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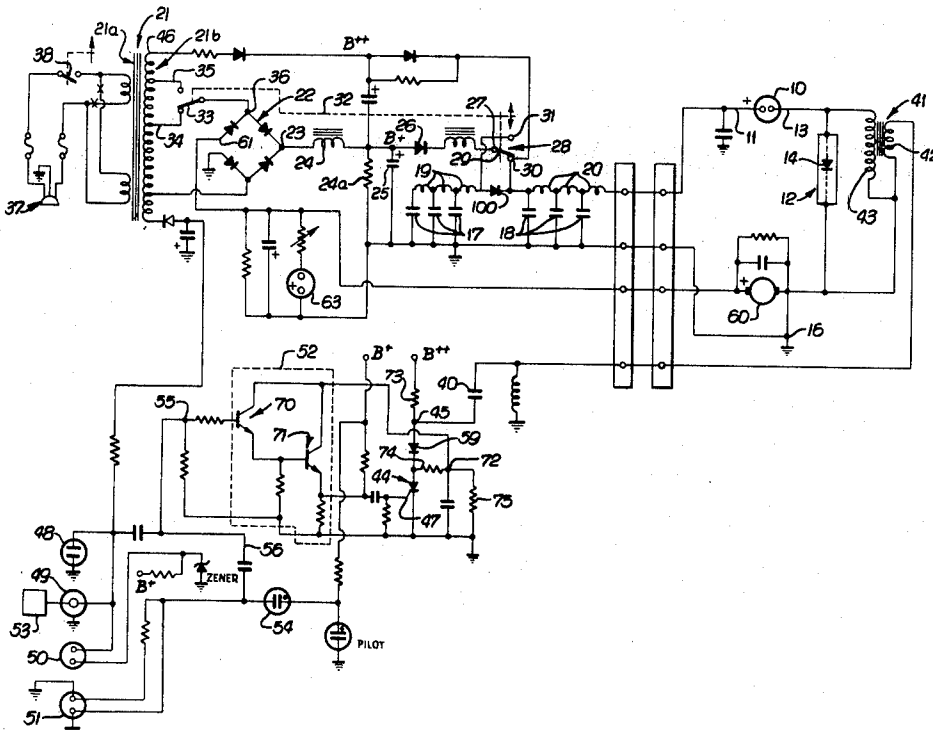
[54] **STROBE LIGHT**
8 Claims, 3 Drawing Figs.

