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ELECTRICAL CIRCUIT

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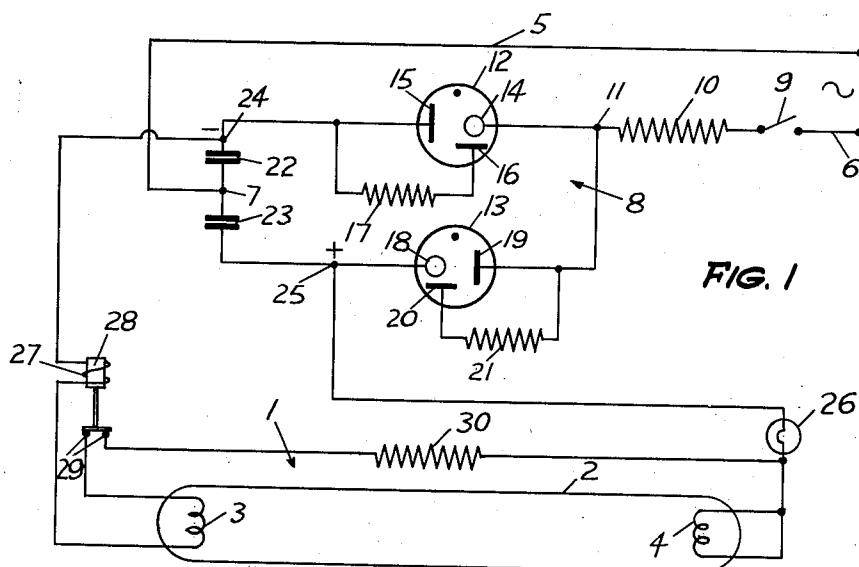


FIG. 1

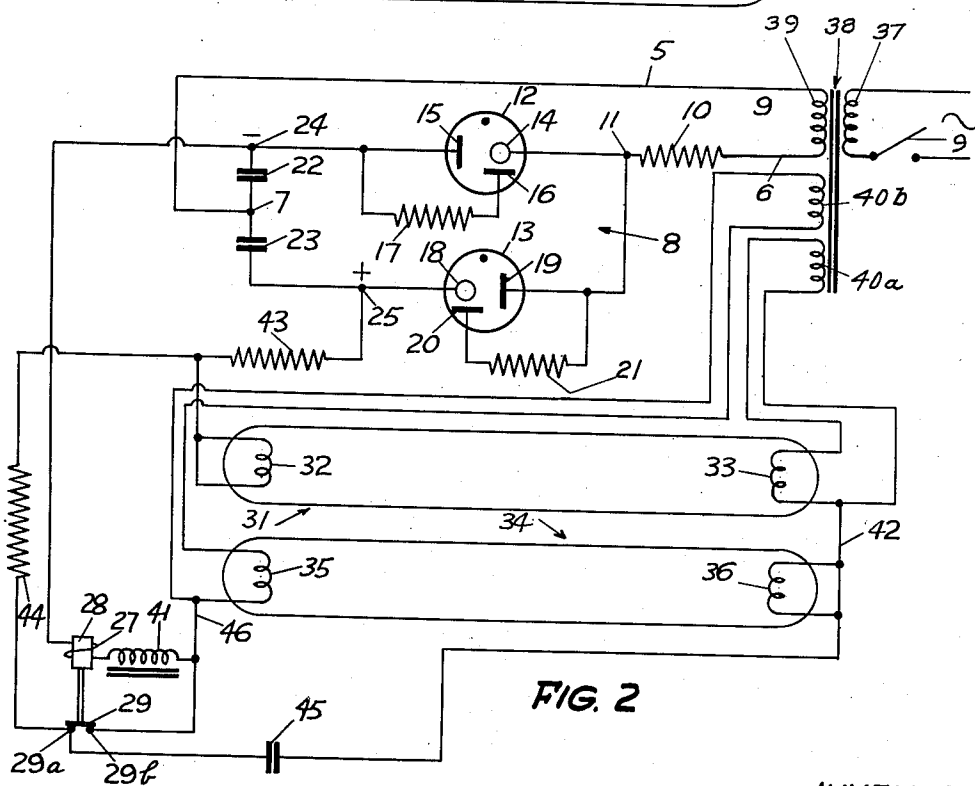


FIG. 2

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ELECTRICAL CIRCUIT

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8 Claims. (Cl. 315-97)

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This is a continuation-in-part of my copending application, Serial No. 669,048, filed May 11, 1946, now abandoned.

