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APPARATUS FOR OPERATING GASEOUS DISCHARGE DEVICES

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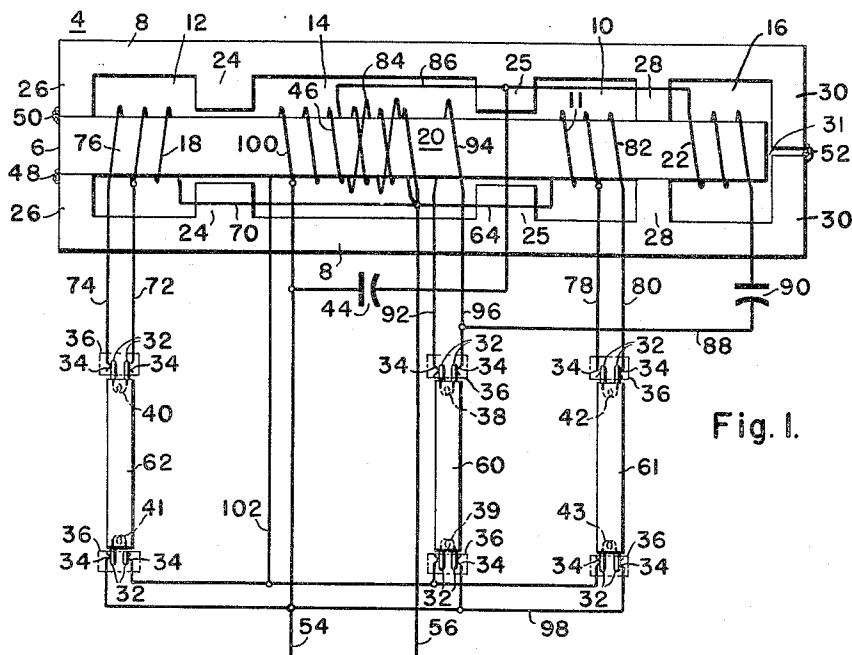


Fig. 1.

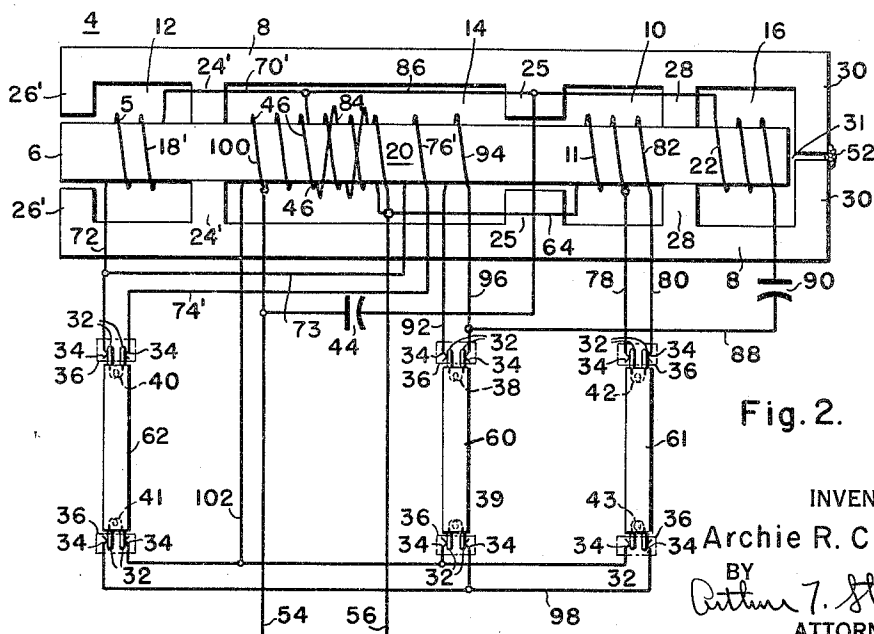


Fig. 2.

