(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 487 244 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
15.12.2004 Bulletin 2004/51

(51) Int Cl.[7]: **H05B 39/02**

(21) Application number: **04102135.3**

(22) Date of filing: **14.05.2004**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL HR LT LV MK

(30) Priority: **11.06.2003 SE 3016953**

(71) Applicant: **Scania CV AB (publ)**
151 87 Södertälje (SE)

(72) Inventors:
- **Gustavsson, Jared**
  641 35 Katrineholm (SE)
- **Österlund, Henrik**
  643 30 Vingaker (SE)

(54) **Control of an incandescent filament based lamp**

(57) The invention relates to control of an electric incandescent filament lamp whereby the initial power load of the lamp after switching on is limited so that the expected service life of the lamp will be relatively long. During an initial phase (T_{wu}) after a switch-on signal is received, the lamp is supplied with a pulsed driving current (I). The incandescent filament of the lamp is thereby gradually warmed up without any need to limit an initial current peak (I_{pk}). The result is that the lamp is not subject to unnecessary stress associated with switching on. At the same time, a simple modification of an existing device for control of an electric incandescent filament lamp is possible so that said device functions according to the proposed principle.

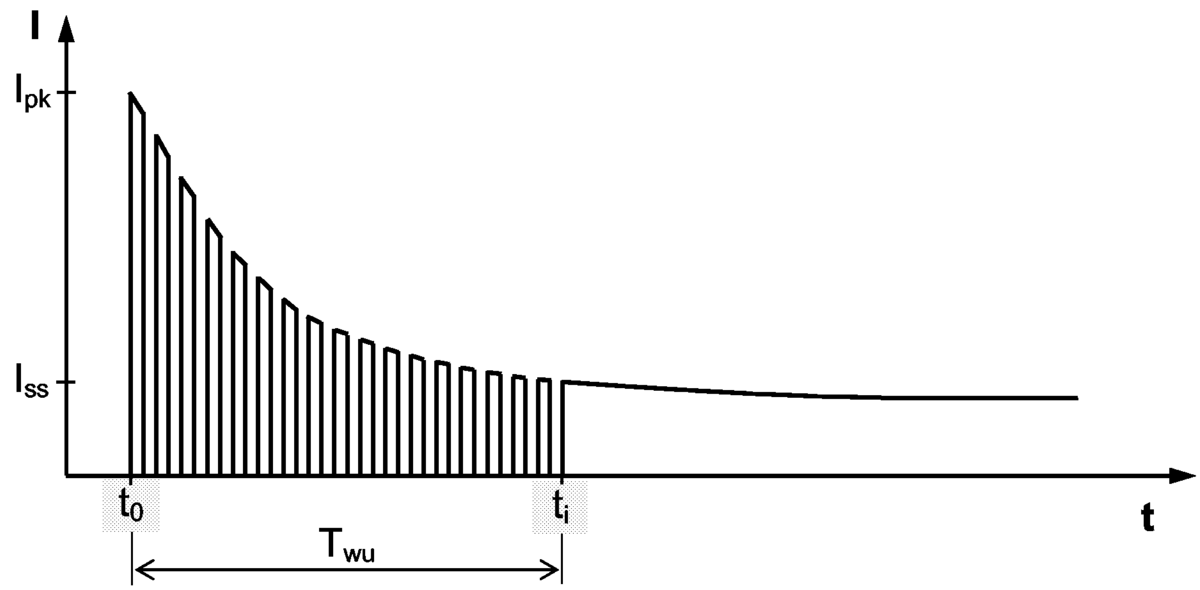

Fig. 3

EP 1 487 244 A1

Description

FIELD OF THE INVENTION AND STATE OF THE ART

[0001] The present invention relates generally to the distribution of electrical energy to incandescent filament lamps. Specifically the invention relates to a device for control of an electric incandescent filament lamp according to the preamble of claim 1 and a corresponding method according to the preamble of claim 5. The invention also relates to a computer program according to claim 11 and a computer-readable medium according to claim 12.

