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FLASH INTENSIFIER CIRCUIT

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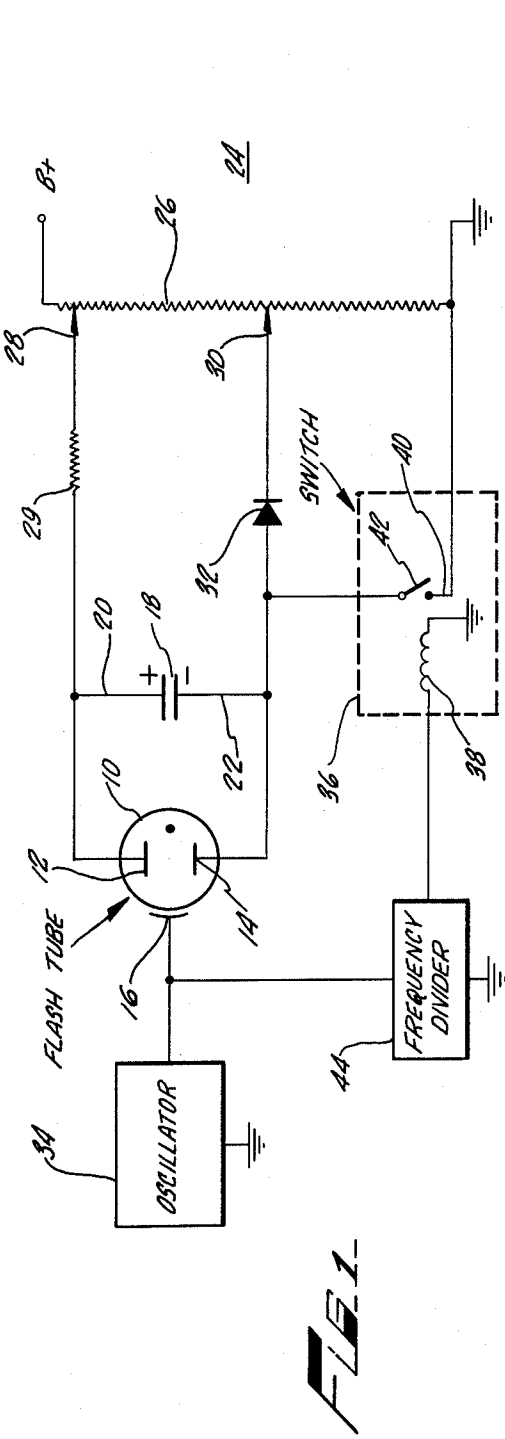


FIG 1

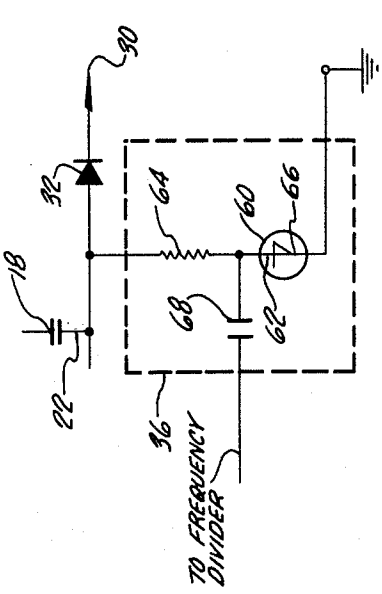


FIG 3

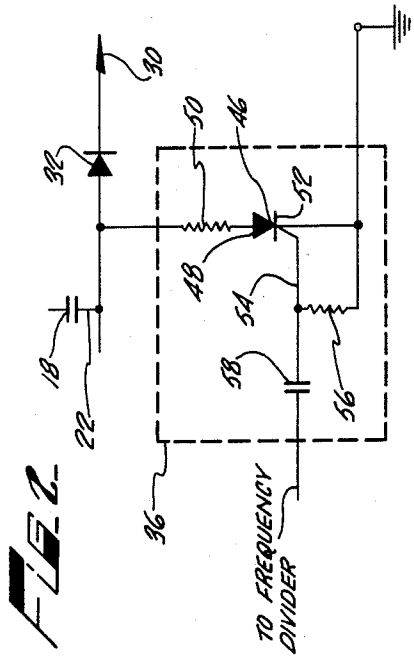


FIG 2

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FLASH INTENSIFIER CIRCUIT

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This invention is directed to an improved flash intensifier circuit which is particularly adapted to use in recording oscillographs.

