



- (51) **International Patent Classification:**
H05B 33/08 (2006.01)
- (21) **International Application Number:**
PCT/IB2012/051623
- (22) **International Filing Date:**
3 April 2012 (03.04.2012)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
PA 2011 70158 4 April 2011 (04.04.2011) DK
- (71) **Applicant** (for all designated States except US): **SGM A/S**
[DK/DK]; Søren Frichs Vej 51, DK-8230 Åbyhøj (DK).
- (72) **Inventor; and**
- (75) **Inventor/Applicant** (for US only): **KRAUSE, Christian**
[DK/DK]; Nørre Søgade 37B, 4-4, DK-1370 København K (DK).
- (74) **Agent:** **COLO', Chiara**; BUGNION S.p.A., Via Vellani Marchi 20, I-41124 Modena (IT).
- (81) **Designated States** (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) **Designated States** (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report (Rule 48.2(g))

- (54) **Title:** METHOD FOR DRIVING LEDs

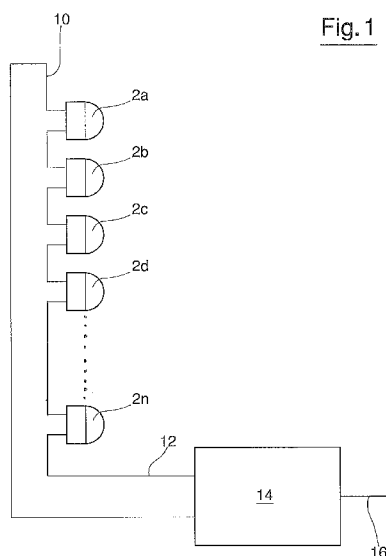


Fig. 1

(57) **Abstract:** The present invention relates to a method for driving at least one LED which is performed in the following steps: by generating a pulsating current through the LED, controlling the voltage drop over at least the LED and generating pulses with at least a raising flange and a falling flange. It is the object of the present invention to perform overdrive of LEDs for increasing high-peak intensities in pulsating light. The object can be achieved by generating the pulses with a sloping rising flange. Hereby it can be achieved that when LEDs are driven with sloped current increases very high-peak intensities can be achieved making a LED suitable for strobe and flash applications by which this driver technology opens a whole new world of applications where LEDs can be implemented. It is possible to increase the peak intensities in all applications where flashing can be accepted.



Method for driving LEDs

Field of the Invention

The present invention relates to a method for driving at least one LED which is performed in the following steps, by generating a pulsating current through the LED, controlling the voltage drop over at least the LED and generating pulses with at least a raising flange and a falling flange.

Background of the Invention

LEDs are getting more and more popular and used extensively in general lighting applications due to high efficiency and low power consumption of LEDs. Other application where LEDs still are used in limited scope is within strobe and flash applications; this is because LEDs are still not capable of achieving high-peak intensities compared to conventional discharge tubes etc. It is the object of the present invention to solve this problem.

EP 2015611 A1 discloses a method for driving a LED and an illumination system comprising at least one LED. The LED is supplied with a driving pulse signal at a cycle equal to a unit of time, wherein said driving pulse signal has a peak value equal to n times of a prescribed current value and a duration of T/n' , and $n/n' \leq 1$. Thereby the light intensity is increased by n times while the power consumption is the same in comparison to driving the LED with a prescribed constant driving voltage and the prescribed constant driving current.

DE 2008200004910U discloses a high power driving circuit for serial connection of LEDs. The driving circuit comprises a filtration circuit for filtration of EMI/EMC in order to reduce noise from the electronic components. The circuit comprises a special circuit for reducing the effect of the phase difference between voltage and current.

Object of the Invention

It is the object of the present invention to perform overdrive of LEDs for increasing high-peak intensities in pulsating light.

Description of the Invention

The object can be achieved by generating the pulses with a sloping rising flange. Hereby it can be achieved that when LEDs are driven with sloped current increases, very high-peak intensities can be achieved making LED suitable for strobe and flash applications by which this driver technology opens a whole new world of applications where LEDs can be implemented. It is possible to increase the peak intensities in all applications where flashing can be accepted.

