

Oct. 6, 1936.

T. E. FOULKE

2,056,661

METHOD OF AND APPARATUS FOR OPERATING ELECTRIC DISCHARGE LAMPS IN SERIES

Filed July 13, 1934

*Fig. 1*

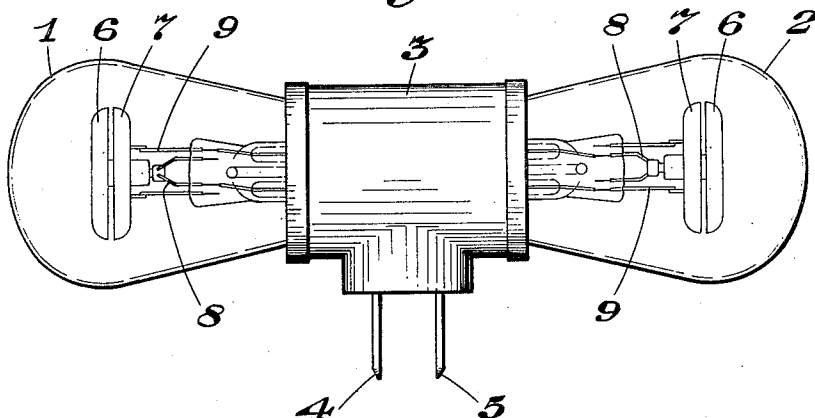
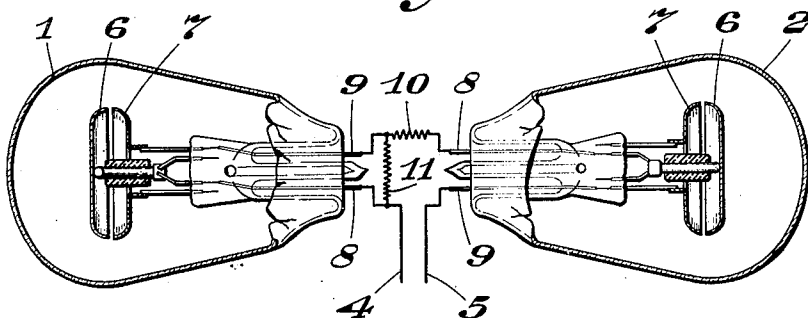


*Fig. 2*



INVENTOR

*Ted E. Foulke*

BY

*Wm. D. Brown*

ATTORNEY

## UNITED STATES PATENT OFFICE

2,056,661

## METHOD OF AND APPARATUS FOR OPERATING ELECTRIC DISCHARGE LAMPS IN SERIES

Ted E. Foulke, Nutley, N. J., assignor to General Electric Vapor Lamp Company, Hoboken, N. J., a corporation of New Jersey

Application July 13, 1934, Serial No. 735,067

5 Claims. (Cl. 176—124)

The present invention relates to electric gaseous discharge devices generally, and in particular to the operation of a plurality of such devices in series on a constant potential system.

5 A particular object of my invention is to increase the luminous efficiency of electric gaseous discharge devices. Another object of my invention is to provide a method of and means for operating a plurality of such devices in series on a circuit whose potential is less than the total individual breakdown potential of said devices. Still other objects and advantages of my invention will appear from the following detailed specification or from an inspection of the accompanying 10 drawing.

The invention consists in the new and novel combination of elements and in the novel steps of the method hereinafter set forth and claimed.

All gaseous discharge devices operating on a constant potential circuit require a series impedance to stabilize the discharge, as is well known. In the case of many of these devices, such as cathode glow lamps, for example, a resistance is ordinarily employed for this purpose. This resistance, however, consumes energy which might well be utilized in the production of light, if possible, and with the lower discharge maintaining voltage resulting from the improvements in electrode surfaces which have been achieved in the 30 last few years an ever increasing amount of energy has been dissipated in these resistances which might be put to a more profitable use when some way of utilizing it was found. With this improvement in the electrode surfaces there was, of course, a corresponding decrease in breakdown potential, but this potential is still too high to insure satisfactory operation of two of these devices in series on the usual 110 volt circuits, hence this mode of decreasing the wasted energy has not 40 been available heretofore.

