ABSTRACT
A strobe light circuit in which the light intensity of the strobe lamp is varied by adding or removing selected flash capacitors in circuit with the lamp to increase or decrease surge current through the lamp. The circuit connection between each of the flash capacitors and the strobe lamp is controlled by a double-pole, double-throw relay with a normally open relay contact in series with the flash capacitor to enable it to charge and discharge and a normally closed contact across the flash capacitor to discharge it when it is not being used to provide a portion of the surge current. Both contacts are connected at the low side of the power line to minimize electrical arcing and are mechanically linked together such that the conducting set of contacts always breaks contact before the nonconducting set of contacts closes. Intensity control switches are provided to energize the relay coils for the selected capacitors. One flash capacitor is always connected across the strobe lamp to maintain a minimum light intensity, and this capacitor is discharged through a normally closed relay contact when power for the entire circuit is interrupted.

9 Claims, 1 Drawing Figure
STROBE LIGHT INTENSITY CONTROL

BACKGROUND OF THE INVENTION

This invention relates to a strobe light circuit and in particular to a strobe light circuit for use as part of a landing field approach lighting system in which the light intensity must be varied with changes in atmospheric visibility.

Airports are required to provide approach lighting systems to indicate to landing aircraft both which runway of a plurality of runways is to be used and the direction from which the runway is to be approached. These approach lighting systems comprise a plurality of strobe lamps located at the end of the runways which flash in sequence starting at the outermost unit from the runway and progressing inwardly toward the runway threshold. The entire sequence may be repeated twice a second.

The FAA requires the strobe lamp circuits or flasher units to be designed for different intensity levels with a simple control such as a switch to effect the change-over from one intensity level to another. Flasher units commonly utilize a gaseous discharge or strobe lamp triggered at a selected frequency, the surge current through the lamps being supplied by discharge current from selected ones of a plurality of flasher capacitors. The light intensity with which the lamp flashes is directly related to the total available surge current which, in turn, is directly related to the total capacitance connected across the lamp. By adding and removing flash capacitors, the intensity may be increased and decreased, respectively.

The FAA further specifies that all intensity step changing of the flashers is to be done with the system operating but if necessary, power to all of the flasher units may be interrupted for a period not to exceed two seconds during intensity step changeover. This two-second shutdown period is at variance with the general requirement that all intensity step changing of the flashers is to be done with the system operating and is a recognition by the FAA of limitations in known strobe light circuits.

The FAA specifies that no arcing is to occur during any intensity step change and to minimize arcing; all of the known prior art devices have provided a bleeder resistor in parallel with each of the flash capacitors which discharge the capacitors during the two-second shutdown to a level low enough so that arcing between switch contacts does not occur when the switches are opened to remove the capacitor from the strobe lamp. Power shutdown has also been required when it is desired to increase the strobe lamp light intensity, due to electrical arcing which occurs when an uncharged flash capacitor is coupled across the power supply and strobe lamp.

SUMMARY OF THE INVENTION

Applicant has discovered that by placing the switch contact between the low side of the power supply and the capacitor rather than between the high side of the power supply line and the capacitor, electrical arcing between switch contacts is substantially reduced. Thus, the requirement for a power shutdown to change intensity levels may be eliminated.

In accordance with the invention, the flash capacitors are coupled at one end to the high voltage or ungrounded side of the power supply. The other side of the capacitor is coupled through a normally open relay contact, i.e., a relay contact which is open when the relay coil is unenergized, to the low side of the power supply line or ground, and the junction between the normally open relay contact and the capacitor is coupled to one side of a normally closed relay contact, i.e., a relay contact which is closed when the relay coil is energized. The other side of the normally closed relay contact is coupled through a bleeder resistor to the one side of the capacitor connected to the high voltage line of the power supply. Both sets of relay contacts are controlled by a common relay coil and are arranged such that the closed contact always breaks its connection prior to the open contact closing. Although a single-pole, double-throw relay switch contact could be utilized in place of the two separate sets of relay contacts, applicant has discovered that the operating life of each set of contacts of the single-pole single-throw relay is substantially greater than the contact life of a single-pole, double-throw relay switch.

A principal object of the present invention is the provision of a variable intensity strobe light circuit in which the intensity may be changed without removing power from the unit to add or remove flash capacitors.