Also the falling flange is generated as a sloping curve. Hereby a slow discharge of passive components in a driving circuit can be achieved.

The pulse is generated as a sinus half pulse. Hereby it is achieved that the racing flange as well as the falling flange are sloping. The half sinus curve has the advantage that all capacities or coils that exist in a serial connection of LEDs will reach a charging and a build-up of current relatively slowly, so these components have less influence on the current when the current starts flowing from serial up to the maximum value. By a fast racing slope capacities that always exist, also with LEDs will have very low impedance according to the high frequency contents of the rising edge of a square-formed curve. Also coils which are only very small in value could exist at least in the connecting lines, or if the lines are having sharp turns, they will be operating as a very small coil. These coils will have relatively high impedance for the racing curve, and together with the capacitors very small oscillating circuits can be formed. The use of a sinus half wave for starting the LEDs also avoids all high frequency noise which could be generated and transmitted from the connection lines. Especially, if a very high number of LEDs are coupled serially and in parallel, the noise that could be generated by fast rising edges of curves would generate noise. This noise has to be reduced by capacitive circuits which will also reduce the actual speed of the rising edge of the curve. Therefore, activating LEDs by sharp edge square curves will give the

result that in the beginning of a sharp square edge curve, most of the power that is transmitted just at the beginning of the racing will end up as heat and not as light in the LED. Therefore, by the present invention it is possible to increase the light emission of LEDs for all kinds of circuits where pulsation is used. For strobe lighting in light shows it is important that the power of the LEDs can be increased. But also in other kinds of LED light, for example street lighting where it is accepted that LEDs are perform a pulsation maybe with a net frequency, is it possible to increase the light that is achieved from the LED. Also for car headlights it should be possible to have fast pulsating LEDs and in that way also to increase the power of the LEDs.

While working with LEDs it was discovered that it is possible to highly overdrive LEDs by using a sloped current increase, instead of a square pulse. A square pulse will increase the failure of the LEDs due to the internal capacitance of the LEDs which will create very high peak current at start-up resulting in LEDs failing, and other components failing, such as resistors etc. This problem is eliminated by using sloped current control.

Description of the Drawing

Figure 1 shows a possible embodiment for a serial connection of LEDs, and figure 2 shows curvature of pulses known from traditional state of the art, figure 3 shows a possible curvature for pulses used by the present invention, and figure 4 shows one possibility for driving the LEDs in figure 1 with a sinus half wave.

Detailed Description of the Invention

Figure 1 shows a circuit comprising a serial connection of LEDs, 2a, 2b, 2c, 2d-2n. The lines 10 and 12 are connected to a control circuit 14 which control circuit is connected to a power source 16. The circuit 14 will generate the pulses to drive the LEDs.

Figure 2 shows a coordinate system 100 having an access 102 indicating the current, and a time axis 104. Curves are shown with a rising flange 106 and a falling flange

108. The curve 110 indicates the light that is emitted from LEDs which are subjected to these current curves for activation.

Figure 3 shows a coordinate system 200 having a current axis 102 and a time axis 204. The pulses have a rising flange 206 and a falling flange 208. The light emission is indicated with a curvature 210. It can be seen that sufficiently more light has been achieved, because the pulses, and thereby the current and also the power dissipated in the LEDs, are much higher than indicated in figure 2.

Figure 4 shows a coordinate system having a current axis 302 and a time axis 304. The curvature is a sinus half wave having a rising slope 306 and a falling slope 308. The figure also indicates the light emission 310 from the LEDs.

Fig. 5 shows a coordinate system having a current axis 402 and a time axis 404 and two curves. Curve 406 represents the current applied to a LED light source, and curve 410 shows responding output of light of the same LED. A standard normal current value being applied to an LED thus results in a corresponding nominal light output.

Fig 6 shows a coordinate system having a current axis 502 and a time axis 504 and two curves. Curve 506 represents the current applied to a LED light source, and curve 510 shows responding output of light of the same LED. Fig 6 shows the same LED under test being given a 10 times nominal current. The resulting light output actually reaches nearly 10 times output but falls quickly depending on LED type. However, this creates a very high-peak light output which is very useful in a flash lighting application. If the current not is turned off after the LED has lowered its intensity, it will eventually fail.

