

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN OR RELATING TO GAS DISCHARGE FLASH-TUBE CIRCUITS

(71) We, HEIMANN GMBH, a German Company, of 6200 Wiesbaden-Dotzheim, German Federal Republic, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to gas discharge flash-tube circuits of the type in which two main electrodes of one flash-tube are connected in parallel with a chargeable flash capacitor via a gas discharge tube to which a voltage generator supplies ignition voltage pulses.

Gas discharge flash-tubes serve to produce short, intensive flashes of light. For this purpose the electric energy stored in a capacitor (flash capacitor) is converted into light by igniting the gas discharge in high current arc operation. The ignition is effected by a high voltage pulse which is fed to the discharge path, normally via an ignition electrode which is provided for the flash-tube in addition to its two main electrodes, generally in the form of a conductor on the outside of the flash-tube envelope. However, as an ignition electrode necessitates a high technical outlay and can involve safety problems (danger of electric shock on contact), it is becoming increasingly desirable to feed the high-voltage pulse which is to lead to the ignition of a gas discharge directly to the two main electrodes of the flash-tube.

Gas discharge flash-lamps without an ignition electrode can be ignited in controllable fashion by connecting the flash tube in series with the flash capacitor and the ignition voltage pulse generator. Then the discharge current which produces the flash of light flows across the ignition voltage pulse generator which imposes a correspondingly high load on the latter. Generally the ignition voltage pulse generator is

in the form of a transformer, whose secondary winding in the discharge circuit must not only be made substantial enough to withstand the load of the discharge current, but undesirably lengthens the discharge process on account of its inductance.

The aforementioned difficulties can be avoided if a secondary winding of the ignition transformer is connected in parallel to the flash-tube, as described for example in the German Patent Specification No. 1,638,977, in which one or more diodes in a discharge circuit prevent a short-circuiting of the ignition voltage pulse via the flash capacitor. Although such a circuit has the advantage that the duration of the discharge process, and thus the flash duration, is fundamentally determined only by the internal resistance of the flash-tube and the capacitance of the flash capacitor, it is disadvantageous that only one half-cycle of the ignition voltage pulse can be active across the flash-tube. Also the requirements imposed on the electric properties of the diodes that are arranged in the discharge circuit in series to the flash capacitor are very high, as these diodes must be designed to stand high voltages in the blocking direction and pass high currents in the forward direction.

One object of the present invention is to provide a construction of a circuit for igniting flash-tubes which do not necessarily possess ignition electrodes, and which avoids the above-described disadvantages.

The invention consists in a gas discharge flash-tube circuit for igniting at least one flash-tube having two main electrodes, which tube is connected in parallel to a chargeable flash capacitor via a further gas discharge tube and the junction of the associated electrodes of said tubes is connected to a voltage generator output which supplies ignition voltage pulses.

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An essential advantage of the invention consists in that in spite of the fact that a flash-tube is ignited only via its main electrodes, it is solely the flash capacitor and the gas discharge paths which form the discharge circuit. The additional gas discharge path assumes the function of separating the ignition voltage pulse generator from the flash capacitor. This avoids the need for use of high-grade diodes, which block only in one direction, in the discharge circuit.

A circuit constructed in accordance with the invention is of particular advantage when a plurality of flash tubes are to be operated in series, since then the additional gas discharge path itself can be a simple flash-tube. Alternatively, the additional gas discharge path can be in the form of a gas discharge vessel of arbitrary shape and gas filling with two main electrodes and an ignition electrode, although preferably the high voltage across the ignition electrode should not represent any danger, e.g. it should be contained inside the power-supply unit of the embodiment.

The invention is particularly suitable to ignite at least two flash-tubes which possess only main electrodes, irrespectively of whether another gas discharge path with or without ignition electrode is being used. Here the flash-tubes are connected in series, and the main or each adjacent pair of electrodes which are directly connected to one another are connected to the output of the voltage generator which supplies the ignition voltage pulses. If the voltage generator is of known construction using an ignition transformer, the connection of a flash tube main electrode that is not directly connected to the flash capacitor to the secondary winding of the ignition transformer is blocked off by capacitors or rectifiers in order to avoid a discharge current flowing across the secondary winding of the ignition transformer.

The invention will now be described with reference to the drawings, in which:—

Figure 1 schematically illustrates one exemplary embodiment of a circuit arrangement constructed in accordance with the invention, for igniting two series-connected gas discharge vessels;

Figure 2 schematically illustrates an alternative exemplary embodiment of a circuit arrangement constructed in accordance with the invention, in which one of the gas discharge vessels possesses an ignition electrode;

Figure 3 schematically illustrates one further exemplary embodiment of a circuit arrangement constructed in accordance with the invention for igniting three series-connected gas discharge vessels; and

Figures 4 and 5 schematically illustrate

alternative exemplary embodiments of the invention for use with four gas discharge vessels in each case.

