

May 6, 1930.

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1,757,776

STARTING AND OPERATING CIRCUITS FOR LUMINOUS TUBES

Filed July 9, 1927

Fig-1

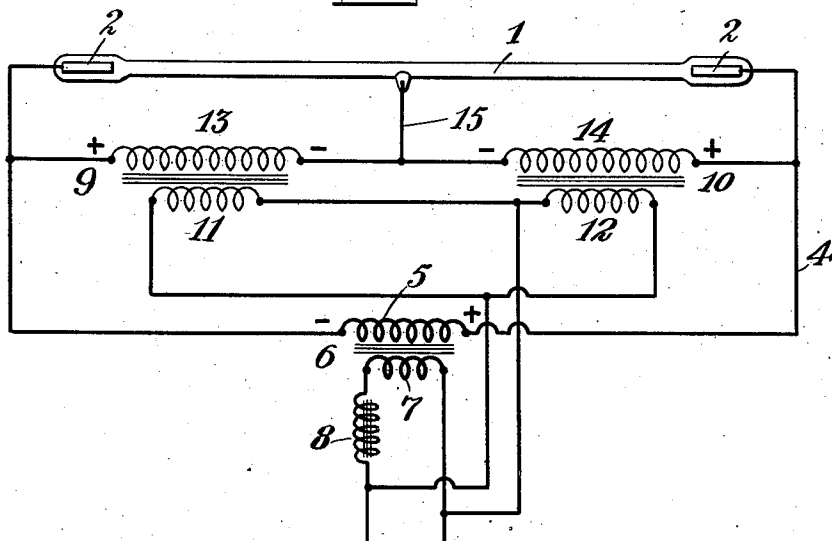
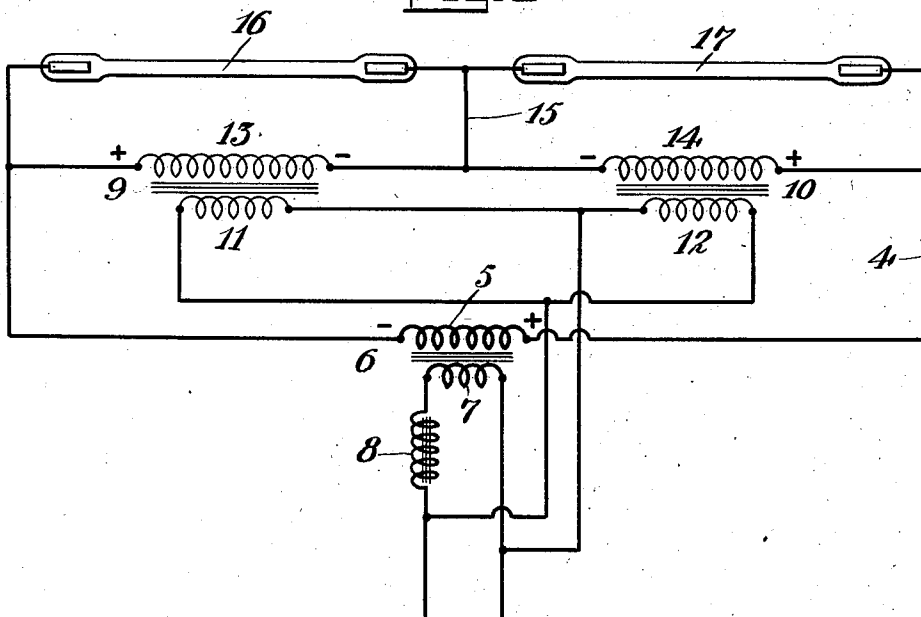


Fig-2



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STARTING AND OPERATING CIRCUITS FOR LUMINOUS TUBES

Application filed July 9, 1927. Serial No. 204,477.

My invention relates to an improved circuit arrangement for starting and operating luminous tubes. These tubes have heretofore generally been long glass tubes filled with a rarefied conducting gas such as neon, provided with interior terminal electrodes and usually bent into the form of letters or symbols so as to constitute an electric sign.