Further test shows that repeating the flash cycle by 10 times nominal value will destroy the LED and its surrounding components after a short while. Further investigation shows that this is due to the high step angle for the applied current shown in Figs. 6-7. The rapid shift in current from 0 to 10 times nominal creates a lot of high-peak current unequally distributed due to capacitance inside the LED and surrounding components at the time of ignition curve 506,606. This unequal distribution of current at

time of ignition is even more obvious when connecting more LEDs together in series as one LED may get much higher than 10 times nominal at ignition time.

Fig 7 shows a coordinate system having a current axis 602 and a time axis 604 and two curves. Curve 606,608 represents the current applied to a LED light source, and curve 610 shows responding output of light of the same LED. Fig. 7 shows how this invention, through the steps of testing in a lab from Fig 5 and 6, has created a way of solving this issue by increasing the current at a rate that creates maximum flash intensity without destroying the LED and its surrounding components, and this slow increase, Fig. 7-606, illuminates the capacitance influence and thereby ensures an equal distribution of the current inside the LED and components ensuring that flash and be cycled again and again at 10 time nominal value without destroying the LED.

By using current pulses which are not sharp in the curvature, but racing from zero to max over a defined time period, it is possible to achieve a much higher yield of light from LEDs. The maximum light emission can be sufficiently higher than what is specified from the supplier, because the operation is performed as pulses, so that the maximum power dissipation probably is less than what the LED was designed for over a long period. The racing edge of the curvature could have different curves, but is maybe part of the sinus curve, as indicated in figure 4, one of the most effective ways of activating an LED, if the LED has to work with a high degree of power. Other forms of curvature could probably also be used, but generally one has to remember that the curves need to have the contents of higher frequencies reduced. Therefore, normal square edge curves are not effective.

It is desirable to have a LED driven in such a way that the highest peak intensity can be achieved. The conventional way of driving LEDs by a square current or voltage pulse introduces problems when trying to overdrive the LED due to the internal capacitance of the LED and thus introducing very high current pulse through the LED and internally in the LED decaying life time or destroying the LED permanently. This problem is only increased when more LEDs are connected together as the internal capacitance may differ from LED to LED delivering unequal current distribution when a square pulse is applied.

This problem can be eliminated by driving the LEDs in a completely different way than what is normally specified by manufacturers, by using a sloped increase of the current of such length that the capacitance internally of each LED and other surrounding components can be rendered of no importance, or less than 2 times of the RMS current of the pulse

When LEDs are driven with sloped current increases, very high-peak intensities can be achieved making LED suitable for strobe and flash applications by which this driver technology opens a whole new world of applications where LEDs can be implemented.

This technology is probably also suitable for other light sources as well, such as OLED etc.

CLAIMS

1. Method for driving at least one LED (2) which is performed in the following steps:

a. generating a pulsating current through the LED (2)

b. controlling the voltage drop over at least the LED (2)

c. generating pulses (4) with at least a raising flange (6) and a falling flange (8)

