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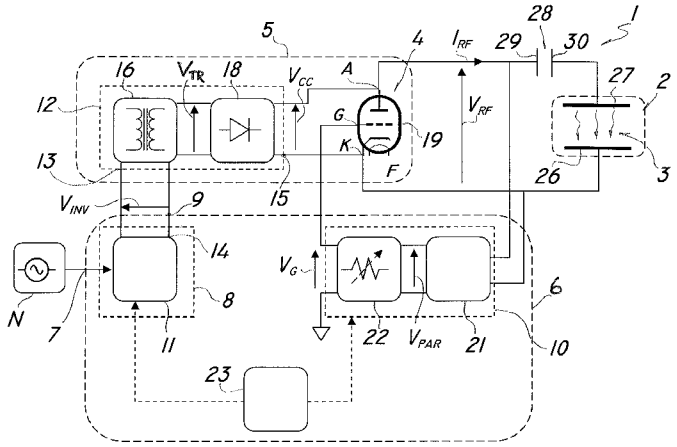

FIG. 1

(57) Abstract: A device for generating an alternating radio-frequency electromagnetic field in a working area (3) comprises an applicator (2) for emitting the electromagnetic field in the working area (3), an oscillator (4) for providing an alternate voltage (V_{RF}) and electric current (I_{RF}) having a predetermined value and a predetermined frequency to the applicator (2), power supply means (5) for supplying a substantially DC voltage (V_{CC}) to the oscillator (4), control means (6) associated with the power supply means (5) for controlling the electrical parameters of the AC voltage, the AC current and/or the frequency provided to the applicator (2) by the oscillator (4). The control means (6) comprise an input port (7) connected to the electric power network (N), a first electronic control circuit (8) which is connected to the input port (7) for substantially instantaneously varying the electrical parameters and instantaneous control of the field emission power, a second electronic control circuit (10) for regulating the operation of the oscillator (4). The first electronic circuit (8) has an output (9) connected to the power supply means (5). A plant comprises the device and a control method for the device.

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DEVICE FOR GENERATING AN ALTERNATE RADIOFREQUENCY ELECTROMAGNETIC FIELD, CONTROL METHOD AND PLANT USING SUCH DEVICE

Field of the invention

[0001] The present invention generally finds application in the field of radio-frequency treatment systems, and particularly relates to a device for generating an alternating radio-frequency electromagnetic field.

[0002] The invention also relates to a method of controlling a device for generating an alternating radio-frequency electromagnetic field, and a product treatment plant comprising such generator device.

Background art

[0003] Plants are known for treating and conditioning various types of products by application and use of alternate electromagnetic fields having various frequencies.

[0004] Particularly, plants are known which operate using electromagnetic fields operating in the microwave or radio-frequency range, and used for drying relatively wet products, such as hides or painted products.

[0005] Electromagnetic fields are further used in the food processing industry, e.g. for pasteurization of products containing milk or eggs products and in general for conditioning and/or sanitization treatment of any food product.

[0006] The applicant hereof manufactures and sells a treatment plant which uses an alternate radio-frequency electromagnetic field, such plant basically comprising a voltage generator that supplies voltage to an applicator having a pair of electrodes for producing the electromagnetic field through which the products to be treated are designed to pass.

[0007] The applicator further comprises a capacitor, which is electrically connected to the electrodes and has a pair of opposed plates. The distance between the plates may be mechanically adjusted to vary the capacitance of the capacitor, thereby varying the supply voltage to the electrodes and, accordingly, the electromagnetic field emission power.

[0008] With power adjustment, the heating temperature generated by the electromagnetic field on the products to be treated may be varied.

[0009] While this solution has shown remarkable effectiveness and reliability, it is still susceptible of improvement, namely concerning regulation of the electromagnetic field power.

[0010] The mechanical movement of the plates of the capacitor for varying the field power has relatively long response times, which do not allow instantaneous operating temperature adaptation.

[0011] US2640908, which represents the closest prior art, discloses an oscillator which comprises a pair of triodes having the characteristics of the preamble of claim 1.

Disclosure of the invention

[0012] The object of the present invention is to obviate the above drawbacks, by providing a device for applying a radio-frequency electromagnetic field that is highly efficient and relatively cost-effective.

[0013] A particular object is to provide a device for applying a RF electromagnetic field that, when used in a plant for RF treatment of products in general, allows quick and dynamic regulation of product treatment temperature.

[0014] A further object is to provide a device for applying a RF electromagnetic field that ensures high safety by preventing generation of unexpected electric discharges.

[0015] Another object is to provide a plant for treating products by applying a RF electromagnetic field that allows effective treatment of products without affecting their inherent properties.

[0016] Another important object of the present invention is to provide a method of controlling a plant for RF treatment of products that allows quick and immediate regulation of one or more electrical control parameters of the plant.

[0017] These and other objects, as better explained hereafter, are fulfilled by a device for generating an alternate electromagnetic field as defined in claim 1.

[0018] The control means comprise an input connected to the electric power network, a first electronic control circuit which is connected to said input for substantially instantaneous variation of such electrical parameters and instantaneous control of the field emission power, a second electronic control circuit for regulating the operation of such oscillator, wherein the first electronic circuit has an output connected to such power supply means.

[0019] With this particular configuration, field emission power, and hence product treatment temperature, may be actually regulated without delay, as no mechanical regulation is required to set the plant to the new operating configuration.

[0020] In a further aspect, the invention relates to a method of controlling a device for generating an alternating electromagnetic field as defined in claim 11.

[0021] In yet another aspect, the invention relates to a plant for treating products with an alternating electromagnetic field as defined in claim 12.

[0022] Advantageous embodiments of the invention are defined in accordance with the dependent claims.

