



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.06.2012 Bulletin 2012/25

(51) Int Cl.:
H01H 47/22 (2006.01) D06F 37/30 (2006.01)

(21) Application number: **11193215.8**

(22) Date of filing: **13.12.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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(30) Priority: **16.12.2010 IT TO20101001**

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(54) **Electronic circuitry for household appliances**

(57) The present invention relates to an electronic circuitry for connecting a household appliance to an electric power mains. The circuitry comprises a control unit (107), a capacitor (104,204) operationally connected between a phase conductor (101) and a neutral conductor (102), the phase conductor and the neutral conductor being adapted to be connected to respective phase and neutral connectors of the power mains, wherein an alternating voltage is applicable between the phase conductor and the neutral conductor, the circuitry being character-

ized in that it comprises a first switch (105) capable of connecting/disconnecting a first terminal of the capacitor (104,204) to/from either one of the phase conductor (101) and the neutral conductor (102), the first switch (105) being driven by the control unit (107), the first switch disconnecting the first terminal of the capacitor when the household appliance is not executing a treatment cycle, the first switch connecting the first terminal of the capacitor when the household appliance is executing a treatment cycle.

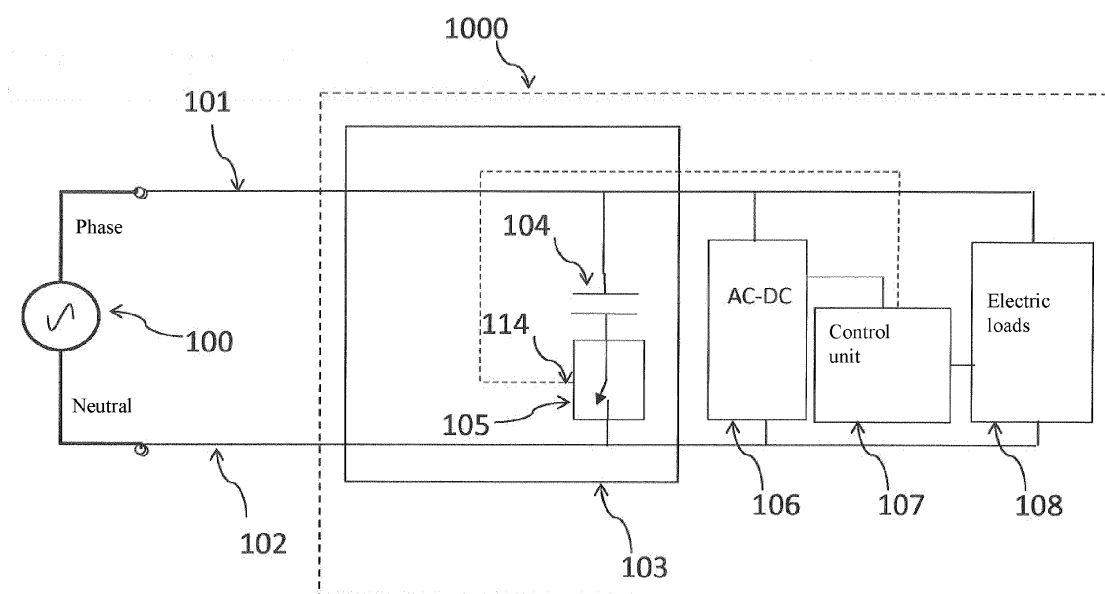


Figure 1

Description

[TECHNICAL FIELD]

[0001] The present invention relates to the field of household appliances, in particular to a special electronic circuitry for connecting a household appliance to a power mains. More in particular, the invention relates to a circuitry in accordance with the preamble of claim 1. The present invention further relates to an associated method for filtering the noise generated by a household appliance.

[PRIOR ART]

[0002] In the household appliances known in the art, an input filter is connected between the electric plug and the electric and electronic components of the household appliance, such as, for example, AC-DC converters, sensors, control units, resistive loads, electric motors, etc.

[0003] In particular, the input filter is connected to the phase and neutral conductors of the electric plug.

[0004] This input filter prevents any noise present on the power mains from propagating to the circuitry of the household appliance. Mains noise might, in fact, degrade the performance of or even cause damage to the electronic circuitry of the household appliance.

[0005] In a dual manner, said filter does not allow the noise coming from the household appliance to propagate to the power mains.

[0006] In this regard, the European standards EN 55014-1 and EN 55014-2 specify the electromagnetic emissions and the immunity performance of household appliances, respectively.