Another object of the present invention is to provide a variable intensity strobe light circuit in which the switch contacts for controlling the circuit connections between the flash capacitors and the strobe lamp are coupled between the low voltage side of the power supply and the flash capacitors, thereby substantially reducing arcing during switching.

A further object of the present invention is to provide a variable intensity strobe light circuit in which separate sets of contacts are utilized for discharging the flash capacitors and for adding or removing from flash capacitors across the strobe lamp, thereby increasing the operative life of the unit.

BRIEF DESCRIPTION OF THE DRAWING

Further features and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawing, which is a circuit schematic of a preferred embodiment of the variable intensity strobe light circuit of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, a circuit schematic of a preferred embodiment of the strobe light circuit of the present invention is shown in which a gaseous discharge or strobe lamp 10 is repetitively fired in response to application of trigger signals applied to its firing electrode 12.

Strobe lamp 10 has a cathode 32 coupled to a low voltage side or terminal 16 of a DC power supply, generally designated by reference numeral 18, which is connected to ground reference potential at 20, and an anode 34 coupled to a high voltage side 26 of power supply 18. Each time a trigger pulse is applied to firing electrode 12, strobe lamp 10 breaks down and momentarily conducts a surge current from anode 34 to cathode 32. The intensity with which strobe lamp 10 lights is directly related to the magnitude of the surge current which, in turn, is directly proportional to the amount of
capacitance coupled across strobe lamp 10 between its anode 34 and cathode 32.

The surge current is supplied from power supply 18, a minimum intensity level flash capacitor 36 and a selected one or both of flash capacitors 38 and 40. Flash capacitor 36 is always coupled across strobe lamp 10 and thus provides the minimum surge current corresponding to the lowest intensity level. During the period between flashes of lamp 10, flash capacitor 36 charges from DC power supply 18, and when lamp 10 is fired it discharges through the lamp thereby providing the necessary surge current.

Flash capacitors 38 and 40 operate in an identical fashion as flash capacitor 36 when they are connected across lamp 10 through their respective normally open, relay contacts RL2-1, controlled by relay coil RL2, and RL3-1, controlled by relay coil RL3. These normally open, relay contacts are coupled between the low voltage side 16 of power supply 18 and their associated capacitors to minimize arcing.

To discharge capacitors 38 and 40 two bleeder resistors 42 and 44 are provided. Bleeder resistor 42 is coupled across capacitor 38 through normally closed relay contacts RL2-2, controlled by relay coil RL2, and bleeder resistor 44 is coupled across flash capacitor 40 through normally closed relay contacts RL3-2 which are controlled by relay coil RL3. The normally closed relay contacts are connected to the low voltage side of their respective capacitors to minimize arcing between the relay contacts.

The light intensity may be remotely controlled by selectively energizing relays RL2 and RL3 by means of intensity control switch 46. Intensity control switch 46 is preferably a two section, three position rotary switch with sections 47 and 48, each having a rotary contact switchable between three stationary contacts designated Lo, Mand H for low, medium and high intensity.

The rotary contact of both sections is coupled at one side to a suitable source of relay power VR. The medium and high position contacts of section 47 are coupled to relay coil RL2, and the high position contact of section 48 is coupled to relay coil RL3. When switch 47 is in the Lo position as shown in the drawing, neither relay is energized and the surge current is provided solely by flash capacitor 36 and power supply 18 which corresponds to the lowest intensity level. With switch 47 in the M position, relay RL2 is energized to open normally closed relay contact RL2-2 to remove the shunt circuit across capacitor 38 and to close relay contact RL2-1 to connect flash capacitor 38 across lamp 10 and power supply 18. The two sets of contacts of both relays RL2 and RL3 are designed such that the conducting set of contacts, i.e., the contacts which are in a closed position, always open before the other contact closes. This is necessary to prevent shorting which would otherwise occur. With relay RL2 energized, surge current is supplied by both flash capacitors 36 and 38, and the strobe lamp flashes at a medium intensity level. With switch 46 in the H position, both relays RL2 and RL3 are energized and surge current is supplied by all three flash capacitors to flash strobe lamp 10 at the highest intensity level.

Power for the circuit may be provided by any suitable AC power source 54, such as the 60 hertz, 110 or 220 VAC current. The requisite DC voltage may be obtained by means of a step-up transformer 56, the secondary winding output of which is rectified by a full wave rectifier circuit 58.

