Jan. 14, 1958 A. E. FEINBERG 2,820,180

BALLAST AND LIGHTING SYSTEM FOR FLUORESCENT LAMPS

Filed Aug. 4, 1953 3 Sheets-Sheet 1

Fig. 1.

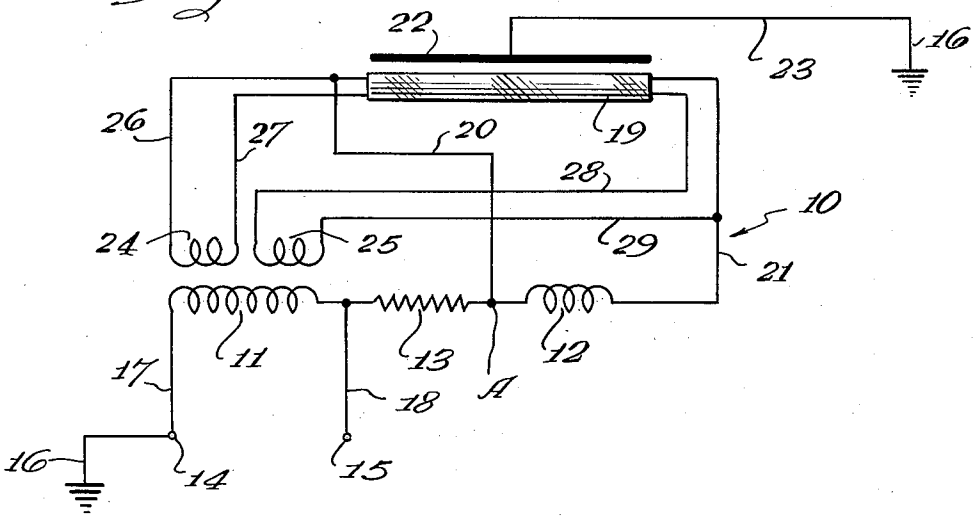


Fig. 2.

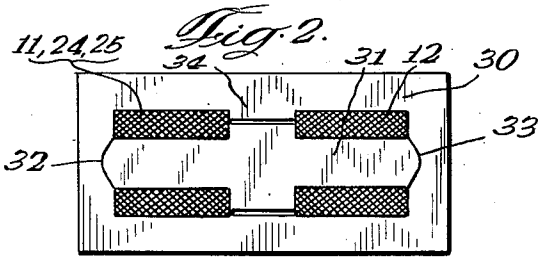
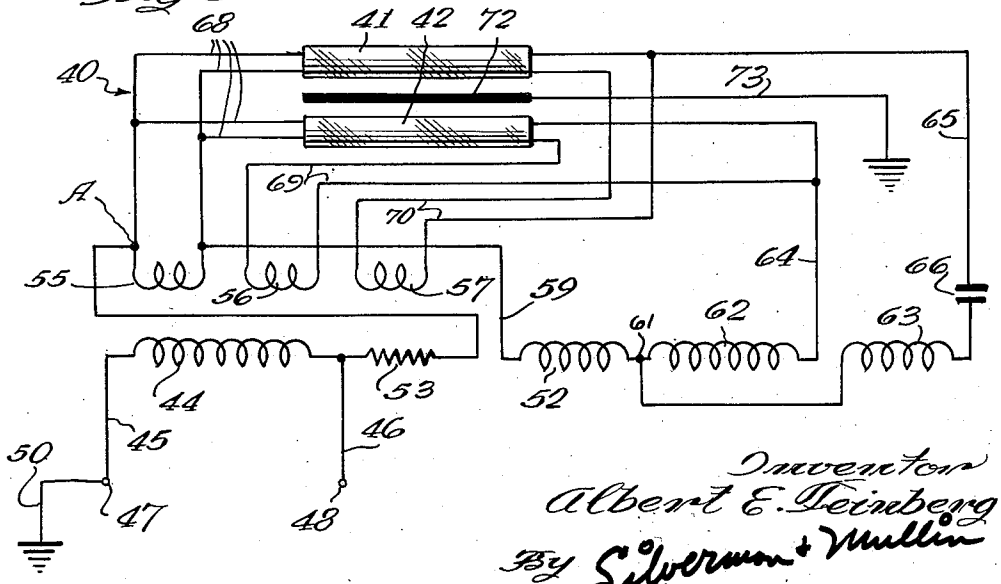


Fig. 3.



