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(54) Process for recognizing the supply power discharge lamps and related device

(57) A device for recognizing the power supply of discharge lamps comprises an output block for the power supplying of the lamp and a power-factor correction block 20 for correcting the power factor on the basis of a given conduction time. A control circuit, such as a microcontroller, which is sensitive to the supply voltage of the lamp, is able to detect the striking voltage of the lamp and to obtain a first recognition of the power supply of the lamp as a function of the striking voltage, likewise estimating the conduction time for the correction of the power factor as a function of the power supply corresponding to the aforesaid first recognition. The control circuit is configured for measuring the conduction time for the correction of the power factor effectively applied to the lamp and comparing the estimated conduction time for the correction of the power factor with the measured one. Consequently:

- i) if the estimated conduction time and the measured conduction time are consistent with one another, the control circuit recognizes the power supply as the one corresponding to the first recognition; and
- ii) if the estimated conduction time and the measured conduction time are not consistent with one another, the control circuit recognizes the power supply as the one corresponding to the conduction time measured.

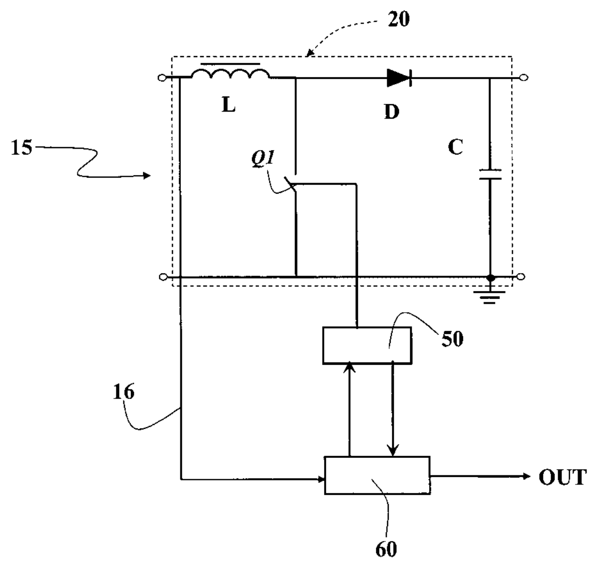

Fig. 4

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Description

Field of the invention

[0001] The present invention relates to techniques that enable recognition of the power of discharge lamps and has been developed with particular attention paid to its possible use in electronic devices designed to supply such lamps.

Description of the known art

[0002] Discharge lamps, such as fluorescent lamps and high-intensity discharge lamps (HIDs), are among the most popular in view of their luminous efficiency, their good chromatic yield and their long life as compared to incandescent lamps.

[0003] The above types of lamps are not able to operate if connected directly to the power supply network. For proper operation, said lamps require the use of intermediate devices, such as, for example, electronic power supplies, which are able to perform the following functions:

- supplying the voltage for initial starting;
- stabilizing the current of the lamp; and
- correcting the operating parameters of the lamp (voltage and current).

[0004] The devices for the power supplying of discharge lamps are divided into two types: electromagnetic and electronic. The electronic devices offer, as compared to magnetic ones, the following advantages:

- high efficiency;
- long life of the tubes;
- better control of the power; and
- smaller dimensions.

[0005] With the advent of microcontrollers in electronic circuits, the devices for the power supplying of said lamps have improved further their performance in terms of precision of the control circuits and of flexibility of design.

[0006] In general, these devices are designed for driving one and the same type of lamp or at the most a set of lamps with a fixed and defined power.

[0007] Some examples of known devices for the power supplying of discharge lamps will now be described with reference to Figures 1, 2, and 3.

[0008] The a.c. voltage 5, supplied by the supply network, is sent at input to the power supply device 100. Said device comprises a rectifier block 10, and the voltage 15, at output from the aforesaid rectifier block 10, is sent to a power-factor correction (PFC) block 20, which performs re-phasing of the current absorbed by the load 40 and regulates the voltage at the output block 30 (high-frequency inverter). The power-factor correction block 20 is controlled by a driving block 50, whilst the output block 30 is controlled by a driving block 55. In the case illustrated, the load 40 is represented precisely by the discharge lamp.

[0009] The devices of Figures 2 and 3 are distinguished with respect to the basic architecture of Figure 1 in so far as they use a microcontroller 60 for controlling the driving blocks 50 and 55 of the power-factor correction stage 20 and of the output stage 30, respectively. In particular, the diagram of Figure 3 highlights the possibility of merging the blocks 50 and 55 into a single block.

[0010] Individual power-supply devices 100, or "ballasts", which supply lamps with different powers are today present on the market and are able to drive lamps traversed by one and the same discharge current. In this case, it is sufficient to size the output block 30 (high-frequency inverter) so as to guarantee the current of the lamp designed to ensure the correct power of the lamp during operation in steady-state conditions.

