

Description**BACKGROUND OF THE INVENTION**

5 The present invention relates generally to automatic heating appliances, and more particularly to an appliance for automatically controlling heating to a cooking object on the basis of variation of the weight of the object to be heated.

known are heating appliances with a plurality of different sensors which automatically controlling the time period of heating of an object in accordance with signals from the plurality of sensors such as humidity sensor, gas sensor and weight sensor. Using the plurality of sensors allows automatization of a wide range of cooking category. For example, the humidity sensor and gas sensor detect gases and vapors generated from the cooked object such as food and the results of the detection is used for controlling the termination of the heating of the cooked object. However, in the case of thawing of an object of a below-zero temperature, i.e., frozen food, the gases and vapors developed from the frozen foods are extremely few and generally the gas sensor and humidity sensor do not have sensitivities sufficient to detect them. Thus, a weight sensor is employed for the control of the termination of the heating, because the thawing time can be calculated by detection of the quantity of the frozen food. That is, the relative permittivity of ice is constant and the heating time period depends on only the quantity of the frozen food regardless of kinds of cooked objects. Accordingly, various sensors should be required for desirable automatization of cooking. However, provision of a plurality of sensors results in the appliance with a complex arrangement and a complex control system, thereby causing increase in the manufacturing cost.

On the other hand, various types of automatic heating appliances with only a weight sensor have been proposed heretofore. One known technique is that as disclosed in Japanese Patent Provisional Publication No. 62-66025 the termination of the heating is controlled by detecting the decrease in the weight of the heated food and then determining the kind of the food on the basis of the variation of the weight with respect to time during heating. There is a problem which arises with this type of appliance, however, in that the detection accuracy depends on the stability of the temperature characteristics of the weight sensor and the detection circuit therefor. One possible solution is to eliminate variation (drift) of the temperature characteristic of the weight-detecting devices, as disclosed in Japanese Patent Provisional Publication No. 62-168364, the technique of which involves detecting the atmosphere temperature of the weight-detecting devices and detecting weight of the food under the condition that the atmosphere temperatures at two timings are equal to each other so as to remove the detection error due to the variation of the temperature characteristic. However, this type of automatic heating appliance also provides problems that the use is limited to the oven cooking and a temperature detecting means should be required to detect the atmosphere temperature of the weight-detecting devices to result in a complex control system.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an automatic heating appliance with a single weight sensor which is capable of satisfying the ordinary heating and thawing requirements.

In accordance with the present invention, there is provided an automatic heating appliance comprising the features of claim 1.

Preferably, said weight detection means is composed of an electric capacitance type pressure sensor which includes a pair of flat plate type detection electrodes facing each other to be spaced by a predetermined distance from each other and a pair of flat plate type reference electrodes facing each other to be spaced by a predetermined distance from each other and respectively provided around said pair of detection electrodes. Said control means is responsive to the electric capacitance due to the detection electrodes and the electrical capacitance due to the reference electrodes to calculate the weight of said object on the basis of both the sensed capacitances.

In accordance with the present invention, there is further provided an automatic heating appliance having therein a heating chamber for housing an object to be heated, comprising: heating means provided on or in said heating chamber for heating said object placed in said heating chamber; table means provided in said heating chamber for keeping thereon said object during heating; weight detection means for obtaining first weight data in response to said object being placed on said table means; temperature compensation means for obtaining a second weight data in response to said object being placed on said table means, said temperature compensation means substantially having the same temperature characteristic as said weight detection means; and control means coupled to said weight detection means and said temperature compensation means so as to remove an error component due to variation of the characteristic

of said weight detection means by variation of temperature in accordance with the result of comparison between said first weight data obtained by said weight detection means and said second weight data obtained by said temperature compensation means so as to determine a weight of only said object, said control means controlling the heating of said object in accordance with variation of the determined object weight.

Preferably, said weight detection means is composed of an electric capacitance type pressure sensor which includes a pair of flat plate type detection electrodes facing each other to be spaced by a predetermined distance from each other, and said temperature compensation means is composed of an electric capacitance type pressure sensor which includes a pair of flat plate type reference electrodes facing each other to be spaced by a predetermined distance from each other, said temperature compensation means being disposed near said weight detection means. Similarly, said control means is responsive to the electric capacitance due to the detection electrode and the electric capacitance due to the reference electrode to calculate the weight of said object on the basis of both the sensed capacitances.

BRIEF DESCRIPTION OF THE DRAWINGS

The object and features of the present invention will become more readily apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a perspective view showing the outward appearance of an automatic heating appliance according to an embodiment of the present invention;

Fig. 2 is a block diagram showing a heating system of the automatic heating appliance of the embodiment;

Fig. 3A is a cross-sectional illustration of an electrical capacitance type weight sensor used in the automatic heating appliance of the embodiment;

Fig. 3B are development illustrations of the Fig. 3A weight sensor;

Figs. 4A to 4C are illustrations of other weight sensors useful in this embodiment;

Fig. 5 is a block diagram showing a control circuit for the weight sensor;

Fig. 6A is a graphic diagram showing variation of the output frequency of a detection circuit with the passage of time;

Fig. 6B is a graphic illustration of the ratio of the frequencies from the detection circuit;

Fig. 7 is a graphic diagram showing the relation between the frequency ratio and the weight;

Fig. 8 is a circuit diagram showing an electric circuit employed in the automatic heating appliance of this embodiment.

