

US00RE46396E

(19) **United States**  
(12) **Reissued Patent**  
**Janning**

(10) **Patent Number: US RE46,396 E**  
(45) **Date of Reissued Patent: May 2, 2017**

(54) **FULL WAVE LOW FLICKER LED LIGHT STRING**

(71) Applicant: **JLJ, Inc.**, Bellbrook, OH (US)  
(72) Inventor: **John L. Janning**, Bellbrook, OH (US)  
(73) Assignee: **JLJ, Inc.**, Bellbrook, OH (US)  
(21) Appl. No.: **14/822,536**  
(22) Filed: **Aug. 10, 2015**

**Related U.S. Patent Documents**

Reissue of:

(64) Patent No.: **8,736,182**  
Issued: **May 27, 2014**  
Appl. No.: **14/026,685**  
Filed: **Sep. 13, 2013**

U.S. Applications:

(60) Provisional application No. 61/863,864, filed on Aug. 8, 2013.

(51) **Int. Cl.**  
**F21S 4/00** (2016.01)  
**H05B 33/08** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H05B 33/0809** (2013.01); **H05B 33/0812** (2013.01); **Y02B 20/348** (2013.01)

(58) **Field of Classification Search**  
USPC ..... 315/185 S  
See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

6,972,528	B2	12/2005	Shao .....	H05B 33/0803	315/185 R
7,609,006	B2 *	10/2009	Gibboney .....	H05B 33/0803	315/185 S
7,649,322	B2 *	1/2010	Neuman et al. ....	315/185 S	
8,072,152	B2 *	12/2011	Neuman et al. ...	H05B 33/0803	315/185 R
2008/0116816	A1 *	5/2008	Neuman et al. ....	315/185 S	
2009/0206762	A1 *	8/2009	Gibboney .....	315/185 R	
2010/0096999	A1 *	4/2010	Neuman et al. ....	315/185 R	
2012/0074854	A1 *	3/2012	Neuman et al. ....	315/185 R	
2012/0111850	A1 *	5/2012	Casper .....	219/420	

