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Tenen

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[54] **BALLAST CIRCUIT FOR GASEOUS DISCHARGE LAMPS**

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[51] **Int. Cl.**[2]..... **H05B 37/00**

[58] **Field of Search**... 315/205, 200, DIG. 4, 209 R, 315/241 R, 242; 321/15

[56] **References Cited**

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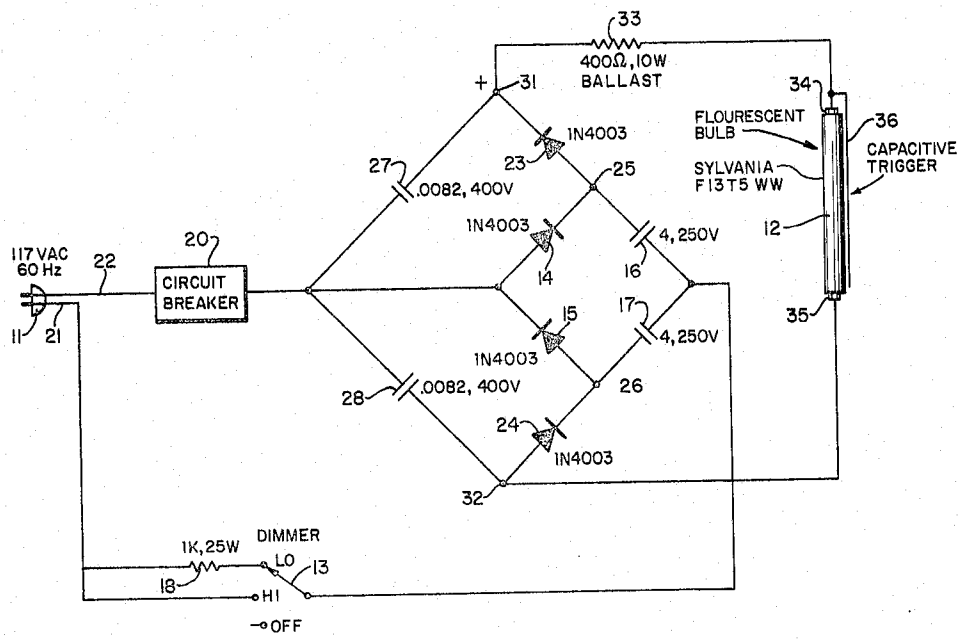
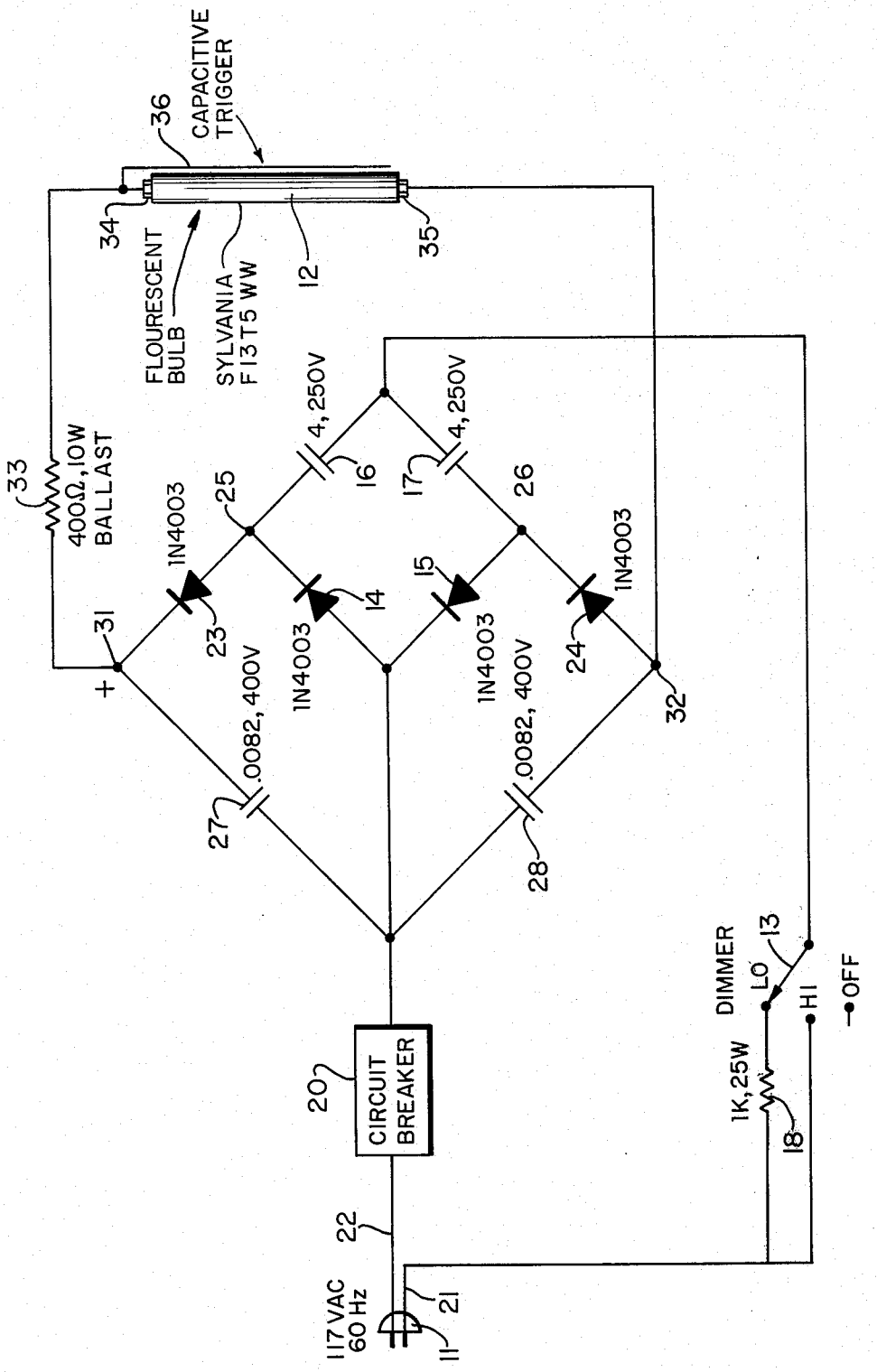
[57] **ABSTRACT**