Fig. 9 is a flow chart showing one example of the control program to be used in the automatic heating appliance of the embodiment;

Fig. 10A shows the heating control executed in response to the thawing instruction key;

Fig. 10B illustrates the heating control executed in response to the heating instruction key;

Fig. 11 is a flow chart showing the measurement of the weight of an object to be heated;

Fig. 12 is a graphic diagram showing the relation between the operating frequency and the temperature characteristic;

Fig. 13 is a graphic diagram showing the relation between the weight of the object and frequencies, frequency ratio; and

Fig. 14 is a graphic illustration of another relation between the weight and frequencies, frequency ratio.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to Fig. 1, there is illustrated an automatic heating appliance such as a microwave oven according to an embodiment of the present invention. In Fig. 1, the automatic heating appliance of this embodiment has a housing 1 equipped with an openable and closable door 2 at its front face, the housing 1 being further provided with an operating panel 3 in the vicinity of the door 2. On the operating panel 3 are disposed a keyboard 4 and an indication section 5, the keyboard 4 having various instruction keys such as a thawing key for giving an instruction of automatically thawing a frozen object and a heating key for providing an instruction of automatically heating an object to be heated up to a predetermined temperature.

Fig. 2 is a block diagram showing an system arrangement of the automatic heating appliance of this embodiment. Illustrated at numeral 6 is a control section which is responsive to various instructions inputted through the various operating keys of the keyboard 4 and gives indications corresponding to the instruction on the indication section 5. The appliance has therein a heating chamber 7 where a rotatable turntable 8 is disposed to place thereon an object 9 such as a food to be heated or cooked. On the ceiling of the heating

chamber 7 is provided a heating means 10 such as a magnetron which is operable in response to an electric power supply from a driver 11 under control of the control section 6. The turntable 8 has a rotating shaft which is coupled to a drive shaft of a drive source 12, disposed at the outside of the heating chamber 7, to as to be rotatable during heating by the magnetron 10 to prevent uneven heating of the object 9 to be heated. The drive shaft of drive source 12 is arranged to be movable in the directions (thrust direction) of the axis of the rotating shaft of the turntable 8 and, at its lower end portion, mechanically engaged with a weight-detecting means 15. A temperature compensation means 16 is disposed in the vicinity of the weight-detecting means 15. The weight-detecting means 15 and the temperature compensation means 16 are electrically coupled through a detection circuit 17 to the control section 6. The weight-detecting means may be of any one of various types weight sensors or detecting-devices such as strain gauge, electrical capacitance type pressure sensor and displacement sensor.

Figs. 3A and 3B show an example of electrical capacitance type weight sensors where the weight detecting means 15 and the temperature compensation means 16 are constructed as one-piece device. In Figs. 3A and 3B, the electrical capacitance type weight sensor 15 comprises a base plate 18 and a diaphragm which are constructed of an insulating flat plate made of an alumina, for example, and which are vertically spaced by a predetermined distance d from each other by means of a circular, or cylindrical, sealing member 20 so as to form therein a cylindrical space. The base plate 18 and the diaphragm 19 respectively have detection electrodes 21 which act as the weight-detection means 15 and which are disposed on substantial center portions of the inner surfaces thereof so as to face each other in the cylindrical space. Around each of the detection electrodes 21 is provided a reference electrode 22 which acts as the temperature compensation means 16.

In response to application of a load P onto the diaphragm 19, the diaphragm 19 is bent as illustrated in Fig. 3A whereby the electrical capacitance C_w developed between the detection electrodes 21 varies. In this instance, the reference electrode 22 provided around the detection electrode 21 of the diaphragm 19 is not virtually bent thereby because it is positioned near the sealing member 20 so that the electrical capacitance C_r developed between the reference electrodes 22 is substantially kept as it is.

Furthermore, the reference electrodes 22 are made of the same material as the detection electrodes 21 and are respectively disposed near the detection electrodes 21, and therefore the temperature characteristics of both the detection electrode 21 and the reference electrode 22 are substantially equal to each other. While the electrical capacitance due to the detection electrodes 21 depends upon both the the load variation and the temperature, the electrical capacitance due to the reference electrodes 22 substantially depends on only the temperature variation. Accordingly, by subtracting the variation of the electrical capacitance due to the reference electrodes 22 from the variation of the electrical capacitance due to the detection electrodes 21, it is possible to attain the variation of the electrical capacitance corresponding to only the weight (load) variation of the object 9 placed on the turntable 8. In Fig. 3A, numeral 23 is a through-hole formed in the base plate 18, whereby the air within the cylindrical space are communicated with the outside air so as to prevent expansion and contraction of the air therewithin due to variation of the atmosphere temperature which adversely affects the temperature characteristic of the weight-detecting means.

Figs. 4A through 4C show other weight sensors, Figs. 4A and AB illustrating weight sensors integrally including both the weight-detecting means 15 and the temperature compensation means 16 and Fig. 4C illustrating a weight sensor in which the weight-detecting means 15 and the temperature compensation means are separated from each other but the temperature compensation means 16 is positioned near the weight-detecting means 15.

In Fig. 4A, the weight sensor is of the double layer type that a diaphragm 19 and two base plates 18 and 24 are arranged vertically so as to form two spaces therebetween by means of two sealing members 20. Detection electrodes 21 are respectively placed on the lower surface of the diaphragm 19 and the upper surface of the base plate 18 so as to be disposed in the upper space between the diaphragm 19 and the base plate 18 to be in opposed relation to each other, whereas reference electrodes 22 are disposed in the lower space between the two base plates 18 and 24. Numeral 25 is a through-hole for establishing the communication between the air within the lower space and the outside air. In Fig. 4B, detection electrodes 21 are disposed inside a sealing member 20, while reference electrodes 22 are arranged outside the sealing member 20. Similarly, the detection electrodes 21 and the reference electrodes 22 are respectively placed on the lower surface of the diaphragm 19 and the upper surface of the base plate 18 so as to face each other. In Fig. 4C, the weight sensor is of the two-piece structure type that reference electrodes 22 are disposed between newly provided base plates 26 and 28, made of the same material as the base plate 18, so that the weight-detecting means 15 and the temperature-compensation means 16 are formed independently, but near from each other. Numeral 28 represents a through-hole for establishing the communication

between the air within the space between the base plates 26, 27 and the outside air. Here, in the case of Fig. 4C, it is also appropriate to use, instead of the reference electrodes 22, a capacitor such as ceramic capacitor with the same temperature characteristic and same capacitance as the detection electrodes 21.