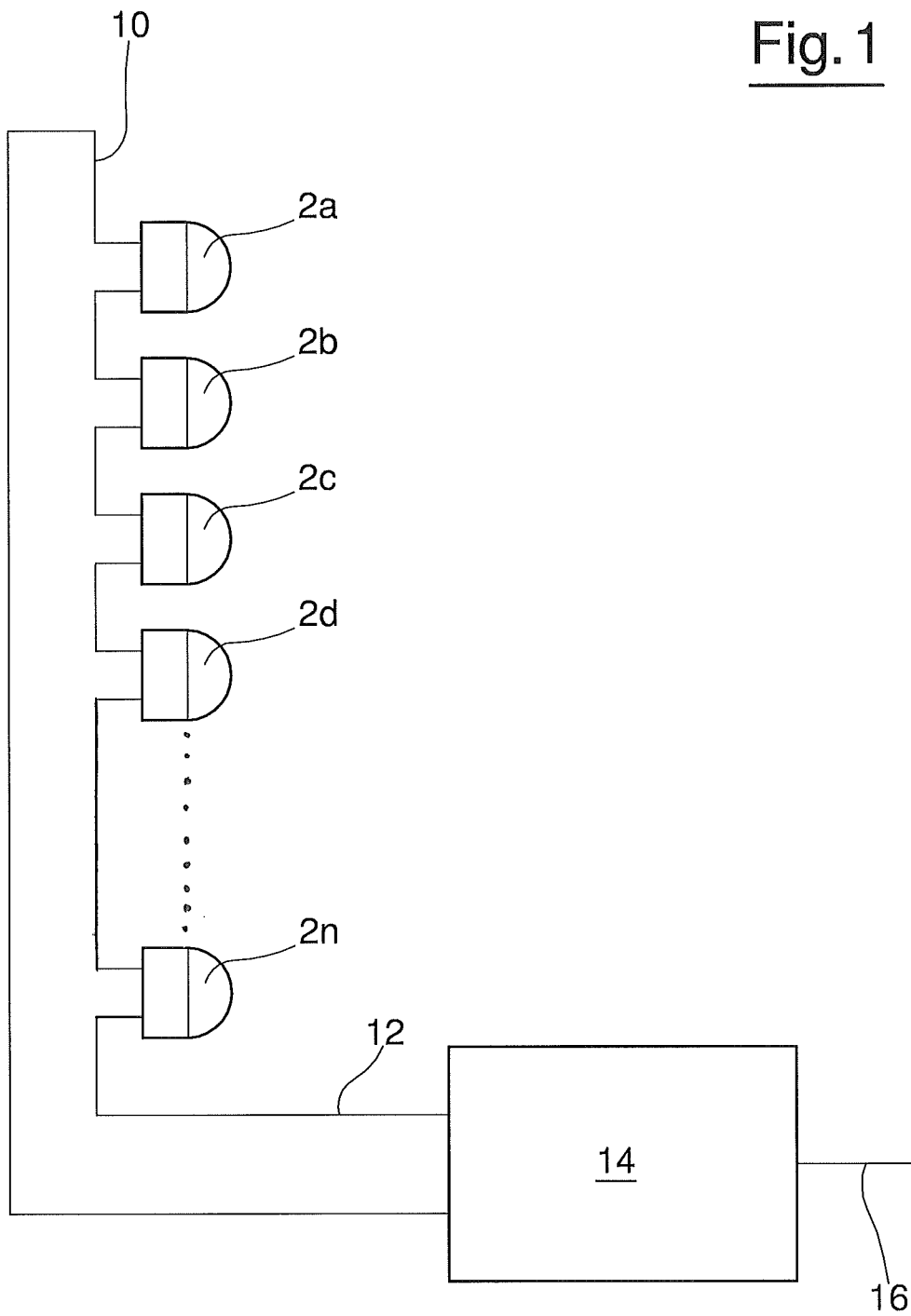
characterized in the following steps:

d. generating the pulses with a sloping rising flange (6).

2. Method for driving at least one LED according to claim 1, **characterized in** that the falling flange is generated as a sloping curve.

3. Method for driving at least one LED according to claim 1 or 2, **characterized in** that the pulse (4) is generated as a sinus half pulse.

