April 25, 1967 C. L. NELSON 3,316,374

THERMOSTAT WITH AN IMPROVED HEAT ANTICIPATION MEANS

Filed March 1, 1965

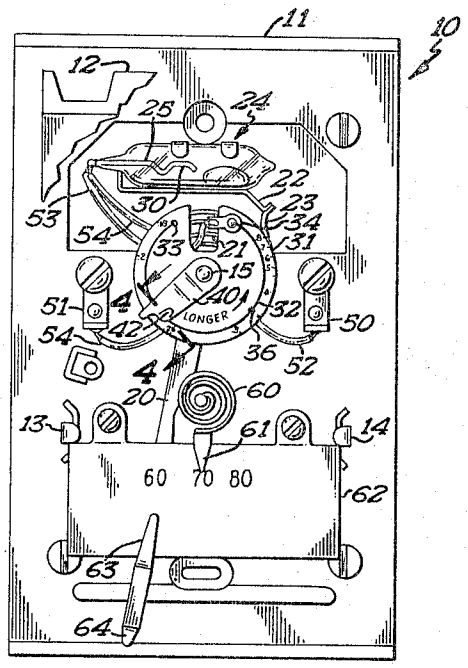


Fig 1

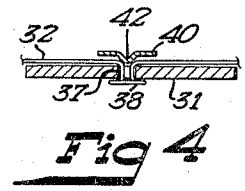


Fig 4

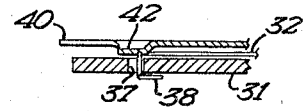


Fig 5

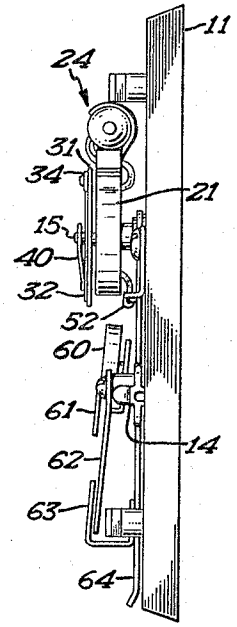


Fig 2

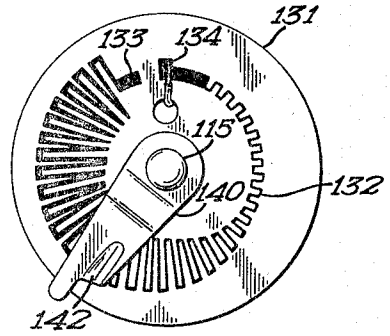


Fig 3

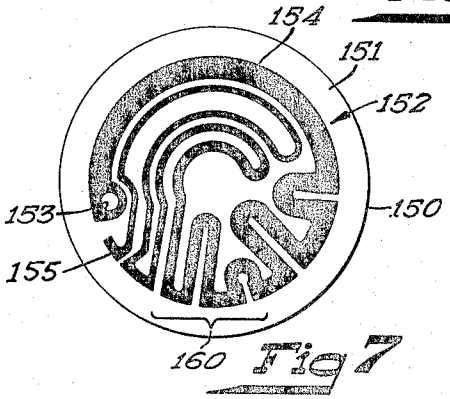


Fig 7

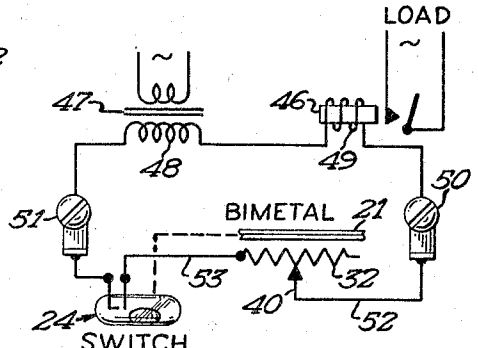


Fig 6

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THERMOSTAT WITH AN IMPROVED HEAT ANTICIPATION MEANS

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The present application is a continuation-in-part application of the application by Clifford L. Nelson, Serial No. 144,656, filed Oct. 12, 1961, now abandoned entitled, "A Thermostat With Improved Anticipation."

The present invention is concerned with an improved heater which is used on a thermostat for heat anticipation purposes; in particular, the heater has a high heat dissipation in the low resistance range and a support member with a high thermal conductivity for a high heat dissipation to protect the heater from an excessive temperature rise when a high current flows through the heater.