In the embodiment, it is also possible to use weight sensing devices such as piezoelectric device and inductance device other than the above-described electrical capacitance type device. In this instance, a device, being the same as the weight-detection means, is disposed in the vicinity of the weight-detecting means and at a position that does not impose virtually no loading regardless of placing the object to be heated on the turntable 8.

Fig. 5 is a control block diagram showing the control relation between the detection circuit 17 and the control section 6. In Fig. 5, here, as the detection circuit 17 is used a CR oscillating circuit 29 which is provided with a resistor R and responsive to the reference electrical capacitance C_r developed due to the reference electrodes 22 and further the detection electrical capacitance C_w developed due to the detection electrodes 21. Illustrated at numeral 30 is a switching means which is controlled by a change-over gate signal control means 31 of the control section 6 so that the reference electrical capacitance C_r and the detection electrical capacitance C_w are selectively coupled to the oscillating circuit 29 which in turn outputs a signal with an oscillating frequency f_r corresponding to the reference electrical capacitance C_r and a signal with an oscillating frequency f_w corresponding to the detection electrical capacitance C_w to a counter means 32 of the control section 6. The outputs (f_r , f_w) of the counter means 32 are temporarily stored in a random access memory (RAM) 33, before directing to a calculation means 34 to calculate a frequency ratio r of the output frequencies f_r and f_w , for example. Fig. 6A shows variations of the output frequencies f_r and f_w of the oscillating circuit 29 with respect to time during heating operation.

The detection oscillating frequency f_w due to the detection capacitance C_w is affected by both the weight variation and temperature variation, whereas the reference oscillating frequency f_r due to the reference capacitance C_r is affected by only the temperature variation. Thus, in accordance with the relation between the frequencies f_w and f_r , it is possible to obtain only a value corresponding to only the weight variation through subtraction or division in the calculation means 34 of the control section 6. Here, a description of the division process will be given hereinbelow. That is, the frequency ratio r of the oscillating frequencies f_w and f_r is initially obtained as follows:

$$r = f_r / f_w \quad (1)$$

and

$$r = \frac{f_r}{f_w} = \frac{K/RC_r}{K/RC_w} = \frac{C_w}{C_r} \quad \dots \dots \dots (2)$$

here, since an single oscillating circuit 29 is used for both the frequencies f_r and f_w , the circuit constants K having the temperature characteristics are the same with respect to f_r and f_w and the resistances R are similar to each other, and therefore, as obvious from the aforementioned equation (2), the frequency ratio r results in obtaining the ratio of the detection capacitance C_w and the reference capacitance C_r .

Since the temperature characteristics of the reference electrodes and the detection electrodes are substantially equal to each other, the weight calculated on the basis of the obtained frequency ratio r does not include the affection of variation of the temperature characteristic. Fig. 6B shows variation of the calculated frequency ratio r with respect time.

Fig. 7 is a graphic illustration showing the relation between the frequency, frequency ratio and the weight. Thus, the weight w can be obtained in accordance with, for example, the following equation:

$$w = ar^2 + br + c \quad (3)$$

where a , b , and c are constants.

Fig. 8 illustrates the entire circuit arrangement of an automatic heating appliance of this embodiment. In Fig. 8, the control section 6 comprises a well known microcomputer including a central processing unit (CPU) and is coupled to the keyboard 4 which has a key matrix which is in turn coupled to input terminals I_0 to I_5 . The indication means 5 comprising a fluorescence indicating tube effects dynamic lighting in response to digit signals S_0 to S_4 and indication data signal 00 to 07 . The driver 11 comprises a relay 35

and a voltage-increasing section 36 and supplies an electric power to the magnetron 10 in accordance with a RLY signal. The detection circuit 17 includes a single oscillating circuit 29 (operational amplifier TL082, for example) comprising a combination of a sawtooth oscillator and a waveform shaping circuit and further includes the switching means 30. The switching means 30 alternately switches the detection capacitance C_w and the reference capacitance C_r which are in turn inputted into an input terminal TC of a counter (counter means 32) encased in the microcomputer 6 (for example, MB88515). The switching operation is effected in accordance with a switching gate signal E_o . Although the switching means comprises an analog switch (μ PC4066, for example), it is also appropriate to use a semiconductor switching means or a relay circuit. Illustrated at numeral 37 is a level shift circuit for voltage transformation and waveform shaping, which is incorporated therein, if required.

Fig. 9 is a flow chart showing operation to be executed in the microcomputer 6 in accordance with a predetermined program prestored in a memory thereof. The microcomputer starts with a step 101 to check the contents of the operated instruction key, for example, whether the thawing key is operated by a user. If so, control goes to a step 102 in order to detect the total weight W_o of an object to be heated prior to heating. In the thawing, generally used is an attachment, made of an appropriate resin, which is arranged so as to drop down water or gravy from a frozen food onto the turntable 8 to allow the food to be separated from the water or gravy. Therefore, in a subsequent step 103, the net weight W_F of the object to be heated is calculated by subtracting the weight W_N of the attachment from the total weight W_o thereof. That is,

$$W_F = W_o - W_N \quad (4)$$

Thereafter, a step 104 is executed in order to calculate a thawing time T_D as a function of the obtained net weight W_F . Here, it is preferable that for the thawing the heating time is determined in stages with the heating power being gradually decreased. Thus, the thawing time T_D maybe set as follows.

$$T_D = T_1 + T_2 + T_3 + T_4 \quad (5)$$

where T_1 represents time for a high-power heating stage, T_2 designates time for a heating interruption stage, T_3 denotes time for a middle-power thawing stage, and T_4 is time for a low-power finishing stage.