[0011] A very different question is the one regarding lamps traversed by different currents. In this case, the output block 30 will have to "understand" what type of lamp is now connected and adapt its working frequency so as to supply the right current intensity to the lamp.

[0012] There exist patents on power-supply devices compatible with different types of lamps.

[0013] For example, document US-B-6 501 235, filed in the name of the present Applicant, illustrates a device for recognition of lamps based upon information obtained from the filaments of the lamps. This device presents limits in recognizing lamps that are different but have similar characteristics in the filaments: the device can thus be adopted only for the recognition of lamps that have filaments with marked differences, given also the variability of these characteristics with temperature.

Object and summary of the invention

[0014] From the foregoing description of the current situation, it may be evinced that there exists the need to define solutions that are able to carry out, in a more satisfactory way, recognition of the discharge lamps in order to correctly supply power to said lamps.

[0015] The object of the present invention is thus to provide a fully satisfactory response to those needs.

[0016] According to the present invention, that object is achieved by means of a process having the features set forth in the claims that follow. The present invention relates also to a corresponding device.

[0017] The claims are an integral part of the disclosure of the invention provided herein.

[0018] In the currently preferred embodiment, the solution described herein relates to a process for recognizing the supply power of discharge lamps, in which the lamps are supplied by making a correction of the power factor on the basis of a given conduction time. The process moreover comprises the steps of:

- starting the lamp, making a first recognition of the power supply of the lamp as a function of the striking voltage,

- estimating the conduction time for the correction of the power factor as a function of the power supply corresponding to the first recognition,
- measuring the conduction time for the correction of the power factor effectively applied to the lamp,
- comparing the estimated conduction time for the correction of the power factor with the measured one, and
- ,i) if the estimated conduction time for the correction of the power factor and the measured conduction time for the correction of the power factor are consistent with one another, recognizing the power supply as corresponding to the first recognition;
- ,ii) if the estimated conduction time for the correction of the power factor and the measured conduction time for the correction of the power factor are not consistent with one another, recognizing the power supply as corresponding to the conduction time measured.

Brief description of the annexed drawings

[0019] The invention will now be described, by way of non-limiting example, with reference to the figures of the annexed drawings, in which:

- Figures 1, 2, and 3 have already been described previously;
- Figure 4 illustrates an example of embodiment of a block that may be inserted in the architectures of Figures 1-3 to achieve the solution described herein; and
- Figure 5 is a flowchart of the solution described herein.

Detailed description of examples of embodiments of the invention

[0020] The present invention relates to devices for the power supplying of discharge lamps, which, thanks to the use of a microcontroller, are able to automatically recognize the lamp that is connected thereto, correctly establishing and setting the operating parameters for the aforesaid lamp.

[0021] By "operating parameters" of a discharge lamp are meant, in general:

- current and/or voltage for pre-heating the cathodes;
- time for pre-heating the cathodes;
- striking voltage of the lamp; and
- current and/or voltage of the lamp in steady-state conditions.

[0022] The use of the phrase "in general" is intended to take into account the fact that not necessarily all discharge lamps, to correctly operate, need to detect and control all the aforesaid parameters.

[0023] Each lamp is characterized by different operating parameters that uniquely distinguish it from the other lamps. It is possible to correctly drive lamps of different types and powers with a single power-supply device by measuring the operating parameters of a lamp and sizing the output of the power-supply device on the basis of the values assumed by these parameters.

[0024] The solution described herein enables the recognition and the proper power supply of lamps that are of different powers and that are traversed by different currents.

[0025] The calculation of the lamp power is not made, as generally occurs in the known art, by multiplying the lamp voltage by the lamp current.

[0026] The solution described herein may be used in the field of known per se architectures, such as the ones represented in Figures 2 and 3, which envisage the use of a microcontroller 60.

[0027] The sequel of the present description will consequently make reference to the architecture represented in Figure 3, comprising at input the rectifier block 10, the power-factor correction block 20 and the output block 30. These blocks are managed by the microcontroller 60, which drives the driving block 50 so as to manage the blocks present in the power-supply device 100.

[0028] Figure 4 refers specifically to the block 20. Here it may be seen that, via a line 16, the microcontroller is set in conditions of directly deriving the lamp power by reading the conduction time Ton of an electronic switch Q1 comprised in the power-factor correction block 20. Specifically the block 20 comprises a network substantially resembling a low-pass filter LC comprising an inductor L and a capacitor C, with an interposed diode D. The electronic switch Q1, by closing itself, short-circuits the point of connection between the inductor L and the diode D to ground.

[0029] The power-factor correction block 20 basically comprises a boost converter that works in transition mode at a variable frequency, with the conduction time of the electronic switch Q1 fixed and designated by Ton. Meanwhile the output block 30 transforms the d.c. voltage into high-frequency a.c. voltage and comprises two electronic switches in half-bridge configuration that work in zero-voltage switching mode.

