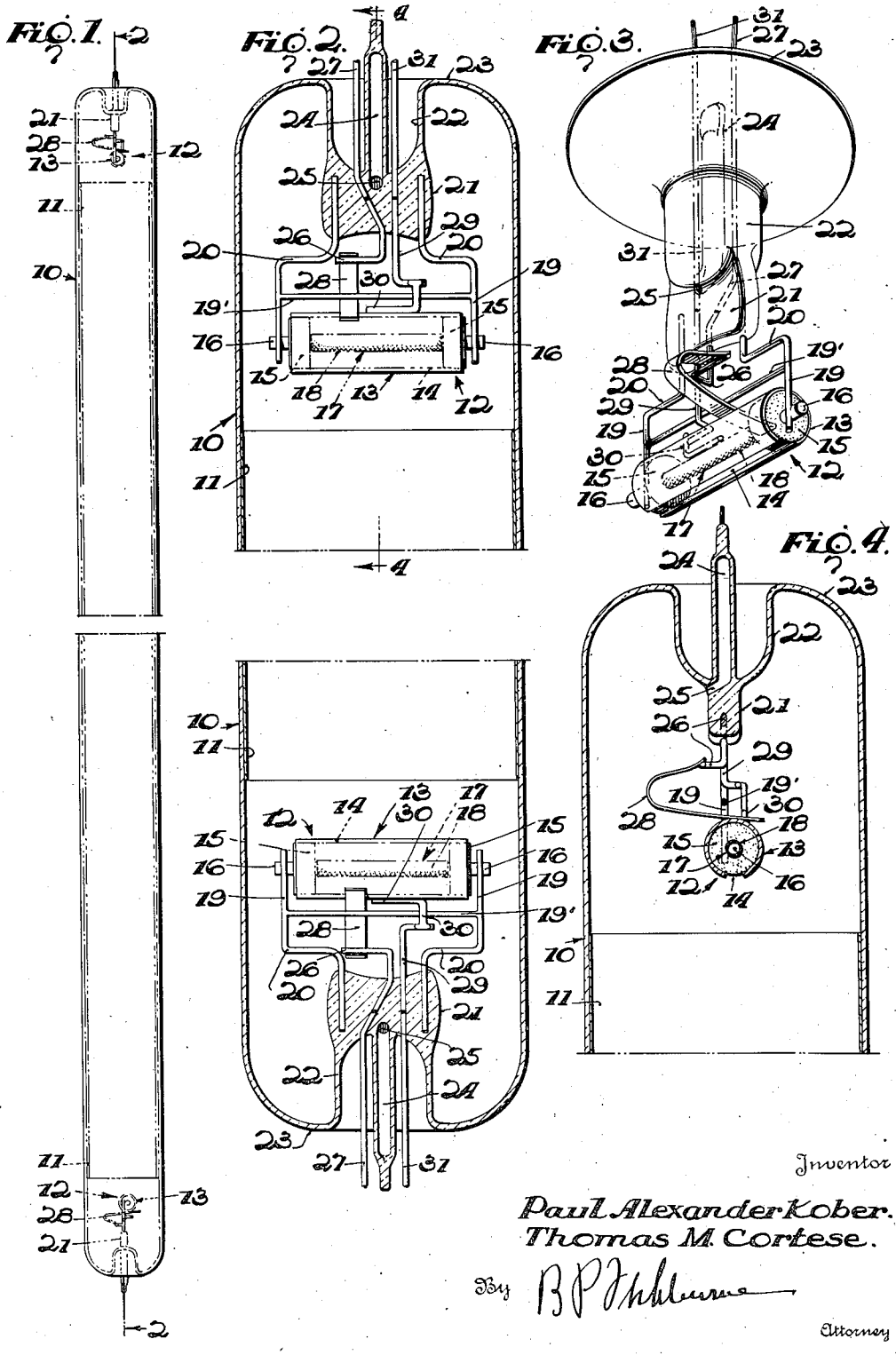
May 4, 1943. P. A. KOBER ET AL 2,318,082

GASEOUS DISCHARGE LAMP

Filed May 9, 1941 3 Sheets-Sheet 1



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May 4, 1943. P. A. KOBER ET AL 2,318,082

GASEOUS DISCHARGE LAMP

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Fig. 5.

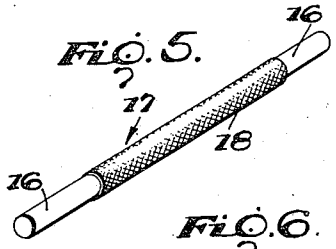


Fig. 6.