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APPARATUS FOR OPERATING GASEOUS DISCHARGE DEVICES

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This invention relates generally to apparatus for starting and operating gaseous discharge devices such as fluorescent lamps, and to the manner in which such apparatus and discharge devices are related; and more specifically to transformer ballast and heater provisions for such discharge devices having continuously heated cathodes.

When a plurality of electric gaseous discharge devices, of which the fluorescent lamp is one example, are operated together, it has been the practice to energize such lamp from a single low voltage source through a transformer to obtain a higher voltage than the source voltage for starting and operating the lamp. Generally, the transformer is of the autotransformer type, and a plurality of discharge devices may be connected to the transformer secondary, there being a separate ballast in the form of an inductance with a magnetic core connected in series with each lamp to stabilize its operation. Also, in order to provide a high power factor and to correct for stroboscopic effects, the circuit of one discharge device is made a leading circuit by the inclusion of a series capacitor. With discharge devices having continuously heated electrodes, the several transformer ballast and heater windings have required a large amount of copper and iron, and prior attempts to reduce their size and weight have not been entirely satisfactory. Also, in some cases, in order to obtain continuous heating of the lamp cathodes, additional windings external of the transformer and ballast windings have been provided with or without auxiliary circuit components.

Accordingly, one object of this invention is to provide a novel unitary combined transformer and ballast assembly for the control of a plurality of gaseous discharge devices of the continuously heated cathode type, which is less in weight and size than such assemblies heretofore employed.

Another object of this invention is to provide a novel transformer and ballast assembly for the control of a plurality of gaseous discharge devices of the continuously heated cathode type, which has heater windings for the lamp cathodes integral with the transformer and ballast assembly.

A further object of this invention is to provide a transformer and ballast assembly for the control of a plurality of gaseous discharge devices of the continuously heated cathode type, wherein all of the various windings are assembled on a single core.

A further object of this invention is to provide a transformer and ballast assembly for the control of more than two gaseous discharge devices of the continuously heated cathode type, wherein all of the various windings are assembled on a single core.

A still further object of this invention is to provide a novel core construction having one or more gaps therein, which is economical to construct, wherein all the various transformer, ballast and heater windings required to control a plurality of gaseous discharge devices may be located.

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A still further object of this invention is to provide a novel core construction having one or more gaps therein, which is economical to construct, and wherein all the various transformer, ballast and heater windings required to control more than two gaseous discharge devices may be located.

Another object of this invention is to provide a novel laminated core construction, wherein each lamination comprises a plurality of parts shaped in a manner to provide a core construction wherein all the transformer ballast and heater windings required to control a plurality of gaseous discharge devices may be located.

These and other objects of this invention will become more apparent upon consideration of the following detailed description of preferred embodiments thereof when taken in connection with the attached drawings, in which:

Figure 1 is a schematic view of a transformer, ballast, and heater winding assembly, for the control of gaseous electric discharge devices, constructed in accordance with the principles of my invention together with a circuit for connecting it to the discharge devices; and

Fig. 2 is a schematic view of a transformer, ballast, and heater winding assembly, different from that shown in Fig. 1, for the control of gaseous electric discharge devices, constructed in accordance with the principles of my invention together with a circuit for connecting it to the discharge devices.

In accordance with my invention the transformer, ballast, and heater windings for controlling the operation of a plurality of gaseous discharge devices, such as fluorescent lamps, are all assembled on a common core structure. While this invention is hereinafter specifically described with relation to the operation of three separate lamps, it is not limited to that specific number, but may be embodied in the control for operation of a greater number of lamps. The various windings for the operation of the lamps as shown in Fig. 1 are assembled in a manner such that the ballast coils for both of the lag lamps are in the same magnetic circuit with the transformer, whereas the ballast coil for the lead lamp is outside the magnetic circuit for the transformer windings, but employs as part of its magnetic circuit a portion of the magnetic circuit of the transformer. The various windings utilized for heating the cathodes of each of the lag lamps are all extensions of various windings of the transformer, while the heater winding for heating one of the electrodes of the lead lamp is a separate coil in the same magnetic circuit as the transformer. From the following detailed description the benefits obtainable from such a design with respect to the reduction in the number of component parts and the amount of material used will become apparent.

