Sept. 14, 1954 E. LEMMERS 2,689,315

PREHEAT NEUTRALIZING CIRCUIT FOR FLUORESCENT LAMPS

Filed Nov. 23, 1949

Fig. 1.

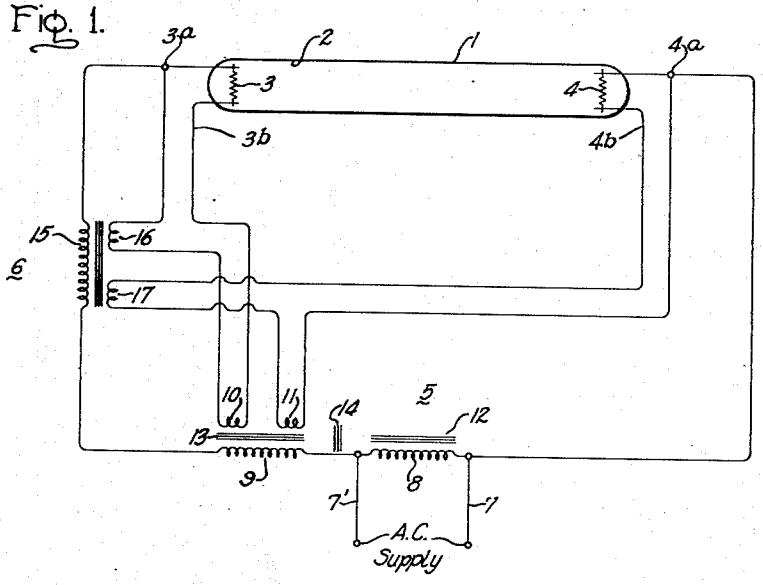
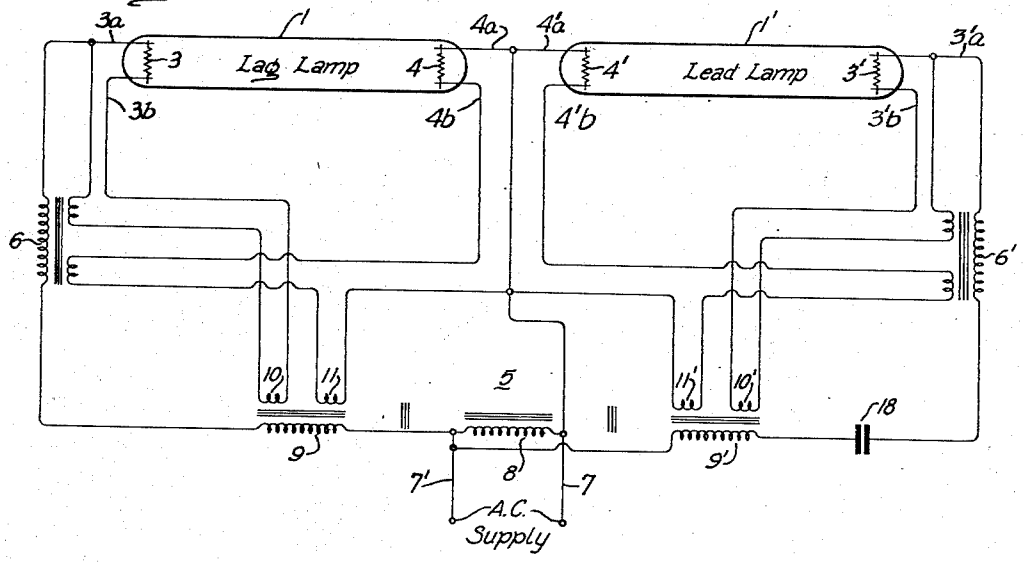


Fig. 2.



Inventor:
Eugene Lemmers,
by Vernet C. Kauffman
His Attorney.

Patented Sept. 14, 1954

2,689,315

UNITED STATES PATENT OFFICE

2,689,315

PREHEAT NEUTRALIZING CIRCUIT FOR FLUORESCENT LAMPS

Eugene Lemmers, Cleveland Heights, Ohio, assignor to General Electric Company, a corporation of New York

Application November 23, 1949, Serial No. 129,157

4 Claims. (Cl. 315—97)

1

My invention relates generally to starting and operating circuits for gaseous electric discharge devices of the type commonly known as fluorescent lamps, and more particularly to a cathode preheating and neutralizing circuit therefor.

The commercially available fluorescent lamps presently on the market may be divided into two generic types, each of which has its own characteristics requiring a particular starting and operating circuit.