[0007] It is known that the input filter comprises at least one capacitor connected between the phase and neutral conductors, and that such a capacitor has adequate capacity to filter the typical frequencies of noise coming from the mains and the household appliance.

[0008] When the electric plug of the household appliance is not connected to the mains outlet, there is a risk that the charge accumulated by the capacitor is discharged on the user, if the latter touches the electric plug. The discharge current might be annoying or even harmful for the user. In particular, in order to ensure the user's safety, the standard EN 60335-1 specifies that the voltage across the plug must fall below 34 V within 1 sec from the moment when the plug is disconnected.

[0009] To avoid this problem, the input filters known in the art include a resistor connected in parallel to the capacitor; as soon as the electric plug of the household appliance is disconnected from the power mains, the capacitor of the input filter discharges itself on the parallel resistor, so that a contact between the electric plug and the user will cause no harm. For the discharge of the capacitor to occur quickly and hence safely for the user, the resistor must have an adequate value, e.g. when using a 0.47µF capacitor one may use a 680KOhm resistor.

[0010] This solution has the drawback that it implies a non-negligible dissipation of power by the resistor required for discharging the capacitor of the input filter. In fact, since it is connected between the phase and neutral mains conductors, the resistor is run by a current having a non-negligible value as long as the household appliance stays connected to the power mains, even if it is off. In particular, when the household appliance is in a stand-by state, the consumption of the resistor significantly contributes to the consumption of the machine in that state, and may therefore adversely affect the energy efficiency classification of the household appliance.

[OBJECTS AND BRIEF DESCRIPTION OF THE INVENTION]

[0011] It is one object of the present invention to improve the input filter solutions known in the art, in particular for applications in the household appliance industry.

[0012] It is another object of the present invention to reduce the power consumption of known input filters.

[0013] These and other objects of the present invention are achieved through a circuitry and a household appliance incorporating the features set out in the appended claims, which are intended as an integral part of the present description.

[0014] Hereafter, the expression "operationally connected devices" will refer to two devices, whether or not directly connected to each other, such that an electric signal present at the terminals of one device affects an electric signal present at the terminals of the other device. The electric connection between the two devices may be a direct one, i.e. occurring through a short circuit, or it may be established through one or more third devices of any kind, e.g. resistors, capacitors, diodes, transistors, integrated circuits, etc.

[0015] The expression "operationally connected" further comprises connecting two devices by means of a switch, regardless of the open or closed state thereof. In particular, if two devices are connected to different terminals of one switch, they are considered to be operationally connected to each other.

[0016] The expression "connected devices" refers herein to a simple connection between two or more devices established through a short circuit, and therefore indicates a particular case of operationally connected devices.

[0017] The idea at the basis of the present invention consists of an electronic circuitry for connecting a household appliance to the power mains, which circuitry comprises a capacitor operationally connected between a phase conductor and a neutral conductor, a switch, and a control unit that drives the switch. The conductors are adapted to be connected to an outlet of the power mains, and therefore an alternating voltage can be applied thereto. The switch can connect/disconnect the capacitor to/from either conductor; in particular, the switch disconnects the capacitor when the household appliance is not

executing a treatment cycle, and connects it when the household appliance is executing a treatment cycle.

[0018] This solution reduces the power consumption and prevents the capacitor from discharging on a user coming in contact with the conductors.

[0019] Advantageously, the switch is arranged in series with the capacitor.

[0020] This allows keeping the power-on circuits of the household appliance alive even when the latter is off.

[0021] Advantageously, the switch is comprised in a changeover device that disconnects the first terminal of the capacitor from one conductor and connects it to a resistor.

[0022] This allows the capacitor to get completely discharged, thus improving the safety of the household appliance.

[0023] Advantageously, the switch is a monostable relay.

[0024] In fact, this is a low-cost and reliable device suited to withstanding the high currents required by household appliances.

[0025] The present invention also includes a method for filtering the electric noise of a household appliance, which comprises a capacitor operationally connected between a phase conductor and a neutral conductor, across which an alternating voltage can be applied. The method comprises the steps of:

- disconnecting the capacitor from either one of the two conductors when the household appliance is not executing a treatment cycle;
- connecting the capacitor to either one of the two conductors when the household appliance is executing a treatment cycle.

[0026] Further objects and advantages of the present invention will become more apparent from the following description of a preferred embodiment thereof, which is supplied by way of non-limiting example with reference to the annexed drawings, wherein:

Fig. 1 is a block diagram of a system for household appliances comprising the circuitry according to the present invention;

Fig. 2 is a block diagram of a system for household appliances comprising a circuitry according to a second embodiment;

Fig. 3 shows a household appliance comprising a circuitry according to the present invention.