[0002] Electric lamps of incandescent filament type are lamps whereby light is generated by driving a current through a wirelike resistive element. In such lamps the so-called incandescent filament therefore has the property of giving off light when an electric current flows through it. The majority of incandescent filament materials, such as alloys of tungsten, molybdenum and titanium, do however have a temperature-dependent resistance which *increases* with rising temperature. This means that the incandescent filament normally has a relatively low resistance when the lamp is switched on, since when it is in a passive (i.e. currentless) state it has a significantly lower temperature than when in a steady working state. Given a certain supply voltage, this initially low resistance results in a relatively high current which typically expresses itself in the form of a current peak when the lamp is switched on. It is not unusual for this current peak to reach a level ten times higher than the current which corresponds to the rated power of the lamp, i.e. the power of the lamp when working in a warmed-up state.

[0003] Current peaks represent large stresses on the incandescent filament and tend to shorten the service life of the lamp. It is therefore essential to minimise current peaks and their undesirable effects. Patent specification DE A1 3339761 describes an electrical control circuit comprising two branches for control of voltage to a lamp whose incandescent filament has a temperature-dependent resistance. In that case a first branch in series with the lamp comprises a first driving stage and a resistor. A second branch in series with the lamp and parallel with the first branch comprises a second driving stage. The two driving stages are regulated by a comparator and a reference voltage so that initially only the first driving stage is active. The voltage across the lamp rises in a controlled manner progressively as the incandescent filament warms up until the reference voltage is reached. Thereafter a full supply voltage is applied by connecting of the second driving stage. The value of the reference voltage is selected such that the lamp is assumed to have warmed up to a suitable working temperature when that voltage is reached.

[0004] Although the above solution means that the current peaks associate with direct switching on are eliminated, it does involve external units in addition to one driving stage per lamp and is therefore relatively complicated to implement.

SUMMARY OF THE INVENTION

[0005] The object of the present invention is therefore to deal with the above problem and provide a solution which in a simple, reliable and effective manner alleviates the effects of said current peaks and thereby lengthens the expected service life of an incandescent filament lamp which may for example be intended to serve as a headlamp as part of a vehicle's driving lights.

[0006] This object is achieved according to one aspect of the invention by the device described in the introduction for control of an electric incandescent filament lamp which is characterised in that the device is adapted to controlling the driving stage in such a way that during the initial phase it supplies a pulsed driving current to the lamp.

[0007] An important advantage achieved by such pulsing of the driving current is that the average power supplied to the lamp during the initial phase can be held at a low enough level for the lamp to be able to have a relatively long service life. At the same time, only one driving stage is required and no special measures need be adopted for regulating the current supplied. The result is of course a design which is both simple and reliable.

[0008] According to a preferred embodiment of said aspect of the invention, the driving current comprises a number of pulses. During each of these pulses a current is caused to move in a particular direction through the incandescent filament in the lamp. Two mutually consecutive pulses are separated, however, by an interval period during which substantially no current flows through the incandescent filament. This current profile is advantageous in that it is easy to achieve by, for example, software-controlled connection and disconnection of the driving stage. Software control is also advantageous in making pulse width variation easy and enabling variation of the time relationship between pulse width and interval periods.

[0009] According to another preferred embodiment of said aspect of the invention, the device is adapted to causing the drive stage to deliver the driving current to the lamp during a substantially constant supply voltage both during the pulses of the initial phase and after that phase (i.e. when the lamp is supplied with a continuous DC voltage). This type of design is advantageous in not requiring any feedback and therefore being relatively easy to construct.

[0010] According to another aspect of the invention, the object is achieved by the method described in the introduction for controlling an electric incandescent filament lamp which is characterised by pulsing of the driving current during the initial phase. The average power to the lamp can therefore by simple means be held at a low enough level during the initial low-resistance operating phase to achieve a relatively long expected service life for the lamp.

[0011] According to a preferred embodiment of said other aspect of the invention, the driving current comprises a number of pulses during which the current is caused to flow in a particular direction through the incandescent filament. But no current flows through the incandescent filament during an interval period between each pulse and the next. It is for example advantageous that the driving current have between such current pulses and interval periods an average time ratio within the range of 1:2 to 1:10, preferably about 1:5. The result is in fact an initial power development in the lamp which brings about a desirable gentle start for the majority of the lamps on the market and halogen lamps in particular.

[0012] According to another preferred embodiment of said other aspect of the invention, the extent in time of the initial phase is such that by the end of said phase the incandescent filament of the lamp is expected to have reached a temperature substantially closer to its steady working temperature than when the switch-on signal was received. Such a parameter setting is of course advantageous for the incandescent filament from the load point of view.

