

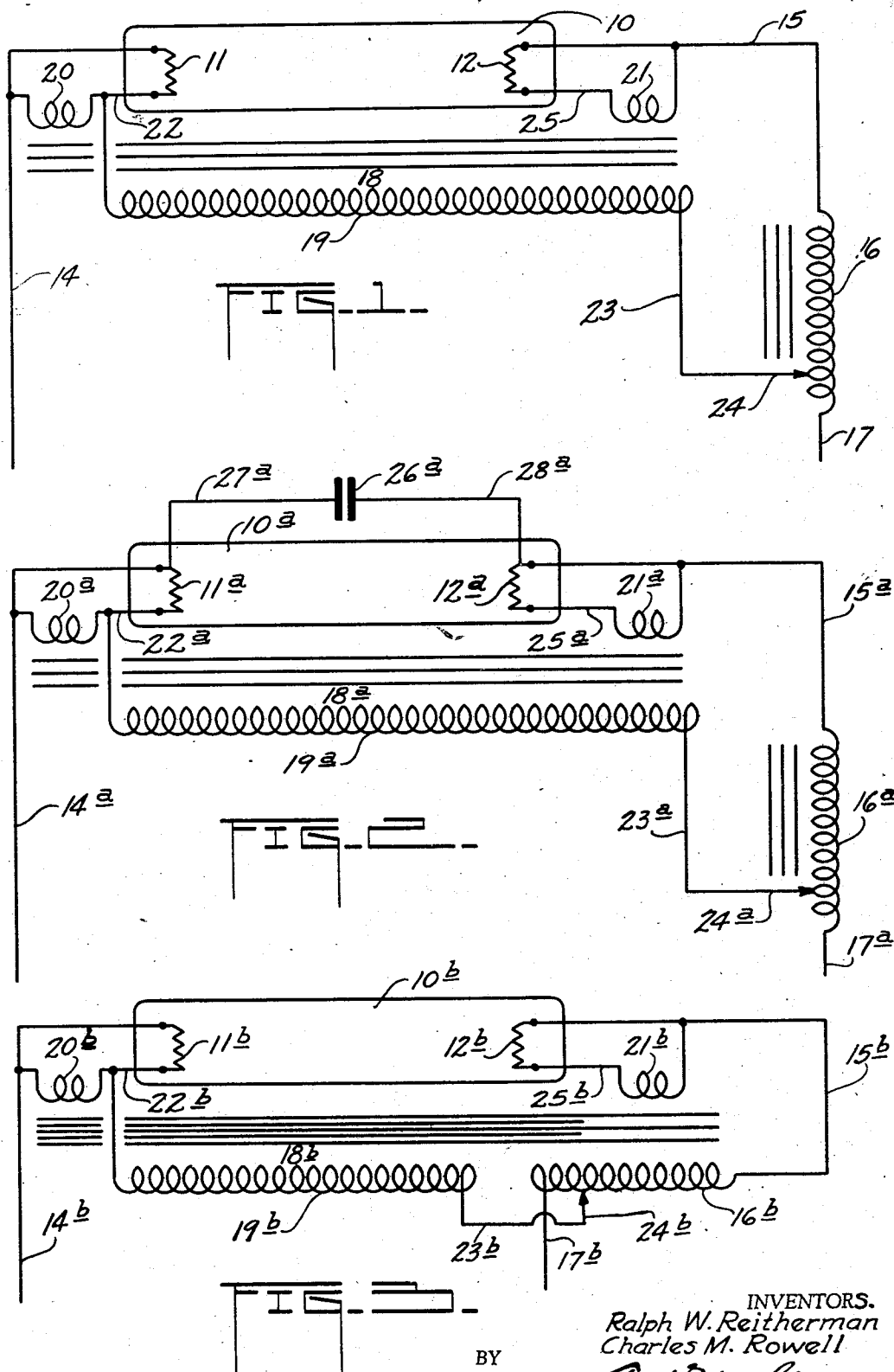
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ELECTRIC DISCHARGE APPARATUS

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ELECTRIC DISCHARGE APPARATUS

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This invention relates to gaseous electric discharge devices of the type having thermionic cathodes, such as illuminating lamps, and more particularly to a method and means for starting and operating such devices from alternating current. As is well known, devices of this class require the application of a relatively high voltage for starting as compared to that required for maintaining the device in operation.

Heretofore, various types of starting and operating mechanisms and electrical circuits have been employed, practically all of which present certain objectionable conditions. In certain types of apparatus which have been used or proposed the mechanism included a time delay relay or bimetallic thermal strips in connection with which there usually is employed one or more sets of movable contact points which require relatively fine initial adjustment for proper functioning of the apparatus, and which contacts, in a short period of time, deteriorate by constant arcing, resulting in inefficient and slow starting of the lamp. Also, in certain types of apparatus of this class, the cathodes are only heated for effecting electronic emission across the cathodes to initially start the lamp. It has been found that in such apparatus, small particles of the cathodes are constantly being broken off the main body, reducing the life of the cathodes. Furthermore, such deterioration of the cathodes results in more difficult starting; reduced life of the lamp; blackening of the ends of the lamp; reduced efficiency of the lamp; and detracts from its appearance.