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BALLAST AND LIGHTING SYSTEM FOR FLUORESCENT LAMPS

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Fig. 4.

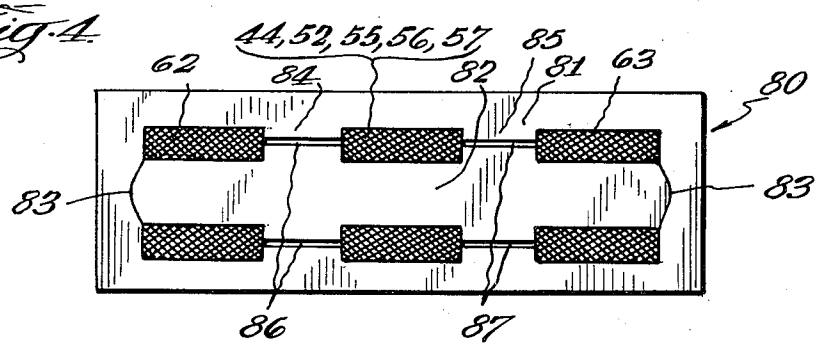


Fig. 5.

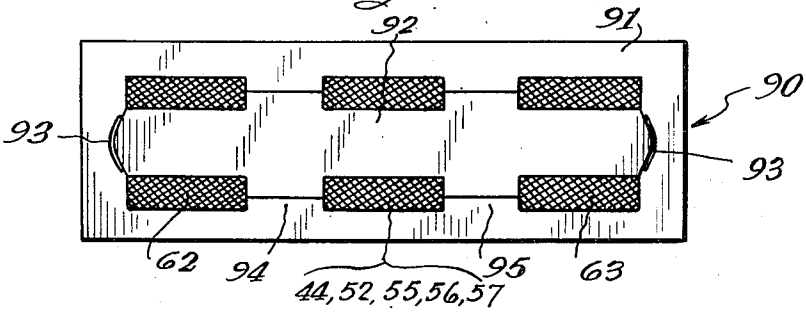
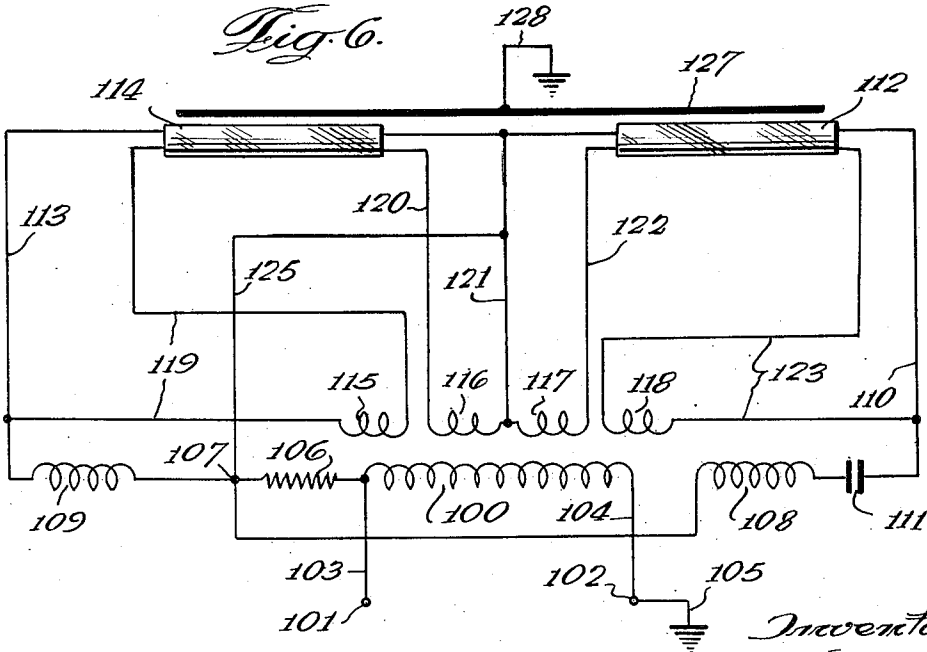


Fig. 6.



