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ULTRAVIOLET LAMP TRANSFORMER

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Fig. 1.

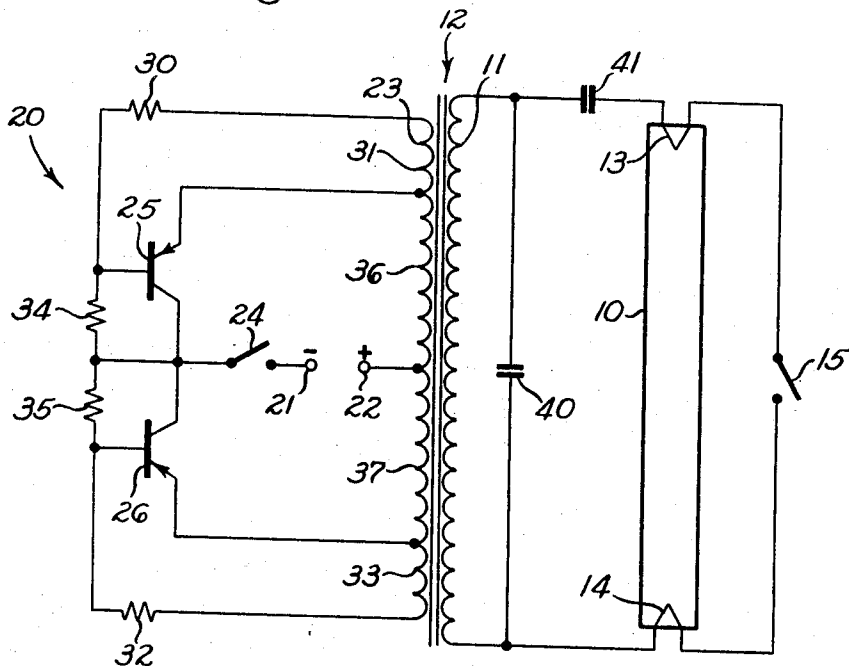


Fig. 2.

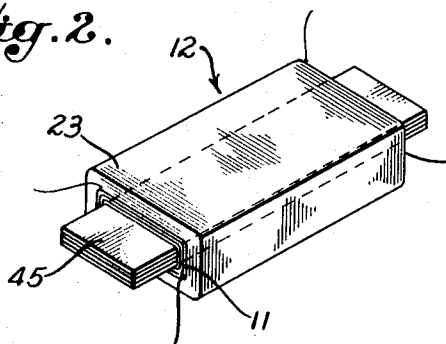
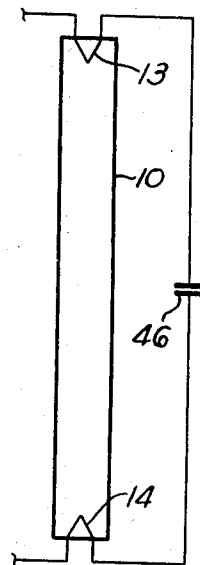


Fig. 3.



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ULTRAVIOLET LAMP TRANSFORMER

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3 Claims. (Cl. 315-219)

This invention relates to circuits for gas or vapor discharge devices such as ultraviolet lamps and, in particular, to a new and improved transformer and power supply.

Fluorescent lamps for room lighting are ordinarily operated at line voltage from A.C. power sources and transformers are not utilized in the circuitry. However, in many applications of lamps of the gas or vapor discharge type, transformers are utilized for voltage changing and/or as a part of equipment for power conversion from D.C. to A.C. Compact, portable, battery operated units are presently in demand and it is an object of this invention to provide a new and improved lamp circuit that is particularly adapted for use in small battery operated units.

It is an object of the invention to provide a new and improved transformer for use in a lamp circuit. A further object is to provide such a transformer which will serve a number of functions and which is small, compact and inexpensive. A particular object is to provide such a transformer which will have the leakage inductance to function as a ballast for lamp operation and which can be used to provide the desired voltage stepup from the A.C. at the primary and which can be used as a portion of a D.C. to A.C. inverter.

It is an object of the invention to provide for a lamp circuit, a transformer having a primary winding for connection to an A.C. power source and a secondary winding for connection in series with a tube, the transformer having a core with an open magnetic flux path with the primary and secondary windings disposed on the core. A further object is to provide such a structure in which the transformer is in the form of a bar, typically a stack of rectangular laminations, with the primary and secondary windings in the form of solenoid coils carried on the bar.

It is an object of the invention to provide such a transformer which can be used in lamp circuits employing various starting techniques, such as a starter switch, or a starter capacitor, or a high voltage start without a starter unit.

These and other objects of the invention will more fully appear in the course of the following description. The drawing merely shows and the description merely describes preferred embodiments of the present invention which are given by way of illustration or example.

In the drawing:

FIG. 1 is a schematic diagram of a preferred embodiment of the electrical circuit incorporating a starter switch;

FIG. 2 is an isometric view of the preferred form of transformer construction; and

FIG. 3 is an alternative form of a portion of the diagram of FIG. 1, illustrating a capacitor used as the starter unit.

A tube 10 may be operated from an A.C. power source such as that appearing at the secondary 11 of a transformer 12 by connecting the filaments 13, 14 of the lamp and a starting switch 15 in series with an inductive ballast. When a transformer is utilized, the transformer secondary may function as the inductive ballast provided the transformer has sufficient leakage inductance. With A.C. power on the transformer secondary and the starting switch 15 temporarily closed, the filaments 13, 14 are heated and energy is stored in the ballast (the winding 11). When the starting switch 15 is opened, the energy stored in the winding 11 produces a high voltage pulse in the circuit

and fires the tube into conduction. The tube then continues to operate so long as the A.C. voltage supply is on.

