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Field of the invention

The invention relates to a microwave oven with a magnetron comprising an anode, a cathode and a cathode heating and with a controller circuit for the magnetron. The invention also relates to a method for operating such a microwave oven.

Background

Normally, a microwave oven has a transformer with two secondary windings. The one secondary winding serves to drive the cathode heating of the magnetron while the other secondary winding is used for generating the high voltage between the cathode and the anode. In such devices, a separate controlling of the anode current and the heating current is not possible.

US 4 742 442 describes a device in which the driving circuit has heating a current generator which is controllable separately from the high voltage generator. Particularly, two separate transformers for the heating current and the high voltage are provided. After activating the device, an alternating voltage is applied to the heating current transformer in order to heat up the cathode. After a certain time, e.g. five seconds, also an alternating voltage is subsequently generated for the high voltage transformer, such that the high voltage is applied to the magnetron only after pre-heating the cathode.

The lifetime of a magnetron is directly depending on the temperature of the filament of the cathode heating. The lifetime is prolonged if the heating power in operation is as low as possible. However, the cathode temperature has to be high to such extent that enough free electrons are present for generating the microwaves.

During the aging process of the magnetron, it requires an increasing heating power for a stable operation. For this reason, in conventional solutions the heating power is chosen such that even an already old magnetron can still be operated securely. Hence, it is accepted that this heating power is in principle too high for a new magnetron and that the magnetron will age faster due to this reason. Therefore, WO 98/11591 proposes to choose the heating current of the magnetron in dependence of its dynamic impedance or of its noise level.

Description of the invention

It is therefore the objective of the invention to provide an alternative microwave oven and an alternative method of the type mentioned at the beginning, in case of which the magnetron has a long lifetime. This objective is met by the device or the method, respectively, according to the independent claims.

According to this, the driving circuit of the magnetron has a high voltage generator between the anode and the cathode for generating the high voltage as well as a heating current generator for generating the heating current for the cathode heating, as known. Additionally, a controller is provided which controls these components.

Furthermore, a measurement circuit is provided, which is adapted to determine fluctuations in a parameter dependent on an anode current of the magnetron, and the controller is adapted to control the heating current generator depending on these fluctuations in such a way that the heating current is increased with increasing fluctuations.

Consequently, the invention also relates to a method for operating a microwave oven, wherein the microwave oven has a magnetron having a cathode, an anode and a cathode heating. At least the following steps are carried out in the method:

(A) Measuring fluctuations in a parameter depending on the anode current of the magnetron. This parameter may e.g. be the anode current itself or another parameter depending on the anode current.

(B) Controlling the heating current generator depending on the fluctuations in such a way that the heating current is increased with increasing fluctuations. In other words, the heating current is increased in case of an increase of the fluctuations, e.g. above a fluctuation threshold value.

The invention is based on the recognition that fluctuations in the anode current are an early indicator that the cathode is too cold. By means of the features according to the claims it is possible to account for this circumstance. Particularly, the heating power may be increased to the point that the fluctuations drop. In this way, the cathode can always be heated with the power needed at that point for a stable operation. In this way, the lifetime of the magnetron is prolonged. When the magnetron ages, the heating power is automatically increased needs-based. Tolerances of the device and particularly the parameter of the magnetron are automatically adjusted, as well as also fluctuations of the grid voltage.

The invention also makes it possible to operate the magnetron in most cases with lower heating power than a conventional operation, such that the efficiency of the device is increased.

Advantageously, a power controller is provided, being adapted to regulate the heating power absorbed by the cathode heating to a target value. In this case, the controller is adapted to prescribe the target value for the heating power depending on the fluctuations.

In a further advantageous embodiment, the high voltage generator has a power inverter and a high voltage transformer. The power inverter feeds current pulses into the primary winding of the high voltage transformer. The secondary winding of the high voltage transformer generates a voltage, via a rectifier, across the anode and the cathode of the magnetron. The mentioned measurement circuit is adapted for measuring fluctuations in the current pulses through the primary winding. The strength of the current pulses as well as also their rise times depend directly on the anode current and form a very suitable measurement parameter for the aim described here, because they can be easily measured on the primary side.

In this case, the measurement circuit is preferably adapted to measure rise times of the current pulses and to determine fluctuations of the rise times. This is based on the recognition that for practical operation the current pulses are so short as compared to the inductance of the high voltage transformer, that the current doesn’t reach its peak value, however that the rise time of the current at the beginning of the pulse is a measure for this peak value and therefore also for the anode current.

Short description of the drawings

Further embodiments, advantages and applications of the invention result from the dependent claims and the now following description by means of the drawings. It is shown in:

Fig. 1 a section through the parts of a microwave oven that are most important for the present context,

Fig. 2 a simplified circuit diagram of the microwave oven,

Fig. 3 a diagram of a number of signals of the driving circuit for the cathode heating,

Fig. 4 a diagram of a number of signals for the driving circuit for the high voltage generator,

Fig. 5 a detail view of the course of the voltage drop Ur and

Fig. 6 the rise time of the current pulses during stable operation (a) and during unstable operation (b).

