United States Patent [19]

Nuckolls et al.

[11] **Patent Number: 5,047,694**

[45] **Date of Patent: Sep. 10, 1991**

[54] **LAMP STARTING CIRCUIT**

[75] Inventors: **Joe A. Nuckolls; Isaac L. Flory, IV,** both of Blacksburg, Va.

[73] Assignee: **Hubbell Incorporated,** Orange, Conn.

[21] Appl. No.: **374,068**

[22] Filed: **Jun. 30, 1989**

[51] **Int. Cl.**[5] **H05B 41/14**

[52] **U.S. Cl.** **315/290;** 315/276; 315/205; 315/289; 315/DIG. 5

[58] **Field of Search** 315/290, 205, 239, 289

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,679,936	7/1972	Moerkens	315/289
3,699,385	10/1972	Paget	315/239
3,710,184	1/1973	Williams	315/227
3,771,014	11/1973	Paget	315/136
3,889,152	6/1975	Bodine, Jr. et al.	315/205
3,917,976	11/1975	Nuckolls	315/258
4,072,878	2/1978	Engel et al.	315/289
4,092,565	5/1978	Neal	315/290
4,143,304	3/1979	Hitchcock et al.	315/289
4,209,730	1/1980	Pasik	315/290
4,337,417	1/1982	Johnson	315/290
4,415,837	11/1983	Sodini	315/207
4,416,982	7/1984	Fähnrich	315/290

FOREIGN PATENT DOCUMENTS

0046684	4/1977	Japan	315/290
0010584	1/1979	Japan	315/290
0068080	5/1979	Japan	315/290

Primary Examiner—Eugene R. Laroche
Assistant Examiner—Son Dinh
Attorney, Agent, or Firm—Jerry M. Presson; Walter C. Farley

[57] **ABSTRACT**

A hot restart circuit includes a storage capacitor and SCR connected across a tapped portion of a ballast with a breakdown device to start the SCR. A charging circuit for the storage capacitor includes a diode, pumping capacitor and choke in series from the ballast tap to the AC line and a further diode interconnecting the capacitors. The pumping capacitor increases the charge on the storage capacitor in a step-wise fashion until the breakdown voltage is reached, whereupon starting pulses are applied to the lamp.