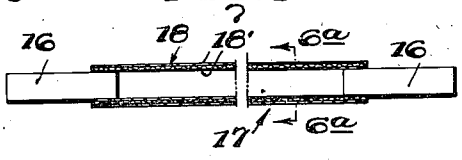


Fig. 8.

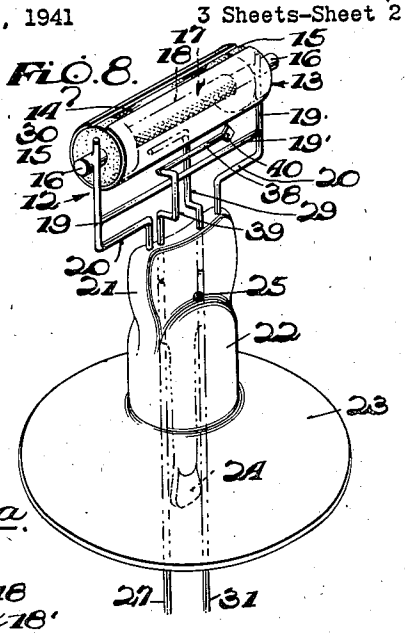


Fig. 6a.

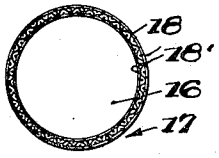


Fig. 9.

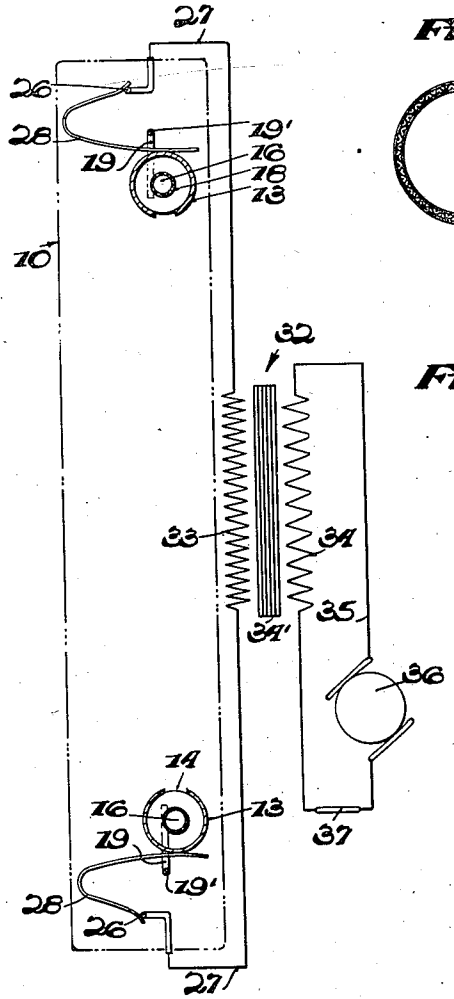
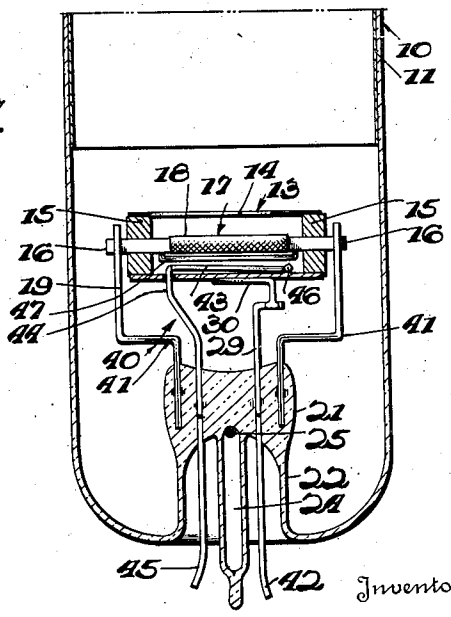


Fig. 7.



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GASEOUS DISCHARGE LAMP

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Fig. 10.

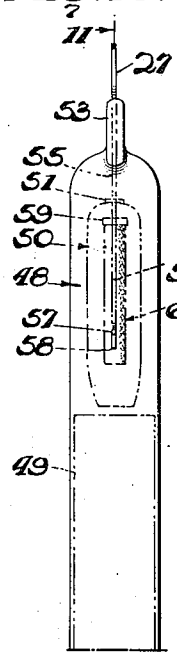


Fig. 11.