Brief description of the drawings

[0023] Further features and advantages of the invention will become more apparent from the detailed description of a few preferred, non-exclusive embodiments of the device of the invention, which are described by way of non-limiting examples with the help of the accompanying drawings in which:

FIG. 1 is a schematic block view of a device for generating an electromagnetic field according to the invention;

FIG. 2 shows the current-voltage characteristic of a common diode as used in the plant of Fig. 1;

FIGS. 3 to 7 show simplified wiring diagrams in various embodiments of a detail of Fig. 1;

FIG. 8 is a schematic block diagram of the method of controlling a device for generating an electromagnetic field according to the invention.

Detailed description of a preferred embodiment

[0024] Fig. 1 shows a device for generating an alternate radio-frequency electromagnetic field in a predetermined working area.

[0025] The device, generally designated by numeral 1, may be designed to generate an alternating electromagnetic field at a substantially constant frequency or, alternatively, at a frequency that falls within a predetermined band.

[0026] Preferred frequencies for the electromagnetic field range from 5 MHz to 500 MHz. Particularly, suitable frequencies may be selected within frequency ranges admitted by international standards for civil or industrial uses, whose central values are 6.78 – 13.56 – 27.12 – 40.68 – 433.92 MHz.

[0027] More preferably, the operating frequency will range from 20 MHz to 50 MHz, as best results were experimentally found to be obtained with these lower values, e.g. about 27.12 MHz or 40.68 MHz.

[0028] The device 1 may be used in any plant for RF treatment of products.

[0029] A general plant incorporating the device of the invention, not shown, may find application in the food processing industry, e.g. for sterilization, pasteurization and/or treatment of food products in general, particularly milk- and/or egg-based products, flours, grains and the like, as described and illustrated in EP2375910 and EP1912512, both by the Applicant hereof.

[0030] Further promising applications are found in the field of tannery and treatment of industrial hides in general, e.g. for reducing the initial relative moisture content in hides that come from tanning baths or other industry-specific treatments.

[0031] The Applicant has provided an industrial hide drying plant which uses a device for generating an alternating RF electromagnetic field having flat electrodes for generating a substantially uniform electromagnetic field through which the hides to be treated are designed to pass.

[0032] A further application of a similar plant may be treatment and

drying of polymeric materials, such as profiles or the like that have undergone a surface treatment with water-based paints.

[0033] The plant of the invention essentially differs from such prior art plants for the particular configuration of the alternate RF electromagnetic field generator device.

[0034] The device 1 basically comprises an applicator 2 for emitting the electromagnetic field in the working area 3, an oscillator 4 for providing an alternate voltage V_{RF} and electric current I_{RF} having a predetermined value and a predetermined frequency and power supply means 5 for supplying a substantially DC voltage V_{CC} to the oscillator 4.

[0035] The working area 3 is the area through which the products to be treated are designed to pass, and is designed according to the type of products and the particular means for feeding them through the plant.

[0036] The feeding means, not shown and known per se, may comprise one or more conduits or pipes, in case of pasty, semi-pasty, liquid or powdered products, or a belt conveyor, a roller conveyor or a similar device in case of loose products or industrial hides, polymeric profiles and large products in general.

[0037] The device 1 further comprises control means 6 associated with the power supply means 5 for controlling the electrical parameters of the alternate voltage V_{RF} or current I_{RF} provided to the applicator 2 by the oscillator 4.

[0038] Conveniently, the control means 6 may be designed to control the electrical parameters concerning the amplitude and/or frequency of the voltage V_{RF} and/or the current I_{RF} provided to the applicator 2.

[0039] The control means 6 comprise an input 7 connected to the electric power network N, a first electronic control circuit 8 which is connected to the input 7 for substantially instantaneous variation of such electrical parameters and hence for instantaneous control of the field emission power.

[0040] The first electronic control circuit 8 further has an output 9 connected to the power supply means 5 and the control means 6 comprise a second electronic control circuit 10 for regulating the operation of the

oscillator 4.

[0041] Furthermore, the first control circuit 8 may control the electrical parameters of the electric signals provided to the power supply means 5.

[0042] A variation of such electrical parameters will cause instantaneous variation of the alternate voltage V_{RF} and current I_{RF} provided to the applicator 2.

[0043] Such voltage variation will cause a corresponding variation of the power of the electromagnetic field emitted in the working area 3 with a particularly short delay or with no delay at all.

[0044] In a particular, non-exclusive embodiment, the first electronic control circuit 8 may comprise an inverter 11, for converting the standard voltage of the network N, having a constant frequency and a constant rms value, into an AC voltage V_{INV} having a controlled rms value and/or a controlled frequency.

[0045] Conveniently, as best shown in FIG. 1, the supply means 5 may include an amplifier circuit 12 with an input 13 connected to the output 14 of the inverter 11 to receive the voltage V_{INV}, and an output 15 connected to the oscillator 4.

[0046] The amplifier circuit 12 may amplify and change the voltage V_{INV} at the output of the inverter 11 to provide a substantially DC voltage VCC to the oscillator 4.

[0047] The amplifier circuit 12 may comprise a voltage boost transformer 16 having an input 13 connected to the output 14 of the inverter 11 and a rectifier 18 downstream from the transformer 16 having an output 15 connected to the oscillator 4.

[0048] In a particular configuration of the device, designed for food processing, the voltage V_{INV} at the output 14 of the inverter 11 may be an AC voltage, with an value ranging from 0 V to 400 V, the output voltage V_{TR} of the transformer 16 will also be an AC voltage with a rms value not exceeding 9000 V, whereas the DC voltage V_{CC} at the output of the rectifier 18 is limited to about 12000 V.

[0049] Preferably, as best shown in FIG. 1, the oscillator 4 may comprise at least one triode 19 having two power terminals, i.e. the anode A and the cathode K respectively.

[0050] The triode 19 may also comprise a grid terminal G which is adapted to receive a control signal designed to vary the electrical parameters of the signal between the anode A and the cathode K.

[0051] FIG. 2 shows a voltage-current characteristic of a bias triode whose instantaneous operating point lies along a substantially straight segment T.

[0052] Particularly, a controlled displacement of the operating point P along such segment will cause a corresponding predetermined variation of the AC voltage V_{RF} between the anode A and the cathode K, which is represented on the x-axis in the diagram of FIG. 2.