One of the objects of this invention is to provide improved apparatus of the above mentioned character which maintains the cathodes heated during both starting and operation of the lamp and which eliminates all of the above mentioned objectional characteristics of apparatus heretofore employed.

Another object is to provide simple and improved apparatus of the character indicated, including a balanced circuit and novel means for limiting the cathode heating current after the lamp is operating.

A further object is to provide improved apparatus of the character indicated, which is durable, highly efficient, effects quick starting of lamp, and capable of being economically manufactured.

Other objects and advantages of the invention will be apparent from the following description, taken in connection with the accompanying drawing, in which—

Fig. 1 is a diagrammatic illustration of an electrical circuit embodying one form of the present invention.

Fig. 2 is a diagrammatic illustration of an electrical circuit embodying another form of this invention, in which circuit a capacitor is connected in shunt across the cathodes of the electric discharge lamp.

Fig. 3 is a diagrammatic illustration of an electrical circuit embodying a further modification of our invention, wherein the inductance and transformer are magnetically coupled.

In the diagrammatic electrical circuit illustrated in Fig. 1, the gaseous electric discharge device comprises a lamp 10, of the commercially known fluorescent type including an interiorly coated, elongated, sealed, glass tube containing a suitable gaseous filling, such as argon or neon together with particles of mercury, and having thermionic cathodes 11 and 12, of the electron emissive type, disposed adjacent opposite ends thereof. One terminal of cathode 11 is connected to a conductor wire 14, the free end of which is connected to a main source of alternating current of usual line voltage, such as in the range of 115 volts. A corresponding terminal of cathode 12 is connected by a conductor wire 15 to a ballast inductance or swinging choke coil 16, the opposite end of which coil is connected by a conductor wire 17 to the main source of current. It is to be understood that a suitable switch (not shown) may desirably be connected in either of conductor wires 14 or 17. The circuit thus far described, in which the lamp 10 and inductance 16 are in series, constitutes the normal operating circuit for the lamp. Obviously, however, this circuit is not self-starting for two reasons; namely, first, some means must be provided for preheating the cathodes 11 and 12 to obtain electronic emission, and second, the negative static charge on the glass wall of the lamp must be overcome.

In the electrical circuit illustrated, the cathodes are heated constantly during the entire period the lamp 10 is operating. The heating of the cathodes is accomplished by means of a transformer 18, including a primary coil 19 and secondary coils 20 and 21. One end of the primary coil 19 of the transformer is connected in series with the secondary coil 20 to the main conductor wire 14, and a conductor wire 22 connects the other terminal of cathode 11 to the junction of said primary coil 19 and secondary coil 20. The other end of the primary coil is connected by a conductor wire 23 to a tap 24,

taken out on the ballast inductance or choke coil 16. The secondary coil 21 is connected at one end to the conductor wire 15, and at the other end by a conductor wire 25 to the other terminal of cathode 12.

By virtue of the connection of the primary coil 19 to the tap on the ballast inductance coil 16, it is possible to maintain a constant flow of current through the cathodes for maintaining them heated while the circuit is closed. The choke coil or inductance 16 functions as a step-up auto-transformer so as to produce a desired increase in voltage ratio. This ratio can be varied to accommodate lamps of varying potential gradients, by varying the position of tap 24.

It is essential to the proper functioning of the apparatus constituting this invention that the volts per turn ratio must be substantially lower in transformer 18 than in inductance or choke coil 16, and the core cross-section of said transformer must be substantially greater than the core cross-section of said inductance or choke coil 16, provided that steel of the same permeability be used in both cores. This will cause a drop in potential across the respective windings involved proportional to the differential in volts per turn ratio between primary 19 and inductance or choke coil 16. This relationship makes it possible to obtain a rise in voltage output from said choke coil 16 for that portion of the operating cycle that choke coil 16 is in the circuit as an auto-transformer, which is at the time the cathodes 11 and 12 are being heated preparatory to striking of the arc across the cathodes. It has been found that the momentary potential rise necessary for dissipating the static charge on the wall of the lamp 10, with a lamp within the range of 15 or 20 watt capacity and a normal input of 115 volts, is between 700 and 800 volts, depending upon the humidity and other atmospheric conditions. To accomplish such increase in potential, the turn ratio of that portion of the inductance coil 16 between the tap 24 and wire 17 to the remainder of said coil 16 is approximately 7 to 1 in the inductance or choke coil 16, with a normal input of 115 volts.

When the circuit is closed for energizing the lamp 10, the transformer 18 immediately functions to cause heating of the cathodes 11 and 12 for causing electronic emission, and substantially simultaneously the high potential produced by the inductance coil 16, operating as an auto-transformer, is impressed across the cathodes 11 and 12. This high potential breaks down and dissipates the static charge on the wall of the lamp and permits establishment of an arc from one cathode to the other. The arc current thus flowing causes the iron core of the inductance coil to become saturated, and causes the impedance to rise across that portion of the inductance coil 16, between the tap 24 and the connection to conductor 17, and thereby functions to limit the cathode heating current produced by transformer 18 in inverse proportion to the leakage reactance of the inductance coil 16. The lamp 10 thereafter functions in a circuit including the lamp and inductance coil in series, at a relatively reduced voltage, and the cathodes are maintained heated by the limited current flowing through the transformer 18.