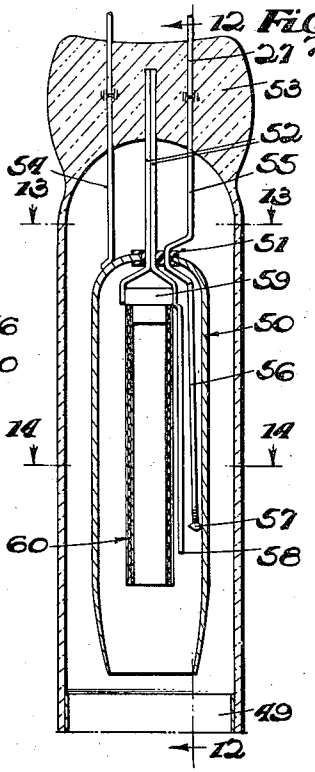


Fig. 12.

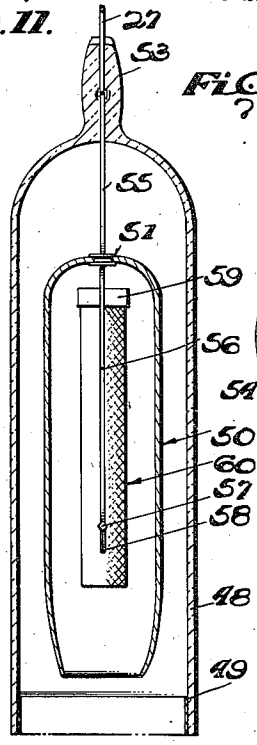


Fig. 13.

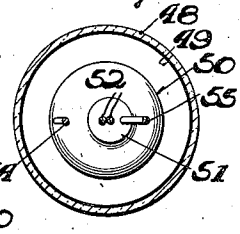
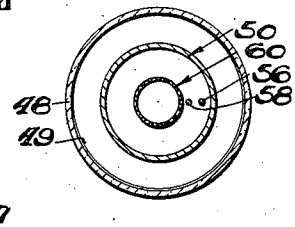
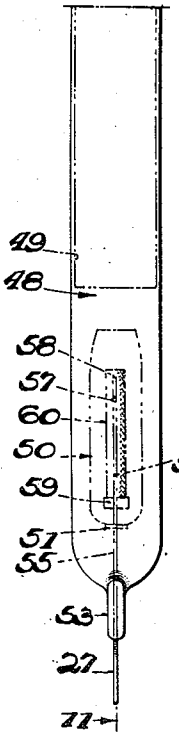
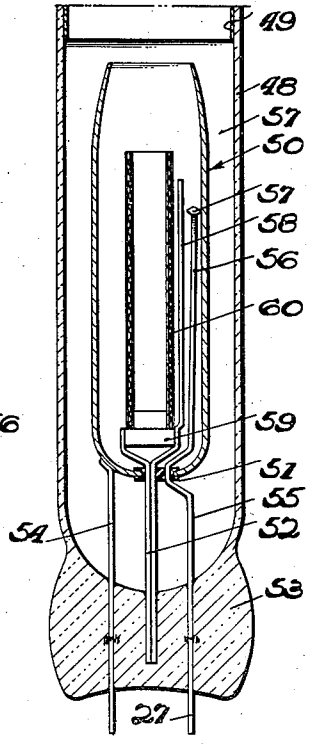


Fig. 14.







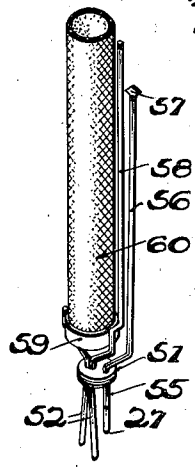


Fig. 15.

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2,318,082

UNITED STATES PATENT OFFICE

2,318,082

GASEOUS DISCHARGE LAMP

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Application May 9, 1941, Serial No. 392,782

13 Claims. (Cl. 176—124)

The present invention relates to gaseous discharge tubes and more particularly to fluorescent tubes.

An important object of the invention is to provide a tube of the above-mentioned character which may be operated by a simplified circuit.

A further object of the invention is to provide a tube of the above-mentioned character which is positive and instantaneous in starting.

A further object of the invention is to provide a tube of the above-mentioned character which will have efficiencies equal to the present commercial low voltage fluorescent tubes.

A further object of the invention is to provide a tube of the above-mentioned character so constructed that failure of the tube to light up, due to the drop in line voltage, or increased voltage requirements of the tube which may be caused by the electron emission coating failure, is eliminated.

A further object of the invention is to provide tubes of suitable commercial lengths which will operate on a low voltage below the 600-volt limit, whereby the present high voltage type restrictions for interior installations, as regulated by underwriters, municipal and national electric codes, will be avoided.

A further object of the invention is to provide means to reduce the darkening effect upon the inner side of fluorescent tubes, produced by the operation of the tube, and which is ordinarily more pronounced near the electrodes, thus increasing the light efficiency.

