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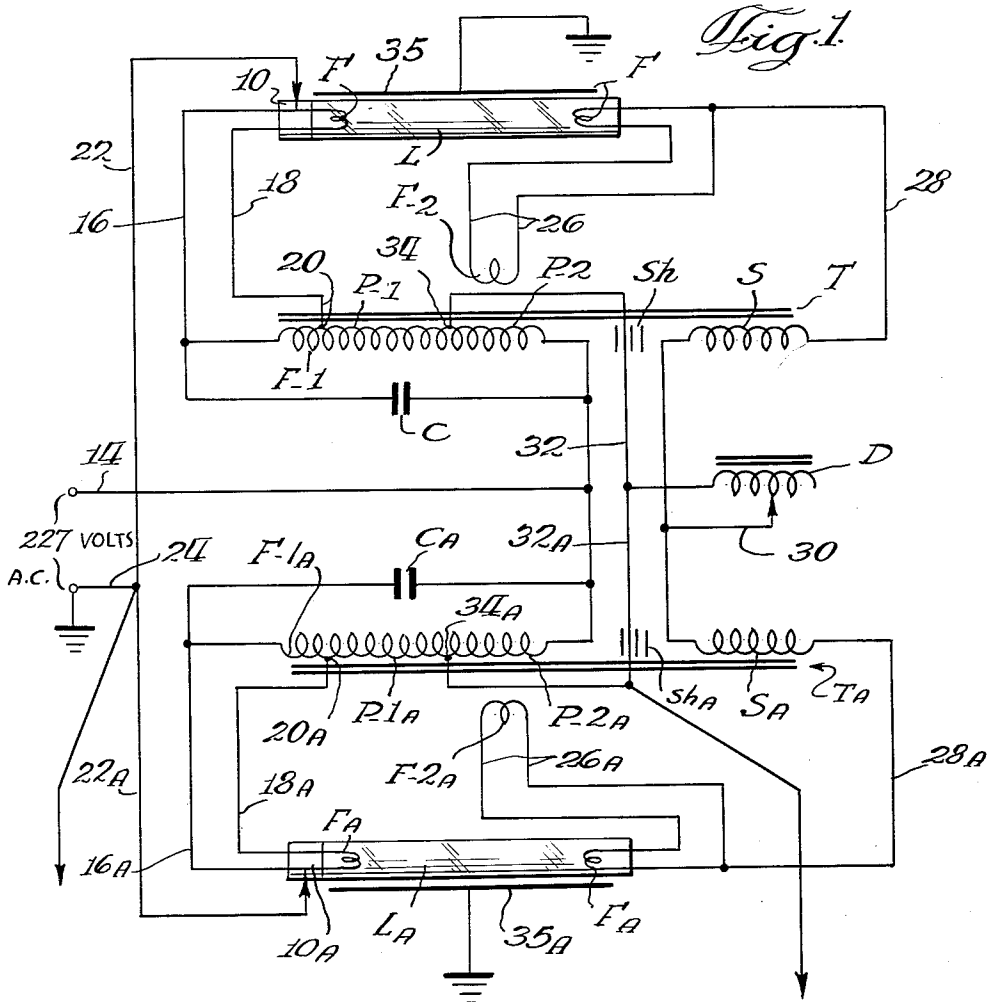
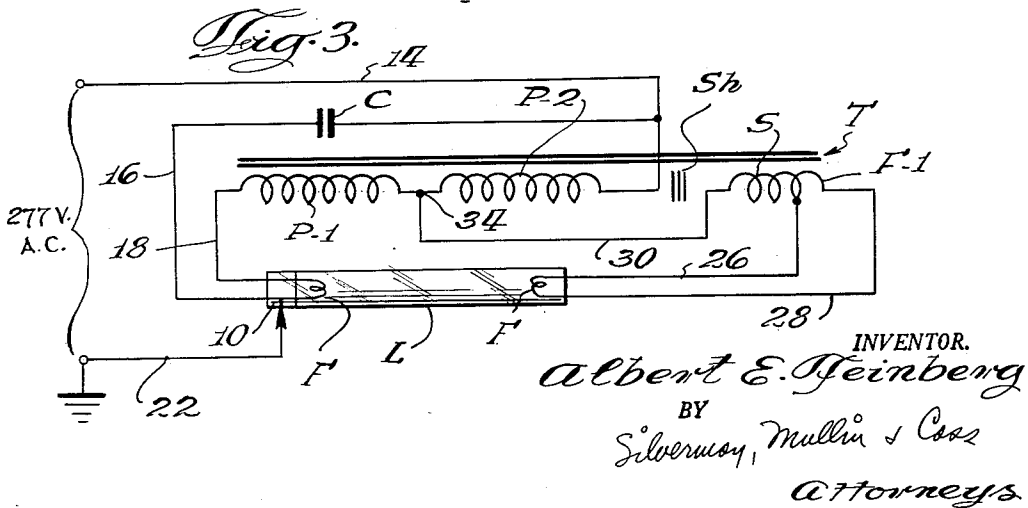
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BALLAST APPARATUS FOR GASEOUS DISCHARGE DEVICES

