July 12, 1960 D. F. MOYER 2,944,324

METHOD OF ASSEMBLING A CIRCUIT BREAKER

Original Filed Sept. 4, 1953 2 Sheets-Sheet 1

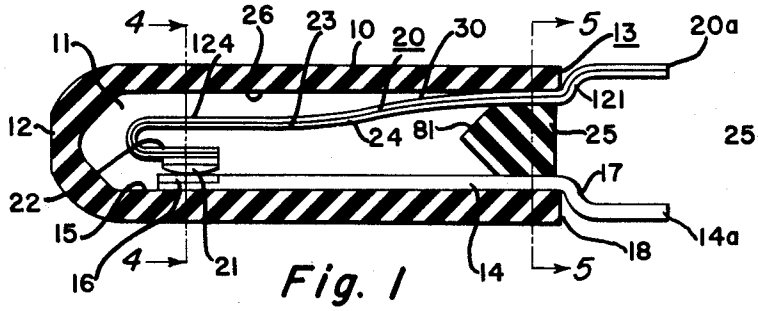


Fig. 1

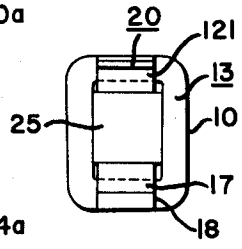


Fig. 2

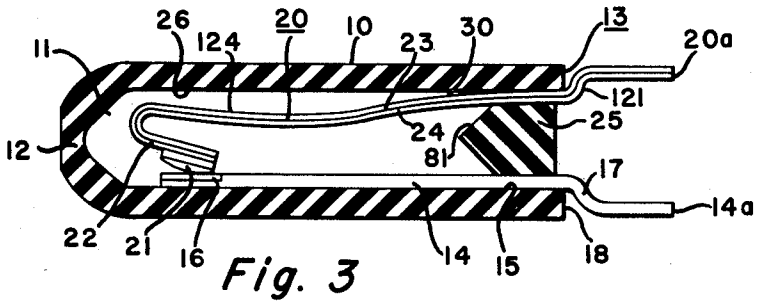


Fig. 3

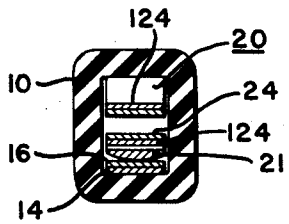


Fig. 4

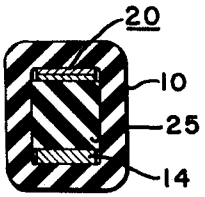


Fig. 5

INVENTOR.
David F. Moyer
BY John T. Marmion
His Attorney

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METHOD OF ASSEMBLING A CIRCUIT BREAKER