FIGURE 1 is a front view of the improved thermostat showing the temperature responsive bimetal for operating the switch and the closely, thermally coupled heat anticipation heater;

FIGURE 2 is a side view of the thermostat shown in FIGURE 1 looking to the left of FIGURE 1;

FIGURE 3 is another embodiment of the heat anticipation resistance heater of the thermostat shown in FIGURE 1;

FIGURE 4 is a sectional view of a portion of the heat anticipation resistor to show the mounting method;

FIGURE 5 is a sectional view of the resistor at 90° from the view of FIGURE 4;

FIGURE 6 is a schematic representation of the circuit used in the thermostat as shown in FIGURES 1 and 2; and,

FIGURE 7 is another embodiment of the present invention wherein the support member is a metal disc which supports a resistance windnig which is electrically insulated from the member.

Referring to FIGURE 1, the thermostat **10** has a base member **11** and a cover **12**, which is partially cut away, mounted on the base in a conventional manner using a pair of clips **13** and **14** attached to the base. Pivotally attached to the base and extending perpendicularly thereto is a support post or shaft **15** which can be rotated by a lever **20** attached to the shaft. A temperature responsive means or circular, coiled bimetal element **21** is solidly attached to shaft **15** at one extremity of the bimetal and connected to a switch supporting member **22** at another extremity **23** of the bimetal. Upon a change in temperature of the bimetal, extremity **23** moves to position a switch **24** supported on member **22**. Switch **24** is a conventional mercury switch having a pair of electrodes **25** and **30** sealed in a glass enclosure so that a circuit is closed when a small amount of mercury moves to one end of the enclosure to bridge the electrodes.

Mounted on shaft **15** at its outer extremity is a circular card support member or card-like sheet of electrical insulating material **31**. Material **31** is selected to have an adequate electrical resistance characteristic and yet, material **31** should have a fairly good heat conducting characteristic. One typical material is glass melamine laminate. Support **31** is attached to shaft **15** to be supported in a plane parallel to base **11** and parallel to the plane of movement of switch **24**. Mounted on support **31** is a resistance wire heater winding or "heat anticipation" resistance **32** which extends along the periphery of sheet **31** to surround the end of shaft **15**. Wire **32** is attached to sheet **31** at one extremity by terminal **34**. Along the length of wire **32** at selected points, the wire is attached to sheet **31** by looping a portion of the wire through a triangular shaped hole at points **33**, **36** and **37** in a manner as shown in

FIGURES 4 and 5. Referring to FIGURE 4, wire **32** is looped and the loop **38** is passed across one side and into hole **37**. The lower end of loop **38** is bent flat against the under side of sheet **31**. The adjacent portions of the wire in loop **38** do not touch so the complete length of the wire in loop **38** is a part of the electrical resistance circuit of the used portion of wire **32**. FIGURE 5 shows the lower portion of loop **38** as bent against the under side of sheet **31** so the wire **32** is held in place on the upper side of sheet **31** when a similar method of attachment is used at all the holes **33**, **36** and **37**. A wiper **40** is pivotally attached to shaft **15** by staking or rolling the end of post **15**. The wiper engages wire **32** in a position selectively made by the manual movement of the wiper along the length of wire **32** in an arc-like movement. An indentation **42** on wiper **40** provides for a better electrical contact between the wiper and the wire. The position of the wiper can be set at the desired current level by a scale near the periphery of member **31**.

Mounted on base **11** is a pair of terminals **50** and **51** which provide suitable connections for an external circuit, as shown in FIGURE 6, for the thermostat which could include a load device or relay **46** having an energization winding **49** and a source of power or transformer **47** having a secondary **48**. A series circuit is connected between terminals **50** and **51** which can be traced in FIGURE 1; or in the schematic circuit of FIGURE 6 as follows: from terminal **50**, wire **52**, shaft **15**, wiper **40**, wire **32**, terminal **34**, wire **53**, electrode **30** and electrode **25** of switch **24**, wire **54**, and back to the other terminal **51**. The circuit in FIGURE 6 shows a load device or relay and a source of power as a transformer secondary.

