

March 30, 1948.

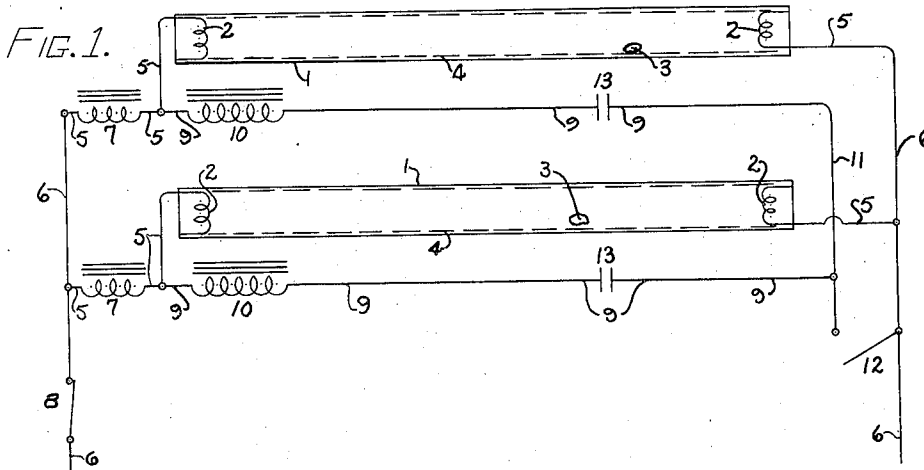
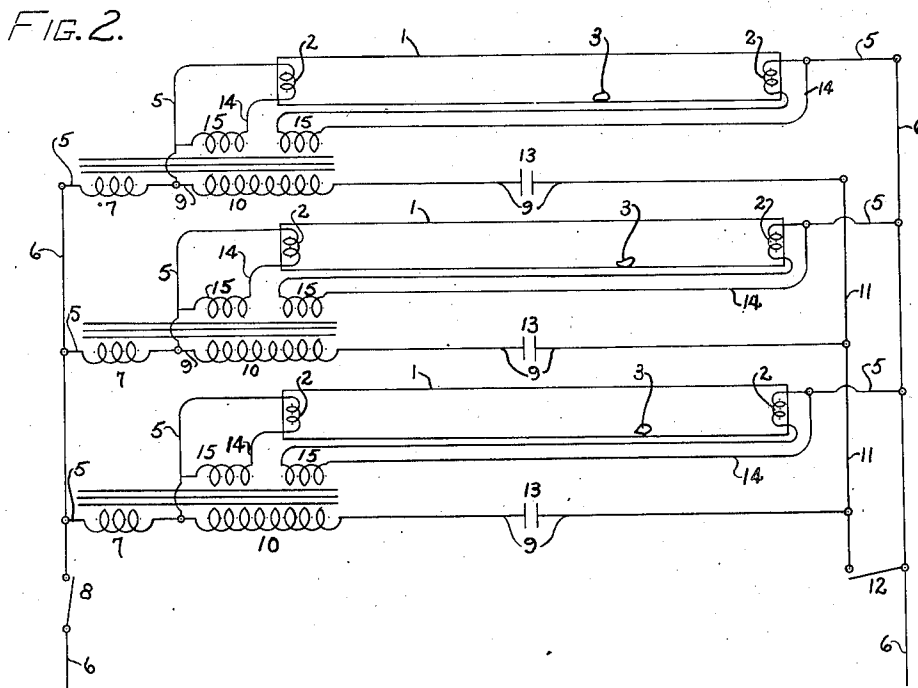
E. LEMMERS

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MULTIPLE DISCHARGE LAMP CIRCUIT

