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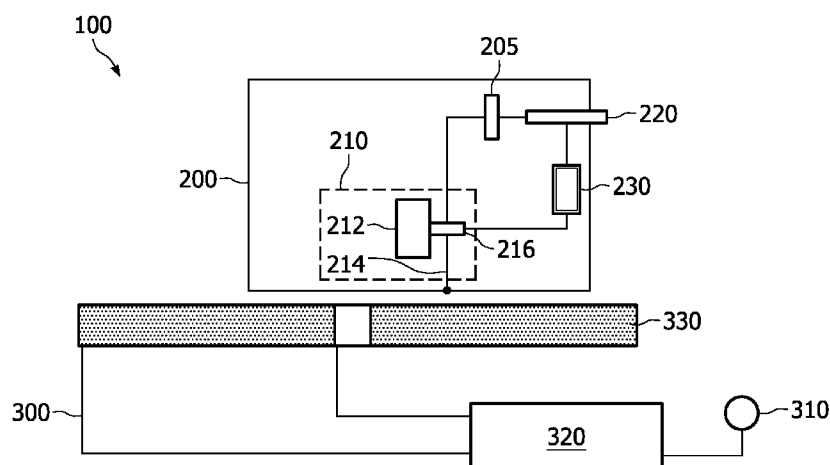
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(54) Title: TEMPERATURE CONTROL FOR A HEATING DEVICE

**FIG. 1**

(57) Abstract: A system comprises an object including a temperature control device, a transmitter and a power source. The temperature control device senses the temperature of the object and activates the power source. The power source in turn activates the transmitter for transmitting a wireless signal, depending on the sensed temperature. The system further comprises a heating device including a receiver and a switching circuit. The heating device is configured for heating the object. The receiver receives the wireless signal transmitted from the object, and the switching circuit activates the heating device, based on the wireless signal received. This system allows only a signal to be transmitted to the receiver of the heating device to decide whether the object needs to be heated or not.



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Temperature Control for a heating device

FIELD OF THE INVENTION

The invention relates to a system comprising an object and a heating device for heating the object and more in particular to a temperature control of the heating device.

BACKGROUND OF THE INVENTION

Conventional heating devices such as electric stoves have a thermal efficiency lower than 50%. An object to be heated must be in a close contact with the heating device.

- 5 Such heating devices can realize temperature control by a rough estimation or via a temperature sensor that is coupled to the heating device. If the object moves away for a while from the heating device during operation, contact between the object and the heating device is lost. In such cases, the temperature of the object will be out of control as temperature control is based on detecting the temperature of the heating device. Thus, an induction
- 10 heating technology, which is a non-contact and non-thermal energy transfer technology with very high thermal efficiency, i.e., about 90%, is introduced to get rid of the required contact between the object and the heating device. A conventional induction heating device normally needs a piece of ceramic resting plate, which is a good thermal conductor, for supporting the object to be heated up by the induction heating device. The temperature of the object is
- 15 monitored by a temperature sensor placed under the ceramic plate. The temperature sensor is a thermistor, a thermocouple, an NTC or a thermal diode. The disadvantage of such temperature control is that the object must be in contact with the ceramic plate where temperature sensors are installed. So it does not give a true non-contact solution. It will also result in a lag in sensing the temperature. Also, the special ceramic material is expensive and
- 20 supply of it is limited. Moreover, the accuracy in sensing the temperature will still be influenced by proper contact and thermal conduction. Furthermore, the sensors must sense the hot surface directly and cannot be covered or insulated, and hence may not be safe.

- US4268737 describes an apparatus in which a cordless flat iron is energized by one or more high-frequency oscillators subjacent the normally horizontal work supporting
- 25 surface of an associated ironing board. The sole plate of the iron consists of a thin layer of conductive material and is electrically and thermally insulated from the handle of the flat

iron. The magnetic field, of a polarity alternating at high frequency, which is generated above the work supporting surface by the oscillator, generates eddy currents in the sole plate when the flat iron is placed on the surface or separated from the surface by normally nonconductive textile material to be ironed. A temperature sensor on the iron senses the temperature of the sole plate, and a wireless transmitter transmits a temperature signal, based on the sensed temperature, from the iron to the receiver on the ironing board and this signal is compared to the pre-set temperature. The induction heating coils are turned on/off based on the temperature signal transmitted. Since this involves transmission of information regarding the temperature, it requires expensive components.