Ways for carrying out the invention

Definitions:

In the present context, high voltage is understood as the voltage required as anode-cathode-voltage for operating the magnetron. Practically, this voltage amount in most cases to at least 1 kV, normally a number of kilovolts.

A push-pull stage is a series circuit of two electronic components that can be alternatingly switched conductive such that a time-varying voltage is present at the center tap of both components.

A half-bridge configuration is a circuit with precisely one push-pull stage.

A full bridge configuration (H-circuit, H-bridge) is a circuit with two push-pull stages connected in parallel, wherein the load is located between the center taps of both push-pull stages.

Basic configuration:

The invention relates to a microwave oven as exemplarily shown in Fig. 1. The microwave oven has a cooking space 1 for receiving the food to be heated, which can be closed towards the used by a user door 2. A magnetron 3 is additionally arranged inside the device, which is connected to the cooking space 1 via a waveguide 4. A controller 5 controls the function of the device.

Fig. 2 shows the components of the controller 5 that are most important in the present context.

The grid voltage of e.g. 230 volts at 50 Hz is rectified in a rectifier 10. The first intermediary voltage Uz generated in this way is then slightly filtered via a first capacitor C1, wherein the capacitor C1 is dimensioned such that on load the value of the first intermediary voltage Uz fluctuates with the double grid frequency by at least 50%. The intermediary voltage Uz is additionally tapped via a diode D1 and further filtered via a second capacitor C2 in order to generate a second intermediary voltage Uz'.

The first intermediary voltage Uz is supplied to a high voltage generator 11, by means of which the high voltage described below is generated for driving the magnetron 3. The second intermediary voltage Uz' is supplied to a heating current generator 12 by means of which the heating current for the cathode heating of the magnetron 3 is generated as described below.

The operation of the high voltage generator 11 and of the heating current generator 12 is controlled by a controlling unit 13, e.g. as a microprocessor.

A value that is proportional to the intermediary voltage Uz is supplied to an analog-digital-converter of the controlling unit 13 via a voltage divider R5, R6, such that the controller unit can determine the intermediary voltage Uz.

High voltage generator:

The high voltage generator 11 comprises a full-bridge-circuit with four electronic switching elements T3 – T6, particularly IGBT-transistors, each one having a free-wheel diode. The switching elements T3 – T6 are arranged, as known, in two branches T3 and T4 or T5 and T6, respectively, wherein the switching elements of each branch are arranged in series between the first intermediary voltage Uz and ground. A center tap is provided between the switching elements of each branch, wherein both center taps are connected to both connectors of the primary winding of a high voltage transformer 14. In this way, the switching elements T3 - T6 form a power inverter that supplies an alternating voltage into the primary winding of the high voltage transformer.

The high voltage transformer 14 has a secondary winding with a substantially higher number of turns than the primary winding for generating the high voltage. The high voltage is rectified via two diodes D2 and D3, doubled and filtered via two capacitors C3 and C4. The high voltage Uh generated in this way is applied between the cathode K and the anode A of the magnetron 3.

A driving circuit 16 is provided for driving the switching elements T3 - T6, which is controlled by the controller unit 13. The driving circuit 16 generates the control voltages (gate voltages or base voltages) UG3 - UG6 for the switching elements T3 - T6. The controller unit 13 is adapted to switch the two branches of the full-bridge-circuit T3 - T6 alternatingly. The driving is carried out in such a way that during a switching cycle the primary winding of the high voltage transformer 14 is not all the time between the first intermediary voltage Uz and ground, but that the primary winding is uncoupled from the intermediary voltage Uz during a time period chosen by the controller unit 13, i.e. the circuit is clocked with pulse width modulation, such that the value of the high voltage Uh can be controlled.

In order to monitor the high voltage Uh it can be divided via a voltage divider R10 - R13 and R14 and supplied to an optocoupler 17, the output signal of which is transferred to the controller unit 13. For example, an absence or no-firing of the magnetron can be detected in this way.

Furthermore, a resistor R20 is provided between both branches T3, T4 or T5, T6, respectively, and a fixed reference potential, particularly ground. The initial rise of the voltage drop Ur across this resistor at the beginning of a current pulse is a measure for the anode current of the magnetron 3 and it is supplied to the controller unit 13 via an amplifier 18 for measurement purposes. This will be described in more detail below.

Heating current generator:

The heating current generator 12 is formed in the present embodiment by a half-bridge with two switching elements T1 and T2 operated as push-pull stage. The switching elements T1 and T2, which are themselves formed e.g. as IGBT-transistors and each of which has a free-wheel diode, are arranged in series between the second intermediary voltage Uz′ and ground.