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BALLAST AND LIGHTING SYSTEM FOR FLUORESCENT LAMPS

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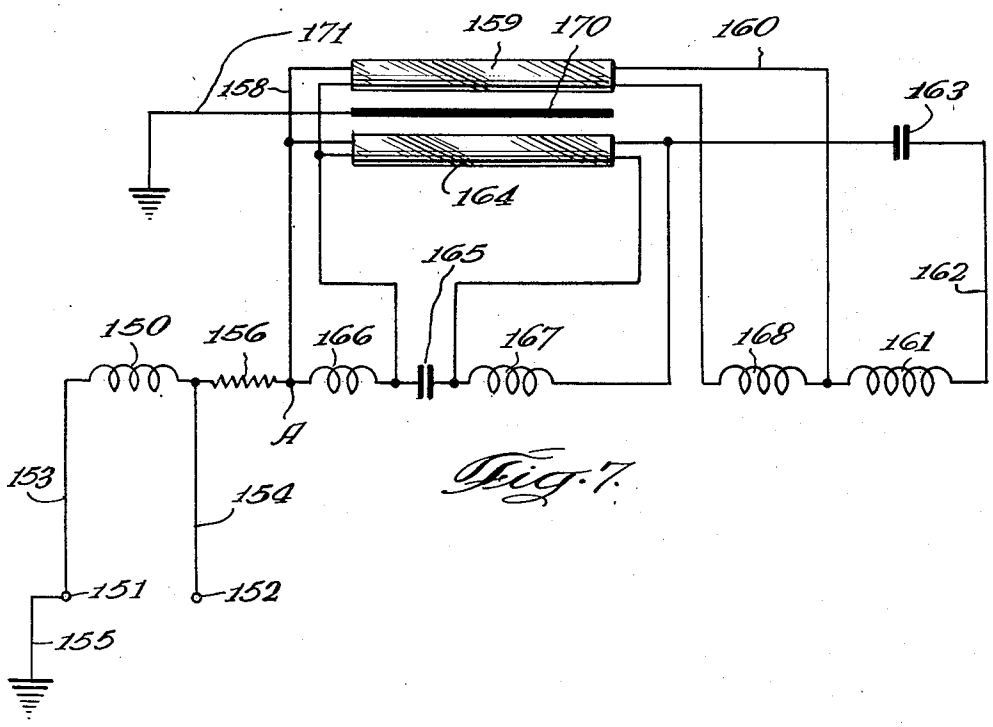


Fig. 7.

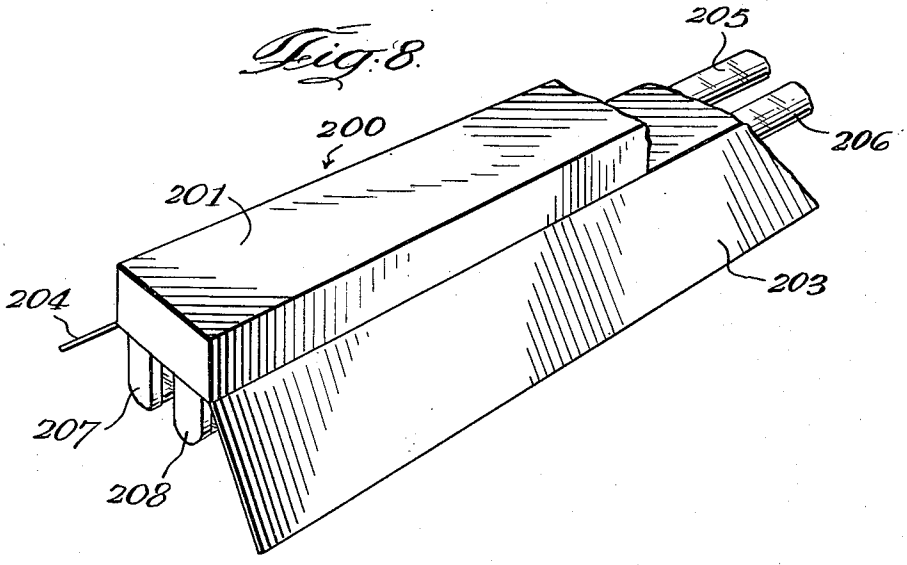


Fig. 8.