\* cited by examiner

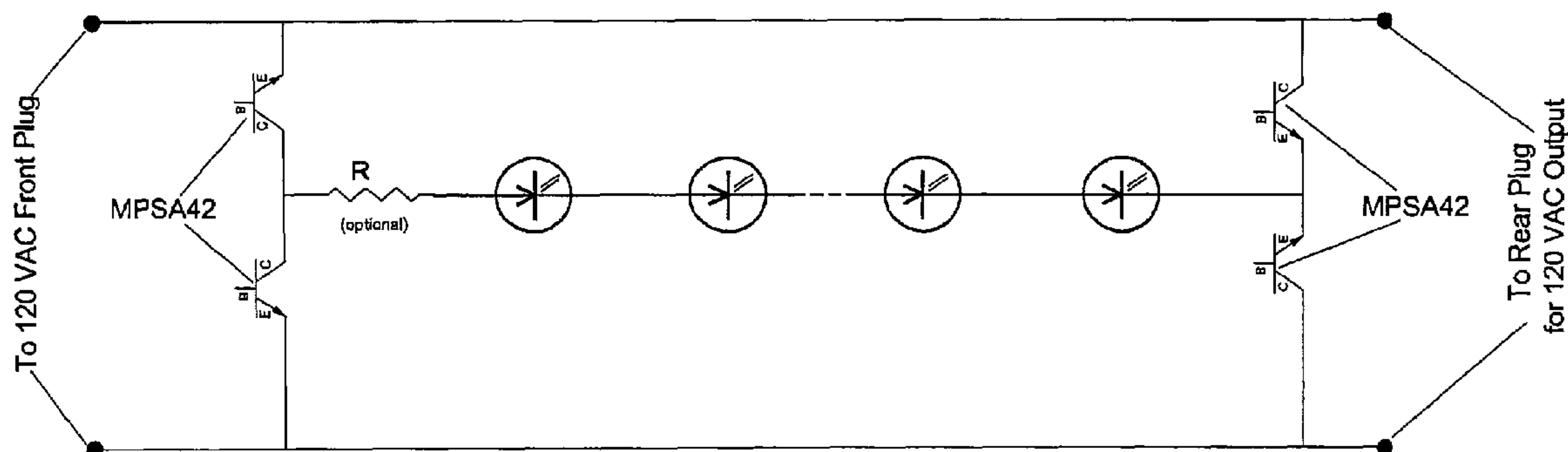
*Primary Examiner* — Angela M Lie

(74) *Attorney, Agent, or Firm* — Blank Rome LLP

(57) **ABSTRACT**

A split bridge circuit for rectifying the alternating current house supply into direct current (D.C.), using hi-polar transistor as rectifying devices. Using specified terminals of the bi-polar transistors results in a high forward voltage drop across the transistors (particularly as compared to the voltage drop across diode rectifiers in the prior art circuits), which reduces ripple significantly and lessens, or even eliminates, the need for a series limiting resistor in the circuit.