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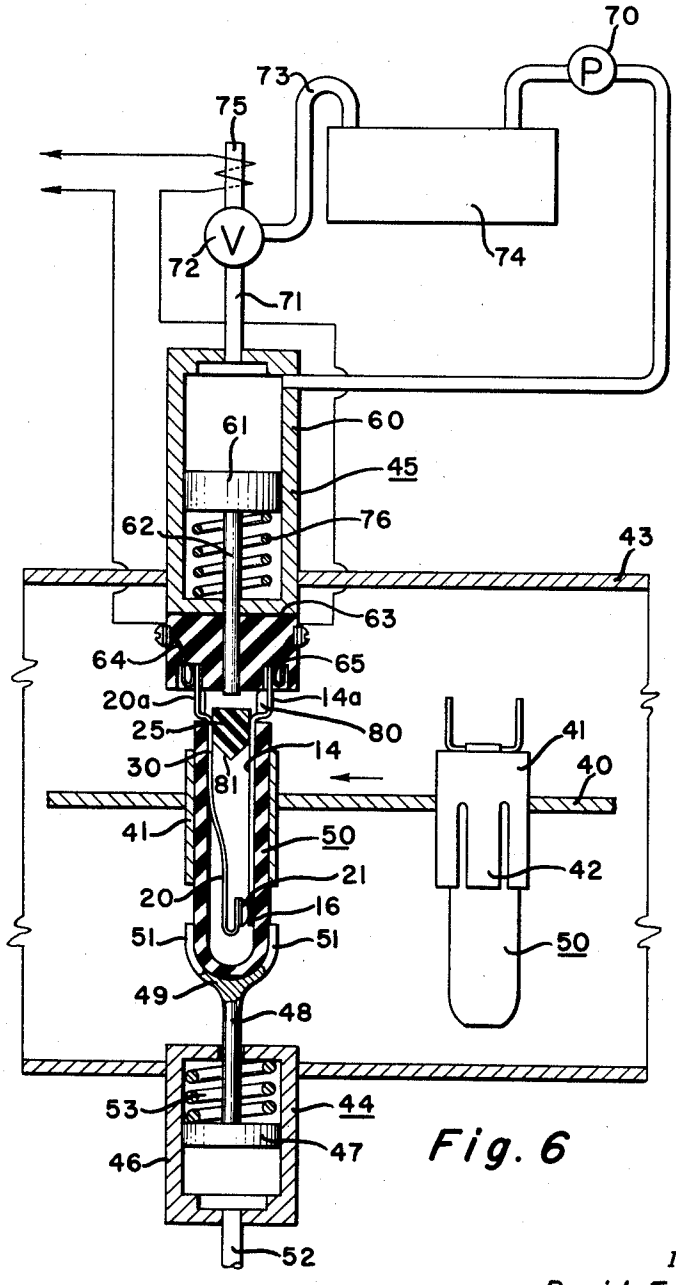


Fig. 6

INVENTOR.
David F. Moyer
BY John T. Harvin
His Attorney

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METHOD OF ASSEMBLING A CIRCUIT BREAKER

David F. Moyer, Dayton, Ohio, assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Original application Sept. 4, 1953, Ser. No. 378,555, now Patent No. 2,743,335, dated Apr. 24, 1956. Divided and this application Feb. 14, 1956, Ser. No. 565,416

5 Claims. (Cl. 29—155.5)

This invention relates to a thermal control device, and particularly to a small inexpensive thermostat for making and breaking electric circuit in response to ambient temperature conditions, and a method of assembling and initially adjusting the thermal control device.

This application is a division of S.N. 378,555, filed September 4, 1953, now Patent No. 2,743,335.

The device of this invention particularly concerns thermal control devices of the bimetallic type wherein deflection of a bimetal member directly effects opening and closing of a pair of contacts, and even more specifically wherein a contact member is carried directly by a bimetal arm that deflects relative to a second contact carrying member to open and close the contacts by deflection of the bimetallic arm. In such controlled devices there is a point at which the contacts are about ready to open, this point resulting in substantially no contact pressure between the contacts which results in a high resistance to flow of electric current between the contacts thereby effecting heating of the bimetal member with resultant disturbance in the calibration of the movement of the bimetallic member.

Further, when such a control device closes contacts, the initial closing of the contact carried by the bimetallic arm upon the closing contact is at a time when very light contact pressure exists between the contacts. Here again the light contact pressure results in high contact resistance causing heating of the bimetal with resultant opening of the contacts. Such opening of the contacts causing cooling of the bimetal and reclosing of the contacts until such times as deflection of the bimetal is sufficiently strong to establish sufficient contact pressure upon closing of the contacts as will reduce the contact resistance sufficiently as to substantially eliminate the heating of the bimetal. Such operation of the thermal control device results in erratic control operations and a high degree of arcing of the contacts.

It is therefore an object of this invention to provide a simplified structure of a thermal control device incorporating a direct acting contact carrying bimetallic arm which will eliminate the aforementioned difficulties by effecting an increase of contact pressure at the time the contacts are opening or immediately after the initial closing of the contacts until the bimetallic arm has sufficient deflection under ambient temperature conditions to result in either a positive opening or closing of the contacts with resultant elimination of the contact resistance heating and normal deflection of the bimetallic member under response to ambient temperature conditions.