The tube 10 typically may be a gas discharge lamp producing ultraviolet radiation and may incorporate phosphors which produce additional radiation of different wavelengths, including visible light.

In the circuit of FIG. 1, a transistorized inverter circuit 20 is energized from a battery or other D.C. source connected at terminals 21, 22. The inverter 20 is a conventional circuit and utilizes the primary 23 of the transformer as a portion of the inverter.

The inverter is turned on by closing switch 24. The circuit is self starting and current will initially flow through one of the transistors, say the transistor 25. Current will continue through the transistor 25 until it is driven into saturation, at which time the transistor 26 is biased hard on. Conduction is now blocked in the transistor 25 and builds up in the transistor 26. The process is self regenerative and continues cyclically until the switch 24 is opened. The combination of resistor 30 and winding section 31 supplies the appropriate bias voltage for the transistor 25. Similarly, the resistor 32 and winding section 33 supplies the bias voltage for the transistor 26. Resistors 34, 35 supply a fixed bias for the transistors. The current of the transistor 25 passes through the winding section 36 and the current of the transistor 26 passes through the winding section 37. These currents provide the A.C. output from the inverter, producing fluxes in the transformer core which in turn provide the A.C. voltage at the secondary. The capacitor 40 is connected across the secondary winding 11 for the purpose of reducing spike voltages reflected across the transistors. The capacitor 41 is connected in series with the tube to improve the power factor of the circuit.

The preferred construction for the transformer 12 with open magnetic flux path is shown in FIG. 2. The core 45 comprises a stack of rectangular laminations resulting in a core in the form of a straight bar. The secondary winding 11, preferably in the form of a straight solenoid is positioned on the core and the primary winding 23, also preferably in the form of a straight solenoid, is disposed about the secondary winding. While the primary winding is illustrated herein as a single continuous winding with taps for the various sections 31, 36, 37, 33, it should be noted that individual windings could be used if desired. The open magnetic flux path construction of the transformer provides the necessary leakage inductance so that the secondary winding can serve as the ballast for the tube. The transformer serves as a stepup transformer for providing the necessary voltage stepup to operate the tube and it also functions as a portion of the inverter circuit. The transformer is small, simple and inexpensive and permits the achievement of all these desired features without requiring any special winding or special arrangement of windings on the core.

In a typical circuit for operation of a single four-watt tube, from a six-volt battery, transformer core is an eight-piece stack of laminations $\frac{5}{8}$ " x $2\frac{1}{2}$ " of Armco No. M-27 material. The secondary winding 11 comprises 930 turns of No. 32 wire. The primary winding 23 is of No. 27 wire with 20 turns for section 31, 32 turns for section 36, 32 turns for section 37 and 20 turns for section 33. The transistors are Type SP 1073, the resistors 30 and 32 are 10 ohms, the resistors 34 and 35 are 390 ohms, the capacitor 40 is .0033 microfarad and the capacitor 41 is .068 microfarad. The switch 24 is a conventional on-off switch and the switch 15 is a conventional push button switch spring loaded to the off position. Of course, an automatic starter switch could be utilized in place of the manual starter switch 15 if desired.

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FIG. 3 illustrates an alternative circuit utilizing a capacitor 46 as the starter unit in place of the switch 15. When the tube filaments are cold, the impedance of the tube is relatively high and the charging current of the capacitor 46 provides for the filament heating. When the filaments are heated, the tube fires into conduction and the impedance thereof drops to a relatively low value. The current of the capacitor 46 is now relatively small.

In another alternative starting circuit, a higher secondary voltage may be used with the starter unit omitted. This is the least efficient circuit in terms of power consumption, while the starter switch circuit is the most efficient and is preferred in battery powered units.

While the preferred form of inverter circuit has been illustrated herein, it should be noted that the transformer of the invention is not limited to use with this particular inverter and can be used with other inverters and can be used with other sources of A.C. power.

Although exemplary embodiments of the invention have been disclosed and discussed, it will be understood that other applications of the invention are possible and that the embodiments disclosed may be subjected to various changes, modifications and substitutions without necessarily departing from the spirit of the invention.

I claim as my invention:

1. In a circuit for a tube lamp, a transformer having a multisection balanced primary winding for connection to an A.C. power source and a secondary winding for connection in series with a tube, with said primary and secondary windings in the form of concentric solenoid coils disposed on a core in the form of a bar having a substantially uniform cross-sectional area along the axis of said coils providing an open magnetic flux path and substantially uniform flux density in said core within said coils.

2. In a circuit for a tube lamp, the combination of: a D.C. to A.C. inverter; a starter unit connected across a tube; and a transformer having a multisection balanced primary winding connected in circuit with said inverter and

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a secondary winding connected in series with said starter unit, the transformer having a core in the form of a bar having a substantially uniform cross-sectional area providing an open magnetic flux path, with said primary and secondary windings disposed on said core and providing a substantially uniform flux density in said core within said windings.

3. In a circuit for a tube lamp, the combination of: a voltage stepup transformer having a multisection balanced primary winding and a secondary winding, with said windings in the form of concentric solenoid coils disposed on a core in the form of a bar having a substantially uniform cross-sectional area along the axis of said coils providing an open magnetic flux path and substantially uniform flux density in said core within said coils; an inverter circuit for operation from a D.C. power source and connected in circuit with said primary winding for developing an A.C. voltage at said transformer; means for connecting a tube in series with said secondary winding; and a starter switch connected across the tube in series with said secondary winding.

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