

THERMAL-EFFECT APPLIANCE COMPRISING A TEMPERATURE INDICATOR

REPLACED SHEETS	SG
☒ Description : paged ...1... to paged ...4...	
☒ Claim(s) : paged ...7... to paged ...7...	
☒ Drawing(s) : paged ...4... to paged ...7...	
☒ Abstract : paged ...1... to paged ...7...	
DATE OF RECEIPT	

The invention relates to a thermal-effect appliance comprising a thermal body and an indicator for indicating a temperature of the thermal body.

This may concern appliances for household use, such as irons, cook-tops, hot-plates, cooking ovens, heating appliances, toasters, air conditioners and the like, or
5 appliances for professional use such as ovens of all kinds.

All these appliances comprise a thermal body heated by a heating element. When the user has access to the thermal body he may inadvertently touch the body and sustain severe burns. Therefore, it has been considered to protect the user by warning him when the thermal body is at a safe temperature or, conversely, when he should
10 refrain from touching the thermal body. Some appliances have light-emitting indicator diodes which, when the appliance is connected to the mains, operate in conjunction with a thermal transducer controlling the electrical power supply of these light-emitting diodes. However, this type of alarm is no longer operative when the appliance is
15 disconnected from the mains, which occurs particularly in the case of various portable appliances to be put away and/or cleaned, such as irons, portable cookers and the like. The heating element, which initially has been brought at a high temperature, often exhibits a substantial thermal lag and cools slowly, which entails the risk of burning by contact if there is no alarm to indicate that the element is at a temperature above a safe temperature while the appliance is not electrically energized.

20 Substances are known whose optical properties change abruptly with the temperature and which have been envisaged as indicators for indicating the temperature of the thermal body. The document JP KOKAI 63-61081-A thus reveals a substance based on lead-oxide/bismuth/vanadium and capable of withstanding high temperatures. It has been considered to use said substance for this purpose in domestic appliances.
25 However, this substance as well as other substances still have high transition temperatures of 80 to 150°C so that they cannot be used directly for this purpose in a wholly reliable manner. This is because the so-called safe range is situated below these





temperatures and a user may burn himself if he touches the thermal body.

Consequently, safety is not guaranteed.

Moreover, other substances are known which have transition temperatures closer to the safe temperatures, such as for example liquid crystals. Unfortunately, these
5 substances cannot withstand the high temperatures of the thermal body during normal operation without being destroyed. Thus, they cannot directly replace the above substances to indicate a safe range.

Therefore, it is an object of the invention to define means enabling the last-mentioned substances to be used for indicating to the user whether he can safely
10 touch the thermal body by defining a safe temperature compatible with the perception of an average user.

This object is achieved with an appliance in which the indicator comprises:

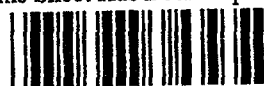
- at least one temperature reducer which provides a thermal gradient
15 between a first temperature (T_c) at a first end and a second temperature (T_s) at a second end, which second temperature is lower than the first temperature, the first end of the reducer being secured to the thermal body, and

- at least one substance disposed on the temperature reducer between the first and the second end, which substance exhibits a transition of a visual property when
20 said first temperature (T_c) reaches a predetermined reference temperature (T_r).

In order to ensure a safe use the reference temperature is a so-called safe-use temperature below which a user cannot burn himself. Moreover, the transition temperature of the substance should be higher than the usual maximum ambient temperature in order to ensure that the substance exhibits its transition when the
25 appliance resumes the ambient temperature.

Particularly when the appliance is not electrically connected this has the advantage that, in accordance with the invention, the temperature indicator can indicate safe operating conditions to the user in a passive manner, *i.e.* in the absence of any electrical power supply to the indicator.

30 The reducer may comprise a thin and/or narrow strip, or a radiator, or a base connected to a gradient-forming wire, or a base portion forming a thermal gradient. The strip may be made of a metal or a heat-insulating material. The radiator may be, for example, a ribbed radiator. The reducer may be an integral part of a base



carrying the thermal body (for example a cook-top) either by mounting the reducer on the base or by using a part of the base to obtain said thermal gradient. The reducer has its first end secured to the thermal body. The other end is provided, for example coated, with a thermochromic substance. This substance may also be affixed by gluing
5 or the like. Since the thermal body may also have an operating temperature which is too high for the thermochromic substance the reducer is designed in such a manner that, as a result of ambient cooling, a substantial thermal gradient appears between the two ends of the reducer when the temperature T_c of the thermal body is high and a smaller gradient when this temperature T_c decreases to a level at which the thermal body can be
10 touched.