[0030] The conduction time Ton, in the operating mode of the power-factor correction block 20, i.e. in the transition mode, is constant and is directly proportional to the lamp power. The power-factor correction block 20 is in fact controlled by the block 50 (in a way known per se) so as to maintain the voltage at output on the load 40, i.e. on the lamp, constant. For this purpose it adapts the conduction time Ton proportionally to the power absorbed, as emerges from the relation given below.

[0031] The relation, which links the power absorbed by the load 40 to the conduction time Ton of the electronic switch Q1 of the power-factor correction block 20, is:

$$\mathrm{Ton} = \frac{2 \cdot L \cdot P_0}{V_{\mathrm{inrms}}^2}$$

where:

- Ton is the conduction time of the electronic switch Q1;
- L is the inductance of the power-factor correction block 20;
- V_{inrms} is the r.m.s. value of the a.c. voltage 15 at input to the block 20; and
- P_0 is the power applied to the load 40.

[0032] From the foregoing relation it may be noted that the time Ton is directly proportional to the power of the load 40, which in this case is represented by the lamp itself.

[0033] The advantage of using this solution consists in recognizing the lamp power without making measurements of voltage on the lamp and without resorting to complex multiplications on the microcontroller 60.

[0034] The principle of operation will now be described with reference to the flowchart of Figure 5.

[0035] In a step 200 the a.c. input voltage is recognized in order to be able to identify the factor V_{inrms} in the preceding relation, and in a step 202 the power supply is initialized. The microcontroller 60 carries out a check on the input voltage as soon as the power supply is supplied. In a step 204 it is verified whether the lamp has already been recognized previously or not.

[0036] Once the lamp 40 has been recognized, an identification code is stored on the EEPROM of the microcontroller 60, said code enabling the microcontroller itself to set the correct parameters of the lamp each time the lamp 40 is turned back on.

[0037] Having made this check, the microcontroller 60 fixes the initial parameters (current/voltage and time for pre-heating of the cathodes, striking sequence, etc.), and makes a first selection on the type of lamp. This selection implies a measurement of resistance of the filaments in the lamps.

[0038] If the lamp has already been recognized (output YES from step 204), the process proceeds with a step 206, in which all the subsequent steps of power supply of the lamp are carried out with the values of the parameters already previously set.

[0039] If the lamp has not yet been recognized (output NO from step 204), the process proceeds with a step 208, in which the family to which the lamp to be supplied belongs is recognized.

[0040] In particular, there exist families of lamps with high-resistance cathodes and families of lamps with low-resistance cathodes. By measuring the resistance of the cathodes it is possible to distinguish to which of the two families a given lamp belongs. This distinction is necessary in so far as lamps belonging to different families work with totally different parameters also in the initial step.

[0041] With these initial conditions, the lamp is turned on, monitoring the voltage at striking. Once this datum is acquired, the microcontroller 60 recognizes the lamp that is connected and fixes a current therefor. In this way, the lamp will absorb a clearly determined power.

[0042] In particular, in the flowchart of Figure 5, the reference number 210 designates the step in which the power-factor correction block 20 is activated, whilst in a step 212 the lamp is pre-heated (according to criteria known per se). In a subsequent step 214, the lamp is started, and in a step 216 the striking voltage of the lamp is monitored by the microcontroller 60, which is able to make a first detailed recognition of the lamp.

[0043] Next, in a step 218, the microcontroller fixes the current of the lamp and the conduction time Ton for the power-factor correction block 20, setting them at the values corresponding to the recognized lamp.

[0044] In a step 220 the microcontroller verifies whether the conduction time Ton measured on the switch Q1 is consistent with the conduction time Ton estimated for the type of recognized lamp. Basically, the microcontroller 60 carries out a check on the conduction time of the switch Q1 of the block 20, verifying, in effect, the power absorbed by the load 40 (i.e. the lamp). This verification is necessary to confirm whether, with the current set, the lamp has been recognized correctly.

[0045] If it has, the process proceeds with a step 226, in which the operating parameters are confirmed.

[0046] Otherwise, the process proceeds with a step 222, in which a new recognition of the lamp is made in accordance with the value of the conduction time Ton actually measured. Next, in a step 224, the microcontroller fixes the new parameters associated to the recognized lamp. Also in this case, the process proceeds with a step 226, in which the operating parameters are confirmed.

[0047] The recognition of the lamp is then made by associating a reading of the striking voltage of the lamp, with a verification of the conduction time Ton of the switch Q1 in the block 20.

[0048] Once the lamp has been uniquely identified, the microcontroller establishes the parameters for properly driving the lamp in all its operating conditions, adapting also all the protection thresholds.

[0049] The next time the lamp is turned on, the initial conditions will be the ones for the lamp previously recognized, but the microcontroller will always verify that the parameters set correspond to those of the actually connected lamp.

