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(54) MULTI-PATH LED DRIVER CIRCUIT

(57) An LED driver circuit includes a rectifier circuit (2), a filter circuit (3), a constant voltage (CV)(4) circuit, a first constant current (CC)(51) circuit and a second CC circuit (52). The rectifier circuit (2) connects an AC power source for converting an AC power into a DC power. The filter circuit (3) connects the rectifier circuit (2) for filtering an AC component. The CV circuit (4) connects the filter circuit (3) for generating a fixed voltage and outputting the fixed voltage via a voltage output end (41). The voltage output end (41) is used for connecting a first electrode of each of two LEDs. The first CC circuit (51) connects both the CV circuit (4) and a second electrode of one of the two LEDs. The second CC circuit (52) connects both the CV circuit (4) and a second electrode of another one of the two LEDs. The first and second CC circuits (51, 52) make currents flowing through the two LEDs independently controllable.

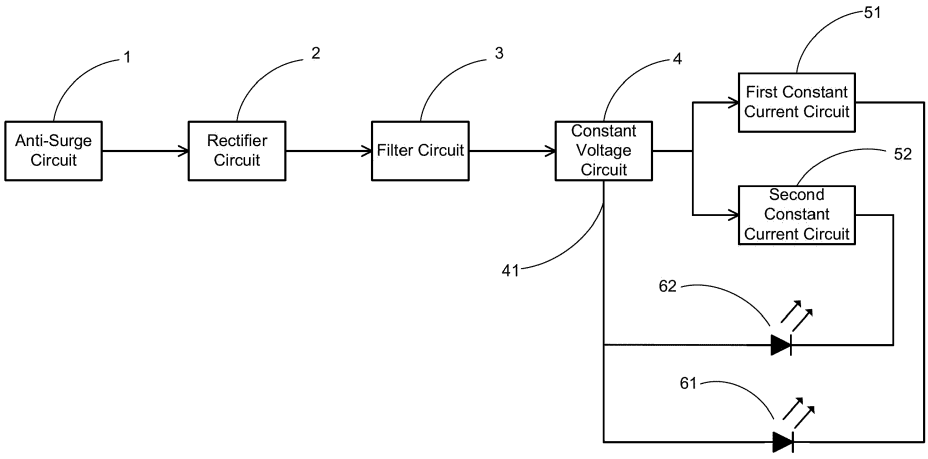

FIG. 2

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Description

Technical Field

[0001] The invention relates to LED lamps, particularly to drivers of LED lamps.

Related Art

[0002] Light emitting diodes (LEDs) have widely replace conventional lighting because of high lighting luminous efficiency. There is a filament bulb in various kinds of LED lamps. Such a filament bulb possesses both shape characteristics and illuminating characteristics of incandescent bulbs, so it has become a rising product. In an LED filament bulb, multiple tiny LED chips are connected into a linear or curved shape to imitate a filament of a traditional incandescent bulb and one or more filaments are disposed in a bulb shell.

[0003] Most of LED filament bulbs adopt multiple filaments connected in parallel. There must be a difference of forward voltage (VF) between LED filaments. Complete identification of forward voltage (VF) between LED filaments is impossible. Individual bias of semiconductors always exists even if both the same material and lighting color are adopted. Parallel use of LED filaments differentiates forward currents (IF) flowing through each LED filament. A forward current flowing through an LED filament with a lower VF is higher than a forward current flowing through an LED filament with a higher VF. This is called "current hogging". Also, because the property of VF-IF of LED, a tiny difference of forward voltage can cause a drastic variation of forward current.

[0004] The more the power of an LED filament lamp is, the more serious the influence to overall quality of a lamp due to the current hogging is. Because when power of a light source is increased, the number of LED filaments connected in parallel is correspondingly increased. The more the number of LED filaments connected in parallel is, the higher the possibility of current hogging is and the more serious the influence of current hogging is. Current hogging causes variations of intensity of LED filaments. Also, service life of an LED filament with a large forward current will be shortened because of excessive illumination.