A ballast circuit for a fluorescent bulb comprises a voltage quadrupler circuit in series with a ballast resistor and the bulb. The quadrupler circuit comprises a voltage doubler circuit whose output voltage is doubled by a second voltage doubler circuit. The first voltage doubler circuit includes a first pair of series capacitors capable of supplying lamp current at operating voltage. The second voltage doubler circuit comprises a pair of series capacitors for providing full quadrupler voltage for no-load triggering but negligible effect under load and have a capacitance that is much smaller than the capacitance of the first doubler capacitors. A variable resistance in series with the first voltage doubler circuit may function as a dimmer control.

6 Claims, 1 Drawing Figure




36
CAPACITIVE TRIGGER
34
FLOURESCENT BULB
SYLVANIA F13T5 WW
12
35
33
400Ω,10W BALLAST
4,250V
16
17
4,250V
25
26
1N4003
23
1N4003
14
15
1N4003
24
1N4003
31
+
.0082, 400V
27
.0082, 400V
28
32
20
CIRCUIT BREAKER
22
117 VAC 60 Hz
21
11
DIMMER
13
LO
HI
OFF
1K, 25W
18

BALLAST CIRCUIT FOR GASEOUS DISCHARGE LAMPS

BACKGROUND OF THE INVENTION

The present invention relates in general to ballast circuits for fluorescent lights and more particularly concerns novel apparatus and techniques for initially igniting a fluorescent or other gaseous discharge lamp and efficiently sustaining ignition with a compact quiet economical lightweight circuit that provides the additional feature of facilitating economical intensity control over a continuous range of intensities.

It is an important object of this invention to provide an improved ballast and starter circuit for gaseous discharge lamp, such as a fluorescent bulb.

It is a further object of the invention to achieve the preceding object while providing especially convenient means for controlling lamp intensity.

It is a further object of the invention to achieve one or more of the preceding objects with a circuit comprising low-cost electronic components.

It is still a further object of the invention to achieve one or more of the preceding objects with a circuit capable of energizing a number of fluorescent lamps in parallel.