[0050] Consequently, without prejudice to the principle of the invention, the details of construction and the embodiments may vary, even significantly, with respect to what is described and illustrated herein purely by way of non-limiting example, without thereby departing from the scope of the invention, as defined by the annexed claims.

Claims

1. A process for recognizing the power supply of discharge lamps (40), in which said lamps (40) are supplied (30) by making a correction of the power factor (20) on the basis of a given conduction time (Ton), the process comprising the steps of:

   - starting (214) the lamp (40), making (216) a first recognition of the power supply of the lamp (40) as a function of the striking potential;
   - estimating (60) the conduction time (Ton) for said correction of the power factor (20) as a function of the power supply corresponding to said first recognition;
   - measuring (Q1) the conduction time (Ton) for said correction of the power factor (20) effectively applied to said lamp (40);
   - comparing (220) the estimated (60) conduction time (Ton) for said correction of the power factor (20) with the measured (Q1) one; and

     - i) if said estimated (60) conduction time (Ton) for said correction of the power factor (20) and said measured (Q1) one are consistent with one another, recognizing (226) said power supply as corresponding to said first recognition;
     - ii) if said estimated (60) conduction time (Ton) for said correction of the power factor (20) and said measured (Q1) one are not consistent with one another, recognizing (226) said power supply as corresponding to said conduction time measured (Q1).

2. The process according to Claim 1, **characterized in that** said step of estimating (60) the conduction time (Ton) involves application of the relation:

$$P_0 = \frac{Ton \cdot V_{inrms}^2}{2 \cdot L}$$

   where:

   - P_0 is said power supply corresponding to said first recognition;
   - Ton is said conduction time;
   - L is a value of inductance associated to the correction (20) of the power factor; and
   - V_{inrms} is the r.m.s. value of the a.c. voltage at input to said correction (20) of the power factor.

3. The process according to Claim 1 or Claim 2, **characterized in that** it also includes the step of regulating at least one of the following parameters of the lamp (40):

   - current and/or voltage for pre-heating of the cathodes;
   - time for pre-heating the cathodes;
   - striking voltage; and
   - current and/or voltage of the lamp in steady-state conditions.

4. A device for recognizing the power supply of discharge lamps (40), comprising:

   - an output block for the power supplying of the lamp (40);
   - a power-factor correction block (20) for correcting the power factor on the basis of a given conduction time (Ton); and
   - a control circuit (60), which is sensitive to the supply voltage of the lamp (40) for detecting, at starting of the lamp (40), the striking voltage and making (216) a first recognition of the power supply of the lamp (40) as a function of the striking voltage, likewise estimating the conduction time (Ton) for said correction of the power factor as a function of the power supply corresponding to said first recognition;

   said control circuit (60) being configured for measuring (Q1) the conduction time (Ton) for said correction of the power factor effectively applied (20) to said lamp (40) and comparing (220) the estimated (60) conduction time (Ton) for said correction of the power factor with the measured (Q1) one so that

   - i) if said estimated (60) conduction time (Ton) for said correction of the power factor (20) and said measured (Q1) one are consistent with one another, said control circuit (60) recognizes (226) said power supply as corresponding to said first recognition;
   - ii) if said estimated (60) conduction time (Ton) for said correction of the power factor (20) and said measured (Q1) one are not consistent with one another, said control circuit (60) recognizes (226) said power supply as corresponding to said conduction time measured (Q1).

5. The device according to Claim 4, **characterized in that** said control circuit (60) is configured for estimating (60) said conduction time (Ton) with the relation:

$$P_0 = \frac{Ton \cdot V_{inrms}^2}{2 \cdot L}$$

   where:

   - P_0 is said power supply corresponding to said

first recognition;
- Ton is said conduction time;
- L is a value of inductance associated to the correction (20) of the power factor; and
- V_{inrms} is the r.m.s. value of the a.c. voltage at input to said correction (20) of the power factor.

6. The device according to Claim 4 or Claim 5, **characterized in that** said control circuit (60) is configured for regulating at least one of the following parameters of the lamp (40):

   - current and/or voltage for pre-heating of the cathodes;
   - time for pre-heating the cathodes;
   - striking voltage; and
   - current and/or voltage of the lamp in steady-state conditions.

7. The device according to Claim 6, **characterized in that** said control circuit is a microcontroller (60).

8. The device according to any one of Claims 4 to 7, **characterized in that** said correction block (20) for correcting the power factor comprises a boost converter that works in transition mode at a variable frequency.