[0053] The displacement of the operating point P may be controlled by varying the voltage V_G in the grid terminal G of the triode 19, which is represented on the y-axis of the diagram of FIG. 2.

[0054] As best shown in FIG. 1, the bias of the triode acting as an oscillator is such that the anode A and the cathode K are supplied with the DC voltage V_{CC} present at the output 15 of the rectifier.

[0055] In this case, the oscillation voltage V_{RF} at the output of the anode A and cathode K terminals of the triode 19 may be varied by controlling the waveform of the voltage V_G in the grid terminal G.

[0056] The use of the triode 19 as an oscillator at a predetermined frequency requires a substantially periodic voltage V_G with a positive wave portion to be applied to the grid terminal G.

[0057] Particularly, the duration of the positive grid voltage V_G may be equal to a predetermined angular fraction of the oscillation period of the voltage V_{RF} provided to the applicator 2.

[0058] This angular fraction may be substantially close to one third of a round angle, and may particularly range from about 80° to about 150°.

[0059] Furthermore, the triode 19 comprises a heating filament F with a power supply circuit that is known per se and will not be further

described herein.

[0060] The second electronic control circuit 10 may be connected to the grid terminal G of the triode 19 for controlling the grid voltage V_G according to the instantaneous value of the AC voltage V_{INV} at the output of the inverter 11.

[0061] Particularly, as schematically shown in FIG. 1, the second electronic control circuit 10 may comprise a voltage divider circuit 21 connected to the input of the applicator 2 for drawing a predetermined portion V_{PAR} of the voltage V_{RF}.

[0062] Furthermore, the second electronic control circuit 10 may comprise a DC voltage adder circuit 22, downstream from the divider circuit 21.

[0063] The adder circuit 22 may be connected to the grid terminal G of the triode 19 to adapt the average value of the grid voltage VG such that the triode 19 is continuously kept oscillating.

[0064] Conveniently, the control means 6 may comprise a programmable central control unit PLC 23, which is adapted to control at least the output voltage V_{INV} of the inverter 11, and the second electronic control circuit 10 for varying the power emitted by the electromagnetic field generated by the applicator 2 and for ensuring constant oscillation of the triode 19.

[0065] Particularly, a central control unit 23 may be programmed to control the second electronic control circuit 10 by varying the DC voltage value of the adder circuit 22 according to the instantaneous value of the voltage V_{RF} provided to the applicator 2.

[0066] Furthermore, the central control unit 23 may comprise interface means, not shown, which are used to enter and/or display the data concerning the value of the electrical parameters provided and/or detected in the first 8 and second 10 electronic control circuits.

[0067] Particularly, the central control unit 23 may comprise an alphanumeric keyboard, not shown, for entering data concerning the values of the desired electrical parameter and a display, also not shown and known

per se, for displaying the data concerning the instantaneous values of such parameters.

[0068] The divider circuit 21, as best shown in FIGS. 3 to 7, may comprise the pair of inherent capacitors C_{AG}, C_{GK} of the triode 18 which are present between the anode A and the grid G and between the grid G and the cathode K respectively.

[0069] The divider circuit 21, as best shown in FIG. 3, may also comprise an inductor LAC inserted between the anode A and the grid G of the triode 19 and an inductor L_B for blocking the DC component, having a first terminal 24 electrically connected to the grid terminal G.

[0070] Alternatively, as shown in FIG. 4, the divider circuit 21 may differ from the diagram of FIG. 3 in the presence of an inductor L_{GK} connected between the grid G and the cathode K of the triode 19.

[0071] This configuration has the advantage of using an inductor whose maximum operating voltage is lower than that used in the diagram of FIG. 3.

[0072] Thus, during operation of the triode, the voltage between the grid G and the cathode K is considerably lower than the voltage between the anode A and the grid G.

[0073] Conveniently, the value of the inductors L_{AK} or L_{GK} may be varied during calibration to adjust the value of the voltage V_{PAR} according to the voltage V_{RF} provided to the applicator 2. Particularly, the voltage V_{PAR} may be a predetermined fixed portion of the voltage V_{RF} presented to the applicator 2.

[0074] Conveniently, the voltage V_{PAR} may range from 10% to 20% the value of the voltage V_{RF} and is preferably about 15% the value of the voltage V_{RF}.

[0075] The adder circuit 22 may be connected downstream from the divider circuit 21 and may be electrically connected to the second terminal 25 of the inductor L_B and the cathode K of the triode 19.

[0076] FIGS. 3 to 7 schematically show three different types of adder circuits 22.

[0077] Particularly, in the embodiment of FIGS. 3 and 4, the adder circuit 22 may be electrically equivalent to a variable resistor R.

[0078] Alternatively, as shown in FIG. 5, the adder circuit 22 may be electrically equivalent to a DC voltage generator, with a variable tension E.

[0079] Conveniently, the central control unit 23 may be programmed to control the ohmic value R of the equivalent variable resistor or the value of the tension E of the equivalent generator according to the instantaneous value of the voltage V_{RF} provided to the applicator 2.

[0080] Conveniently, as shown in FIG. 6, the diagrams of FIG. 4 and FIG. 5 may be combined to form an adder circuit 22 substantially equivalent to a variable resistor R connected in series to a voltage generator E.

[0081] In this case, the central control unit 22 may be designed to simultaneously control both the ohmic value of the equivalent resistor and the electromotive force of the generator R.

[0082] The divider circuit 21 and the adder circuit 22 may be designed to provide a voltage V_G to the grid terminal G which is substantially in phase opposition to the voltage V_{RF} provided to the applicator 2.

[0083] In the diagrams as shown in FIGS. 3 to 6, the voltage V_G at the input of the grid terminal G of the triode 19 is obtained by adding the variable-amplitude DC voltage to an AC signal V_{PAR} having a substantially constant amplitude.

