United States Patent [19]

Graham et al.

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[54] **DISCHARGE-LIGHTING APPARATUS**

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[73] Assignee: **Stone-Platt Crawley Limited,** Crawley, England

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[30] **Foreign Application Priority Data**

Jan. 26, 1972 Great Britain 3726/72

[52] **U.S. Cl.** ..... **315/201,** 315/228, 315/238, 315/240, 315/241 R, 340/331, 340/341

[51] **Int. Cl.** **H05b 37/02**

[58] **Field of Search** ..... 315/132, 133, 135, 136, 315/200 A, 201, 227 R, 228, 238, 240, 241 R, 241 S; 313/1, 25, 26; 340/331, 332, 340, 341; 240/57.12

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[57] **ABSTRACT**

This invention relates to lighting apparatus which includes two or more discharge lights, and switching means which are arranged to send an actuating pulse to each of said lights in turn during each switching cycle. Electronic means are provided to alter the order in which these actuating pulses are applied to the respective lamps in successive switching cycles, and a rechargeable power supply is connected to the lights and arranged to be discharged by the first actuated light to correctly operate.

9 Claims, 6 Drawing Figures

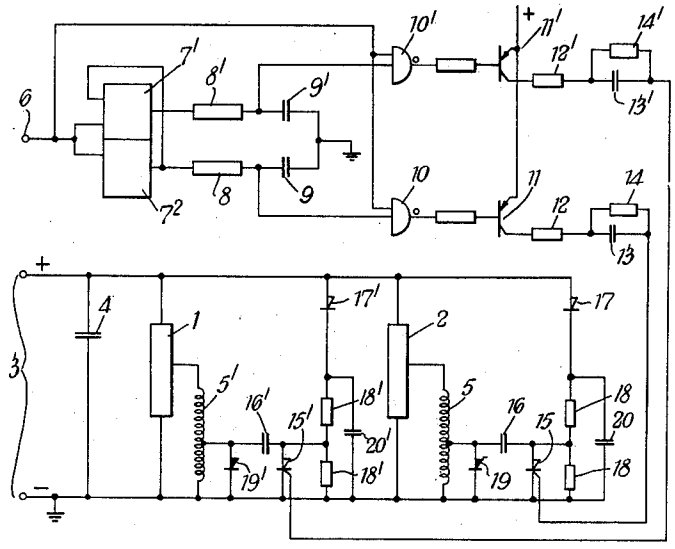

FIG.1.

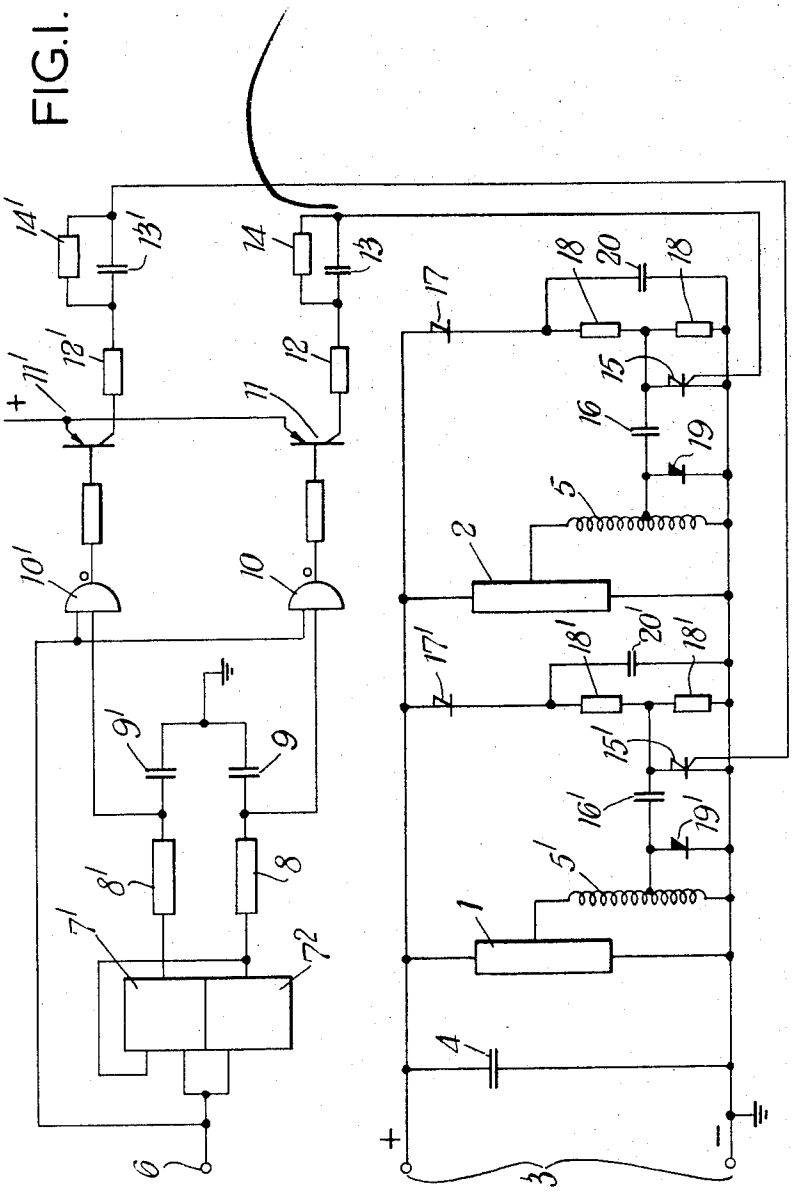
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FIG.2.