[0027] In the present invention, identical or equivalent means will be designated by the same reference numerals.

[0028] With reference to Fig. 1, a generator 100 of alternating voltage, typically having a frequency of 50 Hz and an effective value of 230 V, is connected to two wires 101 and 102 made of conductive material, typically copper, hereafter simply referred to as conductors 101 and

102. The conductors 101 and 102 can be connected to the two pins of a normal electric plug, e.g. a "schuko" plug.

[0029] The voltage generator 100 represents the household electric mains normally used for supplying power to modern household appliances.

[0030] The first conductor 101 is used for transmitting the phase voltage; hence it is called phase conductor 101.

[0031] The second conductor 102 is used for transmitting the neutral voltage; hence it is called neutral conductor 102.

[0032] Between the two conductors 101 and 102, an input filter 103 for attenuating the noise coming from and/or directed towards the household appliance, an AC-DC converter 106 for supplying power to the direct-voltage electronic circuitry, and electric loads 108, which may comprise heating resistors, electric motors, etc., are connected in parallel.

[0033] A direct-voltage output of the AC-DC converter 106 is connected to a control unit 107 of the household appliance; for example, said direct voltage is 3.3 V. The AC-DC converter 106 also includes at least one more direct-voltage output, which is used for supplying appropriate power to other electronic circuits and devices which are useful for the proper operation of the household appliance, such as sensors, LCDs, communication boards, relay drive circuits. For example, said additional output supplies a 12V direct voltage.

[0034] The filter 103 comprises a capacitor 104 and a monostable relay 105 with a single switch. Alternatively, the monostable relay 105 may consist of a monostable changeover relay wherein only the normally open contact is used as a switch.

[0035] The relay 105 is connected in series with the capacitor 104, in particular between a first terminal of the capacitor 104 and the neutral conductor 102. A second terminal of the capacitor 104 is connected to the phase conductor 101.

[0036] The relay 105 comprises two terminals, hereafter referred to as conduction terminals, which are short-circuited when the relay is closed and which create an open circuit, or at least high impedance, when the relay is open. The opening and closing of the relay is controlled by means of one or more control terminals 114. This is the typical structure of a drivable switch.

[0037] By stating that the relay 105 and the capacitor 104 are connected in series it is meant that the capacitor 104 is arranged in series with the two conduction terminals, and therefore the capacitor and both conduction terminals of the relay are run by the same current, save for any parasitic losses, when the relay is closed.

[0038] The control terminals 114 of the relay 105 are operationally connected to the control unit 107, which thus controls, whether directly or indirectly, the opening and closing of the relay.

[0039] The relay 105 is a monostable switch whose closed state coincides with the unstable state, i.e. that state which the switch only maintains when the relay is

energized through the control terminals 114. On the contrary, the stable state coincides with the opening of the relay, and is taken when the relay is not energized.

[0040] When a treatment cycle is in execution, the control unit 107 energizes the relay 105 through the control terminals, and therefore the relay 105 stays closed, thereby connecting the first terminal of the capacitor 104 to the neutral conductor 102.

[0041] In this configuration, the filter 103 is connected to the power mains and is operational, i.e. it carries out its normal noise filtering function.

[0042] The term treatment cycle refers herein to all the actions that the household appliance executes in order to carry out its main function. For example, since the main function of a washing machine is washing the laundry in the drum, it will take in water, heat it to the desired temperature, supply water and detergents into the drum, rotate the drum, drain the water, etc. Through these actions the washing machine carries out its treatment cycle. When the household appliance is not executing a treatment cycle, e.g. when in stand-by, the control unit 107 does not energize the relay 105, thus not switching it to the stable state. In such a condition, since the relay 105 is open, the capacitor 104 is no longer connected to the neutral conductor 102 and is therefore "floating". This prevents the charge accumulated by the capacitor 104 from discharging on a user coming in contact with the conductors 101 and 102.

[0043] In particular, if mains power is lost across the conductors 101 and 102 during a treatment cycle, e.g. due to a blackout or a sudden disconnection of the household appliance from the mains, the control unit will stop energizing the relay 105 and switch it back to the stable state, in which it will remain until the interrupted treatment cycle is resumed. The absence of voltage across the conductors 101 and 102, hereafter simply referred to as absence of mains voltage, can be detected by the control unit 107, e.g. by monitoring a zero-crossing signal of the mains voltage. The control unit 107, which is operationally connected to the phase conductor 101 and to the neutral conductor 102, detects the instants at which the alternating voltage across the two conductors, by crossing the null value, changes from positive values to negative values and vice versa; if no crossings are detected within a time longer than a predetermined threshold, then the control unit 107 will detect the absence of mains voltage.