[0084] In a further configuration of the second electronic control circuit, as shown in FIG. 7, the voltage V_G at the grid terminal G may be obtained by the sum of a variable DC voltage provided by the adder circuit 22 to a variable AC voltage provided by the divider circuit 21.

[0085] The variation of the amplitude of the AC voltage provided by the divider circuit 21 may be obtained by appropriately varying the capacitance value of the capacitors C_{AG} and C_{GK} of the triode 19 between the anode A and the grid G and between the grid G and the cathode K respectively.

[0086] Conveniently, the central control unit 23 may be designed to simultaneously control the capacitance values of the capacitors C_{AG} and C_{GK}

and the ohmic value of the equivalent variable resistor R.

[0087] Furthermore, the control means 6 may comprise an oscillation frequency control circuit, not shown, downstream from the triode 19 and adapted to vary the voltage frequency V_{RF} provided to the applicator 2.

[0088] Conveniently, as shown in the block diagram of FIG. 1, the applicator 2 may comprise at least one pair of electrodes 26, 27 for emitting and directing the electromagnetic field in the working area 3.

[0089] The shape, type and number of electrodes may be selected according to the particular type of plant for which the device 1 is designed and particularly the electrodes may be configured as described in the above mentioned patent documents by the Applicant hereof.

[0090] For example, they may be formed with a pair of facing plates, placed at a predetermined distance from each other for radiating a substantially uniform electromagnetic field into the gap therebetween, or they may be annular electrodes adapted to have said product feeding conduit extending therethrough such that products may pass through the field.

[0091] Conveniently, the applicator 2 may comprise a capacitor 28 with plates 29, 30 electrically connected in series to the electrical terminals of the electrodes 26, 27.

[0092] Furthermore, the capacitor 28 may be designed to limit the value of the electric current provided at the output of the power supply means 5 if the electrodes 26,27 are short-circuited.

[0093] This might occur accidentally or due to malfunctions of the device 1 and the presence of the capacitor 28 may ensure that a limiting load is provided at the output of the amplifier 11, thereby reducing the current provided to the triode 18.

[0094] Conveniently, the plates 29, 30 may be substantially flat and face each other at a fixed distance.

[0095] Thus, the capacitor may have a fixed-value capacitance which is adapted to define an impedance with an ohmic value sufficient to limit the current generated by the triode 19 if the electrodes 26, 27 are short-

circuited.

[0096] Furthermore, proper adjustment of the distance between the plates of the capacitor 28 will allow the impedance value of the applicator 2 to be adapted to that of the power supply means 4.

[0097] In a further aspect, the invention relates to a method of controlling the above described device 1 for generating the alternate RF electromagnetic field, as shown in FIG. 8, which essentially comprises a step a) of providing an applicator 2 for emitting the electromagnetic field in a working area 3, a step b) of providing an oscillator 4 which provides an alternate voltage V_{RF} and an alternate current I_{RF} having a predetermined value and a predetermined frequency to the applicator 2.

[0098] There are further provided a step c) of supplying a substantially DC voltage V_{CC} to the oscillator 4 and a control step d) which comprises varying the electrical parameters of voltage, current and/or frequency provided to the applicator 2 through appropriate control means 6.

[0099] Conveniently, the control step d) comprises varying the electrical parameters to instantaneously vary the electromagnetic field emission power and the controlled power supply to the oscillator 4.

[00100] Furthermore, the control means 6 comprise an inverter 11 and the oscillator 4 comprises a triode 19.

[0100] The inverter 11 is designed to convert the network voltage into an AC voltage having a variable rms value and/or a variable frequency.

[0101] Also, the triode 19 is powered with a grid voltage V_G, which is controlled to ensure constant oscillation thereof as the AC voltage V_{INV} transformed by the inverter 11 is varied.

[0102] Particularly, the control step d) may be obtained by varying the alternate voltage and/or frequency at the output 14 of the inverter 11 without requiring any mechanical adjustment that would inevitably involve plant response delays.

[0103] The control step d) may be carried out while maintaining the waveform of the voltage V_G applied to the grid G of the triode 19 substantially constant.

[0104] The control of the voltage V_G at the grid G of the triode 19 will allow the triode to keep on oscillating, such that it may provide a voltage V_{RF} adapted to supply the applicator 2, between the anode A and the cathode K.

[0105] Thus, the control step d) will control the positive portion of the grid voltage V_G, such that the latter has a duration equal to a predetermined angular fraction of the oscillation period.

[0106] The above disclosure clearly shows that the device of the invention fulfills the intended objects and particularly meets the requirement of allowing immediate and dynamic regulation of electromagnetic field emission power, for delay-free regulation of product treatment temperature.

[0107] Furthermore, if the plant operates with no load between the electrodes, the use of an inverter will allow voltage to be regulated to values lower than the operating values to prevent the formation of electric arcs.

[0108] The device, plant and method of the invention are susceptible to a number of changes or variants, within the inventive concept disclosed in the appended claims. All the details thereof may be replaced by other technically equivalent parts, and the materials may vary depending on different needs, without departure from the scope of the invention.

[0109] While the device, plant and method have been described with particular reference to the accompanying figures, the numerals referred to in the disclosure and claims are only used for the sake of a better intelligibility of the invention and shall not be intended to limit the claimed scope in any manner.

CLAIMS

1. A device for generating an alternating radio-frequency electromagnetic field in a working area (3), comprising:

- an applicator (2) for emitting the electromagnetic field in the working area (3);
- an oscillator (4) for providing an alternate voltage (V_{RF}) and an alternate current (I_{RF}) having a predetermined value and a predetermined frequency;
- power supply means (5) for supplying a substantially DC voltage (V_{CC}) to said oscillator;
- control means (6) associated with said power supply means (5) for controlling the electrical parameters of said alternate AC voltage (V_{RF}), AC current (I_{RF}) and/or frequency provided to said applicator (2) by said oscillator (4);

wherein said control means (6) comprise an input port (7) connected to the electric power network (N), a first electronic control circuit (8) which is connected to said input port (7) for substantially instantaneously varying said electrical parameters and instantaneously controlling of the field emission power, a second electronic control circuit (10) for regulating the operation of said oscillator (4), wherein said first electronic circuit (8) has an output port (9) connected to said power supply means (5),

characterized in that said first electronic control circuit (8) is an inverter (11) adapted to convert the mains network voltage (N) having a constant frequency and a constant RMS value, into an AC voltage (V_{INV}) having a controlled RMS value and/or a controlled frequency, said oscillator (4) comprising a triode (19) having a grid terminal (F), said second electronic control circuit (10) being connected to the grid terminal (G) of said triode (19) for controlling the grid voltage (V_G) according to the instantaneous value of said AC voltage (V_{INV}) at the output (14) of said inverter (11).