[0013] According to a further aspect of the invention, the object is achieved by means of a computer program which is directly loadable to the internal memory of a computer and which comprises software for controlling the method described above when the program is run on a computer.

[0014] According to yet another aspect of the invention, the object is achieved by a computer-readable medium on which a program suited to enabling a computer to control the method described above is stored.

[0015] The proposed solution is an easy and reliable way of ensuring that an incandescent filament lamp need not be subject to unnecessary stresses relating to switching the lamp on. The invention thus contributes to bringing about a relatively long expected service life for the lamp.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The invention will now be explained in more detail with reference to preferred embodiments described by way of examples, and with reference to the attached drawings.

Figure 1 depicts a block diagram of a device according to an embodiment of the invention,

Figure 2 illustrates current versus time after switching on a lamp without any power limitation,

Figure 3 illustrates current versus time after switching on a lamp where the driving current is controlled according to an embodiment of the invention,

Figure 4 illustrates how the voltage to the lamp is pulsed during an initial phase according to an embodiment of the invention, and

Figure 5 illustrates by flow diagram a general method according to the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

[0017] Figure 1 depicts a block diagram of a device 100 according to an embodiment of the invention. The device 100 comprises a driving stage 110 which is adapted to providing a lamp 120 (e.g. of halogen type) with a suitable driving current I as long as a switch-on signal S is received. This means that the driving stage 110, during an initial phase after receiving the switch-on signal S, delivers a pulsed driving current I to the lamp 120 so that the incandescent filament of the lamp 120 gradually warms up.

[0018] The supply voltage U to the lamp 120 is nevertheless substantially constant both during each of the current pulses of the initial phase and, after that phase, when a continuous current is delivered. This situation will be described in more detail below with reference to Figures 3 and 4.

[0019] Figure 2 illustrates the current I versus the time t after the switching on of a lamp without the power to the lamp being controlled in a limiting manner. It is here assumed that a switch-on signal is received at a time to. This results in closing of the electric circuit in which the lamp is situated, and in a given rated voltage being applied across the lamp. As the incandescent filament of the lamp has initially a relatively low resistance, a peak current I_{pk} at time t_0 will be relatively high. When thereafter the current I gradually warms the incandescent filament up, the latter's resistance increases and the current I decreases correspondingly, e.g. according to an exponential relationship. At a time t_1 (e.g. 50 ms after to) it is assumed that a steady working state has been reached whereby the resistance does not continue to increase and the current I levels out towards a constant value I_{ss}. As previously mentioned, it is not unusual for the peak current I_{pk} to be of the order of ten times as high as the steady current I_{ss}, i.e. $I_{pk} = 10 \times I_{ss}$. The high power delivered to the lamp during the time t_0 to t_1 is damaging to the incandescent filament and tends to have an adverse effect on the service life of the lamp.

[0020] Figure 3 illustrates the driving current I versus the time t after the switching on of a lamp where the current I is controlled according to an embodiment of the invention. The driving current I comprises in this case a number of pulses, e.g. 10-40, during which a current is caused to flow in a particular direction through the incandescent filament of the lamp. The supply voltage is supposed to be substantially constant during all the pulses, but when the resistance of the incandescent filament increases as the current warms up the incandescent filament, the current I for each pulse decreases. Two mutually consecutive pulses are separated by an interval period during which in principle no current flows through the incandescent filament. The current pulses are generated advantageously by software-controlled connection and disconnection of the voltage from the driving stage to the lamp.

[0021] Current pulses begin to be generated when a switch-on signal is received at a time to and are delivered by the proposed device during an initial phase T_{wu} thereafter. At a later time t_i, however, the current pulses cease and a continuous current I is delivered. According to a preferred embodiment of the invention, the extent in time of the initial phase T_{wu} is such that the temperature of the incandescent filament of the lamp at the end of that phase is expected to have approached its steady working temperature. This means that the temperature at time t_i is significantly closer to the steady working temperature than at time t_0 (i.e. when the switch-on signal was received).

[0022] The initial phase T_{wu} may for example be 17 ms long and comprise 26 current pulses each about 100 µs wide. Each pulse is thus separated by an average interval period of about 554 µs. Alternatively, the initial phase T_{wu} may be 13 ms long and comprise 32 pulses each about 80 µs wide. Yet another alternative is to make the initial phase T_{wu} 29 ms long and comprise 55 pulses each about 75 µs wide.