Also mounted on the thermostat base is a conventional bimetal temperature indicating device comprising a bimetal **60** which is attached to the base and to a pointer **61** cooperating with an index on a panel **62** attached to the base. Connected to the lower end of member **20** is a pointer **63** which cooperates with the index on panel **62**; so that, when the extreme end **64** of member **20** is manually moved, the temperature to be controlled can be selected by positioning shaft **15** and one end of the bimetal.

Referring to FIGURE 3, another embodiment of the anticipation heater shown in FIGURE 1 has a support member **131** which is connected to shaft **115**. A printed circuit heater winding **132** is connected between terminals **133** and **134** in a circular manner. A movable wiper **140** attached to a shaft **115** is manually positioned; so that, an indented portion **142** on member **140** engages the printed circuit winding. By the selection of the position of member **140**, the amount of resistance winding **132** between the member **140** and terminal **134** in the circuit shown in FIGURE 6 is selected for heat anticipation purposes. When wiper **140** is moved along resistance **132**, the wiper engages the resistance along the outer ends of each loop to provide for a larger resistance length by extending each loop inward.

Referring to FIGURE 7, another embodiment of the present invention comprises a support member **150** which may be supported on the shaft **15** of the thermostat as shown in FIGURE 1. Member or card **150** has a good thermal heat conductivity characteristic and might be made out of sheets of metal such as aluminum. The surface **151** of the member is anodized or coated to provide an electrical resistance coating; so that, a printed circuit wiring network or heater **152** can be placed on the member **150** to be electrically insulated from the member. The circuit **152** has a terminal connection **153** so that a circuit is provided from end **153** to a wiper which moves along the outer periphery of the electrical circuit. Varying amounts of electrical resistance between the end

153 and the wiper is used in the same manner as the heater as shown and described in FIGURES 1 and 3.

With the support of heater **152** on aluminum, the heat is conducted rapidly to the temperature responsive means. The rate of heat transfer establishes a time constant which is indicative of the thermostat "offset." With the support being thermally connected to the support shaft, the heat transfer to the bimetal has a relatively constant time constant at different settings of the wiper. For this reason the system offset or "droop" is unaffected by different current settings of the wiper.

The printed circuit **152** comprises a first portion **154** which is quite wide to have a low resistance and as the circuit moves along from the end **153** to the other extreme end **155**, the cross-section width of the circuit becomes narrower and the resistance per unit length becomes greater until at other end **155** the circuit is quite small. By means of the wide portion **154**, the heater is capable of dissipating a considerable amount of heat to member **150** to provide for a high current capacity should an abnormal condition exist.

During the installation of such a thermostat in a circuit as shown in FIGURE 6, the installer can modify the circuit in various ways to test the operation during which time an excessive current would be caused to pass through the heater winding **32**. For example, if the relay winding **49** is shunted by a screwdriver or some other means to cause the relay to drop out for test purposes, the impedance of the circuit is changed and the current through heater winding **32** may be quite large. If when such a test operation is done and the position of the wiper on the impedance winding is close to the connected end; that is, the wiper would be closed to the end **153** of the element in FIGURE 7, a large current would pass through the resistance winding. With a low amount of resistance in the heater winding, the current would be quite high and if the resistance winding is not capable of dissipating the heat which then exists, the winding will burn out. By making the resistance winding so that conductor is quite wide to provide for the dissipation of the heat, such a resistance winding is capable of withstanding such short circuits as might be imposed on the heater.

Printed circuit **152** has a second portion **160** made up of a plurality of loops. Second portion **160** has a slightly higher resistance per unit length than first portion **154**. By the difference in resistance per unit length, a scale similar to FIGURE 1 associated with portion **154** of FIGURE 7 can be expanded at the high current or first portion and to allow for easier adjustment and a readable scale.

Operation

When a relay or some control device and a source of power are connected in series between terminal **51** and **50** of thermostat **10**, as shown in FIGURE 6, a current circulates through the active portion of the heater between terminal **34** and wiper **40** when switch **24** is closed as shown in FIGURE 1. When bimetal **21** calls for heat and the extremity **23** moves to the left to tip switch **24** so that electrodes **25** and **30** are shorted, a current passes through the active portion of resistor **32**. The active portion with the wiper as shown in FIGURE 1 includes the looped portion of wire **32** which extends into hole **36** to hold the wire on card **31**. The heat developed by the resistor is transmitted to the bimetal to artificially heat the bimetal. As the bimetal increases in temperature due to the artificial heat, switch **24** is moved to the right to open the circuit to anticipate the increase in temperature in the space in which thermostat **10** is mounted. The use of the heat from a heater mounted close to the temperature responsive element **21** is quite commonly known as "heat anticipation."