It is therefore an object of the invention to control the temperature of the heating device without having the disadvantage described above, more in particular to provide a safe and simple temperature control for the induction heating device.

BRIEF SUMMARY OF THE INVENTION

This is achieved by a system according to the invention, comprising an object including a temperature control device, a transmitter and a power source, wherein the temperature control device is arranged for sensing the temperature of the object and activating the power source, and the power source in turn is configured for activating the transmitter for transmitting a wireless signal, depending on the sensed temperature; and comprising a heating device including a receiver and a switching circuit, wherein the heating device is configured for heating the object, the receiver is configured for receiving the wireless signal, and the switching circuit is configured for activating the heating device, based on receipt of the wireless signal.

The temperature control device is in series with the transmitter and lets or does not let the transmitter transmit its signal, depending on the sensed temperature. The temperature control device uses inexpensive elements to detect the temperature of the object. When the temperature of the object is lower than a desired temperature, it indicates a "1" / "high" state wherein the heating device is turned on. However, when the temperature of the object exceeds the desired temperature, it interrupts the wireless signal and indicates a "0" / "low" state wherein the heating device is turned off. The temperature control device could use a simple mechanical control to control the transmittance of the signal. The presence or absence of this signal indicates whether the object needs to be heated or not. This is only a signal transmission rather than an information transmission. It is a binary logic and uses

simple components and signal processing. The temperature control provides real-time temperature control, firm and uninterrupted linkage between the heating device and the object as well as a user-friendly and safe design.

According to an embodiment of the invention, the temperature control device
5 comprises a temperature setting element configured for setting a pre-determined temperature to which the object has to be heated; a sensing element configured for sensing the temperature of the object; and a switching element configured for activating the power source when the sensed temperature is below the pre-determined temperature, with the power source being configured to activate the transmitter for transmitting a wireless signal to the heating
10 device.

The temperature setting element is used to input the pre-determined temperature and works together with the sensing element to provide a controllable temperature setting. The switching element activates the power source when the sensed temperature of the object is below the pre-determined temperature. Only then the power
15 source activates the transmitter to send the signal to the receiver of the heating device and the heating device is turned on. On the other hand, when the temperature of the object equals or exceeds the pre-determined temperature, the switching element deactivates the power source which in turn deactivates the transmitter and interrupts the wireless signal, and the heating device is turned off. Thus, the temperature control device along with the transmitter and the
20 power source forms a simple electrical circuit unit. It provides wireless linkage/communication between the object and the heating device by transferring temperature information about the object in the form of a signal that is detected by a temperature sensing element and regulated by a temperature setting element.

According to another embodiment of the invention, the sensing element is a
25 mechanical thermostat or a thermocouple, a thermal diode, a thermistor, an infrared sensor or the like.

According to yet another embodiment of the invention, the sensing element is provided with multiple sensing points for sensing the temperature of the object at multiple positions. This is because the object may not be made of pure material and also its
30 configuration may not be uniform. Heat transfer from points of heating to points of sensing may cause a lag in sensing the temperature. Therefore, more sensing points are provided which rectify the final temperature reading, depending on analysis of the overall temperature distribution.

According to another embodiment of the invention, a thermal fuse is connected to the object, said thermal fuse being configured for deactivating the power source when the temperature control device fails. In order to limit the maximum temperature that can be attained by the object, a thermal fuse, which does not depend on any control or
5 feedback process, is indispensable. This is because temperature control could fail for any unpredictable reason. If the heated object is overheated, the thermal fuse will be blown to cut off the power source and thus stop the system from working.

According to a further embodiment of the invention, the wireless signal is transmitted to the heating device by a carrier wave.