A further object of the invention is to provide means for heating indirectly the thermionic electrodes by positive ion bombardment, by gas convection currents, and the reflection of heat, prior to the striking of the heated thermionic electrodes.

A further object of the invention is to provide means whereby cold electrodes are employed to heat thermionic electrodes during tube operation.

A further object of the invention is to provide electrode devices which are simple and compact and which may be mounted within the tube of the lamp.

A further object of the invention is to provide means of the above-mentioned character having a thermostatic element which may be arranged interiorly or exteriorly of the cold electrode.

A further object of the invention is to provide a fluorescent lamp operating upon a low voltage and which may be longer than the average present low voltage fluorescent tubes, whereby the same will have an increased efficiency over the present commercial tubes.

A further object of the invention is to provide means whereby the current and corresponding light output of the fluorescent tube can be varied during operation within greater limits without materially affecting the tube performance, than with the present commercial low voltage tube.

A further object of the invention is to provide a fluorescent lamp so constructed that the tube and electrodes can be processed by a special pumping schedule with the regular high voltage bombarder transformer, thereby avoiding the complicated processing method heretofore employed.

A further object of the invention is to provide a fluorescent lamp for operation with a high leakage reactance transformer which has a high voltage reserve, whereby the failure of the tube to operate due to insufficient voltage, is eliminated.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings forming a part of this application and in which like numerals are employed to designate like parts throughout the same:

Figure 1 is a side elevation of a fluorescent lamp embodying the invention,

Figure 2 is a central vertical longitudinal section through the same, taken on line 2—2 of Figure 1,

Figure 3 is a perspective view of one electrode device,

Figure 4 is a transverse section taken on line 4—4 of Figure 2,

Figure 5 is a perspective view of the thermionic electrode,

Figure 6 is a central longitudinal section through the same,

Figure 6a is a transverse section taken on line 6a—6a of Figure 6,

Figure 7 is a diagrammatic view showing the circuit for the electrode devices,

Figure 8 is a perspective view of an electrode device embodying a modification of the invention,

Figure 9 is a side elevation of an electrode device, embodying a further modification of the invention, parts being shown in section,

Figure 10 is a side elevation of a fluorescent lamp embodying a further modification of the invention,

Figure 11 is a central vertical section through the same, taken on line 11—11 of Figure 10,

Figure 12 is a vertical section taken on line 12—12 of Figure 11,

Figure 13 is a horizontal section taken on line 13—13 of Figure 11,

Figure 14 is a similar view taken on line 14—14 of Figure 11, and,

Figure 15 is a perspective view of the thermionic electrode and associated contacts.

Attention being called first to Figures 1 to 7, inclusive, the numeral 10 designates the tube of a fluorescent lamp, which tube may be formed of glass, and has its inner surface coated with fluorescent material 11. This tube contains a gaseous atmosphere such as mercury and a carrier gas such as argon, neon, or a mixture of the same. The tube is evacuated prior to the introduction of the mercury and the carrier gas, as will be explained.

Mounted within the opposite ends of the tube 10 are electrode devices 12, each of which comprises an auxiliary electrode 13, which is preferably cylindrical and is provided upon its inner side with a longitudinal opening or slot 14. This cylindrical auxiliary electrode 13 is preferably arranged transversely of the tube and preferably extends diametrically of the same. The auxiliary electrode 13 is preferably formed of "SVEA" metal, or nickel, while it may be formed of any other suitable metal.

Held within the opposite ends of each tubular auxiliary electrode 13 are insulating ends or disks 15, having openings to receive the terminals or plugs 16 of a thermionic electrode 17. The terminals or plugs 16 are preferably formed of nickel. The thermionic electrode 17 includes a tube 18, receiving the plugs 16 in its ends and spot welded to these plugs. The tube 18 is formed from a fine woven metallic mesh. The fine wire mesh tube 18 is preferably formed of nickel, although it may be formed of tungsten, molybdenum, "SVEA" metal or pure iron which is nickel plated or pure iron without the nickel plating. "SVEA" designates the trade name of the purest commercially produced iron made by a special process and freed to the highest extent from carbon and occluded gases. The tube 18 may have a mesh of from 50 to 400 mesh, but we prefer to form the tube of a mesh of from 100 to 300 mesh. The wire from which the screen tube 18 is formed has a diameter of from .0005" to .005" and we prefer using a wire having a diameter of .001" to .002". The inside diameter of the tube 18 may be from .008" to .060". The tube 18 is sprayed with an electron emission coating 18'. This coating may be of the usual composition containing barium carbonate and strontium carbonate with a suitable binder. This coating is originally in the liquid form and is sprayed upon the wire mesh tube 18 and will become attached to the interior and exterior of the tube. After this coating dries it is subjected to a heat treatment whereby the carbonates are converted into the oxides of barium and strontium. Since the mesh of the tube 18 is fine it is also necessary that the barium carbonate and strontium carbonate should be finely divided so that they will pass through at least a 200 mesh sieve. The advantage in using the tubular type electrode 17 is that the electron emission coating will adhere to the outer and inner surfaces of the tube in a superior manner than when such coating is applied to the ordinary coil or filament electrode. While it is preferred to use the tube type thermionic electrode 17, yet it is to be understood that the ordinary coil or filament electrode may be substituted for the same, in which event the filament electrode would be spot welded to the plugs 16.