[0044] As an alternative, the control unit 107 monitors the 12V output voltage of the AC-DC converter 106, and if it decreases to a predetermined voltage threshold, e.g. 6 V, it will detect the absence of mains voltage.

[0045] Whatever state the relay 105 is in, the AC-DC converter 106 and the electric loads 108 will still be connected to the conductors 101 and 102, even though they must not be necessarily active.

[0046] When the household appliance starts or resumes a treatment cycle, e.g. when the user presses a button, the control unit 107 energizes the relay 105,

which thus will close. As a consequence, the capacitor 104 will be re-connected to the neutral conductor 102 and the filter 103 will be operational again.

[0047] Fig. 2 shows a system which is similar to the one described so far, but which comprises a different implementation of the input filter. The alternating voltage generator 100 is connected to two conductors 101 and 102, which may be connected to the two pins of a normal electric plug, e.g. a "schuko" plug.

[0048] The first conductor 101 is used for transmitting the phase voltage; hence it is called phase conductor 101.

[0049] The second conductor 102 is used for transmitting the neutral voltage; hence it is called neutral conductor 102.

[0050] Between the two conductors 101 and 102, an input filter 203 for attenuating the noise coming from and/or directed towards the household appliance, the AC-DC converter 106 for supplying direct voltage to an electronic circuitry, and electric loads 108, which may comprise heating resistors, electric motors, etc., are connected in parallel.

[0051] The 12VDC output of the AC-DC converter 106 is connected to the control unit 107 of the household appliance.

[0052] The filter 203 comprises a capacitor 204, a resistor 210 and a monostable changeover relay 205.

[0053] The term changeover relay 205 refers herein to an electronic device that can connect a first terminal 211 of the changeover relay, called pin 211 of the changeover relay 205, to a second terminal 212 of the changeover relay 205, called first way 212, or to a third terminal 213 of the changeover relay 205, called second way 213. Therefore, the changeover relay 205 is equivalent to two switches having a common terminal coinciding with the pin 211 of the changeover relay. Also, these two switches are in counterphase, i.e. when one is open the other is closed, and vice versa. The changeover relay 205 comprises at least one control terminal 214 used for driving the changeover relay 205, i.e. for determining to which way 212 or 213 the pin 211 must be connected.

[0054] The capacitor 204 is connected between the phase conductor 101 and the pin 211 of the changeover relay 205.

[0055] The resistor 210 is connected between the phase conductor 101 and the first way 212 of the changeover relay 205.

[0056] The second way 213 of the changeover relay 205 is connected to the neutral conductor 102.

[0057] The control terminals of the changeover relay 205 are operationally connected to the control unit 107.

[0058] The changeover relay 205 is in the unstable state when it is energized through the control terminals 214; in this state, the pin 211 is connected to the second way 213.

[0059] The changeover relay 205 is in the stable state when it is not energized; in this state, the pin 211 is connected to the first way 212.

[0060] When a treatment cycle is in execution, the control unit 107 energizes the changeover relay 205 through the control terminals 214, and therefore the changeover relay 205 connects the capacitor 204 to the neutral conductor 102.

[0061] In this configuration, the filter 203 is connected to the power mains and is operational, i.e. it carries out its normal noise filtering function. On the contrary, the resistor 210 is "floating" and absorbs no power; its value can therefore be much smaller than those used in the prior art, thus speeding up the discharge of the capacitor 204 when it is connected thereto.

[0062] On the other hand, when the household appliance is not executing a treatment cycle or when the mains voltage is lost across the conductors 101 and 102, the control unit 107 stops energizing the changeover relay 205 and sets it back to the stable state, in which it will remain until a treatment cycle is executed. When the changeover relay 205 is in the stable state, the capacitor 204 is connected in parallel to the resistor 210 and discharges on it.

[0063] The discharge of the capacitor 204 through the resistor 210 ensures that, within 1 sec from the disconnection of the plug, the voltage across the phase 101 and neutral 102 conductors will be reduced to a safe level, in particular below 34 V.

[0064] The control unit 107 detects the absence of mains voltage across the conductors 101 and 102 by using the same techniques already described.