The transformer and ballast assembly shown in Fig. 1 is supported on an elongated core structure 4 which may be fabricated from a plurality of laminations each of which may include a central, longitudinally extending winding leg portion 6, and a pair of yoke portions 8 positioned at opposite sides of the winding leg portion 6. Although the core structure 4 is herein described as composed of laminations, each of which is in three parts, forming the winding leg portion 6 and the yoke portions 8, respectively, the utilization of laminations does not form a part of my invention. For the broad purposes of my invention, each lamination may be constructed in one integral piece, though preferably it is of more than one piece, such as the three herein illustrated.

The core structure 4 has four pairs of opposed openings 12, 14, 10 and 16 provided in the yoke portions 8 thereof at opposite sides of the winding leg portion 6, and spaced along the length of the core structure 4. The opposed openings 12 are adapted to receive a lag coil 18

wound on winding leg portion 6, and the opposed openings 14 are for the purpose of receiving transformer windings 20, all of which are wound on the winding leg portion 6. Opposed openings 19 are adapted to receive a second lag coil 11 wound on winding leg portion 6, and the opposed openings 16 are for the purpose of receiving a lead coil 22 also wound on winding leg portion 6. Intermediate lag coil 18 and transformer windings 20, the yoke portions 8 of the core structure 4 are provided with opposed legs 24 which extend inwardly toward winding leg portion 6, but terminate short thereof to form a leakage gap in the core structure 4 between the openings 12 and 14. In a similar manner, opposed legs 25 are located between lag coil 11 and transformer windings 20 for the same purposes. The yoke portions 8 of the core structure 4 also have inwardly extending opposed leg portions 26 which extend into engagement with the winding leg portion 6 at the left end of the core structure, and inwardly extending leg portions 28 which also extend into engagement with the winding leg portion 6. Leg portions 28 are located between the lead coil 22 and the lag coil 11 at the right-hand end of the transformer windings 20 as viewed in Fig. 1. Yoke portions 8 are also provided at the right-hand end with opposed inwardly extending legs 30 which may, if desired, terminate short of each other and in spaced relation to the right-hand end of winding leg portion 6, whereby a gap 31 will be formed between the right-hand end of the winding leg portion 6 and the legs 30 of the yoke portion 8.

When the core structure 4 is formed of three-piece laminations, as illustrated in Fig. 1, the laminations may be secured together in any desired manner, preferably as by welding them at three exterior junctions of the three parts of each lamination, namely, at the junctions 48 and 50 between the legs 26 of the yoke portions 8 and the adjacent end of winding leg portion 6, and at the gap between the legs 30 of yoke portions 8. If desired, additional securing means, such as bolts (not shown), may extend through aligned apertures in winding leg portion 6.

As shown, the various windings of the transformer and ballast assembly are electrically connected to fluorescent lamps 60, 61 and 62, each of which has at each of its ends a pair of outwardly extending terminals 32 which are adapted to engage, respectively, contacts 34 mounted in a pair of lamp holders 36. Each lamp has a cathode located at each of its ends, which is connected between the terminals 32 at that end. Although all the cathodes of each lamp 60, 61 and 62 may be identical, for the sake of clarity in describing the illustrative embodiment of my invention, separate identifying numerals have been assigned to each cathode. Thus, as shown in Fig. 1, the electrodes at the top of lamps 60, 61 and 62 have been designated as 38, 42 and 40, respectively, and the electrodes at the bottom of lamps 60, 61 and 62 have been designated as 39, 43, and 41, respectively. Such fluorescent lamps are generally installed where they are to be operated from a low voltage supply source, such as 118 or 236 volts commonly supplied customers of electricity, and such a source of supply may be connected to supply conductors 54 and 56, either of which may be controlled by a switch (not shown), inserted in series circuit relation therewith.