This invention relates to electrical circuits, and more particularly to circuits for starting, and for supplying operating voltages to fluorescent lamps.

An object of this invention is to provide a starting circuit for fluorescent lamps, whereby such lamps may be started substantially instantaneously.

Another object is to provide a fluorescent lamp supply circuit which will absorb a minimum amount of power from the power source.

A further object is to provide a fluorescent lamp supply circuit by the use of which flickering of said lamps is eliminated.

A still further object is to devise a circuit whereby a plurality of fluorescent lamps may be operated in such a manner as to provide a maximum amount of light at the expenditure of a minimum amount of power.

The foregoing and other objects of the invention will be best understood from the following description of some exemplifications thereof, reference being had to the accompanying drawing, wherein:

Fig. 1 is a diagrammatic representation of one means for carrying out the invention; and

Fig. 2 is a diagrammatic representation of another means for carrying out the invention.

A fluorescent lamp 1 consists of an elongated sealed bulb 2, having filaments 3 and 4 sealed into opposite ends thereof, and containing a low-pressure gaseous atmosphere. Filaments 3 and 4 are coated with an electron-emissive material.

Leads 5 and 6 are connected to a source of alternating current, for example, a commercial supply of the order of 115 volts. Lead 5 is connected directly to one of the A. C. input terminals 7 of a rectifying and voltage doubling circuit indicated generally by 8, while lead 6 is connected through a switch 9 and a resistor 10 of low resistance to the other input terminal 11 of said circuit 8.

Circuit 8 includes a pair of gaseous-discharge devices 12 and 13, said devices being oppositely connected to terminal 11. These devices are preferably of the OY4 ionically-heated cathode type, each having a cathode, an anode, and a starting anode. Thus, device 12 includes a cathode 14, an anode 15, and a starting anode 16, said starting anode being connected to main anode 15 through a resistor 17. Device 13 includes a cathode 18, a main anode 19, and a starting an-

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ode 20, said starting anode 20 being connected to main anode 19 through a resistor 21. Cathode 14 of device 12 and main anode 19 of device 13 are connected to A. C. input terminal 11. Main anode 15 of device 12 is connected to one terminal of a condenser 22, the other terminal of said condenser being connected to A. C. input terminal 7. Cathode 18 of device 13 is connected to one terminal of a condenser 23, the other terminal of said condenser also being connected to A. C. input terminal 7. The negative D. C. output terminal 24 of circuit 8 is connected to anode 15, while the positive output terminal 25 of circuit 8 is connected to cathode 18.

When switch 9 is closed to complete the circuit from the A. C. source to input terminals 7 and 11, arc discharges are established in tubes 12 and 13, and the condensers 22 and 23 are charged in alternate halves of the cycle through rectifier tubes 12 and 13. The condensers are connected in series, so that their voltages add, giving a direct voltage across terminals 24 and 25 that approaches twice the crest alternating voltage.

Terminal 25 is connected through a ballast resistor 26, for example, a 40-watt lamp, to filament 4 at one end of fluorescent lamp 1. Negative terminal 24 of circuit 8 is connected through operating winding 27 of a relay 28, to one end of filament 3, the other end of said filament being connected to one of a pair of normally-closed contacts 29 carried by relay 28. The other of said contacts 29 is connected, through a resistor 30, to filament 4.

To start the discharge in fluorescent lamp 1, switch 9 is closed. As stated above, this causes a direct voltage, of approximately twice the voltage of the A. C. source, to be produced across terminals 24 and 25, this voltage being produced substantially simultaneously with the closing of switch 9 because of the negligible charging time of condensers 22 and 23. Since relay contacts 29 are originally closed, current will flow from terminal 25, through lamp 26, resistor 30, contacts 29, filament 3, and winding 27, back to terminal 24, this current serving to heat filament 3 to the temperature of thermionic emission. The flow of current through winding 27 will energize relay 28 to open its contacts 29, thus opening the circuit through said winding, causing said relay to be deenergized to again close contacts 29 and complete the circuit through said winding to again energize it. Resistor 30 serves to limit the current through filament 3 during the starting operation. As will be appreciated, fila-

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ment 4 serves as the anode for the discharge through tube 1, since it is connected to the positive terminal 25. As filament 3 is being heated through the above-described circuit, relay 28 will be rapidly, and successively, energized and de-energized, opening and closing contacts 29 in a "buzzing" fashion.