[0005] To solve this problem, a multi-path output driver as shown in FIG. 1 is available. It integrates two or more independent driver circuits into a single circuit board. In fact, it just combines two or more driver circuits together, but it has drawbacks of high cost and large volume. Such a design can only be used in externally driving lamps (for example, LED fluorescent lamps). However, an LED filament lamp is very similar to a traditional incandescent bulb in shape, so its driver can only be received in the base (cap). A space in the base is so limited, so a conventional multi-path output driver as shown in FIG. 1 cannot be received in the base.

Summary of the Invention

[0006] An object of the invention is to provide a multi-path LED driver circuit, whose volume can be effectively shrunk to be received in a base of an LED filament bulb.

[0007] To accomplish the above object, the invention provides a multi-path LED driver circuit, which includes a rectifier circuit, a filter circuit, a constant voltage circuit, a first constant current circuit and a second constant current circuit. The rectifier circuit connects an AC power source for converting an AC power into a DC power. The filter circuit connects the rectifier circuit for filtering an AC component. The constant voltage circuit connects the filter circuit for generating a fixed voltage and outputting the fixed voltage via a voltage output end. The voltage output end is used for connecting a first electrode of each of two LEDs. The first constant current circuit connects both the constant voltage circuit and a second electrode of one of the two LEDs. The second constant current circuit connects both the constant voltage circuit and a second electrode of another one of the two LEDs. The first and second constant current circuits make currents flowing through the two LEDs independently controllable.

Brief Description of the Drawings

[0008]

FIG. 1 is a circuit diagram of a conventional multi-path LED driver;
FIG. 2 is a block diagram of the invention;
FIG. 3 is a circuit diagram of the invention;
FIG. 4 is a schematic view of overall framework of the invention applied in an LED filament bulb; and
FIG. 5 is a schematic view of filament arrangement of the invention applied in an LED filament bulb.

Detailed Description of the Invention

[0009] In the following description, numerous specific details are set forth in order to provide a thorough understanding of various embodiments.

[0010] Please refer to FIG. 2. The multi-path LED driver circuit of the invention includes an anti-surge circuit 1, a rectifier circuit 2, a filter circuit 3, a constant voltage circuit 4, a first constant current circuit 51 and a second constant current circuit 52.

[0011] The anti-surge circuit 1 is a protection circuit for additionally resisting lightning strokes or voltage spikes from external alternating current (AC) power source. The anti-surge circuit 1 is not directly relative to the operation of the LED driver circuit of the invention, so it is not a necessary element. The rectifier circuit 2 is either connected to the anti-surge circuit or directly connected to an AC power source for converting AC power from the AC power source into a direct current (DC) power. The filter circuit 3 is connected to the rectifier circuit 2 for filtering an AC component (i.e. ripple) of the AC power

output from the rectifier circuit 2. The constant voltage circuit 4 is connected to the filter circuit 3 for generating a fixed voltage output. The fixed voltage is output via a voltage output end 41. The voltage output end 41 is used for connecting a first electrode of each of two LEDs 61, 62 as a load. In the shown embodiment, the first electrode is a positive electrode. The first constant current circuit 51 is connected to both the constant voltage circuit 4 and a second electrode of one of the two LEDs 61, 62. The second constant current circuit 52 is connected to both the constant voltage circuit 4 and a second electrode of the other one of the two LEDs 61, 62. In the shown embodiment, the second electrode is a negative electrode. The first and second constant current circuits 51, 52 make currents flowing through the two LEDs 61, 62 independently controllable.

[0012] The embodiment shown in the figures is just an example. And a single LED in each load path is also shown as an example. Three or more load paths may be used according to actual demands. There may be multiple LEDs connected in series and/or parallel in each load path.