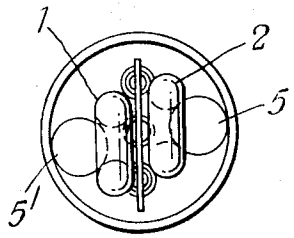


FIG.3.

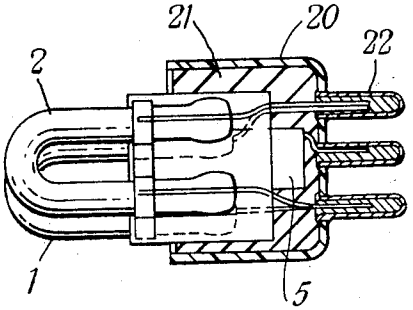


FIG.4.

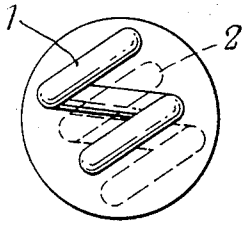
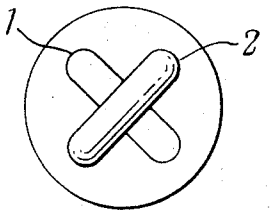


FIG.5.



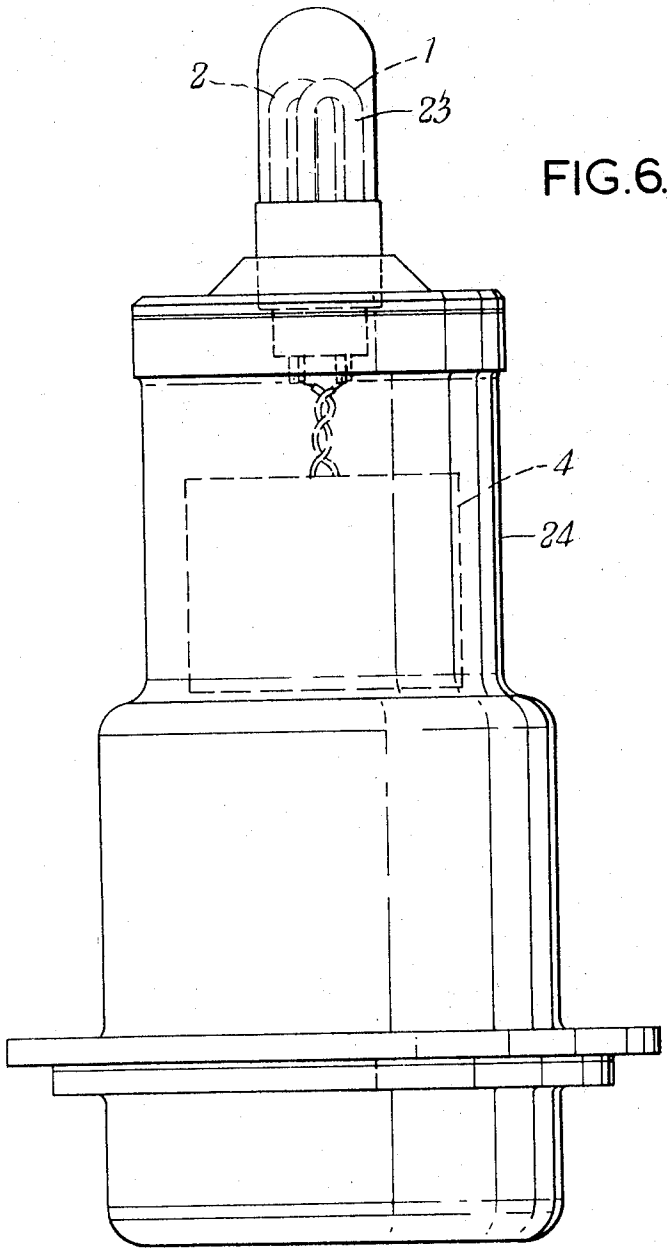


FIG.6.

DISCHARGE-LIGHTING APPARATUS

This invention concerns improvements relating to discharge-lighting apparatus, particularly but not exclusively condenser-operated xenon discharge lights used for flashing navigational aids.

In certain applications of such apparatus in unattended equipment, it is desirable to increase the period of unattended service beyond the period which could be provided by a single discharge tube.

According to the present invention there is provided lighting apparatus including two or more discharge lamps, switching means arranged to send an actuating pulse to each of said lamps in turn during each switching cycle, means being provided to alter the order in which the said actuating pulses are applied to the respective lamps in successive switching cycles, a single rechargeable power supply means being connected in common to said lamps and arranged to be discharged by the first actuated lamp to correctly operate. The relationship between the life of each discharge lamp and the operative or duty cycle may then be made such that the possible unattended life of equipment incorporating the apparatus can be increased by a factor in excess of the number of lamps provided.

The apparatus may, furthermore, be so devised that when one discharge tube eventually fails, its duty is taken over by the other or another, so that the total performance of the equipment is not affected until the ultimate failure of the other or last tube.

This may be achieved, for example where two tubes are provided, by applying the main discharge voltage to both tubes at once, but the triggering voltage first to the tube which should fire next in the sequence and then, after a short delay, to the other tube, which serves as standby at this firing. On successive firings, the tubes are alternated with respect to their duties as main and standby tubes.

The delay between the applications of the triggering pulse to the tubes is made such that, if the main tube is in serviceable condition, triggers correctly and discharges the condenser, the triggering pulse will be applied to the standby tube at a time subsequent to such discharge of the condenser but prior to its recharging from the power-supply circuit.

