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(54) PROCEDURE FOR CONTROLLING THE ENERGY UPTAKE IN A COOKING OVEN

VERFAHREN ZUR STEUERUNG DER ENERGIEAUFNAHME IN EINEM BACKOFEN

PROCEDE PERMETTANT DE REGULER L'ABSORPTION DE L'ENERGIE DANS UN FOUR

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Description

[0001] The invention relates to a procedure for controlling the energy uptake in a cooking oven which is loaded with food when cold and subsequently heated to its operating temperature at full power and maintained at said temperature according to the preamble of claim 1. Such a procedure is known for example from US-A-4 188 528. The invention further relates to an electric circuit adapted to carry out the procedure of claim 1.

[0002] There are generally two ways in which an oven may be used for cooking and baking:

1. The oven may be preheated until a traditional thermostat switches off because the set operating temperature for the cavity has been reached, whereupon the food is introduced in the cavity.
2. The food is introduced in the cold cavity and the thermostat is set for the desired temperature in the cavity.

[0003] Some foods may be prepared by both methods, others are limited to one or the other. The present invention relates to the second of these methods.

[0004] When comparing the energy uptake of various ovens a standardised load simulating food is used according to the EU-norm EN 50304.

[0005] It has been found that the use of thermostats for the purpose of controlling the heat supplied to the load in a cooking oven does not optimize the energy uptake of the load. It has been established that the energy supplied to the oven cavity represents an overdose in comparison to what is needed to sufficiently increase the temperature in the load. Some of this energy is given off to the surrounding atmosphere and some is absorbed by the inner walls of the oven cavity without contributing to the temperature rise in the load. In an attempt to save energy, preferably the energy should be injected directly into the load. For practical reasons this is not an option and for cooking purposes the aim should instead be to reduce the temperature in the oven cavity which most likely will result in a longer cooking time but which might give a reduced overall energy supply for a given temperature rise in the load. Accordingly, there is a need for an improved control procedure, possibly completed by proper modification of component parameters available to the designer, such as the power rating of the heating elements, their placement in the cavity, the maximum power that may be drawn from the power supply and the level of power supplied (in the case of analogue or linear control), the pulse width and the pulse height (in the case of discrete control), and the total duration of supply. Obviously, at the same time care must be taken that the food quality does not suffer and that the possible deviation from traditional practices is not perceived as surprising or unpleasant to the user of the oven.

[0006] Generally, control procedures are based on the measurement of the temperature rise in the cavity, as an indication of the energy used to heat the food, and a subsequent adjustment of the energy supply to reach a fmal temperature without overshoot. These procedures are easy to perform by the user but are not optimized for energy savings. A need to change the power rating of heating elements and their placement in relation to the cavity is a complex process which is far-reaching with respect to the planning of production.

[0007] The above objects will be achieved in accordance with the invention by use of a procedure according to claim 1 and by and electric circuit according to claim 3.

[0008] The advantage of the use of the invention is that the total energy consumed in the treatment of a load is reduced by from 180 to 250 Wh from a common value of about 1kWh based on traditional thermostat technology, this reduction being relatively independent of the dimensions of a common domestic oven cavity, the arrangement of the heating elements, and the set temperature (provided this is in the range 140-240 °C).

[0009] The invention will be further described in the following with reference to the drawings, in which:

Fig. 1 shows a power/time chart, a temperature/time chart and an energy/time chart for a heating process in an oven operated by use of a traditional thermostat control method,

Fig. 2 shows similar charts for the same oven operated in accordance with a control procedure of to the invention, and

Fig. 3 shows a circuit diagram for a control arrangement by which the control procedure according to the invention may be carried out.

[0010] In the following the invention will be described in connection with tests made by the use of an electrically heated conventional domestic oven and by use of an artificial load as defined in the European norm EN 50304. Briefly, the artificial load is a brick-shaped element made of diatomaceous earth with the dimensions 0.05 m* 0.10 m* 0.20 m defining a standard load which simulates a real one, such a roast or the like. For monitoring the temperature rise in the load two thermocouples are arranged near the centre of the brick-shaped load. By use of such arrangement analysis of energy losses and effects of various control methods or procedures can be made.