[0013] Please refer to FIG. 3. The LED driver circuit of the invention adopts the Boost framework. As shown, the constant voltage circuit 4 includes a voltage controller IC3. In this embodiment, the voltage controller IC3 adopts the BP2606D made by Bright Power Semiconductor Co., Ltd. in China. The fixed voltage is output to the first (positive) electrodes of the two load LEDs 61, 62 via a voltage output end 41. Each of the first and second constant current circuits 51, 52 forms an individual branch. Each branch includes a current controller IC1, IC2. In the shown embodiment, BP5616C made by Bright Power Semiconductor Co., Ltd. is adopted to serve as each of the current controllers IC1, IC2.

[0014] The voltage controller IC3 includes two voltage detecting pins (i.e. the OVP pin and the FB pin). The two voltage detecting pins are separately connected to high voltage interfaces of the current controllers IC1, IC2 to provide a maintenance voltage to each of the current controllers IC1, IC2. Each of the current controllers IC1, IC2 can be individually set to output a specific current. The current controllers IC1, IC2 are powered by the filter circuit 3. An output current (i.e. load current) of each branch is controlled by resistors R8 and R9 connected between the CS pin of the current controller IC1, IC2. When R8=R9, two output currents of the two branches are equal to implement current-balancing. When R8≠R9, two branches have different currents.

[0015] Please refer to FIG. 4. In an application of LED filament bulb, the driver circuit of the invention is received in a lamp base 7. A positive electrode of a first set of filaments 61' is electrically connected to the positive terminal LED+ as shown in FIG. 3, and a negative electrode thereof is electrically connected to the first negative terminal LED1-. A positive electrode of a second set of filaments 62' is electrically connected to the positive terminal LED+, and a negative electrode thereof is electrically connected to the second negative terminal LED2-. Each set of filaments 61', 62' of the embodiment shown in FIG. 4 is composed of two filaments. Of course, one filament is also available.

[0016] Please refer to FIG. 5. Each of the first set of filaments 61" and the second set of filaments 62" may be individually composed of multiple filaments connected in series and/or parallel, and the number of the filaments connected in series and/or parallel may be identical or different.

[0017] It will be appreciated by persons skilled in the art that the above embodiment has been described by way of example only and not in any limitative sense, and that various alterations and modifications are possible without departure from the scope of the invention as defined by the appended claims.

Claims

1. A multi-path light emitting diode (LED) driver circuit comprising:

   a rectifier circuit (2) for connecting an alternating current (AC) power source, converting an AC power into a direct current (DC) power;
   a filter circuit (3), connecting the rectifier circuit (2), and filtering an AC component in the DC power;
   a constant voltage circuit (4), connecting the filter circuit (3), generating a fixed voltage, outputting the fixed voltage via a voltage output end (41), and the voltage output end (41) being used for connecting a first electrode of each of two LEDs;
   a first constant current circuit (51), connecting both the constant voltage circuit (4) and a second electrode of one of the two LEDs; and
   a second constant current circuit (52), connecting both the constant voltage circuit (4) and a second electrode of another one of the two LEDs;
   wherein the first and second constant current circuits (51, 52) make currents flowing through the two LEDs independently controllable.

2. The multi-path LED driver circuit of claim 1, wherein the first electrode is a positive electrode, and the second electrode is a negative electrode.

3. The multi-path LED driver circuit of claim 1, further comprising an anti-surge circuit (1) connected between the rectifier circuit (2) and the AC power source.

4. The multi-path LED driver circuit of claim 1, wherein the constant voltage circuit (4) comprises a voltage controller (IC3).

5. The multi-path LED driver circuit of claim 4, wherein the voltage controller (IC3) is an integrated circuit BP2606D.

6. The multi-path LED driver circuit of claim 1, wherein each of the first and second constant current circuits (51, 52) comprises a current controller (IC1, IC2).

7. The multi-path LED driver circuit of claim 6, wherein the current controller (IC1, IC2) is an integrated circuit BP5616C.

8. The multi-path LED driver circuit of claim 6, wherein the current controllers (IC1, IC2) are powered by the filter circuit.