I have now discovered, however, that two of these improved cathode glow lamps can be operated in series on any 110 volt A. C. line with complete success, despite any usual line voltage fluctuation, provided a novel means of my invention is utilized to unequally distribute the line potential between the lamps at starting, causing the lamps to break down in turn. With this novel arrangement the breakdown potential of 45 the combination is no longer the sum of the individual breakdown potentials, as heretofore, but instead is the breakdown potential of one plus the maintaining potential of the other. This difference is just enough to secure satisfactory operation of the lamps under all conditions on a

110 volt circuit. According to my invention this new result is obtained by bridging the terminals of one of the lamps with a resistance or other impedance of the order of 100,000 ohms, this resistance robbing the bridged lamp of potential 5 and thus applying the entire line potential to the other lamp until a discharge is started therein. This resistance thereupon consumes considerably more than half of the line potential, thus raising the potential across the bridged lamp sufficiently 10 to initiate the discharge therein. The two lamps thereupon continue to operate in series with virtually no current flow through the high resistance. The series ballasting resistance is, of course, reduced to a small value due to the presence of the second lamp, and the luminous efficiency of the combined unit is not only doubled as compared to a single lamp as a result thereof, but is also greater than would be possible with the simple connection of two lamps in series, due 20 to the decrease in the voltage required to operate my novel combination of lamps.

For the purpose of illustrating my invention I have shown a preferred embodiment thereof in the accompanying drawing, in which

Fig. 1 is an elevational view showing two cathode glow lamps of a well known type combined in a single mounting unit for series operation, and

Fig. 2 is a schematic diagram showing the electrical connections of the same unit.

As shown in this drawing a pair of identical cathode glow lamps 1 and 2 are cemented within opposite ends of a suitable insulating base 3 having plug contacts 4 and 5 on the bottom thereof. Each glow lamp has a pair of electrodes 6 and 7 which are suitably supported on the inleads 8 and 9, respectively. These glow lamps contain any suitable gas or vapor or mixture thereof at a relatively low pressure. For example, in some cases I prefer to use a mixture of neon with .05 to .5% 40 of argon at a pressure of the order of 20 to 50 m. m. of mercury. The electrodes 6 and 7 are each preferably coated on the convex face thereof with barium and strontium with an oxygen bond, as disclosed in my Patent 1,965,589, issued July 10, 1934, since this coating has been found to provide both low work function, with a correspondingly low breakdown potential, and long life. The concave side of each of these electrodes is preferably coated with finely divided aluminum in order to keep the glow from covering this part of the surface, where the light could not be utilized. This aluminum also serves as a getter as the result of the treatment it receives during the man- 55

ufacture of the lamp, and thus cleans up any undesired impurities.

Within the socket 3 the connections are as follows. The plug contact 4 is connected to the inlead 8 of the lamp 1, while the other plug contact 5 is connected to the inlead 9 of the lamp 2. The inlead 9 of lamp 1 is connected to the inlead 8 of the lamp 2 through a resistance 10 of the order of 600 to 700 ohms. The exact position of this resistance is of no particular importance, so long as it is connected in series, and in some cases it may be divided and the halves directly associated with the lamps 1 and 2. Other forms of impedance may likewise be employed where desired. A resistance 11, of the order of 100,000 ohms, is connected between the inleads 8 and 9 of the lamp 1.