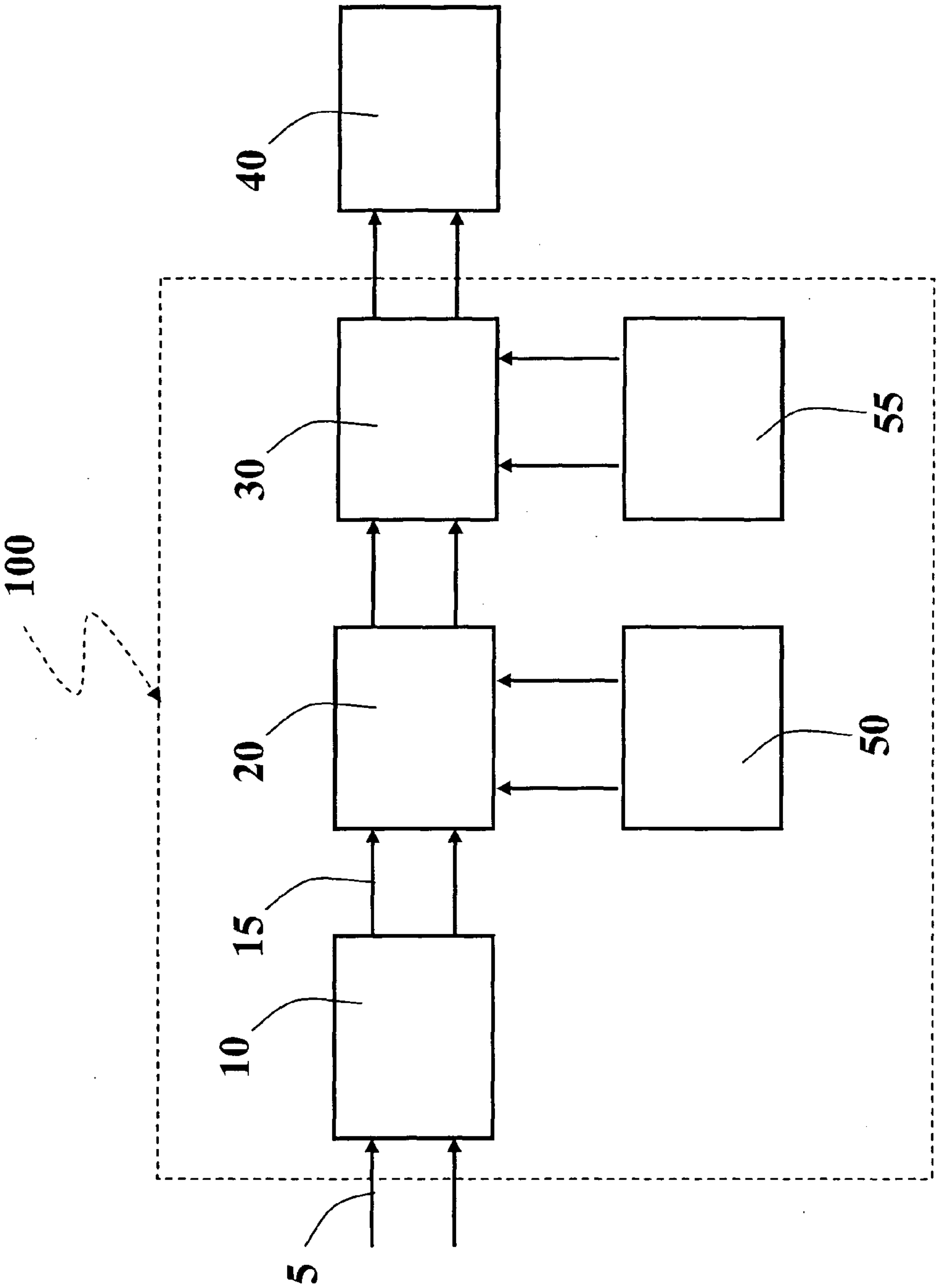

Fig. 1

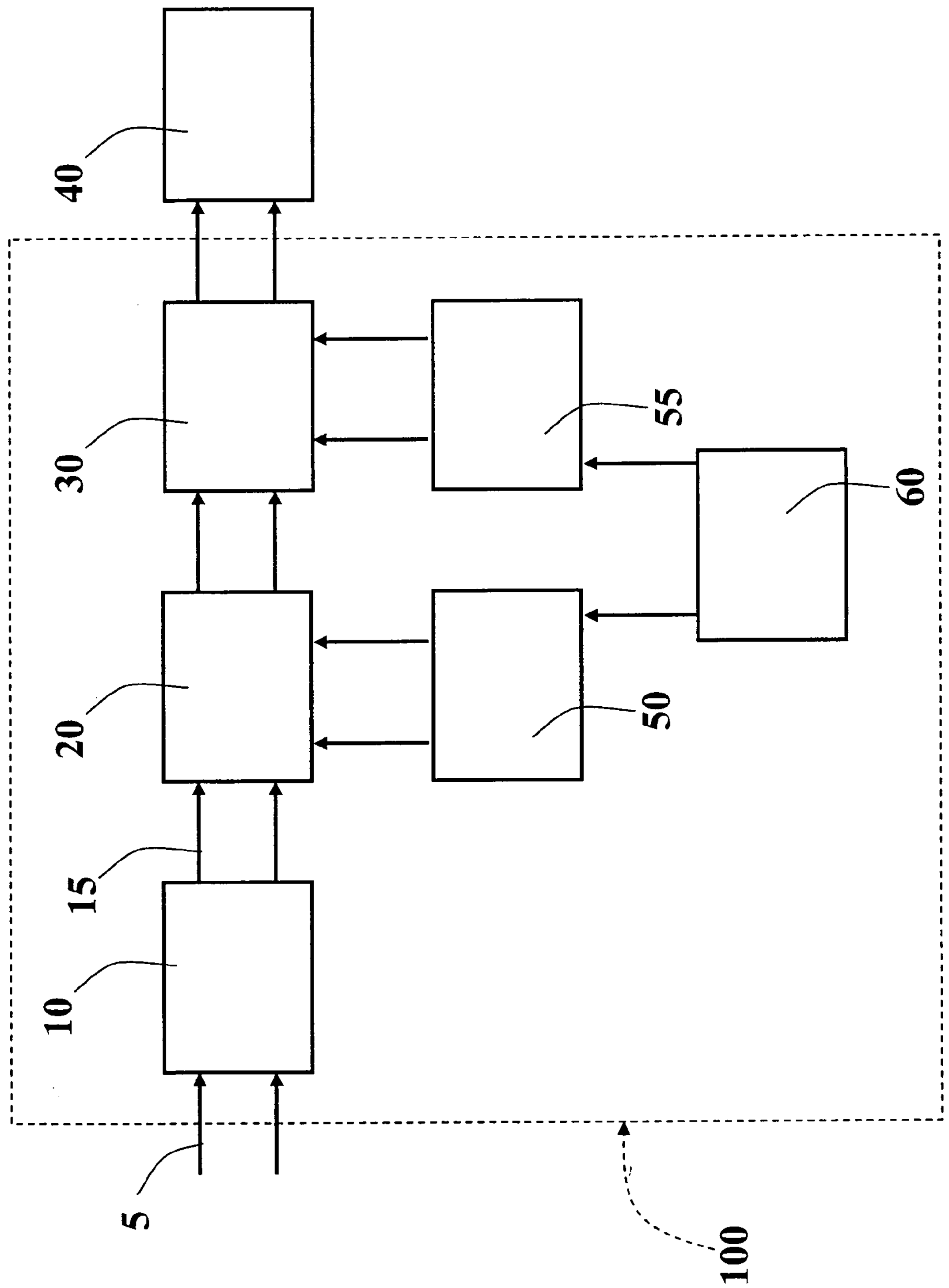

Fig. 2

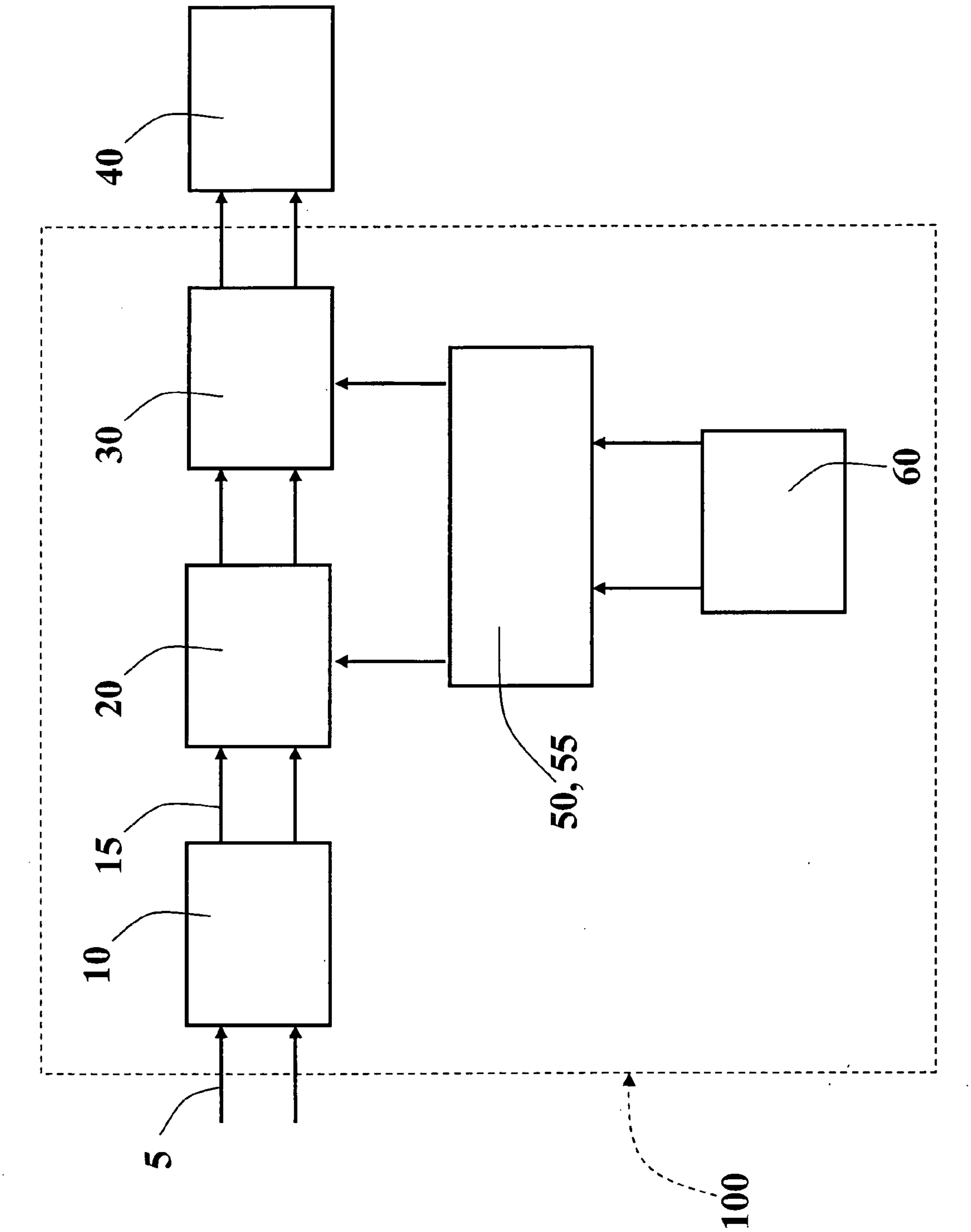