The center tap between the two switching elements T1, T2 is connected to the one connector of the primary winding of a heating transformer 15. The second connector of the primary winding of the heating transformer 15 is connected to the center tap of a capacitive voltage divider consisting of two capacitors C5 and C6. The two capacitors C5 and C6 are arranged in series between the second intermediary voltage Uz′ and ground.

The diode D1 avoids that current is diverted from the capacitors C5, C6 when the high voltage generator 11 connected to the intermediary voltage Uz takes current.

The secondary winding of the heating transformer 15 is connected to the cathode heating, i.e. the filament, of the magnetron 3 and supplies it with current.

For driving the switching elements T1 and T2 a driving circuit 20 is provided, which is controlled by the controller unit 13. The driving circuit 20 generates the control voltages (gate voltages and base voltages) UG1, UG2 for the switching elements T1 or T2, respectively. The type of driving is described below in more detail.

A resistor R21 is arranged between the push-pull stage formed by the switching elements T1, T2 and ground (or another fixed reference potential), by means of which the current flows towards ground (or the reference potential, respectively) from the push-pull stage T1, T2 through the heating transformer. The voltage drop across this resistor is a measure for the current flowing from the second intermediary voltage Uz’ through the primary coil of the high voltage transformer 15 towards ground (or reference potential, respectively). It is tapped by an amplifier 21 and supplied to an analog-digital-converter of the control unit 13.

Driving the heating current generator:

In the following it is described by Fig. 3 how the control unit 13 drives the switching elements of the heating current generator 12. The figure shows the course of the voltages UG1 and UG2 which are present at the control inputs of the switching elements T1 and T2, as well as the course of the voltage Uih that drops across the resistor R21.

The control unit 13 is adapted to switch on both switching elements in a cyclic and alternating manner. A typical cycle period Tz is preferably in the range of 10 – 50 µs.

The time periods during which one of the switching elements T1 and T2 is switched on are called heating phases H1 or H2, respectively, in the following, and they are drawn in Fig. 3, wherein the first switching element T1 is switched on in heating phase H1 and the second switching element T2 is switched on in heating phase H2. Both switching elements T1, T2 are switched off between the heating phases H1 and H2 or H2 and H1, respectively. The phases during which both switching elements T1, T2 are switched off are called idle phases

R1 and R2 and they are also drawn in Fig. 3. The heating phases have a duration th, the idle phases have a duration tr.

In a simple embodiment, the time th may be chosen identic for both switching elements T1, T2, equally tr.

In this way an alternating current is generated in the primary winding of the heating transformer 15, which is supplied as heating power to the cathode heating of the magnetron 3 (except losses in the components, particularly in the heating transformer 15). The averaged value of the heating power is a function of the duty cycle, i.e. of the quotient th/Tz.

As can be seen in Fig. 3, after switching on the switching elements T1, T2, the current through the primary winding of the heating transformer 15 and therefore also the voltage drop Uih across the resistor R21 can be measured by the control unit 13 via the amplifier 21.

The voltage drop Uih forms a parameter that depends on the resistance of the cathode heating of the magnetron 3. Under the assumption that no losses occur in the heating transformer 15, Uih is inversely proportional to the resistor of the cathode heating towards the end of the heating pulse. Thus, the resistor R21 forms together with the amplifier 21 a measurement circuit adapted to determine a parameter depending on the resistance of the cathode heating.

In Fig. 3 a time instant tm is drawn, in which the controller 13 measures the voltage drop Uih. This time instant tm is preferably shortly before the end tx of the respective heating phase H1 or H2, e.g. maximally 1 µs before the end tx of the heating phase. Advantageously, a measurement takes place in every heating phase.

The control unit 13 is adapted to keep the product P = Uz′ • Uih(tm) • th constant by varying the duration th of the heating phases depending on the values Uih(tm) and Uz’. The product P is at least approximately proportional to the power supplied to the cathode heating.

Approximately the value of the intermediary voltage Uz can be used for the value of the intermediary voltage Uz’, as it is determined by the control unit via the voltage divider R5, R6. As long as (during the pre-heating phase) the high voltage generator 11 is not in operation, Uz’ corresponds to the value of Uz except for the voltage drop across D1. After that Uz’ is partly a little higher than Uz, however the difference remains small if the components are dimensioned in a suitable way. If Uz’ shall be determined precisely, a second voltage divider can be provided additionally or alternatively to R5, R6, which supplies the second intermediary voltage Uz’ for measurement by the control unit 13.

Preferably, P is averaged during a filtering time, which amounts to at least half of a cycle period of the grid voltage, i.e. at least 10 ms. An adjustment of the pulse width th is only done after the filtering time has passed.

P is a direct measure for the power given by the push-pull stage T1, T2 and therefore (not taking into account the losses, particularly in the heating transformer 15) also a measure for the heating power of the cathode heating of the magnetron 3. Thus, the controller unit 13 also forms a power regulator by means of which the power received by the cathode heating can be regulated to a target value.

