

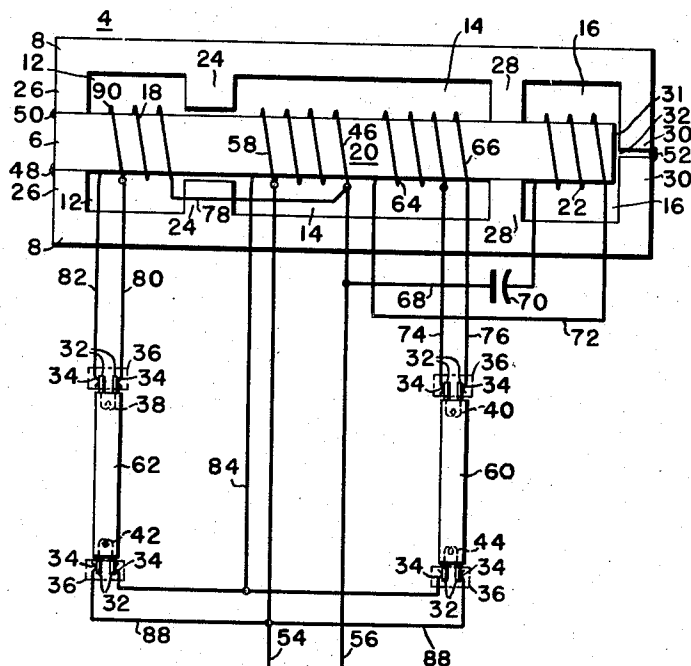
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APPARATUS FOR OPERATING GASEOUS DISCHARGE DEVICES

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1

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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 them 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 improve the power factor and to correct for stroboscopic effect, the circuit of one discharge device is made a leading circuit by the inclusion of a series capacitor. Heretofore, discharge devices having continuously heated electrodes have in some instances resorted to separate windings inductively connected to the autotransformer in order to obtain energy for heating the lamp cathodes. Such separate windings require additional material, labor, and manufacturing time, and in some instances have resulted in considerably larger and heavier assemblies. Also, by using externally coupled windings for energizing the cathodes of a gaseous discharge device, for the amount of copper used it is not possible to obtain the greatest open circuit voltage across the discharge devices.

Accordingly, one object of my 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 has heretofore been employed.

Another object of my 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 wherein each winding for energizing such cathodes is an extension of the windings of the autotransformer.

Another object of my 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 wherein one cathode of each discharge device is energized by an extension of separate windings of an autotransformer and the other cathode of each discharge device is energized by another extension of a separate winding of the autotransformer.

A further object of my invention is to provide a novel assembly of the transformer, ballast and heater windings on a single core for controlling the operation of a plurality of gaseous discharge devices having continuously heated cathodes.

2

Still another object of my 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, wherein the highest open circuit voltage for a given amount of copper used is obtained across each discharge device.

These and other objects of my invention will become more apparent upon consideration of the following detailed description of a preferred embodiment of my invention when taken in connection with the drawing in which is illustrated 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.

In accordance with my invention, the transformer, ballast, and cathode 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 in connection with the operation of a pair of lamps, it is not limited to this specific number of lamps but may be embodied in the control for operation of a single lamp, or for a greater number of lamps. The windings for operation of a pair of lamps are assembled in a manner such that the ballast coil for the lag lamp is in the same magnetic circuit with the autotransformer, whereas the ballast coil for the lead lamp is outside the magnetic circuit for the autotransformer windings, but employs as part of its magnetic circuit a portion of the magnetic circuit for the autotransformer. The various windings utilized in heating the cathodes of the discharge device are all extensions of certain of these windings. From the following detailed description, the benefits obtainable from such a design with respect to the open circuit voltage across the discharge devices and with respect to reduction in component parts and materials will become apparent.