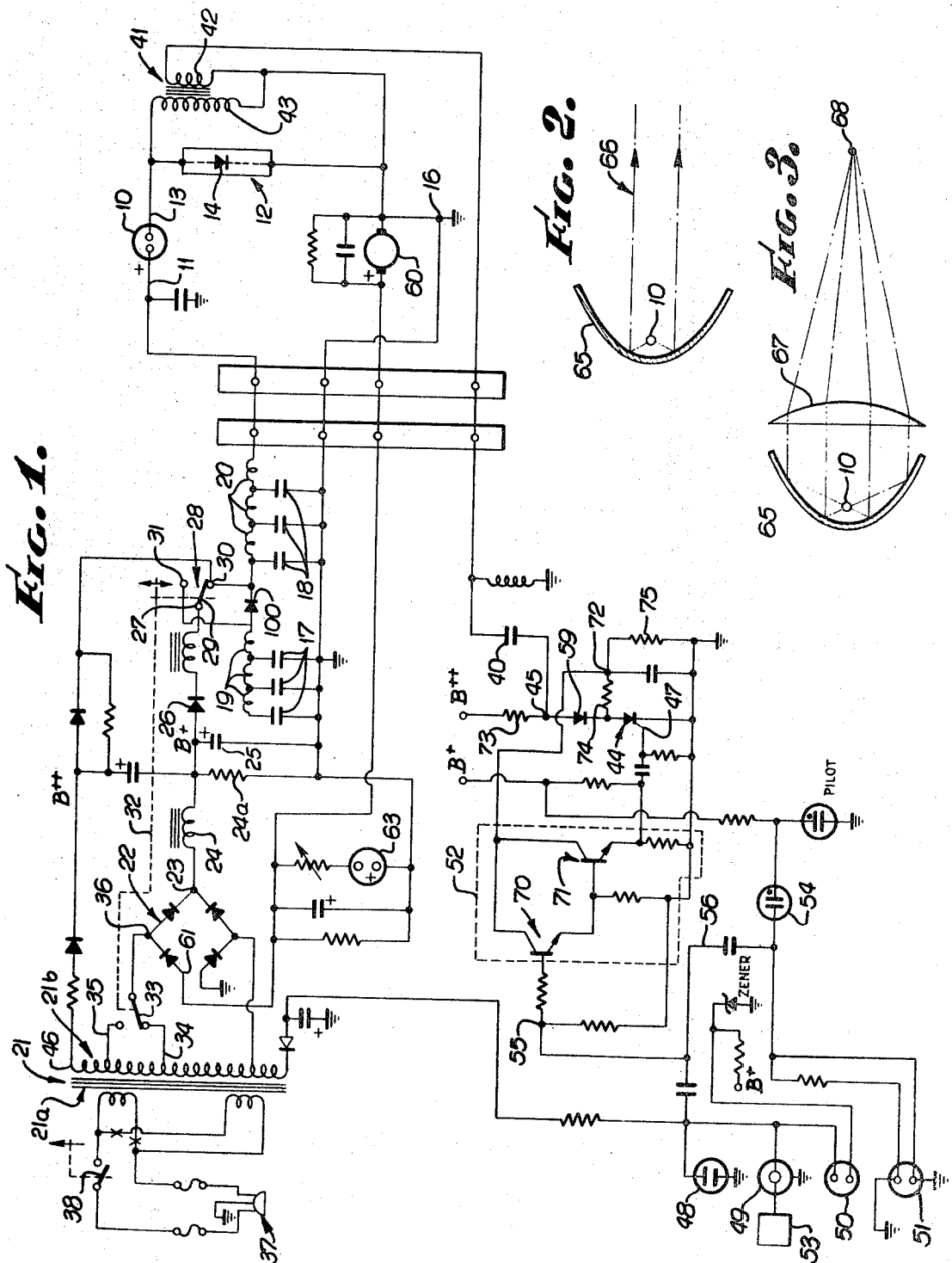
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H05b 39/00, H05b 41/14
 [50] **Field of Search**..... **320/1;**
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241 LD,S.P, 349, 352—356; 313/184;
313/182—185; 240/41—3; 382/198—203;
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[56] **References Cited**
UNITED STATES PATENTS
 2,391,225 12/1945 Clark..... 315/241
 2,965,790 12/1960 Ittig et al..... 313/217
 3,144,584 8/1964 Fiandra et al..... 315/241
 3,337,755 8/1967 Grabowski et al..... 307/106
 3,355,625 11/1967 Ward..... 315/200
 3,364,374 1/1968 Wilson 313/184
 2,080,908 5/1937 Bunker et al..... 315/117
 2,496,102 1/1950 McCord 352/200X
 2,893,289 7/1959 Edgerton..... 313/184X
 2,974,249 3/1961 Thourer..... 313/113
 3,286,128 11/1966 Ward..... 315/241

FOREIGN PATENTS
 1,091,853 4/1955 France 315/200
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ABSTRACT: The disclosure concerns stroboscopic apparatus in which high intensity flashes of light are yielded from an extremely small light source.





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STROBE LIGHT

This invention relates generally to flasher circuits, and more particularly concerns a novel stroboscopic light and flasher circuit therefor.

Conventional strobe light sources are less than satisfactory for many applications due to their inability to produce sufficient light intensity at relatively high flash rates. For example, a typical strobe light utilizes a flash tube whose effective light producing diameter is about 1 inch or more. Such a large light source spreads the light energy so that is impractical to illuminate a small target effectively, especially at some distance. If a standard strobe source is reduced in size, the light intensity yield is reduced to too greatly. Also, conventional strobe tubes are filled to a relatively low gas pressure so that ionization is very easy and is usually accomplished by an external trigger wire wrapped around the bulb or by a third electrode in the envelope; however, this low gas pressure yields very poor volumetric light producing efficiency, i.e. small number of lumens per unit volume. To achieve the high efficiency necessary when small volume is required (e.g. point source) high gas pressure, 8—10 atmospheres for instance, is necessary. But then external triggering is very difficult.