Controlling the high voltage generator:

In the following it is described by Fig. 4 how the controller unit 13 controls the switching elements T3 - T6 of the high voltage generator 11. The figure shows the course of the voltages UG3 - UG6 that are present at the voltage inputs of the switching elements T3 - T6, as well as the course of the current Ip in the primary winding of the high voltage transformer and of the voltage Ur that is present across the resistor R20.

The controller unit 13 is adapted to drive the four switching elements T3 - T6 cyclically. A typical cycle period tc is advantageously in the range of 10 - 50 µs.

Each cycle period comprises four phases A - D:

- In phase A the switching elements T3 and T6 switched on and the switching elements T4 and T5 are switched off, such that a positive current Ip is generated from the intermediary voltage Uz through the bridge circuit towards ground. This current leads to an increasing voltage drop Ur across R20. (Because the inductance of the high voltage transformer 14 is considerably higher than the one of the heating transformer 15, the current doesn’t go into saturation, contrary to the situation according to Fig. 3, but increases practically linearly during phase A.)
- In phase B the switching element T6 remains switched on. The switching element T3 is switched off and thereafter the switching element T4 is switched on. The current through the high voltage transformer 14 decreases again by flowing through the switching element T6 and the free-wheel diode of the switching element T4.
- In phase C the switching element T6 is switched off and the switching element T5 is switched on. Now, a negative current Ip is generated, from the intermediary voltage Uz through the bridge circuit and the primary winding towards ground. This current leads again to an increasing voltage drop Ur across R20.
- In phase D the switching element T4 remains switched on. The switching element T5 is switched off and thereafter the switching element T6 is switched on. The

current through the high voltage transformer 14 decreases again by flowing through the switching element T4 and the free-wheel diode of the switching element T6.

In operation, the phases A and C preferably have the same length, i.e. the corresponding durations tA and tC are identical. In the same way, the phases B and D preferably have the same length, i.e. the corresponding durations tB and tD are identical. However, the phases A and C are normally shorter than or at most equally long like the phases B and D. The power to be delivered by the magnetron can be adjusted by the ratio tA + tC with respect to the cycle time tc. This ratio is adjusted by the controller 13, e.g. depending on the prescriptions of the user.

Operation:

When the user activates the microwave oven, i.e. when he has given the command to supply the food in the cooking space with energy, the controller 13 first starts a pre-heating phase. In this pre-heating phase the switching elements T3 - T6 remain all switched off, such that no high voltage falls across the magnetron 3. After the pre-heating phase there is an operation phase, during which also the switching elements T3 - T6 are taken into operation alternatingly in order to apply the high voltage to the magnetron and to generate the desired microwave radiation. In the following, the operation phase is described in more detail.

As mentioned at the beginning, the power of the cathode heating is kept as low as possible during the operation phase, to such extent low that a stable operation of the magnetron 3 is just possible.

In order to recognize the limit of this stable operation, fluctuations in a parameter depending on the anode current are evaluated, as mentioned at the beginning. In the embodiment described so far, this parameter is the rise time of the current pulses through the primary coil of the high voltage transformer 14. For this, the increase of the voltage drop Ur across R20 is measured.

Fig. 5 shows the course of the voltage drop Ur in detail. The controller unit 13 carries out two measurements per current pulse at the instants t1 and t2 and calculates from this the corresponding difference $\Delta = Ur(t2) - Ur(t1)$, which is a measure for the rise time of the current pulse. Fig. 5 shows two corresponding measurements Δ_i and Δ_{i+1}, wherein i and i+1, respectively, denote the indices of two consecutive current pulses.

Instead of the measurement of two values at the instants t1 and t2, only one value can be measured in a known time duration from the beginning of the pulse. However, the measurement of two values has the advantage that the pulse shape can be determined more precisely, such that particularly a more reliable recognition of error states is possible. In this way, negative currents or voltages, respectively, are detected e.g. at the instant t1 if a short circuit is present at the output of the high voltage transformer 14.

Fluctuations of the rise time, as shown with dashed lines in Fig. 5, may have two causes:

1) A first cause is that the intermediary voltage Uz is only insufficiently flattened. It varies with a frequency which corresponds to the double of the grid frequency, hence of about 100 Hz. The higher the intermediary voltage Uz is, the higher is the rise time of the current pulses. The rise time Δ_i/Uz scaled with Uz is however depending on the intermediary voltage to a considerably smaller extent. This is shown in Fig. 6, which illustrates the intermediary voltage Uz, the value of the rise time Δ_i and the scaled rise time Δ_i/Uz.

2) A second cause is the instability of the magnetron 3. If the heating power is too low, the rise

times start fluctuating, see Fig. 6b. The fluctuations can also be observed in the scaled rise time Δ_i/Uz.

As soon as the controller unit 13 identifies fluctuations of the type shown in Fig. 6b, it increases the target value for the heating power of the cathode heating.