The numeral 19 designates a stiff U-shaped supporting element, formed of wire, the ends of which are spot welded to the terminals or plugs 16. Rigidly attached to the supporting element 19 are stiff supporting wires 20, the ends of which are fused to and anchored within the head 21 of a stem 22. This stem has a part 23 which is fused to the end of the tube 10, as is well known. The stem 22 is provided with a tube 24, the inner end of which is in communication with the interior of the tube 10, as shown at 25, and the outer end of this tube is closed by being pinched. The tube 24 is employed in evacuating the tube 10. A stiff wire 26 is anchored within the head 21 and is connected with a lead wire 27. Attached to the wire 26 is a generally V-shaped bi-metal thermostatic element 28, secured thereto by spot welding or the like and this thermostatic element is so tensioned that when it is cold it has electrical contact with the cold electrode 13. The free end of the thermostatic element 18 is disposed between the sleeve or electrode 13 and the base 19' of the supporting element 19, and when the thermostatic element 28 is heated, it disengages the sleeve 13 and engages the base 19'. A wire 29 is embedded in the head 21 and is electrically connected with the sleeve 13 through the medium of the wire 30. The wire 29 is also connected with a lead wire 31. The wire 29 is only employed during the heating of the sleeve 13 for the processing of the sleeve 13, thermionic electrode 17, and the coating 11 of the tube 10. A high bombarding current is supplied to the wire 31 and this heats the sleeve 13 to a cherry red removing the occluded gases. At the same time, the barium and strontium carbonates of the coating of the tube 18 are reduced to the barium and strontium oxides. The tube 10 is also heated until paper applied to the outer surface will become charred and this treatment will also remove the occluded gases from the coating 11. After this treatment the wires 31 are not used during the operation of the lamp. Prior to this heat treatment, the tube 10 has been evacuated, and after such heat treatment a small amount of mercury and a carrier gas, in a proper amount, is introduced into the tube 10 through the tube 24 and the tube 24 is sealed.

In Figure 7, the numeral 32 designates a high leakage reactance transformer which has a high voltage reserve, whereby the failure of the tube to operate due to insufficient voltage is eliminated. This transformer includes a secondary coil 33, the ends of which are connected with the lead wires 27. 34 designates the primary coil, connected in a circuit 35 having a source of alternating current 36 and a switch 37, and 34' is the laminated iron core.

The operation of the apparatus is as follows: To operate the lamp, the switch 37 is closed. The thermostatic elements 28 are now in electrical contact with the auxiliary electrodes or sleeves 13 and hence these auxiliary electrodes are connected with the opposite ends of the secondary coil 33. As soon as the switch 37 is closed, the high potential being applied to the auxiliary electrodes 13, the lamp is instantly lit up or struck and the auxiliary electrodes 13 are heated. When this occurs, the thermionic electrodes 17 are subjected to the heating effect of the positive ion bombardment and also from the hot gases surrounding the electrode 17 and also from the heat reflected from the now heated auxiliary electrode

or sleeve 13. This heating of the thermionic electrodes, occurs almost instantly, probably during a second or more. As soon as the auxiliary electrodes or sleeves 13 are heated, as described, the thermostatic elements 28 are operated and disengage the sleeves 13 and electrically engage the bases 19', thereby placing the thermionic electrodes 17 in connection with the opposite ends of the secondary coil 33. As an illustration, when the opposite ends of the secondary coil 33 were connected with the auxiliary electrodes 13, these auxiliary electrodes may be regarded as subjected to the action of 1000 volts, the instant that the switch 37 was closed, but this voltage will automatically drop to a somewhat lower voltage, depending upon the length and diameter of the tube, and this operation will take place while the auxiliary electrodes are still connected with the opposite ends of the secondary coil. Now when the auxiliary electrodes are disconnected from the secondary coil and the thermionic electrodes 17 are connected with the opposite ends of the secondary coil, which occurs after the thermionic electrodes 17 have been heated, as described, the voltage will drop from 1000 volts to about 100 volts to 200 volts, as an example, depending upon the length and diameter of the tube. When this occurs the current will adjust itself to the desired value. The secondary circuit is now made between the thermionic electrodes 17 through the medium of the vaporized mercury whereby ultra violet light is produced which acts upon the fluorescent material 11, causing the lamp to glow, as is well known. The operation will continue until the switch 37 is opened after which the thermostatic elements 28 will cool and disengage the bases 19' and again engage the cold electrodes or sleeves 13.