As is well known, the electrical characteristics of these tubes are such that a current of very much higher voltage is required to start the tubes than to operate them after they have once been started. When these tubes are employed for electric signs and analogous purposes, currents of the order of from 20 to 40 milliamperes are used and with currents of these low values it is entirely practical commercially to make use of transformers having an open circuit voltage sufficient to start the tube. In an electrical sense such an arrangement is inefficient but since the currents used are small, a high measure of economy of operation is not important as compared with the simplicity of the structure. However, if a luminous tube is employed with relatively heavy currents of the order of $\frac{1}{10}$ of an ampere up to 10 amperes, or greater, as is the case, for example, with a neon beacon, a different situation presents itself. Here the power factor becomes important, not only as a matter of economy but in order to prevent undesirable fluctuations in the power lines supplying adjacent territory.

If a luminous tube intended for operation with very heavy currents was simply started and allowed to burn continuously, the objection referred to would not be so pronounced except as it would involve very large and expensive apparatus capable of providing the necessary starting voltage and unduly heavy conductors to handle the excessive current. It has, however, been found desirable that the tubes in question when used as beacons should flash on and off at intervals of a few seconds and thus the difficulty referred to is a constantly recurring one.

I am aware that it has been proposed to use auxiliary apparatus for starting luminous tubes but to the best of my knowledge

they all depend upon contacts and switching devices and usually include complicated moving parts which are likely to get out of order.

With my present invention I employ an auxiliary circuit for starting the tube having no moving parts but utilizing a simple transformer arrangement by which the desired starting voltage may be secured with a current of very small value, say of the order of 10 milliamperes. This allows for the design of a transformer to supply the operating energy to the tube or tubes which is entirely practical in its proportions. The arrangement results in a very much improved power factor which may be of the order of 50% to 60% or higher, and generally in improved operating conditions.

In order that the invention may be better understood, attention is directed to the accompanying drawing, in which,

Figure 1 shows an arrangement in which a single tube is used with a central auxiliary electrode, and

Figure 2 a modified arrangement in which two luminous tubes are employed operating in series.

In both of these views, corresponding parts are represented by the same numerals of reference.

Referring first to Figure 1, the tube 1 is a long glass tube filled with a rarefied gas such as neon and having terminal electrodes 2—2. It is also provided with an auxiliary electrode 3 located substantially at the midpoint of the tube. Such a tube will be of substantial diameter and is designed to be operated with very heavy currents—currents exceeding $\frac{1}{10}$ of an ampere and preferably as high as 10 amperes or more.

The electrodes 2—2 are included in a circuit 4 including the secondary 5 of transformer 6, the primary 7 of which is connected to the usual 110 volt or 220 volt supply. The transformer 6 is so designed that its open circuit voltage is insufficient to start the tube. Its open circuit voltage is, however, higher than that required to supply the desired current to the tube under operating conditions when it has once been started. If the transformer 6 were so designed as to operate the

tube at its open circuit voltage, the unstable characteristics of the tube would cause it to fluctuate very badly and it is therefore desirable to always maintain sufficient inductive reactance in the primary circuit of the transformer 6 as to balance or counteract the unstable characteristics of the tube so as to cause it to operate steadily. This may be done either by designing the transformer to possess sufficient inductive reactance or by the use of a special reactance coil 8 as shown. Constant current transformers are, of course, well known.

In order to start the tube I make use of an auxiliary circuit arrangement including two transformers 9 and 10, the primaries 11 and 12 of which are connected in multiple to the supply circuit as shown. The secondaries 13 and 14 of these transformers are connected in series across the circuit 4 and the center connection 15 leads to the auxiliary starting electrode 3. The transformers 9 and 10 are so designed as to provide the necessary starting voltage with a current of low value, preferably of the order of 10 milliamperes.

It is important that the auxiliary electrode 3 shall be so located with respect to the two branches of the tube 1 on either side of the auxiliary electrode that these branches shall have approximately the same starting voltage, at least within the limits of the reactance of the main transformer. If one branch of the tube should start before the other branch the auxiliary transformer 9 or 10 of such other branch would have the possibility of discharging through the already started tube and through the secondary 5 of the main operating transformer 6. It is necessary, therefore, that the current which might pass the secondary of the main transformer in this way and the impedance of that secondary be of sufficient value to cause a sufficient voltage drop to balance whatever difference might exist between the starting voltages of the two branches of the luminous tube. This represents the maximum case, but of course it is desirable that the two branches of the tube should be as evenly balanced as possible with respect to their starting voltages.

