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FLASHTUBE TRIGGERING CIRCUIT

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Fig. 1.

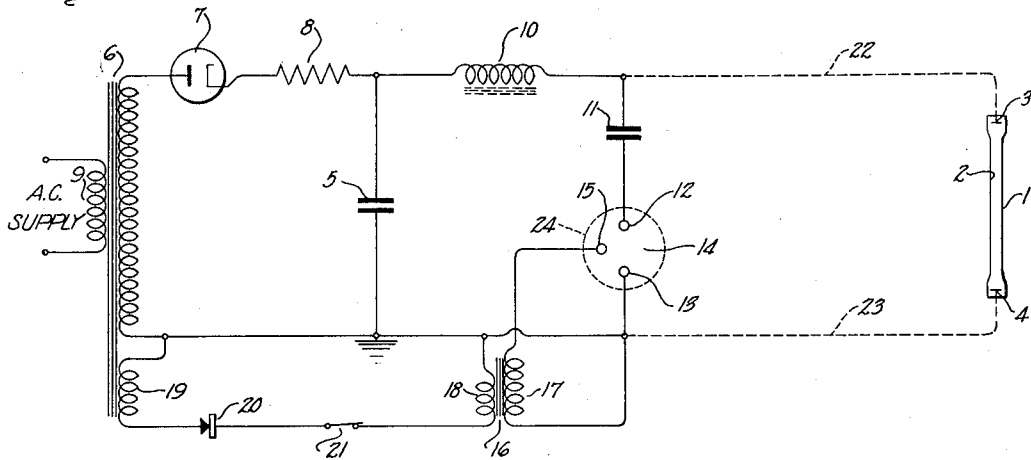
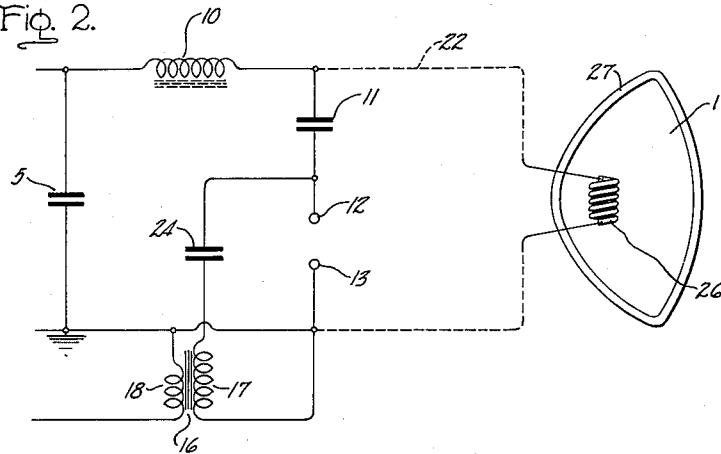


Fig. 2.



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FLASHTUBE TRIGGERING CIRCUIT

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This invention relates generally to arrangements for operating an electric discharge lamp so as to produce intense flashes of light of short duration, as commonly utilized in photography. It relates more particularly to a circuit of the type comprising a capacitor arranged to be charged from a suitable source and to be rapidly discharged through the lamp, thereby producing the desired flash of light.

The lamps employed in such arrangements usually have a striking voltage higher than that to which the capacitor is charged, and it is, accordingly, necessary to provide triggering means for initiating the lamp discharge in order to produce the flash. The common practice hitherto has been to provide the triggering means in the form of apparatus for generating a voltage pulse having a steep wave-front, and to apply the pulse to an auxiliary starting electrode associated with the lamp. This arrangement, however is not always convenient: for example, the lamp may be so small that the provision of an auxiliary starting electrode is difficult or uneconomical; or the lamp may have to be located at a considerable distance from the rest of the equipment, in which case, the starting pulse is liable to be considerably attenuated in the connecting leads by virtue of interlead capacity; or it may be desired to flash a plurality of lamps by means of the same pulse and to reduce to a minimum the number of leads connecting the lamps to the equipment.

Accordingly, it is an object of this invention to provide a new and simplified arrangement for flashing a discharge lamp which eliminates the necessity for an auxiliary starting electrode associated with the lamp.

Another object of my invention is to provide a new and improved oscillatory starting circuit for ionizing a gaseous column within a lamp in order to permit an associated capacitor to discharge through the lamp and produce an intense flash of light, said apparatus requiring only two connections between the lamp and the operating equipment.

For further objects and advantages and for a better understanding of the invention, attention is now directed to the following description and accompanying drawings. The features of the invention believed to be novel will be more particularly pointed out in the appended claims.

In the drawings:

Fig. 1 is a schematic diagram of a starting and flashing circuit embodying my invention and shown connected to a discharge lamp.