When the thermionic electrodes 17 are operating, the auxiliary electrodes or sleeves 13 serve as guards for these thermionic electrodes, thereby preventing to a considerable extent the darkening effect upon the inner surface of the fluorescent tube 10, which is more pronounced near the electrodes, and which is caused by the sputtering of the electrodes. The slot 14 is shown as relatively narrow so that the sleeve 13 will properly serve as a guard for the thermionic electrode, but the slot is sufficiently wide to permit of the proper electrical discharge. It is to be understood however that the width of the slot may be varied as may be found advantageous.

In Figure 8, we have shown a modification of the invention. In this figure the numeral 38 designates a bi-metal thermostatic element, extending longitudinally of the cold electrode or sleeve 13, and arranged between the sleeve 13 and the base 19'. This thermostatic element 38 is attached to a stiff wire 39, connected with the wire 27. A double ended contact 40 is secured to the thermostatic element 38 and engages the sleeve 13 when the thermostatic element 38 is cold, but disengages the sleeve 13 and engages the base 19' when the thermostatic element is heated. Two of the thermostatic devices as shown in Figure 8 are used in connection with the tube 10, as shown in connection with the thermostatic devices 12, Figure 2, and all other parts remain substantially identical with those shown and described in connection with the first form of the invention.

In Figure 9 of the drawings, we have shown a thermostatic device 40 two of which are applied to the tube 10 in the manner shown in connection with the electrodes 12. Each device 40 includes the sleeve or cold electrode 13, having the thermionic electrode 17 mounted therein. The terminals 16 are spot welded to rigid support wires 41, corresponding to the wires 20, and anchored in the head 21. A wire 42, corresponding to the wire 31, is electrically connected with the sleeve 13. Disposed internally of the sleeve 13 is a bi-metal thermostatic element 43, extending longitudinally of the sleeve, and mounted upon a wire support 44, passing through the sleeve 13 and insulated therefrom. The wire support is connected with a wire 45, corresponding to the wire 27. The thermostatic element 43 has a double ended contact 46, which engages the sleeve 13 when the thermostatic element 43 is cold, and breaks this engagement and engages a stiff contact wire 47, when the thermostatic element 43 is heated. The wire 47 is spot welded to the terminals 16.

In Figures 10 to 15, we have shown a further modification of the invention wherein a fluorescent lamp is shown as comprising a main tube 48, the inner surface of which is coated with a fluorescent material 49. Arranged within the opposite ends of the tube 48 are auxiliary electrodes or cups 50 preferably formed of "SVEA" metal or nickel, or "SVEA" metal nickel plated or of other suitable metal. These auxiliary electrodes extend longitudinally of the main tube 48 in spaced concentric relation thereto and their inner ends are arranged innermost. The electrode or cup 50 is provided at its outer closed end with an insulating plug 51, through which passes stiff supporting wires 52, embedded in the pinched end 53 of the tube 48. The wires 52 are rigidly held within the insulating plug 51 and serve to rigidly hold the cup 50 in place. A wire 54, corresponding to the wire 31, is anchored in the end 53 and is spot welded to the cup 50. A second wire 55, corresponding to the wire 26, is anchored in the end 53 and passes through the insulating plug 51 and has a bi-metal thermostatic element 56 spot welded thereto. The thermostatic element 56 extends longitudinally of and within the cup 50 and has a double ended contact 57 which engages the cup 50 when the thermostatic element 56 is cold but disengages the cup 50 and engages a stiff contact wire 58, when the thermostatic element is heated. The contact wire 58 may be a continuation of one of the support wires 52. The support wires 52 are spot welded to a metal plug 59, which may be formed of nickel, and this metal plug is inserted within one end of a tubular thermionic electrode 60, corresponding to the tubular element 18. The thermionic electrode 60 is preferably identical with the tube 18. The thermionic electrode 60 extends longitudinally of the cup 50 in spaced concentric relation thereto, and elements 56 and 58 are arranged between it and the cup 50, as shown. While we prefer to employ the tubular thermionic electrode 60, a filament thermionic electrode may be substituted for the electrode 60 and will be electrically mounted upon the plug 59.