In order to decrease the starting time of lamps, it is desirable that each cathode of each lamp be initially heated in order to partially ionize the chamber within the lamp in order to assist in initiating a discharge across the lamp. Once such a discharge occurs, it is no longer necessary that the lamp cathodes be heated by external provisions, as the arc current of the lamp will thereafter maintain the cathode heat. In view of the minor losses incurred, and the relatively high cost of providing means for disconnecting the cathode heating circuits, it has been found to be practical, however, to heat the cathodes continuously, even through such external heat-

ing is not required during the period that a discharge occurs across the lamp.

It will be observed from Fig. 1 that the transformer windings 20 are in the form of an autotransformer having a winding 46 connected between the supply conductors 54 and 56. Supply conductor 56 is also connected by means of a conductor 70 to the lag coil 18 which in turn is connected by means of a conductor 72, and a lamp holder 36 to one of the terminals 32 of lamp 62 connected to cathode 40. The other terminal 32 of lamp 62 which is connected to the cathode 40 is connected by a conductor 74 to an extension 76 of lag coil 18. In a similar manner, supply conductor 56 is connected by a conductor 64 to lag coil 11 which is connected by a conductor 78 and a lamp holder 36 to one of the terminals 32 of lamp 61 connected to cathode 42. The other terminal 32 of lamp 61 which is connected to the cathode 42 is connected by a conductor 80 to an extension 82 of the lag coil 11. Supply conductor 56 is also connected to winding 84 of the transformer, which in turn, by means of conductor 86 is connected to the lead coil 22. The lead coil 22 is connected by a conductor 88 having condenser 90 therein to one of the terminals 32 of lamp 60 connected to cathode 38. The other terminal 32 of lamp 60 which is connected to electrode 38 is connected by a conductor 92 to a winding 94 which is located in the opposed openings 14 and in turn is connected by a conductor 96 to the conductor 88.

In order to energize cathodes 39, 43 and 41 of lamps 60, 61 and 62, respectively, supply conductor 54 is connected to a conductor 98 which in turn is connected through lamp holders 36 to one of the terminals 32 of each lamp. Winding 46 of transformer windings 20 is provided with an extension 100 from supply conductor 54 which is connected by a conductor 102 to the other terminals 32 of each lamp connected to the cathodes 39, 41 and 43. Although the particular circuit for heating cathodes 39, 41 and 43 is described as a parallel arrangement, if desired, a series circuit may be utilized.

It will be noted that the transformer winding 20 comprising windings 46 and 84 and extension winding 100 are in autotransformer relationship with the winding 46 functioning as a primary winding portion. Thus, when supply lines 54 and 56 are energized, extension winding 100 functions as a portion of an autotransformer secondary and a resultant electrode heating current flows through conductor 102, cathodes 39, 41 and 43 of lamps 60, 62, and 61, respectively, in parallel, and conductor 98 to the supply conductor 54. It is also noted that lag coils 18 and 11, as more particularly described hereinafter, are in the same magnetic circuit as winding 46 and that such windings also function as autotransformers with primary winding portion 46. Thus, extension winding 76 of lag coil 18 functions in a similar manner to induce a current flow through conductor 74, cathode 40 of lamp 62 and conductor 72. In a similar manner, extension winding 82 of lag coil 11 functions to induce a current flow through conductor 80, cathode 42 of lamp 61 and conductor 78. As winding 94 is positioned on the winding leg portion 6 in the opposed openings 14 it is inductively coupled to the winding 46 of the transformer, so that a current is induced in winding 94 which flows through conductor 96, cathode 38 of lamp 60 and conductor 92. By such a construction, there is a current flow through each cathode of each lamp which enables each cathode to become heated when there is a current flow through the winding 46. Such current flow through the cathodes causes the chamber within the lamps 60, 61 and 62 to become partially ionized, whereby a lower voltage can be utilized to start and maintain a discharge across the lamp cathode.