[0011] Fig. 1 shows the temperature development in a standard load described above with respect to the time elapsed from the start of a test in which the oven is controlled by a traditional thermostat only. The operating temperature of the oven is set and the power is switched-on and full power is applied until the operating temperature has been reached whereupon the operating temperature is maintained by the effect of the thermostat until the load has been properly treated. The power chart is indicated by P in the diagram which also shows that initially power is on and then regulated by the thermostat in an on/off manner. According to the test in compliance with EN 50304 the temperature of the load is monitored and the fmal value shall be 55 °C. From Fig. 1 it appears that this temperature has been reached after 45 minutes and the total energy supplied to the oven at that time is about 909 Wh. It also appears that the energy supplied during the initial period, the warming-up period, until the thermostat switches off is about 540 Wh. The temperature/time chart is denoted by T_{trad} and the energy/time chart is denoted by E_{trad}.

[0012] With reference to Fig. 2 the temperature development is shown for an artificial load, as described, inserted in the same oven as in the example of Fig. 1 but by use of a control procedure according to the invention. According to this procedure full power (power chart denoted by P as in fig. 1) is on during a warming-up period of about 10 minutes and then the power supply is regulated in an on/off manner by use of an energy regulator and not a thermostat regulating on temperature. From the diagram it appears that the time for reaching the set temperature of 55 °C in the load has been extended to 64 minutes but the energy uptake, i.e. the total energy supplied to the oven has been reduced to 717 Wh. It also appears that the energy supplied to the oven during the initial warming-up period has been reduced to 320 Wh. The temperature/time chart for the load is denoted by T_{inv} and the energy/time chart for the oven has been denoted by E_{inv}. It is hence very clear that there is a considerable saving in the energy supplied to the oven, and, in addition, a slower absorption of the heat in the cavity will ensure that the surface of food, in case of a real load, will not overheat. It may be noted that the losses to the environment due to the longer duration of heating are more than balanced by the more efficient manner of injecting the energy.

[0013] Fig. 3 shows a circuit diagram for a control arrangement provided for carrying out the control procedure according to the invention. As shown, a thermostat 10 having a contact 10a is connected in series with heating elements 12, 14 to live and ground terminals 16, 18 of a mains power supply. Between the contact 10a and the heating elements 12, 14 a first temperature switch 20 is connected in parallel to a second temperature switch 22 and an energy regulator 24 operating as a timer. The first temperature switch 20 is normally open and closes at a temperature in the oven of 130 °C whereas the second temperature switch 22 is normally closed and opens at a temperature in the oven of about 65 °C. When the cavity temperature is below 65 °C full power is applied to the heaters. When the cavity temperature exceeds 130 °C the power supply to the heating elements is entirely controlled by the traditional thermostat, because the thermostat contact 10a is closed. When the temperature is between 65 °C and 130 °C the power supply is provided by the energy regulator 24 which provides a set duty cycle, typically in the range 20-28 %. This means that full power is provided at a rate which is typically in the range 0.8 to 1,5 per minute. This rate is adjusted such that the heat will be absorbed by the load without creating a temperature which is too high on the surface of the load. The temperature settings for the temperature switches 20, 22 can vary in dependence on the design of the oven cavity.

[0014] It should be noted that the charts in Figs. 1 and 2 do not show any results beyond the phase of reaching the desired temperature in the artificial load, and hence that there are no results for cavity temperatures above 130 °C. However, the invention is mostly concerned about reduction of energy supply during the initial phase of a cooking procedure in an oven and, accordingly, during the subsequent phases of the cooking procedure traditional thermostat control has been advised.