When filament 3 has been heated to the temperature of thermionic emission, a sufficient number of ions will be produced in bulb 2 to cause the main discharge to be started between filaments 3 and 4, a voltage high enough to establish this discharge being supplied by circuit 8. When current begins to flow in the discharge path between electrodes 3 and 4, the circuit including contacts 29 and resistor 30 is effectively bypassed, so that the "buzzing" of relay 28 is stopped, and enough current flows in this discharge path to maintain relay 28 energized, and contacts 29 open. With contacts 29 open, the heating circuit for filament 3 is opened, so that thereafter filament 3 is heated by ionic bombardment in the usual manner.

Lamp 26 serves as a ballast resistor, limiting the current through lamp 1 during operation. By choosing the proper value of resistance for resistor 30, the filament 3 may be heated rapidly, so that the lamp 1 may be started practically instantaneously. Also, since tubes 12 and 13 require no external source for heating their cathodes, a minimum amount of power is drawn from the A. C. source. Since the discharge in lamp 1 is unidirectional on account of D. C. being utilized therefor, flicker of the discharge is removed or eliminated.

In Fig. 2, another embodiment of this invention is shown, and, in said figure, similar parts have been denoted by the same reference numerals as in Fig. 1. When switch 9 is closed, it energizes the primary winding 37 of a transformer 38. A secondary winding 39 energizes circuit 8, which is similar to that of Fig. 1, and thereby supplies high voltage direct current to terminals 24 and 25.

A fluorescent lamp 31 has filaments 32 and 33 sealed into opposite ends thereof, and a second fluorescent lamp 34 has filaments 35 and 36 sealed into opposite ends thereof. Filament 33 is energized by being connected across a secondary winding 40a of transformer 38, and filament 35 is energized by being connected across secondary winding 40b of transformer 38.

Negative terminal 24 is connected, through winding 27 of relay 28 and an inductance 41, to one side of filament 35. Filament 36 is connected to filament 33 by means of lead 42. Filament 32 is connected to positive terminal 25 through a ballast resistor 43, of, for example, 40 ohms.

Contact 29a, one of a pair of normally-closed contacts 29 of relay 28, is connected to resistor 43 through another resistor 44, which latter may for convenience be built into relay 28. Contact 29a is also connected, through a condenser 45, to filament 36, while contact 29b is connected to filament 35.

When switch 9 is closed, terminal 25 becomes the positive terminal for D. C., as stated above, and current flows through resistor 43, resistor 44, normally-closed contacts 29a and 29b, inductance 41, and winding 27, to negative terminal 24, energizing relay 28 to open its contacts 29. When switch 9 is closed, the heating circuits for filaments 33 and 35 are completed. When contacts 29 are opened by the energization of relay 28, the series circuit through inductance 41 and

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winding 27 is broken, so that a high-voltage inductive "kick," due to the decay of current in these inductances, appears across these inductances, driving the potential at each end of lead 46 negative with respect to terminal 24. When contacts 29 of relay 28 are closed, a circuit is completed as follows between terminals 25 and 24 of the source: terminal 25, resistor 43, resistor 44, contact point 29a, contact point 29b, inductance 41, winding 27, to terminal 24. Inductance 41 and winding 27 both have a negligible resistance as compared to resistors 44 and 43, and, as a result, current flow in this circuit produces substantially all of the voltage drop across resistors 43 and 44, so that, while contacts 29 are closed, point 29a has a potential which is substantially the same as that of terminal 24, and, assuming condenser 45 to be originally uncharged, the potential at each end of lead 42 is also substantially the same as that of terminal 24. When contacts 29 are opened by the energization of relay 28, the potential of point 29a quickly rises to the potential of terminal 25, which is positive with respect to terminal 24. When the potential of point 29a thus rises, that at each end of lead 42 will rise along with it, and to the same value, assuming condenser 45 to be originally uncharged.

It will be seen that the voltage applied to lamp 34 is the difference of potential between leads 42 and 46. When contacts 29 are opened, the potential of lead 46 will go negative with respect to terminal 24, while the potential of lead 42 will go positive with respect to said terminal. Thus, there will be a large difference of potential between leads 42 and 46, sufficient to start the discharge in lamp 34.