The transformer and ballast assembly shown in the drawing is supported on an elongated core structure 4 which may be fabricated from a plurality of stacked laminations, and includes 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 three parts, forming the winding leg portion 6 and yoke portions 8, respectively, this specific arrangement, per se, forms no part of my invention but is more specifically described and claimed in the pending application Serial No. 267,628 of Oglesbee and Cornell, filed January 22, 1952, on Cores, and which is assigned to the same assignee as this application. 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 three pairs of opposed openings 12, 14 and 16 provided in the yoke portion 8 thereof at opposite sides of the winding leg portion 6, and spaced along the length of the core structure, with the opposed openings 12 adapted to receive a lag coil 18 wound on winding leg portion 6. The opposed openings 14 are for the purpose of receiving the autotransformer winding 20 which is wound on the 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 at the location of openings 16. Intermediate lag coil 18 and the autotransformer winding 20, the yoke portions of the core structure are provided with opposed legs 24 which extend inwardly toward winding leg portion 6 but terminates short thereof, to form a leakage gap in the core structure between the openings 12 and 14. The

yoke portions 8 of the core structure 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 likewise extending into engagement with winding leg portion 6. Leg portions 28 are located between the autotransformer winding 20 and the lead coil 22 adjacent the right-hand end of the core structure, as viewed in the drawing. Yoke portions 8 have opposed inwardly extending legs 30 which may, if desired, terminate short of each other and are spaced from the right-hand end of winding leg 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 the drawing and as is more particularly pointed out in the above-mentioned pending application, 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 portion 8 and the adjacent end of winding leg portion 6, and gap 52 between the legs 30 of yoke portion 8. If desired, additional securing means, such as bolts, not shown, which may extend through aligned apertures in winding leg portion 6, may also be employed.

As shown, the various windings of the transformer and ballast assembly are electrically connected to a pair of fluorescent lamps 60 and 62, each of which has at each of its ends outwardly extending terminals 32 which are adapted to engage contacts 34 mounted in lamp holders 36. Each lamp has a cathode located at each of its ends, which is connected between the lamp terminals 32. Although all the cathodes of each lamp 60 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 the drawing, the cathodes at the top of lamps 60 and 62 have been designated as cathodes 38 and 40, and those at the bottom as 42 and 44, 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 start such lamps rapidly, it is necessary that the cathodes at each end of each lamp be initially heated in order to partially ionize the gas within the lamp 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 from an external source as the arc current of the lamp will thereafter maintain the cathode heated. 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 to heat the cathodes continuously, even though such external heating is not required during the period that a discharge occurs across the lamp.

It will be observed from the drawing that the transformer winding 20 is 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 68, having a condenser 70 therein to the lead coil 22 which, in turn, by means of conductor 72 is connected to the winding 64 of the autotransformer. Winding 64 is connected by means of conductor 74 and a lamp holder 36 to one of the terminals 32 of lamp 60 which is connected to cathode 40. The other terminal 32 of lamp 60 which is connected to the cathode 40 is connected through lamp holder 36 by a conductor 76 to an extension 66 of winding 64. Supply conductor 56 is also connected by a conductor 78 to the lag coil 18 which in turn is connected to a terminal 32

of lamp 62 which is connected to cathode 38 by a conductor 80 and a lamp holder 36. The other terminals 32 of lamp 62 connected to the cathode 38 is connected by conductor 82 to an extension 90 of the lag coil 18. In order to energize cathodes 42 and 44 of lamps 62 and 60 respectively, supply conductor 54 is connected to a conductor 88 which in turn is connected through lamp holders 36 to one of the terminals 32 of each lamp. Winding 46 is provided with an extension 58 from supply conductor 54 which is connected by a conductor 84 to the other terminals 32 of each lamp connected to the cathodes 42 and 44. Although the particular circuit for heating cathodes 42 and 44 as described is a parallel arrangement, if desired a series circuit may be utilized.

It will be noted that the transformer winding 20 comprising windings 46 and 64 and extension windings 58 and 66 is in autotransformer relationship with winding 46 serving as a primary winding portion. Thus when supply conductors 54 and 56 are energized, extension winding 58 functions as a portion of an autotransformer secondary and a resultant cathode heating current flows through conductor 34, cathodes 42 and 44 in parallel and conductor 88 to the supply conductor 54. In a similar manner extension winding 66 induces a current flow through conductor 76, cathode 40 and conductor 74. It will also be noted that lag coil 18 as more particularly described hereinafter is in the same magnetic circuit as winding 46 and that such windings also function as an auto-transformer. Thus extension winding 90 of lag coil 18 functions in a similar manner to induce a current flow through conductor 82, cathode 38 and conductor 80. By such a construction there is a current flow through each cathode of each lamp which enables each cathode to become heated when winding 46 is energized. Such current flow through the cathodes causes the gas within the lamps to become partially ionized, whereby a lower voltage can be utilized to start and maintain a discharge across the lamp cathodes.