In order to capture the fluctuations numerically, the controller unit calculates in the present embodiment the following specific value S for the fluctuations:

$$S = \sum_i \left|\frac{\Delta_{i+1}}{Uz_{i+1}} - \frac{\Delta_i}{Uz_i}\right|. \qquad (1)$$

Here, Uz_i denotes the intermediary voltage Uz at the instant of the pulse i. The sum preferably extends over at least half a grid period, i.e. 10 ms. If the value S is above an upper threshold value S1, the controller 13 increases the target value for the heating power. If the value S is above a lower threshold value S2, the controller unit 13 reduces the threshold value for the heating power.

Instead of the formula (1), which determines the fluctuations from the sum of the absolute values of the differences of the scaled current rise times, another function may also be used for determining the fluctuations, which depends on the absolute differences of the scaled current rise times of multiple pairs of consecutive current pulses i, i + 1

$$S = F\left(\left|\frac{\Delta_{i+1}}{Uz_{i+1}} - \frac{\Delta_i}{Uz_i}\right|_{i=1..N}\right), \qquad (2)$$

wherein F is said function, and N is the number of the pairs of current pulses considered in the function F. F may e.g. be the sum of the squares of differences of the scaled current rise times.

It has been observed that each of the first fluctuations is visible between consecutive current pulses at the beginning of an instability, in such a way that the one current pulse rises faster and in turn the next current pulse rises slower, as shown in Fig. 6b. For this reason, a function of the type of equation (1) or (2), respectively, is a particularly good indicator of beginning instabilities.

Alternatively to a formula of the type shown in equation (2), another variable may also be used, which describes the fluctuation of the scaled current rise times or of the non-scaled current rise times. For example, the non-scaled current rise times may be filtered in a highpass filter and thereafter their statistical variance can be calculated. The highpass has a cutoff frequency that is higher than the double grid frequency but lower than the switching frequency of the power inverter.

Notes:

In the above embodiment, the voltage drop Ur across R20 is used as parameter for the fluctuations of the anode current of the magnetron 3. However, another value may also e.g. be used alternatively, which describes the current in the primary circuit or the secondary circuit of the high voltage transformer 14. For example, a measurement winding may be integrated in the high voltage transformer 14, the voltage of which is monitored. Or, the anode current may also be measured directly and e.g. transferred to the controller unit 13 via an optocoupler.

The sequence controlling of the described method steps may be implemented in the controller unit 13 as hardware and/or software.

To sum up, a controller circuit for the microwave oven is described. It has a push-pull stage T1, T2 for driving a heating transformer 15, by means of which the cathode heating of the magnetron 3 is operated. A separate high voltage transformer 14 is provided for the generation of the high voltage, which is supplied by a bridge circuit T3 - T6. The controller unit 13 of the device is adapted to determine fluctuations of a parameter depending on the anode current of the magnetron 3. If these fluctuations are high, the heating power of the cathode heating is increased. In this way it is possible to operate the magnetron 3 with an optimum, low heating power.

While preferred embodiments of the invention are described in this application, it has to be clearly noted that the invention is not limited thereto and may be executed in other ways within the scope of the now following claims.

Patentkrav

1. Mikrobølgeovn med en magnetron (3) omfattende en katode (K), en anode (A) og et katodevarmelegeme og med et styrekredsløb til magnetronen (3), hvor styrekredsløbet omfatter:
en højspændingsgenerator (11) til generering af en højspænding mellem anoden (A) og katoden (K),
en varmestrømsgenerator (12) til generering af en varmestrøm til katodevarmelegemet og
en styreenhed (13), der omfatter
et målekredsløb (R20, 18), der er udformet til at fastslå udsving i et parameter, der afhænger af en anodestrøm af magnetronen, **kendetegnet ved, at** styreenheden (13) er udformet til at styre varmestrømgeneratoren (12) afhængigt af udsvingene på en sådan måde, at varmestrømmen forøges, når udsvingene tiltager, indtil udsvingene går tilbage.

2. Mikrobølgeovn ifølge krav 1 med en effektregulator (13, 21, R21), hvormed en varmeeffekt, der optages af katodevarmelegemet, kan reguleres, hvor styreenheden (13) er udformet til at angive en indstillingsværdi til varmeeffekten afhængigt af udsvingene.

3. Mikrobølgeovn ifølge et af de foregående krav, hvor højspændingsgeneratoren (11) omfatter en vekselretter (T3 - T6) og en højspændingstransformator (14), hvor vekselretteren (T3 - T6) føder strømpulser til en primærvikling af højspændingstransformatoren (14), hvor en sekundærvikling af højspændingstransformatoren via en ensretter (D2, D3) genererer en spænding via magnetronens (3) anode (A) og katode (K), og hvor målekredsløbet (R20, 18) er udformet til måling af udsving i strømpulserne.

4. Mikrobølgeovn ifølge krav 3, hvor vekselretteren er et brokredsløb med fire koblingselementer (T3 - T6).

5. Mikrobølgeovn ifølge et af kravene 3 eller 4, hvor der mellem vekselretteren og et referencepotential, især masse, er anbragt en modstand (R20), hvor målekredsløbet (R20, 18) til måling af et spændingsfald er udformet over modstanden (R20).

