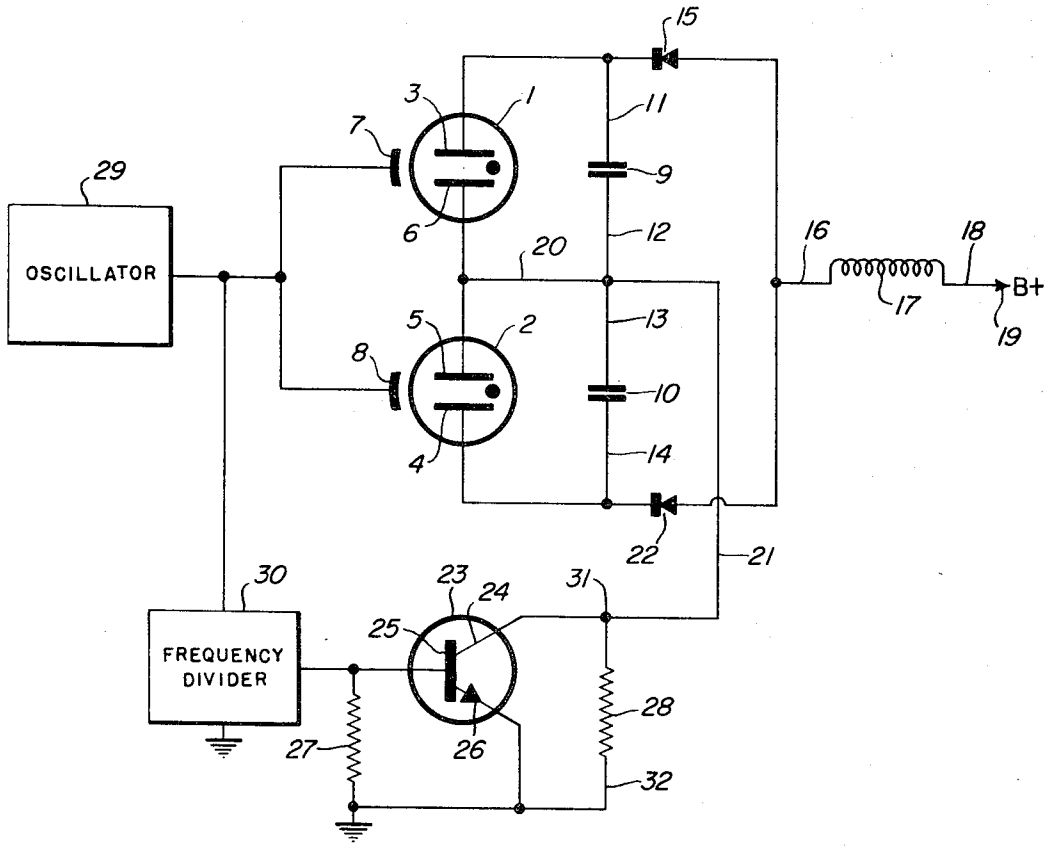
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FLASH INTENSIFIER APPARATUS

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FLASH INTENSIFIER APPARATUS

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ABSTRACT OF THE DISCLOSURE

Flash apparatus is provided in which capacitors in a charging circuit are charged to a first voltage level by the ringing action of an underdamped R-L-C circuit. Diodes are included in the charging circuit to hold the voltages accumulated on the capacitors. Switching means are further provided to periodically short circuit the resistor out of the charging circuit whereby the capacitors are charged to a second higher voltage level. A flash tube is connected in shunt with each capacitor, and means are provided for intermittently initiating conduction in the flash tubes, thereby to discharge the capacitors through their respective flash tubes for normally producing flashes of predetermined brilliance and periodically producing flashes of intensified brilliance.

A general object of the present invention is to provide an improved flash intensified apparatus for use in recording oscillographs, wherein a novel combination of circuitry is used to develop intensified flashes of controlled brilliance which is capable of high freqency operation without generating undesirable amounts of heat. A specific object of this invention is to provide such improved apparatus wherein capacitors placed in shunt with flash tubes are charged to first and second voltage levels and by being periodically discharged through the flash tubes are used to produce normal and intensified flashes, depending upon whether the capacitors had been previously charged to the first or second voltage level.

A more specific object of this invention is to provide such improved apparatus wherein underdamped series R-L-C circuits are employed to charge the shunt capacitors to a first normal or second intensified voltage level by charging the capacitors to the first normal voltage level with the series resistor in the R-L-C circuit or by charging the capacitors to the second intensified voltage level with the series resistor shorted out of the R-L-C circuit. A still more specific object of the invention is to provide such an improved apparatus wherein a transistor switch is used to short the series resistor by coupling the series resistor between the emitter and collector terminals of the transistor; the series resistor functioning in the R-L-C circuits when the transistor is off and being shorted out of the series R-L-C circuit when the transistor is on.