For example, the time T_n for each of the stages can be expressed as follows.

$$T_n = A_n W_F + B_n \quad (6)$$

where A_n and B_n are constants ($n = 1$ to 4) determined in accordance with the respective stages.

in response to the determination of the heating times, control advances to a step 105 to start the heating, followed by a step 106 to control the heating time and the high-frequency output to the heating means 10. After elapse of the total time T_D , the heating is automatically terminated in a step 107.

Fig. 10A is a time chart for an understanding of the power supply to the heating means 10.

On the other hand, if the answer of the step is negative, control goes to a step 108 in order to check whether the heating instruction key is operated. If the answer of the step 108 is "NO", other process will be effected. If so, control goes to a step 109 to start the heating operation. Here, the heating operation should be required to be executed so as not to receive influence of vibration and disturbance with respect to the weight sensor. Therefore, after the start of the heating, a step 110 is executed to detect the initial weight W_i of the object to be heated and a step 111 is then executed to have a wait for a predetermined time period. Thereafter, a step 112 is performed to detect the weight W_n of the heated object, then followed by a step 113 to calculate the difference DW between the successively detected weights as follows.

$$DW = W_n - W_{n-1} \quad (7)$$

In the initial state, the weight of the heated object is not virtually varied and therefore the value of DW corresponds to only the output variation due to the temperature characteristics of the circuits and elements. As the heating proceeds, vapors and so on are started to be generated from the heated object so as to decrease the weight of the heated object. Thus, the completion timing of the heating can be controlled in accordance with the variation of the weight of the heated object.

Based on the weight detected at a predetermined time interval, the the difference DW can be considered to be the time change rate of the weight variation, i.e., the time differential value. Accordingly, it is possible to check whether the obtained difference value DW results from the normal weight decrease of the heated object by comparing the difference value DW with predetermined values. Thus, in a step 114,

the difference value DW is compared with two predetermined values (constants) C1 and C2 as follows.

$$C1 < DW < C2 \quad (8)$$

That is, if the difference value DW is greater than the value C1, the difference value DW includes the decrease in the weight of the heated object in addition to the value due to the temperature characteristics of the devices. Further, if smaller than the value C2, the difference value DW is the normal weight decrease value of the heated object without including the value due to the noises such as vibration from the external.

If the condition shown in the equation (8) is satisfied, control advances to a step 115 to add the difference value DW so that the difference weight DW is integrated so as to obtain the weight variation ΔW as follows.

$$\Delta W = \Sigma DW \quad (9)$$

In the step 114, if the difference value Dw is smaller than the value C1, the difference value DW is considered to be a value due to the output variation caused by the temperature characteristics of the devices and others and therefore the difference value DW is not used in this process. Similarly, If the difference value DW is greater than the value C2, the difference value Dw is considered to be based on noises and so on and is not used as data in this process.

With above-mentioned process, the difference value integration weight ΔW accurately corresponds to the weight variation of the heated object. The integration value ΔW is compared with a threshold value W_{TH} in a step 116 so as to check whether the weight variation reaches a predetermined value. If exceeding the threshold value W_{TH} , the heating of the object advances to a predetermined level and hence the power supply to the heating means 10 is changed or terminated in a step 117. Fig. 10B is a time chart for understanding the above-mentioned heating operation due to the operation of the heating instruction key. The time T1 reaching the threshold value W_{TH} is counted, and then the heating is continuously performed with a low output for a predetermined time period KT1 where K is a constant, for example.

Fig. 11 is a flow chart showing a control program for the weight sensor. This program starts with a step 201 to set the gate signal Eo to the high-level state, then followed by a step 202 to provide a delay time and further followed by a step 203 to start the counter coupled to the TC terminal, thereby starting the detection of the reference frequency fr. Control further advances to a step 204 to count the gate time (for example, 1 second). after elapse of the time, the counter is stopped in a step 205. and the result fr is stored in the RAM 33 in a step 206. Thereafter, control goes to a step 207 to change the gate signal Eo to the low-level state, then followed by steps 208 to 212 to similarly perform the measurement of the detection frequency fw.

Thereafter, the frequencies fr and fw stored in the RAM 33 are processed so as to obtain the frequency ratio r in a step 213 and the weight w is calculated on the basis of the obtained frequency ratio r.

Here, the reason that the drift of the temperature characteristic is not completely eliminated by only the frequency ratio r will be described herein below with reference to Fig. 12 showing the measurement results of the temperature characteristic of the operating frequency f of an oscillating circuit, where the operating frequency f indicated on the horizontal axis is varied by variation of the capacitance or resistance and the temperature characteristic Δf is obtained in accordance with the following equation.

$$\Delta f = (f_{20} - f_{\alpha}) / \{f_{20} \times (\alpha - 20)\} \quad (10)$$

where f_{20} represent a frequency under the condition of the temperature of 20°C and f_{α} designates a frequency under the condition of the temperature of α °C.

That is, Fig. 12 shows that irrespective of keeping small the temperature characteristic of the sensor, the temperature characteristic of the oscillating circuit is kept as it is and developed in accordance with the operating frequency so that the temperature characteristic increases with the heightening frequency. Generally, regardless of the type of the oscillating circuit, the temperature characteristic depends upon the operating frequency. In the case of using an oscillating circuit as means for detecting the capacitance of the sensor, when the detection frequency and the reference frequency is equal to each other, that is, when the detection capacitance and the reference capacitance are equal to each other, the temperature characteristic can be completely eliminated. However, in response to occurrence of the difference between the frequencies, the temperature characteristic due to the circuit is developed accordingly.