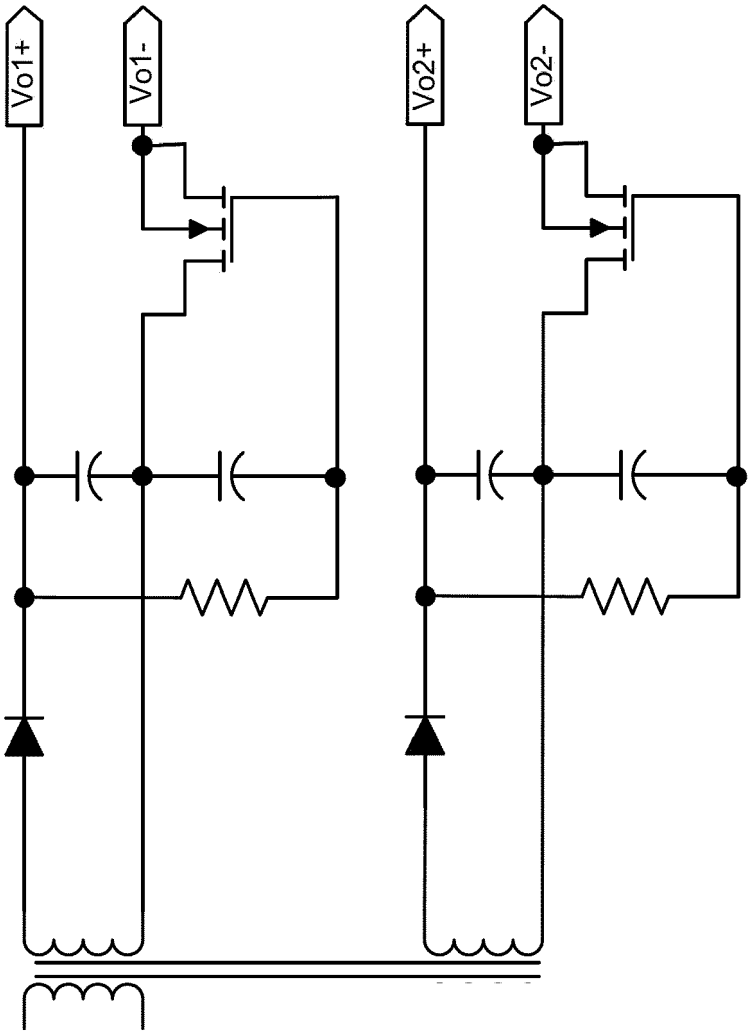

FIG. 1 Prior Art

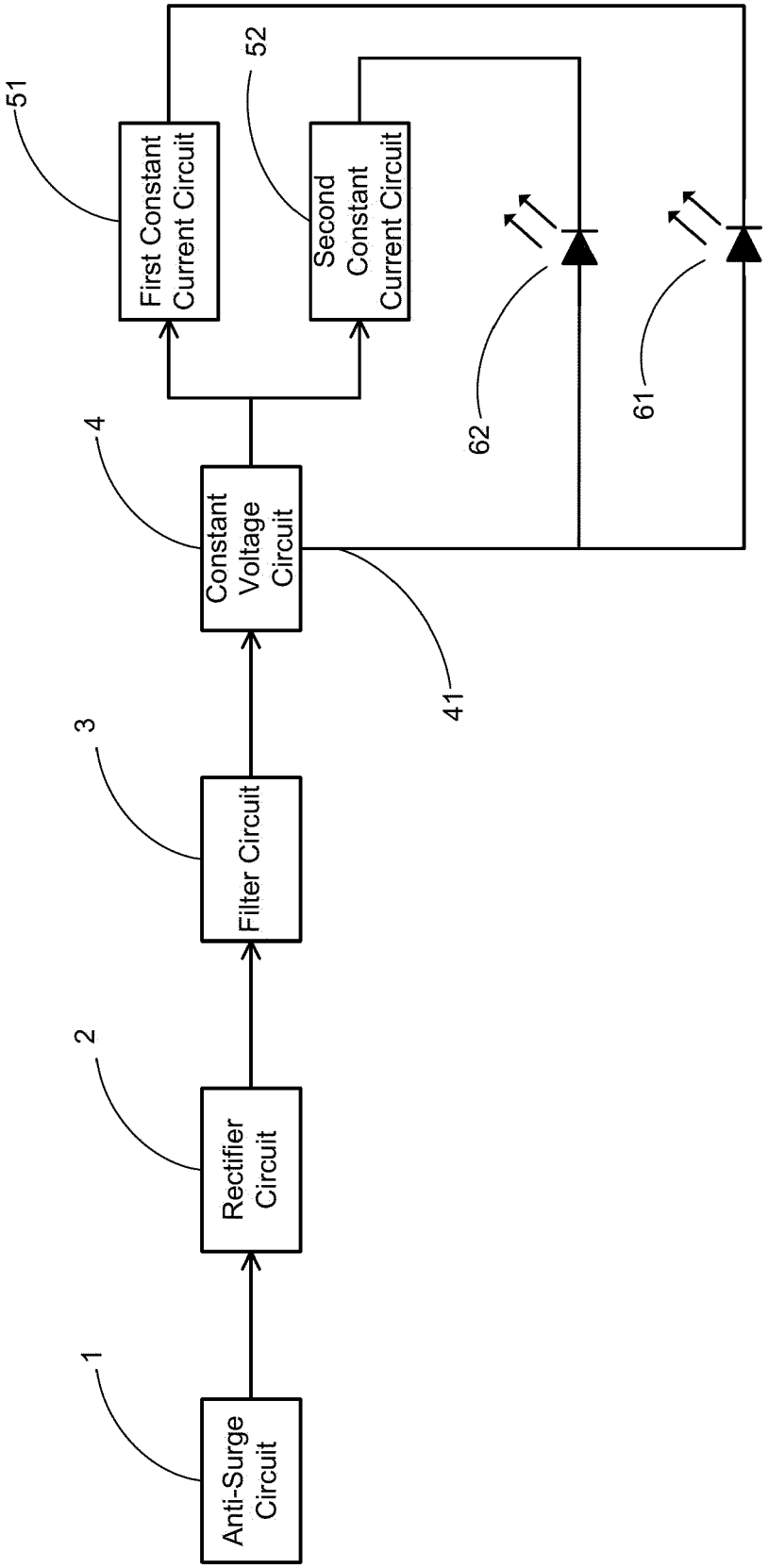
Anti-Surge Circuit
1
Rectifier Circuit
2
Filter Circuit
3
Constant Voltage Circuit
4
41
First Constant Current Circuit
51
Second Constant Current Circuit
52
62
61

