June 13, 1939. G. ZECHER 2,162,597

PARALLEL CONNECTED GAS FILLED DISCHARGE TUBE

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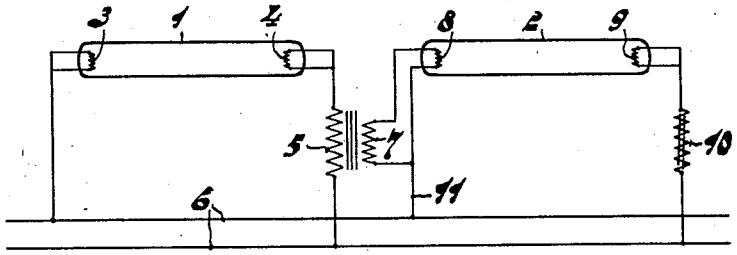



Fig. 1.

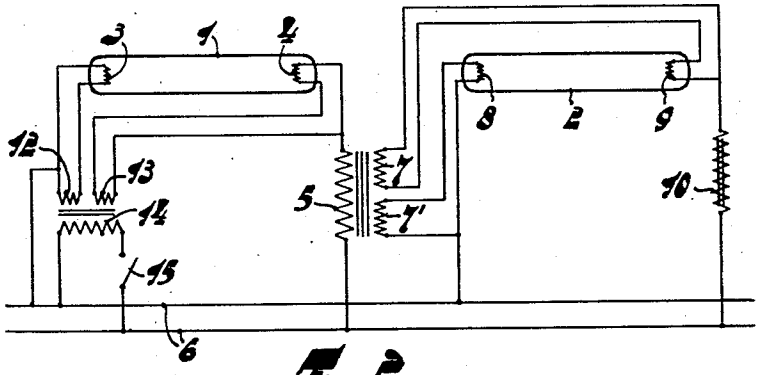



Fig. 2.

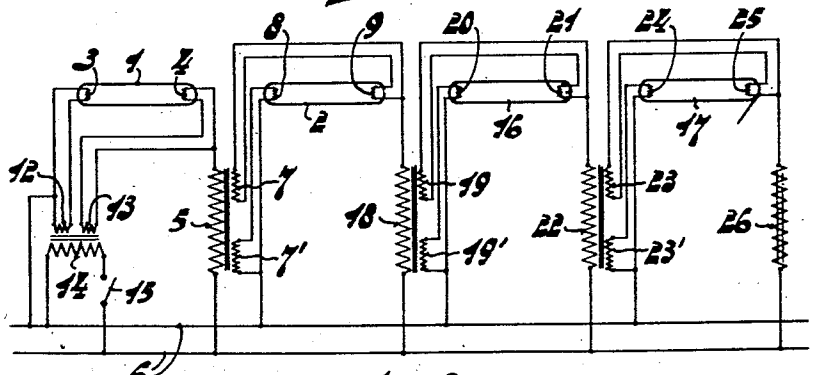



Fig. 3.

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Fig. 4

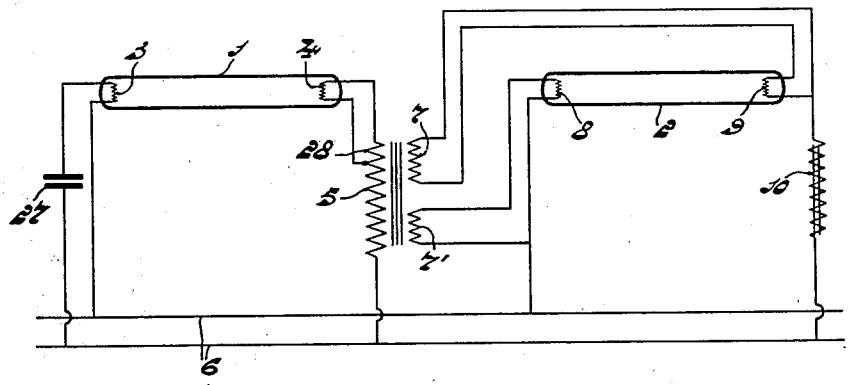
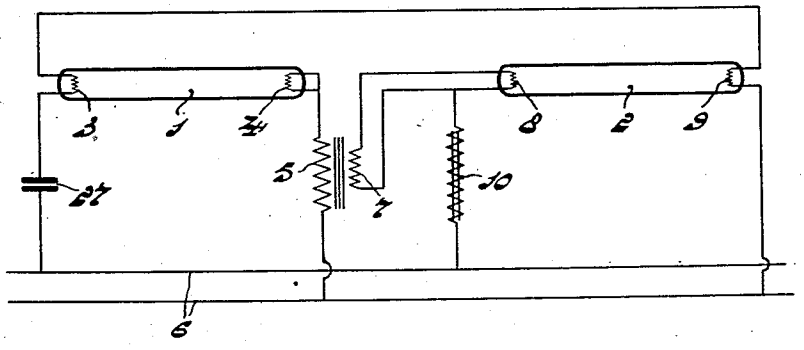