It is still another object of the invention to provide a thermal control device in accordance with the foregoing object wherein the bimetallic arm is provided with a return bend portion that carries a contact member, the return bend portion having less deflection in response to ambient temperature conditions than the main portion of the bimetallic arm to thereby render the bimetallic

arm sensitive only to ambient temperature responses but with the return bend portion being directly responsive to contact resistance heating to establish thereby increased contact pressure without effecting any substantial change in the responses of the main bimetallic arm to ambient temperature changes.

It is another object of the invention to provide a simplified structure of a direct acting bimetal thermal control device which is completely sealed and provided with an initial factory setting by deflection of the bimetal member under controlled conditions.

It is another object of the invention to provide a method to establish an initial factory adjustment on a direct acting bimetal thermal control device of the type referred to in the foregoing objects wherein the control device controls its own initial setting.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of the invention is clearly shown.

In the drawings:

Figure 1 is a longitudinal cross sectional view of a thermal control device incorporating features of this invention.

Figure 2 is an end view of the device of Figure 1, as viewed from the right hand end thereof.

Figure 3 is a longitudinal cross sectional view similar to Figure 1 but illustrating the device under certain conditions of operation.

Figure 4 is a transverse cross sectional view taken along line 4—4 of Figure 1.

Figure 5 is a transverse cross sectional view taken along line 5—5 of Figure 1.

Figure 6 is a schematic view of an apparatus providing a method for establishing initial factory adjustment of the thermal control device of this invention.

Referring to Figures 1 to 5, the thermal control device comprises a hollow casing 10 having a substantially rectangular chamber 11 therein. The end 12 of the casing is closed while the end 13 is open. A current conducting arm 14 is placed within the chamber 11 and rests against the side 15 of the rectangular opening in the casing 10.

The current conducting arm 14 has a contact portion 16 on one end thereof. The opposite end of the member 14 has a formed portion 17 that engages the end wall 18 of the casing 10 to control the entry of the arm 14 into the casing 10 and thus the position of the contact member 16 is controlled relative to the end 18 of the casing 10.

A bimetal thermal control arm 20 is placed within the opening 11 of the casing 10. This arm 20 has a formed portion 121 that engages the end wall 18 of the casing 10 to control the entry of the bimetal member 20 into the opening 11, and thus position the contact 21 on the end thereof in cooperating engagement with the contact 16 on the current conducting arm 14. The bimetal member 20 is also a current conducting member.

The bimetal arm 20 has one end thereof provided with a return bend portion forming a leg portion 22 that is substantially shorter than the main bimetal leg portion 23. Since the bimetal member 20 is adapted to move the contact 21 from the contact 16 upon a rise in ambient temperature, the high expansion metal of the bimetal member 20 will be on the side 24 thereof with the low expansion metal being on the side 124. Thus, the return bend leg portion 22 is adapted to deflect downwardly, as viewed in Figure 1, while the leg portion 23 deflects upwardly, in response to a rise in temperature.

However, since the leg portion 22 has a total length that is substantially less than the total length of the leg 23, the degree of deflecting activity of the leg portion 22

in response to ambient temperature conditions will be substantially less than the degree of deflection activity of the leg 23 in response to small rise in temperature such as that occurring in ambient temperatures surrounding the thermal control device. Thus, it can be said that the leg portion 22 is substantially insensitive to rise in ambient temperature to which the leg portion 23 of the bimetal member readily responds.

The bimetal member 20 is of uniform thermal and physical characteristics from one end to the other thereof so that normal conduction of current through the bimetal member 20 will not affect its response to ambient temperature conditions. The bimetal member 20 is not a current sensitive device, as this term is normally used, since the bimetal 20 is adapted in this invention to carry the normal current load required of the device without sufficient heating of the bimetal as to affect its response to ambient temperature conditions.