In the thermostat shown in FIGURE 1, the heat from the active portion of winding **32** is transmitted to bimetal element **21**. The thermal path for this heat can be

through the member **31** by conduction to shaft **15** and then to bimetal **21** and by radiation from member **31** to bimetal **21**. The thermal path through member **40** and shaft **15** into the bimetal is also used to conduct the heat from heater **32** to the bimetal **21**. With the heater **32** closely associated with the bimetal **21**, an even distribution of heat for heat anticipation purposes is provided. When the material for member **31** is selected, the electrical resistance between heater **32** and the support must be high enough; however, the member **31** is selected to have a heat conducting characteristic sufficient to provide proper operation. With a high heat transfer characteristic heat from any part of wire **32** can be conducted directly to shaft **15** to provide a low time constant which decreases the "droop" of the thermostat.

Referring to the heater embodiment shown in FIGURE 3, the active portion of heater **132** between member **140** and terminal **134** is used in the same manner to provide heat to the bimetal. The bimetal is mounted adjacent member **131** as shown in FIGURE 1 with the first embodiment of the invention.

While the thermostat heater of FIGURE 1 and FIGURE 3 is mounted on a card of material which has a thermal heat conducting path through the card and through the wiper to the shaft and thus to the bimetal as well as providing a radiation surface so that heat can be radiated to the bimetal. The heater of FIGURE 7 has a member **150** which has an even larger thermal conductivity characteristic; so that, as the heat is produced by the current passing through the circuit mounted on the member **150**, the heat is conducted into the member and through the member to the shaft to pass through the bimetal. The heat also conducts throughout the member to provide that the member has a more even temperature so that the heat can radiate to the bimetal.

In the operation of a heat anticipation heater for a thermostat, the time constant, that is the time required for the heat to pass from the heater to the bimetal must be as low as possible to provide for the minimum amount of offset or "droop." With the present heater design, no matter what the position of the wiper is to select the various values of resistance in the heater winding, the heat can pass from the resistance winding into the member **150** as shown in FIGURE 7 to be readily conducted to the shaft and then to the bimetal or be conducted throughout the member **150** to provide a constant tempertaure heat radiating source to the bimetal. In other types of thermostat heaters, the time constant of the heat anticipation heater often varies with different sizes of the heater resistance; so that, for different values of the heater, the offset or droop of the thermostat is changed. The present heater not only provides for relatively constant droop characteristic at various settings of the heater, but the heater has a physical size which provides for the mounting of the heater on the free extremity of the bimetal shaft to make the heater and bimetal unit relatively compact in size which is very important when the overall size of the thermostat is to be maintained at a minimum.

While the present invention has been shown in one particular manner, the intention is to limit the invention only by the scope of the appended claims.

I claim:

1. A thermostat comprising, temperature responsive means, a base, a resistance heater, a support member mounting said heater having a relatively high thermal conductivity, common support means connected to said base for supporting said responsive means and said support member on said base so said heater is adjacent said responsive means, said support means and said support member providing a heat conduction path between said heater and said responsive means, switch means operably connected to said responsive means, and circuit means adapted to connect said switch means and said heater to a source of power whereby said heater applies heat to

said responsive means when said switch operates for anticipation purposes, said heater comprising a first portion and a second portion connected in series, said first portion being a low range resistance portion, an adjustable connection for selecting the amount of said heater to be energized, said first portion having a large physical dimension increasing the surface area per unit length to increase the heat dissipation whereby upon a predetermined high current passing through said first portion, the temperature of said first portion will be limited to a predetermined value by the loss of heat from said support member.

2. An improvement in a thermostat having a base, temperature responsive means, a support connected to said base, means connecting said temperature responsive means to said support, adjustable heater means, support means mounting said heater means, and circuit means adapted to connect said heater to a source of power when said responsive means calls for a change in temperature, the improvement comprising said heater means having a larger surface area for a high heat dissipating characteristic in the low resistance range and said support means having a relatively high thermal conductivity to provide for heat dissipation by radiation whereby at low resistance settings of said heater means excessive current cannot develop sufficient heat to overheat said heater means.

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