Filed Sept. 20, 1960

3 Sheets-Sheet 1



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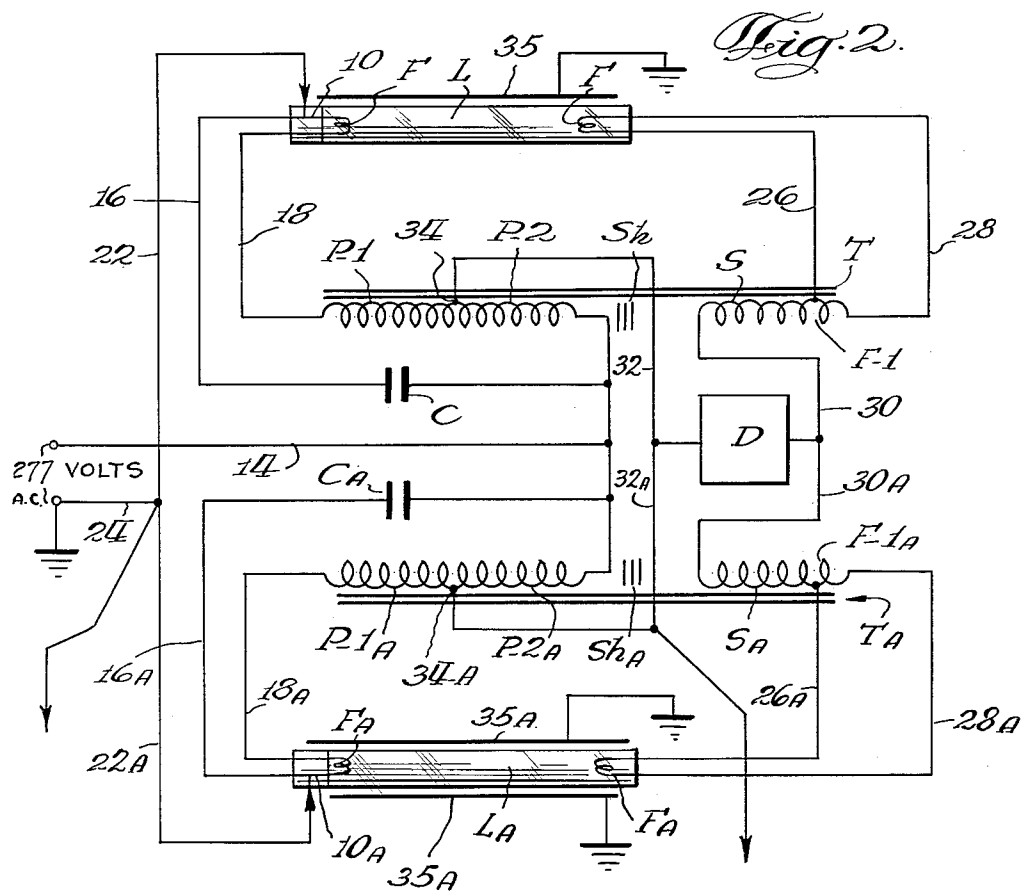
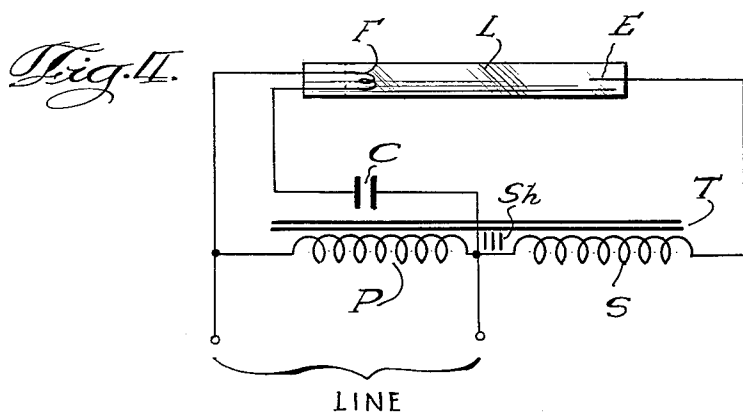
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3 Sheets-Sheet 3