6. Mikrobølgeovn ifølge et af kravene 3 til 5, hvor målekredsløbet (R20, 18) er udformet til at måle strømpulsernes stigningshastigheder og fastslå udsving i stigningshastighederne.

7. Mikrobølgeovn ifølge krav 6, hvor målekredsløbet (R20, 18) er udformet til på mindst to tidspunkter (t1, t2) i hver strømpuls i at måle en strømhøjde og herudaf af fastslå strømmens stigningshastighed Δ_i i strømpulsen.

8. Mikrobølgeovn ifølge krav 7, hvor styreenheden (13) er udformet til at beregne
en skaleret stigningshastighed Δ_i/Uz_i, hvor Uz_i er en mellemspænding, der på pulsens i tidspunkt ligger over vekselretteren (T3 - T6), og
at fastslå udsvingene ud fra den skalerede stigningshastighed.

9. Mikrobølgeovn ifølge krav 8, hvor styreenheden (13) er udformet til at beregne en funktion, der afhænger af de absolutte forskelle af de skalerede strømstigningshastigheder af flere par af efter hinanden følgende strømpulser i, i+1.

10. Mikrobølgeovn ifølge et af de foregående krav, hvor styreenheden (13) er udformet til at beregne
en karakteristisk værdi (S) for udsvingene,
at forøge varmestrømmen, når den karakteristiske værdi (S) stiger til over en øvre tærskelværdi (S1).

11. Indretning ifølge krav 10, hvor styreenheden (13) endvidere er udformet til at reducere varmestrømmen, når den karakteristiske værdi (S) falder til under en nedre tærskelværdi (S2).

12. Fremgangsmåde til drift af en mikrobølgeovn ifølge et af de foregående krav, hvor fremgangsmåden er kendetegnet ved de følgende trin:
at måle udsving i et parameter, der afhænger af en anodestrøm af magnetronen (3) og

at styre varmestrømsgeneratoren (12) afhængigt af udsvingene på en sådan måde, at varmestrømmen forøges ved tiltagende udsving, indtil udsvingene går tilbage.

13. Fremgangsmåde ifølge krav 12, hvor der til generering af anodestrømmen er tilsluttet en højspændingstransformator (14) til magnetronen via en ensretter (D2, D3), hvor strømpulser fødes til en primærvikling af højspændingstransformatoren (14), og hvor udsvingene måles som udsving i strømpulserne.

14. Fremgangsmåde ifølge krav 13, hvor strømpulsernes stigningshastigheder måles, og udsvingene måles som udsving i stigningshastighederne.