Filed July 11, 1945

2 Sheets-Sheet 1



INVENTOR
EUGENE LEMMERS
By *John Henderson*
HIS ATTORNEY

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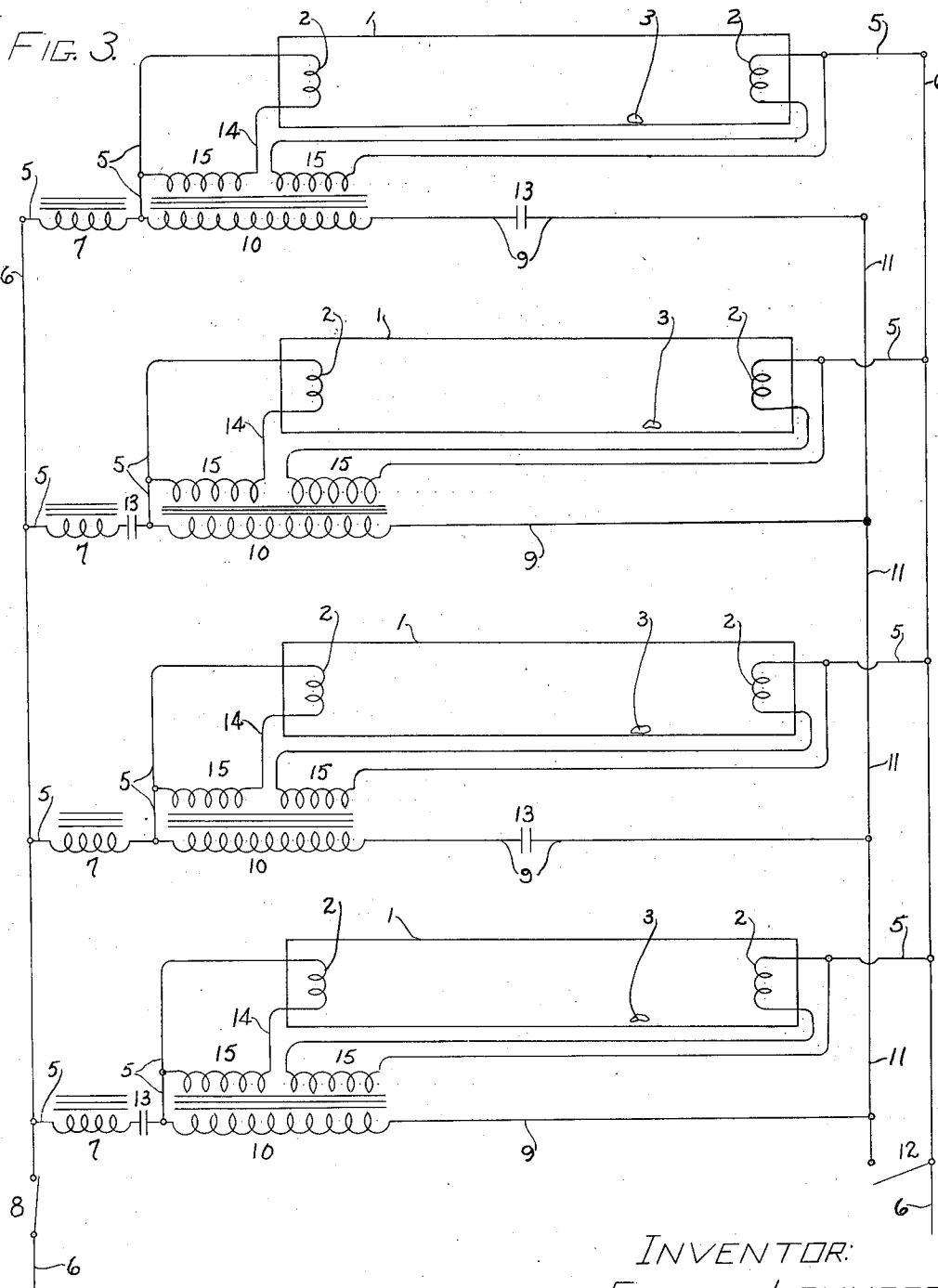
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INVENTOR:
EUGENE LEMMERS
BY *John H. Henderson*
HIS ATTORNEY

UNITED STATES PATENT OFFICE

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MULTIPLE DISCHARGE LAMP CIRCUIT

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

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2 Claims. (Cl. 315-283)

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This invention relates to electric discharge devices or lamps and their circuits, and is especially concerned with the starting and operation of a plurality of such devices in parallel. The invention aims at assuring the starting and stable operation of all the devices, and at keeping down the circuit losses during operation, after starting. A further advantage of the invention is that it allows of controlling a bank of lamps by one single switch. The invention is especially useful for fluorescent lamps of the usual low-pressure positive column type, and particularly (though not exclusively) in railway train lighting.

Various other features and advantages of the invention will appear from the description of species and forms of embodiment, and from the drawings.

In the drawings, Fig. 1 shows a simple circuit arrangement embodying the invention; Fig. 2 illustrates the adaptation of the circuits to lamps whose electrodes are preheated for starting; and Fig. 3 illustrates the adaptation of the arrangement to lead and lag circuits.

Fig. 1 shows a plurality of low pressure positive column discharge lamps 1, 1 each consisting of an envelope tube equipped with widely spaced cooperating electrodes 2, 2 in its opposite ends. Either or each of the electrodes 2, 2 may be a thermionic activated cathode embodying an electric heater for bringing it to a temperature of electron emission before the discharge between the electrodes is initiated. For instance, the electrodes 2, 2 may consist of tungsten filament wires, in coil or coiled coil form charged or coated with activating alkaline earth oxides, such as a mixture including barium and strontium oxides. The envelope 1 may contain an atmosphere of gas or vapor or both at low pressure: e. g., an inert rare starting gas, like argon at 2 to 6 mm. of mercury, and a supply of mercury that is indicated by a droplet 3. Also, an internal coating of luminescent material or phosphor 4 excitable by the radiation from the discharge is indicated on the envelope walls. Since the system illustrated in Fig. 1 has no provisions for preheating the cathode(s) 2 before discharge is initiated, these cathode(s) should be of a type adapted for "cold" or "instant" starting, such as that disclosed in U. S. Patent No. 2,306,925 to John O. Aicher.