In recording oscillographs and the like, light sensitive paper is continuously passed beneath a light source arrangement. The light source arrangement is controlled by electrical circuitry to project a beam of light onto the paper. The light, in striking the paper, breaks down an emulsion on the surface of the paper to produce a darkened area on the paper. Changes in electrical signals generated by the circuitry causes the light beam to be moved across the paper to produce a visual trace and hence a permanent record of the variations in the electrical signals.

In developing the record of the variations in the electrical signals it is desirable to provide a timing reference for the trace. To accomplish this, the light source arrangement includes a flasher circuit for periodically projecting a separate beam of light across the paper to produce regularly spaced timing marks on the paper. To further aid in providing a timing reference the flasher circuits generally include means for intensifying particular ones of the timing marks. Such intensification is generally accomplished by a flash intensifier circuit which is incorporated into the flasher. Generally, flash intensifier circuits include means for introducing increased amounts of current flow through a flash tube to provide the flasher circuit with means for periodically producing a beam of light having an intensified brilliance.

To increase the current flow through the flash tube, flash intensifier circuits generally include a thyratron or the like coupled in a series circuit with a capacitor. The series circuit, in turn, shunts the flash tube. The capacitor is charged during a predetermined number of excitations of the flash tube. Then, on a particular excitation, for example, each tenth excitation of the flash tube, the thyratron is fired. Upon a firing of the flash tube the charged series capacitor discharges to pass an increased current through the flash tube, thereby producing a flash of increased brilliance.

Such flash intensifier circuits operate satisfactorily at low repetition rates. However, with developments in the recording oscillograph art it has become desirable to increase the operation rate of oscillographs and hence the rate at which timing marks may be developed on the oscillograph paper. In the flash intensifier circuit, such as described above, to produce a flash of intensified brilliance the thyratron is required to pass a current approximating forty amperes. Since thyratrons are not generally capable of passing such magnitudes of current at frequencies above eight hundred cycles per second (800 c.p.s.) the inclusion of flash intensifier circuits employing thyratrons or the like for coupling a charged capacitor in parallel with a flash tube poses a distinct limitation upon the rate of oscillograph operation. Further, flash intensifier circuits, including thyratrons, or the like, require separate filament supplies which generate unwanted heat within the recording oscillograph. Also, since such flash intensifier circuits rely upon the charge of a capacitor in series with a thyratron or the like to provide an increased current flow through the flash tube the brilliance of flash produced thereby is limited by the size of the series capacitor. Thus, the

prior art type flash intensifier circuit produces intensified light flashes of a substantially fixed brilliance.

In view of the above the present invention comprises an improved flash intensifier circuit for developing intensified flashes of controlled brilliance and which is capable of high frequency operation without generating undesirable amounts of heat.

To accomplish this, the present invention, in a basic form, includes a flash tube which is shunted by a capacitor. The capacitor is normally charged through a series connected diode to a first voltage level. Means coupled to the flash tube periodically excite the flash tube to cause the capacitor to discharge therethrough, producing a flash having a predetermined brilliance. Coupled to a junction of the diode and the charging capacitor is a normally open switching means. Means are coupled to the switching means for charging the capacitor to a second voltage level when the switching means is closed. The second voltage level has a magnitude which is greater than the first voltage level and is preferably controllable to provide means for varying the brilliance of the intensified flashes produced by the present invention. The operation of the switching means is controlled by means responsive to the periodic excitation of the flash tube.