10 According to a still further embodiment of the invention, the carrier wave is an electromagnetic wave, a light wave, a sound wave and the like

According to yet another embodiment of the invention, the electromagnetic wave is a radio frequency wave and the like, the light wave is an infrared wave, a laser wave and the like, the sound wave is an ultrasonic wave and the like.

15 According to a further embodiment of the invention, the power source is a dry cell or alkaline battery. It can also be a Lithium-ion, Nickel-Cadmium, Nickel-metal hydride battery. The switching element cuts off the battery while the system is not in use and hence the battery will not drain. Moreover, the power required by the transmitter to emit the signal is very low. Hence the battery will last for several years.

20 According to another embodiment of the invention, the object is provided with an auto shut off feature, which auto shut off feature is configured for ensuring the safety of the heating device. This feature ensures extended life of the power source by shutting off signal transmission when the system is not in use and even when the user forgets to turn the object off.

25 According to a further embodiment of the invention, the heating device is in the form of (an) induction coil(s), halogen lamps, conventional tubular heating elements and the like. The above-mentioned temperature control works for any kind of heating device.

According to a still further embodiment of the invention, the object is configured to be heated while moving or while stationary. While in use, the object may move
30 away from the heating device. The wireless signal transmitted from the transmitter ensures that the temperature of the object is controlled even when the object is away from the heating device.

According to a further embodiment of the invention, the object is an iron and the heating device is one or more induction coil(s). The iron has a soleplate that is heated by

electromagnetic radiation from the induction coil. Due to the dynamics of the iron during ironing, it is difficult to control the temperature of the iron. The wireless signal ensures that the temperature of the iron is under control.

5 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a system including an object and a heating device according to an embodiment of the invention;

Fig. 2 shows a system wherein a thermal fuse is coupled to an object according to another embodiment of the invention;

10 Fig. 3 shows a system including an object provided with an integrated circuit; and

Fig. 4 shows an ironing system according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

15 A system 100 includes an object 200 to be heated by a heating device 300. The object 200 is provided with a temperature control device 210 which includes a temperature setting element 212, a sensing element 214 and a switching element 216. The sensing element 214 senses the temperature of the object 200 at a sensing point 215. The object 200 is provided with a transmitter 220 and a power source 230. The object 200 is
20 provided with a button 205 to allow a user to switch the object on or off. The heating device 300 includes heating coils 330, a receiver 310 and a switching circuit 320.

The system 100 as shown in Fig. 2 is similar to the system shown in Fig.1 except that the object 100 is additionally provided with a thermal fuse 240.

The system 100 as shown in Fig. 3 includes the object 100 and the heating
25 device 200. All the electrical parts of the temperature control device are built in an integrated circuit 250. The integrated circuit 250 includes the temperature setting element 212, the switching element 216 and a magnetic chip. The heating device 300 is provided with a reader 340. The magnetic chip of the integrated circuit 250 responds to the reader of the heating device.

30 The ironing system 400 shown in Figure 4 includes an iron 410 and an ironing board 430. The iron 410 is provided with a soleplate 412 comprising an induction heatable material. The ironing board 430 can be either a compact board or a full-size board or it can also be a stand where the iron is placed for charging. The one or more induction coils 420 positioned within the entire ironing board or stand 430 can charge the iron 410. The iron 410

is provided with the temperature control device, the transmitter and the power source (not shown).

The object 200 is provided with the button 205 to switch on or off the object 200 and hence the system 100. The temperature control device 210 as shown in Fig.1 is
5 situated on the object and includes the temperature setting element 212, the sensing element 214 and the switching element 216. The temperature-setting element 212 is used to input the required temperature setting. It works together with the temperature-sensing element 214 to provide a controllable temperature setting. The temperature-sensing element can be a mechanical thermostat, a bimetal, a thermocouple, a thermal diode, a thermistor, an infrared
10 sensor, and/or the like. Furthermore, there may be more than one sensing point for accurate temperature detection, because the object 100 may not be made of pure material. The configuration of the object may not be uniform. For example, the object 200 may be an iron and the heating device 300 may be an induction coil. The iron comprises a soleplate, which is made of different material-layers such as a metallic layer and a ferromagnetic layer. The
15 ferromagnetic layer is the calorifier in the induction heating device and hence its temperature is the highest. However, thermal conduction of ferrous material is poorer than that of other materials such as aluminium, so heat needs time to transfer from heating points to sensing points. This results in a lag in the temperature sensing. Hence there may be more sensing points for reference to rectify the final temperature reading.