1 / 3

Fig. 1

2 / 3

Fig. 2

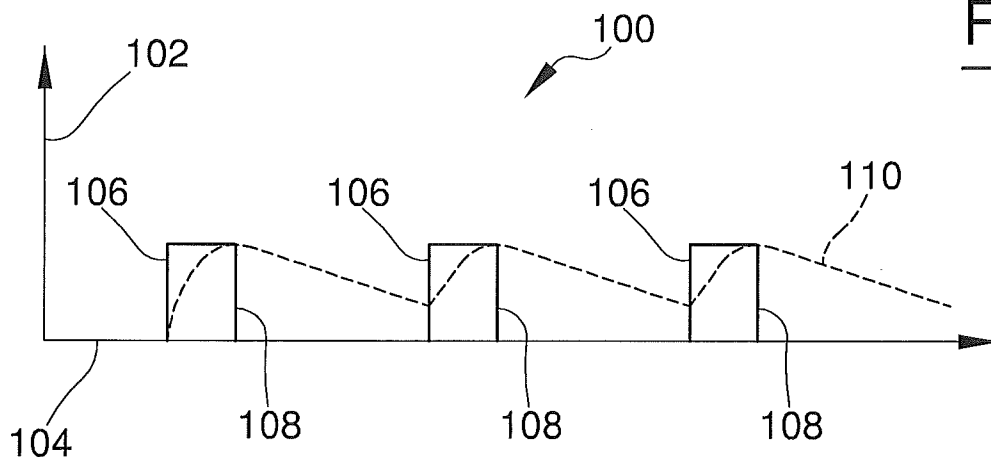


Fig. 3

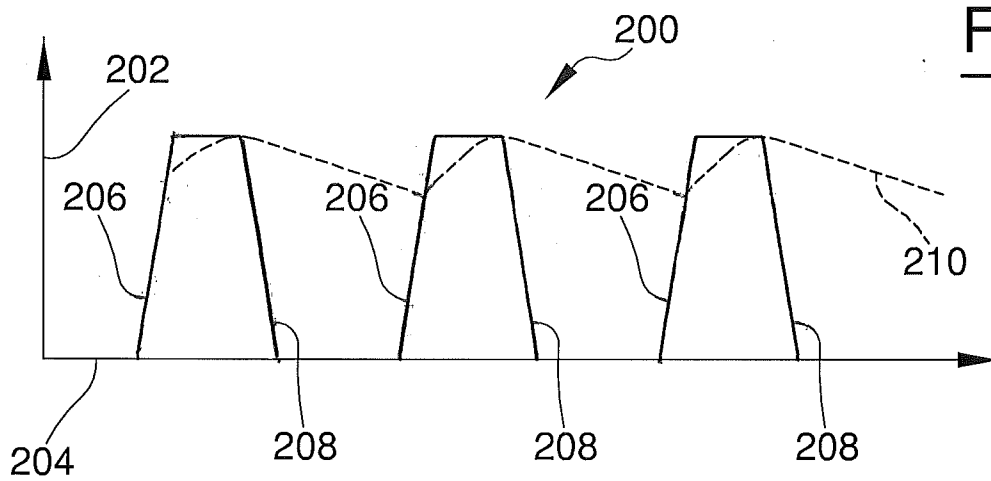


Fig. 4