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BALLAST AND LIGHTING SYSTEM FOR FLUORESCENT LAMPS

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Application August 4, 1953, Serial No. 372,310

4 Claims. (Cl. 315—257)

This invention relates generally to gaseous discharge devices and more particularly is concerned with transformers, or "ballasts" as they are known, for initiating and subsequently operating lighting systems which include fluorescent lamps.

Of recent years there has been developed a type of lamp which is known as "rapid start" to designate the same from the lamp heretofore known as the "instant start." In the latter, ignition was achieved through the use of high voltages without the necessity of employing preheated filaments to produce clouds of electrons. In the former, filaments are provided but due to their durable construction, it is not necessary to provide starters or switching systems to remove the filaments from the circuit once ignition has been achieved. The filaments of rapid start lamps are connected into the circuits with which the same are used and carry current at all times. If desired, filament windings may be arranged to have bucking voltages generated therein after ignition to decrease the flow of current through the filaments.

Many problems have arisen in the construction of fixtures and lighting systems in the utilization of these rapid start lamps, among which have been considerations of safety. Consider, for example, a situation where a voltage exists to ground which is of such value as to be dangerous to one handling the fluorescent lamp. It is possible for one end of the lamp to be touched by one who is himself grounded. If the combined open circuit voltage from ground through the person holding the lamp and through the transformer is greater than ignition voltage or even close to it, the lamp may ignite and current flow. This is dangerous to the person who is holding the lamp, especially if the current through line is over 5 milliamperes.

This value of 5 milliamperes has therefore been chosen by the Underwriters' Laboratories as that current which is the maximum which may flow to ground through the circuit.

Through the use of a high resistance inserted between the primary and the remainder of the transformer, it is possible to limit the flow of current to ground. This invention contemplates that type of circuit, i. e. one in which such a high resistance is electrically inserted between the primary winding and the remainder of the transformer.

An important object of the invention is to provide in a circuit of the character which utilizes such an isolating resistance, means so that the voltage which exists from the isolating point to ground may be utilized as an additional starting aid to ignite the lamp or lamps.

A further object of the invention is to provide in a circuit of the character described, means for utilizing a reflector of the lamp fixture as a capacitive coupling to ground, so that a flow of current to ground through reflector may be possible, giving rise to an initial starting aid voltage for the lamp.

Still a further object of the invention is to provide a

novel lighting system utilizing lead-lag circuits for igniting and thereafter providing for the operation of two (2) fluorescent lamps.

Still a further object of the invention is to provide a series-sequence lighting circuit utilizing the principles of the invention.

Other objects will appear as the description of the invention proceeds, especially in view of the detailed exposition of preferred embodiments illustrated in the attached drawings.

In the drawings which include electrical diagrams more or less conventional in nature:

Fig. 1 is an electrical diagram of a lighting system utilizing my invention for operating a single gaseous discharge device in the form of a fluorescent lamp.

Fig. 2 is a schematic plan view, with portions shown in section, of a transformer embodying the invention.

Fig. 3 is an electrical diagram of a fluorescent lighting system embodying the invention, in which two (2) fluorescent lamps are connected in circuit in lead-lag arrangement.

Figs. 4 and 5 are views similar to that of Fig. 2, but showing a transformer intended for use with the circuit shown in Fig. 3.

Fig. 6 is a modified form of the circuit shown in Fig. 3.

Fig. 7 is a circuit diagram of a fluorescent lighting system embodying the invention, utilizing two (2) fluorescent lamps and operating on the series sequence principle.

Fig. 8 is a simplified perspective view of the type for fixture which may be used in practising the invention.

As explained previously, the Underwriters' Laboratories have established requirements for fluorescent ballasts utilizing rapid start lamps such that the flow of current to ground is limited to 5 milliamperes. This is achieved by isolating the primary from the remainder of the transformer and, hence, it has been necessary to increase the number of turns in the windings which provide the starting voltages in the lamps. The voltage generated across the primary has not been available as an aid n starting.