It is also necessary that the auxiliary circuit including the secondaries 13 and 14 shall be so coordinated that these windings oppose each other in such a way that the common conductor 15 shall receive potential of the same polarity at any instant and that the electrodes 2-2 be also of the same polarity at any instant. In other words, the transformers 9 and 10 operate in multiple in starting the tube. In this way, and provided the two branches of the tube are sufficiently alike in starting characteristics, no potential is applied to the secondary of the main transformer 6 by reason of the presence of the auxiliary transformers and thus no current

will flow from the auxiliary transformers into the main transformer.

The potential imposed by the auxiliary transformers 9 and 10 is limited entirely to the branches of the tube and is of sufficient value to start the tubes and cause approximately 10 milliamperes or more to flow through them. The tube having once been started, the potential now required to further excite it is very much reduced and is of the order of 50% or less than the starting voltage.

The main operating transformer 6 may therefore be designed simply to fit the conditions after the tube has been started which results in the possibility of designing it with a voltage ratio of less than one-half of what would be necessary if it also had to provide for the additional starting of the tube.

The arrangement of Figure 2 is electrically the same as Figure 1 as will be obvious. Here, instead of making use of a single tube, I employ two tubes 16 and 17 connected in series and having interior electrodes 2-2 as before. The adjacent electrodes where the tubes are connected together function in the same way as the auxiliary starting electrode 3 of Figure 1.

The principle described and illustrated in Figure 1 employing an auxiliary electrode, may also be used with a series of luminous tubes in place of the single luminous tube illustrated. In this case it is immaterial what the respective lengths of the various tubes which constitute the series might be so long as the auxiliary electrode is located at the approximate midpoint between the eventual terminals of the series.

The invention is furthermore not limited to the use of two separate transformers as illustrated at 9 and 10 in the drawings for the auxiliary circuit since these two transformers may be readily combined into a single transformer with two secondary windings, one of which is opposed to the other. The three transformers may in fact be combined to have a common primary and common core if it is desirable, it being understood that the circuit shown in the drawing is chosen because it illustrates the principle involved most clearly.

In the following claims where reference is made to a luminous tube, I mean to include both a single continuous tube with a separate auxiliary electrode therein as well as two tubes in series, the adjacent electrodes of which constitute the mechanical and electrical equivalent of a single auxiliary electrode.

Having now described my invention, what I claim as new therein and desire to secure by Letters Patent is as follows:

1. In a circuit including a luminous tube intended for operation with currents of high value, the combination with a tube having a rarefied gas therein and provided with in-

terior electrodes, of a transformer connected to said electrodes and supplying current to the tube, the secondary voltage of said transformer being insufficient to start the tube, and auxiliary starting means permanently in circuit with the tube for supplying a starting voltage to the same and balanced with respect to the main operating transformer, substantially as set forth.

2. In a circuit including a luminous tube intended for operation with currents of high value, the combination with a tube having a rarefied gas therein and provided with interior electrodes, of a transformer connected to said electrodes and supplying current to the tube, the secondary voltage of said transformer being insufficient to start the tube, of two auxiliary transformers connected in series to the outside electrodes of the tube and having a common branch to the center portion of the tube, substantially as set forth.

3. In a circuit including a luminous tube intended for operation with currents of high value, the combination with a tube having a rarefied gas therein and provided with interior electrodes, of a transformer connected to said electrodes and supplying current to the tube, the secondary voltage of said transformer being insufficient to start the tube, of two auxiliary transformers permanently connected to the electrodes in the tube in opposition to each other and a common conductor leading to the center portion of the tube, substantially as set forth.

4. In a circuit including a luminous tube intended for operation with currents of high value, the combination with a tube having a rarefied gas therein and provided with a plurality of interior electrodes spaced along the tube, of a transformer connected to the electrodes spaced apart the greatest distance and supplying current to the tube, the starting voltage of said transformer being insufficient to start the tube, and auxiliary transformer means permanently in circuit with the tube and furnishing sufficient voltage across adjacent electrodes to start the tube, the starting current being at low value.

5. In an electric circuit, the combination of a luminous tube intended for operation with currents of high value, said tube containing a rarefied gas and being provided with electrodes at its ends and an electrode between its ends, a transformer connected to said end electrodes to supply current to the tube, the starting voltage of said transformer being insufficient to start the tube, and auxiliary transformer means permanently in circuit with the tube and furnishing sufficient voltage across said middle electrode and said end electrodes to start the tube.

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