Fig. 5




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# UNITED STATES PATENT OFFICE

2,162,597

## PARALLEL CONNECTED GAS FILLED DISCHARGE TUBE

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Application February 15, 1938, Serial No. 190,628
In Germany March 30, 1937

6 Claims. (Cl. 176—124)

It is known to equip a gas-filled discharge tube, i. e. in the case under consideration not only a tube filled with one or more gases, but also tubes having a vapour-filling or a gas-and-vapour-filling, with incandescent electrodes and to connect these to a secondary winding of a transformer, whose primary winding is connected in series with the tube itself. The last-mentioned winding serves as a stabilization impedance for the discharge tube and constitutes at the same time the primary winding of the transformer supplying the heating current for the incandescent electrodes. In this known device the primary transformer winding, upon ignition of the tube, but when no discharge occurs as yet in the tube, is not traversed by current and consequently no voltage is produced on the secondary side and no heating current is supplied to the incandescent electrodes. In this case the ignition of the discharge occurs between initially cold electrodes. It is known that in this case the voltage necessary for the ignition is higher than when the incandescent electrodes are heated to a high temperature already before ignition of the tube. This means that with a definite available feed voltage only a tube of little length can be ignited by this voltage.

Therefore it has been proposed to short-circuit the discharge path upon ignition, so that the primary transformer winding is traversed by current also without a current traversing the discharge tube and consequently the electrodes are supplied with heating current. For this short-circuit of the discharge tube a switch is required which must be closed and opened either automatically or manually. This involves a complication of the device and of its operation, especially when the device comprises more than one tube, since in this case each tube is furnished with a short-circuit switch.

The present invention relates to a device comprising at least two parallel-connected gas-filled discharge tubes, of which at least one has an incandescent electrode heated by a heating current, and has for its purpose to effect the heating of the electrode(s) before ignition of the discharge in another advantageous manner, thus avoiding the drawbacks referred to above.

According to the invention either the incandescent electrode of a tube to be heated by a heating current or the heating element of this incandescent electrode is connected to the secondary winding of a transformer, whose primary winding is connected in series with another discharge tube. When the last-mentioned tube has been ignited a current is induced in the secondary winding of this transformer, which current heats the incandescent electrode of the first-mentioned tube to a high temperature before ignition of this tube and consequently promotes the ignition of this tube, without this tube needing to be provided with a switch short-circuiting the discharge path.

When the device comprises more than two discharge tubes the electrodes of all tubes but one to be heated by a heating current may be connected to secondary windings of a transformer, whose primary winding is connected in series with the remaining tube. As an alternative a plurality of transformers may be used, whose primary windings are connected in series quently the ignition of the remaining tubes. The ignition of the last-mentioned tube then effects the heating of the electrodes and consequently the ignition of the remaining tubes.

Preferably, however, only one tube is coupled with the discharge tube igniting first, and the incandescent electrode of the $n^{th}$ tube to be heated by heating current or the heating element of this incandescent electrode is connected to the secondary winding of the transformer, whose primary winding is connected in series with the $(n-1)^{th}$ tube. After the first tube of this device has been ignited, the incandescent electrode of the second tube is heated, so that this tube can ignite; this is followed by heating the incandescent electrode and ignition of the third tube, which is repeated until all of the tubes have been ignited.

When the discharge tubes are furnished with more than one incandescent electrode, it is generally desirable to connect all of the incandescent electrodes to the secondary transformer windings. In many cases it will be sufficient, however, to heat only one of the incandescent electrodes of each tube by a separate heating current. In this case the other incandescent electrodes may be heated to a high temperature by the discharge.

Of course, it is also possible to design the electrodes to be heated by a separate heating current as indirectly heated electrodes and to connect the heating elements of these electrodes to the secondary transformer windings, so that the heating currents traverse these heating elements.

The discharge tubes of the device according to the invention may all be of the same kind. However, this is not always necessary; the invention may also be used in a device comprising discharge tubes of different kinds, for instance in installations for the emission of mixed light, which are

equipped with discharge tubes emitting light of different colour. It is known, for instance, to mix the light of mercury vapour discharge tubes with the light of discharge tubes filled only with neon. In such devices the tubes are usually mounted in one holder. These installations are extremely suitable for using the invention, the more so since in such devices the discharge tubes are brought closely together. It is particularly advantageous when at least one of the discharge tubes, that are connected in series with a primary transformer winding, is a high-pressure metal-vapour discharge tube. In fact, such a tube has shortly after ignition a stronger discharge current than during normal operation. This stronger current which traverses also the primary transformer winding induces in the secondary winding an amplified heating current for the electrode of the following tube still to be ignited. It is just in this phase that strong heating of this electrode is very suitable since this promotes the ignition. After the ignition the electrode is partly heated also by the discharge, so that during normal operation the heating current can be reduced, which occurs automatically when the preceding discharge tube has a high-pressure metal-vapour discharge.