The bimetal member 20 and the current conducting arm 14, which is a temperature and current insensitive material, relatively speaking, are retained in position in the casing 10 by means of a spacing member 25. The spacing member 25 frictionally engages the members 20 and 14 to hold them in engagement with the sides 15 and 26 respectively of the rectangular opening 11 in the casing 10. Also, the spacing member 25 provides means for establishing the initial opening point of the contact 21 from the contact 16 in a manner hereinafter described.

The bimetal member 20 has an angular portion 30 that is engaged by the spacer member 25 for the purpose of regulating the initial opening point of the contact 21 from the contact 16.

Assuming the thermal control device to have been assembled and properly adjusted, in a manner hereinafter described, the bimetal member 20 will therefore open contact 21 from contact 16 at a predetermined temperature upon a rise in temperature.

Since the movement of the bimetal 20 is a slow movement, the break between the contact 21 and the contact 16 is made extremely slow. Thus, a position of the bimetal 20 is reached at which the contact 21 barely touches the contact 16 with resulting loss of any substantial contact pressure between the contacts.

This loss of contact pressure between the contacts 21 and 16 results in a high resistance being established between the contacts 21 and 16 which causes substantial heating. This heating resulting from contact resistance, is transmitted to the end portion 22 of the bimetal 20, and since the degree and rate of heat involved is substantially above that at which the ambient temperature is affecting the leg portion 23 of the bimetal, the leg portion 22 of the bimetal will deflect downwardly, as viewed in Figure 1, to increase the pressure of the contact 21 upon the contact 16 and thereby substantially reduce the contact resistance between the contacts. However, since the leg portion 22 is substantially shorter than the leg portion 23, and substantial travel is required for the heat entering the leg 22 to be transmitted to the leg 23 of the bimetal, and a large dissipating area is provided in the leg portion 23, the leg portion 23 of the bimetal 20 will be substantially insensitive to the heat effect of the leg portion 22 of the bimetal 20.

Thus, the resistance heating of the leg portion 22 provides deflection of this leg portion relative to the leg portion 23 to increase the contact resistance without any substantial effect on the responsiveness of the leg 23 of the bimetal 20 to ambient temperatures.

With the leg portion 22 deflected downwardly to increase the contact pressure between the contacts 21 and 16 a further rise in ambient temperature is required to move the leg portion 23 upwardly until such time as the leg portion 23 physically disconnects the contact 21 from the contact 16. Instantly upon such disconnection heating of the leg portion 22 ceases so that the leg portion 22 moves upwardly to further increase the gap 16 and the contact 21. This insures positive opening of the contact 21 from the contact 16.

Also, since there was required an increase rise in ambient temperature sufficient to produce physical breaking of the contact 21 from the contact 16 above that which would normally be required without any deflection of the leg portion 22, a substantial decrease in ambient temperature is required before the contact 21 again closes on contact 16. This creates the desired temperature differential of operation to the thermal control device.

Upon closing of contact 21 upon contact 16, the light contact pressure occurring at the instant of closing again results in high resistance to flow of current between the contacts and resultant heating of the leg portion 22 of the bimetal 20. The quick response of the leg portion 22 to the heating effect of the contact resistance deflects the leg portion 22 downwardly to increase the contact pressure and thereby prevent reopening of the contacts after the initial closing. This insures positive closing of the contacts and elimination of arcing.

In Figure 3 there is illustrated the thermal control device of this invention wherein the bimetal member 20 has the leg portion 23 thereof and the leg portion 22 deflected in a manner occurring at the instant of initial contact break between the contact 21 and the contact 16.

The thermal control device illustrated in Figures 1–5 is assembled by first placing the current conducting member 14 and the bimetal member 20 within the casing 10 with the formed portions 17 and 121 respectively engaging the end wall 18 of the casing 10. The spacer member or plug 25 is then inserted between the members 14 and 20 to frictionally retain them in the position illustrated in Figure 1. At this time however the initial calibrated break point between contact 21 and contact 16 has not been established.

An apparatus and method to establish the initial break point between the contact 21 and the contact 16 is illustrated in Figure 6. This apparatus comprises a transfer belt 40 having a plurality of sleeves 41 secured therein. The sleeves 41 have flexible fingers 42 adapted to receive and frictionally engage a thermal control device 50.