In recording oscillographs and the like, the light source arrangement, controlled by electrical circuitry, projects a beam of light onto light sensitive paper. Changes in electrical signals cause the light beam to be moved to produce a visual trace on the paper and hence a permanent record of the variations in the electrical signals. In general, it is desired to provide a timing reference for the trace. This is normally accomplished by including a flasher apparatus in the light source arrangement for periodically projecting a separate beam of light across the paper to produce regularly spaced timing marks. Further, flash intensifier

apparatus is frequently incorporated in the flasher to periodically intensify particular ones of these timing marks.

Such intensification is generally produced by increasing the current flow through the flash tube. In the prior art flash intensified apparatus generally has incorporated a thyratron or the like coupled in series with a capacitor, the series circuit shunting the flash tube. After being charged during a predetermined number of excitations of the flash tube, the capacitor is conditioned to discharge through the flash tube producing a flash of increased brilliance upon the firing of the thyratron and the flash tube.

Flash intensifier apparatus incorporating thyratrons have generally imposed a limitation upon the rate of oscillograph operation since they generally cannot be operated at frequencies above 800 cycles per second due to the excessive currents they are required to pass at those frequencies. Further, thyratrons or the like, require separate filament supplies and generate unwanted heat.

In the prior art a flash tube shunted by a capacitor, coupled with various switching arrangements incorporated into the capacitor charging circuit, also has been used to develop intensified flashes of controlled brilliance. These arrangements in general, to charge the capacitor to two voltage levels, have required two voltage pickoffs from the power supply and have been able to charge the shunt capacitor only to that maximum voltage carried by the voltage pickoff of highest potential. The present invention, however, comprises an improved flash intensifier apparatus incorporating a novel method for developing intensified flashes of controlled brilliance, by using novel circuitry to cause, by use of a single pickoff from a power supply, capacitors shunting flash tubes to be charged to predetermined voltage levels in excess of that voltage provided by the power supply pickoff, and by use of semiconductors to provide a device capable of high frequency operation which does not generate undesirable amounts of heat.

The present invention, in one form, includes two flash tubes, each shunted by a capacitor. The capacitors are charged to a first normal voltage level by the ringing action of underdamped R-L-C circuits which incorporate series connected diodes to block and hold voltages on the capacitors. Means coupled to the flash tubes periodically excite the flash tubes to cause the capacitors to discharge therethrough, producing a flash of predetermined brilliance. Means responsive to the periodic excitation of the flash tube are coupled to and periodically excite a transistor switch. The transistor switch when excited turns on, thereby shorting the resistance out of the R-L-C circuits. The circuits then being further underdamped, charge by ringing action the flash capacitors to a second voltage level, the magnitude of which is greater than the first 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.

A better understanding of the present invention can be had from the following detailed description of one form of a flash intensified apparatus embodying the invention, which description is to be read in connection with the accompanying drawing, wherein:

The single figure drawing is a basic schematic block diagram of the flash intensifier apparatus according to the present invention.

As represented in the drawing, the flash intensifier apparatus of the present invention includes two flash tubes 1 and 2, having anodes 3 and 4, cathodes 5 and 6, and

control elements 7 and 8, respectively. The flash tubes 1 and 2 are shunted by the capacitors 9 and 10, respectively, capacitor 9 having terminals 11 and 12. Capacitor 10 has terminals 13 and 14. Terminals 11 and 14 are coupled to the anodes 3 and 4 respectively, and through diodes 15 and 22, respectively, to terminal 16 of inductor 17. Terminal 18 of inductor 17 is coupled to the power supply 19 which is the source of potential B+. The diodes 15 and 22 are poled for series current flow from the source of potential B+ through inductor 17, the diode 15 or 22, the capacitors 9 and 10, respectively, and the resistor 28 to ground. Cathodes 5 and 6 and terminals 12 and 13 are commonly connected by conductor 20. Transistor 23 has collector terminal 24, base terminal 25 and emitter terminal 26. Resistor 28 has terminal 31 connected to collector terminal 24 and has terminal 32 connected to emitter terminal 26. Terminals 32 and 26 are commonly coupled to ground. Terminals 24 and 31 are commonly connected by conductor 21 to conductor 20. Resistor 27 is connected between the base terminal 25 and ground.

As briefly described above capacitors 9 and 10 are periodically discharged through their respective flash tubes 1 and 2 to produce a flash. To accomplish this an oscillator represented as 29 is coupled to the control elements 7 and 8 of the flash tubes 1 and 2, respectively. Oscillator 29 generates pulse signals which are supplied to control elements 7 and 8 causing the flash tubes 1 and 2 to become conductive and the capacitors 9 and 10 to discharge through the flash tubes 1 and 2, respectively, to produce a flash of predetermined brilliance proportional to the voltage level to which the capacitors 9 and 10 are charged.

