

Electric thermal appliance with remotely mounted temperature sensor.

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The invention relates to an electric thermal appliance comprising: an electric heating element for heating an object, a temperature sensor for sensing a temperature of the object and means for controlling the electric heating element in response to the temperature of the object sensed by the temperature sensor.

5 Such an electric thermal appliance, in particular a pressing iron, is known from United States Patent No. 5,042,179. Electronic thermostats in thermal appliances such as pressing irons and cooking devices are constituted of a temperature sensor, a power switch, a temperature setting device, usually a dial or push buttons, and a controller. The controller constantly compares the signals from the temperature sensor with the temperature set by the
10 temperature setting device and determines whether or not energy is to be supplied or cut off from the heating element of the appliance. For this purpose the temperature sensor, usually a thermistor, i.e. a resistor with positive (PTC) or negative (NTC) temperature coefficient, is directly mounted on the surface to be heated by the electric heating element, i.e. on the sole plate of an pressing iron or on the hot plate of a cooking device. The thermistor is usually
15 electrically isolated from the surface to be heated by at least one insulation layer for safety reasons. This kind of temperature sensing provides a rather accurate temperature feedback to the controller, but there is always a delay in response time due to the heat transfer from a desired temperature sensing point of the surface to be heated to the actual mounting location of the temperature sensor. The delay in response time can also arise from the mandatory
20 insulation layers required in the mounting of the temperature sensor on the surface to be heated. The delay reduces the performance of the temperature control as it causes overshoot and reduced switch range accuracy.

It is an object of the invention to provide an electric thermal appliance with an improved temperature control. For this purpose, according to the invention, the thermal
25 electric appliance mentioned in the opening paragraph is characterized in that the temperature sensor is a radiation sensor remotely mounted from the object for sensing radiation emitted by the object.

The remotely mounted radiation sensor directly sees the temperature of the desired temperature sensing point of the surface to be heated and provides a feedback signal nearly

instantaneously. Hence there will be minimum delay in response time resulting in a more sensitive and accurate temperature control without overshoot.

The non-contact temperature sensing concept according to the invention further has the advantage that insulation layers between the temperature sensor and the surface to be heated
5 and the involving high voltage tests are not needed any more.

The radiation sensor preferably comprises a wave guide having a first end mounted for receiving radiation from the object, and a thermopile mounted at a second end of the wave guide for converting the radiation into an electrical signal. The wave guide may be a polyamide (Nylon) tube with a mirroring inner wall and provides electrical insulation between
10 the thermopile and the surface to be heated. The mirroring inner wall reflects the radiation and concentrates the radiation in the direction of the thermopile. The tube may be tapered to better concentrate the radiation in the direction of the thermopile. In order to avoid dust particles entering the tube and polluting the mirroring wall, the open ends of the tube are covered by caps made of material which is transparent for the radiation to be sensed by the thermopile.
15 Suitable materials for this purpose are heat resistive polyimide (Kapton) at the hot end of the tube nearby the surface to be heated, and polyethylene at the cold end of the tube where the thermopile is located.

The remotely mounted radiation sensor can be used in pressing irons in which the electric heating element heats a sole plate, the temperature of the sole plate of the pressing iron
20 being remotely sensed by the radiation sensor. Other applications are cooking devices such as in which the electric heating element heats a hot plate, the temperature of the hot plate being remotely sensed. The remotely mounted radiation sensor can also be used in thermal appliances such as pressing irons and cooking devices having a heat conductive surface heated by the electric heating element, for sensing the temperature of an object to be heated by the
25 heat conductive surface. For this purpose the surface is provided with a window which enables the radiation sensor to look through the surface to the object. In case of a pressing iron this object may be a cloth to be ironed and the radiation sensor directly measures the temperature of the cloth through the window in the sole plate. In case of a cooking device this object may be the bottom of a cooking pan or the like, or may be a fluid in a deep fat fryer or in an electric
30 kettle, or may be a piece of food resting on the heated surface of an electric grill.

These and other aspects of the invention will be described and explained with reference to the appended drawing, in which:

Figure 1 is a circuit diagram of a conventional temperature control system for an electric thermal appliance;

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Figure 2 shows a pressing iron with a remotely mounted radiation sensor according to the invention;

Figure 3 shows a construction of a remotely mounted radiation sensor for use in a thermal appliance according to the invention; and

5 Figure 4 shows a further construction of a remotely mounted radiation sensor for use in a thermal appliance according to the invention.