In the circuit arrangement referred to care is to be taken that the first tube ignites without any difficulties, since the ignition of the other tubes depends thereon. Reliable ignition may be assured in a known manner. This tube may be equipped with incandescent electrodes that are heated only by the discharge. To ensure a satisfactory ignition at the available voltage, provided all tubes are of the same kind, the length of the tube to be ignited first may be smaller than the length of the tubes having incandescent electrodes heated by a separate heating current. The incandescent electrodes of the first tube may also be connected to a heating current transformer which remains switched on during normal operation. This heating current transformer may also be cut out after ignition, the incandescent electrodes then being further heated by the discharge only.

A particular advantageous method known per se of facilitating the ignition of the first tube consists in providing this tube with an incandescent electrode which is connected itself or whose heating element is connected to the supply with the interposition of a condenser. In this case the current traversing the condenser heats the incandescent electrode, whereby the ignition of the tube is facilitated, and in addition compensates entirely or partly for the lagging of the discharge current.

The condenser may advantageously be given such a value that the electrode-heating current traversing the condenser is stronger than the current necessary for compensating for the lagging of the current of the first discharge tube, so that the lagging of the current of the following tube(s) is also entirely or partly offset. This increased heating current is often of great advantage in proportioning the incandescent electrode to be heated by this current.

The increased heating current may be used not only for heating an incandescent electrode of the tube to be ignited first, but also for heating an incandescent electrode of one or more following tubes, for which purpose the last-mentioned incandescent electrode or the heating element of this incandescent electrode is interposed in the circuit constituted by the condenser and the incandescent electrode (or its heating element) of the tube to be ignited first.

One advantage of the device according to the invention is that the incandescent electrodes, which are fed from a transformer whose primary winding is connected in series with a preceding tube, can be heated to a high temperature, without a voltage loss occurring in the stabilization impedance of the tube to be ignited, so that the full feed voltage is available upon ignition.

The invention will be more clearly understood by reference to the accompanying drawings.

Figs. 1 to 5 represent diagrammatically five forms of construction of the invention.

In Fig. 1, 1 and 2 are two discharge tubes designed for the emission of light rays and furnished with a gas filling consisting, for instance, of neon having a pressure of a few millimeters. The tubes may also contain metal vapour such as mercury vapour. The discharge tube 1 comprises two incandescent electrodes 3 and 4 which may be provided with substances having a high electron-emitting capacity and are heated only by the discharge. The tube 1 is connected to the source of alternating current 6 with the interposition of the primary transformer winding 5 which source may, for instance, have a value of 220 volts. The winding 5 constitutes the stabilization impedance of the discharge tube 1. The winding 5 has coupled to it the secondary winding 7 to which is connected the incandescent electrode 8 of the discharge tube 2. The incandescent electrode 9 of this tube is not heated by a separate heating current, but only by the discharge and is connected through the choke coil 10 to one terminal of the source of alternating current 6. The other terminal of this source of alternating current is connected through the lead 11 to the incandescent electrode 8.

The discharge tube 1 has such a length that this tube ignites without previously heating the electrodes 3 and 4 to a high temperature. After igniting the tube 1 the winding 5 is traversed by a current inducing in the secondary winding 7 the heating current for the incandescent electrode 8, whereby the latter is heated to a high temperature. This facilitates the ignition of the discharge tube 2 which consequently occurs after igniting the tube 1. The ignition of the tube 1 may be further facilitated by providing an earthed auxiliary electrode on the exterior of the wall of the tube.

When the tube 1 is a high-pressure metal-vapour discharge tube such as a high-pressure mercury vapour lamp the winding 5, shortly after ignition of the tube 1, is traversed by a materially stronger current than when the discharge in the tube 1 has attained its final state. This stronger current causes an initially increased heating current of the electrode 8 which is highly beneficious to the ignition of the tube 2, for instance, a neon tube. The tubes 1 and 2 may be mounted in a mix-light fitting.

The device shown in Fig. 2 is different from that represented in Fig. 1 in that the incandescent electrodes 3 and 4 of the discharge tube 1 are heated by a separate heating current to which end these electrodes are connected to the secondary windings 12 and 13 of a heating current transformer, whose primary winding 14 is connected to the source of alternating current 6 with the interposition of a switch 15. The transformer winding 5 is furthermore coupled to two secondary windings, viz. the windings 7 and 7' which supply the heating current for the incan-

descent electrodes 8 and 8 so that in this case the two electrodes can be heated to a high temperature before igniting the tube 2.