Claims

1. A procedure for controlling the energy uptake in a cooking oven which is loaded with food when cold and subsequently heated during a warming-up period to its operational temperature at full power and during a subsequent period in which the operational temperature is maintained by the supply of full power at a certain repetition rate wherein the duty cycle during the subsequent period is in the range between 20-28% and, **characterized in that** the warming-up period is selected such that energy of an amount of 233 to 400 Wh is supplied and that during the subsequent heating period the repetition rate is in the range of 0.8-1.5 pulses per minute.

2. A procedure according to claim 1, **characterized in that** the energy supplied during the warming-up period is in the range of 317 to 350 Wh and that during the subsequent heating period the duty cycle is in the range of 22-24%.

3. An electric circuit adapted to carry out a procedure according to claim 1 in an oven comprising electric heating elements (12, 14), said circuit comprising a thermostat (10) connected in series with the heating elements (12, 14), **characterized by** timer switch means (24) adapted to provide the desired duty cycle and the desired repetition rate and to override the action of the thermostat (10) during the subsequent heating period.

4. An electric circuit according to claim 3, **characterized in that** the timer switch means (24) is an energy regulator connected between the thermostat switch (10a) and the electric elements (12, 14) in parallel with a first temperature switch (20), normally open and closing at a temperature of about 130 °C and in parallel with a second temperature switch (22), normally closed and opening at a temperature of about 65 °C.

Patentansprüche

1. Verfahren zum Steuern der Energieaufnahme in einem Kochofen, der mit einem Nahrungsmittel befüllt wird, wenn er kalt ist, und anschließend mit voller Leistung während eines Aufwärmzeitraums auf seine Betriebstemperatur erwärmt wird und während eines anschließenden Zeitraums, bei dem die Betriebstemperatur gehalten wird, durch Zuführen der vollen Leistung mit einer gewissen Wiederholungsrate erwärmt wird, wobei der Tastgrad während des anschließenden Zeitraums zwischen 20 bis 28 % liegt, **dadurch gekennzeichnet, dass** der Aufwärmzeitraum derart gewählt ist, dass eine Energie in einer Menge von 233 bis 400 Wh zugeführt wird und dass während des anschließenden Beheizungszeitraums die Wiederholungsrate zwischen 0,8 bis 1,5 Pulsen pro Minute liegt.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** die während des Aufwärmzeitraums zugeführte Energie zwischen 317 und 350 Wh liegt und dass während des anschließenden Beheizungszeitraums der Tastgrad zwischen 22 und 24 % liegt.

3. Elektrische Schaltung, die ausgebildet ist, um ein Verfahren gemäß Anspruch 1 in einem elektrische Heizelemente (12, 14) aufweisenden Ofen durchzuführen, wobei die Schaltung einen Thermostaten (10) aufweist, der in Reihe mit den Heizelementen (12, 14) geschaltet ist, **gekennzeichnet durch** eine Zeitgeber-Schalteinrichtung (24), die ausgebildet ist, um den gewünschten Tastgrad und die gewünschte Wiederholungsrate zu liefern, und die Wirkung des Thermostaten (10) während des anschließenden Beheizungszeitraums außer Kraft zu setzen.

4. Elektrische Schaltung nach Anspruch 3, **dadurch gekennzeichnet, dass** die Zeitgeber-Schalteinrichtung (24) eine Energieregeleinrichtung ist, die zwischen den Thermostatschalter (10a) und die elektrischen Elemente (12, 14) parallel mit einem ersten Temperaturschalter (20) geschaltet ist, der normalerweise offen ist und bei einer Temperatur von ca. 130° C schließt, und parallel mit einem zweiten Temperaturschalter (22), der normalerweise geschlossen ist und bei einer Temperatur von ca. 65° C öffnet.

Revendications

1. Procédé pour réguler l'absorption d'énergie dans un four de cuisson rempli de nourriture lorsqu'il est froid et est ensuite chauffé pendant une période de préchauffage jusqu'à sa température opérationnelle à pleine puissance, et pendant une période suivante pendant laquelle la température opérationnelle est maintenue par la fourniture de la pleine puissance à un certain taux de répétition, dans lequel le cycle opératoire pendant la période suivante est compris dans la plage entre 20 % et 28 %, et **caractérisé en ce que** la période de préchauffage est sélectionnée de sorte qu'une énergie en une quantité de 233 à 400 Wh soit fournie, et **en ce que** pendant la période de chauffage suivante, le taux de répétition soit compris dans la plage de 0,8 à 1,5 impulsions par minute.