The transfer belt 40 passes through a chamber 43 that has the temperature thereof controlled internally at a predetermined value. The transfer belt 40 moves the control device 50 positioned thereon to a work-station position at which there is provided a fluid motor 44 and a fluid motor 45 disposed in alignment. The fluid motor 44 comprises a cylinder 46 having a piston 47 that carries a plunger 48 provided with a cup shaped member 49 on the end thereof that is adapted to engage the bottom end of the control device 50 that is moved into alignment with the fluid motor 44. The cup shaped member 49 has flexible fingers 51 adapted to engage the thermal control device 50.

The fluid motor 44 has a pressure connection 52 for moving the piston 47 upwardly. An internal spring 53 in the motor 44 is provided for retracting the piston 47 and the plunger 48.

The fluid motor 45 comprises a cylinder 60 having a piston 61 provided with a plunger 62 that projects through a guide sleeve 63 of insulating material and is adapted to engage the spacer or plug 25 of the thermal control device 50. Electric spring contacts 64 and 65 are provided in the insulating guide sleeve 63 for engagement by the terminal ends 14*a* and 20*a* of the current conducting arm 14 and the bimetal 20 respectively.

The cylinder 60 is supplied with fluid under pressure from any suitable source, such as the pump 70. The cylinder 60 has an outlet 71 controlled by an electrically operated valve 72, the valve 72 being adapted to open or close the outlet connection 71 of the cylinder 60 with a conduit 73 that returns to a reservoir 74 from which the pump 70 is supplied.

The electrically operated valve **72** has a solenoid actuator **75** that is in series circuit with the spring contacts **64** and **65** and is energized when the thermal control device **50** has the terminals thereof engaging the spring contacts.

A spring **76** is provided to return the piston **60** and thus the plunger **62**.

When a thermal control device **50** is moved into alignment with the fluid motors **44** and **45**, the fluid motor **44** is supplied with fluid under pressure through the conduit **52** to move the piston **47** upwardly and thus move the terminal ends **20***a* and **14***a* into engagement with the spring contacts **64** and **65**. The upward position of the control device **50** relative to the fluid motor **45** is controlled by a stop **80** that engages the end wall **18** of the casing **10** of the control device.

The control device is assembled with the contacts **21** and **16** in closed position. Thus the contacts in the control device **50** close circuit for the valve **72** to provide closing of the valve and thus entrapment of fluid under pressure within the cylinder **60** above the piston **61** to cause the plunger **62** to move downwardly. When the plunger **62** moves downwardly it engages the plug or spacer member **25** to move it longitudinally between the current conducting member **14** and the bimetal member **20** with the forward wall **81** of the plug **25** engaging the angular portion **30** of the bimetal member **20**. This forward movement of the plug **25** deflects the bimetal member **20** tending to move the contact **21** away from the contact **16**.

Since the operation of moving the plug **25** forwardly into the casing **10** of the control device occurs in a controlled temperature atmosphere at a temperature at which the control switch will normally break contact or circuit through the same, the initial setting of the control device is occasioned under actual operating conditions. Thus the initial break of the contact **21** from the contact **16** will be occasioned under temperature conditions representing actual working conditions with the bimetal **20** free to function under its normal operating conditions heretofore described.

When the plug **25** is moved inward of the casing **10** a sufficient distance to cause the initial break of contact **21** from contact **16**, electric circuit will be broken through the electrically controlled valve **72** to immediately stop further advancement of the plunger **62** of the fluid motor **45**. The valve **72** at this time opens to release pressure from above the piston **61** to allow the plunger **62** to return under the action of the spring **76** to its normal position.

Thereafter, pressure is released from the fluid motor **44** to allow return of the piston **47** by the spring **53** and withdrawal of the control device **50** from engagement with the spring contacts **64** and **65** so that the transfer belt **40** can be moved forwardly to place another control device in the work-station.