In the use and operation of the lamp combination illustrated as soon as the plug terminals are connected to a suitable source of supply, such as a nominal 110 volt A. C. line, the entire line voltage is impressed between the electrodes 6 and 7 of the lamp 2, due to the fact that there is no voltage drop in either of the resistances 10 or 11 so long as there is no current flow therethrough. The glow lamp 2 has a breakdown potential, however of the order of 50 to 55 volts A. C., if it is made as hereinbefore described, and hence the impressed potential immediately initiates the discharge therein. This discharge is limited to a small value, however, by the resistance 11, which now consumes virtually all of the line potential less the maintaining potential of the lamp 2. Since the latter is of the order of 40-45 volts it is apparent that this resistance drop, which is likewise the potential now impressed between the electrodes 6 and 7 of the lamp 1, is of the order of 65-70 volts, and in some cases an even higher voltage can be obtained by use of a condenser in place of the resistance 11, due to the shift in phase relations. The lamp 1 has a breakdown potential, however, of but 50-55 volts, and hence the discharge is now initiated in this lamp. The current in both lamps then increases to the limit set by the ballast resistance 10, this current being about .027 amperes in the case described and illustrated. The resistance 11, due to its relatively high value, carries but little of this current, so that both lamps glow with substantially the same brilliancy. It will be noted that with this novel arrangement sufficient tolerance is provided so that the line voltage can drop from the nominal 110 volts to 100 volts or even less, and both of my novel lamps will still start and operate satisfactorily, although in the absence of the resistance 11 these same lamps will fail to operate as soon as the potential drops appreciably below the nominal voltage of 110. Thus in an actual case two lamps which required a minimum of 105 volts when merely connected in series would operate satisfactorily on 87 volts after the resistance 11 was added. From this it will be apparent that it is only through my novel use of a bridging resistance or impedance that these lamps can be satisfactorily operated in series, for on most lines there is a greater deviation from the nominal voltage than these lamps could otherwise tolerate. As

a result of this novel arrangement I now find it possible to obtain double the luminous efficiency which has heretofore been attainable with these lamps without altering the operating conditions of the lamps in any way.

While the above description has been limited to the use of two lamps in series on A. C. it is to be understood that it is also applicable to the use of such lamps in series on D. C. if desired, although 220 volts D. C. is ordinarily employed for this purpose. It is also to be understood that more than two lamps can be connected in series with advantage in some cases, as where 220 volts D. C. is employed, with one of the lamps by-passed as described during starting, and that other types of gaseous discharge devices than that described may likewise be started and operated in series on a lower voltage by the aid of my novel circuit. Various other changes, substitutions, and omissions, within the scope of the appended claims, may also be made in the structure illustrated without departing from the spirit of my invention.

I claim as my invention:—

1. In combination, a plurality of electric gaseous discharge devices connected in series, and a single impedance permanently connected between the terminals of a single one of said devices whereby the remaining devices receive more than their proportionate share of an applied potential before a discharge is initiated therein.

2. In combination, a plurality of electric gaseous discharge devices connected in series, and a single resistance permanently connected between the terminals of a single one of said devices whereby the remaining devices receive more than their proportionate share of an applied potential before a discharge is initiated therein.

3. In combination, a plurality of cathode glow lamps connected in series, and an impedance connected between the terminals of a single one of said lamps, said impedance having a value greater than the apparent impedance of one of said lamps after a discharge is initiated therein whereby the remaining lamps first receive more than their proportionate share of an applied potential before a discharge is initiated therein, and then less than their share until a discharge is initiated in said single lamp.

4. In combination a socket adapted to retain a plurality of electric gaseous discharge devices and to connect said devices in series, an impedance within said socket to stabilize the current through said devices, and means comprising another impedance within said socket and connected in multiple with one of said devices to provide an unequal distribution of an applied potential on said devices before a discharge in each one thereof.

5. The method of starting and operating a plurality of electric gaseous discharge devices in series which comprises applying line potential to all except one of said lamps in series through an impedance to initiate a discharge in said lamps, and thereafter applying the voltage drop in said impedance across the excepted lamp to initiate a discharge therein.

TED E. FOULKE.