The present invention has as major objects the provision of a very small strobe light source capable of effective and highly efficient use with reflectors and lenses; the provision of small size strobe light source capable of unusually high light intensity and flash rates; and the provision of an unusually effective and simple flasher circuit that includes a flash tube, electrical charge storage means connected to discharge through the tube in response to triggered ionization of tube gas diode means connected to provide a relatively low impedance path for such discharge, and trigger voltage supply means connected to supply to the tube a high trigger voltage of polarity such that the diode means presents a high impedance path to the trigger voltage.

The invention affords advantages and results in extending the use of stroboscopic techniques to many applications heretofore impossible of accomplishment with ordinary strobe lights. For example, helicopter blades can be tracked in normal daylight while in flight with the light many feet distant from the blades; vibration modes of a hot turbine blade may be observed; and a vibrating specimen in a space simulation chamber can be clearly illuminated and studied through a window. The extremely small bright spot can be used to great advantage in photo stress, photo microscopy, laryngoscopy, and the spot can be coordinated with a telescope or binoculars for a survey of a very large object at distances of many feet from light to target.

Other objects and advantages of the invention include the provision of multiple charge storage capacitors together with means to optionally charge different of the capacitors to effect control of flash intensity created by capacitor discharge through the flash tube; the inclusion of inductance connected with the storage capacitors so as to provide delay line to reduce peak discharge currents without loss of energy; the inclusion of series connected silicon diodes to provide the low impedance flash tube discharge path and also to present high impedance to the trigger voltage; the provision of an unusually effective and simple trigger voltage supply circuit as will be described; and the provision of a reflector and of a lens in combination with the point source of high intensity light offered by the flash tube and associated circuit.

These and other objects and advantages of the invention, as well as the details of illustrative embodiments, will be more fully understood from the following detailed description of the drawings in which:

FIG. 1 is a circuit diagram showing one preferred form of flasher circuit incorporating the invention;

FIG. 2 is a section showing use of the flash tube as a point source of light with a reflector; and

FIG. 3 is like FIG. 2, but showing the addition of a focusing lens.

The flasher circuit of FIG. 1 shows one form of flash tube 10 containing gas subject to ionization response to application

across the tube of a predetermined voltage differential. A typical usable tube is identified by the designation X-80 a product of PEK Laboratory, Sunnyvale, Calif. and having a light source zone or arc gap less than 4 millimeter in use. Connected to one side 11 of the tube is one form of electrical charge storage means to discharge current through the tube in response to gas ionization. Also provided are diode means 12 connected to the opposite side 13 of the tube to provide a relatively low impedance path for the discharge, and trigger voltage supply means also connected to tube side 13 to apply to the tube a relatively high trigger voltage of a polarity such that the diode means presents a relatively high impedance path thereto, the trigger voltage being sufficient to effect tube gas ionization. Typically, the diode means may comprise silicon junction diodes 14 connected as shown between point 13 and common terminal or ground 16 for presenting high impedance to negative trigger voltage.

More specifically, the charge storage means connected to tube side 11 may include multiple storage capacitors 17 and 18, the former connected with inductance elements 19 to form one segment of a delay line and the latter capacitors connected with inductance elements 20 to form another segment of the delay line. Means is also provided to optionally charge different of the capacitors to effect control of flash intensity and flash rate upon capacitor discharge through tube 10. For example, such means may include a transformer 21; a full wave rectifier bridge 22 taking input voltage from the transformer, rectified DC output at 23 being filtered at inductance 24, resistance 24a and capacitance 25 and supplied via diode 26 to terminal 27 of SPDT switch 28. When switch arm 29 engages terminal 30, only capacitors 18 are subjected to charging, since diode 100 connected between inductances 19 and 20 blocks charging of capacitors 17. On the other hand, when switch arm 29 engages terminal 31, all capacitors 17 and 18 are charged. The former mode is characterized by fast flash rates and lower flash intensity, whereas the latter mode is characterized by slower flash rates and high flash intensity or power. The delay line reduces peak currents delivered to the flash tube upon capacitor discharge.