[0065] With reference to Fig. 3, a household appliance 300, in particular a washing machine, comprises an electronic circuitry 303 according to the present invention.

[0066] The circuitry 303 is a circuitry like the one described above with reference to Figs. 1 and 2. The circuitry 303 is connected to an electric plug 301 through the phase 101 and neutral 102 conductors.

[0067] It is apparent that the invention is not limited to the embodiment examples described above with reference to Figs. 1 and 2; the man skilled in the art may therefore make numerous changes to the above-described system.

[0068] For example, the single-switch relay 105 may be replaced with a generic bidirectional switching device, such as a triac.

[0069] Likewise, the changeover relay 205 may be replaced with a generic bidirectional changeover device, e.g. obtained by using a pair of triacs.

[0070] The input filter may be connected to the phase and neutral conductors in an inverted manner, i.e. the filter parts connected to the phase conductor may be connected to the neutral conductor and vice versa.

[0071] The input filter may comprise additional capacitors, inductors, resistors, transformers, etc. A man skilled in the art may also employ different and more effective techniques for detecting the absence of mains voltage.

[0072] It is also apparent that the parts of the filters 103 and 203 may be mounted on one or more interconnected boards, may be contained in one or more pack-

ages and may be discrete or integrated components, and that the sizing of the components of the circuit depends on the specific application it is intended for.

[0073] In a preferred embodiment, which is particularly advantageous when applied to a household appliance, the components of the input filter 103 and 203 have the values and/or codes listed in the following Table 1.

Component	Value/code
104	0.47 μ F
204	0.47 μ F
210	4.7 KOhm
105	OMRON G5LA-1A-CF 12V DC
205	OMRON G5LA-1-E-CF 12V DC

[0074] Although the invention has been described herein with reference to an electronic circuitry, it is not limited to a system, but also encompasses a method for filtering the noise generated and/or received by a household appliance.

[0075] In particular, the household appliance comprises a capacitor operationally connected between a phase conductor and a neutral conductor, the phase conductor and the neutral conductor being adapted to be connected to respective phase and neutral connectors of a power mains, e.g. those of a wall-mounted electric outlet. An alternating voltage, i.e. the mains voltage, can be applied across the two conductors of the household appliance.

[0076] The method comprises the steps of:

- disconnecting the capacitor from either one of the phase conductor and the neutral conductor when the household appliance is not executing a treatment cycle;
- connecting the capacitor to said conductor when said household appliance is executing a treatment cycle.

[0077] In one embodiment, the method provides for disconnecting the capacitor when the absence of said alternating voltage is detected.

[0078] In another embodiment, the capacitor, once disconnected from the conductor, is discharged to a value below a second predetermined threshold voltage within a predetermined time interval.

Claims

1. An electronic circuitry (1000, 2000) for connecting a household appliance to an electric power mains, said circuitry (1000, 2000) comprising a control unit (107), a capacitor (104, 204) operationally connected between a phase conductor (101) and a neutral conductor (102), said phase conductor (101) and said neutral conductor (102) being adapted to be con-

nected to respective phase and neutral connectors of said power mains, wherein an alternating voltage is applicable between said phase conductor (101) and said neutral conductor (102),

said circuitry (1000, 2000) being **characterized in that** it comprises a first switch (105) capable of connecting/disconnecting a first terminal of said capacitor (104, 204) to/from either one of said phase conductor (101) and said neutral conductor (102), said first switch (105) being driven by said control unit (107), said first switch (105) disconnecting said first terminal of said capacitor (104, 204) when said household appliance is not executing a treatment cycle, said first switch (105) connecting said first terminal of said capacitor (104, 204) when said household appliance is executing a treatment cycle.

2. A circuitry (1000, 2000) according to claim 1, wherein said first switch (105) disconnects said first terminal of said capacitor (104, 204) when said control unit (107) detects the absence of said alternating voltage.

3. A circuitry (1000, 2000) according to claim 1 or 2, wherein said first switch (105) is arranged in series with said capacitor (104, 204).

4. A circuitry (2000) according to any one of the preceding claims, wherein said circuitry (2000) comprises a resistor (210) and a changeover relay (205), said changeover relay (205) being driven by said control unit (107), said changeover relay (205) comprising said first switch (103) and a second switch, said changeover relay (205) being adapted to take two positions:

in a first position, said changeover relay (205) disconnects said first terminal of said capacitor (204) from one of said conductors (101, 102) by opening said first switch (105) and operationally connects said first terminal of said capacitor (204) to a first terminal of said resistor (210) by closing said second switch;

in a second position, said changeover relay (205) disconnects said first terminal of said capacitor (204) from said first terminal of said resistor (210) by opening said second switch and operationally connects said first terminal of said capacitor (204) to one of said conductors (101, 102) by closing said first switch;

wherein said changeover relay (205) takes said first position when said household appliance is not executing a treatment cycle, and wherein said changeover relay (205) takes said second position when said household appliance is executing a treatment cycle.