**14 Claims, 3 Drawing Sheets**



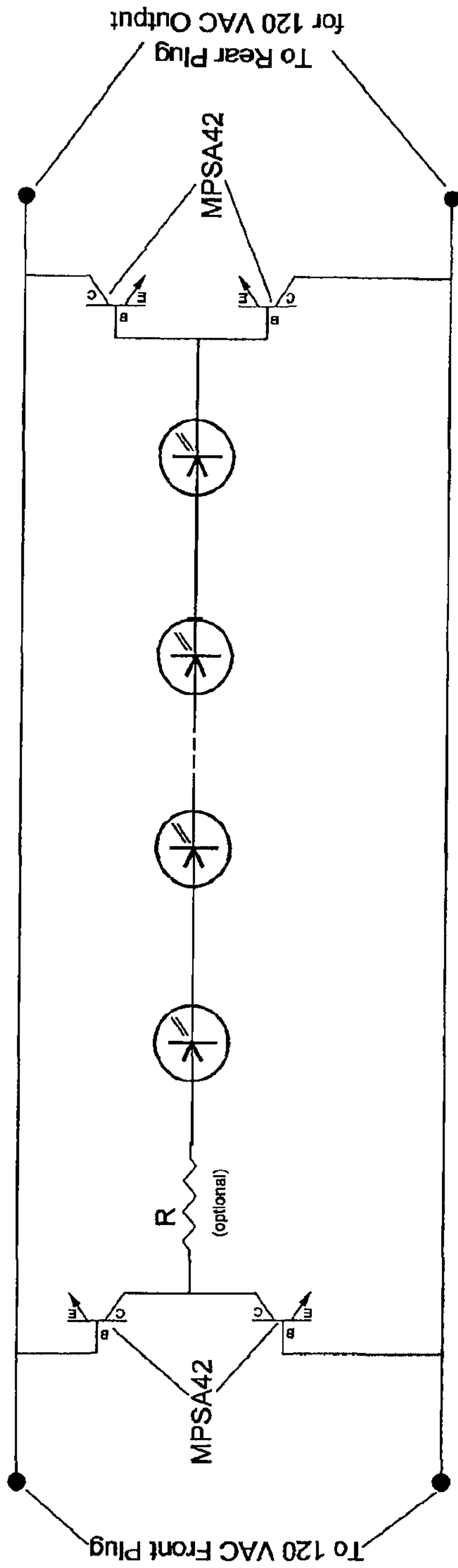


Figure 1

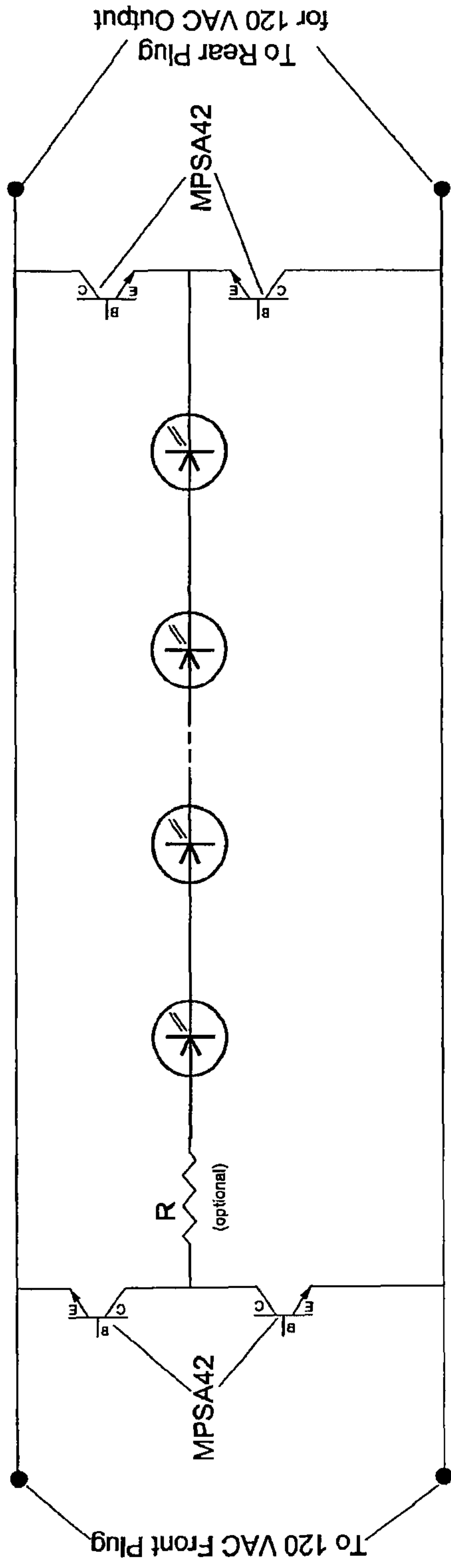


Figure 2

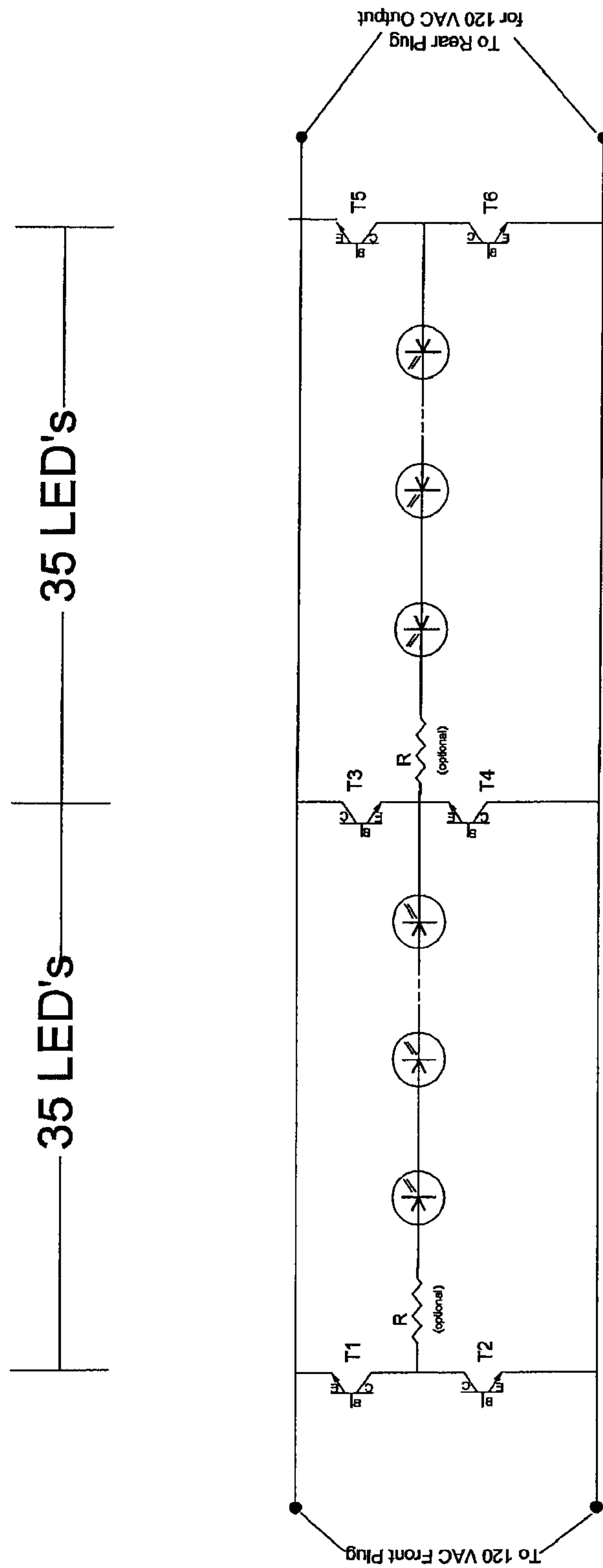


Figure 3



## 1

FULL WAVE LOW FLICKER LED LIGHT  
STRING

**Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.**

This application claims the benefit of U.S. Provisional Application No. 61/863,864, filed Aug. 8, 2013, the disclosure of which is herein incorporated by reference.

## BACKGROUND OF THE INVENTION

Present day Christmas lighting and decorating is now done mostly by using light emitting diodes (LED's). LED light strings, with multiple LED's, are usually wired in electrical series and powered by rectified alternating current (A.C.). Some light strings are powered by half-wave rectification using a single rectifier diode while others are powered by full-wave rectified 120 volt A.C. yielding better brightness and less flicker. Since light emitting diodes are DC devices and emit light according to the voltage applied, any variation in voltage will cause a variation in brightness—thus flickering. This flicker is annoying to some people, even though at full-wave rectification it occurs 120 times per second.

To achieve low flicker in an LED light string, it is necessary to rectify the 120 volt A.C. supply voltage into D.C. (direct current) as ripple free as possible. This is usually done by using a full wave bridge rectifier circuit. However, for light strings with end-to-end connectors, this usually means four wires need to go “down the line”. In U.S. Pat. No. 6,972,528, Shao teaches a circuit in which the full wave rectifier is split into two groups—one group of two rectifiers connected at the front end of the string and the other group of two rectifiers connected at the end of the light string, i.e., a split bridge circuit. In U.S. Pat. Nos. 7,649,322 and 8,072,152, Neuman et al., teaches a similar split bridge approach, but uses an LED in series with each rectifier diode in the split bridge structure.