Switch arm 29 is ganged at 32 with another SPDT switch arm 33 operable to connect different taps 34 and 35 of transformer secondary 21b with the input terminal 36 of the rectifier bridge. Thus, higher voltage is applied to terminal 36 during operation in slower flash, high flash intensity (and duration) mode. The transformer primary 21a is suitably connected at 37 with AC source current via on-off switch 38.

Turning now to the trigger voltage supply means, it may typically include a trigger charge storage capacitor 40, a pulse transformer 41 having a low voltage primary winding 42 connected in series with the capacitor and a high voltage secondary winding 43 connected with the trigger input side 13 of tube 10, together with means to trigger the discharge of the capacitor 40. The latter means may typically and advantageously comprise a silicon controlled rectifier or SCR 44 connected in series with capacitor 40, B ++ voltage being supplied at junction 45 to charge capacitor 40. Such voltage may be obtained from tap 46 of power transformer secondary winding 21b, as indicated. That voltage may also be applied to terminal 30 of switch 28 so as to assure a desirably high voltage charge on the capacitors 18 at the time of the first flash.

The SCR 44 has a control or switching input terminal 47 to receive amplified trigger input signals. Various pulse input points are indicated at 48—50, whereas a sine wave input point appears at 51. Pulse inputs are suitably amplified at 52 and applied to SCR terminal 47. Collector voltage for transistors 70 and 71 is obtained from point 72 in voltage divided that includes resistors 73, 74 and 75. A source of controllable frequency stroboscopic pulses is indicated generally by clock 53. The sine wave input point 51 is connected in series with a normally nonconducting neon bulb 54. The latter becomes conductive during the negative portion of the sine wave trigger input signal, and a corresponding pulse is applied to the amplifier input at 55 via path 56.

In operation, when a positive input trigger pulse, amplified at 52, is applied to the SCR switch terminal 47, capacitor 40 discharges in the circuit that includes the SCR and the primary winding 42, generating a very high voltage pulse (as for example -10,000 volts) at the trigger input 13 to the flash tube 10. This trigger pulse ionizes the gas in tube 10 and the storage capacitors discharge through the tube and the diode means 12. Accordingly, the diode means 12 provides series impedance to "hold off" triggering voltage until the tube ionizes, then freely passing current during the energy discharge.

The use of silicon diodes is of particular advantage since the "hold off" (back) impedance can be very large and "conducting" (forward) impedance very small and switching from one state to the other very rapid. In this regard, the point source has a lower conducting impedance than a conventional flash tube, which requires a much lower series impedance.

Also diode means 12 prevents reverse conduction of flash tube should the characteristics of the tube and circuit cause the discharge capacitors to end with a negative voltage. Reverse conduction of flash tube tends to degrade operation of the tube due to electrode abuse.

When the voltage across tube 10 falls sufficiently, the tube deionizes and the storage capacitors recharge. Likewise, the SCR 44 is switched off by a dropoff in the output of amplifier 52, after capacitor 40 discharges, so that capacitor 40 then recharges. Diode 59 prevents any ringing from reaching the SCR 44.

A blower 60 has a motor connected in a circuit path from common terminal 16 to the rectifier bridge terminal 61, so that average charging current for the discharge or storage capacitors is drawn through the blower causing it to run at a rate proportional to the power input to tube 10. The blower fan cooling air discharge cools the tube 10. Meter 63 also indicates average power by reading the voltage across the blower motor circuit.

FIG. 2. shows the flash tube 10 in the form of a point source of light contained within and spaced from parabolic reflector 65 to yield a nearly collimated light beam 66. A typical source 10 may be rounded and about 1 mm. in diameter, the associated reflector having a focal length of 0.4 inch and a 3½ inch diameter. The ionizable gas in the lamp is typically above 8 atmospheres pressure. FIG. 3 shows the same structure as in FIG. 2, and adds a lens 67 in front of the point source 10. The lens sharply focuses the light from the reflector, generating a small spot at 68, almost all light from source 10 is utilized in FIG. 3.