As has been indicated, core 4 provides a low reluctance magnetic circuit comprising the parts of winding leg portion 6 and yoke portions 8 between the legs 26 and 28 as well as these legs themselves. Winding 84, together

with the winding 46, is connected across the lamp 60 in autotransformer relationship, so that the voltage in winding 84 is added to that of winding 46 to thus provide the necessary high voltage for operation of the lamp 60, once lamp 60 has been sufficiently ionized by the heated cathodes 38 and 39 to cause such a discharge at that voltage. The operating circuit for lamp 60 comprises supply conductor 54, winding 46, winding 84, conductor 86, lead coil 22, conductor 88 having condenser 90 therein, lamp 60, conductor 102, and extension winding 100 to supply conductor 54. While the lead coil 22 is included in the supply circuit for lamp 60, the gaps between legs 30 and the adjacent end of winding leg portion 6 of the core 4 determines the reactance for coil 22. The gap between legs 30 themselves, while not essential, is desirable to insure proper assembly of the parts of each lamination, particularly to insure proper engagement of yoke legs 26 and 28 with winding leg 6, and thus properly determine the gaps between yoke legs 24 and 25 and winding leg 6.

The operating circuit for lamp 62 comprises supply conductor 54, winding 46, conductor 70, lag coil 18, extension winding 76, conductor 74, lamp 62, conductor 102, and extension winding 100 to the supply conductor 54. As lag coil 18 is in the same magnetic circuit as winding 46, the voltage of the windings are additive, which provides the necessary high voltage needed for operation of the lamp 62 once lamp 62 has been sufficiently ionized by the heated electrodes 40 and 42 to cause such a discharge at that voltage. Lag coil 18, however, acts somewhat differently than the winding 84 of the transformer, in that the legs 24 of the yoke portions of the core 4 provide for magnetic leakage at a point between windings 46 and the lag coil 18, and the gap between these legs and the winding leg portion 6 provides for a high reactance for the lag circuit containing lag coil 18. Lag coil 18 may be designed to produce in conjunction with winding 46 a starting and operating voltage for the lamp 62 which will be substantially the same as that provided by the autotransformer for lamp 60. The lag coil 18 also provides a reactance in series with lamp 62 of a value comparable to that provided for lamp 60 by lead coil 22 and capacitor 90. As lag coil 18 provides a relatively high reactance in the circuit for lamp 62, it will be apparent that the current in this lamp will lag behind that of the source of supply, whereas the condenser 90 in the circuit for lamp 60 will cause the current in this circuit to lead that of the source of supply, to thus supply a relatively high power factor and correction for stroboscopic effect of the lamps.

In a similar manner, and as discussed with reference to the operation of lamp 62, lag coil 11 and extension 82 operate to energize and cause a discharge across lamp 61 as lag coil 11 is in the same magnetic circuit as winding 46, legs 25 provide for magnetic leakage and will function in the same manner as legs 24. It will be noted, however, that in utilizing two lag coils, in order to compensate for the additional inductance in the circuit, a condenser 44 is placed between supply conductor 54 and conductor 86. Although condenser 44 is in parallel with the winding 46 and the winding 84, it may, if desired, be placed over only a portion of these windings. The operating circuit for lamp 61 comprises supply conductor 54, winding 46, conductor 64, lag coil 11, extension 82, conductor 80, lamp 61, conductor 102, and extension winding 100 to the supply conductor 54.

In operation, the voltage available for starting lead lamp 60 will be increased due to the common portion of the magnetic circuit comprising legs 28 of yoke portions 8, which may be restricted in cross-sectional area so that they partly saturate during the open circuit condition of the lead lamp 60. By properly phasing the lead coil 22 with respect to winding 46, that is, by winding it so that the induced flux is additive, the open circuit voltage applied to lamp 60 will be substantially higher than the output voltage of the autotransformer due to some of the

flux generated by winding 46 linking with the lead coil 22. By employing this expedient the size of the windings may be reduced for any given circuit voltage requirement of lamp 60, while the required voltage for lamps 62 and 61 may still be achieved by appropriately designing lag coils 18 and 11, respectively. Once lamp 60 starts the flux in reduced area legs 28 decreases it then being the vector difference between the autotransformer flux and that of lead coil 22. Also, once lamp 60 starts the coupling between the autotransformer and the lead coil 22 will be reduced, so that for all practical purposes the lead coil 22 operates as an entirely separate unit from the autotransformer.