Capacitors 9 and 10 are charged to a first normal voltage level in excess of the source potential B+, since the two series circuits consisting of inductor 17, capacitor 9, and resistor 28 and inductor 17, capacitor 10, and resistor 28 are each underdamped R-L-C circuits. The ringing action of the circuits swings the voltage impressed on the capacitors 9 and 10 higher than that of the source potential B+ and the diodes 15 and 22 then block and hold this higher potential on the capacitors.

To produce an intensified flash in accordance with the present invention, transistor 23 is turned on periodically during the recharge cycle. This shorts out resistor 28 causing the R-L-C circuits of the inductor 17, capacitor 9, and resistor 28 and inductor 17, capacitor 10, and resistor 28 to be further underdamped, and thus by the ringing action of the now essentially R-L-C circuit, the capacitors 9 and 10 charge to a second voltage, higher than that of the first. Transistor 23 is periodically turned on by a pulse received from the frequency divider 30, the pulse being applied across the resistor 27 to the base terminal 25 of transistor 23. By way of example, the frequency divider 30 may be a counter producing a pulse output for each ten pulses developed by the oscillator.

Thus, in operation pulse signals developed by the oscillator 29 are applied to the frequency divider 30. In response to these pulse signals the frequency divider periodically develops a pulse signal which is applied to the base 25 of the transistor 23. The pulse causes the transistor 23 to turn on thereby essentially shorting out resistor 28. With resistor 28 shorted out, the two R-L-C circuits consisting of inductor 17, capacitor 9, and resistor 28 and inductor 17, capacitor 10, and resistor 28 are further underdamped and the capacitors 9 and 10 then charge to a magnitude substantially greater than the first voltage level. Thus, in response to the next pulse signal applied to the control elements 7 and 8 of the flash tubes 1 and 2 respectively, the flash tubes 1 and 2 become conductive to allow the capacitors 9 and 10 now charged to the second voltage level to discharge through their respective flash tubes, producing a flash having an increased brilliance.

What is claimed is:

1. In flash apparatus for producing flashes of first predetermined brilliance and second intensified brilliance, the combination of:

a pair of terminals for connection to voltage supply means;

a charging circuit connected between said terminals, said charging circuit comprising an inductor, a diode, a capacitor and a resistor connected in series with respect to each other, said diode being series connected in said charging circuit between said inductor and said capacitor;

a flash tube having a control electrode, said flash tube being connected in shunt with said capacitor;

means for generating a series of discharge pulses, said discharge pulse generating means being connected to said flash tube control electrode for transmitting said discharge pulses thereto, each of said discharge pulses being operative to initiate conduction in said flash tube whereupon said capacitor discharges through said flash tube to produce a flash, the brilliance of said flash being proportional to the voltage level to which said capacitor is charged; and

switching means connected in shunt with said resistor, said switching means being responsive to said discharge pulses for periodically short circuiting said resistor whereby with a supply voltage applied to said pair of terminals said capacitor is charged to a first voltage level for producing a flash of first predetermined brilliance whenever said resistor is in said charging circuit and is charged to a second voltage level for producing a flash of intensified brilliance whenever said resistor is short circuited out of said charging circuit.

2. The invention recited in claim 1 wherein said switching means comprises:

frequency divider means responsive to said discharge pulses for periodically producing control signals in time-phase relationship with said discharge pulses; and

an electronic switch connected to said frequency divider means, said electronic switch being operable to periodically short circuit said resistor in response to each of said control signals.

3. The invention recited in claim 1 wherein:

said charging circuit is series connected between said terminals in the sequence of said inductor, said first diode, said first capacitor and said resistor; and including:

a second diode and a second capacitor series connected in shunt with said first diode and said first capacitor, said second diode being connected between said second capacitor and said inductor whereby with a supply voltage applied to said pair of terminals said first and second capacitors are each charged to a first voltage level for producing a flash of first predetermined brilliance whenever said resistor is in said charging circuit and are each charged to a second voltage level for producing a flash of intensified brilliance whenever said resistor is short circuited out of said charging circuit;

a second flash tube having a control electrode, said second flash tube being connected in shunt with said second capacitor; and

said pulse generating means connected to said second flash tube control electrode for transmitting said discharge pulses thereto, each of said discharge pulses being operative to initiate conduction in said second flash tube whereupon said second capacitor discharges through said second flash tube to produce a flash, the brilliance of said flash being proportional to the voltage level to which said second capacitor is charged.

4. The invention recited in claim 3 wherein said switching means comprises:

frequency divider means responsive to said discharge pulses for periodically producing control signals in time-phase relationship with said discharge pulses; and

an electronic switch connected to said frequency divider means, said electronic switch being operable to periodically short circuit said resistor in response to each of said control signals.

5. The invention recited in claim **4** wherein said electronic switch is a transistor having its emitter-collector current path connected in shunt with said resistor, and having its base electrode connected to said frequency divider means whereby said control signals are transmitted to said base electrode.

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