[0023] Figure 4 illustrates this pulsing in the form of a graph in which the supply voltage U to the lamp is plotted against time t. The time for a current pulse is here designated as T_P and the interval period as T_0.

[0024] On the above basis, the ratio between the current pulse time T_P and the interval period time T_0 is about 1:5 (specifically 100/554 ≈ 1/5, 80/320 = 1/4 and 75/450 = 1/6). Depending on the application concerned, the type of lamp and the type of incandescent filament, however, it may be advantageous to vary this ratio considerably more, e.g. from 1:10 to 1:2. It is nevertheless preferred that the current profile be such that the eye cannot perceive any resulting flickering and sees only constant light from the lamp. As may be seen, the supply voltage U to the lamp is also a substantially constant U_C, both during the initial phase from t_0 to t_i (i.e. T_{wu}) and after that phase (i.e. from t_i onwards).

[0025] With the object of the summarising the invention, the general method for controlling an incandescent lamp according to the proposed method will now be described with reference to the flow diagram in Figure 5.

[0026] A first stage 510 investigates whether a switch-on signal has been received, in which case a stage 520 follows, otherwise the procedure loops back and stops at stage 510. Stage 520 starts a timer which determines the extent in time of the initial phase, i.e. the period after the beginning of the switch-on signal during which a pulsed driving current is to be delivered to the lamp. A subsequent stage 530 delivers a pulsed driving current to the lamp so that the latter's incandescent filament gradually warms up. A stage 540 thereafter investigates whether the timer has run out, in which case a stage 550 follows, otherwise the procedure loops back to stage 530.

[0027] Stage 550 delivers a continuous driving current to the lamp. A stage 560 (which is actually executed parallel with stage 550) investigates whether the switch-on signal is still active, i.e. whether the lamp should remain lit. If it is found that the switch-on signal has ceased, there then follows a stage 570 in which the driving current is disconnected and the procedure ends, otherwise the procedure loops back to stage 550.

[0028] All of the process stages (as also any desired partial sequence of stages) described above with reference to Figure 5 can of course be controlled by a computer program which is directly loadable to the internal memory of a computer and comprises suitable software for controlling the necessary stages when the program is run on the computer. In addition, although the embodiments of the invention described above with reference to the drawings are software-controlled by means of a computer and processes performed by a computer, the invention also extends to computer programs, particularly such computer programs stored on a data carrier adapted to implementing the invention. The program may be in the form of source code, object code, a code comprising a level between source ad object code, e.g. in partly compiled form, or in whatever form may be suitable for use in implementing the method according to the invention. The data carrier may be any desired entity or device capable of storing the program. For example the data carrier may comprise a storage medium, flash memory such as an ROM (read only memory), e.g. a CD or a semiconductor ROM, or a magnetic recording medium, e.g. a diskette or a hard disk. The data carrier may also take the form of a transferable carrier such as an electrical or optical signal which can be transferred via an electrical or optical cable or by radio or in some other way. If the program is comprised within a signal which can be led directly through a cable or other device or means, the data carrier may take the form of such a cable, device or equipment. Alternatively, the data carrier may be an integrated circuit in which the program is stored, whereby the integrated circuit is adapted to perform, or be used in the performance of, relevant processes.

[0029] The invention is not limited to the embodiments described with reference to the drawings but may be varied freely within the scope of the ensuing claims.

Claims

1. A device (100) for control of an electric incandescent filament lamp (120), which device (100) comprises a driving stage (110) adapted, when operating, to supplying the lamp (120) with a driving current (I), whereby the driving stage (110), during an

initial phase (T_{wu}) after a switch-on signal (S) has been received, delivers to the lamp (120) a driving current (I) such that the incandescent filament of the lamp gradually warms up, **characterised in that** the device (100) is adapted to controlling the driving stage (110) in such a way that the driving stage (110) delivers to the lamp (120) during the initial phase (T_{wu}) a pulsed driving current (I).

2. A device (100) according to claim 1, **characterised in that** the driving current (I) comprises a number of pulses during which a current is caused to flow in a particular direction through the incandescent filament, whereby two mutually consecutive pulses are separated by an interval period (To) during which substantially no current flows through the incandescent filament.

3. A device (100) according to either of claims 1 and 2, **characterised in that** the device (100) is adapted to causing the driving stage (110) to deliver the driving current (I) to the lamp (120) during a substantially constant supply voltage (U_C) both during the pulses of the initial phase (T_{wu}) and after that phase.