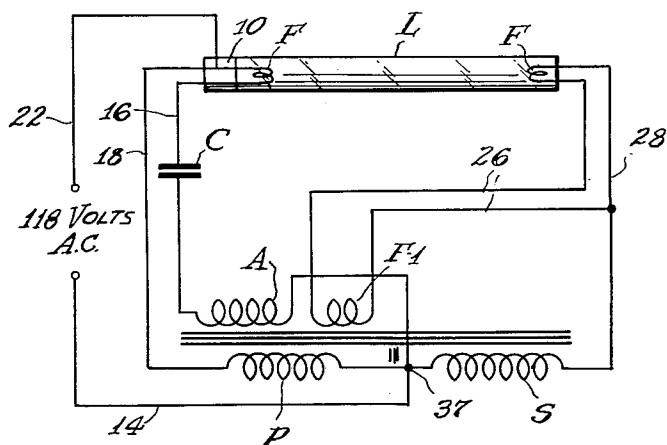


Fig. 5.

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BALLAST APPARATUS FOR GASEOUS DISCHARGE DEVICES

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This invention relates generally to apparatus for the ignition and operation of gaseous discharge devices and more particularly is concerned with apparatus for use with gaseous discharge devices which have filaments therein subjected to continuous flow of current at all times including during operation.

The invention solves a problem which arose in the field of so-called dimmers, that is, apparatus which provides for control of the light output of the gaseous discharge devices, but the solution of the problem was found to have much broader application, as will be seen.

It has been found that the so-called "rapid-start" fluorescent lamps are best suited for use in dimmer circuits because the fact that current is continuously flowing through the filaments thereof insures a greater range of variation of brilliance under operating conditions of the lamps.

The problem referred to above was the likelihood of burning out the primary winding of the ballast because of large currents circulating if some of the leads were opened. The opening of the leads during operation is caused principally by faulty shunting socket connections, and even by the removal of a lamp from the shunting sockets.

The primary object of the invention is the provision of apparatus which will prevent the burn-out of windings under the conditions mentioned, but an equally important object of the invention is the provision of apparatus for igniting and operating gaseous discharge devices having filaments in which economy is achieved through the elimination of filament windings in a novel manner.

Other objects will appear and advantages will become apparent as a description of the invention proceeds in connection with which a preferred example has been illustrated and described, but only by way of explanation and not limitation.

In the drawing:

FIG. 1 is a circuit diagram illustrating the prior art apparatus.

FIG. 2 is a circuit diagram of apparatus constructed in accordance with the invention.

FIG. 3 is a circuit diagram of the basic circuit of FIG. 2 arranged to operate one fluorescent lamp without dimming.

FIG. 4 is a simplified circuit of the invention.

FIG. 5 is a modified form of the circuit of FIG. 4.

This invention primarily is intended to solve the problem of burn-outs which has caused difficulty where dimmer circuits for rapid-start fluorescent lamps are connected to a high voltage line, such as for example the 277 volt leg of a 440 volt Y connection commonly found in commercial structures.