Thus, in this embodiment, the capacitances of the detection electrodes and the reference electrodes are selectively determined with respect to the weight of the turntable 8. Fig. 13 shows the relation between the

capacitances of the detection electrodes and reference electrodes (reference and detection frequencies) and the weight of the object to be measured (heated) (load applied to the sensor), where the horizontal axis represents the weight w of the object to be measured and the vertical axis represents the output frequency of the detection means and the frequency ratio r . In Fig. 13, the point of $W = W_{PL}$ represents the weight of only the turntable. Here, in the case of $W = W_{PL}$, when the reference capacitance C_r and the detection capacitance C_w are arranged to be equal to each other, the lines indicating the frequencies f_r and f_w are crossed at the point of $W = W_{PL}$. Accordingly, at the point of $W = W_{PL}$, the frequency ratio r becomes 1. As described above with reference to Fig. 12, when the operating frequencies are equal to each other, the temperature characteristic due to the circuit can be completely eliminated. That is, the temperature characteristic at the point W_{PL} resulting in $r = 1$ becomes zero. Thus, if the ratio e of the frequencies f_r and f_w is obtained and the detection capacitance C_w and the reference capacitance C_r are arranged to be equal to each other at the point of $W = W_{PL}$, it is possible to remove the temperature characteristic of the sensor and the temperature characteristic of the circuit. This means that as the weight of the object to be measured is smaller, the temperature characteristic can be kept smaller, thereby obtaining an excellent performance.

Fig. 14 is a graphic illustration of the relation between the capacitances of the detection electrodes and reference electrodes and the weight of the object to be measured in another example. In this case, the reference capacitance C_r and the detection capacitance C_w are arranged to be equal to each other when $W = W_z$, where W_z is substantially a middle value between the turntable weight W_{PL} and the maximum weight W_{max} . Accordingly, the temperature drift becomes zero when $W = W_z$. Therefore, the temperature drift becomes minimum over all the range of the detection weight.

There is disclosed herein an automatic heating appliance for controlling heating of an object in response to operation of instruction keys and on the basis of the weight of an object to be heated. The appliance includes therein a heating chamber for housing the object, a heater provided on or in the heating chamber for heating the object placed therein, and a turntable provided in the heating chamber for keeping thereon the object during heating. Also included in the appliance are a weight detector for obtaining first weight data in response to the object being placed on the turntable and a temperature compensator for obtaining a second weight data in response to the object being placed thereon, the temperature compensator substantially having the same temperature characteristic as the weight detector. A control unit of the appliance is responsive to the first and second weight data in order to remove an error component due to variation of the characteristic of the weight detector by variation of temperature in accordance with the result of comparison between the first and second weight data so as to determine a weight resulting from only the object. The control unit controls the heating of the object in accordance with variation of the determined object weight.

Claims

1. An automatic heating appliance having therein a heating chamber (7) for housing an object (9) to be heated, comprising:
 - heating means (10) provided on or in said heating chamber (7) for heating said object (9) placed in said heating chamber (7) in accordance with a heating control signal;
 - table means (8) provided in said heating chamber (7) for keeping thereon said object (9) during the heating;
 - instruction key means (4) including a thawing instruction key for giving instructions to thaw said object (9) of a below zero-temperature and a heating instruction key for giving instructions to heat said object (9) up to a predetermined temperature;
 - weight detection means (15) for obtaining first weight data in response to said object (9) being placed on said table means (8);
 - temperature compensation means (16) for obtaining a second weight data in response to said object (9) being placed on said table means (16) substantially having the same temperature characteristic as said weight detection means (15);
 - control means (6) coupled to said instruction key means (4) for controlling heating of said object (9) by outputting said heating control signal to said heating means (10) in response to operation of said instruction key means (4) and further coupled to said weight detection means (15) and said temperature compensation means (16) so as to control the heating of said object (9) on the basis of the detected weight of said object (9),
 - characterized in that
 - said control means (6) remove an error component due to variation of the characteristic of said weight



capacitances of the detection electrodes and reference electrodes (reference and detection frequencies) and the weight of the object to be measured (heated) (load applied to the sensor), where the horizontal axis represents the weight w of the object to be measured and the vertical axis represents the output frequency of the detection means and the frequency ratio r . In Fig. 13, the point of $W = W_{PL}$ represents the weight of only the turntable. Here, in the case of $W = W_{PL}$, when the reference capacitance C_r and the detection capacitance C_w are arranged to be equal to each other, the lines indicating the frequencies f_r and f_w are crossed at the point of $W = W_{PL}$. Accordingly, at the point of $W = W_{PL}$, the frequency ratio r becomes 1. As described above with reference to Fig. 12, when the operating frequencies are equal to each other, the temperature characteristic due to the circuit can be completely eliminated. That is, the temperature characteristic at the point W_{PL} resulting in $r = 1$ becomes zero. Thus, if the ratio e of the frequencies f_r and f_w is obtained and the detection capacitance C_w and the reference capacitance C_r are arranged to be equal to each other at the point of $W = W_{PL}$, it is possible to remove the temperature characteristic of the sensor and the temperature characteristic of the circuit. This means that as the weight of the object to be measured is smaller, the temperature characteristic can be kept smaller, thereby obtaining an excellent performance.

Fig. 14 is a graphic illustration of the relation between the capacitances of the detection electrodes and reference electrodes and the weight of the object to be measured in another example. In this case, the reference capacitance C_r and the detection capacitance C_w are arranged to be equal to each other when $W = W_z$, where W_z is substantially a middle value between the turntable weight W_{PL} and the maximum weight W_{max} . Accordingly, the temperature drift becomes zero when $W = W_z$. Therefore, the temperature drift becomes minimum over all the range of the detection weight.

There is disclosed herein an automatic heating appliance for controlling heating of an object in response to operation of instruction keys and on the basis of the weight of an object to be heated. The appliance includes therein a heating chamber for housing the object, a heater provided on or in the heating chamber for heating the object placed therein, and a turntable provided in the heating chamber for keeping thereon the object during heating. Also included in the appliance are a weight detector for obtaining first weight data in response to the object being placed on the turntable and a temperature compensator for obtaining a second weight data in response to the object being placed thereon, the temperature compensator substantially having the same temperature characteristic as the weight detector. A control unit of the appliance is responsive to the first and second weight data in order to remove an error component due to variation of the characteristic of the weight detector by variation of temperature in accordance with the result of comparison between the first and second weight data so as to determine a weight resulting from only the object. The control unit controls the heating of the object in accordance with variation of the determined object weight.