## SUMMARY OF THE INVENTION

The present invention provides a split bridge circuit for rectifying the alternating current house supply into direct current (D.C.) using bi-polar transistor as rectifying devices. Using specified terminals of the bi-polar transistors results in a high forward voltage drop across the transistors (particularly as compared to the voltage drop across diode rectifiers in the prior art circuits), which reduces ripple significantly and lessens, or even eliminates, the need for a series limiting resistor.

Other advantages, variations and other features of the invention will become apparent from the drawings, the further description of examples and the claims to follow.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows the split bridge circuit of the present invention employing transistors, using the collector and base terminals of the transistors, with the emitter terminal of the transistors floating.

## 2

FIG. 2 shows the split bridge circuit of the present invention, with the emitter and collector terminals of the transistors connected in their opposite polarity direction with the base terminal of these transistors not connected.

FIG. 3 shows an embodiment of the split bridge circuit of the present invention using a single pair of rectifying transistors in the center of the light string.

DETAILED DESCRIPTION OF THE  
PREFERRED EMBODIMENTS

Referring first to FIG. 1, the split bridge circuit of the present invention is shown, employing transistors such as the MPSA42 or other low cost small signal transistors with a suitable  $V_{cbo}$  of 180 volts or more. The emitter terminal of the transistors float and do not get connected. Only the collector and base terminals are used. To avoid having to use an optional series resistor R, the number of light emitting diodes can be increased to 40 LED's connected in electrical series, in the light string. LED's used in Christmas light strings are usually rated at 20 milliamperes. With 40 LED's in the light string of FIG. 1, this works out nicely. As known to those skilled in the art, strings can be made in multiples of 40 LED's, such as 80 or 120 lights in the string.

The transistors at the front end of the light string can be mounted inside the front 120 VAC plug. Likewise, the transistors at the end of the light string can be mounted inside the rear plug.