Fig. 2 is a schematic diagram of part of a similar circuit comprising certain modifications over that of Fig. 1, and wherein similar reference numerals refer to corresponding elements.

According to the invention, the arrangement for operating an electric discharge device or flashtube so as to produce intense flashes of light of short duration, comprises a main energy storage capacitor and means for charging it to a suitable potential. The lamp or flashtube is connected across the capacitor in series with an inductance, while an auxiliary capacitance of relatively

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small value is connected, in series with a spark gap, across the lamp. External means are provided for initiating a spark across the gap. When such occurs, the small capacitor is suddenly discharged across the gap, and a damped oscillation is set up whose frequency is quite high and is determined mainly by the constants of the inductance and auxiliary capacitance. The high frequency oscillation ionizes the lamp, whereupon the main capacitor discharges therethrough and produces the flash. It might be pointed out that the essential operation of the circuit is to draw off a small portion of the charge in the main energy storage capacitor, and utilize it to set up a high frequency oscillation which produces a high voltage across the auxiliary capacitance and ionizes the lamp; the remainder of the charge in the main capacitor is then consumed in flashing the lamp.

Referring to Fig. 1 wherein one such arrangement embodying my invention is illustrated, the discharge device or flash lamp 1 comprises an elongated glass envelope 2 having a pair of electrodes 3 and 4 sealed into opposite ends thereof. The envelope 2 contains an ionizable gas such as xenon but other gases may be used for special purposes, including, for example, argon, hydrogen, neon and krypton, or mixtures of gases and metallic vapors may likewise be employed.

The main energy storage capacitor 5 is charged by means of a circuit comprising a high voltage transformer 6, a rectifying tube 7, and a current limiting resistor 8. The primary winding 9 of transformer 6 is adapted to be connected to an alternating current supply such as the usual commercial 115 volt, 60 cycle mains. Capacitor 5 may, for instance, have a value of 1 microfarad and is charged by the circuit to a potential of 2000 volts. Resistor 8 serves to protect the rectifying tube and also prevents too frequent flashing of the lamp which might cause it to overheat and be destroyed.

The oscillatory circuit which is utilized to ionize lamp 1 initially, comprises an inductance 10 and a capacitor 11 of relatively small value. Inductance 10 is connected in series with lamp 1 across the main energy storage capacitor 5. Capacitor 11 is connected in series with electrodes 12 and 13 of spark gap 14, to constitute a shunt path which is connected in parallel with lamp 1. In a particular construction of the circuit, I have utilized a value of 150 microhenrys for inductance 10, and 1000 micromicrofarads for capacitance 11. It will thus be seen that inductance 10 is so small as not to prolong unduly the duration of the main capacitor discharge through the lamp. Moreover, the resonant capacitor 11 is small in comparison with the main energy storage capacitor, so that the resonant frequency of the resulting circuit is high, for example, 1 megacycle per second.

In order to shock-excite the resonant circuit, I have shown in Fig. 1 a third spark electrode 15 which is arranged to be in proximity to both electrodes 12 and 13 of gap 14. The spark across the main electrodes 12 and 13 may then be initiated by means of a spark between electrodes 15 and 13 which lowers the breakdown potential of the atmosphere in the main gap.

The triggering spark between terminals 15 and 13 may be obtained in a variety of ways; for instance, a spark coil similar to that utilized in automobile ignition systems is suitable for the purpose. Thus I have shown a pulse transformer 16 comprising a secondary 17 connected across electrodes 15 and 13, and a primary 18 which is energized by means of a secondary winding 19 on transformer 6 and a rectifier 20 of the copper oxide type. A normally closed switch 21 is included in the circuit and primary winding 18 is normally energized by means of direct current. When switch 21 is opened, the rupture of the magnetic field in transformer 16 produces a high voltage pulse in secondary winding 17 in well

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known maner. Instead of the switch, a gas-filled tube may be utilized and provided with control means for sending a pulse of current through the primary. This pulse causes a spark to jump the gap between the electrodes 15 and 13, whereupon the atmosphere in the vicinity of gap 14 becomes ionized. Auxiliary capacitor 11 then discharges across electrodes 12 and 13. The oscillatory circuit comprising inductance 10 and capacitor 11 is thus shock-excited and the high frequency oscillations are supplied over conductors 22 and 23 to the electrodes of lamp 1 and ionize the gaseous column therein. The main energy storage capacitor 5 then discharges through lamp 1 and produces the flash of light.

If desired, electrodes 12, 13, and 15 may be contained within a partially evacuated glass envelope, as indicated in dotted outline at 24, the whole constituting a device commonly known as a gap tube. Such a construction permits the use of a standardized component having constant breakdown potentials, and which may be replaced readily whenever necessary.