Upon operating this device the switch 15 is closed due to which the incandescent electrodes 3 and 4 are heated. After igniting the tube 1 the transformer windings 7 and 7' are energised and the incandescent electrodes 8 and 9 are heated whereupon the tube 2 is also ignited.

The device shown in Fig. 3 comprises four tubes 1, 2, 16 and 17. In this case the stabilization impedance of the discharge tube 2 is also constituted by a primary transformer winding 18 whose secondary windings 19 and 19' heat the incandescent electrodes 21 and 20 of the discharge tube 16. Similarly the stabilization impedance 22 of the tube 16 constitutes the primary winding of a transformer having secondary windings 23 and 23' which supply the heating current for the electrodes 25 and 24 of the tube 17. The stabilization impedance of this tube is designated by 26.

In the device shown in Fig. 3 the electrodes of the tube 2, after the tube 1 has been ignited, are heated to a high temperature after which the tube 2 is ignited. Thereupon ignition of the tube 16 is effected by energizing the windings 19 and 19'. After this tube has been ignited the tube 17 is ignited in a similar manner.

If desired, a current branch may be connected in parallel with each discharge path of the tubes 1, 2 and 16, this branch including an element which does not allow the passage of current or lets through only a very weak current in the normal state, but becomes conductive with some time-lag when the corresponding discharge tube does not ignite, which may be the case when this tube is defective. Thus it is avoided that if one of the tubes breaks down the following tubes cannot ignite either. Of course, the said current branch must conserve a sufficient resistance to keep the current intensity below the admissible maximum value.

In the device shown in Fig. 4 the incandescent electrode 3 of the tube 1 is connected to the supply 6 with the interposition of the condenser 27, so that this electrode 3 is heated by the current traversing the circuit thus formed. In addition the condenser 27 effects complete or partial compensation of the current-lag caused by the inductive stabilization impedance 5. The condenser 27 itself may be so proportioned that also the lagging caused by the inductance 10 of the tube 2 is entirely or partly offset.

The incandescent electrode 4 of the discharge tube 1 is connected to the portion 28 of the winding 5 so that after the discharge tube has been ignited heating current may be supplied also to the incandescent electrode 4.

In the device shown in Fig. 5 the current let through by the condenser 27 traverses not only the incandescent electrode 3 of the tube 1 but also the incandescent electrode 9 connected in series with the electrode 3 and the condenser 27. Due to this the electrode 9 of the tube 2 is also heated by the current compensating for the lag.

In this device the stabilization impedance 10 of the tube 2 is connected not between the electrode 9 and the supply, but between the electrode 8 and this supply.

What I claim is:

1. A device comprising at least two parallel-connected gas-filled discharge tubes, of which at least one tube is equipped with at least one incandescent electrode heated by a heating current, wherein this incandescent electrode of one tube or the heating element of this electrode is connected to the secondary winding of a transformer, whose primary winding is connected in series with the other discharge tube.

2. In combination, a plurality of electric discharge tubes each having spaced electrodes therein, means for supplying discharge current to each of said tubes, a transformer having its primary in series with one of said tubes and its secondary connected to supply heating current to one of the electrodes of another of said tubes.

3. In combination, a plurality of electric discharge tubes each having spaced electrodes therein, means for supplying discharge current to each of said tubes, a transformer having a primary winding in series with one of said tubes and having a plurality of secondary windings each arranged to supply heating current to one of the electrodes of another of said tubes.

4. In combination, a plurality of electric discharge tubes each having spaced electrodes therein, means for supplying discharge current to each of said tubes, a transformer having a primary connected with said supply means and having a secondary connected to supply heating current to an electrode of one of said tubes, a transformer having a primary in series with said tube and having a secondary connected to supply heating current to an electrode of another of said tubes and ballasting means in circuit with said other tube.

5. In combination, a plurality of electric discharge tubes each having spaced electrodes therein, means for supplying discharge current to each of said tubes, a transformer having a primary in series with one of said tubes and having a plurality of secondaries, one of said secondaries being connected to supply heating current to an electrode of said one tube and another of said secondaries being connected to supply heating current to an electrode of another of said tubes.

6. In combination, a plurality of electric discharge tubes each having spaced electrodes therein, a source of current supply, means for supplying discharge current therefrom to each of said tubes, means connecting an electrode of one of said tubes in series with an electrode of another of said tubes whereby the same heating current is supplied to both of said electrodes, a transformer having a primary in series with one of said tubes and a secondary connected to supply heating current to another of the electrodes of said other tube.

GUSTAV ZECHER.

# CERTIFICATE OF CORRECTION.

Patent No. 2,162,597. June 13, 1939.

GUSTAV ZECHER.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, second column, line 17, for the syllable and words "quently the ignition of the remaining tubes" read with each other and with this remaining tube; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of August, A. D. 1939.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.