When the discharge has started in lamp 34, a charging circuit will be completed as follows for condenser 45: terminal 25, resistor 43, resistor 44, point 29a, condenser 45, discharge path 36—35, lead 46, inductance 41, winding 27, to terminal 24. Current will flow in this circuit, charging condenser 45 with a polarity such that point 29a becomes positive with respect to lead 42. The voltage across condenser 45 is applied to lamp 31, since lead 42 is connected to the right-hand side of condenser 45 and filament 33, while the left-hand side of condenser 45 is connected through point 29a and resistor 44 to filament 32. The voltage across condenser 45 rises as it is charged, until a point is reached at which the voltage thereacross is sufficient to start the discharge in lamp 31. When the discharge is established in lamp 31, the voltage across condenser 45 falls to the voltage drop of the discharge in said lamp, because condenser 45 will not pass direct current.

When the discharges have been started in lamps 31 and 34, as will be seen, paths 32—33 and 36—35 are in series with each other across the source. The establishment of current flow in both paths 32—33 and 36—35 establishes a holding circuit for maintaining relay 28 energized and contacts 29 open, this circuit being traced as follows: terminal 25, resistor 43, path 32—33, lead 42, path 36—35, lead 46, inductance 41, winding 27, to terminal 24. The voltage supplied by circuit 8 at terminals 24 and 25 is sufficient to maintain discharges through tubes 31 and 34, in series. During operation of the lamps, and also during starting thereof, filaments 32 and 36 act as anodes for the discharges, while filaments 33 and 35 are continuously supplied with heating current from the A. C. source and act as cathodes or electron emitters.

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When switch 9 is actuated to extinguish the lamps, the discharges in paths 32—33 and 36—35 will cease and relay 28 will be deenergized in preparation for the next operation. Condenser 45 will retain its charge, because there is no discharge path for it, and therefore the charge will leak off of it only extremely slowly, if at all. The charge retained by condenser 45 produces a voltage thereacross which causes the potential of lead 42 to not attain as high a positive value when contacts 29 are opened as it would if said condenser were originally discharged. However, the value of inductance of element 41, and the speed of operation of relay 28, are made such that the potential of lead 46 goes sufficiently negative, when relay 28 is energized, to provide the proper potential difference across lamp 34, even though the potential of lead 42 may not be as highly positive at this time as it would have been if condenser 45 had originally been discharged.

Resistance 44, which may, for example, be built into relay 28, serves as a limiting resistor to protect relay 28 from a large initial inrush of current when switch 9 is first closed. Ballast resistor 43 limits the current flowing through lamps 31 and 34 during operation thereof, while inductance 41, in addition to its function stated above, has the additional function of keeping the circuit from oscillating.

In the circuit of Fig. 2, a minimum amount of power is expended in the ballast resistor 43, because of the low resistance of said resistor. In Fig. 2, as in Fig. 1, flicker will be eliminated, because of the unidirectional character of the discharge due to the direct current supplied to the lamps. The discharge in lamps 31 and 34 may be started substantially instantaneously because of the rapid energization of relay 28 and the consequent "kick" applied to the lamps. It has been found that the total voltage drop in a lamp of the type of this invention is the sum of three voltage drops: the cathode drop, the anode drop, and the drop in the positive column. Most of the light produced is a result of the drop in the positive column. Therefore, if the tube is lengthened until the positive column is of such length that the voltage drop therein is almost equal to the voltage available, the lamp will be operated at a higher efficiency, for the production of light.

Of course, it is to be understood that this invention is not limited to the particular details as described above, as many equivalents will suggest themselves to those skilled in the art. It is accordingly desired that the claims be given a broad interpretation commensurate with the scope of this invention within the art.

What is claimed is:

1. A gaseous discharge device starting circuit, comprising a gaseous discharge device having a pair of filaments, a relay having an operating winding and a pair of normally closed contacts, an inductance, a voltage source, means connecting said winding and said inductance in series between one terminal of said voltage source and one of said filaments, means connecting said contacts in series between the other terminal of said source and said one filament, and capacitive means connected between said other terminal and the other of said filaments.