Another transformer and ballast assembly incorporating the principles of my invention is shown in Fig. 2, wherein similar components have been given the same reference numerals. The transformer, ballast and heater windings, and the connections thereto are identical in construction and function for lamps 60 and 61 as previously discussed. It will be noted however that lag coil 18' is no longer in autotransformer relationship with winding 46 as legs 26' are foreshortened from the winding leg portion 6, and the legs 24' have been lengthened to engage winding leg portion 6 in the same manner as legs 28, previously discussed. By this construction lag coil 18' and legs 24' function in the same manner as lead coil 22 and legs 28 previously discussed. In order, however, to obtain the necessary high voltage for starting lamp 62, lag coil 18' is connected to the high voltage side of winding 84 by conductor 70' and a separate winding 76' is provided which is inductively coupled to the transformer windings 20 to provide a heater current for electrode 40 of lamp 62. Thus, the operating circuit for lamp 62 comprises supply conductor 54, winding 46, winding 84, conductor 70', lag coil 18', conductor 72, lamp 62, conductor 102, and extension winding 100 to supply conductor 54. The heater winding 76' is connected to conductor 72 by conductor 73 and is connected to one of the terminals 32 of lamp 62 connected to electrode 40 by a conductor 74'. The other terminal 32 of lamp 62 connected to electrode 40 is, as before connected to conductor 72. Thus, it will be noted that there are various core constructions which may be utilized, when accompanied by the necessary wiring changes, without departing from the purposes of my invention.

The transformer and ballast assemblies described above have been found to be more economical in construction than has heretofore been practical and have resulted in very substantial savings in the amount of copper iron employed, thus reducing losses as well as the size and weight of the assemblies. It will be noted particularly that each cathode is heated by a winding on a single ballast unit which results in considerable savings in fabricating costs as separate additional coils and their support means are eliminated. Also by utilizing extensions for the heater windings where possible, the open circuit voltage across the lamps will be increased by the amount of voltage generated across such extensions. Thus for a given amount of copper used in the coils a greater open circuit voltage can be obtained than is obtained with non-extension types of heater windings.

From this description of my invention it will be noted that I have provided a transformer ballast assembly for a discharge device having continuously heated cathodes wherein all of the heater windings for each of the cathodes of each lamp are wound upon a common core, whereby one unitary structure is provided. By eliminating external auxiliary apparatus, it is believed apparent that a substantial savings in fabricating and installing such devices can be achieved. Accordingly having described preferred embodiments of the invention in accordance with the Patent Statutes, it is desired that the invention be not limited to the specific constructions illustrated, inasmuch as it will be apparent that many modifications other than those shown may be made without

departing from the spirit and scope of my invention. Accordingly it is desired that this invention be interpreted as broadly as possible and that it be limited only as required by the prior art.

I claim as my invention:

1. Apparatus for controlling the operation of a plurality of gaseous discharge devices comprising a plurality of lampholders each having two contacts and being arranged in pairs, an autotransformer having a primary winding portion and a plurality of high reactance secondary winding portions, each connected to separate pairs of said lampholders to impress a high voltage therebetween, each of said high reactance secondary winding portions having means for impressing a voltage across the contacts of a lampholder in said separate pairs of said lampholders, and said primary winding portion having an extending portion whereby a voltage may be impressed across the other contacts of each of said separate pairs of lampholders.