It is another object of the invention to achieve one or more of the preceding objects with compact economical apparatus that is relatively easy and inexpensive to fabricate by relatively inexperienced personnel and functions reliably for relatively long intervals.

SUMMARY OF THE INVENTION

According to the invention, there is a first voltage doubler circuit in series with an a-c power source. The first voltage doubler circuit includes means for substantially doubling the voltage across an input terminal pair and comprises first and second unilaterally conducting devices connected in series and shunted by first and second capacitors connected in series to form a bridge circuit means for receiving a-c energy applied between the junction of the unilaterally conducting devices and the junction of the first and second capacitors. Third and fourth unilaterally conducting devices are connected in series between respective ones of the junctions between unilaterally conductive devices and capacitors in the bridge circuit means and a gas discharge lamp. Third and fourth capacitors are connected in series across the series combination of the four unilaterally conducting devices. The junction of the third and fourth capacitors is connected to the junction of the first and second unilaterally conducting devices.

A ballast resistor is connected in series between the four unilaterally conducting devices and the gas discharge lamp. An optional capacitive trigger electrode adjacent to the bulb is connected to the junction of the ballast resistor and a terminal of the lamp. In a preferred form of the invention a variable resistance is connected in series between the bridge circuit means and the input terminals for controlling the current to and brightness of the lamp.

Numerous other features, objects and advantages of the invention will become apparent from the following specification when read in connection with the accompanying drawing,

BRIEF DESCRIPTION OF THE DRAWING

the single FIGURE of which is a schematic circuit diagram of an exemplary embodiment of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

With reference now to the drawing, there is shown a schematic circuit diagram of an exemplary embodiment of the invention in which power from conventional a-c plug **11** ignites and illuminates fluorescent bulb **12** when switch arm **13** is moved to the high or low positions. While the specific embodiment includes a fluorescent bulb, the principles of the invention are applicable to other gas discharge lamps, such as an HeNe gas laser tube.

The circuit comprises voltage doubler diodes **14** and **15** shunted by voltage doubler capacitors **16** and **17.** The junction of capacitors **16** and **17** is connected to terminal **21** of a-c plug **11** through switch arm **13** and through dimmer resistance **18** in the low position as shown and directly when in the high position. The junction between diodes **14** and **15** is connected to the other terminal **22** of a-c plug **11** through circuit breaker **20.**

Trigger diodes **23** and **24** are connected to junctions **25** and **26,** respectively, of the voltage doubler bridge circuit comprising diodes **14** and **15** and capacitors **16** and **17.** Trigger capacitors **27** and **28** are connected in series across the four diodes **14, 15, 23** and **24** between +junction **31** and −junction **32.** The junction of capacitors **27** and **28** is connected to terminal **22** of a-c plug **11** and the junction of diodes **14** and **15.**

A ballast resistor **33** is connected between positive junction **31** and electrode **34** of fluorescent lamp **12.** The other electrode **35** of fluorescent lamp **12** is connected to negative junction **32.** A capacitive trigger electrode **36** adjacent fluorescent lamp **12** is also connected to electrode **34.** Representative parameter values are set forth on the diagram.

Having described the physical arrangement of circuit components, the mode of operation will now be described. It is convenient to initially assume that switch arm **13** is in the off position with lamp **12** then extinguished and presenting a relatively high impedance between junctions **31** and **32.** When switch arm **13** is moved to either the high or low positions, very shortly thereafter substantially four times the peak potential between terminals **21** and **22** appears between terminals **31** and **32,** and, hence, between capacitive trigger electrode **36** and lamp electrode **35** to thereby ignite lamp **12.** When lamp **12** ignites, its impedance drops, the current through it increases and the voltage between electrodes **34** and **35** drops because most of the current then flows through capaciitors **16** and **17** of much lower impedance than trigger capacitors **27** and **28** so that the voltage increasing effect of the trigger capacitors is then negligible. The current through fluorescent bulb **12** is then limited by ballast resistor **33** and dimmer resistor **18** with switch arm **13** in the low position as indicated.

While in the specific example shown, dimming is indicated as being effected by switching in a fixed resistor, it is within the principles of the invention to use a variable resistance to provide a continuous range of light intensity. It is also within the principles of the invention to have the variable resistance comprise a pho-

tocell characterized by a resistance that is inversely proportional to light intensity so that the brightness of lamp **12** would track the ambient light level. That is to say, as the ambient light level increased, the intensity of lamp **12** would increase.