Another split bridge circuit of the present invention for rectifying alternating current uses bi-polar junction transistors as rectifying devices with their base terminal not connected. This is shown in FIG. 2, where the emitter and collector terminals of the transistors are connected in their opposite polarity direction with the base terminal of these transistors not connected. Because the forward voltage drop of such rectifying devices with the base terminal floating is high at approximately about 6.5 volts,—compared to approximately 0.7 volts for the standard silicon rectifier diodes—and because in a bridge rectifier circuit, current travels through two devices in electrical series resulting in a total forward voltage drop of about 13 volts for transistors, as compared to about 1.4 volts for rectifier diodes, the ripple found in prior art circuits is virtually eliminated, and the optional resistor R may not be needed. Such a light string would employ 35 LED's wired in electrical series. As before, strings with multiples of 35 LED's can be made having 70 or 105 lights.

The circuit shown in FIG. 3 uses a single pair of rectifying transistors in the center of the light string. This single rectifying transistor pair is used in both halves of the light string to rectify alternating current.

As mentioned previously, the resistor R shown in the figures is optional. It may be necessary in some cases to provide a current limiting means and is therefore used.

Although the invention has been described in detail in connection with the exemplary embodiments, it should be understood that the invention is not limited to the above disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alternations, substitutions, or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention.

Accordingly, the invention is not limited by the foregoing description or drawings, but is only limited by the scope of the appended claims.



I claim:

1. A series wired light string comprising:

(a) at least 30 light emitting diodes (LED's) connected in electrical series; and

(b) a split bridge rectifying circuit for powering the series connected LED's, the split bridge rectifying circuit comprising:

(i) a first half bridge rectifying circuit formed of two transistors as rectifying devices, using only the emitter and collector terminals of the transistors, with the base terminal not connected, and

(ii) a second half bridge rectifying circuit formed of two transistors as rectifying devices, using only the emitter and collector terminals of the transistors, with the base terminal not connected;

wherein the series connected LED's are connected between the first and second halves of the bridge rectifying circuit, and

wherein the first half bridge rectifying circuit is connected to a first AC plug and the second half bridge rectifying circuit is connected to a second AC plug.

2. The light string of claim 1, comprising 40 LED's connected in electrical series.

3. The light string of claim 1, where 35 LED's are connected in electrical series and an optional series resistance of approximately 750 ohms is included in the series light string.

4. The light string of claim 1, where the two transistors of the first half bridge rectifying circuit are mounted inside first AC plug and the two rectifying transistors of the second half bridge rectifying circuit are mounted inside the second AC plug.

5. The light string of claim 1, wherein the transistors of the first and second split bridge rectifying circuits have a  $V_{cbo}$  of at least 180 volts.

6. The light string of claim 1, wherein the transistors of the first and second split bridge rectifying circuits are bi-polar junction transistors.

7. The light string of claim 1, further comprising a third pair of rectifying transistors disposed in the middle of the light string, using only the emitter and collector terminals of the third pair of transistors, with the base terminal not connected.

8. *A series wired light string comprising: (a) a plurality of light emitting diodes (LEDs) connected in electrical series; and (b) a split bridge rectifying circuit for powering the series connected LED's, the split bridge rectifying circuit comprising: (i) a first half bridge rectifying circuit formed of two transistors as rectifying devices and (ii) a second half bridge rectifying circuit formed of two transistors as rectifying devices; wherein the series connected LEDs are connected between the first and second halves of the bridge rectifying circuit, and wherein the first half bridge rectifying circuit is connected to a first AC plug and the second half bridge rectifying circuit is connected to a second AC plug.*

9. *The light string of claim 8, comprising 40 LEDs connected in electrical series.*

10. *The light string of claim 8, comprising at least 35 LEDs connected in electrical series.*

11. *The light string of claim 8, where the two transistors of the first half bridge rectifying circuit are mounted inside first AC plug and the two rectifying transistors of the second half bridge rectifying circuit are mounted inside the second AC plug.*

12. *The light string of claim 8, wherein the transistors of the first and second split bridge rectifying circuits have a  $V_{cbo}$  of at least 180 volts.*

13. *The light string of claim 8, wherein the transistors of the first and second split bridge rectifying circuits are bi-polar junction transistors.*

14. *The light string of claim 8, further comprising a third pair of rectifying transistors disposed in the middle of the light string.*

\* \* \* \* \*