuit controlling device, a substantially straight bimetallic control element having a high expansion side and a low expansion side, means pivotally mounting said element adjacent its mid portion, stop means engaging the low expansion side of said element adjacent one end thereof, spring means biasing said element in engagement with said stop means, said bimetal element bending when heated a predetermined amount to move its other end to effect operation of said device, and electromagnetic means operative in response to predetermined conditions to act on said bimetallic element a a point on the opposite side of the pivot from said other end and thereby move said bimetal element about its pivot to effect operation of said device.

7. In a circuit breaker having relatively movable contacts and operating means therefor including a member releasable to cause opening of

said contacts, a current responsive bimetal trip element heated in response to the current of the circuit and having a high expansion side and a low expansion side, means pivotally mounting said element intermediate its ends, an adjustable stop engaging the low expansion side of said element adjacent one end thereof, a latch portion at the other end of said element for normally engaging and restraining said releasable member, said bimetal element bending when heated a predetermined amount in response to overload current to cause said latch to release said releasable member, and an electromagnet energized by the current of the circuit and mounted adjacent said bimetal element at the opposite side of the pivot from said latch portion for moving said bimetal element about its pivot to cause said latch portion to release said member upon the occurrence of an overload current above a predetermined magnitude.

8. In a circuit controlling device, a bimetallic element responsive thermally to a condition of the circuit, mounting means for said bimetallic element holding a point adjacent one end and a point intermediate the ends of said element substantially stationary during thermal bending of the bimetallic element to cause deflection of the other end thereof, means for controlling the circuit actuated by said other end of the bimetallic element, and magnetic means acting only on said bimetallic element at a point on the opposite side of said intermediate point from said other end which is thermally deflected for also causing deflection of said other end.

MELVIN BINGENHEIMER.

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