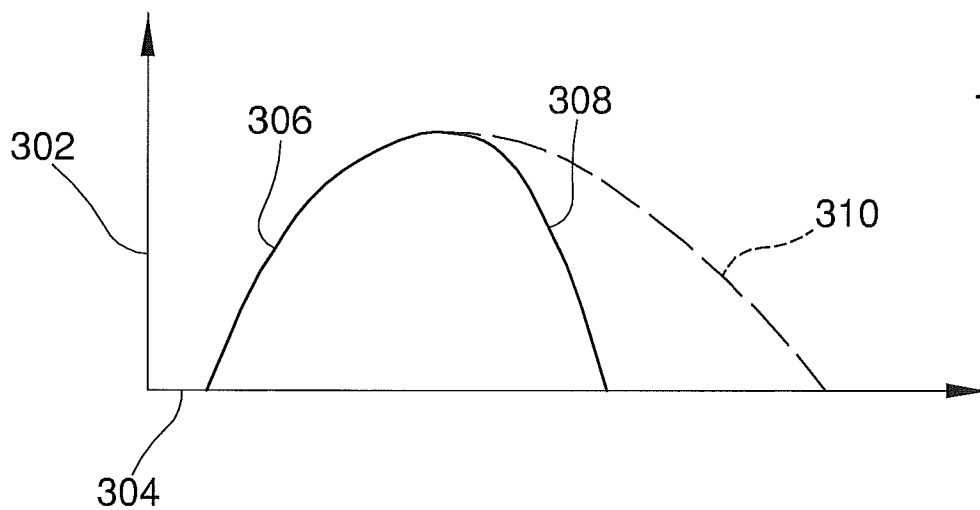


Fig. 5

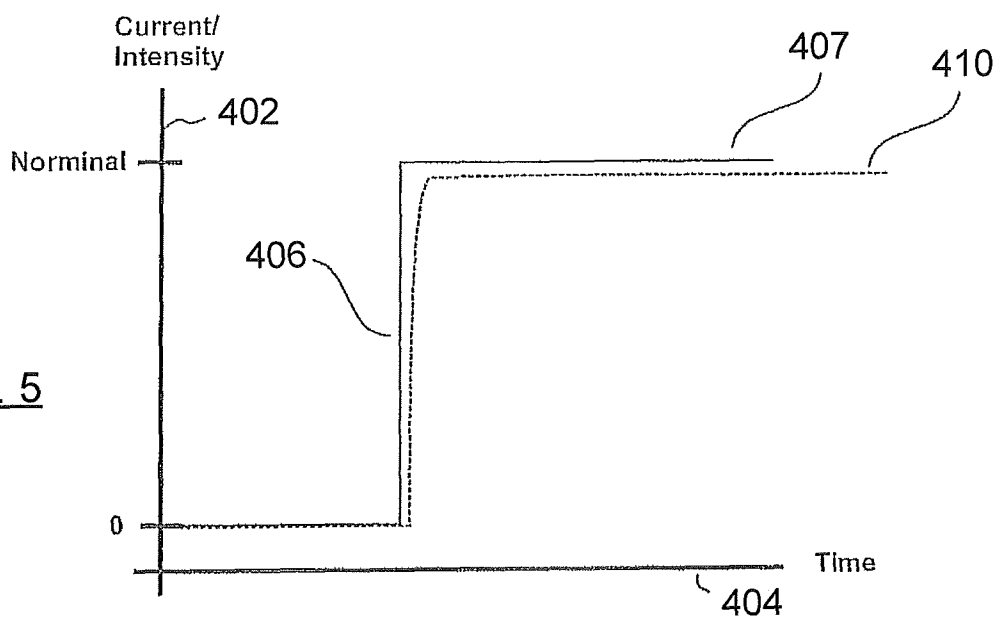


Fig. 6

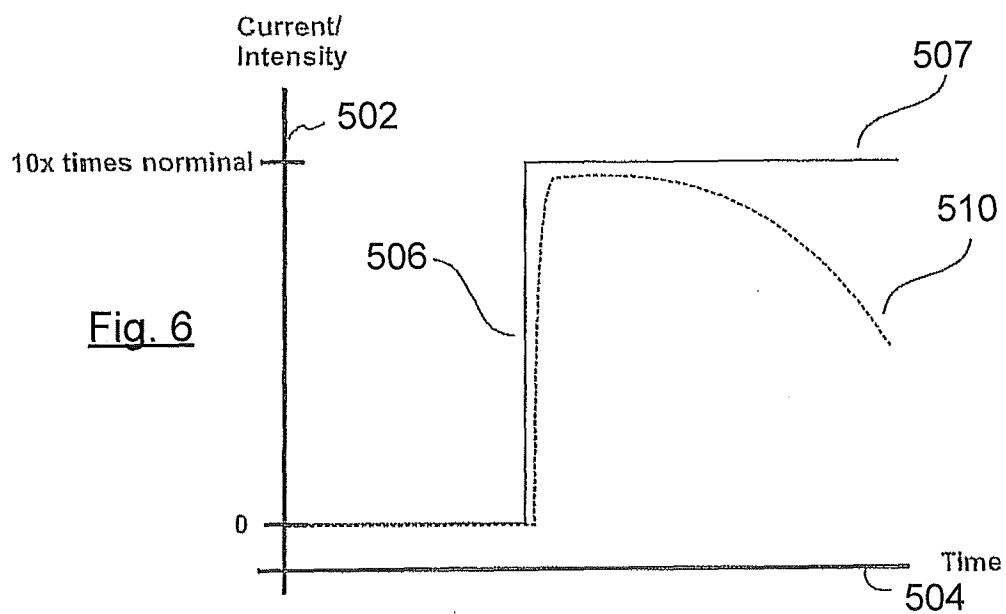


Fig. 7