2. Apparatus for controlling the operation of a plurality of gaseous discharge devices comprising an autotransformer having a primary winding portion and a low reactance secondary winding portion, a plurality of high reactance secondary winding portions, a plurality of lampholders each having two contacts and being arranged in pairs, each of said secondary winding portions being connected so as to impress a high voltage across separate pairs of said lampholders, an extension winding from said primary winding portion connected to impress a low voltage across the contacts of one lampholder of each of said separate pairs, each of said high reactance secondary winding portions having a portion to impress a low voltage across the other contacts of two of said separate pairs of lampholders, and means inductively coupled to said autotransformer for impressing a low voltage across the other contacts of a third of said separate pairs of lampholders.

3. Apparatus for controlling the operation of a plurality of gaseous discharge devices comprising an autotransformer having a primary winding portion and a first high reactance secondary winding portion, a second high reactance secondary winding portion, lampholders each having two contacts and being arranged in at least two spaced pairs, an extension winding from said primary winding portion connected to impress a low voltage across the contacts of one lampholder of each of said pairs, and each of said high reactance secondary winding portions having a portion connected to impress a low voltage across the contacts of the other lampholder of each of said pairs of lampholders.

4. Apparatus for controlling the operation of a plurality of gaseous discharge devices comprising a plurality of lampholders each having two contacts and being arranged in pairs, an autotransformer having a primary winding portion, a winding extending from said primary winding portion connected to impress a low voltage across the contacts of one lampholder of each of said pairs of lampholders, a low reactance secondary electrically connected across a first and second pair of said lampholders whereby a high voltage is impressed therebetween, means inductively coupled to said autotransformer for impressing a low voltage across the other lampholders of said first and second pairs of lampholders, and a high reactance secondary winding portion electrically connected to impress a high voltage across a third pair of lampholders having a portion whereby a low voltage may be impressed across the contacts of the other lampholder of said third pair of lampholders.

5. A transformer and ballast assembly for controlling

the operation of a plurality of gaseous discharge devices having a cathode at each of its ends comprising a core structure having an elongated winding leg portion, a primary winding portion at one location along said winding leg portion, a plurality of ballast coils each mounted at other locations along said winding leg portion, said transformer having a high voltage secondary mounted at said one location connected to one side of said primary winding portion, a low voltage extension connected to the other side of said primary winding portion and a low voltage secondary mounted at said one location, a low voltage tap on two of said ballast coils, and phase shifting means electrically connected to a third of said ballast coils.

6. A transformer and ballast assembly for controlling the operation of a plurality of gaseous discharge devices having a cathode at each of its ends comprising a core structure having an elongated winding leg portion, a primary winding portion at one location along said winding leg portion, a plurality of ballast coils each mounted at other locations along said winding leg portion, said transformer having a high voltage secondary mounted at said one location connected to one side of said primary winding portion, a low voltage extension connected to the other side of said primary winding portion and a low voltage secondary mounted at said one location, a low voltage tap on two of said ballast coils, phase shifting means electrically connected to a third of said ballast coils, and a condenser electrically connected to said other side of said primary winding portion in parallel across said primary winding portion and at least a part of said high voltage secondary.

7. A transformer and ballast assembly for controlling the operation of a plurality of gaseous discharge devices having a cathode at each of its ends comprising a core structure having an elongated winding leg portion, a primary winding portion at one location along said winding leg portion, a plurality of ballast coils each mounted at other locations along said winding leg portion, said transformer having a high voltage secondary mounted at said one location connected to one side of said primary winding portion, a low voltage extension connected to the other side of said primary winding portion and a low voltage secondary mounted at said one location, a low voltage tap on two of said ballast coils, ballast means and phase shifting means electrically connected to a third of said ballast coils, and a condenser electrically connected to said other side of said primary winding portion in parallel across said primary winding portion and said high voltage secondary.

8. A transformer and ballast assembly for controlling the operation of a plurality of gaseous discharge devices having a cathode at each of its ends comprising a core structure having an elongated winding leg portion, a primary winding portion at one location along said winding leg portion, a plurality of ballast coils each mounted at other locations along said winding leg portion, said transformer having a high voltage secondary and a plurality of low voltage secondaries mounted at said one location; a low voltage tap on one of said ballast coils, and phase shifting means electrically connected to a third of said ballast coils.

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