Fig. 3

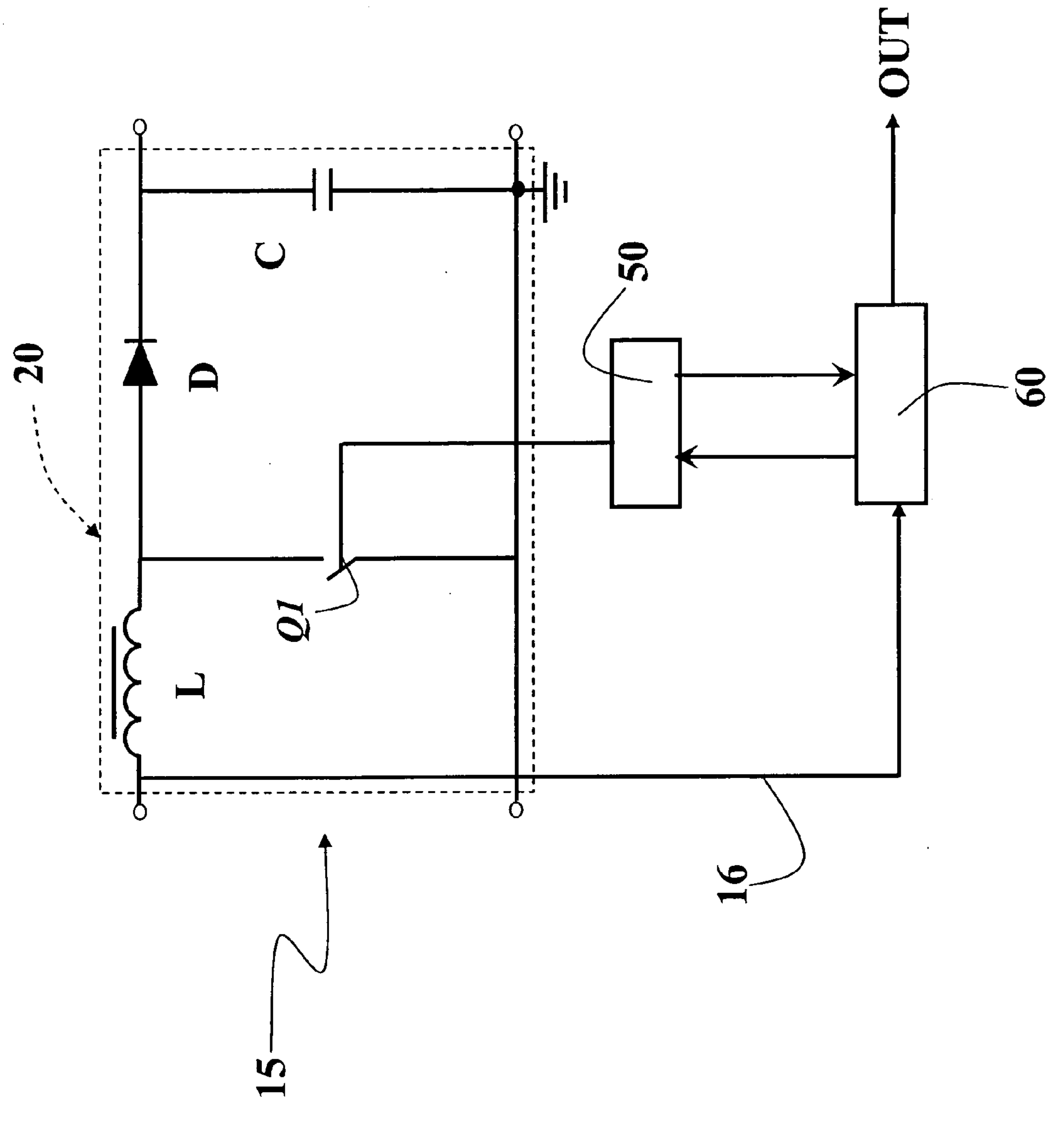

Fig. 4

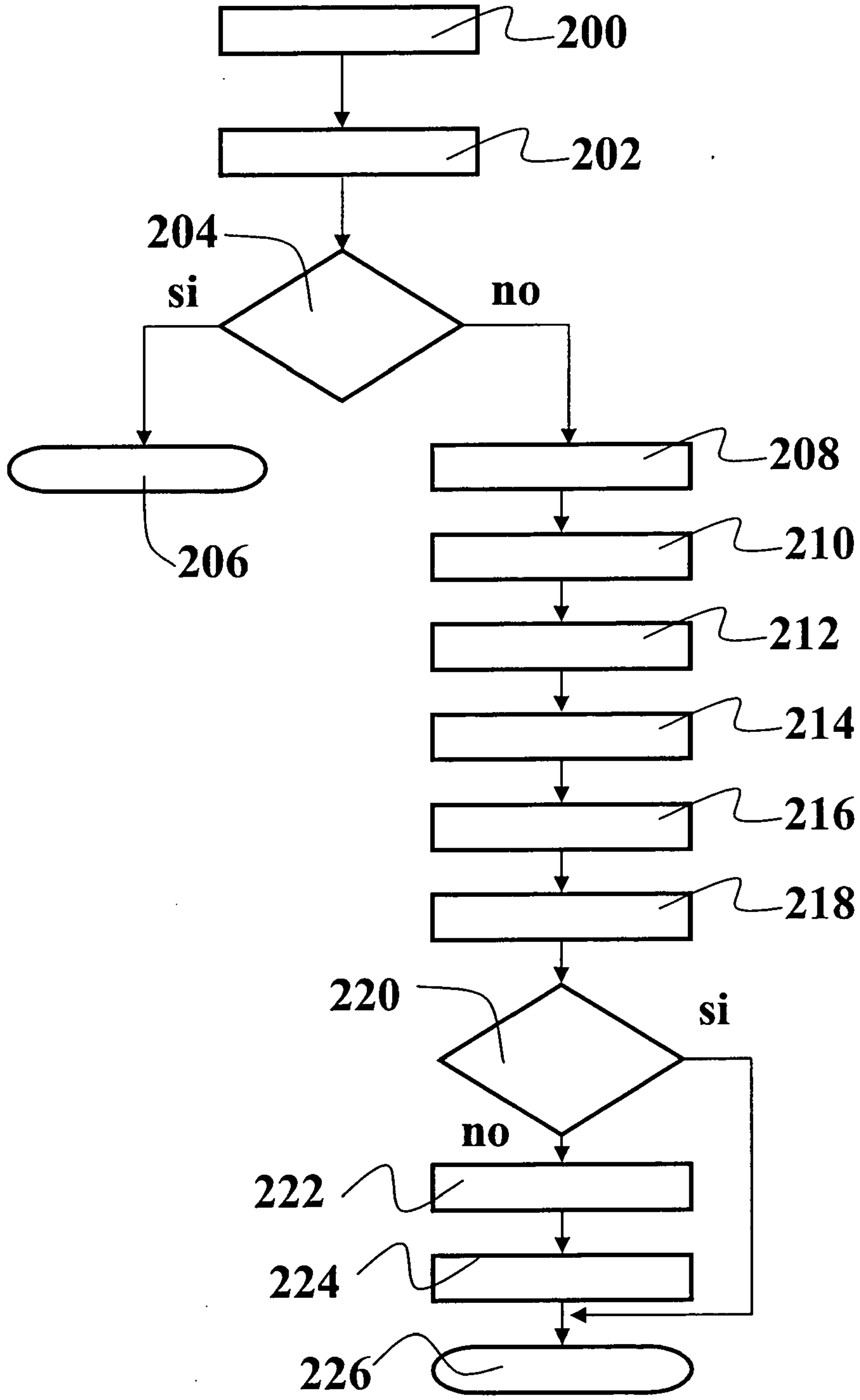
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Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 06 42 5504

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	15 December 2006	Silva, João Carlos

CATEGORY OF CITED DOCUMENTS

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