2. Device as claimed in claim 1, characterized in that said second electronic control circuit (10) comprises a voltage divider (21) connected to

said applicator (2) for drawing a predetermined voltage portion (V_{PAR}).

3. Device as claimed in claim 2, characterized in that said second electronic circuit (10) comprises, past said divider (21), a DC voltage adder circuit (22) connected to said grid terminal (G) of said triode (19) to adapt the average value of grid voltage (V_G) and ensure continuous oscillation of said triode (19).

4. Device as claimed in claim 3, characterized in that said adder circuit (22) comprises an equivalent variable resistor (R) and/or an equivalent voltage generator (E) with a variable tension.

5. Device as claimed in claim 1, characterized in that said control means (6) comprise a programmable central control unit (23), which is adapted to control at least the output voltage (V_{INV}) of said inverter (11), and said second electronic control circuit (8) for varying the power emitted by the generated electromagnetic field and for ensuring constant oscillation of said triode (19).

6. Device as claimed in claim 1, characterized in that said power supply means (5) comprise an amplifier (12) having a high voltage transformer (16) connected to said output (14) of said inverter (11) and a rectifier (18) connected to the output (15) of the transformer and to said oscillator (4) said amplifier (12) being adapted to provide said substantially AC voltage (V_{CC}) to said output (15).

7. Device as claimed in claim 4, characterized in that said amplifier (12) comprises an input (13) connected to said output (14) of said inverter (11) and an output (15) connected to said oscillator (4).

8. Device as claimed in claim 1, characterized in that said applicator (2) comprises at least one pair of electrodes (26, 27) for emitting and directing said electromagnetic field in said working area (3).

9. Device as claimed in claim 8, characterized in that said applicator (2) comprises a capacitor (28) with plates (29, 30) electrically series connected to said electrodes (26, 27).

10. Device as claimed in claim 9, characterized in that said plates (29, 30) are substantially flat and at a fixed distance from each other.

11. Method of controlling a device (1) for generating an alternate RF electromagnetic field comprising the steps of:

a) providing an applicator (2) for emitting the electromagnetic field in a working area (3);

b) providing an oscillator (4) for providing an alternate AC voltage (V_{RF}) and current (I_{RF}) having a predetermined value and a predetermined frequency to said applicator (2);

c) supplying a substantially DC voltage (V_{CC}) to said oscillator (4);

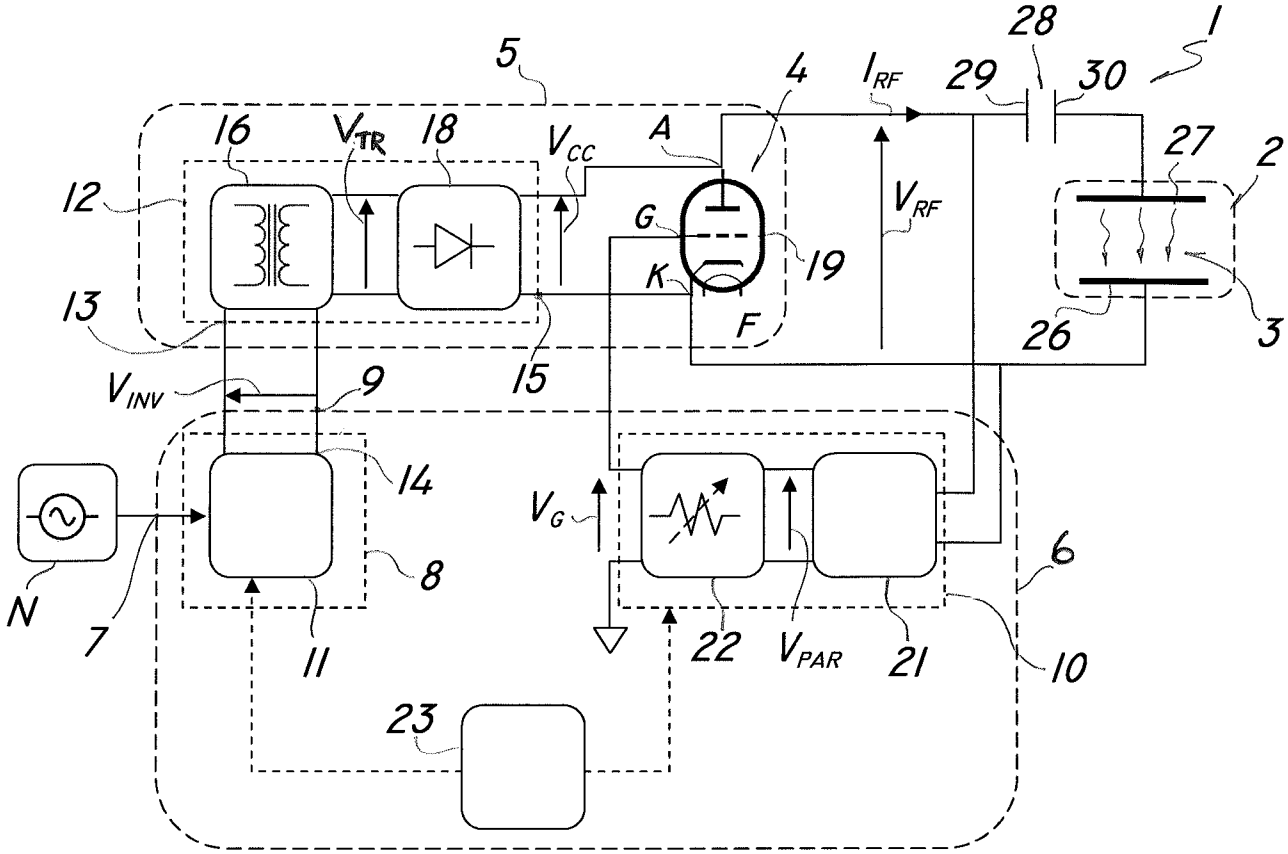
d) controlling the electrical parameters of voltage (V_{RF}), current (I_{RF}) and/or frequency provided to said applicator (2) using control means (6);