20 The signal transferring process serves to convert electric energy provided by the power source 230, such as a battery, to a certain carrier, such as an electromagnetic wave, a light wave, a sound wave, etc., sent out by the transmitter 220. The receiving process serves to convert the carrier, caught by the receiver 310, to decide whether to power the heating coils 330 with the help of the switching circuit 320. The carrier mentioned above can be an
25 ultrasonic wave, a radio frequency wave, infrared wave, laser wave, and so on. In addition, those signals can be modulated under a certain communication protocol, e.g. Bluetooth, WiFi, or a simple on-off 2 states indication.

The power source 230 is a dry cell, a lithium battery, an alkaline battery and/or the like. These could last for several years; because power consumption of the
30 transmitter 220 is very low and the system 100 is turned off while not in use. In addition, there may be a safety battery or a super-capacitor, connected to the temperature control device 210 to provide a non-stop energy supply to increase the safety of the system 100. This ensures that even when the battery 230 fails, the temperature control device 210 has enough energy to continue working for some time, i.e long enough to allow the system 100 to switch

to a safe mode. Moreover, when the battery 230 works efficiently, it can keep the safety battery/super-capacitor fully charged. When the battery 230 fails, the safety battery or the super-capacitor provides energy immediately.

If the power source 230 is a rechargeable battery such as a Lithium Ion or
5 NiMH, it does not last for a long time. Hence, to charge them, a charger is required. The rechargeable battery can be charged in three different ways.

The first charging means is a simple cord charger, like any charger of a portable device, which has an additional adapter. After the battery has run out, the charger is connected by plugging in a demountable connector on the temperature control device 210
10 and by plugging an adapter into an AC power supply, thus causing AC to be converted to DC by the adapter to charge the battery. The second option is a cordless charger, widely used in domestic appliances. There are two sets of coils (primary and secondary coils) in the charger and in the battery, respectively, so the battery can be charged by induction when the two sets of coils are in proximity to one another. There is no physical connection in this scenario, and
15 the charging process can progress even when the object is in use. To ensure the efficiency, the secondary charge coil should be superposed onto the primary charge coil. An energizer drives the primary coil of the charger to transfer energy to the secondary coil in the temperature control device by induction and then the temperature control device converts the generated current in the secondary coil to controllable DC to charge the battery. The third
20 option is also a cordless charger, and its working principle is similar to the second option. However, it utilizes the induction coil in the heating device as its primary charge coil, so the battery can be charged everywhere and anytime when the heating device is in use. There is also no physical connection in this scenario, and there is no limitation on the position of the object while the charging is in progress.

25 As shown in Fig. 1, the user, after switching on the object 200 by pressing the button 205, sets the temperature of the object 200 with the help of the temperature setting element 212. At this point, the transmitter 220 continuously transmits a signal. This is an indication to the heating device 300 to become active. The heating device 300 starts heating the object 200 and the temperature of the object 200 increases continuously. As the
30 temperature of the object 200 reaches the pre-determined value, the sensing element 214 senses this and the switching element 216 deactivates the power source. The power source 230 in turn deactivates the transmitter 220 and no signal is sent to the receiver 310 of the heating device 300. Then the switching circuit 320 turns off the heating coils 330. Thus, the temperature of the object 200 will not increase any further. Subsequently, when the

temperature of the object 200 drops below the pre-determined temperature either because of the use of the object or because of natural heat loss to the atmosphere, the switching element 216 turns the transmitter 220 on and the receiver 310 detects the presence of the signal to turn on the heating coils 330. It is to be noted that no information on the temperature is
5 transmitted and only the signal is transmitted. The signal is either present or absent. The presence of the signal means turn “on” the heating device 300, whereas the absence of the signal means turn “off” the heating device 300.