5. A circuitry (2000) according to claim 4, wherein said

changeover relay (205) takes said first position when said control unit (107) detects the absence of said alternating voltage.

6. A circuitry (1000, 2000) according to any one of the preceding claims, wherein said first switch (105) is a monostable relay which is open in the stable state and closed in the unstable state.

7. A circuitry (2000) according to any one of claims 4-5, wherein said changeover relay (205) is a monostable changeover relay, said first position coinciding with the stable state, said second position coinciding with the unstable state.

8. A circuitry (1000, 2000) according to any one of the preceding claims, wherein said first switch (105) can connect/disconnect said first terminal of said capacitor (104, 204) to/from said neutral conductor (102), and wherein a second terminal of said capacitor is connected to said phase conductor (101).

9. A circuitry (2000) according to any one of claims 4-8, wherein a second terminal of said resistor (210) is connected to a second terminal of said capacitor (204).

10. A circuitry (1000, 2000) according to any one of the preceding claims, wherein said circuitry (1000, 2000) further comprises an AC-DC converter (106) and electric loads (108), said AC-DC converter (106) and said electric loads (108) being connected between said phase conductor (101) and said neutral conductor (102), said AC-DC converter (106) supplying power to said control unit (107).

11. A circuitry (1000, 2000) according to claim 10, wherein said control unit (107) monitors an output voltage of said AC-DC converter (106) and detects the absence of said alternating voltage if said output voltage of said AC-DC converter (106) is below a first predetermined threshold voltage; alternatively, said control unit (107) being operationally connected between said phase conductor (101) and said neutral conductor (102), said control unit (107) detects the absence of said alternating voltage by monitoring a zero-crossing signal of said alternating voltage.

12. A household appliance (300) comprising a circuitry (303) according to any one of the preceding claims, in particular said household appliance (300) being a washing machine.

13. A method for filtering electric noise in a household appliance, said household appliance comprising a capacitor (104, 204) operationally connected between a phase conductor (101) and a neutral con-

ductor (102), said phase conductor (101) and said neutral conductor (102) being adapted to be connected to respective phase and neutral connectors of a power mains, wherein an alternating voltage is applicable between said phase conductor (101) and said neutral conductor (102),
said method comprising the steps of

- disconnecting said capacitor (104, 204) from either one of said phase conductor (101) and said neutral conductor (102) when said household appliance is not executing a treatment cycle;
- connecting said capacitor to said either one of said phase conductor (101) and said neutral conductor (102) when said household appliance is executing a treatment cycle.

14. A method according to claim 13, wherein said capacitor (104, 204) is disconnected from either one of said phase conductor (101) and said neutral conductor (102) when the absence of said alternating voltage is detected.
15. A method according to claim 13 or 14, wherein said capacitor (104, 204) is discharged below a second predetermined threshold voltage within a predetermined time interval, said discharge of said capacitor (104, 204) occurring when said capacitor (104, 204) is disconnected from either one of said phase conductor (101) and said neutral conductor (102).