FIG. 2

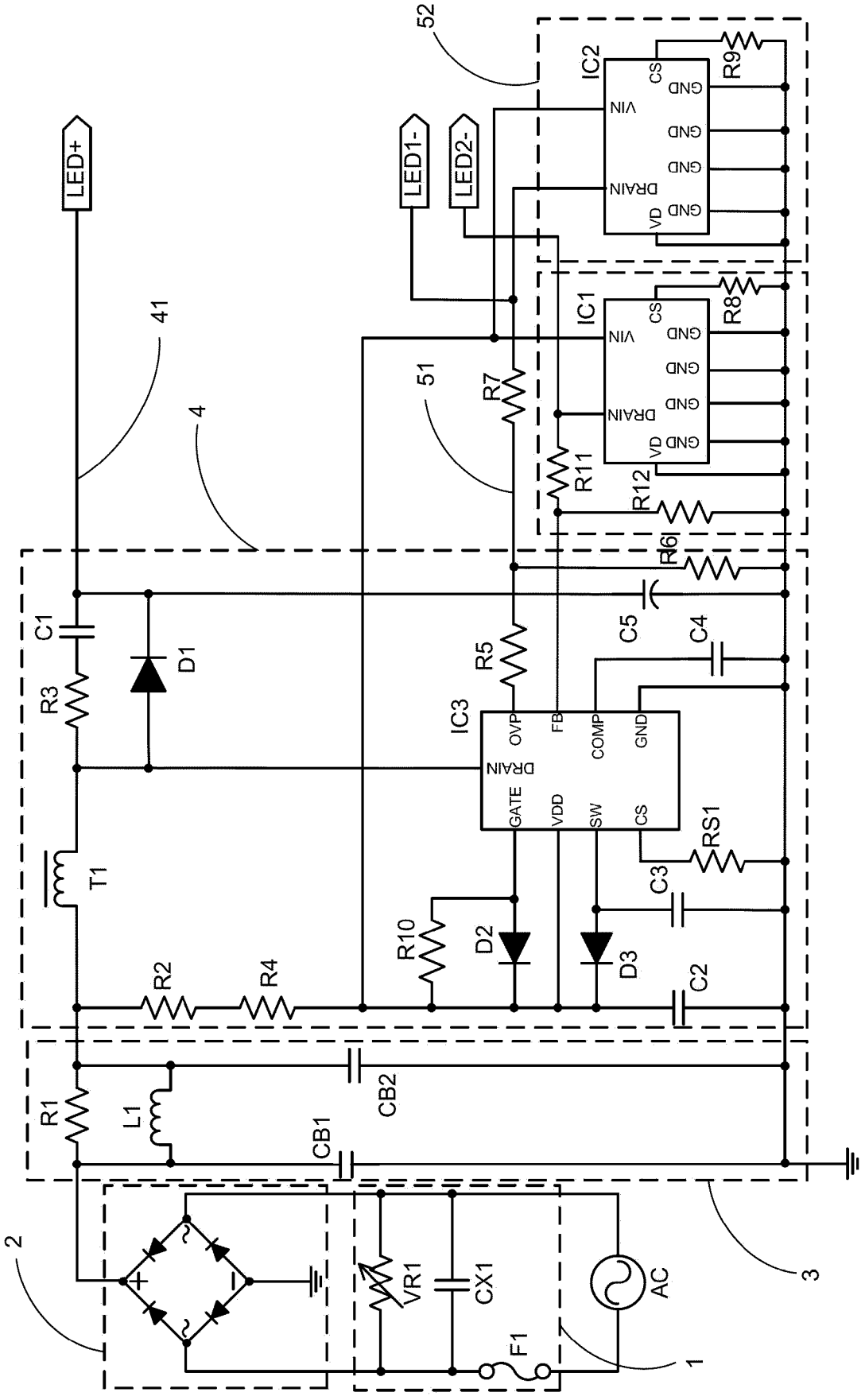
LED+
LED1-
LED2-
41
4
51
52
IC1
IC2
IC3
VIN
DRAIN
CS
GND
VD
OVP
FB
COMP
GATE
VDD
SW
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
RS1
C1
C2
C3
C4
C5
CB1
CB2
D1
D2
D3
L1
T1
VR1
CX1
F1
AC
1
2
3