In my invention I utilize a coupling of capacitive nature between the fluorescent lamp or lamps and a metal reflector which is formed as a part of the fixture within which lamps are installed. This provides a path to ground through the lamp and thereby gives the added voltage of the line in addition to that of the secondary windings as an aid in starting the lamp.

In its simplest form, the invention is shown in Fig. 1. Reference character **10** is used to designate generally the circuit and it will be seen that the usual lines conventionally designating iron cores have been excluded to render more lucid the explanation. There is a primary winding **11** and a secondary winding **12** separated by a high resistance **13**. The winding **11** is connected across the terminals **14** and **15**, the remote terminal **14** being grounded as shown at **16**.

As a matter of convention, the electrical lead **17** will be white and the lead **18** black, contrary to common usage. A fluorescent lamp **19** is connected across the secondary winding **12** by means of the leads **20** and **21**. It is required that the voltage appearing across the secondary winding **12** be sufficient in and of itself to ignite the lamp **19**, unless some additional aid is provided. Without this aid it would be necessary, in the case of a 40 watt rapid start lamp, that the winding **12** generate well over 300 volts. In accordance with my invention, I provide a capacitive coupling which extends from the reflector **22** to the lamp **19** and providing a path through the electrical conductor **23** to ground **16**. This adds to the voltage which has been developed across the secondary winding **12**, at least that voltage which appears from the point designated "A" to ground. This, of course, is line

voltage. It produces a considerable voltage in the lamp at the right hand end thereof exciting the gas within the lamp and rendering it easier for the secondary winding 12 to ignite the lamp. Obviously, the number of turns required in 12 with the starting aid will be substantially less than if the starting aid were not used.

It will be seen that the usual filament windings 24 and 25 are connected across the filaments of the lamp through appropriate leads 26, 27, 28 and 29.

It is important to point out that the instantaneous voltage sense of the primary winding 11 and secondary winding 12 must be such that the windings are additive. This refers to the sense of voltage across the reflector which depends upon voltage sense of the primary winding.

In Fig. 2 I have illustrated generally the type of core which is preferred in connection with the ballast of the circuit 10. There is a shell-type core 30 having a central winding leg 31 adapted to be pressed into the core, matingly engaging the core at its ends, as indicated at 32 and 33. Windows are provided for the windings in the usual manner, the said windings being separated by a magnetic shunt 34. In one window, there is disposed the primary 11 and the filament windings 24 and 25, while in the other window there is disposed the winding 12. As in the usual case of ballasts, the entire transformer, together with the high resistance 13 and, perhaps, radio interference condensers, is disposed in a metal canister, covered with varnish and pitch, and sealed with marked leads protruding therefrom.

In Fig. 3 I have illustrated a circuit 40 of a lead-lag type which utilizes two fluorescent lamps 41 and 42 intended to be ignited simultaneously and operated from the transformer whose primary is shown at 44. It will be noted that the primary 44 is connected by electrical leads 45 and 46 to line terminals 47 and 48. The line terminal 47 is grounded at 50. In this case there is also provided a secondary winding 52 which is electrically isolated from the primary winding 44 by a series resistor 53 of relatively high resistance. This provides the protection required by the Underwriters' Laboratories. It will be noted that there are three filament windings 55, 56 and 57, the winding 55 being disposed in the lead 59 which connects the secondary winding 52 and the resistance 53. As in the case of the usual lead-lag circuit, from the common point 61 to the right of the secondary winding 52 there are connected the two windings 62 and 63. Winding 62 is connected by lead 64 to the lamp 42 and the winding 63 is connected by the lead 65 through a series condenser 66 with the right-hand terminal of the lamp 41. Obviously the lamp 42 will be lagging and the lamp 41 leading. The filament winding 55 is connected in parallel to the left-hand filaments of the lamps, as indicated by the electrical leads 68. Filament windings 56 and 57 are connected to the right-hand filaments of the lamps 41 and 42 respectively by means of electrical leads 69 and 70.

In order to achieve the benefit of a voltage which exists from the point A to ground, I utilize the reflector member 72 which is capacitively coupled to the lamps and grounded through the lead 73. Voltage developed in the secondary winding 52, and perhaps additionally in the windings 62 and 63, is augmented by at least the line voltage in at least parts of the lamps so that in starting, these secondary windings need not be of a great many turns.