- wherein said control step d) comprises varying said electrical parameters to instantaneously vary the electromagnetic field emission power and the controlled power supply to said oscillator (4);

- wherein said control means (6) comprise an inverter (11) and said oscillator (4) comprises a triode (19), said inverter (11) being designed to convert the network voltage (N) into an AC voltage having a variable RMS value and a variable frequency;

wherein said control means (6) are adapted to supply a grid voltage (V_G) controlled according to the instantaneous value of said AC voltage transformed by said inverter (11), to ensure constant oscillation of said triode (19) through variation of the AC voltage (V_{INV}) transformed by said inverter (11).

12. Plant for treating products by an alternate electromagnetic field in the RF band, characterized in that it comprises a working area (3) in which the products to be treated are placed and a device (1) for generating an alternate RF electromagnetic field in said working area (3) as claimed in one or more of claims 1 to 11.


1
2
3
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6
7
8
9
10
11
12
13
14
15
16
18
19
21
22
23
26
27
28
29
30
A
F
G
K
N
V_{TR}
V_{CC}
V_{RF}
I_{RF}
V_{INV}
V_G
V_{PAR}

FIG. 1

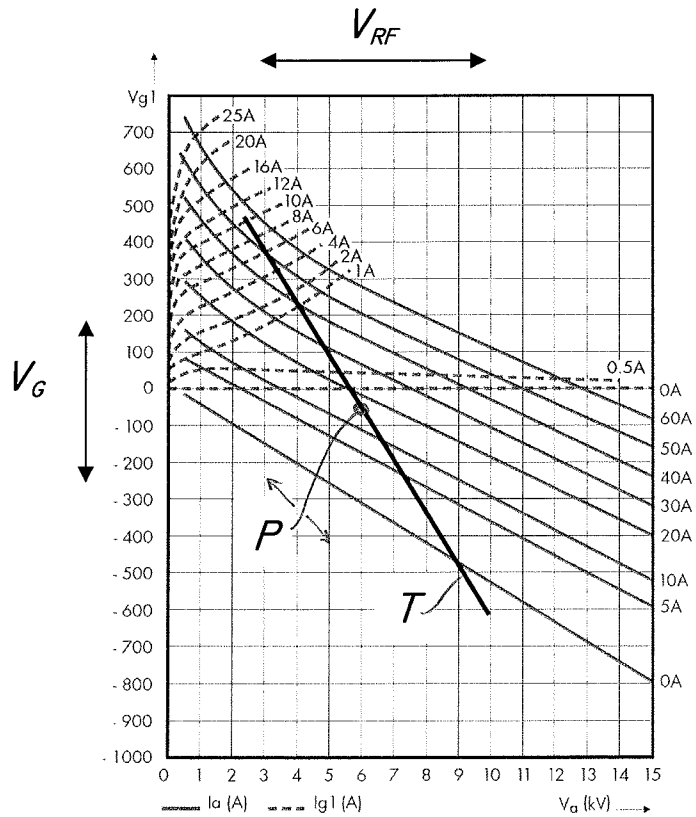
V_{RF}
V_G
Vg1
25A
20A
16A
12A
10A
8A
6A
4A
2A
1A
0.5A
0A
60A
50A
40A
30A
20A
10A
5A
0A
P
T
Ia (A)
Ig1 (A)
V_a (kV)

FIG. 2

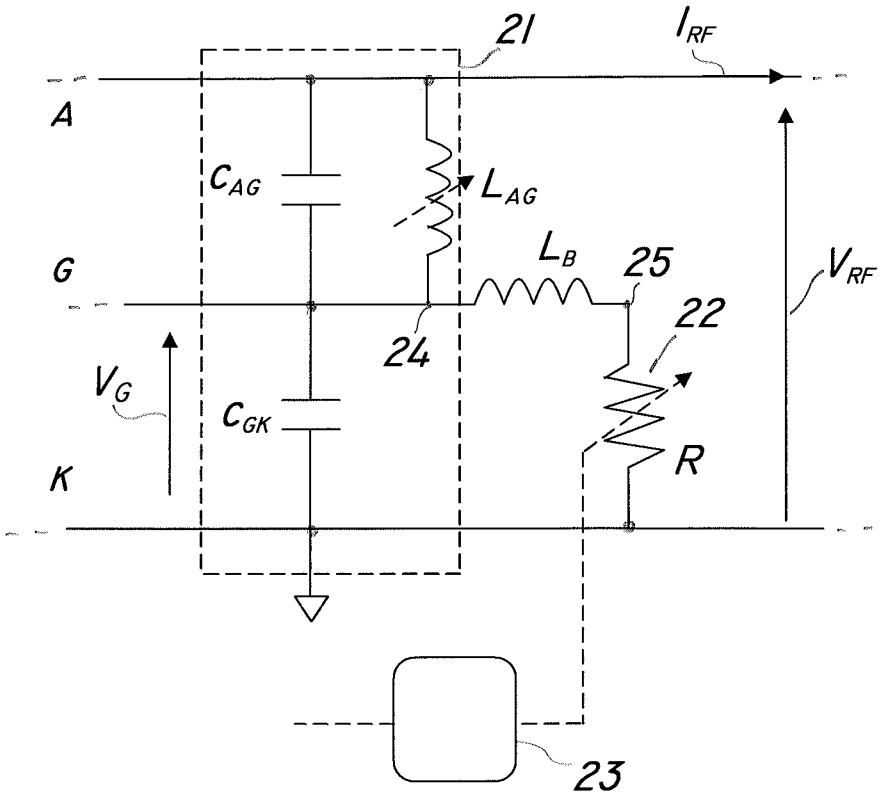
21
I_{RF}
A
C_{AG}
L_{AG}
G
L_B
25
V_{RF}
22
24
V_G
C_{GK}
R
K
23