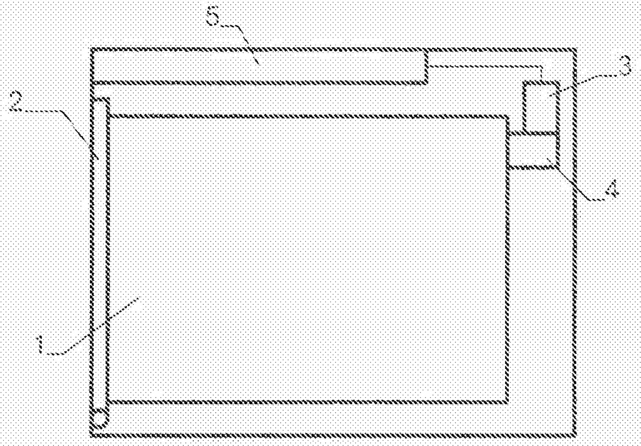

Fig. 1

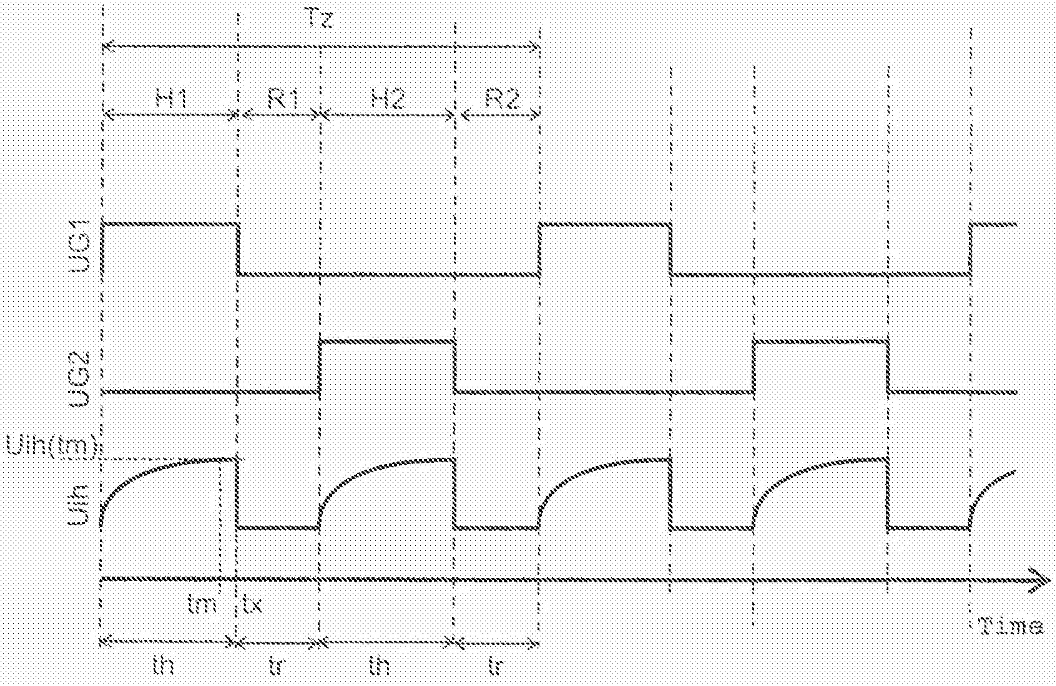

Fig. 3

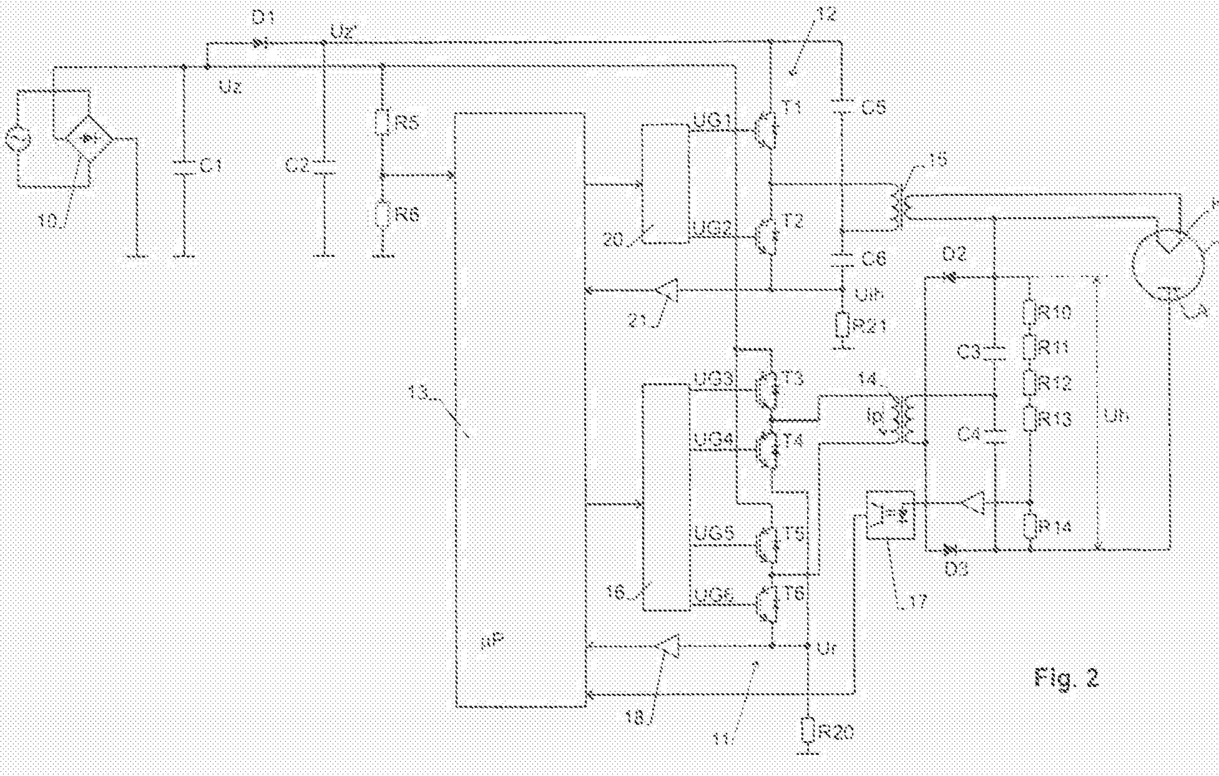
D1
Uz'
12
Uz
T1
C5
15
K
3
UG1
R5
C1
C2
R6
10
20
UG2
T2
C6
D2
Uh
R21
21
R10
R11
R12
R13
C3
C4
13
UG3
T3
14
Ip
UG4
T4
Uh
A
R14
D3
17
UG5
T5
UG6
T6
16
µP
Ur
18
11
R20

