

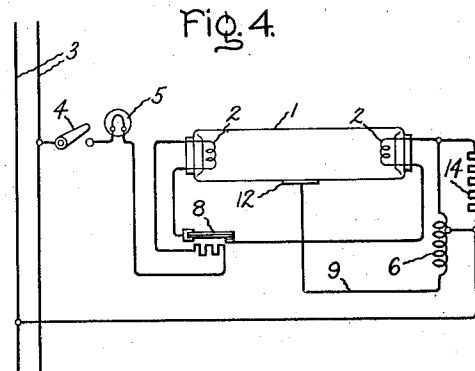
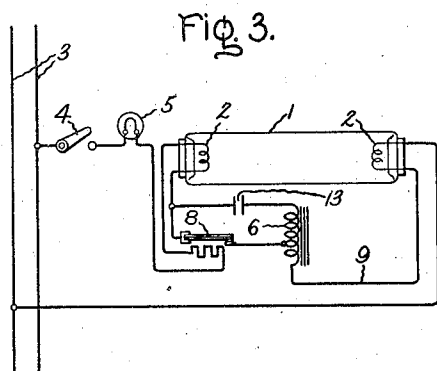
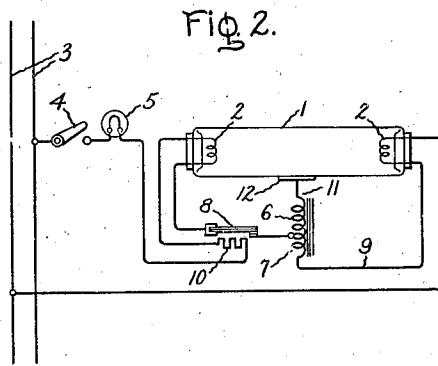
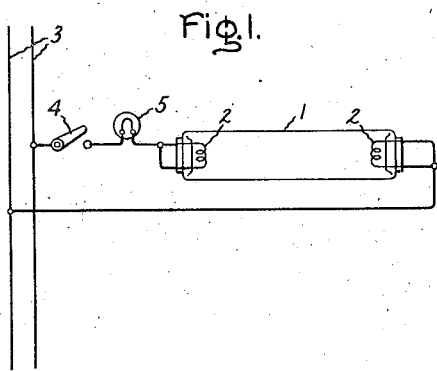
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ELECTRIC DISCHARGE APPARATUS

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ELECTRIC DISCHARGE APPARATUS

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My invention relates to electric discharge apparatus. Inasmuch as an electric discharge device, such for example as a fluorescent lamp, has a negative voltage-current characteristic and hence is unstable when supplied directly from a source of constant potential it is commonly operated from such a source by including in series therewith a ballast impedance, which may be resistive or inductive and which will more than counteract the effect of the negative voltage-current characteristic of the device. The ballast employed is such that its impedance increases in response to an increase in current in the circuit at a faster rate than the impedance of the discharge device decreases, hence the device as so connected is rendered stable.

In spite of the fact that inductive ballasts or choke coils have various objectionable features they are at the present time universally employed to control discharge devices of the fluorescent type since the use of resistive ballasts in the manner in which they have heretofore been employed has been considered too wasteful of electric energy. Such waste has been due to the fact that a device of that type and of the form in common use requires for its starting the application of a much greater voltage than is necessary to operate it after it has been started and to the fact that where the source or line voltage, as in resistance ballasted devices, is the starting voltage the difference between that voltage and the operating voltage of the device must be absorbed by the ballast. Even when the electrodes of the device are preheated to an electron emitting temperature the starting voltage required is approximately twice the operating voltage. Thus the amount of energy consumed by the ballast is approximately equal to that consumed by the device.

One object of my invention is the provision of improved apparatus for the operation of an electric discharge device which apparatus involves a high degree of simplicity and which can be produced at a relatively low cost. Another object of my invention is the provision of improved starting means for an electric discharge device which means function independently of the ballast employed.