The invention is also characterized by the provision of a novel arrangement whereby the power factor correcting condenser of the ballast is in series with one filament of a lamp, eliminating a filament winding.

In FIG. 1 the prior art structure is illustrated. There are two transformers, T and T_A each serving as the energizing transformer for a fluorescent lamp, the lamps being L and L_A respectively. Each lamp has a so-called disconnect or shunt socket shown at the left hand end thereof and designated 10 and 10_A. Each lamp has a pair of filaments, F or F_A one at each end served in each case by suitable filament windings F-1, F-2 and F-1_A, F-2_A suit-

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ably coupled with the primary windings of the respective transformers T and T_A. The primary winding of the transformer T has two parts P-1 and P-2 which are in series, the right hand end of the part P-2 being connected to the line lead 14 and the left hand end of the winding P-1 being connected through the filament winding F-1 to the lead 16 which, together with the lead 18 from the tap 20 defining the filament winding F-1, connect to the two terminals of the disconnect socket 10. The lead 22 is the third lead extending to the disconnect socket 10 and is in contact with one of the leads 16 or 18 only when the lamp L is in place. Lead 22 connects with the grounded line lead 24.

In the same manner, the connections of the primary of the transformer T_A are established, the identical elements being marked in FIG. 1 with a sub-script "A."

Each of the filament windings F-2 and F-2_A is connected across the respective right hand filaments F or F_A of the lamps L and L_A by lead 26 and 26_A respectively, one of each of which is common with the principal circuit lead of the lamp. Each transformer includes a secondary winding such as S and S_A loosely coupled with the primary winding of its respective transformer to provide leakage reactance during operation. The shunts are indicated conventionally at Sh and Sh_A. The right hand end of each secondary connects with its respective lamp through the leads 28 and 28_A. The opposite terminals of the secondaries connect to a common variable choke D through the slider 30 of the choke. The choke D in turn is connected to the leads 32 and 32_A which extend respectively to taps 34 and 34_A that divide the primary windings into their parts.

Each primary winding is shunted by a power-factor correcting condenser C and C_A respectively.

Provision may be made for starting assistance of a grounded metal plate 35 or 35_A in the vicinity of the lamps.

In operation, the entire line voltage, say 277 volts A.C., appears across the primary windings in parallel but since the rapid start lamps L and L_A of the type normally used in such circuits are rated for fairly low voltages, and the voltages generated would be too high for the proper characteristics of ignition and operation, only one part of each of the primaries is used in the igniting and operating circuits. This is the part P-1 in the transformer T and the part P-1_A in the transformer T_A. The lamps L and L_A are 40 watt rapid-starts.

Dimming is accomplished by manually varying the turns of the choke D which are included in the series circuit.

It will be seen that the above described circuit, which comprises the prior art is satisfactory in operation for normal conditions, but is subject to certain disadvantages under circumstances which, while considered abnormal, are nevertheless frequent in occurrence.

Considering the circuit of FIG. 1, if either of the leads 22 or 22_A is opened, its primary part P-1 or P-1_A will be subjected to excessive current and in many cases will burn out, thereby requiring the replacement of the entire transformer. This effect is achieved by carelessly putting the lamp into the circuit in such a manner that the lead connection 22 or 22_A is not established. The same effect is achieved by removing one of the lamps during operation.

What happens is that the voltage across P-2 which may be of the order of a hundred volts is connected in parallel with the winding P-2_A. If lead 22_A is open, winding P-1_A is a passive winding, acting as a secondary, and the autotransformer action causes a high current flow through the condenser C_A which is short-circuited directly across the primary winding from lead 16_A to 14. If lead 22 is opened, primary part P-1 will be subjected to high current. In either case, primary part P-2 or P-2_A may also burn out.

The usual construction of apparatus of this kind will have the primary part P-1 or P-1_A formed of wire designed to carry all of the normal current that flows. For 40 watt rapid-start lamps this may be of the order of .1 ampere. The condenser can only limit circulating current, however, to about .3 ampere, and hence this will flow in winding P-1 or P-1_A and burn it out. P-2 and P-2_A are normally formed of heavier wire of current carrying capacity to handle about .3 ampere.