The end provided with the thermochromic substance may project freely in the air, or it may be secured to an unheated part with reduced exchange of heat. It is possible to use liquid crystals whose colour or transmission-reflection coefficients vary with temperature, or other similar substances.

15 The substance which serves to indicate a safe temperature may be used in conjunction with a second substance which exhibits a change of a visual property at a higher other temperature. This second substance is applied to a warmer part of the temperature reducer in such a manner that the second substance exhibits said change when the thermal body is at a temperature indicating that an appliance is ready for use.

20 Thus, when the appliance is electrically connected the temperature indicator also indicates passively that a "ready for use" state is reached.

It is possible to use two reducers, one provided with the substance indicating a safe temperature of the thermal body and the other provided with the substance indicating a temperature indicative of the fact that an appliance is ready for
25 use.

These and other aspects of the invention will become apparent from and elucidated on the basis of the embodiments described hereinafter.

The invention will be more fully understood with the aid of the following drawing given by way of non-limitative example and in which:

30 Figure 1 is a diagram of a temperature reducer provided with a first substance,

Figure 2 is a curve representing variations of the temperature of the first substance as a function of the temperature of the thermal body,



Figure 3 is a diagram of a flat-iron provided with a reducer.

Figure 4 is a diagram of a temperature reducer provided with a first substance.

Figure 1 shows a temperature reducer formed by a thin strip 10 having one end provided with a substance 12 such as a thermochromic or liquid-crystal substance. One of the ends B, represented as a hatched portion in Figure 1, is intended to be secured to the thermal body. The temperature of the hatched portion is therefore close to the temperature T_c of the thermal body. Between the two ends A and B of the strip 10 a thermal gradient $T_c - T_s$ appears, where T_s is the temperature of thermochromic substance. Figure 2 shows the variations of the temperature T_s as a function of the temperature T_c of the thermal body in the exemplary case of a strip having one end provided with a liquid-crystal capsule. The reducer comprises a black copper strip having a thickness of 0.1 mm, a length of 15-20 mm and a width of 12 mm, clamped onto a soleplate of a flat-iron. The thermal gradient is of the order of 80-90°C between the end provided with the thermochromic substance (temperature of the thermochromic substance $\approx 100-110^\circ\text{C}$) and the soleplate (temperature of the soleplate $\approx 200^\circ\text{C}$). This gradient decreases to $\approx 10^\circ\text{C}$ around $T_c \approx 60^\circ\text{C}$ (transition temperature of the thermochromic substance $T_t \approx 50^\circ\text{C}$). Thus, the maximum temperature to be handled by the thermochromic substance is lower than its destruction temperature T_D of $\approx 140-150^\circ\text{C}$.

Therefore, the thermal gradient obtained by means of the temperature reducer is such that the transition temperature T_t of the substance corresponds to the safe temperature T_{Co} selected for the thermal body and such that the maximum temperature T_M of the thermal body corresponds to a maximum temperature of the substance which is lower than its destruction temperature T_D . Moreover, the transition temperature of the thermochromic substance should be higher than the usual maximum ambient temperature T_{AM} to ensure that the colour change is reversed when the iron is cold. The temperature T_{AM} is generally considered to be 40 to 70°C. The safe temperatures are not standardized and may depend on the time of contact before reaction and withdrawal of the skin, on the nature of the contact, on the thermal mass of the thermal body etc. The safe temperature may be selected around 60°C or 70°C. Consequently, for the transition upon cooling a temperature above 45-50°C and below 55-60°C is suitable.



Figure 3 by way of example shows a method of securing the temperature reducer to a flat-iron 30 having a soleplate 31 and a base 32. The end B of the strip 10 (Figure 1) is in contact with the soleplate 31, which now forms the thermal body. This contact can be obtained by clamping the strip between the soleplate and the base, by welding or riveting it to the soleplate or by any other suitable fixing method. The other end A, which is cooled by the ambient air, may remain free but preferably, for reasons of strength, it is fastened to the base 32, for example by gluing, crimping or the like. As this may influence the thermal gradient it is necessary to allow for the fixing method when the nature and/or the dimensions of the strip are chosen, allowance being made for the fact that the transition temperature T_t of the substance should be reached when the soleplate reaches the safe temperature T_{Co} during cooling.

In view of the low cost it may be considered to arrange several temperature reducers at several points so that they are visible in different positions and viewing conditions of the iron. Thus, they may be arranged at the front, at the side of the iron (visible when the iron is in a flat position) and/or at the bottom in an receding part often provided in flat-irons, so as to be visible when the iron is in a vertical position.