FIG. 3

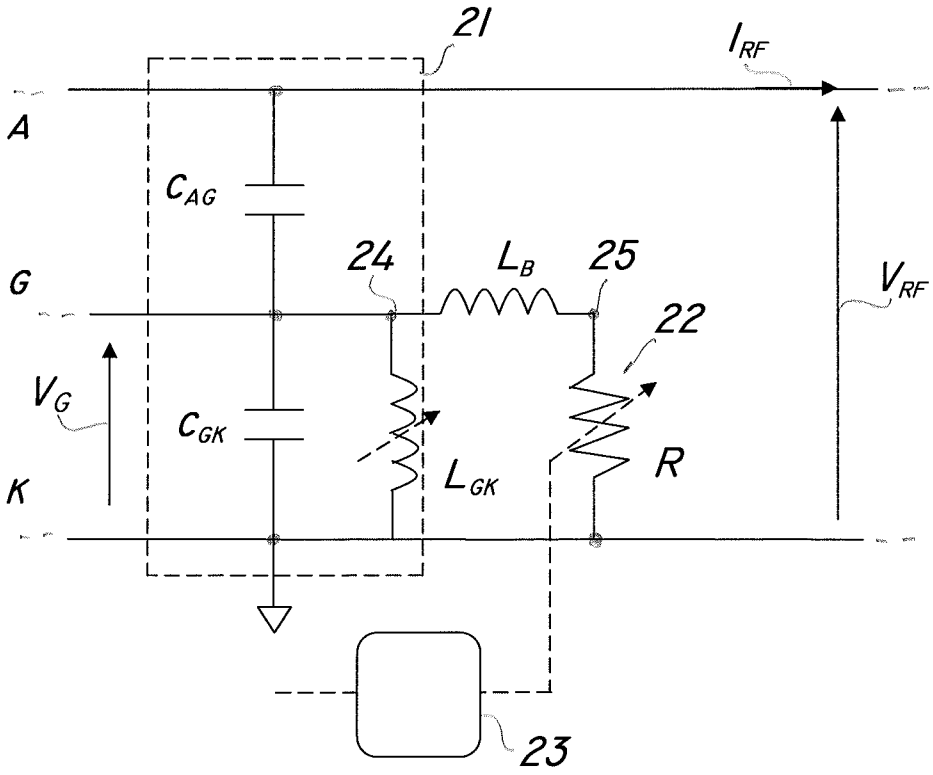
21
I_{RF}
A
C_{AG}
24
L_B
25
G
V_{RF}
22
V_G
C_{GK}
L_{GK}
R
K
23

FIG. 4

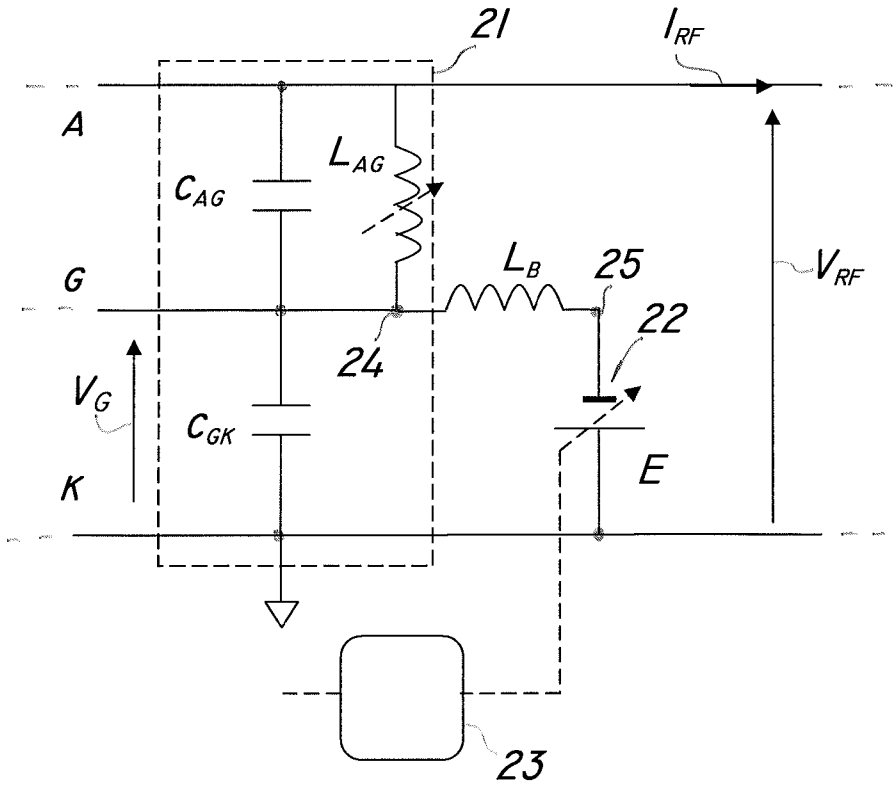
21
I_{RF}
A
L_{AG}
C_{AG}
G
L_B
25
V_{RF}
22
24
V_G
C_{GK}
E
K
23