The structure has other disadvantages, even if the wire of P-1 and P-1_A was heavier than normal. The lamp circuits of FIG. 1 are usually duplicated, as indicated by extensions of leads 24 and 32, so that one dimmer device D may serve a plurality of lamps and their respective transformers, greater in amount than the two indicated. Removal of or faulty insertion of lamps loads the remaining transformers and may cause burn-outs nevertheless.

In order to prevent this from occurring, the circuit of FIG. 2 was devised and successfully solved the problems.

The same reference characters are used in FIG. 2 to illustrate the same components of FIG. 1 wherever possible. The only differences between the circuits are those which will be described.

The most important difference between the circuits is that the filament windings F-1 and F-1_A at the left hand ends of the primary parts P-1 and P-1_A respectively have been eliminated along with the immediate connection of the condensers C and C_A to the end terminals of said primary parts. Thus, condenser C is connected by lead 16 to a terminal of the disconnect socket 10 and the other terminal of the socket 10 extends by way of lead 18 to the left hand end of the primary part P-1. This means that the condenser C connects through the left hand filament winding F of the lamp L to the left hand terminal of the primary part P-1. All current which flows through the condenser C must therefore traverse the filament F. This is also true of the circuit including the condenser C_A; its current must pass through the filament winding F_A at the left hand end of the lamp L_A.

The current flowing through the condensers C and C_A for proper power factor correction on a 277 volt line is of the order of rated current for the filaments F or F_A of a 40 watt rapid-start fluorescent lamp. This means that the circuit itself under normal operating and starting conditions is not materially affected. The filament windings F-1 and F-1_A in this case are taken from a portion of the secondary windings merely to show a variation in the form of the filament energization. A block D has been substituted for the choke D of FIG. 1 to illustrate that any contrivance for varying the total flow of current through the lamps for dimming purposes can be used. This could be a thyatron circuit for example.

The advantages of the circuit are based upon the use of the condenser current for energizing a filament of the lamps. Besides eliminating the need for tapping into the primary, during abnormal conditions the primary windings will not burn out due to opening of the condenser circuit. Note that as in the case of FIG. 1, the left hand terminals of each primary winding connect to the line lead 24 through the respective leads 22 and 22_A. The condensers C and C_A however, are not connected as in FIG. 1, but instead connect through the respective left hand filaments F and F_A.

If the lead 22_A should be opened, either by careless insertion of the lamp L_A or by removal of the lamp L_A while the circuit is operating, the circulating current caused by the auto-transformer action of the primary parts P-1_A and P-2_A in the circuit of FIG. 1 will not be present. The reason for this is that the shunting circuit including the condenser C_A and leads 16_A and 18_A will be opened.

The same thing is true of the upper portion of the circuit of FIG. 2 in which careless insertion or removal of the lamp L will not result in burn-out of the primary

winding or its parts. Other lamp circuits in parallel will likewise be protected.

It should be pointed out that the actual physical opening of the grounded leads 22 or 22_A is most unlikely to occur, but if the lamps have been properly installed and the shunting sockets not disturbed and one of these leads is deliberately opened, the large current flow will occur and may burn out P-1 or P-1_A.

In FIG. 3 there is illustrated a circuit in which the principles of the invention are applied to apparatus in which there is no dimming required, the same actually comprising one half of the circuit of FIG. 2. In this circuit, the same characters of reference are used to where practical in order that a comparison may be made with FIG. 2. The secondary winding S connects directly to the tap 34 between the primary parts P-1 and P-2 by way of the lead 30.

The circuit illustrates the advantageous arrangement referred to in which there is a power factor correcting condenser C shunting the primary winding P-1, P-2 and the current from the condenser passes through the filament F on the left hand end of the lamp L. This eliminates the need for a special filament winding for the left filament F of the lamp L and provides a simple circuit. The shunting socket 10 may not be needed in certain cases, and under these circumstances, the lead 22 is connected directly to either lead 16 or 18.