Claims

1. An automatic heating appliance having therein a heating chamber (7) for housing an object (9) to be heated, comprising:
 heating means (10) provided on or in said heating chamber (7) for heating said object (9) placed in said heating chamber (7) in accordance with a heating control signal;
 table means (8) provided in said heating chamber (7) for keeping thereon said object (9) during the heating;
 instruction key means (4) including a thawing instruction key for giving instructions to thaw said object (9) of a below zero-temperature and a heating instruction key for giving instructions to heat said object (9) up to a predetermined temperature;
 weight detection means (15) for obtaining first weight data in response to said object (9) being placed on said table means (8);
 temperature compensation means (16) for obtaining a second weight data in response to said object (9) being placed on said table means (16) substantially having the same temperature characteristic as said weight detection means (15);
 control means (6) coupled to said instruction key means (4) for controlling heating of said object (9) by outputting said heating control signal to said heating means (10) in response to operation of said instruction key means (4) and further coupled to said weight detection means (15) and said temperature compensation means (16) so as to control the heating of said object (9) on the basis of the detected weight of said object (9),
 characterized in that
 said control means (6) remove an error component due to variation of the characteristic of said weight



detection means (15) by variation of temperature in accordance with the result of comparison between said first weight data obtained by said weight detection means (15) and said second weight data obtained by said temperature compensation means (16) so as to determine a weight of only said object (9), and

5 said control means (6), in response to operation of said thawing instruction key, calculating a heating time in stages with the heating power being gradually decreased on the basis of the weight of said object (9) before heating, and in response to operation of said heating instruction key, detecting the weight variation of said object (9) during the heating and being determined to terminate the heating.

10 2. An automatic heating appliance according to claim 1,
characterized in that

15 said weight detection means (15, 16) is composed of an electric capacitance type pressure sensor which includes a pair of flat plate type detection electrodes (21) facing each other to be spaced by a predetermined distance from each other and respectively provided around said pair of detection electrodes (21).

3. An automatic heating appliance according to claim 2,
characterized in that

20 said temperature compensation means (16) is disposed near said weight detection means (15).

4. An automatic heating appliance according to claim 3,
characterized in that

25 said weight detection means (15, 16) includes sensing means for sensing an electric capacitance (C_w) due to said pair of detection electrodes (21) and an electric capacitance (C_r) due to said pair of reference electrodes (22) and said control means (8) being responsive to the sensed capacitance (C_w) due to said detection electrodes (21) and the sensed capacitance (C_r) due to said reference electrodes (22) to calculate the weight of said object (9) on the basis of both the sensed capacitances (C_w , C_r).

5. An automatic heating appliance according to claim 4,
characterized in that

30 said sensed capacitance (C_w) due to said detection electrodes (21) and said sensed capacitance (C_r) due to said reference electrodes (22) are alternately supplied to said control means (6).

6. An automatic heating appliance according to claim 4,
characterized in that

35 said control means (8) calculates the weight of said object (9) on the basis of the ratio (r) of said sensed capacitance (C_w) due to said detection electrodes (21) and said capacitance (C_r) due to said reference electrodes (22).

40 7. An automatic heating appliance according to claim 2 or 3, **characterized in that**

45 said detection electrodes (21) and said reference electrodes (22) are arranged such that a load (P) applied to said weight detection means (15, 16) so that an electric capacitance due to said detection electrodes (21) and an electric capacitance due to said reference electrodes (22) are substantially equal to each other is a value between the weight of only said table means (8) and a maximum weight to be applied to said weight detection means (15, 16).

8. An automatic heating appliance according to claim 2 or 3, **characterized in that**

50 said detection electrodes (21) and said reference electrodes (22) are arranged such that a load (P) applied to said weight detection means (15, 16) so that an electric capacitance (C_w) due to said detection electrodes (21) and an electric capacitance (C_r) due to said reference electrodes (22) are substantially equal to each other is the same as the weight of only said table means (8).

9. An automatic heating appliance according to claim 7,
characterized in that

55 said load (P) applied to said weight detection means (15, 16) so that said electric capacitance (C_w) due to said detection electrodes (21) and said electric capacitance (C_r) due to said reference electrodes (22) are substantially equal to each other is 1/2 of the difference between the weight of only said table means (8) and a maximum weight to be applied to said weight detection means (15, 16).



Patentansprüche

1. Automatische Heizvorrichtung mit einer darin befindlichen Heizkammer (7) zum Aufnehmen eines zu erheizenden Gegenstandes (9), mit:

einer Heizeinrichtung (10), die auf oder in der Heizkammer (7) zum Erhitzen des in die Heizkammer (7) gelegten Gegenstands (9) gemäß einem Heizsteuersignal gebildet ist;

einer Tischvorrichtung (8), die in der Heizkammer (7) zum Aufnehmen des Gegenstands (9) während des Heizens gebildet ist;

einer Befehlstasteneinrichtung (4) einschließlich einer Auftau-Befehlstaste zum Vorgeben von Befehlen, um den Gegenstand (9) von einer Temperatur unter Null aufzutauen, und einer Heiz-Befehlstaste zum Vorgeben von Befehlen, um den Gegenstand (9) auf eine vorbestimmte Temperatur zu erhitzen;

einer Gewichtserfassungseinrichtung (15) zum Erhalten erster Gewichtsdaten ansprechend auf den auf die Tischvorrichtung (8) gelegten Gegenstand (9);