FIG. 5

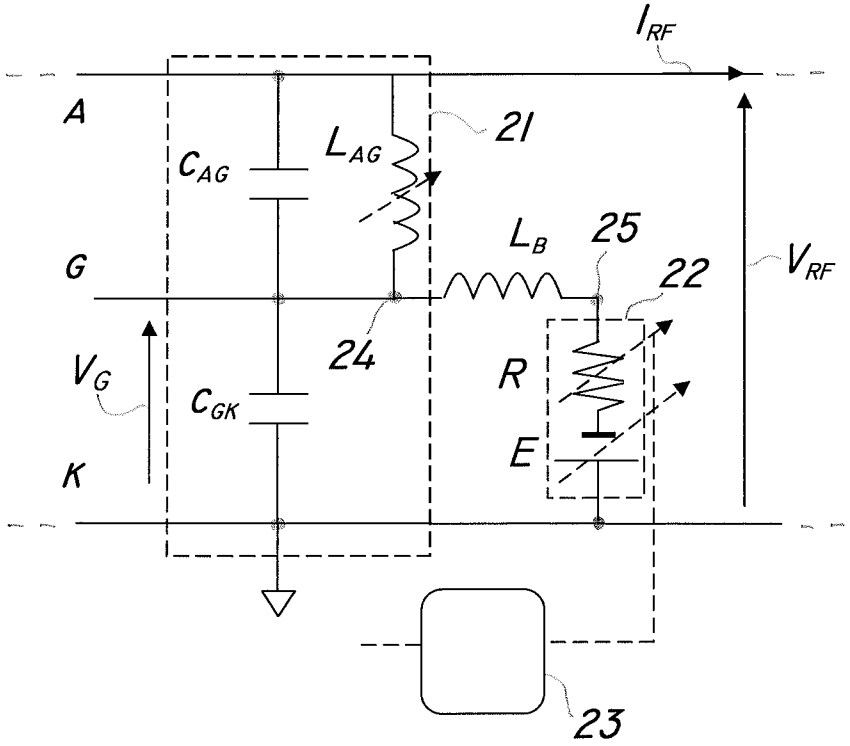
I_{RF}
A
21
L_{AG}
C_{AG}
L_B
25
G
22
V_{RF}
24
R
V_G
C_{GK}
E
K
23

FIG. 6

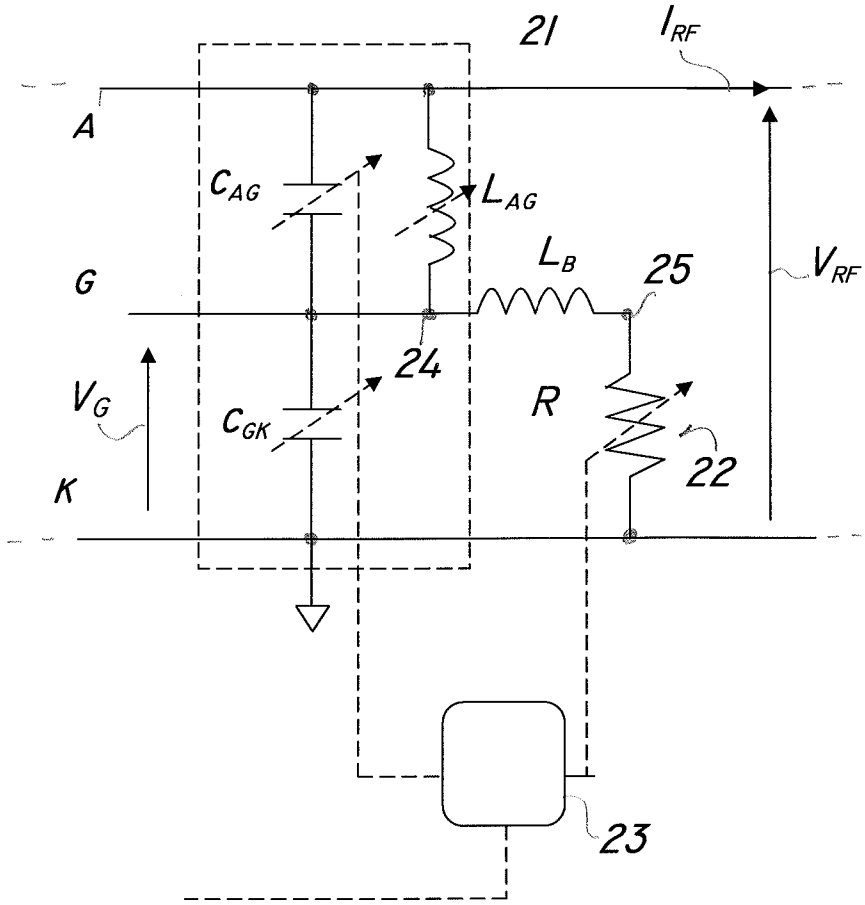

FIG. 7

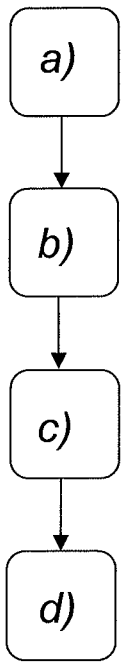

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2013/059541

A. CLASSIFICATION OF SUBJECT MATTER
INV. A23L3/01 H05B6/48
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A23L H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2 640 908 A (WELCH JR EDWARD SOHIER) 2 June 1953 (1953-06-02) column 1, line 1 - line 3 column 11, line 69 - line 75 column 17, line 19 - line 30 column 15, line 44 - line 48 figure 17	1,5,8-11
A	US 2 517 948 A (WARREN HENRY R) 8 August 1950 (1950-08-08) column 3, line 40 - line 44	1,5,8-11
A	US 2009/095402 A1 (HALL WILLIAM ALFRED [US] ET AL) 16 April 2009 (2009-04-16) paragraphs [0039], [0042]	5,10
A	US 2002/047009 A1 (FLUGSTAD BENJAMIN A [US] ET AL) 25 April 2002 (2002-04-25) figure 4	1,6

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 March 2014	18/03/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Garcia Congosto, M

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2013/059541

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US 2517948 A	08-08-1950	NONE	
US 2009095402 A1	16-04-2009	NONE	
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		US 2002047009 A1	25-04-2002
		US 2003205571 A1	06-11-2003
		WO 03019985 A1	06-03-2003