In Figure 1, as in the other Figures, a d.c. voltage source 1 is connected to charge a flash capacitor 2 to a specific voltage. In parallel to the d.c. source 1 and the flash capacitor 2 there is connected two series-connected gas discharge vessels 3 and 4, of which at least the gas discharge vessel 4 is a flash tube. In known manner, a signal generator 5 which produces a high voltage pulse in a secondary winding 7 of an ignition transformer 6 is connected to apply a high voltage pulse via a chain of diodes 8 to a junction point 9 of those two main electrodes of the discharge vessels 3 and 4 which are directly connected together. This high voltage pulse cannot be short-circuited via the flash capacitor 2, since the junction point 9 is separated from the flash capacitor 2 by the gas discharge vessels 3 and 4, but the pulse ignites the gas discharge vessels 3 and 4, which thereupon discharge the capacitor 2. The diodes 8 serve to protect the secondary winding 7 of the ignition transformer 6 from the voltage occurring at the point 9 during the discharge process. As shown by way of example in Figures 2 and 3, a capacitor 15 can assume the same function as a cascade of diodes 8.

Figure 2 represents a circuit arrangement which is to a large extent similar to Figure 1, with the difference, however, that the gas discharge vessel 3 is replaced by a gas discharge vessel 10 which possesses an ignition electrode 11 in addition to two main electrodes. Also the gas discharge vessel 10 is designed in such manner that the high voltage pulse produced by the ignition transformer 6 is not adequate to ignite this discharge vessel, which requires an ignition pulse produced by another ignition transformer 12 and conducted to the ignition electrode 11. As soon as the discharge vessel 10 has been ignited in this way, the resistance on the outer discharge path drops and now allows the capacitor 2 to discharge across the discharge vessel 10 and also via the flash tube 4. It is thus possible to operate a flash tube without an ignition electrode at an exposed point, since the discharge vessel 10 can be accommodated at a non-critical point within a power-supply unit, where the high voltage occurring at the ignition electrode 11 does not represent a danger.

In the exemplary embodiment shown in Figure 3, three gas discharge vessels, 3, 4 and 13, are connected in a series chain that lies in parallel to a flash capacitor 2 which is charged by a d.c. voltage source 1. An ignition transformer 6 contains secondary windings which are contrived to

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be such that not only does a high voltage pulse capable of igniting the discharge vessels 3 and 4 appear at the junction point 9, but also a high voltage pulse to ignite the discharge vessel 13 appears at a junction point 14. After the ignition of all three gas discharge vessels, the flash capacitor 2 is again discharged, in which case the capacitors 15 block the two secondary windings of the ignition transformer 6 from voltage during the discharge process.

The principle can be extended to a cascade of identical or differing gas discharge vessels, all connected in a series chain in parallel to a flash capacitor. This principle is illustrated in Figures 4 and 5. As hitherto, a flash capacitor 2 is charged from a d.c. voltage source 1. In addition to the three gas discharge vessels 3, 4 and 13, the series chain contains a further series-connected gas discharge vessel 16, which is representative of a larger number of gas discharge vessels. High voltage pulse-generators 17, 18 and 19 are controlled by a signal generator 5 to be connected by their outputs either individually (Figure 4) or in a series chain (Figure 5) to those main electrodes which are not directly connected to the flash capacitor 2, but are mutually coupled whatever the number of adjacent gas discharge vessels. The high voltage pulses conducted in this way to the gas discharge vessels 3, 4, 13 and 16 produce conductive plasma channels in the individual gas discharge vessels whose conductivity is so low that the voltage initially prevailing across the flash capacitor 2 is sufficient to supply adequate energy for the continued expansion of the plasma channels until the resistance of the overall discharge path is sufficiently low to discharge the flash capacitor 2. No short-circuit of the ignition pulses can occur, because on the one hand the time required to form the plasma channels and the associated reduction in the conductivity of the individual gas discharge vessels amounts to a few hundred μ sec, and on the other hand the times of the breakthrough of the individual gas discharge vessels follow one another with sufficient rapidity not to interrupt the discharge.

The invention is not limited to the illustrated exemplary embodiments. In particular the ignition voltage pulse does not require to emanate from an ignition transformer but could also be produced by

means of electronic components, for example a piezo-electric crystal. It is not necessary for the gas discharge vessels to be identical to one another, provided they fulfill the conditions governing the ignition of the overall discharge path. In embodiments of the type of circuits shown in Figures 4 and 5, one or more of the gas discharge vessels can be replaced by a respective tube having an ignition electrode, in a similar arrangement to that shown in Figure 2.

WHAT WE CLAIM IS:—

1. A gas discharge flash-tube circuit for igniting at least one flash-tube having two main electrodes, which tube is connected in parallel to a chargeable flash capacitor via a further gas discharge tube and the junction of the associated electrodes of said tubes is connected to a voltage generator output which supplies ignition voltage pulses.
2. A circuit as claimed in Claim 1, in which said further gas discharge tube is a flash-tube.
3. A circuit arrangement as claimed in Claim 1, in which said further gas discharge tube has two main electrodes and an ignition electrode which is connected to a separate output of said voltage generator.
4. A circuit arrangement as claimed in Claim 2 or Claim 3, in which at least two flash-tubes each possessing only two main electrodes are connected in series with said further gas discharge tube, and the main electrodes of the or each adjacent pair of flash tubes, which are directly connected to one another, are respectively connected to a respective output of an associated voltage generator which supplies ignition voltage pulses.
5. A circuit arrangement as claimed in any preceding Claim, in which said voltage generator contains an ignition transformer having a secondary winding that is connected to a said main electrode not directly connected to the flash capacitor, the connection being effected via a path containing blocking capacitors or rectifiers.
6. A gas discharge flash tube circuit substantially as described with reference to any one of Figures 1 to 5.

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