4. A device (100) according to any one of the foregoing claims, **characterised in that** the lamp (120) is of halogen type.

5. A method for control of an electric incandescent filament lamp (120) whereby, during an initial phase (T_{wu}) after a switch-on signal (S) has been received, a driving current (I) to the lamp (120) is controlled in such a way that the incandescent filament of the lamp (120) gradually warms up, **characterised by** pulsing of the drive current (I) during the initial phase (T_{wu}).

6. A method according to claim 5, **characterised in that** the driving current (I) comprises a number of pulses during which the current is caused to flow in a particular direction through the incandescent filament, whereby two mutually consecutive pulses are separated by an interval period (T_0) during which substantially no current flows through the incandescent filament.

7. A method according to either of claims 5 and 6, **characterised by** delivery of the driving current (I) during a substantially constant supply voltage (U_C) to the lamp (120) both during the pulses of the initial phase (T_{wu}) and after that phase.

8. A method according to claim 7, **characterised in that** the driving current (I) has an average time ratio between current pulses (T_P) and interval periods (T_0) which is within the range of 1:2 to 1:10.

9. A method according to claim 8, **characterised in that** the average time ratio between current pulses (T_P) and interval periods (T_0) is about 1:5.

10. A method according to any one of claims 5-9, **characterised in that** the extent in time of the initial phase (T_{wu}) is such that the incandescent filament of the lamp (120) at the end of that phase has a temperature substantially closer to a steady working temperature than when the switch-on signal (S) was received.

11. A computer program directly loadable to the internal memory of a computer and comprising software for controlling the method according to any one of claims 5-10 when the computer program is run on a computer.

12. A computer-readable medium on which a computer program is stored which is suited to enabling a computer to control the method according to any one of claims 5-10.