I claim:

1. In a flasher circuit, a flash tube containing electrodes and gas subject to ionization in response to application across the tube of a predetermined voltage differential, electrical charge storage means connected to discharge forwardly through the tube in response to said ionization, diode means connected to one tube electrode to provide a relatively low impedance path for said forward discharge and to prevent reverse conduction through the tube, and trigger voltage supply means connected to apply to said one tube electrode a relatively high trigger voltage of a polarity such that the diode means presents a relatively high impedance path thereto, said trigger voltage being sufficient to effect said ionization, said tube forming an approximately point light source, said charge storage means being connected with another tube electrode and including multiple storage capacitor means, and means to optionally charge different of said capacitor means to effect control of flash intensity created by capacitor discharge through the

flash tube, inductance means connected to said different capacitor means to provide a delay line, said means to optionally charge different of said capacitor means including circuitry and blocking means electrically connected between portions of said delay line, said trigger voltage supply means comprising a trigger charge storage capacitor, a transformer having primary winding means connected with the trigger capacitor and secondary winding means connected with said one tube electrode, and means to trigger the discharge of the trigger capacitor and including a gate controlled rectifier connected in series with the trigger capacitor and having a control terminal, a trigger signal input connection, an amplifier connected between said input connection and said control terminal, and a source of trigger input signals.

2. The combination of claim 1 in which said diode means comprise series connected silicon diodes.

3. The combination of claim 1 including a reflector spaced from said tube and having an approximately parabolic reflecting surface such that flashing of the tube provides substantially a point source of light which when reflected from the reflector travels in a collimated beam.

4. The combination of claim 3 including a lens located in spaced relation of to the reflector and operable to sharply focus tube light reflected by said reflector.

5. The combination of claim 1 in which said source is about 1 millimeter in diameter.

6. The combination of claim 1 in which the lamp contains ionizable gas at above about 8 atmospheres pressure.

7. The combination of claim 1 including power supply means connected to charge said storage means, and a blower having a fan located to displace air in cooling relation to the tube and a fan motor connected with said power supply means to cause the blower motor to run at a rate which increases in correspondence with increased power delivery to the tube via said charge store storage means.

8. In a flasher circuit, a flash tube containing electrodes and gas subject to ionization in response to application across the tube of a predetermined voltage differential, electrical charge storage means connected to discharge forwardly through the tube in response to said ionization, diode means connected to one tube electrode to provide a relatively low impedance path for said forward discharge and to prevent reverse conduction through the tube, and trigger voltage supply means connected to apply to said one tube electrode a relatively high trigger voltage of a polarity such that the diode means presents a relatively high impedance path thereto, said trigger voltage being sufficient to effect said ionization, said tube forming an approximately point light source, said charge storage means being connected with another tube electrode and including multiple storage capacitor means, and means to optionally charge different of said capacitor means to effect control of flash intensity created by capacitor discharge through the flash tube, inductance means connected to said different capacitor means to provide a delay line, said means to optionally charge different of said capacitor means including circuitry and blocking means electrically connected between portions of said delay line to optionally supply charge current to said portions of said delay line, said trigger voltage supply means comprising a trigger charge storage capacitor, a transformer having primary winding means connected with the trigger capacitor and secondary winding means connected with said one tube electrode, and means to trigger the discharge of the trigger capacitor and including a trigger signal input connection for a source of trigger input signals.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,549,945

Dated December 22, 1970

Inventor(s) James G. Helmuth

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 5; "portions of said delay line, said trigger voltage supply means" should read --portions of said delay line to optionally supply charge current to said portions of said delay line, said trigger voltage supply means--

Signed and sealed this 25th day of May 1971.

(SEAL)
Attest:

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Attesting Officer

WILLIAM E. SCHUYLER, J.
Commissioner of Patent