Due to the swinging characteristics of the inductance or choke coil 16, any desired amount of cathode current may be caused to flow continuously under normal operation, so that the deterioration of the cathodes is controlled and may be

substantially reduced. By correcting the deterioration of the cathodes, which takes place in connection with practically all present type apparatus of this class due to the fact that in these circuits the cathodes are in reality operated as self-energized cathodes with the accompanying high cathode drop, which has a tendency to limit the life of the cathode thus energized, the life of the lamp is substantially increased, and the blackening of the ends of the lamp tube in operation eliminated so as to maintain high efficiency of the lamp, good appearance, and ease of starting of the lamp.

The circuit illustrated in Fig. 2, in the main, is, with one exception, identical with the circuit shown in Fig. 1, as above described, and for convenience, corresponding parts are accorded the same numerical designation together with the exponent "a." The exception referred to comprises the addition of a capacitor 26^a, connected by conductor wires 27^a and 28^a, to the upper terminal of cathodes 11 and 12, in shunt relation. The purpose of the capacitor is to draw off the high static charge on the wall of the tube of the lamp 10^a to facilitate starting of the lamp. The circuit represented in Fig. 2 otherwise functions exactly as the circuit of Fig. 1, as above described.

The modified electrical circuit diagrammatically illustrated in Fig. 3 is, with one main exception, the same as the circuit shown in Fig. 1, and for convenience, corresponding parts are accorded the same numerical designation together with the exponent "b." The difference between the circuits shown in Figs. 1 and 3 consists in the provision of the ballast inductance coil 16^b in magnetically coupled relation to the transformer 18^b. This relationship permits using additional magnetic flux of said transformer with the ballast inductance for expeditiously building up the high potential necessary for establishment of the arc between the cathodes. By virtue of such relationship between the inductance and transformer, it is possible to attain a higher voltage for causing arcing between cathodes without the usual loss attendant upon use of coils whose magnetic fields are separated.

Although there is herein shown certain preferred embodiments of the invention, manifestly it is capable of modification and rearrangement without departing from the spirit and scope thereof. It is not, therefore, intended that the present invention be limited to the precise forms herein shown and described, except as it may be so limited in the appended claims.

We claim:

1. Starting and operating apparatus for a gaseous electric discharge device having thermionic cathodes, said apparatus comprising conductor wires connecting one terminal of each of said cathodes in series with a source of alternating current, a ballast inductance interposed in one of said conductor wires in series with said cathodes, and a transformer including a primary and two secondaries, each of said secondaries being connected to the terminals of one of the respective cathodes, and said primary being connected at one end to said ballast inductance and the other end being in series with the secondary connecting the cathode, one terminal of which is connected to the other conductor wire, said inductance and transformer being magnetically coupled, and the core cross-section of said transformer being substantially greater than the core cross-section of said inductance, whereby the voltage is initially increased to cause electronic

flow between the cathodes and whereupon said inductance serves to ballast the circuit to maintain electronic flow at reduced voltage.

2. Starting and operating apparatus for a gaseous electric discharge device having thermionic cathodes, said apparatus comprising conductor wires connecting one terminal of each of said cathodes in series with a source of alternating current, a ballast inductance interposed in one of said conductor wires in series with said cathodes, and a transformer including a primary and two secondaries, each of said secondaries being connected to the terminals of one of the respective cathodes, and said primary being connected at one end to said ballast inductance at a point intermediate its length and the other end of said primary being in series with the secondary connecting the cathode, one terminal of which is connected to the other conductor wire, said inductance and transformer being magnetically coupled and the core cross-section of said transformer being substantially greater than the core cross-section of said inductance, whereby the voltage is initially increased to cause electronic flow between the cathodes and whereupon said inductance serves to ballast the circuit to maintain electronic flow at reduced voltage, and whereby the portion of the ballast inductance in circuit with said primary, after electronic flow

between cathodes is initiated, limits the cathode heating current inversely proportionate to the leakage reactance in said ballast inductance.

3. Starting and operating apparatus for a gaseous electric discharge device having thermionic cathodes, said apparatus comprising conductor wires connecting one terminal of each of said cathodes in series with a source of alternating current, a swinging ballast inductance interposed in one of said conductor wires in series with said cathodes, and a transformer including a primary and two secondaries, each of said secondaries being connected to the terminals of one of the respective cathodes, and said primary being connected at one end to a tap taken out on said swinging ballast inductance at a point intermediate its length, and the other end being in series with the secondary connecting the cathode, one terminal of which is connected to the other conductor wire, said inductance and transformer being magnetically coupled and the core cross-section of said transformer being substantially greater than the core cross-section of said inductance, whereby the voltage is initially increased to cause electronic flow between the cathodes and whereupon said inductance serves to ballast the circuit to maintain electronic flow at reduced voltage.

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