In this manner, the capacitor, when charged to the first voltage level, is periodically discharged through the flash tube to produce a flash having a predetermined brilliance. In response to particular periodic excitations of the flash tube the switching means is closed to charge the charging capacitor to the second voltage level. Hence, on the next excitation of the flash tube the capacitor discharges through the flash tube to produce a flash having an intensified brilliance.

In a preferred form the switching means of the present invention includes a four-layer semi-conductor switching device such as a four-layer transistor diode or a silicon-controlled rectifier. Such semi-conductor switching devices possess the characteristic of having a high impedance state and a low impedance state and may be switched rapidly at high frequencies between the two states in response to electrical pulse signals applied thereto. Thus, in the preferred form of the present invention a pulse source is coupled to the semi-conductor switching device and is responsive to the excitations of the flash tube to periodically switch the switching device from its high impedance state to its low impedance state. In this manner the switching means operates to periodically charge the capacitor to an increased voltage level, thereby allowing an excitation of the flash tube to produce a flash having an intensified brilliance.

The above, as well as other features of the present invention, may be more clearly understood by reference to the following detailed description when considered with the drawings, in which:

FIGURE 1 is a schematic block-diagram representation of a basic form of the flash intensifier circuit of the present invention;

FIGURE 2 is a schematic representation of the switching means of the present invention including a silicon-controlled rectifier; and

FIGURE 3 is a schematic representation of the switching means of the present invention including a four-layer transistor diode.

As represented in FIGURE 1, the flash intensifier circuit of the present invention includes a flash tube **10** such as a xenon flash tube having an anode **12**, a cathode **14** and a control grid arrangement represented at **16**. The flash tube **10** is shunted by a capacitor **18** having terminals **20** and **22**. The terminal **20** is coupled to the anode **12** and the terminal **22** is coupled to the cathode **14**. The terminal **20** is also coupled, through a current limit-

ing resistor 29, to a power supply represented generally at 24. By way of example only, the power supply 24 is illustrated as comprising a voltage divider arrangement having a resistor 26 coupled between B+ and ground potentials. The voltage divider include a pair of movable contact arms 28 and 30. The movable arm 30 is coupled through a diode 32 to the terminal 22 of the capacitor 18 while the arm 28 is coupled to the terminal 20 of the capacitor 18. The diode 32 is poled for series current flow from the source of potential B+ through the capacitor 18 and the diode 32 to ground. In this manner the capacitor 18 is normally charged to a first voltage level which, for example, may approximate 420 volts. Since the contact arms 28 and 30 are movable, however, the magnitude of the first voltage level may be increased or decreased.

As briefly described above, the capacitor 18 is periodically discharged through the flash tube to produce a pulse having a predetermined brilliance. To accomplish this an oscillator represented as 34 is coupled to the control grid arrangement 16 of the flash tube 10. The oscillator 34 generates pulse signals which are applied to the control grid 16 to cause the flash tube 10 to become conductive. The capacitor 18 then discharges through the flash tube 10 to produce a flash having a predetermined brilliance—the brilliance of the flash being a function of the potential to which the capacitor 18 is charged.

To produce an intensified flash in accordance with the present invention, a switching means represented at 36 is coupled to a junction of the capacitor 18 and the diode 32. As illustrated, the switching means 36 in its basic form includes a coil 38, a fixed contact 40, and a movable contact 42. The movable contact 42 is coupled in series with the charging capacitor 18 and the fixed contact 40 is coupled to ground. The coil 38 is coupled to a frequency divider represented at 44 which is in turn coupled to the oscillator 34. By way of example, the frequency divider 44 may be a counter producing a pulse output for each ten pulses developed by the oscillator 34.