In all cases above described, the secondary winding is normally separated from the primary winding by a shunt Sh to provide leakage reactance during operation. This is shown in the illustrations symbolically. The power factor condenser C may shunt less than the entire primary.

The circuitry which is described above uses no special physical characteristics. The lamps are any of the commercially available rapid-start lamps intended to be energized by ballasting from a 118 volt A.C. source, such as a 40-watt T-12 lamp. The ballast includes a transformer or autotransformer, the entire primary of which is connected across the source, and a secondary winding for aiding in providing operating as well as starting voltage. A popular rapid start circuit is one for two lamps connected in series, with a starting condenser shunting one lamp, and a series condenser in the circuit for power factor correction. The primary winding and secondary winding together are connected across both lamps in series. There are various methods of energizing filaments, but the minimum number of filament windings which must be provided is three. The terminals of one filament of each lamp are connected in parallel and hence can be served by one filament winding. Primary taps or completely separate windings are used.

Transformers used for energizing such lamps from 118 volt A.C. sources have not heretofore used shunting condensers for power factor control because the current required to flow through such a condenser would be unusually high, of the order of .7 ampere. It is usually with higher voltage sources that shunting condensers can be used. Thus, the lamps of FIG. 3 are the same as those normally to be operated from a 118 volt A.C. ballast, but the source is 277 volts A.C. or higher. The winding P-2 is not in the operating circuit, but the condenser C shunts the entire primary.

In FIG. 4 there is illustrated a simple circuit in which there is a shunting condenser C across the primary winding P which is connected fully across the source, which may be 118 volts A.C. more or less. The condenser is in series with the left hand filament F of the lamp L that is connected across the primary and secondary S connected in autotransformer relationship. The transformer T is a high leakage reactance transformer, which has a center shunt between the windings. The lamp L may be assumed to have only one filament F, the other electrode E being simple in structure. It may also be assumed that the lamp is of a type which has a sufficiently rugged

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filament F to carry the condenser current without stress. This, of course, is not conventional.

Obviously the circuit of FIG. 4 is greatly simplified over any other because of the elimination of at least one filament winding.

FIG. 5 illustrates a modified form of the circuit of FIG. 4 which has considerable advantages over FIG. 4 and shows how the shunting condenser may be used with a completely practical apparatus operating from a low voltage line. In this case, a conventional lamp L is shown which is provided at opposite ends with filaments F. The primary winding P is adapted to be connected across a relatively low voltage A.C. line, by the leads 14, 18 and 22. The lead 22 may be a white or grounded lead and is one terminal of a shunting or cut-out socket 10 which is automatically opened if the lamp L is withdrawn therefrom. The lead 18 extends from a filament terminal of socket 10 to the left hand terminal of the primary winding P. The lead 18 extends from a filament terminal of socket 10 to the left hand terminal of the primary winding P. The lead 14 which may be black or ungrounded extends to the right hand terminal 37 of primary winding P.

There is provided a secondary winding S in auto-transformer relation with primary winding P insofar as lamp L is concerned, connected between right hand terminal 37 of primary winding P and the filament F by way of lead 28. Leads 26 connect filament F across filament winding F-1, the latter being closely coupled with primary winding P.

An auto-transformer winding A is close-coupled with the primary winding P and has its common terminal at 37. It is in series with condenser C in lead 16 and connects with the second filament terminal of socket 10. Again, as in the case of FIG. 4, all of the current in the power correction circuit, flowing through condenser C must pass through the left filament F. Removal of the lamp L opens the circuit. Since the windings A and P are in additive auto-transformer relationship, the total voltage across the condenser C is their resultant sum. If not substantially equal turns, the voltage across the condenser can be of the order of 240 volts A.C., with lower current flowing than in FIG. 4. This is an economical condenser, but in addition, by adjusting the turns ratio of windings A and P, the current flow can be made exactly equal to rated filament current flow, without sacrifice of power factor correction.

FIG. 5 may be further modified by changes in the means for energizing the right hand filament.

The invention is believed sufficiently described and illustrated to enable those skilled in the art to understand the same. The details of the invention are capable of wide variation without departing from the spirit or scope of the invention as defined in the appended claims.