It is evident that various components may be interchanged. For example, ballast resistor **33** could be in the lead between junction **32** and electrode **35.** The switch and dimmer assembly could be connected in the lead from terminal **22.**

It is also within the principles of the invention to use higher voltage multiplying coefficients, for example six and eight which would be required for use with an HeNe gas laser tube, for example.

It is evident that those skilled in the art may now make numerous other modifications and uses of and departures from the specific embodiments described herein without departing from the inventive concepts. Consequently, the invention is to be construed as embracing each and every novel feature and novel combination of features present in or possessed by the apparatus and techniques herein disclosed and limited solely by the spirit and scope of the appended claims.

What is claimed is:

1. A gas discharge lamp starting and ballast circuit comprising,

an input terminal pair for receiving a-c energy,

first voltage doubler circuit means coupled to said input terminal pair for substantially doubling the peak voltage between said input terminal pair and comprising first and second unilaterally conductive devices connected in series and poled in the same sense shunted by first and second capacitors connected in series to form a bridge circuit having four junctions with the junction between said first and second unilaterally conductive devices coupled to one terminal of said input terminal pair and the junction between said first and second capacitors coupled to the other terminal of said input terminal pair,

second voltage doubler circuit means for selectively substantially doubling the voltage provided by said first voltage doubler circuit means and comprising third and fourth unilaterally conducting devices separated by, connected in series with and poled in the same sense as said first and second unilaterally conducting devices and third and fourth capacitors connected in series across the series combination of said first, second, third and fourth unilaterally conducting devices with the junction of said third and fourth capacitors coupled to the junction between said first and second unilaterally conducting devices,

the impedance of said first and second capacitors being much lower than the impedance of said third and fourth capacitors whereby the current flowing through said first and second capacitors when a gas discharge lamp is connected in series between the junction of said third capacitor with said third unilaterally conducting device and the junction between said fourth capacitor with said fourth unilaterally conducting device is so much greater than the current then flowing through said third and fourth capacitors that the voltage increasing effect of said third and fourth capacitors is then negligible,

whereby said first voltage doubler circuit means, said second voltage doubler circuit means and said gas discharge lamp may comprise means for initially establishing both said voltage doubler circuit means operative for providing an output voltage more than twice the peak voltage between said first and second voltage doulber circuit means from said input terminal pair and thereafter rendering only said first voltage doubler circuit means operative for providing at the output of said first and second voltage doubler circuit means a voltage substantially twice that between said input terminal pair.

2. A gas discharge lamp starting and ballasting circuit in accordance with claim **1** and further comprising said gas discharge lamp direct coupled between the junction of said third capacitor with said third unilaterally conducting device and the junction of said fourth capacitor with said fourth unilaterally conducting device.

3. A gas discharge lamp starting and ballasting circuit in accordance with claim **1** and further comprising,

variable resistance means connected in series between said input terminal pair and said first voltage doubler circuit means for controlling the current delivered by said voltage doubler circuit means to control the intensity of a lamp attached thereto.

4. A gas discharge lamp starting and ballast circuit in accordance with claim **1** and further comprising,

said gas discharge lamp direct coupled between the junction of said third unilaterally conducting device with said third capacitor and the junction of said fourth unilaterally conducting device with said fourth capacitor,

and variable impedance means coupled between said input terminal pair and said first voltage doubler circuit means for selectively controlling the brightness of said lamp.

5. A gas discharge lamp starting and ballast circuit in accordance with claim **1** and further comprising,

said gas discharge lamp direct coupled between the junction of said third unilaterally conducting device with said third capacitor and the junction of said fourth unilaterally conducting device with said fourth capacitor,

trigger electrode means capacitively coupled to said gas discharge lamp and direct coupled to the junction of said third unilaterally conducting device with said third capacitor for initially coupling said output voltage more than twice the peak voltage to said lamp for igniting said lamp.

6. A gas discharge lamp starting and ballast circuit in accordance with claim **5** and further comprising ballast impedance means connected between the junction of said third unilaterally conducting device with said third capacitor and said gas discharge lamp for limiting the current through said lamp when said lamp is conducting.

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