einer Temperaturnausgleichseinrichtung (16) mit im wesentlichen gleicher Temperatur-Charakteristik wie die Gewichtserfassungseinrichtung (15) zum Erhalten zweiter Gewichtsdaten ansprechend auf den auf die Tischvorrichtung (16) gelegten Gegenstand (9);

einer Steuereinrichtung (6), die mit der Befehlstasteneinrichtung (4) gekoppelt ist, um ansprechend auf eine Betätigung der Befehlstasteneinrichtung (4) eine Erhitzung des Gegenstands (9) durch Ausgeben des Heizsteuersignals an die Heizeinrichtung (10) zu steuern, und die weiter mit der Gewichtserfassungseinrichtung (15) und der Temperaturnausgleichseinrichtung (16) gekoppelt ist, um die Erhitzung des Gegenstands (9) auf der Grundlage des erfaßten Gewichts des Gegenstands (9) zu steuern, **dadurch gekennzeichnet, daß**

die Steuereinrichtung (6) eine Fehlerkomponente aufgrund einer durch Temperaturveränderung veränderten Charakteristik der Gewichtserfassungseinrichtung (15) gemäß dem Vergleichsergebnis zwischen den von der Gewichtserfassungseinrichtung (15) erhaltenen ersten Gewichtsdaten und den von der Temperaturnausgleichseinrichtung (16) erhaltenen zweiten Gewichtsdaten beseitigt, um ausschließlich ein Gewicht des Gegenstands (9) zu bestimmen, und

die Steuereinrichtung (6) ansprechend auf eine Betätigung der Auftau-Befehlstaste stufenweise eine Heizzeit mit allmählich abnehmender Heizenergie auf der Grundlage des Gewichts des Gegenstands (9) vor dem Erhitzen berechnet und ansprechend auf eine Betätigung der Heiz-Befehlstaste, die Gewichtsveränderung des Gegenstands (9) während dem Erhitzen erfaßt und zum Beenden des Heizens bestimmt ist.
2. Automatische Heizvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, daß**

die Gewichtserfassungseinrichtung (15, 16) aus einem elektrischen kapazitiven Druckmeßwertgeber besteht, der ein Paar aus flachen Platten gebildete und einander in einem vorbestimmten Abstand gegenüberstehende Erfassungselektroden (21) enthält, die jeweils um das Paar Erfassungselektroden (21) herum gebildet sind.
3. Automatische Heizvorrichtung nach Anspruch 2, **dadurch gekennzeichnet, daß**

die Temperaturnausgleichseinrichtung (16) in der Nähe der Gewichtserfassungseinrichtung (15) angeordnet ist.
4. Automatische Heizvorrichtung nach Anspruch 3, **dadurch gekennzeichnet, daß**

die Gewichtserfassungseinrichtung (15, 16) eine Erfassungseinrichtung zum Erfassen einer elektrischen Kapazität (C_w) des Erfassungselektrodenpaares (21) und einer elektrischen Kapazität (C_r) des Bezugselektrodenpaares (22) enthält und die Steuereinrichtung (6) auf die erfaßte Kapazität (C_w) der Erfassungselektroden (21) und die erfaßte Kapazität (C_r) der Bezugselektroden (22) reagiert, um das Gewicht des Gegenstands (9) auf der Grundlage der beiden erfaßten Kapazitäten (C_w , C_r) zu berechnen.
5. Automatische Heizvorrichtung nach Anspruch 4, **dadurch gekennzeichnet, daß**

die erfaßte Kapazität (C_w) der Erfassungselektroden (21) und die erfaßte Kapazität (C_r) der Bezugselektroden (22) abwechselnd der Steuereinrichtung (6) zugeführt werden.



6. Automatische Heizvorrichtung nach Anspruch 4,
dadurch gekennzeichnet, daß
die Steuereinrichtung (6) das Gewicht des Gegenstands (9) auf der Grundlage des Verhältnisses (r) der
erfaßten Kapazität (C_w) der Erfassungselektroden (21) und der Kapazität (C_r) der Bezugselektroden (22)
berechnet.
7. Automatische Heizvorrichtung nach Anspruch 2 oder 3,
dadurch gekennzeichnet, daß
die Erfassungselektroden (21) und die Bezugselektroden (22) derart angeordnet sind, daß eine auf die
Gewichtserfassungseinrichtung (15, 16) aufgebrachte Last (P), bei der eine elektrische Kapazität der
Erfassungselektroden (21) und eine elektrische Kapazität der Bezugselektroden (22) im wesentlichen
gleich groß sind, einen Wert zwischen dem Gewicht der Tischvorrichtung (8) allein und einem maximal
auf die Gewichtserfassungseinrichtung (15, 16) aufzubringenden Gewicht besitzt.
8. Automatische Heizvorrichtung nach Anspruch 2 oder 3,
dadurch gekennzeichnet, daß
die Erfassungselektroden (21) und die Bezugselektroden (22) derart angeordnet sind, daß eine auf die
Gewichtserfassungseinrichtung (15, 16) aufgebrachte Last (P), bei der eine elektrische Kapazität (C_w)
der Erfassungselektroden (21) und eine elektrische Kapazität (C_r) der Bezugselektroden (22) im
wesentlichen gleich groß sind, das gleiche Gewicht wie die Tischvorrichtung (8) allein besitzt.
9. Automatische Heizvorrichtung nach Anspruch 7,
dadurch gekennzeichnet, daß
die auf die Gewichtserfassungseinrichtung (15, 16) aufgebrachte Last (P), bei der die elektrische
Kapazität (C_w) der Erfassungselektroden (21) und die elektrische Kapazität (C_r) der Bezugselektroden
(22) im wesentlichen gleich groß sind, die Hälfte der Differenz zwischen dem Gewicht der Tischvorrich-
tung (8) allein und einem maximal auf die Gewichtserfassungseinrichtung (15, 16) aufzubringenden
Gewicht beträgt.