I claim:

1. Apparatus for ballasting at least one gaseous discharge device having a filament, and including a primary winding adapted to be connected across a source of A.C. voltage, a secondary winding in transformer relationship with the primary winding and connected to provide igniting and operating voltages for said device, a power factor condenser connected across at least a part of the said primary winding, and adapted to have the said filament connected in series with said condenser.

2. Apparatus as claimed in claim 1 in which said condenser is connected across the entire primary winding.

3. Apparatus as claimed in claim 1 in which said condenser is connected across the entire primary winding, the secondary winding is connected in additive auto-transformer relation with only a part of said primary winding.

4. Apparatus as claimed in claim 1 in which means are provided adapted for energizing a second filament in said discharge device.

5. Apparatus for ballasting at least one gaseous discharge device having a filament in each end thereof, which

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comprises, a transformer having a primary winding formed of two parts, a secondary winding loosely coupled to the primary winding and having an auto-transformer relationship with one of said parts, and adapted to be connected therewith across said gaseous discharge device, a condenser connected across the primary winding for power factor correction and adapted to be connected in series with one of said filaments, a winding in said transformer for energizing the other of said filaments, the primary winding adapted to be connected across a source of A.C. voltage.

6. Apparatus adapted for igniting and providing the operating voltage for a gaseous discharge device of the type having a filament in each end thereof, said device adapted to be connected to a source of A.C. voltage, and comprising a high leakage reactance transformer including a primary winding and a secondary winding connected in auto-transformer relationship, lead means for extending connections from said windings to said discharge device and a filament winding coupled to one of said windings for energizing one of said filaments, a condenser having one end connected to one terminal of said primary winding, and the other end of said condenser adapted to be connected in series with the second filament and to the second terminal of said primary winding, the terminals of said primary winding adapted to be connected across said source.

7. Apparatus as claimed in claim 6 in which the secondary winding is connected to auto-transformer relationship with only a part of said primary winding.

8. Apparatus for ballasting gaseous discharge devices and including a pair of transformers adapted to be energized from a source of A.C. voltage in parallel, each transformer having at least a primary winding and a secondary winding connected together to provide igniting and operating voltages for at least one gaseous discharge device, said one gaseous discharge device having a filament requiring continuous energization, a condenser connected across at least a portion of said primary winding, and said filament being in series with said condenser whereby all current flowing through said condenser must flow through said filament.

9. The apparatus of claim 8 in which the primary of each transformer comprises two parts and only one part of each is connected in transformer relationship with its secondary, but the entire primary adapted to be connected across said source.

10. The apparatus of claim 9 in which said one device has a disconnect socket with three terminals, the condenser and a primary terminal adapted to be connected respectively to two of said terminals whereby removal of the lamp will prevent circulating current through said condenser, and the third terminal adapted to be connected to one side of said source.

11. Apparatus for ballasting at least one gaseous discharge device having a filament, and including a primary winding adapted to be connected across a source of A.C. voltage, a secondary winding in transformer relationship with the primary winding and connected to provide igniting and operating voltage for said device, a power factor condenser, said power factor condenser having a first terminal connected electrically in common with a first terminal of said primary winding and a second terminal electrically connected in common with a first terminal of said filament, said common connected terminals being respectively connected to opposite terminals of said source and the remaining terminals of said winding and said filament being connected electrically in common whereby there is established a current path from the first terminal of said winding through said condenser and said filament to the remaining terminal of said winding.

12. Apparatus as claimed in claim 11 in which said path also includes a third winding coupled with said pri-

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mary winding and in additive auto-transformer relation therewith.

13. Apparatus for ballasting a gaseous discharge device having a first, filament electrode and a second, igniting electrode which comprises, a primary winding, a secondary winding coupled in transformer relation with said primary winding, said secondary winding further being connected for providing igniting and operating voltage for said device, and a power factor condenser, said condenser, said primary winding, and said filament electrode all being mutually connected in serial relation, and

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means adapting said primary winding for connection to a source of A.C. voltage by way of points respectively common electrically to said condenser and said filament, on the one hand, and to said condenser and said primary winding on the other.

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