2. Procédé selon la revendication 1, **caractérisé en ce que** l'énergie fournie pendant la période de préchauffage est comprise dans la plage de 317 à 350 Wh, et **en ce que**, pendant la période de chauffage suivante, le cycle opératoire est compris dans la plage de 22 % à 24 %.

3. Circuit électrique adapté pour exécuter un procédé selon la revendication 1 dans un four comprenant des éléments de chauffage électriques (12, 14), ledit circuit comprenant un thermostat (10) connecté en série aux éléments de chauffage (12, 14), **caractérisé par** un moyen de minuterie (24) adapté pour fournir le cycle opératoire souhaité et le taux de répétition souhaité et pour annuler l'action du thermostat (10) pendant la période de chauffage suivante.

4. Circuit électrique selon la revendication 3, **caractérisé en ce que** le moyen de minuterie (24) est un régulateur d'énergie connecté entre l'interrupteur de thermostat (10a) et les éléments électriques (12, 14) en parallèle avec un premier commutateur de température (20), normalement ouvert et se fermant à une température d'environ 130°C, et en parallèle avec un deuxième commutateur de température (22), normalement fermé et s'ouvrant à une température d'environ 65°C.

Fig. 1

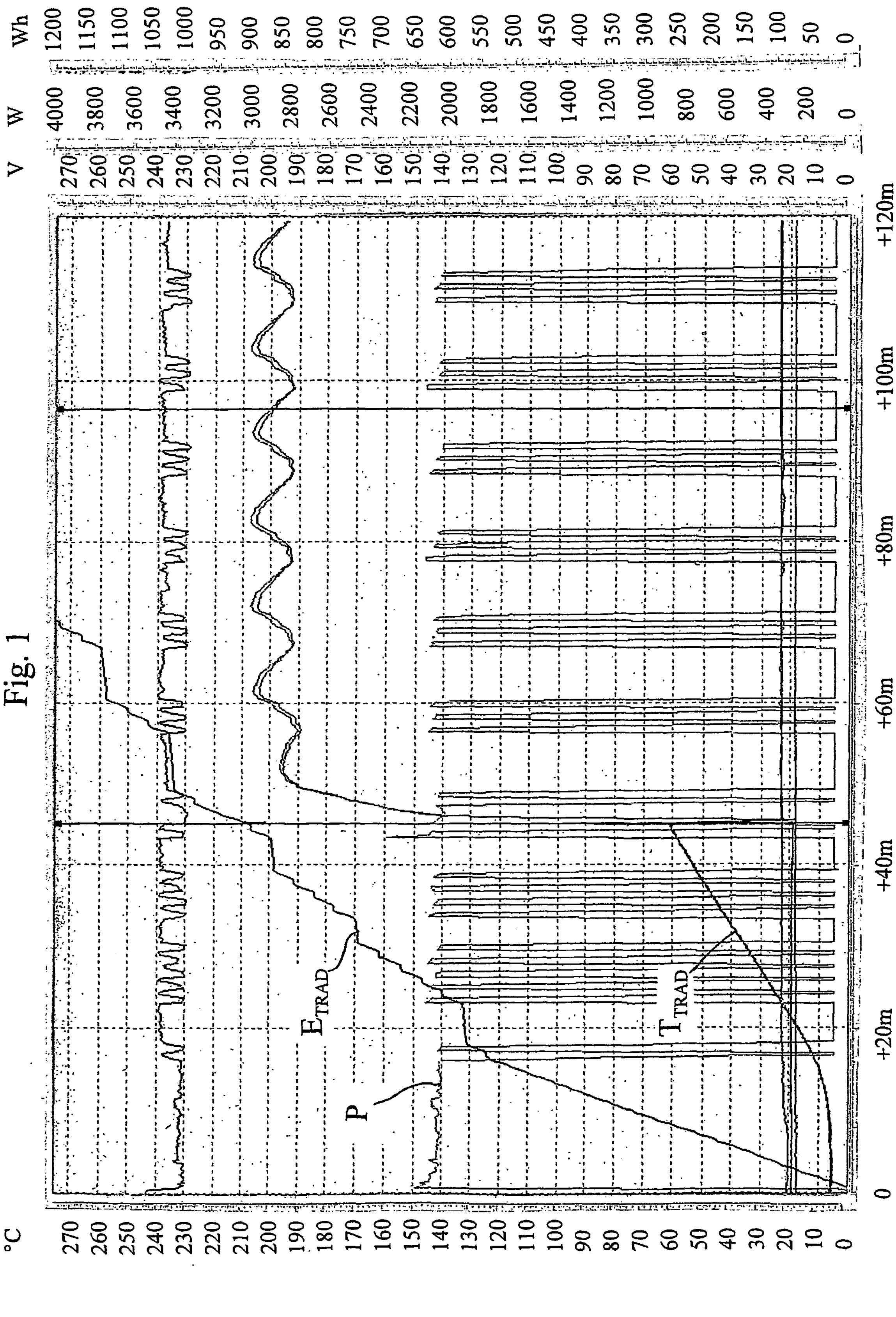
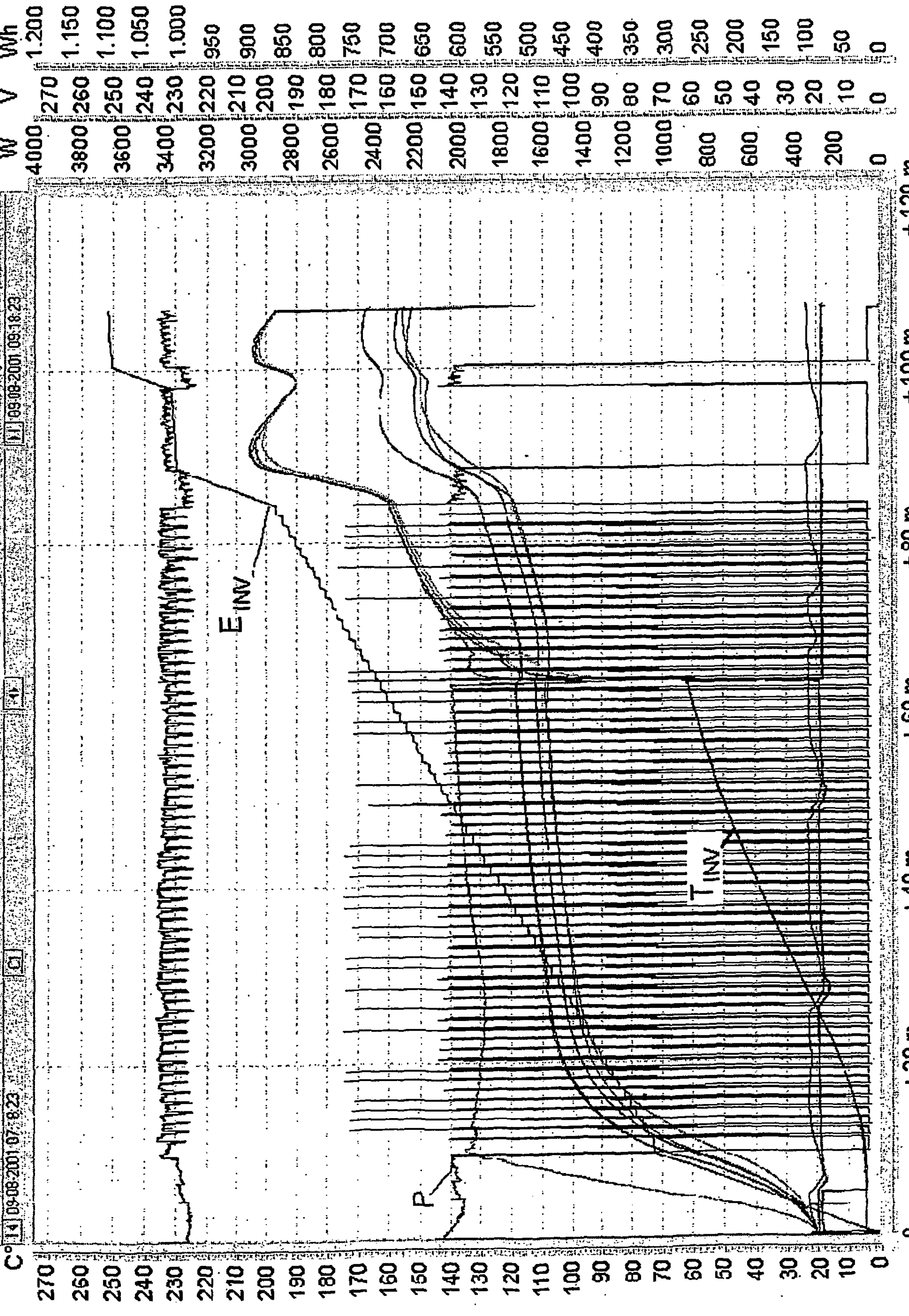


