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MEANS FOR LIGHTING GAS DISCHARGE TUBES

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Fig. 1

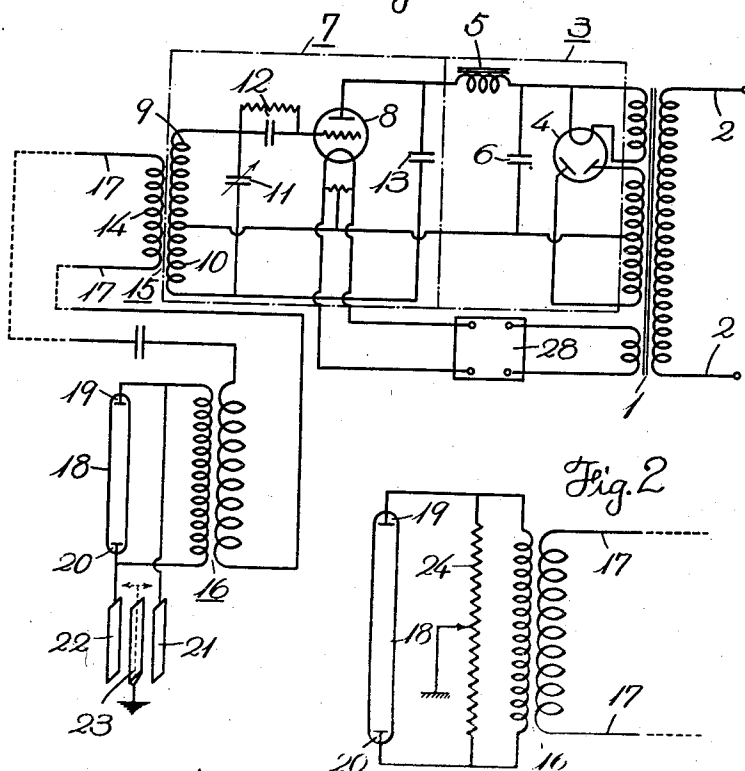


Fig. 2

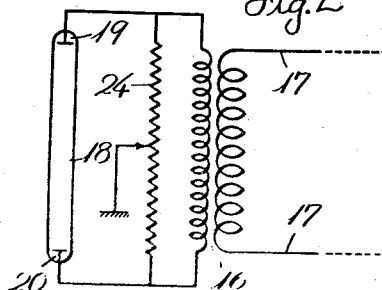
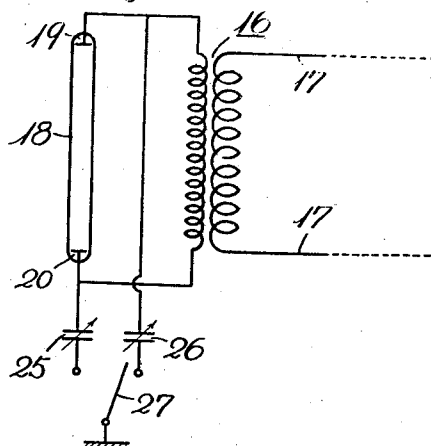


Fig. 3



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MEANS FOR LIGHTING GAS DISCHARGE
TUBES

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4 Claims. (Cl. 176—124)

This invention relates to means for lighting gas discharge tubes, such as a neon tube, which comprises an oscillator producing voltages of super audio-frequencies for energizing the gas discharge tube and means for controlling the glow discharge condition of the gas discharge tube.

The principal object of this invention is to provide means for lighting gas discharge tubes which enables the periodic motion of the growth and shortening of the glow starting from one electrode to the other of the gas discharge tube with a desired slow speed automatically and positively and which is adapted to be used for lighting beacon lamps and neon tubes for decoration and advertisement.

It has heretofore been usual to energize a gas discharge tube, such as a neon tube or a glow discharge tube filled with rare gas or mercury vapour with the electric power having commercial frequency of 50 or 60 cycles. In such a case, however, the gas discharge tube has such characteristics that the glow occurs between the electrodes of the gas discharge tube instantaneously at a predetermined discharge voltage and the glow is maintained thereafter. There has been proposed no lighting means by which the glow starts from either one of the desired electrodes of a gas discharge tube and grows up to the other electrode with desired low speed automatically.

According to this invention, the superior glow discharge characteristics as above described can be afforded to an ordinary gas discharge tube whereby increasing the utility value thereof more effectively.