In these Figures parts having the same function or purpose are denoted by the same references.

Figure 1 shows a circuit diagram of a conventional temperature control system for an
10 electric thermal appliance, for example a pressing iron. An electric heating element 2 is connected in series with a switching device 4 between AC supply terminals 6 and 8. The heating element 2 heats a sole plate 10 in a known way, for example by means of a resistive heating element embedded in the sole plate 10. The temperature of the sole plate 10 is sensed by means of a temperature sensor 12 which is mounted at a suitable location on the sole plate
15 10. The temperature sensor 12 usually is a thermistor, i.e. a resistor with a positive temperature coefficient (PTC resistor) or with a negative temperature coefficient (NTC resistor), but other temperature sensitive devices such as semiconductor junctions can be used as well. For safety reasons the temperature sensor 12 is electrically insulated from the sole plate 10 by means of one or more insulating layers. The temperature sensor 12 generates a sense signal
20 representative of the temperature of the sole plate 10. A temperature setting device, for example a dial 14, generates a signal representative of a desired temperature. A controller 16 compares the sense signal from the temperature sensor 12 with the desired temperature and opens or closes the switching device 4 to maintain the temperature of the sole plate 10 at the desired temperature. This contact type of temperature sensing provides a rather accurate
25 temperature feedback to the controller 16, but there is always a delay in response time due to the heat transfer from a desired temperature sensing point of the sole plate 10 to the actual mounting location of the temperature sensor 12. Also the insulation layers between the temperature sensor 12 and the sole plate 10 causes additional delay time. The delay reduces the performance of the temperature control as it causes overshoot and reduced switch range
30 accuracy.

Figure 2 shows a pressing iron with improved temperature control. The temperature sensor 12 is a radiation sensitive sensor remotely mounted from the sole plate 10 looking to the heated surface of the sole plate 10 through a wave guide 18. The electronic components of the controller 16 are placed on a printed circuit board 17 mounted inside the pressing iron. The





radiation sensitive sensor may be a commercially available thermopile sensor. In this way the temperature sensor 12 directly sees the sole plate 10 from a distance and the aperture of the temperature sensor may be aimed at any suitable location on the heated surface of the sole plate 10. This has the advantage of minimum thermal resistance between the location on the sole plate 10 to be sensed and the temperature sensor 12. No insulation layers are needed any more to meet safety requirements. Another advantage is that no wiring is needed between the printed circuit board 17 of the controller 16 and a sensor on the hot sole plate 10. The thermopile sensor 12 may also form an integral part of the integrated circuit which performs the controller functions of the controller 16. The direct remote sensing of the temperature of the sole plate 10 provides a temperature feedback signal with minimum delay and results in an accurate temperature control without overshoot.

Figure 3 shows in more detail the construction of the temperature sensor 12 in the pressing iron of Figure 2. The thermopile itself (not shown) is incorporated in a metal housing 20 which has a filtering lens 22 to receive radiation and to focus the received radiation on the thermopile. The thermopile sensor further has connection terminals 24 for connecting to the controller 16. The thermopile sensor is mounted at one end 26 of the wave guide 18 which is constructed as a polyamide (Nylon) tube. The inner wall 28 of the polyamide (Nylon) tube is finished with a mirroring material which reflects the radiation towards the thermopile sensor. The tube may have a tapered shape to concentrate the radiation onto the thermopile sensor. The other end 30 of the wave guide 18 is positioned nearby the interior surface of the sole plate 10, for example at 2 millimeters or less distance from the sole plate 10. In order to keep the mirroring inner wall of the polyamide (Nylon) tube clean, the open ends 26 and 30 of the wave guide 18 are covered by caps 32 and 34, respectively, made of material which is transparent for the radiation to be sensed by the thermopile. Suitable materials for this purpose are heat resistive polyimide (Kapton) at the hot end 30 of the tube nearby the sole plate, and polyethylene at the cold end 26 of the tube where the thermopile is located. The thickness of the polyethylene cap 32 may be 1 millimeter or less and the cap 34 may be made from polyimide (Kapton) foil with a thickness of 40 micrometer or less. The upper end 26 of the polyamide (Nylon) tube of the wave guide 18 and the thermopile sensor can be mounted in a plastic, e.g. polycarbonate, block 36. In case of a steam iron this block 36 may rest on top of a water tank 38, but any other suitable position may be chosen. The polyamide (Nylon) tube of the wave guide 18 is further positioned on a cover 40 which rests on top of the sole plate 10.