I have found in the case of a resistance ballasted discharge device that after the device has been started it will operate satisfactorily if the impedance of the ballast employed is but a fraction of that commonly employed. For example, a discharge device ballasted by a small tungsten filament incandescent lamp, an arrangement such for example as that disclosed in my U. S.

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Letters Patent 2,266,619, December 16, 1941, will operate with good regulation if the voltage of the source is only a few per cent greater than that of the device. Moreover if a substantially constant line voltage is available the device can be ballasted with as little as one per cent of the line voltage appearing across the ballast. Thus if the problem of starting be ignored or performed independently of the ballast I am able to effect a large economy in the operation of resistance ballasted discharge devices.

Where the ballast employed is a reactor of the commonly employed iron core type and the starting voltage is produced by the same member the reactor is designed to perform the two-fold function of ballasting the discharge device and of providing the starting voltage therefor. Were it necessary to consider only the ballasting requirement, the reactor might be so designed that the voltage absorbed from the line to provide the required magnetizing current would be little more, if any, than the known minimum for that purpose of 30%. But since consideration of the ability of the reactor to produce an adequate starting voltage must also be given, a compromise is made which results in a reactor in which the percentage of line voltage absorbed therein is considerably above the aforesaid minimum for ballast requirements only. A certain loss in operating efficiency therefore is tolerated.

My invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

Referring to the drawing, Figs. 1, 2, 3 and 4 are circuit diagrams illustrating some of the various forms of my invention.

In Fig. 1 the electric discharge device 1 which, for example, may be a fluorescent lamp having the electrodes 2 at the ends thereof is shown connected to be operated from the source of current supply 3 through the control switch 4 and the ballast 5. The source 3 may be an ordinary 115 volt commercial lighting circuit supplying either direct or alternating current. The discharge device 1 is constructed to have an arc drop or operating voltage which is nearly as high as the voltage of the source. The ballast 5 is a resistor which has a high positive temperature-resistance co-efficient and which operates on the steep part of its temperature-resistance curve. Although the discharge device has a negative voltage-current characteristic the effect of the ballast predominates over that of the device; hence the circuit is stable. A convenient form of ballast resistor is a small

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tungsten filament incandescent lamp whose rated voltage is appreciably higher than the small difference between the source voltage and the operating voltage of the device. The filament of the ballast lamp therefore operates at a temperature materially lower than that for which it is designed to operate as a light source whereby the life of the lamp is greatly increased. While I have demonstrated the possibility of operating resistance ballasted discharge devices with the high efficiencies indicated above the commercial use of such apparatus may for various reasons make it advisable to be content with a somewhat lower efficiency. In a large scale production of discharge devices whose electrical constants depend upon a variety of factors certain tolerances are essential for desired low cost production. Moreover, it is recognized that material changes occur in certain of the constants of a discharge device during the first few hours of use which later become substantially fixed. For manufacturing reasons the same discharge device must be adaptable for use on supply circuits coming within a certain range of rated voltages. For these reasons it may be found desirable to employ a discharge device and resistance ballast combination wherein the voltage drop in the ballast has a value of not more than 50% of the operating voltage of the device or if conditions justify a less liberal tolerance a combination may be used in which the drop in the ballast is only 25% of the voltage of the device. Under conditions of still less liberal tolerance a combination may be used in which only 5% or even less of the device voltage is represented by the ballast drop.

In Figs. 2, 3 and 4 I have shown the discharge device operating circuit comprising Fig. 1 to which is added apparatus which I have devised for automatically starting the device. Referring first to Fig. 2, the starting apparatus comprises the set-up autotransformer 6 whose primary 7 is connected in series with the starting switch 8 in the electrode preheating circuit 9 which shunts the device 1 but includes the electrodes 2 in series. The switch 3 preferably is a thermal switch provided with the resistance heater 10 connected in series with the ballast and constructed to cause the switch to open when or soon after the electrodes reach an electron emitting temperature. The secondary 11 has one end terminating adjacent to or contacting the device at a point intermediate its ends. Preferably that end of the secondary connects with a metal clamp or other conductor shown at 12 on or close to the wall of the device, such for example as the commonly employed reflector.