In the accompanying drawing, Fig. 1 is a connection diagram of means for lighting gas discharge tubes embodying this invention; and Figs. 2 and 3 are connection diagrams of the other embodiments of this invention.

Referring to Fig. 1, 1 represents a power transformer having the primary winding connected to an alternating current source 2 of an ordinary commercial frequency and the secondary windings connected to a rectifier 3. The rectifier 3 consists of a rectifying vacuum valve 4 and smoothing coil 5 and condenser 6 connected to the output side thereof.

According to this invention an oscillator 7 is connected to the rectifier 3 to be energized therefrom. Though, in this figure, an ordinary oscillator comprising an oscillation vacuum valve 8, oscillation coupling coils 9 and 10 respectively connected to the grid and plate circuits of the vacuum valve 8, a variable condenser 11 connected across the oscillation coupling coils 9 and

10, and a grid biasing means 12 is used, yet it is not necessary to limit this invention to the use of such oscillator only, but in general any suitable oscillator which can produce voltages and currents having super audio-frequencies can be used. 13 designates a regenerative condenser. Coupled to the coils 9 and 10 is a coil 14 so as to form a step-down transformer 15. Both terminals of the coil 14 are led to a step-up transformer 16 through feeder lines 17. The secondary winding of the step-up transformer 16 is connected to energize a gas discharge tube 18, such as a neon tube. Both electrodes 19 and 20 of the gas discharge tube 18 are respectively connected to metal plates 21 and 22 to which an earthed metal plate 23 is oppositely arranged to approach alternately as shown by the arrows in order to change the electrostatic potentials of the electrodes of the gas discharge tube with respect to the earth. For the same purpose as shown in Fig. 2, each electrode of the gas discharge tube can be connected to each terminal of a potentiometer 24 the intermediate variable tap of which is earthed, or as shown in Fig. 3 the electrodes 19 and 20 are respectively connected to variable condensers 25 and 26 which are connected through a change-over switch 27 to the earth.

In order to change the frequency of the oscillator repeatedly, the rotor of the variable condenser 11 is arranged to be rotated by a small motor (not shown). If desired, the oscillation vacuum valve 8, the filament of which has a heat capacity of several seconds after heating, may be used. The filament of the vacuum valve 8 is connected to be heated from a secondary winding of the transformer 1 through a switch 28 which operates periodically and automatically with suitable period, such as a heat responsive switch having a bimetal.

In some cases, the switch 28 may be inserted in the supply circuit of the oscillator 7, giving the above described characteristics of heat capacity to the filament of either the oscillation vacuum valve 8 or the rectifying vacuum valve 4.

The operation of the above described means is as follows:—Assuming that the electric constants of the oscillation circuit of the oscillator 7 are so selected that the gas discharge tube 18 is lighted with electric power of super audio-frequencies and both electrodes of the gas discharge tube 18 are maintained at the equal electrostatic condition with respect to the earth. If under such condition the frequency of the oscillator is gradually increased by the operation of the vari-

able condenser 11 or the temperature rise of the filament of the oscillation vacuum valve 8 or rectifying vacuum valve 4, glows occur at both electrodes of the gas discharge tube 18 with a certain frequency and grow up symmetrically to the other electrodes corresponding to the increase of frequencies with a little change of voltage. Thus the dark part of the gas discharge tube is gradually occupied by the glows and it is finally eliminated. The continuous glow connecting both electrodes is divided into two parts at middle of the gas discharge tube 18 and the divided glows are respectively shortened to corresponding electrodes as the frequency is increased more gradually and continuously. The inventor's experiments show that the above described glow discharge phenomena occur at the several frequency bands and that the phenomena are most effective at a super audio-frequency band which depends on the size and form of the electrodes, the dimension of the gas discharge tube and the pressure and kind of the gas filled therein.

As a numerical example, if a glow discharge tube filled with neon gas at the pressure of 6 m. m. Hg having 1 meter in length and 9 millimeters in diameter is used, the above discharge phenomena are most effective at the super audio-frequency of about 120 kilo-cycles.