The first type is the hot cathode starting lamp, and it is usually operated with relays or thermal switches to allow preheating of the electrodes to electron-emitting temperatures. For instance, the lamp may be connected across a source of voltage in series with a reactor or ballast, and the activated filamentary electrodes of the lamp may be temporarily short circuited by a suitable switch to connect them in series across the source and thereby cause them to be preheated to an electron-emitting temperature. Such circuits provide reliable starting, operate at good efficiencies, and make for long life of the lamp electrodes. However, they suffer from the obvious disadvantages of requiring a switch as an operating element, which switches must be replaced periodically, and from the relatively slow starting occasioned by the preheating period.

The second type is the cold cathode starting lamp, in which the discharge is started directly by means of high voltage transformers without any preheating of the electrodes. Such lamps operate at a voltage much lower than that required for starting; and, accordingly, the transformer unavoidably operates with a relatively high power loss. Moreover, the starting without any preheating of the activated electrodes places them under considerable electrical stress so that their life is appreciably shortened.

In my copending United States application No. 631,381, filed November 28, 1945, now U. S. Patent 2,504,548, issued April 18, 1950, assigned to the same assignee as the present invention, there are disclosed circuits which combine the advantages of both of the above-mentioned methods of operation. These circuits may be described generically as being of the cathode switchless preheating and neutralizing type and permit substantially instantaneous starting of fluorescent lamps without undue sputtering of their electrodes and with relatively low power loss in their ballasts.

In general, cathode preheating and neutralizing circuits operate on the principle of applying electrode voltage and heating current simultaneously to the electrodes of fluorescent lamps. The heating current provided to the electrodes causes them to arrive quickly at an electron-emitting temperature, whereupon the arc or discharge starts within the lamp. As soon as the discharge has started, the cathode heating current is substantially neutralized by means of changes in the magnitude and phase of voltages induced in neutralizing or bucking windings connected to the electrodes.

2

In the afore-mentioned application No. 631,381, the preheating and neutralizing circuit for each electrode comprises two windings, of which one, the heating winding, is inductively coupled to the transformer energizing the lamp, and the other, the neutralizing or bucking winding, is inductively coupled to an inductive ballast inserted in series between the lamp and the transformer.

The present invention is directed towards a refinement of the two winding circuits disclosed in application No. 631,381, and permits a more complete neutralization of the resultant voltage. This is achieved by coupling the heating winding to a high reactance secondary winding of the transformer energizing the lamp, rather than to the main or primary winding thereof. This allows the voltages induced in the heating and in the bucking windings, during operation, to be more nearly in phase opposition, with consequent more perfect neutralization.

Accordingly, it is an object of my invention to provide a new and improved switchless starting and operating circuit of the cathode preheating and neutralizing type for fluorescent lamps, in accordance with the foregoing remarks.

For further objects and advantages and for a better understanding of my invention, attention is now directed to the following description taken in conjunction with the accompanying drawings. The novel features of my invention will be more particularly pointed out in the appended claims. In the drawings:

Fig. 1 is a schematic diagram of a cathode preheating and neutralizing circuit embodying my invention as applied to a single fluorescent lamp.

Fig. 2 is a schematic diagram of a similar circuit likewise embodying my invention, as applied to a pair of lamps connected in a lag-lead circuit of a relatively well known type.

Referring to Fig. 1, there is shown a gaseous discharge device 1 which may, for instance, be a fluorescent lamp of the positive column discharge type, comprising a tubular envelope 2 having sealed into its ends a pair of thermionic elec-

trodes 3 and 4 of the two-terminal preheatable type, which electrodes may consist of coils of tungsten wire activated with the usual mixture of barium and strontium oxides. The envelope 2 contains a rare gas such as argon or neon or mixtures thereof at a pressure of a few millimeters, and a small quantity of mercury. The inside walls of envelope 2 may be coated with a fluorescent phosphor which, when excited by a discharge through the mercury vapor, emits visible light.

The lamp electrodes are connected at opposed output terminals 3a, 4a across a source of potential provided by a high leakage reactance step-up autotransformer 5, in series with a current limiting inductance or ballast 6. The autotransformer in turn is connected at input terminals 7, 7' across a suitable source of power which may, for example, be a 115-volt, 60-cycle alternating current supply.