Fig. 2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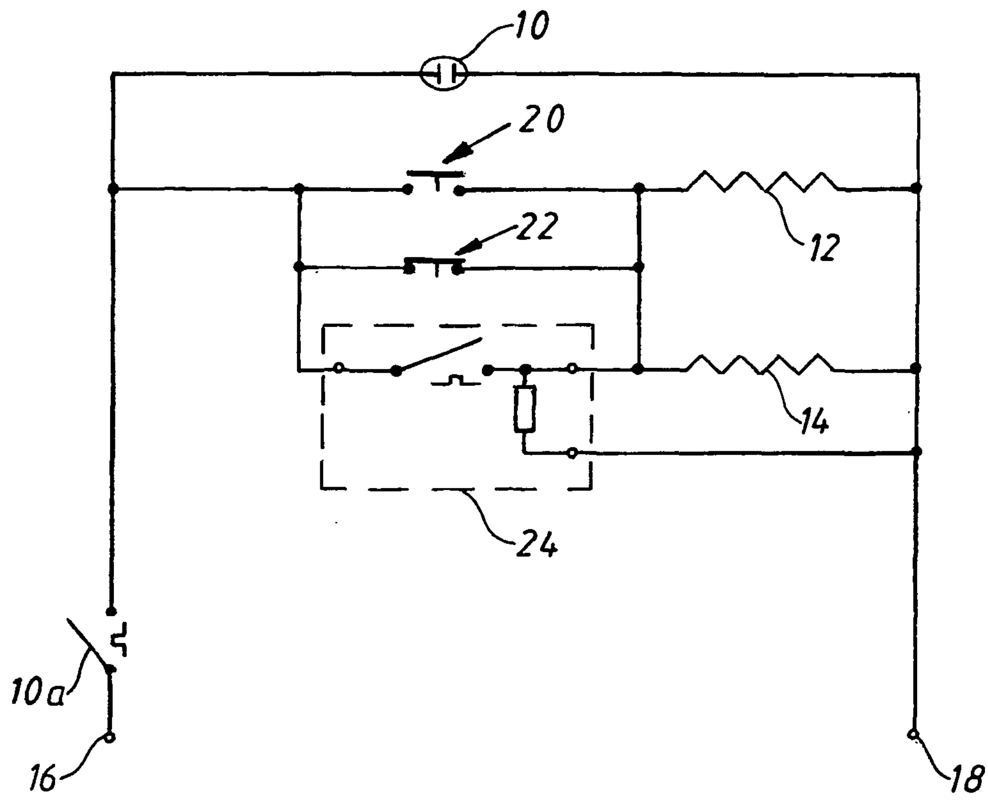

FIG. 3