FIG. 3

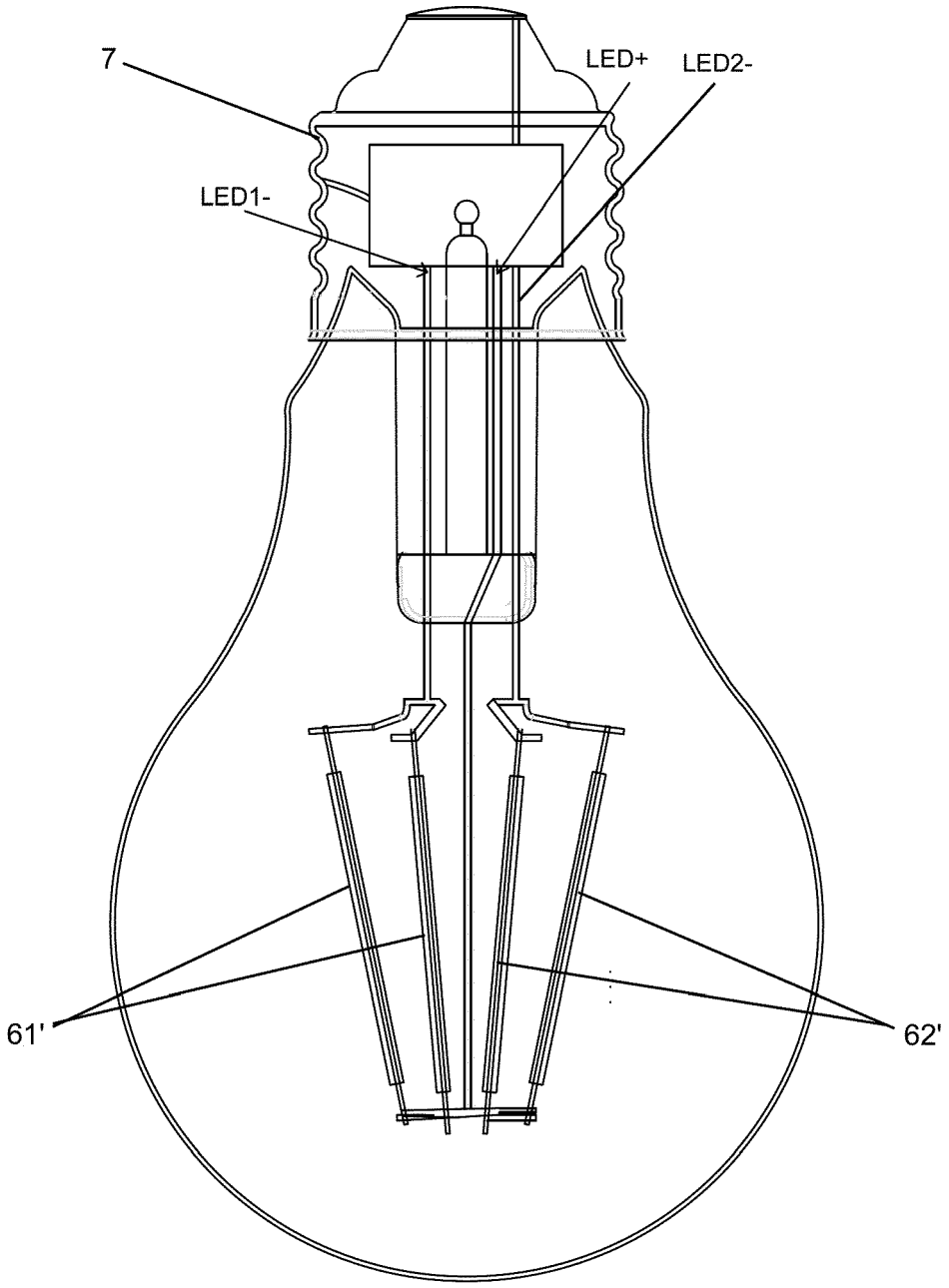

FIG. 4

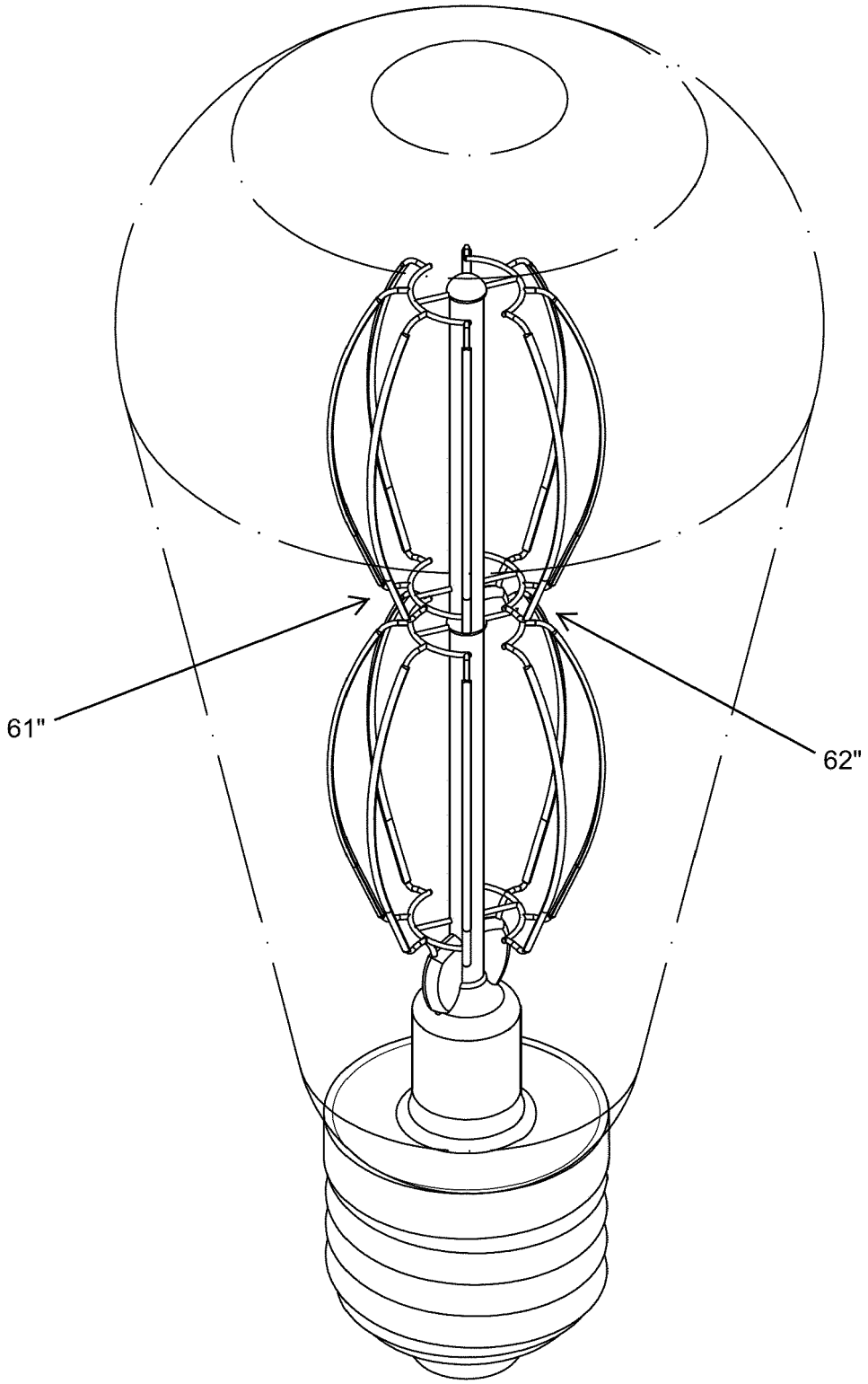

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 19 20 5522

DOCUMENTS CONSIDERED TO BE RELEVANT

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X Y	US 2012/200229 A1 (KUNST DAVID [US] ET AL) 9 August 2012 (2012-08-09) * paragraph [0021] - paragraph [0036]; figures 1-3 *	1,2,4-8 3	INV. H05B45/10 H05B45/46
X	WO 2013/180500 A1 (SEOUL SEMICONDUCTOR CO LTD [KR]) 5 December 2013 (2013-12-05) * page 10, line 1 - page 14, line 30; figures 1-6 *	1-8	
Y A	WO 01/39553 A1 (GELCORE COMPANY [CA]; ST GERMAIN NICHOLAS [CA]) 31 May 2001 (2001-05-31) * page 9, line 8 - page 14, line 12; figure 1 *	3 1	
			TECHNICAL FIELDS SEARCHED (IPC)
			H05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	2 March 2020	Henderson, Richard

CATEGORY OF CITED DOCUMENTS

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