The windings 62 and 63 may either be in the form of chokes, or they may be actual secondaries inductively coupled with the primary.

In Figs. 4 and 5 I have illustrated two different types of cores which provide for the formation of transformers 80 and 90. Considering first the transformer 80, the core has an outer shell formation 81 and a center winding leg 82 intended to be pressed into the shell with its ends 83 matingly engaged as shown. Windows are formed at three places for the windings and through the use of suitable projections, shunts 84 and 85 are formed between the windings. It will be noted that the primary winding 44, secondary winding 52 and the filament windings 55, 56 and 57 are all mounted in the center window in close coupled relationship. Then secondary winding 62 may be mounted in the left window and the other 63 mounted in the right window. In the case of this transformer 80, the coupling between secondaries 62 and 63 and the primary winding 44 is sufficient to induce voltages in these windings. Therefore, the secondary winding 52 need only provide approximately half of the starting voltage for the lamps 41 and 42. The other half is provided by reason of the transformer arrangement of the secondaries 62 and 63, each furnishing approximately one-half of the igniting voltage of one lamp. The sum of voltages for any one lamp provided by the combined induced voltages of the secondaries 52—62, or 52—63 may be considerably less than this igniting voltage, because of the ability of the circuit to use as a starting aid the voltage existing from a point A to ground 50.

In the case of the transformer 90, it will be noted that the same is substantially identical as far as general construction is concerned, except that there are no air gaps between the windows. In the transformer 80, the high leakage reactance shunts 84 and 85 required non-magnetic gaps 86 and 87 respectively. In the transformer 90 there is a shell core 91 and a central winding leg 92 with air gaps at 93 and having two magnetic short circuits 94 and 95 between the formed windows. Without the existence of the air gaps 86 and 87, no voltages will be induced in the windings 62 and 63, so that same may merely act as chokes. Consequently, all of the igniting voltage is required to be generated within the secondary winding 52 and the turns thereof are increased accordingly. The number of turns in the choke windings 62 and 63 of necessity must be sufficient to ballast the lamps used. The circuit of Fig. 3 is identical regardless of where used with the transformer 80 or 90.

In Fig. 6 I have illustrated still another form of lead-lag circuit which differs from the lead-lag circuit of Fig. 3 in that the isolated secondary winding 52 has been eliminated. In this case the lead and lag secondaries both function to provide the total voltage for ignition of the respective lamps and they are both isolated by high resistance from ground. Also, in this case additional voltage for aiding and starting is acquired through the use of a path from the fixture reflector to ground.

Referring to the details, the primary 100 is connected to line terminals 101 and 102 through electrical conductors 103 and 104. The terminal 102 is grounded at 105. There is an isolating resistor 106 connected to the left-hand side of the primary winding 100 and its left-hand terminal 107 which forms the juncture for the lead secondary 108, and the lag secondary 109 is the equivalent of a point A hereinabove referred to. The lead secondary 108 connects by way of the conductor 110 through the capacitor 111 to the right-hand terminal of the lamp 112. The lag secondary 109 connects by way of the conductor 113 and the left-hand terminal of the lamp 114. The filament windings 115, 116, 117 and 118 are closely coupled to the primary winding 100 and serve filaments of the lamps. Filament 115 provides current for the left-hand filament of the lamp 114 through the leads 119 and in a like manner, the filament 116 serves the right-hand filament of the lamp 114 through leads 120 and 121. Filament 117 serves the left-hand filament of lamp 112 through the leads 121 and 122, while filament 118 serves the right-hand filament of the lamp 112 through the leads 123. The terminal 107 is connected by way of a conductor 125 to the right and left terminals respectively of the lamps 114 and 112.

In order to acquire the aided starting voltage described, a capacitive coupling between the reflector member 127 of the fixture in which the lamps are installed is used, the

said reflector **127** being connected to ground through the lead **128**.

The transformer construction which is used in connection with the circuit of Fig. 6 is shown in Fig. 4 and differs only in the respect that there is no secondary winding equivalent to the secondary **52** and there is an additional filament winding. It is also obvious that the lead and lag secondaries **108** and **109** will have to have more turns in order to provide sufficient igniting voltage for the respective lamps.