When the control switch 4 is closed, the starting switch 8 being normally closed, electrode preheating current immediately begins to flow through the ballast 5, the two electrodes 2, the starting switch, and the primary of the transformer. If the source of current supply is alternating the stepped-up voltage of the transformer will be continuously applied to the discharge device but the latter will not start as long as the shunt circuit 9 remains closed even though the electrodes attain an electron emitting temperature. At the instant that the switch 8 opens, whether the source of current supply is direct or alternating, the combined effect of the voltage impulse impressed by the transformer and the heated condition of the electrodes causes the gas in the device to ionize whereupon the device starts. Having thus started the device continues

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to operate, the transformer and the auxiliary electrode being then inoperative since the starting switch remains open. The ballast 5, however, since it is constructed for the sole function of ballasting the device produces a reduction in the voltage of the source of only a few per cent; hence, the apparatus operates at high efficiency.

The form of my invention illustrated by Fig. 3 is like that shown by Fig. 1 except that the discharge device is not provided with an auxiliary electrode and the opposite ends of the secondary connect with the electrodes 2 through the capacitor 13. In operation it is similar to that of Fig. 2.

In that form of my invention illustrated by Fig. 4 I employ an auxiliary starting electrode 12 as in Fig. 2 but the step-up transformer 6 to which it connects has its primary connected across the resistor 14 which itself is connected in series with the discharge device. The circuit of Fig. 4 is adapted for use with a variety of discharge devices having different current ratings but employing the same starting transformer and with each device there would be employed a resistor 14 having the proper resistance for supplying the transformer with its rated voltage. Obviously the resistor during the operation of the device becomes a part of the ballast and hence is a useful element of the circuit both during the operation of the device and at the starting thereof. The shunt or electrode preheating circuit 9 in this case includes the starting switch only in addition to the electrodes. As in Fig. 1 the opening of the switch 8 after the electrodes have been suitably heated causes the secondary of the transformer to deliver a starting voltage between the auxiliary electrode and one of the main electrodes of the device.

It is to be understood that although I have shown and described the ballast 5 as resistive it may be inductive. If therefore a reactor is used to ballast the discharge device instead of an incandescent lamp and if separate and independent means are employed to effect starting, a reactor construction may be employed whereby a higher circuit operating efficiency is obtainable than in circuits in common use where the same member is constructed to perform both ballasting and starting functions.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, an electric discharge device having spaced electrodes and an electrode preheating circuit connected in shunt therewith and including a time delay starting switch, means including a ballast impedance for connecting said device to be operated from a source of current supply, and a step-up transformer having its primary connected to be energized from said source and controlled by said switch and its secondary connected between one of said electrodes and a point of said device intermediate its electrodes.

2. In combination, an electric discharge device having spaced electrodes and an electrode preheating circuit connected in shunt therewith and including a time delay starting switch, means including a ballast impedance for connecting said device to be operated from a source of current supply, an impedance in said connecting means, a step-up transformer having its primary connected across said last mentioned impedance and its secondary connected to supply a starting voltage to said device.

3. Apparatus for starting an electric discharge device having spaced electrodes comprising a conducting member serving as a starting means for said device and positioned at a point thereof

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intermediate its ends, a step-up transformer, a starting switch connected in series with the primary of said transformer, the circuit of said switch and said primary being connected in shunt with said device, and the secondary of said transformer being connected between said member and one of the electrodes of the device.

4. Apparatus for starting an electric discharge device having spaced electrodes comprising a starting switch connected across said device, an impedance connected in series with said device and a source of current and a step-up transformer having its primary connected across said impedance and its secondary connected to said device for supplying a starting voltage thereto.

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