Fig. 2

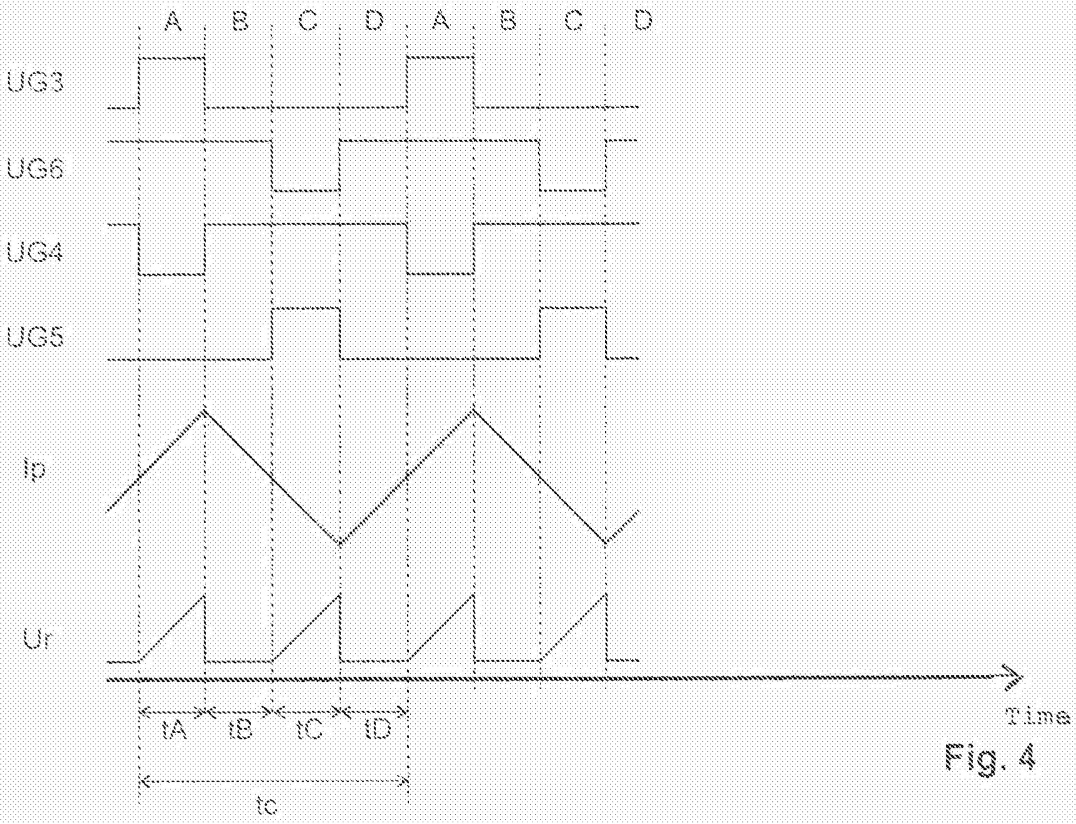

Fig. 4

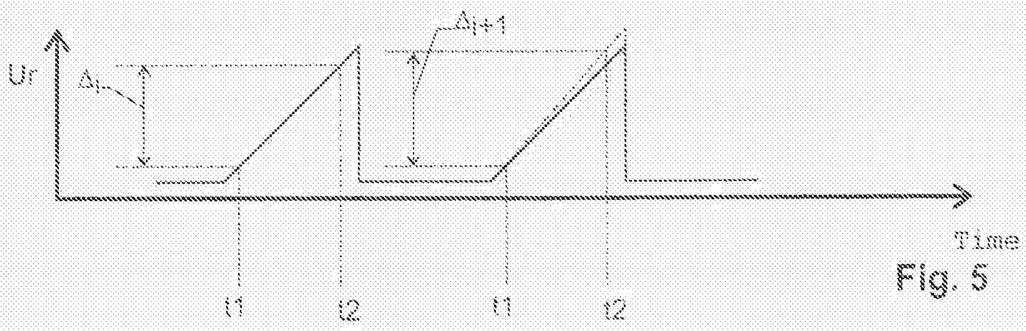

Fig. 5

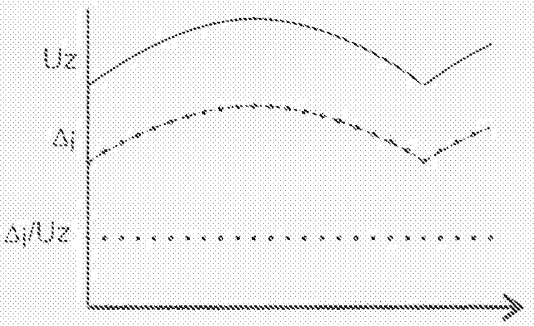

Fig. 6a

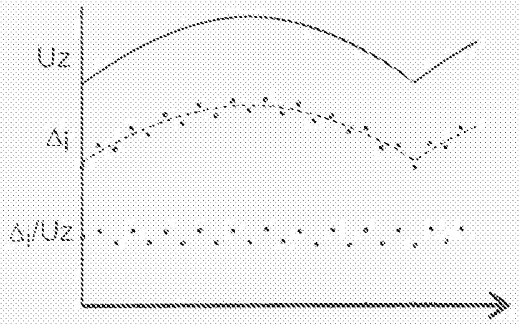

Fig. 6b