Furthermore, as shown in Fig. 3, a thermal fuse 250 is situated on the object 200. If any component of the temperature control device 210 fails and the temperature of the
10 object 200 increases beyond the pre-determined value, the fuse 250 will be blown to cut off the linkage between the temperature control device 210 and the power source 230 to make the system 100 stop working. Moreover, after using the system, the user needs only to turn off the object 200 by means of the button 205 and the heating device 300 will be turned off automatically. Even if the user forgets to switch it off, the system 100 will be auto-off in
15 several minutes for safety and energy saving considerations.

According to another embodiment of the invention, all the electrical parts of the temperature control device 210 are built in an integrated circuit 250 as shown in Fig.3. This is similar to the technology widely used in a smart card. A reader 340 is installed in the heating device 300, which can access data in the integrated circuit 250 without any contact.
20 The reader 340 requests the signal periodically, and the integrated circuit 250 responds and sends back the temperature of the object 200 to the reader 340, allowing it to control the switching circuit 320. Moreover, the integrated circuit is powered by this request signal, and it processes temperature sensing and other operations just in this accessing period, so there is no additional battery required.

25 The object can be an iron, a cooker, a rice cooker, a fryer or a coffee machine and the like. The heating device can be an induction coil or multiple induction coils. The temperature control device mentioned above can be used for any of these devices.

It is to be understood that although preferred embodiments, specific constructions and configurations have been discussed herein according to the present
30 invention, various changes or modifications in form and detail may be made without departing from the scope and spirit of this invention.

CLAIMS:

1. A system comprising:
an object including a temperature control device, a transmitter and a power source, wherein the temperature control device is arranged for sensing the temperature of the
5 object and activating the power source, and the power source in turn is configured for activating the transmitter for transmitting a wireless signal, depending on the sensed temperature; and
a heating device including a receiver and a switching circuit, wherein the heating device is configured for heating the object, the receiver is configured for receiving
10 the wireless signal, and the switching circuit is configured for activating the heating device, based on receipt of the wireless signal.
2. The system of claim 1, wherein the temperature control device comprises:
 - i. a temperature setting element configured for setting a pre-determined
15 temperature to which the object has to be heated;
 - ii. a sensing element configured for sensing the temperature of the object;
and
 - iii. a switching element configured for activating the power source when
the sensed temperature is below the pre-determined temperature, wherein the power source is
20 configured to then activate the transmitter for transmitting a wireless signal to the heating device.
3. The system of claim 2, wherein the sensing element is a mechanical
thermostat or a thermocouple, a thermal diode, a thermistor, an infrared sensor or the like.
25
4. The system of claim 3, wherein the sensing element is provided with multiple
sensing points for sensing the temperature of the object at multiple positions.

5. The system of claim 1, wherein a thermal fuse is connected to the object, and wherein the thermal fuse is configured for deactivating the power source when the temperature control device fails.
6. The system of claim 1, wherein the wireless signal is transmitted to the heating device by a carrier wave.
7. The system of claim 6, wherein the carrier wave is an electromagnetic wave, a light wave, a sound wave and the like
8. The system of claim 7, wherein the electromagnetic wave is a radio frequency wave and the like, the light wave is an infrared wave, a laser wave and the like, the sound wave is an ultrasonic wave and the like.
9. The system of claim 1, wherein the power source is a dry cell battery, alkaline battery and the like.
10. The system of claim 1, wherein the object is provided with an auto shut off feature and wherein the auto shut off feature is configured for ensuring the safety of the heating device.
11. The system of claim 1, wherein the heating device is in the form of (an) induction coil(s), halogen lamps, conventional tubular heating elements and the like.
12. The system of claim 1, wherein the object is configured to be heated while moving or while stationary.
13. The system of claim 1, wherein the object is an iron and the heating device is one or more induction coil(s).