4 Claims, 3 Drawing Sheets

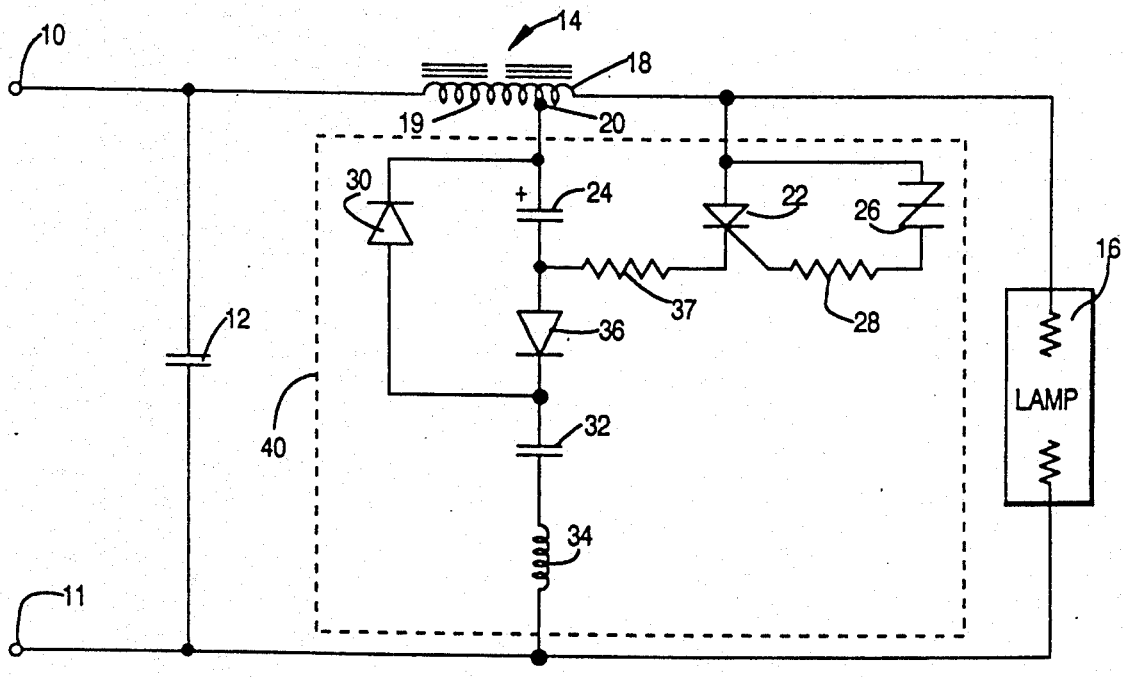


FIG. 1

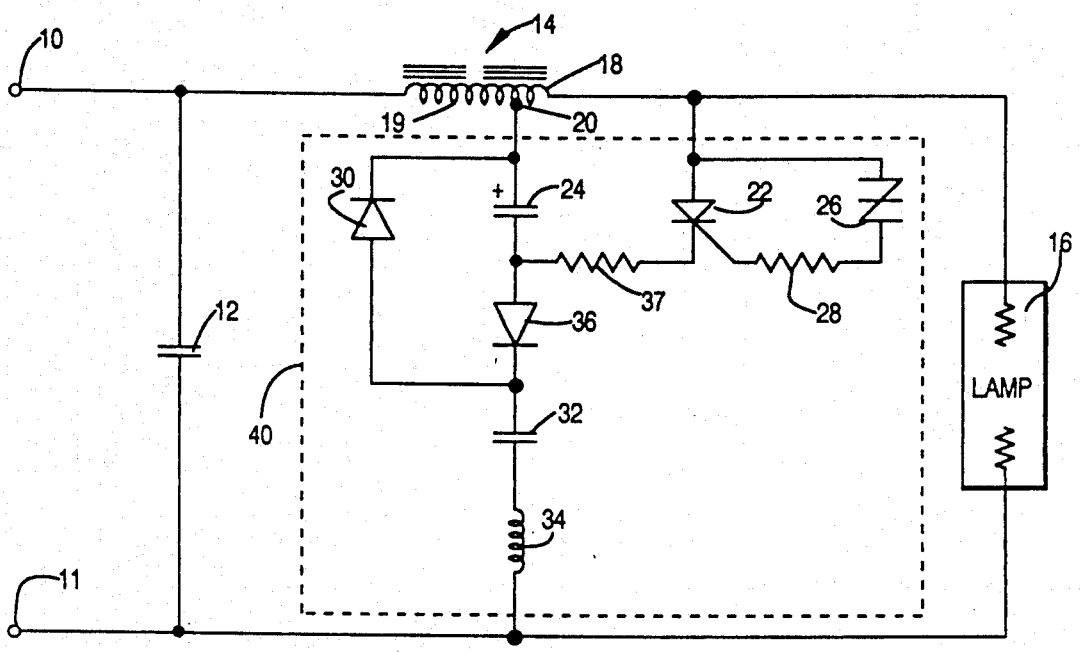


FIG. 2

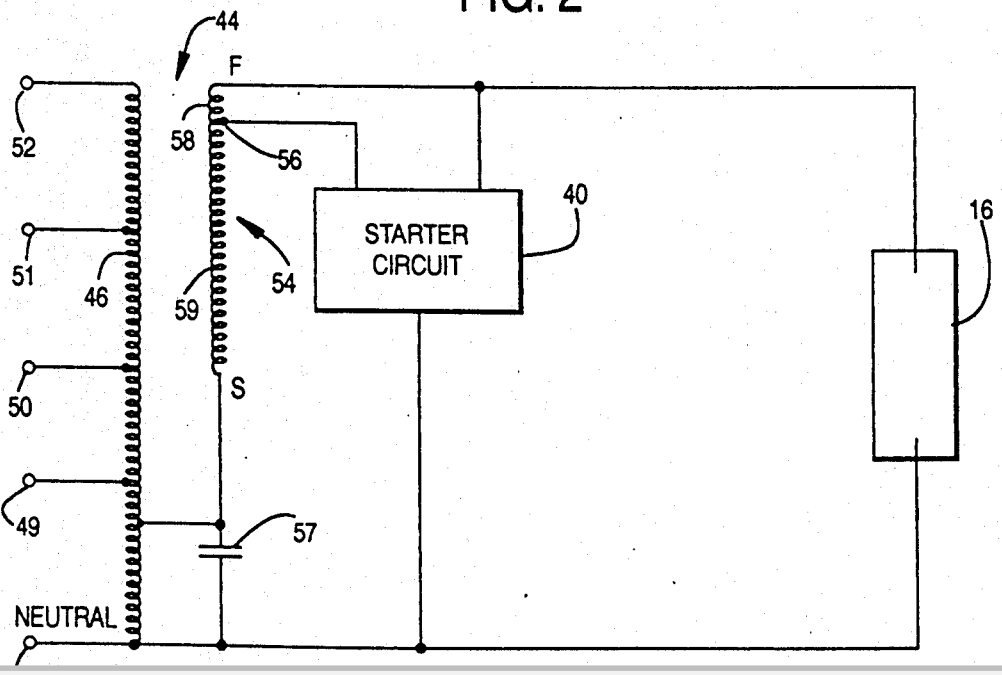


FIG. 3