To discharge capacitor 36 when power is removed, a bleeder resistor 60 is provided. Bleeder resistor 60 is coupled across capacitor 36 through a normally closed relay contact RL4-1 that is controlled by a relay coil RL4 which, in turn, is coupled across the AC source through a single-pole, double-throw power switch 62. When switch 62 is closed, relay RL4 is energized and the normally closed relay contact RL4-1 opens to remove the bleeder capacitor 60 from across flash capacitor 36. However, when power is removed, normally closed relay contact RL4-1 reverts to its normally closed position to shunt capacitor 36 which discharges through bleeder resistor 60.

The trigger signals at firing electrode 12 are generated in response to corresponding trigger signals developed from a suitable trigger source 14 which repetitively energizes single-pole, double-throw relay RL1. One side of the relay contact of relay RL1 is coupled to the low voltage terminal side 16 of DC power supply 18. The other side of the relay contact is coupled to a junction between two resistors 22 and 24 which are connected in series across power supply 18 between the low voltage side 16 and high voltage side 26 of power supply 18. The junction between resistors 22 and 24 is coupled, in turn, to firing electrode 12 through a coupling capacitor and a step-up autotransformer, generally designated by reference numeral 30, having a coil portion 31 and a coil portion 33. Each time the contacts of relay RL1 open, capacitor 28 is charged, and when the contacts of relay RL1 close, capacitor 28 is discharged through autotransformer coil portion 33 which induces a high voltage across autotransformer 30 that is applied between firing electrode 12 and cathode 32.

I claim:

1. In a strobe light circuit having a source of power, a strobe lamp connected across said source of power, and means for repetitively firing said lamp, said lamp flashing when fired with a light intensity directly related to the magnitude of surge current therethrough, intensity control means for varying the light intensity of said lamp, comprising:

- a capacitor means connected with the source of power and said lamp for providing at least a portion of said surge current; and
- switching means including

  - first switch means connected in series with the capacitor means across the lamp and source of power switchable between non-conductive and conductive states, said first switch means when in its conductive state providing a charging path from the power supply to charge the capacitor and also providing a discharge path from the capacitor to the lamp when the lamp is fired to provide a portion of said surge current thereto, said first switch means when in its nonconductive state removing said charging and discharging paths to prevent the capacitor from applying a portion of said surge current to the lamp;

  - second switch means connected across said capacitor means and switchable between non-conductive and conductive states, to enable said capacitor to charge from said source of power when in the non-conductive state and to dissipate any charge on said capacitor when in the conductive state, said
second switch means being normally in a state opposite to that of said first switch means; and means for actuating said switch means between states, the conductive one of said first and second switch means switching to its non-conductive state prior to the non-conductive one of said first and second switch means switching to its conductive state.

2. The light intensity control means of claim 1, including means providing a switch signal for said switch means.

3. The light intensity control means of claim 2, in which both of said switch means are controlled by relay coil means connected with said switch signal providing means.

4. The light intensity control of claim 3, in which said relay coil means comprises a single relay coil for controlling both of said switch means.

5. The light intensity control means of claim 1, in which said first and second switch means comprise mechanical switch contacts, none of the contacts of either of said switch means being common to the contacts of the other of said switch means.

6. The light intensity control means of claim 1, in which said capacitor means comprises a plurality of capacitors connected in parallel with each other, and said switching means comprises a corresponding plurality of pairs of first and second switches connected with said plurality of capacitors, respectively, each of said plurality of pairs of first and second switches selectively controlling the connection between said lamp and the capacitor to which it is connected, whereby the light intensity of said lamp may be selectively varied.

7. The light intensity control means of claim 1, in which said power source has a low voltage terminal at a reference potential and a high voltage terminal at other than said reference potential, and said first switch means is connected between said low voltage terminal and one side of said capacitor means.

8. The light intensity control means of claim 7, in which said second switch means is connected at one side thereof to the junction between the capacitor and the first switch means and connected at the other side thereof through an impedance means to the other side of the capacitor, both said other side of the capacitor and said impedance means being connected to the high voltage terminal of said source of power.

9. The light intensity control of claim 1 including a bleeder resistor in series with said second switch means for dissipating any charge on said capacitor when said second switch means is in its conductive state.