2. A fluorescent lamp circuit including, in combination, a rectifying and voltage-doubling circuit having a pair of output terminals and a pair of input terminals, a source of alternating current, means connecting said input terminals to

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said source of alternating current, a first gaseous discharge fluorescent lamp having a pair of filaments, a second gaseous discharge fluorescent lamp having a pair of filaments, means connecting one of the filaments of said first lamp to one of the filaments of said second lamp, means connecting the other filament of said first lamp to one of said output terminals, and means connecting the other filament of said second lamp to the other of said output terminals.

3. A gaseous discharge device circuit including, in combination, a rectifying and voltage-doubling circuit having a pair of output terminals and a pair of input terminals, a source of alternating current, means connecting said input terminals to said source of alternating current, a gaseous discharge device having a pair of filaments, a relay having an operating winding and a pair of normally closed contacts, an inductance, means connecting said winding and said inductance in series between one of said output terminals and one of said filaments, means connecting said contacts in series between the other of said output terminals and said one filament, and capacitive means connected between said other output terminal and the other of said filaments.

4. A gaseous discharge device circuit including, in combination, a rectifying and voltage-doubling circuit having a pair of output terminals and a pair of input terminals, a source of alternating current, means connecting said input terminals to said source of alternating current, a first gaseous discharge device having a pair of filaments, a second gaseous discharge device having a pair of filaments, means connecting one filament of said first lamp to one filament of said second lamp, a relay having an operating winding and a pair of normally closed contacts, an inductance, means connecting said winding and said inductance in series between one of said output terminals and the other filament of said first device, means connecting said contacts in series between the other of said output terminals and said other filament of said first device capacitive means connected between said other output terminal and said one filament of said first device, and means connecting said other filament of said second device to said other output terminal.

5. A fluorescent lamp circuit including, in combination, a gaseous discharge fluorescent lamp having a pair of filaments, a relay having an operating winding and a pair of normally closed contacts, a voltage source, means connecting said winding in series between one terminal of said voltage source and one of said filaments, means for heating said one filament to emission temperature, means connecting said contacts in series between the other terminal of said source and said one filament, capacitive means connected between said other terminal and the other of said filaments, and a shunt circuit connected across said capacitive means between said other terminal and said other filament.

6. A fluorescent lamp circuit including, in combination, a first gaseous discharge device having a pair of filaments, a second gaseous discharge device having a pair of filaments, means connecting one filament of said first device to one filament of said second device, a relay having an operating winding and a pair of normally closed contacts, a voltage source, means connecting said winding in series between one terminal of said voltage source and the other filament of said first device, means for heating said other filament of said first device and said one filament of said

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second device to emission temperature, means connecting said contacts in series between the other terminal of said source and said other filament of said first device, capacitive means connected between said other terminal and said one filament of said first device, and means connecting the other filament of said second device to said other terminal, whereby the interelectrode path of said second device provides a shunt circuit connected across said capacitive means between said other terminal and said one filament of said first device.

7. A gaseous discharge device circuit including, in combination, a rectifying and voltage-doubling circuit having a pair of output terminals and a pair of input terminals, a source of alternating current, means connecting said input terminals to said source of alternating current, a gaseous discharge device having a pair of filaments, a relay having an operating winding and a pair of normally closed contacts, means connecting said winding in series between one of said output terminals and one of said filaments, means for heating said one filament to emission temperature, means connecting said contacts in series between the other of said output terminals and said one filament, capacitive means connected between said other output terminal and the other of said filaments, and a shunt circuit connected across said capacitive means between said other output terminal and said other filament.

8. A fluorescent lamp circuit including, in combination, a rectifying and voltage-doubling circuit having a pair of output terminals and a pair of input terminals, a source of alternating current, means connecting said input terminals to said source of alternating current, a first gaseous discharge fluorescent lamp having a pair of filaments, a second gaseous discharge fluorescent lamp having a pair of filaments, means connect-

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ing one filament of said first lamp to one filament of said second lamp, a relay having an operating winding and a pair of normally closed contacts, means connecting said winding in series between one of said output terminals and the other filament of said first lamp, means for heating said other filament of said first lamp and said one filament of said second lamp to emission temperature, means connecting said contacts in series between the other of said output terminals and said other filament of said first lamp, capacitive means connected between said other output terminal and said one filament of said first lamp, and means connecting the other filament of said second lamp to said other output terminal, whereby the interelectrode path of said second lamp provides a shunt circuit connected across said capacitive means between said other output terminal and said one filament of said first lamp.

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