In an actual construction of this circuit utilizing the constants given heretofore, and with the main capacitor 5 charged to 2000 volts, I have found the arrangement suitable for flashing a discharge lamp having a striking voltage, between its main electrodes, of 2500 to 3500 volts. These results were obtained even when the length of the conductors 22 and 23 between the input terminals at inductance 10 and capacitor 5, and the output terminals at the lamp electrodes is as much as 15 feet, and the conductors are constituted by cable having a capacitance of 20 micromicrofarads per foot.

Referring to Fig. 2, I have illustrated therein a modified version of my invention in which the high voltage pulse generated in the secondary winding 17 of transformer 16 is coupled directly across electrodes 12 and 13 of spark gap 14 by means of a small capacitor 25. The operation of the circuit is in other respects similar to that of Fig. 1. In order to illustrate the application of the circuit to photography, I have illustrated lamp 1 in the form of a coiled helix 26 contained within a reflecting container 27.

While certain specific embodiments have been shown and described, it will of course be understood that various modifications may be made without departing from the invention. It will, moreover, be understood that the circuit may be applied to flashing other types of lamps than the ones which have been specifically illustrated. The appended claims are, therefore, intended to cover any such modifications coming within the true spirit and scope of the invention.

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

1. Apparatus for producing a flash discharge, comprising an electric discharge device having a pair of opposed electrodes, a main energy storage capacitor, means for charging said capacitor to a potential less than that required to start a discharge within said device, a main discharge circuit comprising an inductance and said device connected in series across said main capacitor, said inductance being small enough to cause only an unsubstantial retardation in the discharge of said main capacitor through said device, a spark gap, an auxiliary capacitor connected, in series with said gap, across said device, said auxiliary capacitor having a small value relative to said main capacitor and being proportioned to resonate with said inductance at a high frequency, and means for initiating a spark across said gap in order to shock-excite the circuit comprising said inductance and said auxiliary capacitor into oscillation for ionizing said device.

2. Apparatus for producing a flash discharge, comprising an electric discharge device having a pair of opposed electrodes, a main energy storage capacitor, means for charging said capacitor to a potential less than that required to start a discharge within said device, a main discharge circuit comprising an inductance and said de-

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vice connected in series across said main capacitor, said inductance being small enough to cause only an unsubstantial retardation in the discharge of said main capacitor through said device, a spark gap, an auxiliary capacitor connected, in series with said gap, across said device, said auxiliary capacitor having a small value relative to said main capacitor, and means for initiating a spark across said gap in order to discharge a portion of the energy, stored within said main capacitor, through said auxiliary capacitor and gap, thereby shock-exciting into a damped oscillation the circuit comprising said inductance and said auxiliary capacitor, said inductance and auxiliary capacitor being proportioned to produce a high voltage high frequency oscillation across said auxiliary capacitor which ionizes said device, whereupon the remainder of the energy stored within said main capacitor discharges through said device and produces said flash.

3. Apparatus as in claim 1, wherein the means for initiating a spark across the gap comprise a spark coil having a high voltage secondary capacitively connected across the gap.

4. Apparatus for producing a flash discharge, comprising an electric discharge device having a pair of opposed electrodes, a main energy storage capacitor, means for charging said capacitor to a potential less than that required to start a discharge within said device, a main discharge circuit comprising an inductance and said device connected in series across said main capacitor, said inductance being small enough to cause only an unsubstantial retardation in the discharge of said main capacitor through said device, a pair of main electrodes defining a spark gap and an auxiliary electrode in proximity thereto, an auxiliary capacitor connected in series with the main gap electrodes across said device, said auxiliary capacitor having a small value relative to said main capacitor and being proportioned to resonate with said inductance at a frequency of the order of 1 megacycle, and means for producing a spark between said auxiliary gap electrode and one of said main gap electrodes to initiate the discharge of said auxiliary capacitor across said gap and shock-excite into oscillation the circuit comprising said inductance and said auxiliary capacitor, thereby ionizing said device and causing said main capacitor to discharge therethrough and produce said flash.

5. Apparatus for producing a flash discharge, comprising an electric discharge device having a pair of opposed electrodes, a main energy storage capacitor, means for charging said capacitor to a potential less than that required to start a discharge within said device, a main discharge circuit comprising an inductance and said device connected in series across said main capacitor, said inductance being small enough to cause only an unsubstantial retardation in the discharge of said capacitor through said device, a pair of main electrodes defining a spark gap and an auxiliary electrode in proximity thereto, an auxiliary capacitor connected in series with the main gap electrodes across said device, said auxiliary capacitor having a small value relative to said main capacitor and being proportioned to resonate with said inductance at a frequency of the order of 1 megacycle, and means for initiating a spark across said gap in order to shock-excite into oscillation the circuit comprising said inductance and said secondary capacitor for ionizing said device, said last named means comprising a spark coil having a high voltage secondary connected between said auxiliary electrode and one of said main gap electrodes.

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