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. Windings 64 and 66 together with the winding 46 are connected across the lamp 60 in autotransformer relationship so that the voltage in windings 66 and 64 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 40 and 44 to permit a discharge to occur at that voltage. The operating circuit for lamp 60 comprises supply conductor 54, winding 46, conductor 68 having condenser 70 therein, lead coil 22, conductor 72, winding 64, winding 66, conductor 76, lamp 60, conductor 84 and winding 58 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 winding leg 6.

The operating circuit for lamp 62 comprises supply conductor 54, winding 46, conductor 78, lag coil 18, extension 90, conductor 82, lamp 62, conductor 84 and winding 58 to the supply conductor 54. As lag coil 18 is in the same magnetic circuit as winding 46, the voltage of the two is additive which provides the necessary high voltage needed for operation of the lamp 62 once lamp 62 has been sufficiently ionized by the heated cathodes 38 and 42 to permit a discharge at that voltage. Lag coil 18, however, acts somewhat differently than the winding 64 of the transformer winding 20, in that the legs 24 of the yoke portions of the core provide for magnetic leakage between windings 46 and the lag coil

5

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 70. 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 70 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 the stroboscopic effect of the lamps.

In operation, the voltage available for starting lead lamp 62 will be somewhat in excess of that provided for operating lamp 60 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 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 lamp 62 may still be achieved by appropriately designing lag coil 18. 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. 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.

The transformer and ballast assembly described above has been found to be more economical in construction than has heretofore been practical and has resulted in very substantial savings in the amount of copper and iron employed, thus reducing losses as well as the size and weight of the assembly. It will be noted particularly that each cathode is heated by an extension winding which results in considerable savings in fabricating costs as only a tap need be provided on a single winding rather than providing a separate heater winding. Also by utilizing such extensions instead of separate heating coils, 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 is an extension of an autotransformer winding. It will be noted that only one unitary structure

6

is provided and that no auxiliary apparatus is required external of the transformer and ballast assembly. It is believed apparent that by so providing a unitary structure a substantial savings in fabricating and installing such devices can be achieved. Accordingly having described a preferred embodiment of the invention in accordance with the patent statutes, it is desired that the invention be not limited to the specific construction illustrated, inasmuch as it will be apparent that many modifications 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 at least one pair of gaseous discharge devices comprising an autotransformer having a core, a primary winding and a closely coupled low reactance secondary winding both of which are mounted on said core and connected in autotransformer relation, a pair of spaced lampholders each having two contacts, a loosely coupled high reactance ballast winding electrically connected in series in the connection between said primary and secondary windings, a first winding extending from the free end of said secondary winding and connected across the contacts of one of said lampholders for impressing a low voltage thereon, and a second winding extending from the free end of said primary winding and connected across the contacts of the other of said lampholders for impressing a low voltage thereon, while at the same time impressing a high voltage across said autotransformers.

2. The apparatus of claim 1 having a second pair of spaced lampholders each having two contacts, a high reactance secondary winding also mounted on said core with one end connected to the same side of said primary winding as said low reactance secondary, means connecting an outer end portion of said high reactance secondary winding to the contacts of one lampholder of said second pair of lampholders, and means connecting said second winding to the contacts of the other lampholder of said second pair of lampholders.

3. The apparatus of claim 1 having a second pair of spaced lampholders each having two contacts, a high reactance secondary winding also mounted on said core with one end connected to the same side of said primary winding as said low reactance secondary, means connecting the other end of said high reactance secondary winding to a contact of one lampholder of said second pair of lampholders, and means connecting said second winding to the contacts of the other lampholder of said second pair of lampholders.

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