Experiments also show that the higher the super audio-frequency increases, the lower the voltage at which the glow discharge occurs. Generally in the means according to this invention the glow discharge starts at far lower voltages than that of the electric power having ordinary commercial frequencies. In order to determine the electrode from which the glow starts, the electrode must be maintained at a lower electrostatic potential with respect to the earth than that of the opposite electrode. Accordingly when the earthed metal plate 23 is moved nearer to the metal plate 21, the intermediate tap of the potentiometer 24 is moved to the upper terminal thereof or the change-over switch 27 is moved to the condenser 26, and at the same time the frequency of the oscillator 7 is continuously changed, the glow occurs only at the electrode 20 of the gas discharge tube 18 and starts therefrom and grows up to the opposite electrode 19 gradually corresponding to the frequency change. In this case if the earthed metal plate 23 is moved to approach to the metal plates 21 and 22 alternately, the glows start from one electrode and grow up to the other electrode alternately at the desired slow speed corresponding to the frequency changing speed. It is obvious that the above described operation is also caused by changing the frequency with the switch 28 instead of the variable condenser 11, the other operating conditions being unchanged. It is often necessary to locate the gas discharge tube at a place distant from the oscillator 7. In such a case if an ordinary feeder means is applied the polarity effect due to the different electrostatic condition of the electrodes with respect to the earth will appear and the considerable power loss due to the super audio-frequency may occur so that the desired electrode from which the glow discharge will start can not be selected positively and economically. The step-down transformer 15 and step-up transformer 16 serve to obviate the disadvantage. That is, the potential of the feeder lines 17 may become possibly low to the earth potential by the step-down transformer 15. Hence the terminals of the primary and secondary windings of the step-up transformer 16 and

accordingly both electrodes of the gas discharge tube 18 are maintained at the same electrostatic condition with respect to the earth, which enables the positive selection of a desired electrode. It is clear that the feeder lines 17 can be earthed so as to maintain it substantially at the earth potential.

As above described according to this invention the glow can start from a desired electrode or both electrodes in a gas discharge tube and grow up to the other opposite electrode with desired speed periodically at a predetermined period. Consequently this invention may be adopted to light a beacon lamp or a neon lamp for decoration and advertisement and the utility value of these glow discharge lamps is greatly increased.

Though, in the drawing, the oscillator 7 is connected to be supplied from the alternating current source 2 through the rectifier 3, the oscillator may be connected to a direct current source such as a dynamo or storage batteries.

Moreover in order to attract the special attention to the glow discharge, the electric power of the oscillator 7 may be modulated by the current of low frequencies such as 60, 50 or lower cycles thereby flickering the glow at the same frequency.

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

1. Means for lighting gas discharge tubes comprising an oscillator which produces the voltage of super audio-frequencies, a gas discharge tube connected to the output circuit of said oscillator to be energized therefrom, means for changing the frequency of said oscillator gradually and periodically, and means for applying to the electrodes of said gas discharge tube, in synchronism with the frequency changing operation of said oscillator, alternately different electrostatic potentials with respect to the earth.

2. Means for lighting gas discharge tubes comprising a rectifier connected to an alternating current source having an ordinary commercial frequency, a super audio-frequency oscillator having an oscillation vacuum valve connected to the output side of said rectifier, the filament of said oscillation vacuum valve having a heat capacity of several seconds and being connected to said alternating source through an automatic switch operating periodically, a gas discharge tube connected to the output circuit of said super audio-frequency oscillator through a step-down transformer, a feeder line and a step-up transformer, metal plates connected to the electrodes of said gas discharge tube and an earthed metal plate which is arranged to approach alternately to said metal plates so as to change periodically the electrostatic potentials of said electrodes of the gas discharge tube with respect to the earth.

3. Means for lighting gas discharge tubes comprising a rectifier connected to an alternating current source having an ordinary commercial frequency, a super audio-frequency oscillator having an oscillation vacuum valve connected to the output side of said rectifier, a grid coil of said oscillation vacuum valve, a plate coil coupled to said grid coil and a variable condenser connected across said grid and plate coils, a gas discharge tube connected to said grid and plate coils through a step-down transformer, a feeder line and a step-up transformer, and a potentiometer connected across the electrodes of said gas discharge tube, the intermediate tap of said potentiometer being earthed.

4. Means for lighting gas discharge tubes com-

prising a direct current source, a super audio-frequency oscillator connected to said direct current source to be energized therefrom, a gas discharge tube connected to the output circuit of
5 said super audio-frequency oscillator to be energized therefrom, a variable condenser connected

to the electrode of said gas discharge tube, and a change-over switch for connecting the electrode of said said gas discharge tube to the earth through said variable condenser.

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