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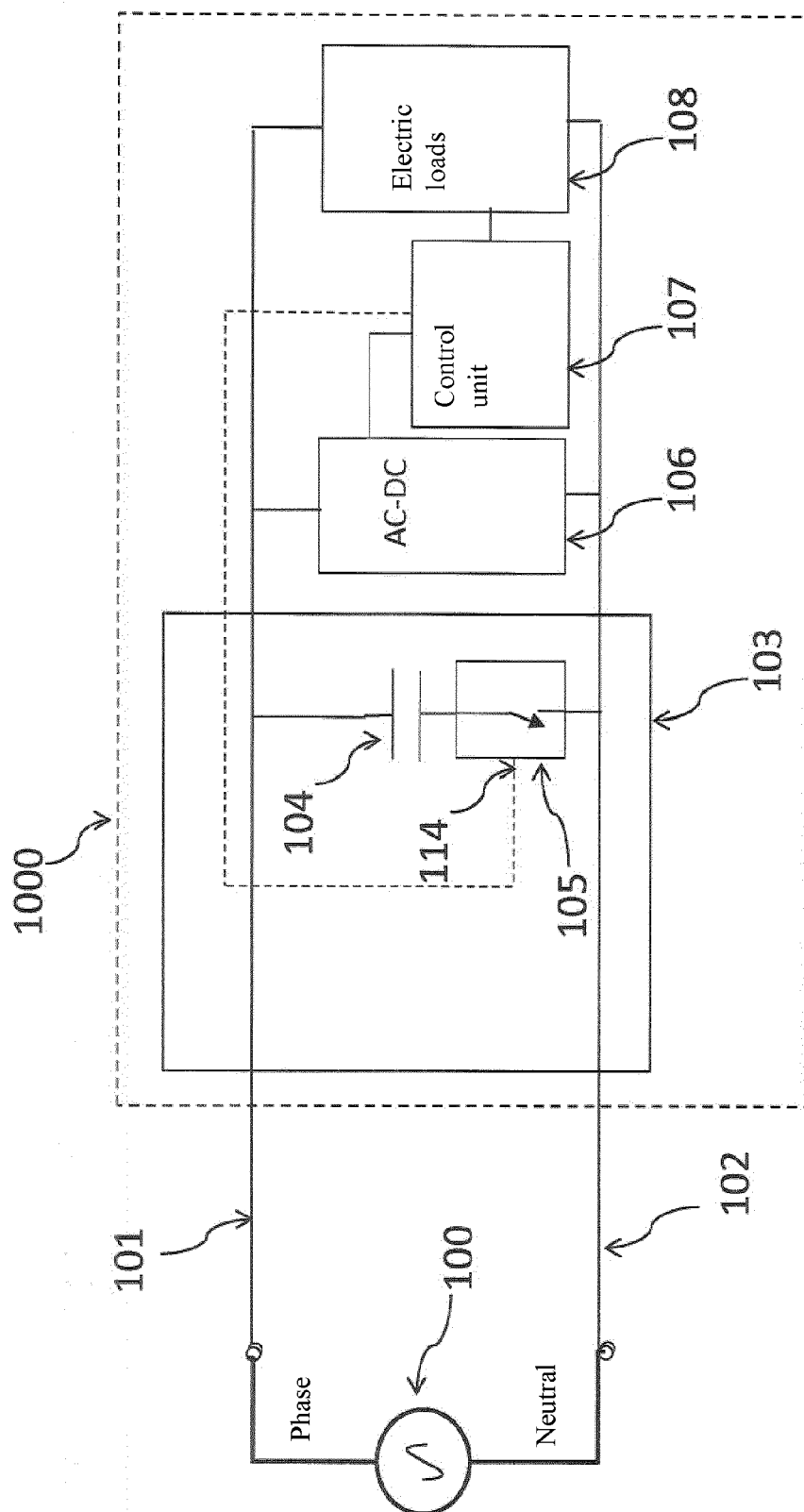