As shown, the discharge lamps 1, 1 are connected in parallel circuits 5, 5 across a main discharge circuit 6 which may be energized from any suitable A. C. source—such as a 110 volt 60 cycle lighting circuit. Two such parallel lamp circuits 5 are here represented; but the number

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is generally unimportant. Each lamp circuit 5 includes the usual inductive ballast or reactor 7, and a manual switch 8 for controlling energization of the whole circuit 6 is also shown. A starting circuit 9 is provided for connection across the circuit 6 in parallel with each lamp 1, and includes an additional auxiliary inductive ballast or choke 10 for starting purposes. The several circuits 9 are shown as connected at corresponding ends to a common circuit lead 11 which may be connected to a corresponding side of the circuit 6 by means of a switch 12 of either manual or automatic type. The other ends of the several circuits 9 are connected to the other side of the circuit 6, preferably through portions of the circuits 5 that include the corresponding ballasts 7, rather than directly and independently.

The discharge circuit 6 being in the present instance a lagging power factor circuit, a capacitor or condenser 13 is shown connected in each starting circuit 9 in series with its inductive ballast 10. In the case of a discharge circuit 6 with a leading power factor, however, the capacitor or condenser 13 would be connected in the lamp circuit 5 itself instead of in the corresponding starting circuit 9, as hereinafter more fully explained and illustrated. The values of the lamp circuit inductances 7 (and of the capacitors 13, when included in the circuits 5) are so chosen that during operation the desired discharge current and a suitable voltage less than the supply voltage on the circuits 5 are maintained across the electrode gap 2, 2 of each discharge device 1. The values of the starting circuit inductances 10 and of the capacitors 13 (when the latter are in the circuits 9, as here shown) are so chosen that the total circuit which in effect shunts each lamp 1 across the line 6 (when the switch 12 is closed during starting) is a resonant circuit which produces across the electrode gap 2, 2 a voltage exceeding the supply voltage in the circuit 6 and the breakdown voltage of the lamp 1. With the connection shown in Fig. 1, each such resonant circuit includes the inductance 7 as well as the inductance 10 and the capacitor 13, and the values of the last two are correlated with that of the inductance 7 to produce the desired resonance and the desired starting voltage on the lamp. The same is also the case when the capacitor 13 is in the circuit 5, as above mentioned.

It will be seen that with the system as shown in Fig. 1, the connection from each lamp 1 to its neighbor via their circuits 9, 9 and the interconnecting portion of lead 11 includes a large impedance: viz., two capacitors 13, 13 and two

chokes 10, 10. Considerable impedance in this connection 9, 11, 9 between corresponding ends of adjacent lamps 1, 1 is an essential condition for the stability of the system during the period when switch 12 is closed, in order to insure proper starting and continued operation of both lamps. If, on the contrary, the impedance of this connection is inadequate, only one lamp 1 will start; or if both start, one will presently drop out. The presence of high or substantial impedance in the starting circuits 9, 9, serves to minimize circulating currents between these circuits which would otherwise tend to flow by virtue of the common connection and dissimilarities in circuit constants and lamp operating characteristics. If such current limiting impedance is not affording, the circulating currents assume such proportions that an initially started lamp may undergo voltage variations at its terminals which prevent the maintenance of an arc discharge therethrough.

When the circuits 5 and 9 are first energized by closing the control switch 8, the current in each combined circuit 5, 9 and the "Q" and resonance of this circuit suffice to give a voltage exceeding the break-down voltage of the corresponding lamp 1, so that the discharge starts and becomes established in the lamp. The discharge once established, the effective impedance of the lamp 1 becomes less than that of the circuit 9, resulting in a reduction of the current in this circuit. As soon as the discharges become established, or directly after, the switch 12 is opened (either manually or by its own time-delay action), so that the starting circuits 9 no longer carry current or consume power. The losses due to the ballasts 7 during operation are very moderate, and only what is characteristic of fluorescent lamp circuits generally.