Autotransformer 5 which is utilized in this circuit is of specialized construction and therein lies the essential distinction between the circuit herein and that which I have disclosed in application No. 631,381. Autotransformer 5 comprises a primary winding 8 of which the terminals are connected as shown to the alternating current supply 7, 7', a secondary winding 9 which is relatively loosely coupled to primary winding 8, and a pair of tertiary windings 10 and 11 which are tightly coupled to secondary winding 9. Evidently, tertiary windings 10 and 11 will likewise be loosely coupled to primary winding 8. The respective couplings between the different windings are indicated symbolically at 12, illustrating a magnetic core associated with primary winding 8, at 13, illustrating a magnetic core associated with secondary winding 9 and tertiary windings 10 and 11, and at 14 illustrating a shunt magnetic circuit which serves to introduce a high leakage reactance between the primary winding and the other associated windings.

Inactive ballast 6 is preferably provided in the form of a transformer structure and comprises a primary or main winding 15 and a pair of secondary or auxiliary windings 16 and 17 in close magnetic coupling therewith.

In accordance with my invention, lamp 1 is connected across the output circuit of autotransformer 5, that is, across primary 8 and secondary 9 connected in series, and in series with the primary winding of ballast inductance 6. Heating voltage for electrode 3 is supplied at output terminal 3a and its conjugate terminal 3b by the circuit comprising tertiary winding 10 and auxiliary winding 16 connected in series; similarly heating voltage for electrode 4 is supplied at output terminal 4a and its conjugate terminal 4b, by the circuit comprising tertiary winding 11 and auxiliary winding 17 connected in series.

When voltage is applied across primary winding 8, secondary winding 9 and likewise tertiary windings 10 and 11 are energized; thus cathode heating voltage is supplied to electrodes 3 and 4 and potential is applied across the electrodes for starting the discharge within the lamp. Up to the instant when a discharge starts within the lamp, there is no current flowing through primary winding 15 of inductive ballast 6; and, accordingly, no voltage is generated in bucking or neutralizing windings 16 and 17. However, as soon as the discharge occurs, current flows through winding 15 and induces a neutralizing or bucking voltage in windings 16 and 17.

The neutralizing voltages induced in windings 16 and 17, whereas they would not be in completely reverse phase to the voltages induced in windings 10 and 11 from the application of supply voltage to the autotransformer 5, are in very close phase opposition to the voltages induced in windings 10 and 11 when current flows through secondary winding 9. This follows from the fact that the flow of current through secondary winding 9 substantially eliminates the inductive effect of winding 8 on tertiary windings 10 and 11, so that the voltages induced in windings 10 and 11 bear a definite phase relation, not to the supply voltage, but to the discharge current flowing through winding 9. The same discharge current likewise flows through winding 15, so that the voltages induced in secondary windings 16 and 17 bear an identical phase relation. Thus, both the voltages induced in windings 10 and 11 and those induced in windings 16 and 17 bear a common phase relationship to the discharge current, so that windings 10 and 16, respectively, and 11 and 17, respectively, may be connected in reverse phase and provide substantially complete neutralization of their resultant output voltages. It is in this respect that the present circuit provides a very substantial improvement in performance over that described in application No. 631,381 wherein the windings corresponding to tertiary windings 10 and 11 are coupled to the primary winding of the autotransformer rather than to the secondary winding as in the present circuit. In an actual construction embodying the present invention, I have found that it is possible to reduce the cathode heating power from a value of approximately three watts at starting, to a residual neutralized value less than 0.05 watt during operation. Thus, the present invention provides a considerable advantage since it is desirable to reduce the residual heating power to as low a figure as possible. This is accomplished in the present invention without any increase in the number of windings and with only a change in the magnetic coupling, which change, needless to say, is essential because the new principle of operation follows necessarily therefrom.

It will be appreciated that whereas the invention has been described with reference to a common fluorescent lamp having cooperating two-terminal preheatable main electrodes at both ends, it is equally applicable to a discharge lamp having only one two-terminal preheatable electrode and a cooperating main electrode of another type. Such a lamp might have, for instance, a single terminal cooperating main electrode. In such case, a preheating winding and a neutralizing winding would be provided for the two-terminal preheatable electrode only.

Referring to Fig. 2, wherein the same reference numerals refer to corresponding elements, the same mode of operation is illustrated as applied to a two-lamp lag-lead circuit. Thus, autotransformer 5 is now provided with a primary winding 8, a secondary winding 9 and an additional secondary winding 9', said secondary windings having associated in relatively close magnetic coupling, tertiary windings 10 and 11, and 10' and 11' respectively. Lamp 1 is connected as before, in series with the primary winding of inductive ballast 6, to secondary winding 9; the lamp 1' is connected, in series with the primary winding of inductive ballast 6' and the usual phase advancing capacitor 18, to secondary winding 9'.