30 Revendications

1. Appareil de chauffage automatique dans lequel se trouve une chambre de chauffage (7) pour abriter un
objet (9) devant être chauffé, qui comprend:
- un moyen de chauffage (10) placé sur ou dans ladite chambre de chauffage (7) pour chauffer
ledit objet(9) placé dans ladite chambre de chauffage (7) conformément à un signal de comman-
de du chauffage,
 - un moyen formant plateau (8) placé dans ladite chambre de chauffage (7) pour supporter ledit
objet (9) pendant le chauffage,
 - un moyen formant clavier d'instruction (4) comprenant une touche d'instruction de décongélation
pour donner des instructions afin de décongeler ledit objet (9) se trouvant à une température
inférieure à zéro, et une touche d'instruction de chauffage pour donner des instructions afin de
chauffer ledit objet (9) jusqu'à une température prédéterminée,
 - un moyen de détection du poids (15) pour obtenir une première donnée de poids en réponse à la
mise en place dudit objet (9) sur ledit moyen formant plateau (8),
 - un moyen de compensation de température (16), pour obtenir une seconde donnée de poids en
réponse à la mise en place dudit objet (9) sur ledit moyen formant plateau (8), ayant sensiblement
la même caractéristique de température que ledit moyen de détection de poids (15),
 - un moyen de commande (6) couplé audit moyen formant clavier d'instruction (4) pour comman-
der le chauffage dudit objet (9) par envoi dudit signal de commande du chauffage audit moyen
de chauffage (10) en réponse à l'actionnement dudit moyen formant clavier d'instruction (4), et
couplé en outre audit moyen de détection de poids (15) et audit moyen de compensation de
température (16) afin de commander le chauffage dudit objet (9) sur la base du poids détecté
dudit objet (9),
caractérisé en ce que:
 - ledit moyen de commande (6) retire une composante d'erreur due à une variation de la
caractéristique dudit moyen de détection de poids (15) par variation de la température en fonction
du résultat de la comparaison entre ladite première donnée de poids fournie par ledit moyen de
détection de poids (15) et ladite seconde donnée de poids fournie par ledit moyen de compensa-



tion de température (16) afin de ne déterminer que le seul poids dudit objet (9), et

- ledit moyen de commande (6), en réponse à l'actionnement de ladite touche d'instruction de décongélation, calcule un temps de chauffage par étapes avec la puissance de chauffage qui diminue progressivement sur la base du poids dudit objet (9) avant chauffage et, en réponse à l'actionnement de ladite touche d'instruction de chauffage, détecte la variation de poids dudit objet (9) pendant le chauffage et est apte à arrêter le chauffage.

2. Appareil de chauffage automatique selon la revendication 1, caractérisé en ce que ledit moyen de détection de poids (15, 16) se compose d'un capteur de pression du type à condensateur qui inclut une paire d'électrodes de détection (21) du type plaques planes en vis-à vis l'une de l'autre pour être espacées d'une distance prédéterminée l'une de l'autre et respectivement placées autour de ladite paire d'électrodes de détection (21).
3. Appareil de chauffage automatique selon la revendication 2, caractérisé en ce que ledit moyen de compensation de température (16) est placé près dudit moyen de détection de poids (15).
4. Appareil de chauffage automatique selon la revendication 3, caractérisé en ce que ledit moyen de détection de poids (15, 16) inclut un moyen de détection pour mesurer la capacité électrique (C_w) due à ladite paire d'électrodes de détection (21) et la capacité électrique (C_r) due à ladite paire d'électrodes de référence (22) et ledit moyen de commande (6) répond à ladite capacité détectée (C_w) due auxdites électrodes de détection (21) et à ladite capacité détectée (C_r) due auxdites électrodes de référence (22) pour calculer le poids dudit objet (9) sur la base des deux capacités détectées (C_w , C_r).
5. Appareil de chauffage automatique selon la revendication 4, caractérisé en ce que ladite capacité détectée (C_w) due auxdites électrodes de détection (21) et ladite capacité détectée (C_r) due auxdites électrodes de référence (22) sont alternativement envoyées audit moyen de commande (6).
6. Appareil de chauffage automatique selon la revendication 4, caractérisé en ce que ledit moyen de commande (6) calcule le poids dudit objet (9) sur la base du rapport (r) de ladite capacité détectée (C_w) due aux électrodes de détection (21) et de ladite capacité détectée (C_r) due auxdites électrodes de référence (22).
7. Appareil de chauffage automatique selon la revendication 2 ou 3, caractérisé en ce que lesdites électrodes de détection (21) et lesdites électrodes de référence (22) sont disposées de telle sorte qu'une charge (P) appliquée audit moyen de détection du poids (15, 16) qui fait que la capacité électrique due aux électrodes de détection (21) et la capacité électrique due aux électrodes de références (22) sont pratiquement égales l'une à l'autre est une valeur comprise entre le poids du seul moyen formant plateau (8) et un poids maximal à appliquer audit moyen de détection du poids (15, 16).
8. Appareil de chauffage automatique selon la revendication 2 ou 3, caractérisé en ce que lesdites électrodes de détection (21) et lesdites électrodes de référence (22) sont disposées de telle sorte qu'une charge (P) appliquée audit moyen de détection du poids (15, 16), qui fait que la capacité électrique (C_w) due aux électrodes de détection (21) et la capacité électrique (C_r) due aux électrodes de références (22) sont pratiquement égales l'une à l'autre, est identique au poids du seul moyen formant plateau (8).
9. Appareil de chauffage automatique selon la revendication 7, caractérisé en ce que ladite charge (P) appliquée audit moyen de détection du poids (15, 16) qui fait que la capacité électrique (C_w) due aux électrodes de détection (21) et la capacité électrique (C_r) due aux électrodes de références (22) sont pratiquement égales l'une à l'autre est la moitié de la différence entre le poids du seul moyen formant plateau (8) et un poids maximal à appliquer audit moyen de détection du poids (15, 16).