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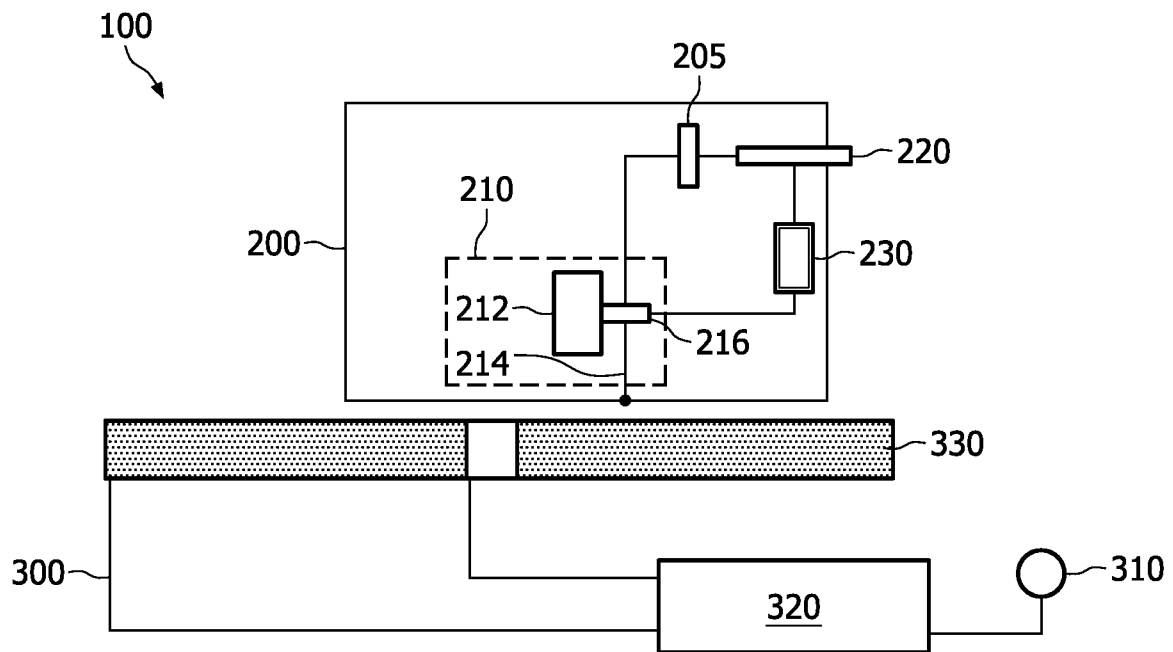