The invention is also very suitable for use in hot-plates, table-top cooking devices (stone grill, fondue ...). The strip may be clamped between the stone and the base carrying said stone. Such reducers may be arranged on all the sides so as to be visible to all the table-companions. The reducer may form an integral part of the cooking device.

Alternatively, the reducer may be arranged on walls of cooking ovens, heating appliances, toasters, air conditioners and the like.

Preferably, the reducer has such a very small thermal mass that the risk of burning is minimal when it is inadvertently touched for a brief instant. Nevertheless, the reducer may be shielded by arranging it underneath a transparent window to provide a thermal and mechanical protection.

In view of the low cost of a device of this type and the ease with which a plurality of devices can be arranged at different locations so as to be visible to several persons (for example, table-companions) it may be considered to use the same principle in order to determine when, for example, a hot-plate or a soleplate of an iron being warmed up has reached a temperature T_{PAE} at which the appliance is ready for use.

This temperature is high and generally lies between 200 and 300°C. There are no reliable low-cost substances which have a transition temperature in these temperature ranges and which, in addition, exhibit a very sharp and distinct change in colour. It is possible to use the same principle as described above, *i.e.* to use a temperature reducer
5 with a thermal gradient. For this purpose, another substance 12a (Figure 4) having a high transition temperature is arranged on the reducer at a suitable location in order to obtain a change in colour when the thermal body reaches the temperature indicative of the fact that an appliance is ready for use. Thus, when the thermal body reaches a reference temperature equal to TPAE (for example between 200 and 300°C) the
10 location where the second thermochromic substance is situated may be at temperatures of the order of 150°C or even 120°C, thereby enabling the use of substances as cited in the document JP KOKAI 63-61081-A.

It is possible to arrange the first substance and the second substance on the same reducer by arranging them at different respective locations where the
15 temperature of the strip of the reducer is suitable. It is also possible to arrange the two substances on different reducers.



CLAIMS:

1. A thermal-effect appliance (30) comprising a thermal body (31) and an indicator for indicating a temperature of the thermal body, characterized in that the indicator comprises:
 - at least one temperature reducer (10) which provides a thermal gradient
- 5 between a first temperature (T_c) at a first end and a second temperature (T_s) at a second end, which second temperature is lower than the first temperature, the first end of the reducer being secured to the thermal body, and
 - at least one substance (12) disposed on the temperature reducer between the first and the second end, which substance exhibits a transition of a visual property
- 10 when said first temperature (T_c) reaches a predetermined reference temperature (T_r).
2. An appliance as claimed in Claim 1, characterized in that the reducer is constituted by a thin and/or narrow strip, or by a radiator, or by a base connected to a gradient-forming wire, or by a base portion forming a thermal gradient.
3. An appliance as claimed in Claim 1 or 2, characterized in that the visual
- 15 property is either a coloration or an optical reflection/transmission coefficient.
4. An appliance as claimed in Claim 1, characterized in that it comprises a first substance which exhibits a transition at a first temperature when said reference temperature (T_r) is equal to a so-called safe temperature (T_{Co}).
5. An appliance as claimed in any one of the Claims 1 to 4, characterized in
- 20 that the substance is a liquid-crystal material.
6. An appliance as claimed in any one of the Claims 1 to 5, characterized in that said safe temperature lies between 40°C and 70°C .
7. An appliance as claimed in any one of the Claims 1 to 7, characterized in that it comprises a second substance which exhibits a transition at a second temperature
- 25 when said reference temperature (T_r) is equal to a temperature (T_{PAE}) indicative of the fact that an appliance is ready for use.

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8. An appliance as claimed in Claim 7 and in any one of the Claims 4 to 6, characterized in that the first substance and the second substance are disposed on a single temperature reducer.
9. An appliance as claimed in Claim 7 and in any one of the Claims 4 to 6,
5 characterized in that the first substance and the second substance are disposed on different temperature reducers.
10. An appliance as claimed in any one of the Claims 1 to 9, characterized in that it comprises a plurality of reducer/substance combinations arranged on the appliance at different locations so as to be visible from a plurality of directions.
- 10 11. An appliance as claimed in any one of the Claims 1 to 10, characterized in that the thermal body is constituted by a soleplate of a flat-iron, or by a plate of a cook-top or of a hot-plate, or by a wall of a cooking oven, of an air conditioner, of a heating appliance or of a toaster.

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