In Fig. 7 I have illustrated still another embodiment of the invention which utilizes a series sequence starting arrangement. In this case substantially all of the igniting voltage for the lamps is provided by a single secondary winding, augmented by the voltage developed between ground and the reflector of the fixture with which the lamps are associated. Also in this case, the lamps are ignited one at a time so that all the voltage which need be developed in the secondary winding is the igniting voltage of one lamp.

Referring now to the details, there is illustrated a primary **150** which is connected to line terminals **151** and **152** by leads **153** and **154**. The terminal **151** is grounded as shown at **155** and a high ohmage resistor **156** is connected between the right-hand terminal of the primary winding **150** and the remainder of the transformer. Tracing the principal circuit, the right-hand terminal of the resistor **156**, which is designated A, connects by way of the lead **158** to the left-hand terminal of the lamp **159**, thence by the lead **160** to the left-hand terminal of the secondary winding **161**, thence by way of the lead **162** and the series condenser **163** to the right-hand terminal of the lamp **164** and back to the terminal A. Across the lamp **164** there is provided a condenser **165** to aid in series igniting the lamps. Obviously, first the lamp **159** will ignite after which the lamp **164** will ignite. After the lamps have ignited, the condenser **165** serves as a high reactance and the circuit is a series circuit through both lamps.

Filament windings are provided as shown at **166**, **167** and **168** and these are connected to the various filaments of the lamps as shown. It will be seen that in the ignition of each lamp in turn there will be added a voltage caused by capacitive coupling between the reflector **170** and the lamps **159** and **164**. This provides a path through the conductor **171** to ground and adds to the voltage induced in the secondary winding **161**, that voltage appearing from the point A to ground. In addition, as in the case of all other circuits herein described, the resistor **156** effectively isolates the primary winding and limits the flow of current to that required by the Underwriters' Laboratories.

The transformer core with which the ballast comprising windings **150**, **161**, **166**, **167** and **168** are associated, does not differ greatly from that illustrated in Fig. 1.

In Fig. 8 I have shown a rather simplified form of fixture with which the invention is intended to be used. The fixture is designated generally **200** and only the left-hand end is shown. There is a base or standard which may be either a flat plate or an enclosed housing. As shown it is in the form of a rectangular housing for holding the ballast. The housing includes a bottom plate **201** and side reflector wings **203** and **204** which surround the lamps **205** and **206**. These lamps are held in the usual holders **207** and **208** provided at the ends of the fixture. In accordance with the invention the spacing between the lamps **205** and **206** and the reflector formation comprising the plate **201** and the wings **203** and **204** is such as to provide a capacitive connection. When the reflector formation is grounded as explained hereinbefore, there will be a voltage existing across the capacitive connection suitable for use as a starting aid.

It is believed that one skilled in the art could readily construct and use the ballast and systems as set forth hereinabove. Depending upon the types of lamps used and the line voltage, one may readily determine the number of turns for the respective windings and the value of resistance of the isolating resistor. For example, in the case of the circuit of Fig. 1 and the transformer of Fig. 2, the resistor **13** was approximately 1.5 megohms for the case of a 40 watt fluorescent lamp. Line voltage was 118 volts. The primary was 670 turns of number 23 gauge wire and the secondary was approximately 1350 turns of number 28 wire. The width of the winding leg **31** was .8 inch and the total width of the shell core was 2.25 inches. A 1 inch stack of laminations was used and the length was adjusted to provide a sufficient shunt **34** and sufficient bridging ends to accommodate the number of turns. The voltage developed across the secondary winding from the point A to the lead **21** was approximately 205 volts. During starting there was available to parts of the lamp **205** plus 118 or 323 volts which gave quite an assist in igniting the rapid start lamp **19**.

The specific dimensions and physical specifications of the other circuits and transformers illustrated may be worked out on the basis of the technique set forth above.

It is believed that the invention has been fully set forth as required by the patent laws, and it is also desired to point out that considerable variation is possible without in any way departing from the spirit or scope of the invention as defined in the appended claims.