Thus, in operation, pulse signals developed by the oscillator 34 are applied to the frequency divider 44. In response to these pulse signals the frequency divider periodically develops a pulse signal which passes through the coil 38 to ground. The pulse signal causes the movable contact 42 to impinge the fixed contact 40 thereby closing the switching means 36. Due to the closing of the switching means 36, the diode 32 is back-biased and the terminal 22 of the capacitor 18 is effectively coupled to ground. The capacitor 18 then charges through the switching means 36 to a second voltage level determined by the voltage between the contact arm 28 and ground and is of a magnitude which is substantially greater than the first voltage level. For example, the second voltage level may approximate 600 volts. Thus, in response to the next pulse signal applied to the control grid 16 of the flash tube 10, the flash tube 10 becomes conductive to allow the capacitor 18 to discharge from the second voltage level through the flash tube and produce a flash having an increased brilliance.

Again, since the contact arms 28 and 30 are movable, the absolute value of the second voltage level, as well as the magnitude relative to the first voltage level, may be varied. In this manner the brilliance of the intensified flash may also be varied.

As briefly mentioned above, the switching means 36 of the present invention is a rapid acting device and may preferably take the form of a four-layer semi-conductor switching element. A preferred embodiment of the switching means 36 employing a silicon-controlled rectifier 46, which may be utilized in the flash intensifier circuit of the present invention, is illustrated in FIGURE 2. As represented, the silicon-controlled rectifier 46 includes an anode 48 which is coupled through a resistor 50 to the terminal 22 of the charging capacitor 18 and an anode 52 which is coupled to ground. The silicon-controlled rectifier 46 further includes a gate electrode 54. The gate electrode 54 is coupled through a resistor 56 to ground and through a capacitor 58 to the frequency divider 44.

The silicon-controlled rectifier is a rapid acting switching device having two stable states, namely, a high impedance state and a low impedance state. The silicon-controlled rectifier 46 is chosen to have a switching characteristic such that it is normally biased to its high impedance state by the voltage between the contact arm 30 and ground and is responsive to pulse signals applied through the capacitor 58 and the gate electrode 54 to switch to its low impedance state. Since the magnitude of the voltage at the arm 30 is substantially greater than ground potential, the silicon-controlled rectifier, in so switching, back-biases the diode 32 and effectively couples the terminal 22 of the capacitor 18 to ground. In this manner the capacitor 18 is allowed to charge to the second voltage level to produce the flash of intensified brilliance.

Another embodiment of the switching means 36, including a four-layer transistor diode 60, is illustrated in FIGURE 3. The four-layer diode 60 includes an anode 62 which is coupled through the resistor 64 to the terminal 22 of charging capacitor 18 and a cathode 66 which is coupled to ground. The anode 60 is also coupled through a capacitor 68 to the frequency divider 44.

The four-layer transistor diode 60 is a rapid acting semi-conductor switching device having two stable states, namely, a high impedance state and a low impedance state. The diode 60 is chosen to have a switching characteristic such that it is normally biased to its high impedance stage by the voltage between the contact arm 30 and ground and is rapidly switched to its low impedance state in response to pulse signals applied through the capacitor 68.

Thus, the capacitor 18 is normally charged to the first voltage level. In response to a pulse signal developed at the frequency divider 44, the four-layer transistor diode 60 rapidly switches to its low impedance state. Since the voltage at the arm 30 is substantially greater than ground potential, the four-layer diode 60, in switching, back-biases the diode 32 and effectively connects the terminal 22 of the capacitor 18 to ground. In this manner the capacitor 18 is allowed to charge to the second voltage level thereby providing means for developing the flash of intensified brilliance.

Since the flash intensifier circuit of the present invention includes rapid acting switching means which rapidly operate to impress a voltage signal of increased magnitude across the charging capacitor, the flash intensifier circuit is capable of high frequency operation. Further, since the flash intensifier circuit is ideally suited to the employment of semi-conductor switching devices, the circuit does not present the heating problem of the prior art type flash intensifier circuit arrangements.