The operation of the various forms of electrode devices described after the first form of the invention is so similar that a detailed explanation is deemed unnecessary. In connection with each modification after the first form of the invention, the cold electrodes are first electrically connected with the opposite ends of the secondary coil, and when these cold electrodes are heated upon the closing of the circuit including the primary coil, the thermostatic elements then operate to disengage the cold electrodes and electrically connect with the thermionic electrodes, whereby

these thermionic electrodes are connected with the opposite ends of the secondary coil.

In the operation of all forms of the fluorescent lamp of the present application, there is an instant when the thermostatic element disengages both the auxiliary electrode and the thermionic electrode, in the transition from the auxiliary electrode to the thermionic electrode. However, the light does not go out. This is due to an electrical conducting path of ionized gas between the thermionic and auxiliary cathode elements of the electrode, also because of the sufficiently high secondary voltage of the transformer and a high instantaneous voltage induced by the breaking of the auxiliary cathode circuit containing the transformer secondary reactance.

It is to be understood that the forms of the present invention herewith shown and described are to be taken as preferred examples of the same and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

Having thus described the invention, what is claimed is:

1. In a gaseous discharge lamp, a container having a gaseous atmosphere, spaced tubular auxiliary electrodes within the container, a source of electrical potential, thermionic electrodes within the tubular auxiliary electrodes, said thermionic electrodes having no connection with the opposite poles of the source of electrical potential before the auxiliary electrodes are heated, thermostatic elements having electrical connection with the source of electrical potential and in electrical connection with the auxiliary electrodes before the thermostatic elements are heated and serving to break such electrical connection and having electrical connection with the thermionic electrodes when the thermostatic elements are heated, said thermostatic elements being arranged within the tubular auxiliary electrodes.

2. In a gaseous discharge lamp, a container having a gaseous atmosphere, spaced tubular auxiliary electrodes within the container having contact parts, thermionic electrodes within the tubular auxiliary electrodes having contact parts, thermostatic elements arranged within the container and having connection with the opposite poles of a source of current and having parts disposed between the contact parts of the auxiliary electrodes and the contact parts of the thermionic electrodes to alternately engage with such parts, the thermostatic elements being heated by the action of the auxiliary electrodes, the auxiliary electrodes and the thermionic electrodes having electrical connection with the opposite poles of the source of current solely through the means of the thermostatic elements.

3. In a gaseous discharge lamp, a container having a gaseous atmosphere, spaced tubular auxiliary electrodes within the container, tubular thermionic electrodes within the tubular auxiliary electrodes and insulated therefrom, and means to alternately connect the tubular auxiliary electrodes and the thermionic electrodes with a source of potential, said means including thermostatic elements arranged within the container to be heated by the action of the tubular auxiliary electrodes, said thermionic electrodes being free from electrical connection with the source of potential prior to the heating of the thermostatic elements.

4. In a gaseous discharge lamp, a tube, a gaseous atmosphere within the tube, spaced auxiliary electrodes within the tube, thermionic electrodes within the tube and arranged in cooperative relation to the auxiliary electrodes to be heated thereby, and means for electrically connecting the auxiliary electrodes with the opposite poles of a source of current and then disconnecting the auxiliary electrodes from the opposite poles of the source of current and connecting the thermionic electrodes with the opposite poles of the source of current, the thermionic electrodes being previously disconnected from the opposite poles of the source of current.

5. In a gaseous discharge lamp, a container having a gaseous atmosphere, spaced auxiliary electrodes within the container, thermionic electrodes within the container and arranged near the auxiliary electrodes to be heated thereby, means for connecting one auxiliary electrode with one pole of a source of current and the other auxiliary electrode with the opposite pole of the source of current whereby the auxiliary electrodes are heated solely by the electrical potential thereon, said means also serving to connect one thermionic electrode with one pole of the source of current and the other thermionic electrode with the opposite pole of the source of current, the thermionic electrodes being free from connection with the opposite poles of the source of current before the means operates to connect said thermionic electrodes with said opposite poles.

6. In a gaseous discharge lamp, a tube, a gaseous atmosphere within the tube, spaced auxiliary electrodes within the tube, thermionic electrodes within the tube arranged near the auxiliary electrodes to be heated thereby, and means for electrically connecting one auxiliary electrode with one pole of a source of current and the other auxiliary electrode with the other pole of the source of current, said means also serving to disconnect the auxiliary electrodes from said poles of the source of current and to then connect one thermionic electrode with one pole of the source of current and the other thermionic electrode with the other pole of the source of current, the thermionic electrodes being previously free from electrical connection with said poles of the source of current, said means including thermostatic elements arranged to be heated by the auxiliary electrodes.