Figura1

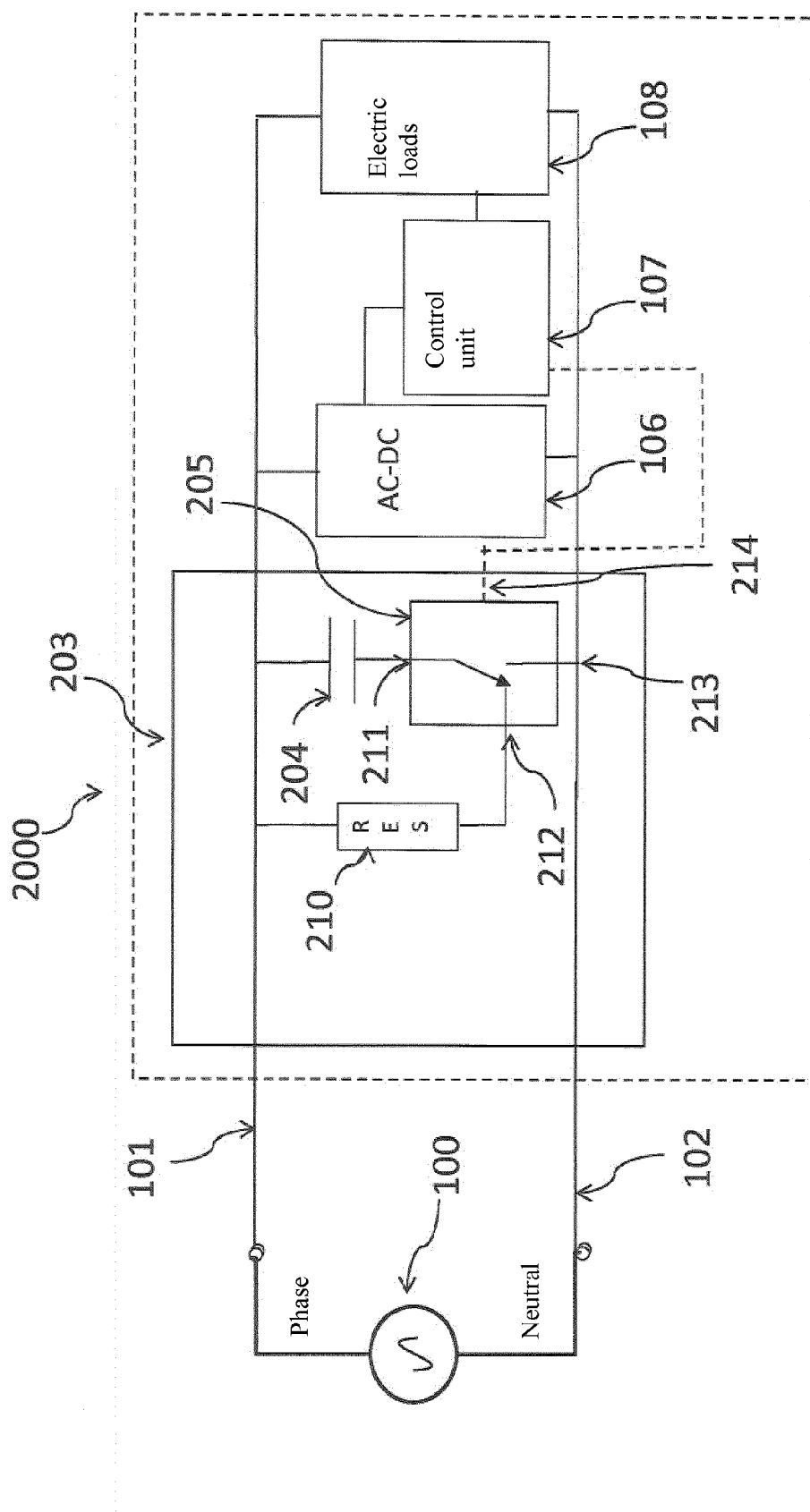


Figure 2

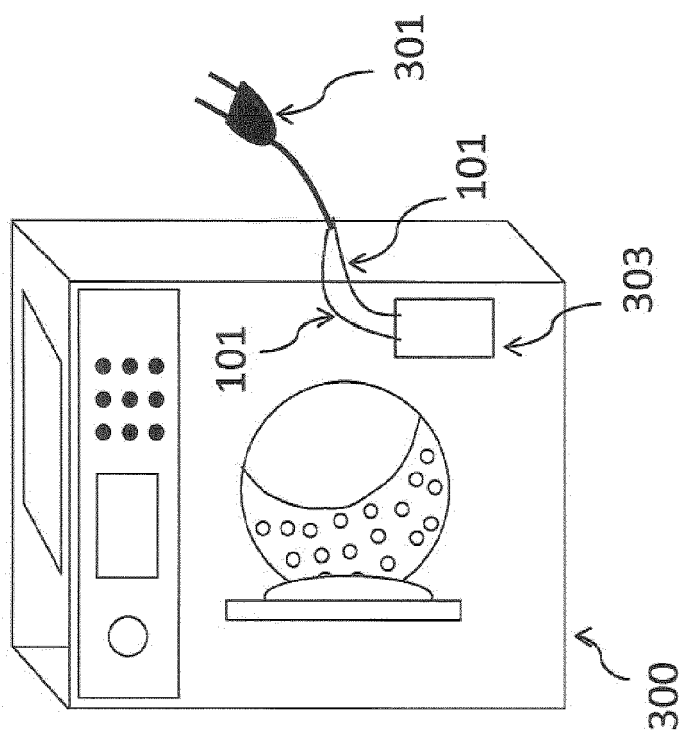


Figura 3



EUROPEAN SEARCH REPORT

Application Number
EP 11 19 3215

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2010/251776 A1 (BISCHOFF MARTIN [DE] ET AL) 7 October 2010 (2010-10-07)	1-3,6,8,9,12-15	INV. H01H47/22
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			TECHNICAL FIELDS SEARCHED (IPC)
			H01H D06F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 5 March 2012	Examiner Mäki-Mantila, M
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 19 3215

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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05-03-2012

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