What it is desired to claim by Letters Patent of the United States is:

1. A system for igniting and operating at least one gaseous discharge lamp from a source of A. C. voltage substantially less than the igniting voltage of the said lamp which comprises, an iron core transformer having a primary winding and at least one secondary winding inductively coupled thereto to have a voltage induced in the secondary winding, an elongate gaseous discharge lamp in circuit with the secondary winding, a fixture supporting said lamp and having an elongate, grounded metal part thereof extending along the length of said lamp contiguous and capacitively coupled therewith, a high ohmage resistor connected between one terminal of the primary winding and one terminal of said lamp and providing a connection with said circuit electrically separating the primary and said circuit, the second terminal of the primary winding being grounded, the primary winding being connected across said source, the secondary winding being connected to the lamp to provide igniting and operating voltage therefor, the instantaneous open circuit voltage sense of said primary winding relative said lamp and secondary winding being such as to provide an augmenting additive starting voltage for said lamp, said resistor having a value such as to provide a substantial electrical connection between the primary winding and the circuit, including the secondary winding while limiting current flow through the system to a relatively safe value.

2. A system for igniting and operating a pair of gaseous discharge devices in lead-lag arrangement, which comprises, an iron core transformer having a primary winding and a secondary winding inductively coupled therewith to have a voltage induced therein and loosely coupled relative to the primary to provide high leakage reactance, a lead circuit connected across the secondary winding and comprising first inductive means, a first elongate gaseous discharge device and a capacitor all in series, a lag circuit also connected across the secondary winding and comprising second inductive means and a second elongate gaseous discharge device both in series, a high impedance element connected between one terminal of said primary winding and a terminal of each of said gaseous discharge devices and being also electrically interposed between said one primary terminal and the circuit including said secondary winding, the second terminal of said primary winding being grounded, elongate grounded metallic means extending adjacent and capactively coupled with said discharge devices, the open circuit instantaneous volt-

age sense of said primary winding being additive relative to that of said secondary winding whereby to provide an additional starting voltage for said devices, the high impedance element being of a value to limit current in said system to a safe value while providing a substantial electrical connection to said primary winding.

3. A system for igniting and operating two gaseous discharge devices comprising, a source of A. C. voltage, an iron core transformer having a primary winding connected across the source with one terminal grounded, a high ohmage resistor having one side connected to the other terminal of the primary winding, two loops connected to the second side of the resistor and electrically isolated from said primary winding thereby whereby any current flowing from said loops to said primary must traverse said resistor and be limited thereby, one loop comprising a first gaseous discharge device, a condenser and a first secondary winding all connected in series, with the secondary winding inductively related to said primary winding and one terminal of said gaseous discharge device connected to said second side of said resistor, said second loop comprising a second gaseous discharge device and a second secondary winding in series with the secondary winding inductively related to said primary winding and said second gaseous discharge device having one terminal connected to said second side of said resistor, metallic electrode means capactively coupled to both devices and connected to ground, the instantaneous open circuit voltage sense of said secondary windings both being additive relative to the primary winding whereby on open circuit the voltage of said primary will aid said secondaries in igniting said discharge devices through said electrode means.

4. A circuit including two gaseous discharge devices,

a source of A. C. voltage, an iron core transformer, a primary winding mounted on the transformer and connected across said source to be energized thereby with one terminal grounded, a high ohmage resistor having one side connected to the second terminal of the primary winding, a loop comprising a secondary winding inductively related to the primary winding, said two gaseous discharge devices, and a capacitor all connected in series with a second capacitor shunting one device, the second side of said resistor being connected to said loop electrically isolating said loop from the primary, the connection of said second side of said resistor being at a terminal of at least the second gaseous discharge device, there being a grounded metallic member capactively coupled at least to said second gaseous discharge device, the relative open circuit instantaneous voltage sense of the primary and secondary windings being additive such that said primary winding aids in the starting of at least said second discharge device, the value of said resistor being such as to limit the flow of current between loop and primary to a relatively safe value while providing a substantial electrical connection therebetween.

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Disclaimer

2,820,180.—*Albert E. Feinberg*, Chicago, Ill. BALLAST AND LIGHTING SYSTEM FOR FLUORESCENT LAMPS. Patent dated Jan. 14, 1958. Disclaimer filed July 30, 1964, by the inventor, the assignee, *Advance Transformer Co.*, assenting.

Hereby enters this disclaimer to claim 1 of said patent.

[*Official Gazette September 1, 1964.*]