7. In a gaseous discharge lamp, a container having a gaseous atmosphere, spaced auxiliary electrodes arranged within the container, spaced thermionic electrodes arranged within the container and disposed near the auxiliary electrodes to be heated by positive ion bombardment, gas convection currents and the reflection of heat from the auxiliary electrodes when they are heated, means for connecting one auxiliary electrode with one pole of a source of current and the other auxiliary electrode with the opposite pole of the source of current, the auxiliary electrodes being heated solely by the potential applied thereto, said means also serving to connect one thermionic electrode with one pole of the source of current and the other thermionic electrode with the other pole of the source of current and to disconnect the auxiliary electrodes from said poles of the source of current, said means including thermostatic elements arranged to be heated by the auxiliary electrodes, the thermionic electrodes being previously free from connection with said poles of the source of current before the lamp is started.

8. In a gaseous discharge lamp, a container

having a gaseous atmosphere, spaced tubular auxiliary electrodes within the container for connection with the opposite poles of a source of current, thermionic electrodes within the tubular electrodes and free from connection with the opposite poles of the source of current before the lamp is started, a thermostatic element connected with one pole of the source of current, a second thermostatic element connected with the opposite pole of the source of current, the thermostatic elements being heated by the auxiliary electrodes and when heated being adapted to have electrical connections with the thermionic electrodes.

9. In a gaseous discharge lamp, a container having a gaseous atmosphere, spaced auxiliary electrodes within the container for connection with the opposite poles of a source of current, thermostatic elements for connection with the opposite poles of the source of current and arranged adjacent to the auxiliary electrodes to be heated thereby, and thermionic electrodes arranged within the container and disposed in cooperative relation with the auxiliary electrodes and being free from connection with the opposite poles of the source of current before the thermostatic elements are heated, the thermostatic elements when heated serving to connect the thermionic electrodes with the opposite poles of the source of current.

10. In a gaseous discharge lamp, a container having a gaseous atmosphere, spaced auxiliary electrodes arranged within the container for connection with the opposite poles of a source of current, thermostatic elements for connection with the opposite poles of the source of current and in thermal contact with the auxiliary electrodes to be heated by the auxiliary electrodes, and thermionic electrodes arranged within the container and disposed in cooperative relation to the auxiliary electrodes and being free from electrical connection with the opposite poles of the source of current before the thermostatic elements are heated, the thermostatic elements when heated serving to connect the thermionic electrodes with the opposite poles of the source of current.

11. In a gaseous discharge lamp, a container having a gaseous atmosphere, spaced tubular auxiliary electrodes for connection with the opposite poles of a source of current and mounted within the container and extending transversely thereof, the tubular auxiliary electrodes having openings upon their inner sides, thermostatic elements for connection with the opposite poles of the source of current and arranged adjacent to the auxiliary electrodes to be heated thereby, thermionic electrodes mounted within the tubular auxiliary electrodes and insulated therefrom and free from connection with the opposite poles of the source of current before the thermostatic elements are heated, the thermostatic elements when heated serving to connect the thermionic electrodes with the opposite poles of the source of current.

12. In a gaseous discharge lamp, a container having a gaseous atmosphere, spaced tubular auxiliary electrodes within the container for connection with the opposite poles of a source of current, said auxiliary electrodes having longitudinal openings, insulating disks held within the ends of the tubular auxiliary electrodes, thermostatic elements for connection with the opposite poles of the source of current and disposed adjacent to the auxiliary electrodes to be heated thereby, thermionic electrodes arranged within the tubular auxiliary electrodes and having parts held by the insulating disks, the thermionic electrodes being free from connection with the opposite poles of the source of current before the thermostatic elements are heated, the thermostatic elements when heated serving to connect the thermionic electrodes with the opposite poles of the source of current.

13. In a gaseous discharge lamp, a container having a gaseous atmosphere, spaced tubular auxiliary electrodes arranged within the container for connection with the opposite poles of a source of current, said auxiliary electrodes having openings for the electrical discharge, thermostatic elements for connection with the opposite poles of the source of current and arranged adjacent to the auxiliary electrodes to be heated thereby, thermionic electrodes arranged within the tubular auxiliary electrodes and free from connection with the opposite poles of the source of current before the thermostatic elements are heated, each thermionic electrode including a foraminous tubular body portion and an electron emission coating applied to the foraminous tubular body portion, the thermostatic elements when heated serving to connect the thermionic electrodes with the opposite poles of the source of current.

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