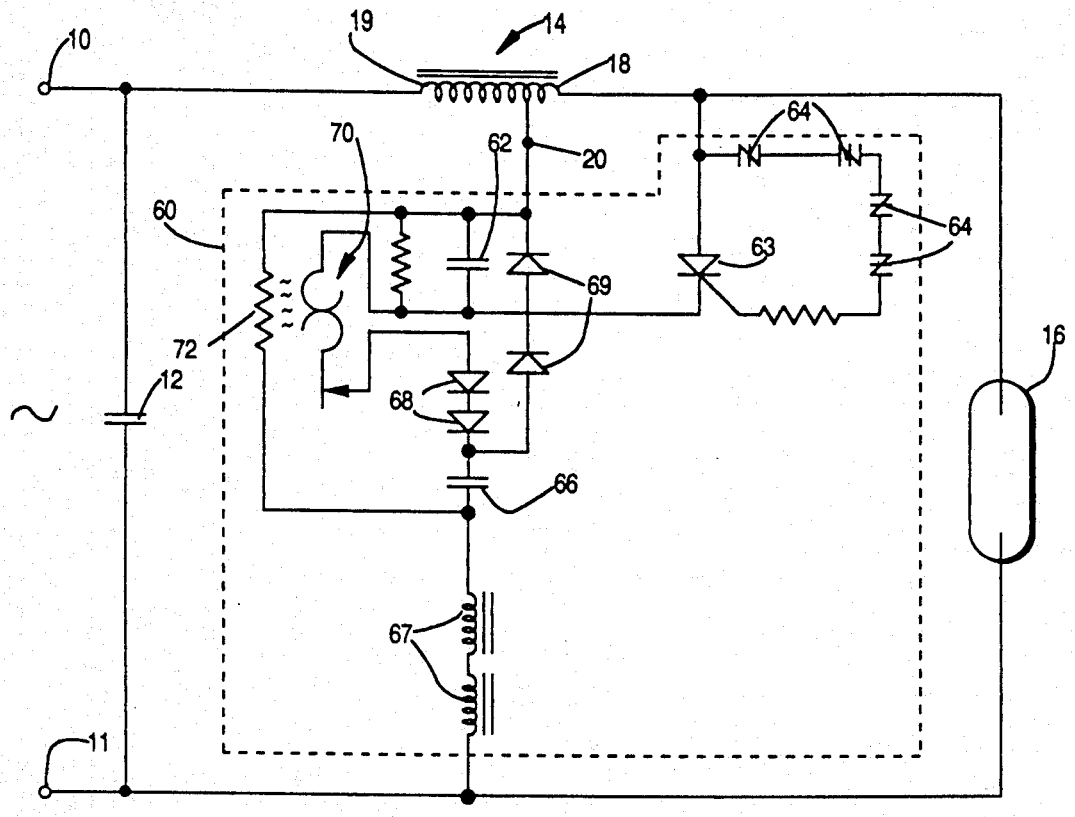


FIG. 4

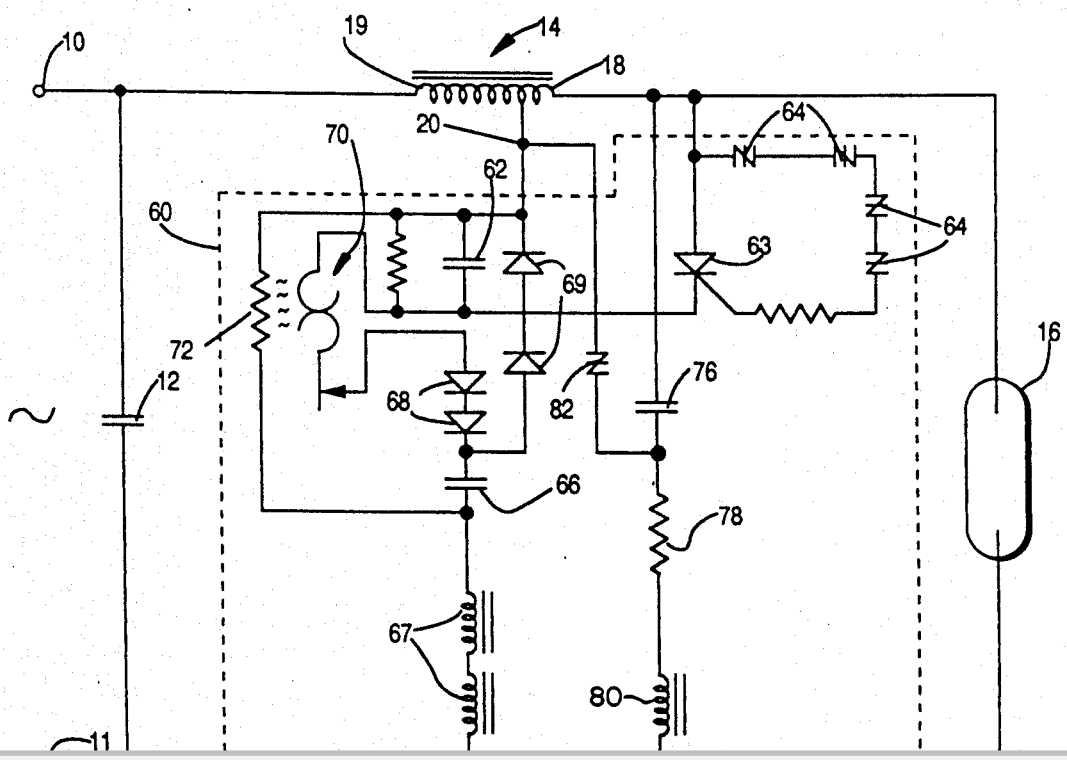
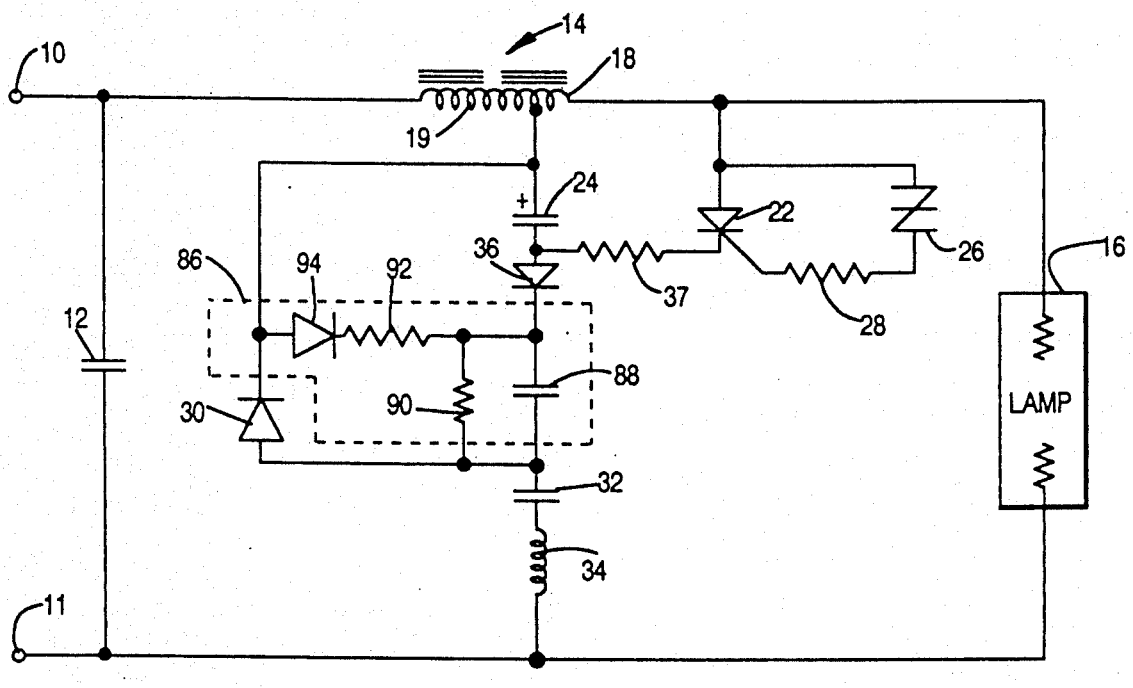


FIG. 5



LAMP STARTING CIRCUIT

This invention relates to an improved circuit for starting, operating and hot restarting a high pressure sodium (HPS) lamp using a simple, non-resistive circuit which incorporates a voltage multiplying technique.