While the form of embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted as may come within the scope of the claims which follow.

What is claimed is as follows:

1. The method of effecting a predetermined opening point between the contacts of a thermal control device having a pair of longitudinally extending contact carrying arms at least one of which is a bimetallic arm and positioned in spaced fixed relationship at one end thereof with cooperating contacts at the opposite ends, the steps of, effecting stabilized deflection of the bimetallic arm at a predetermined controlled temperature, establishing a signal current of predetermined value across the said contacts and through said bimetallic arm to heat the arm to normal operating temperature, and inserting a spacer member between the spaced arm ends in frictional engagement therewith and then moving the spacer longitudinally between the arms in engagement with the said one arm to separate the arms until the contacts on the ends thereof effect initial opening as reflected by a discontinuance of the signal current.

2. The method of effecting a predetermined opening point between the contacts of a thermal control device having a pair of longitudinally extending contact carrying arms at least one of which is a bimetallic arm and positioned in spaced fixed relationship at one end thereof with cooperating contacts at the opposite ends and with one portion of one of the arms at the spaced fixed ends disposed angular to the other arm, effecting stabilized deflection of the bimetallic arm at a predetermined controlled temperature, establishing a signal current of predetermined value across the said contacts and through said bimetallic arm, and inserting a spacer member between the spaced arm ends in frictional engagement therewith and then moving the spacer longitudinally between the arms in engagement with the angular portion of the said one arm to separate the arms until the contacts on the ends thereof effect initial opening as reflected by a discontinuance of the signal current.

3. The method of effecting a predetermined opening point between the contacts of a thermal control device having a contact member and a flexible bimetallic arm positioned with a contact on one end engageable with said contact member and having the opposite end engaging a stop to position the bimetallic arm in operating relationship with said contact member for engagement of the contact on the bimetallic arm with said contact member, the steps of, effecting stabilized deflection of the bimetallic arm at a predetermined controlled temperature, establishing a signal current of predetermined value across the said contacts and through said bimetallic arm to heat the arm to normal operating temperature, and then moving an arm positioning member longitudinally of the bimetallic arm in engagement therewith to flex the arm relative to the contact member until initial opening is effected between the said contact member and the contact on said arm as reflected by a discontinuance of the signal circuit.

4. The method of effecting a predetermined opening point between the contacts of a thermal control device contained in a closed casing having a contact member in a fixed position within the casing and a flexible bimetallic arm positioned in the casing with a contact on one end engageable with said fixed contact member and having the opposite end fixed within the casing to position the bimetallic arm within the casing, the steps of, effecting stabilized deflection of the bimetallic arm at a predetermined controlled temperature, establishing a signal current of predetermined value across said contact, and through said bimetallic arm to heat the arm to normal operating temperature, and then moving an arm positioning member longitudinally of the bimetallic arm in engagement therewith to flex the arm relative to the contact member until initial opening is effected between the said contact member and the contact on said arm as reflected by a discontinuance of the signal current.

5. The method of effecting a predetermined opening point between the contacts of a thermal control device contained in a closed casing having a contact member in a fixed position within the casing and a flexible bimetallic arm positioned in the casing with a contact on one end engageable with said fixed contact member and having the opposite end fixed within the casing to position the bimetallic arm within the casing with the contact on the bimetallic arm in cooperating engagement with said fixed contact and having an angular portion at the fixed end thereof, the steps of, inserting a closure plug member into one end of the casing to close the same and in frictional engagement with said bimetallic arm to retain the fixed end thereof in position in said casing, establishing a signal circuit of predetermined value across the contacts of the control device and through said bi-

metallic arm to heat the arm to normal operating temperature, establishing stabilized deflection of the bimetallic arm at a predetermined temperature, then moving the plug member longitudinally of the bimetallic arm in engagement with the angular portion thereof to flex the arm relative to the contact member until the signal circuit signals initial opening of the said contacts and concurrently therewith and in response thereto stopping movement of the plug relative to the bimetallic arm whereby to fix the opening point of the contact.

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