In the Figures 2 and 3 also an optional window 42 in the sole plate 10 is shown. By providing the window 42 in the sole plate 10 the temperature sensor 12 can directly see a cloth

(not shown) to be ironed with the pressing iron and in this way the temperature of the cloth can be measured. The window 42 may be constituted by a hole in the sole plate 10, but can also be constructed by heat resistive and radiation transmitting material, e.g. glass.

Figure 4 shows a thermopile sensor 12 which looks to more than one location of the sole plate 10. For this purpose the wave guide 18 has a multiple tube construction to collect radiation from several hot spots on the sole plate 10. In this way the hottest spot of the sole plate dictates the temperature control. Instead of simultaneously looking to several hot spots, it is further possible to look with the thermopile sensor 12 to different locations on the sole plate 12 one by one. This can be realised, for example, by collecting the radiation from different locations on the sole plate 10 by means of glass fiber cables and by coupling the outputs of the glass fiber cables one by one to the thermopile sensor with optical switches.

The principles of the invention are not limited to pressing irons, but can also be applied to other electric thermal appliances, such as cooking devices. In that case the electric heating element heats a hot plate or the like. The temperature of the hot plate is controlled in a fashion similar as shown in relation to the sole plate of the pressing iron in the Figures 2 and 3. By making a window in the hot plate the temperature of the bottom of a cooking pan or the like can be sensed, or the temperature of a fluid in a deep fat fryer or in an electric kettle, or the temperature of a piece of food resting on the heated surface of an electric grill.

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CLAIMS:



1. An electric thermal appliance comprising: an electric heating element (2) for heating an object (10), a temperature sensor (12) for sensing a temperature of the object and means (16) for controlling the electric heating element (2) in response to the temperature of the object (10) sensed by the temperature sensor (12), characterized in that the temperature sensor (12) is a radiation sensor remotely mounted from the object (10) for sensing radiation emitted by the object (10).
2. An electric thermal appliance as claimed in claim 1, wherein the object is a heat conductive surface (10) heated by the electric heating element (2).
3. An electric thermal appliance as claimed in claim 1, wherein the electric thermal appliance comprises a heat conductive surface (10) for heating the object, the heat conductive surface (10) being heated by the electric heating element (2), and the heat conductive surface (10) having a window (42) for transmitting the radiation from the object to the radiation sensor (12).
4. An electric thermal appliance as claimed in claim 2 or 3, wherein the appliance is a pressing iron and the heat conductive surface is a sole plate (10) of the pressing iron.
5. An electric thermal appliance as claimed in claim 2 or 3, wherein the appliance is a cooking device and the heat conductive surface is a hot plate.
6. An electric thermal appliance as claimed in claim 1, 2, 3, 4 or 5, wherein the radiation sensor comprises a wave guide (18) having a first end (30) mounted for receiving radiation from the object (10), and a thermopile mounted at a second end (26) of the wave guide (18) for converting the radiation into an electrical signal.
7. An electric thermal appliance as claimed in claim 6, wherein the wave guide (18) is a polyamide (Nylon) tube with a mirroring inner wall (28).

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8. An electric thermal appliance as claimed in claim 6, further comprising a polyimide (Kapton) foil (34) for covering the first end (30) of the wave guide (18).
- 5 9. An electric thermal appliance as claimed in claim 6, further comprising a polyethylene cap (32) for covering the second end (26) of the wave guide (18).
10. An electric thermal appliance as claimed in claim 7, wherein the polyamide (Nylon) tube is tapered for concentrating the radiation in the direction of the thermopile.
- 10 11. An electric thermal appliance as claimed in claim 1, wherein the temperature sensor (12) is mounted on a printed circuit board (17) which carries electronic components of the means (16) for controlling.
- 15 12. An electric thermal appliance as claimed in claim 1, wherein the temperature sensor (12) is an integral part of an integrated circuit which performs control functions of the appliance.
13. An electric thermal appliance as claimed in claim 6, wherein the wave guide (18)
- 20 comprises a multiple guiding construction for simultaneously guiding radiation from different locations of the object (10).
14. An electric thermal appliance as claimed in claim 6, wherein the wave guide (18) comprises a glass fiber cables and optical switches for selectively coupling radiation of
- 25 different locations of the object (10) to the radiation sensor.

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