It will be apparent that lamp 1 operates with

a lagging power factor and that neutralization of its electrode heating current occurs in identical fashion as in the circuit of Fig. 1. Lamp 1', on the other hand, is connected in a leading power factor circuit; but since the same leading current now flows through secondary winding 9' as flows through inductive ballast 6', cathode heating voltage neutralization occurs in the same fashion as described heretofore.

While certain specific embodiments have been shown and described, it will of course be understood that various modifications may be made without departing from the invention. Thus, the circuit may be applied to combinations of lamps and their diverse electrode heating requirements provided by means of additional secondary windings bearing the same coupling relationships to their associated windings as I have described herein. The appended claims are, therefore, intended to cover any such modifications coming within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. Apparatus for starting and operating a gaseous electric discharge device having at least one thermionic two-terminal preheatable electrode and a cooperating main electrode, comprising: a pair of input terminals, a pair of opposed output terminals, and at least one conjugate terminal cooperating with one of the output terminals for supplying electrode heating current; a transformer having a primary winding connected across said input terminals, a secondary winding loosely coupled to said primary winding and a tertiary winding tightly coupled to said secondary winding; an inductive ballast comprising a main winding and an auxiliary winding coupled thereto; an operating circuit comprising said primary and secondary windings and said main winding connected in series across said opposed output terminals; and a heating and neutralizing circuit comprising said tertiary winding and said auxiliary winding connected in series across one output terminal and its conjugate terminal and poled for bucking voltage relationship during current flow through said operating circuit.

2. Apparatus for starting and operating a fluorescent lamp having a pair of thermionic two-terminal preheatable electrodes comprising: a pair of input terminals, and a pair of opposed output terminals each having a cooperating conjugate terminal for supplying electrode heating current; a transformer having a primary winding connected across said input terminals, a secondary winding loosely coupled to said primary winding, and a pair of tertiary windings tightly coupled to said secondary windings; an inductive ballast comprising a main coil and a pair of auxiliary coils coupled thereto; an operating circuit comprising said primary and secondary windings and said main coil connected in series across said opposed output terminals; and a pair of heating and neutralizing circuits each comprising one of said tertiary windings and one of said auxiliary windings connected in series across an output terminal and its conjugate terminal and poled for bucking voltage relationship during current flow through the operating circuit.

3. Apparatus for providing switchless starting and operation of fluorescent lamps each having a pair of thermionic two-terminal heatable electrodes, comprising: a pair of input terminals, and a pair of opposed output terminals each having a cooperating conjugate terminal for supplying electrode heating current; a transformer having a primary winding connected across said input terminals, a secondary winding and a pair of tertiary windings, said secondary and tertiary windings being tightly coupled together and having but a loose coupling to said primary winding; an inductive ballast comprising a main coil and a pair of auxiliary coils coupled thereto; an operating circuit comprising said primary and secondary windings and said main coil connected in series across said opposed output terminals and a pair of heating and neutralizing circuits each comprising one of said tertiary windings and one of said auxiliary coils connected in series and in bucking polarity across an output terminal and its conjugate terminal for applying heating current to said thermionic electrodes at starting, the voltage induced in said auxiliary coils during operation providing an out-of-phase bucking voltage opposing that induced in said tertiary windings during operation so as to provide neutralization of said heating current.

4. Apparatus for starting and operating a pair of fluorescent lamps each having a pair of thermionic two-terminal preheatable electrodes comprising: a pair of input terminals and two pairs of opposed output terminals each having a cooperating conjugate terminal for supplying electrode heating current; a transformer having a primary winding connected across said input terminals, a pair of secondary windings loosely coupled thereto and two pairs of tertiary windings, respective pairs of said tertiary windings being tightly coupled to respective ones of said secondary windings; a pair of inductive ballasts each comprising a main coil and a pair of auxiliary coils coupled thereto; a capacitor; a pair of operating circuits, respective ones of said operating circuits comprising said primary, one of said secondary windings and one of said main coils connected in series across a pair of opposed output terminals, and one of said operating circuits having said capacitor serially included therein; and heating and neutralizing circuits each comprising one of said tertiary windings and one of said auxiliary coils connected in series and in bucking polarity across an output terminal and its conjugate terminal for applying heating current to respective ones of said thermionic electrodes.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,980,534	Kirstein	Nov. 13, 1934
2,025,471	Osborne	Dec. 24, 1935
2,231,584	Lord	Feb. 11, 1941
2,256,242	Edwards et al.	Sept. 16, 1941
2,444,408	Larime	June 29, 1948
2,504,548	Lemmers	Apr. 18, 1950