Although the charging paths for the capacitor 18 have been described as being from B+ through the diode 32 and the switching means 36, it is to be understood that the source of maximum potential of the power supply 24 might be coupled to the switching means 36 to provide charging current flow from the switching means 36 and diode 32 respectively, through the capacitor 18 without departing from the scope of the present invention. In such a modified circuit arrangement it is to be undertsood that a four-layer diode 60, the silicon-controlled rectifier 46, and the diode 32 would be poled in an opposite direction to that indicated in FIGURES 2 and 3, respectively.

What is claimed is:

1. A flash intensifier circuit comprising: a flash tube having a control grid; a capacitor shunting the flash tube; a diode coupled to the capacitor; means coupled to the capacitor and the diode for normally charging the capacitor to a first voltage level through the diode; a normally

open switching means coupled to a junction of the diode and the capacitor; means coupled to the switching means and the capacitor for charging the capacitor to a second voltage level when the switching means is closed, the second voltage level having a magnitude which is greater than the first voltage level; oscillator means coupled to the control grid of the flash tube for periodically exciting the flash tube to cause the capacitor to discharge through the flash tube and normally produce a flash having a predetermined brilliance; frequency divider means coupled between the oscillator means and the switching means for periodically closing the switching means to back-bias the diode such that the capacitor charges to the second voltage level whereby an excitation of the flash tube produces a flash having an intensified brilliance.

2. A flash intensifier circuit comprising: a flash tube; a capacitor shunting the flash tube; a diode coupled to the capacitor; means for developing a first potential across the capacitor and diode in series to charge the capacitor to a first voltage level; normally open switching means coupled to a junction of the diode and the capacitor; means for developing a second potential across the capacitor and switching means in series to charge the capacitor to a second voltage level when the switching means is closed, the second voltage level having a magnitude which is greater than the first voltage level; pulsing means for periodically exciting the flash tube to cause the capacitor to discharge through the flash tube to produce a flash having a predetermined brilliance; and means operatively associated with the pulsing means for periodically closing the switching means to charge the capacitor to the second voltage level such that an excitation of the flash tube produces a flash having an intensified brilliance.

3. The apparatus defined in claim 2 wherein the switching means includes a silicon-controlled rectifier coupled to the junction of the diode and the capacitor and having a gate electrode coupled to the means responsive to the pulsing means, the silicon-controlled rectifier having a high impedance state and a low impedance state, the silicon-controlled rectifier normally being in its high impedance state and switching to its low impedance state in response to a pulse applied to the gate electrode.

4. The apparatus defined in claim 2 wherein the switching means includes a four-layer transistor diode coupled to the junction of the diode and the capacitor.

5. A flash intensifier circuit comprising: a flash tube; a capacitor shunting the flash tube; means for charging the capacitor to a first voltage level; switching means coupled to the capacitor; means for charging the capacitor to a second voltage level through the switching means when the switching means is closed, the second voltage level having a magnitude which is greater than the first voltage level; means for periodically exciting the flash tube to cause the capacitor to discharge through the flash tube; and means responsive to the means for exciting the flash tube for periodically closing the switching means.

6. A flash intensifier circuit comprising: a flash tube; a capacitor shunting the flash tube; a diode coupled to the capacitor; a first potential means coupled across the diode and capacitor in series to charge the capacitor to a first voltage level; an electrical switching device coupled to a junction of the diode and the capacitor, the switching device having a high impedance state and a low impedance state; a second potential means shunting the switching device to normally maintain the switching device in its high impedance state; means for periodically exciting the flash tube to discharge the capacitor through the flash tube and produce a flash having a predetermined brilliance; and means responsive to the means for exciting the flash tube for periodically pulsing the switching device to switch the switching device to its low impedance state, back bias the diode, and charge the capacitor to a voltage level determined by the first and second potential means such that an excitation of the flash tube produces a flash having an intensified brilliance.

No references cited.