FIG. 1

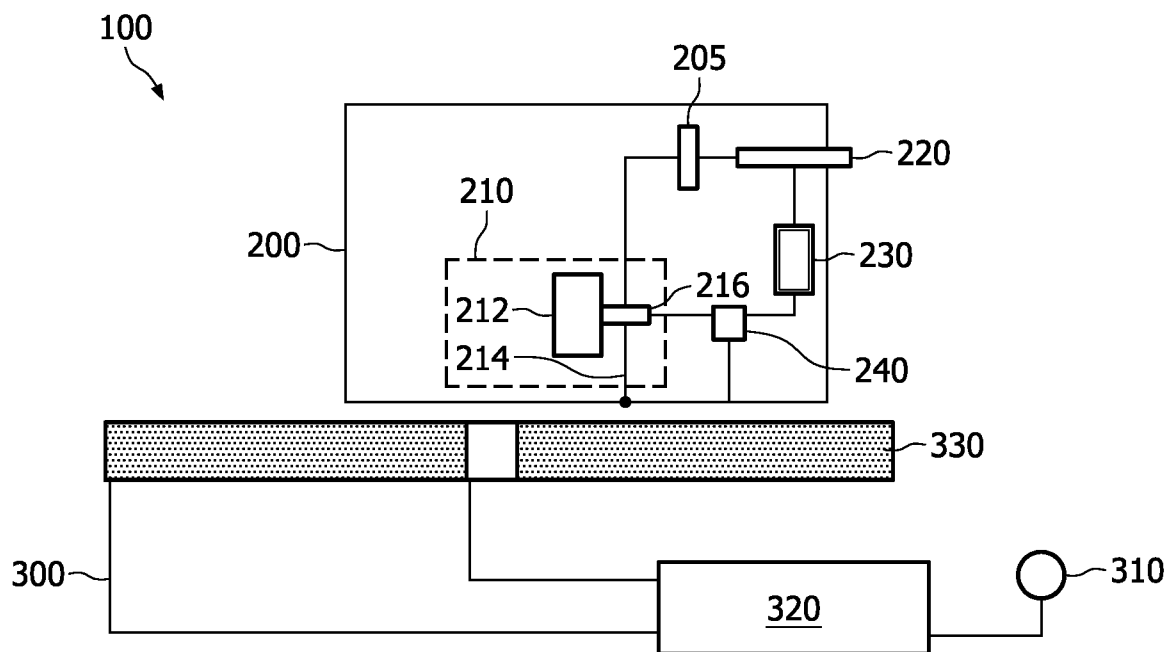


FIG. 2

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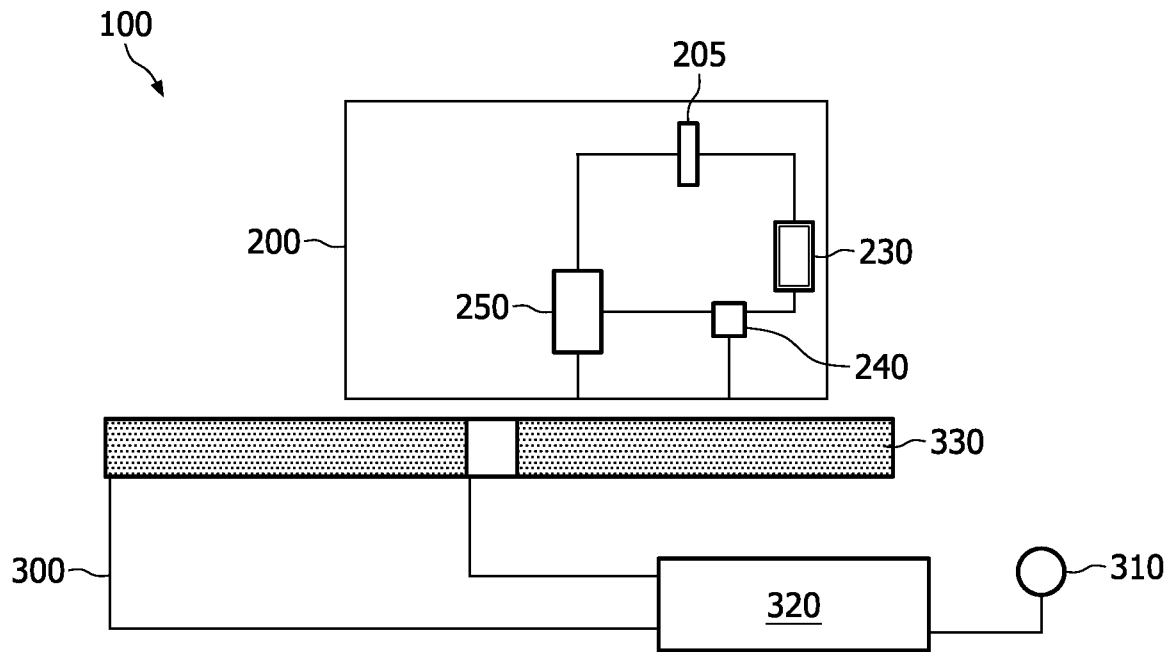


FIG. 3

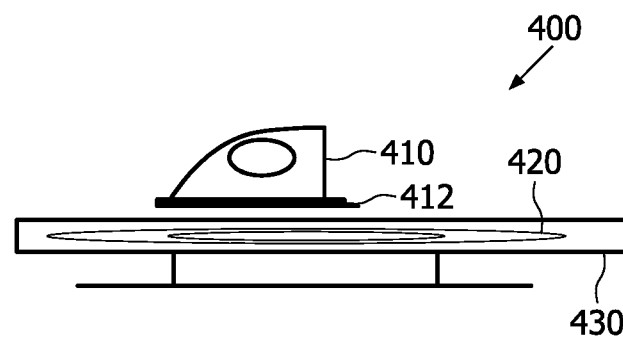


FIG. 4