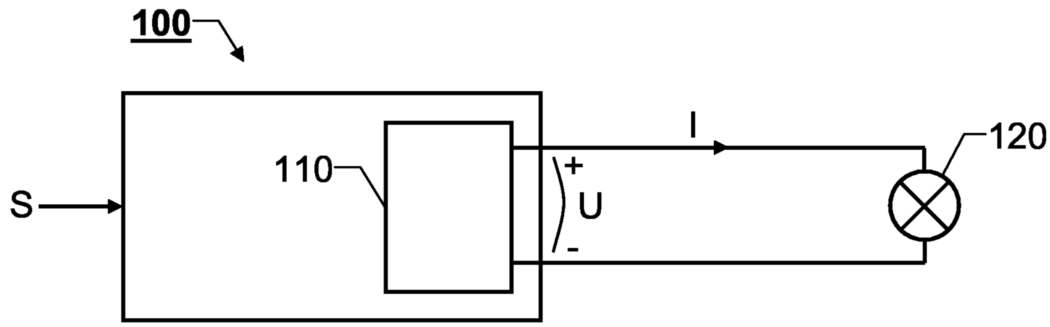

Fig. 1

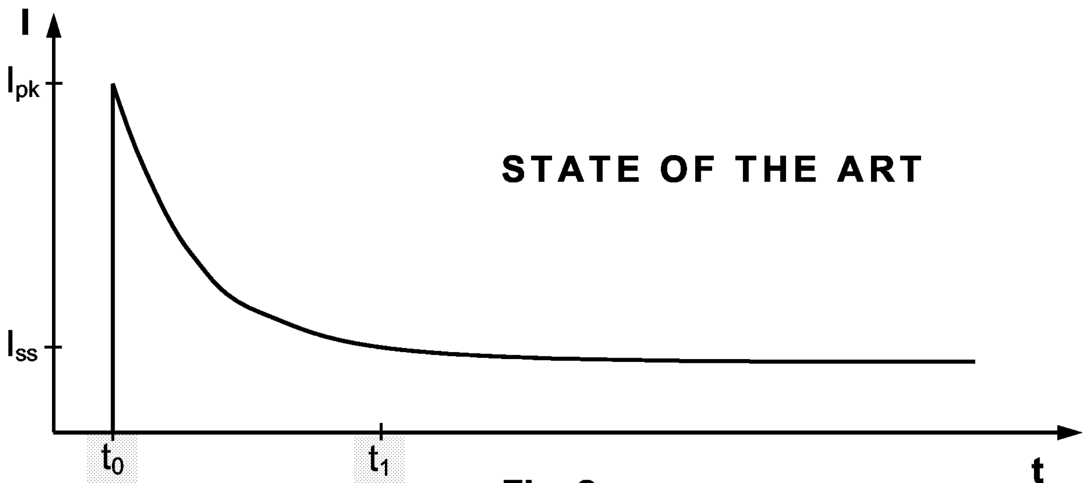

Fig. 2

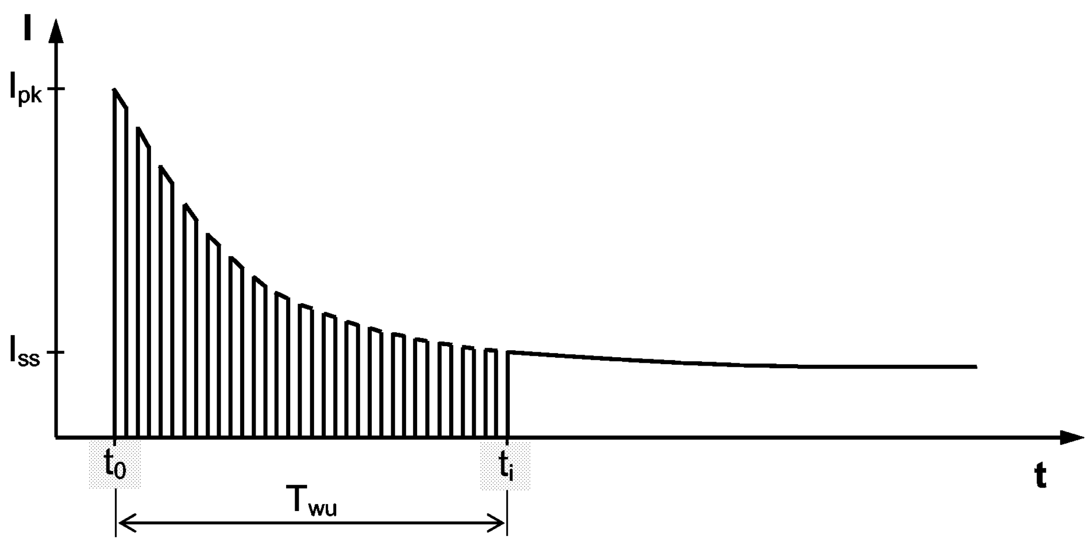

Fig. 3

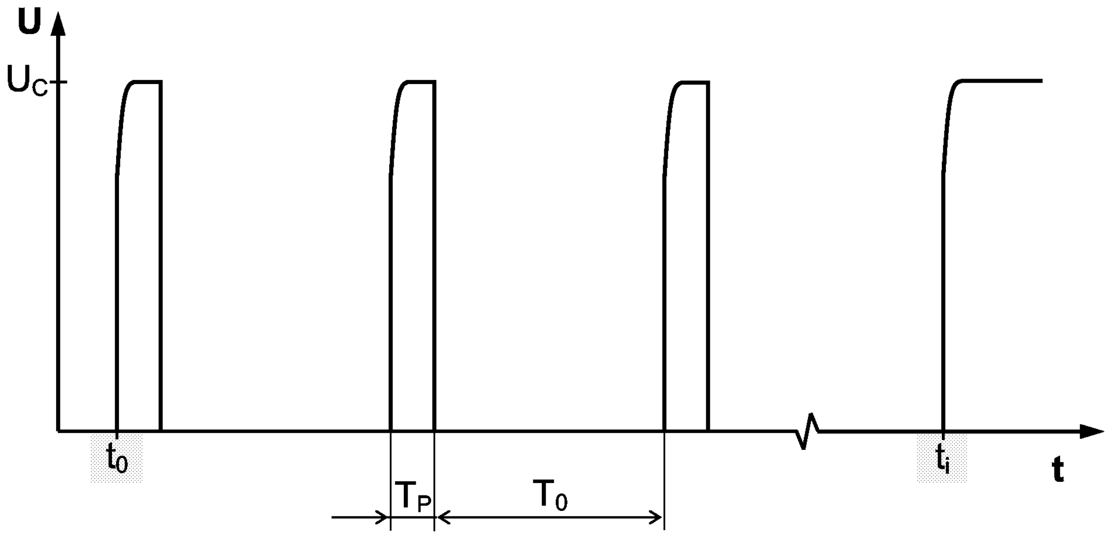
U
Uc
t0
TP
T0
ti
t

Fig. 4

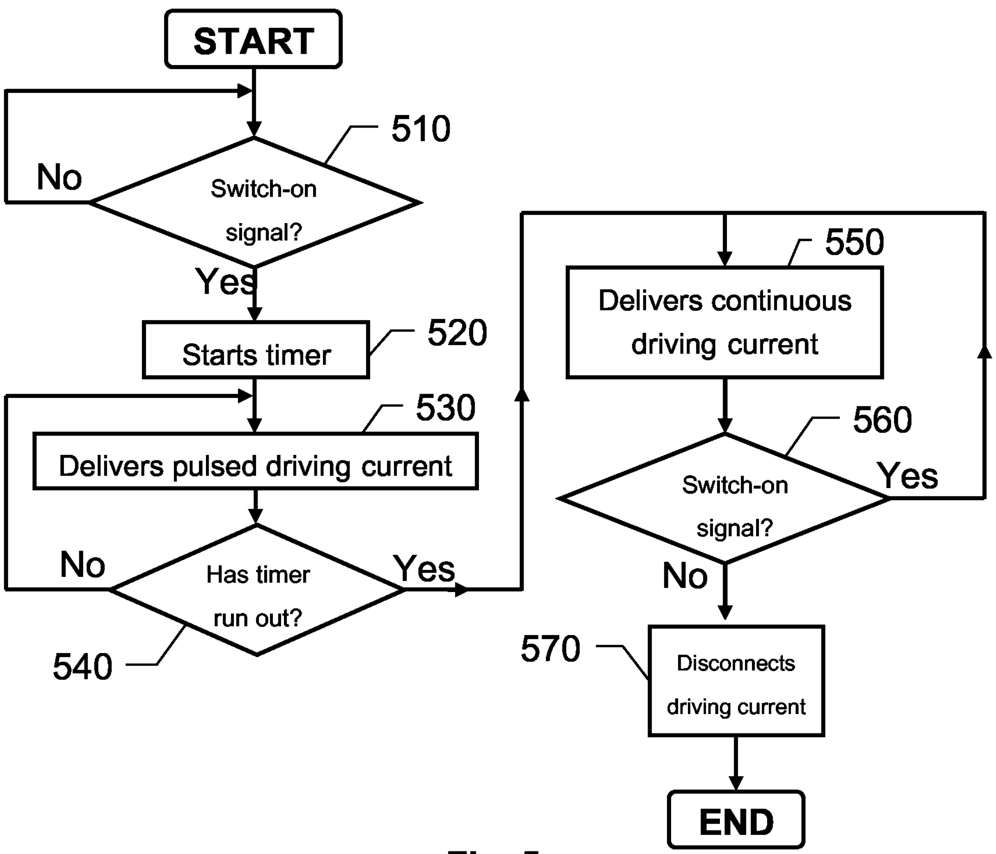
START
510
Switch-on signal?
No
Yes
Starts timer
520
530
Delivers pulsed driving current
No
Has timer run out?
Yes
540
550
Delivers continuous driving current
560
Switch-on signal?
Yes
No
570
Disconnects driving current
END

Fig. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 10 2135

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 0 240 402 A (BENDIX ELECTRONICS SA) 7 October 1987 (1987-10-07) * column 3, line 15 - line 26 * * column 4, line 23 - line 26 * * column 8, line 28 * * figures 1,5 *	1-12	H05B39/02
X	US 5 293 077 A (NUNOGAWA YASUHIRO ET AL) 8 March 1994 (1994-03-08) * abstract; figures 1,3 *	1,5	
X	US 5 030 890 A (JOHNSON SAMUEL A) 9 July 1991 (1991-07-09) * abstract; figures 1,2 *	1,5	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)
H05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 October 2004	Boudet, J

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

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 10 2135

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

13-10-2004

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0240402 A	07-10-1987	FR 2596935 A1	09-10-1987
		DE 3770307 D1	04-07-1991
		EP 0240402 A1	07-10-1987
		JP 62236016 A	16-10-1987
		US 4772804 A	20-09-1988
US 5293077 A	08-03-1994	JP 1220864 A	04-09-1989
		JP 1255471 A	12-10-1989
		JP 2660715 B2	08-10-1997
US 5030890 A	09-07-1991	US RE35220 E	30-04-1996

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82