Fig. 2 illustrates the adaptation of the system shown in Fig. 1 to hot cathode resonant circuits for a bank of lamps 1 whose cathodes 2, 2 are preheated by passage of current before discharge is initiated. The principal difference is the provision of a heating circuit 14 for each cathode coil or heater 2 of each lamp 1, this circuit 14 being energized from the corresponding starting circuit 9, and as here shown including a portion of the circuit 5. For this purpose may be used a transformer whose primary is the winding of the auxiliary starting inductance 10 and whose secondary is a winding 15 connected in the circuit 14 and associated with the winding 10 and its core. With this arrangement, the values of the inductance 10 and capacitor 13 (when the latter is also in the starting circuit 9) may be so chosen as to produce a voltage across the electrode gap 2, 2 that is lower than in the Fig. 1 system, and only suffices to initiate the discharge after the atmosphere in the lamp 1 has been ionized by a preliminary discharge along each cathode coil 2, as is usual in the hot-starting of ordinary fluorescent tubes. It will be observed that opening of the switch 12 after starting substantially deenergizes the cathode heating circuits 14, 14, as well as the starting circuit 9.

As another difference from Fig. 1 that is illustrated in Fig. 2, it may be mentioned that the windings of the ballasts 7, 10 for each lamp 1 are wound on a common core, which also carries the secondaries 15, 15.

For the convenience of those wishing to use my invention, I will now give illustrative values of circuit constants suitable for an ordinary commercial 15 watt positive column fluorescent lamp of usual 18 inch tube length and 1 inch diameter;

but these are not to be understood as defining or limiting the invention in its broader aspects.

In the case of the lag circuits of Fig. 2, the inductance 7 may be wound to give a 108 volt drop on a 60 cycle A. C. current of 0.33 amp. R. M. S., with a D. C. resistance of 15 ohms or less, and the inductance 10 may be wound to give a 92 volt drop on a 60 cycle A. C. current of 0.33 amp. R. M. S., with a D. C. resistance of 36 ohms or less. The capacitor 13 may be a two microfarad condenser. Accordingly, the total reactance 13, 13, 10, 10 in the connection 9, 11, 9 between adjacent lamps 1, 1 amounts to as much as 3200 ohms, as against some 1400 ohms which I have found necessary for stabilization as explained above. The cathode coils 2, 2 of each lamp 1 are assumed to be the usual coiled coils of the 15 watt lamp above mentioned, each comprising an active length of 252 mm. of 2.54 mil tungsten wire.

Fig. 3 illustrates the adaptation of the system shown in Fig. 2 to a bank of lamps 1 whose circuits 5 are lag and lead circuits arranged in alternation. Accordingly, the first and third circuits are essentially like those shown in Fig. 2, with the capacitors 13 in the starting circuits 9, while the second and fourth circuits have their capacitors 13 in the lamp circuits 5, between each lamp 1 and its ballast 7, as already referred to in connection with Fig. 1. Fig. 3 also differs from Fig. 2 in showing the ballasts 7 as entirely separate from the ballasts 10, instead of having their windings on the same core as said ballast 10. While in Fig. 3 the connection from each lamp 1 to its neighbor via their circuits 9, 9, and the lead 11 includes only the impedance represented by one capacitor 13 and two chokes 10, 10—instead of two capacitors 13, 13 and two chokes 10, 10, as in Figs. 1 and 2—this impedance 13, 10, 10 is nevertheless very considerable, and sufficient to stabilize the action of the system during the period when switch 12 is closed, as already explained in connection with Fig. 1.

In Figs. 2 and 3, various parts and features are marked with the same reference characters as their counterparts in Figs. 1 and 2, as a means of dispensing with repetitive description.

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

1. The combination, an alternating current supply circuit, a discharge circuit and a plurality of electrical discharge lamps connected across the same in parallel circuits each including inductance, of resonant circuits connected in parallel to one side of said discharge circuit and each including inductance and capacitance in series; and means including a switch for connecting said resonant circuits to the other side of the discharge circuit during starting, and for disconnecting these resonant circuits from said other side of the discharge circuit during subsequent lamp operation; the aggregate impedance represented by the inductance and capacitance in the connection between adjacent lamps via said means being sufficient to assure starting of said lamps and also stable operation of all the lamps by minimizing circulating currents among the starting circuits.

2. The combination, an alternating current supply circuit, a discharge circuit and a plurality of electric discharge lamps connected across the same in parallel lamp circuits each including inductance; of starting circuits each also including inductance connected in parallel to one side of said discharge circuit through the inductive por-

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tions of said lamp circuits, and having their other ends connected to a common lead, the combined circuits between said discharge circuit and lead including capacitances as well as the corresponding inductances aforesaid, the inductance of the starting circuit and the inductance of the associated discharge circuit constituting with said capacitance a resonant circuit, and switch means for connecting said combined circuits to the other side of the discharge circuit during starting, and for disconnecting these combined circuits from said other side of the discharge circuit during subsequent lamp operation; the aggregate impedance represented by the inductance and capacitance in the connection between adjacent lamps via said common lead being sufficient to assure

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starting of said lamps and also stable operation of all the lamps by minimizing circulating currents among the starting circuits.

EUGENE LEMMERS.

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The following references are of record in the file of this patent:

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