BACKGROUND OF THE INVENTION

As is well known in this art, HPS lamps, generally speaking, are difficult to start and require special circuitry for restarting if the lamp is extinguished after sufficient operation to elevate its temperature. This is normally referred to as hot restarting and is known to require high voltage across the lamp, considerably higher than the line operating voltage.

Numerous circuits have been developed for the purpose of hot restarting such lamps, as well as starting and operating circuits, and many of those circuits operate quite satisfactorily. However, the operative circuits which are commonly used include numerous resistors and/or pulse transformers, apart from the conventional ballast, to accomplish the starting operation. The resistors, which are commonly low resistance but have high wattage ratings, generates significant heat, necessitating special designs to either extract the heat or package the circuit in such a way that the heat does not damage other components. In addition to the heat generation, the resistive losses are wasteful of energy and the use of the resistors as well as pulse transformers increase the cost of the circuits.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide an HPS lamp starting, operating and hot restarting circuit in which the hot restarting circuit is non-resistive in the sense of not requiring any separate resistive components which would introduce losses and generate heat.

A further object is to provide a circuit which is simple and has a minimum of components and includes no separate pulse transformer.

Briefly described, the invention includes a starting, operating and hot restarting circuit for a high pressure sodium lamp comprising the combination of terminals connectable to an AC source, connector means connectable to a high pressure sodium lamp and an inductive ballast connected between the terminals so as to be in series with the lamp across the AC source. The ballast includes first and second winding portions with a tap at the junction of those portions, the second portion having a significantly larger number of windings than the first. A semiconductor switch is connected to the first portion of the ballast at the junction of the ballast with the lamp connector and a storage capacitor is connected between the tap and the other end of the semiconductor switch. A voltage sensitive breakdown device is connected across the switch so as to respond to the capacitor voltage and to breakdown when its voltage threshold is reached, placing the switch into conduction. The switch and capacitor are connected to the first portion so that, when the switch conducts, a pulse of current passes through the first portion, inducing a large voltage in the second portion which is applied to the lamp to start the lamp. A charging circuit is connected between the tap and the other side of the line, oppositely poled from the first, connected between the pumping capacitor and the junction of the storage capacitor with the switch. The diode polarities are such that the pumping capacitor is charged during one half of each AC cycle and the storage capacitor is charged during the other half of each cycle to a voltage higher than the half cycle amplitude of the source by an amount proportional to the charge on the pumping capacitor, the voltage on the storage capacitor thus increasing during each cycle until the breakdown device conducts.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to impart full understanding of the manner in which these and other objects are attained in accordance with the invention, particularly advantageous embodiments thereof will be described with reference to the accompanying drawings, which form a part of this specification and wherein:

FIG. **1** is a schematic circuit diagram of a hot restart circuit in accordance with the present invention;

FIG. **2** is a schematic circuit diagram, partly in block form, of a starter circuit in accordance with FIG. **1** used with an auto-lag ballast;

FIG. **3** is a further embodiment of a circuit in accordance with the present invention incorporating a thermal disabling device;

FIG. **4** is a schematic circuit diagram of a further embodiment of a starting and operating circuit in accordance with the present invention; and

FIG. **5** is a further embodiment of a circuit in accordance with the present invention incorporating an electronic disabling device.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the circuit shown in FIG. **1**, terminals **10** and **11** are provided so as to be connectable to a suitable AC source which would typically be 240 V. line voltage. A power factor correcting capacitor **12** is connected between terminals **10** and **11** in a conventional manner. An inductive ballast indicated generally at **14** has one end terminal connected to terminal **10** and the other end terminal connected to one terminal of a high pressure sodium lamp **16**, the other side of lamp **16** being connected to terminal **11**. Thus, the ballast and lamp are in series circuit relationship with each other across the AC source terminals.

Ballast **14** is a tapped ballast such that it has a first winding portion **18** and a second winding portion **19** which are inductively coupled, portion **18** constituting a much smaller number of windings than portion **19**, preferably on the order of about 5% of the total number of windings of the ballast. A tap **20** is provided at the junction between winding portions **18** and **19**.

A semiconductor switch **22** such as a silicon-controlled rectifier (SCR) or the like is connected so that one end of its switchable conductive path is connected to the end of first portion **18** of the ballast and a storage capacitor **24** has one end connected to tap **20**. The other end of the capacitor is connected to the other end of the conductive path of SCR **22**. A sidac **26** or other breakdown device is connected between the gate and anode of the SCR, a current-limiting resistor **28** being included in series with the sidac if the characteristics thereof require current limitation.

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.