While the tubes should both be close to the focal point of any optical system, for instance a lens system, with which they are employed, it is also important that they should obscure one another to a minimum extent. To this end, the tubes may be disposed as interwound helices. For instance, two tubes may be interwound with two similar turns each about a common horizontal axis. Alternatively use may be made of tubes of inverted U-shape with one bridging another at an angle, giving a cross formation in plan view in the case of two tubes.

As the tubes will normally be expendible, they may be arranged to be plugged in, for example by means of a pin base. For some uses, especially in marine environments, it may be undesirable to have triggering voltages, typically 8 kV, applied to a plug connection. According to a further feature of the invention, therefore, trigger transformers associated with respective tubes may be encapsulated together with the tube terminations in the plug base, so that only the low voltage supply to the said transformers is conducted through the plug-in connection. However, in some cases, it will be possible to dispose trigger transformers in the body of the lighting apparatus and to conduct the triggering pulses through the said connection.

A preferred embodiment of the present invention will now be described with reference to the accompanying drawings in which:

FIG. 1 is a circuit diagram of a flashing-light navigational aid,

FIG. 2 is a top plan view of a lamp structure showing one arrangement of a pair of discharge tubes,

FIG. 3 is a partially sectioned side view of the lamp structure shown in FIG. 2,

FIG. 4 is a top plan view of a second example of a lamp structure showing an alternative arrangement for the pair of discharge tubes.

FIG. 5 is a top plan view of a third example of a lamp structure.

FIG. 6 is a side view of a complete flashing light unit.

The circuit illustrated in FIG. 1 is intended for the supply and control of two Xenon tubes **1** and **2** connected across a source of power **3** at, say, 500 volts in parallel with a main storage condenser or condensers **4.** Triggering auto-transformers **5, 5^1** are incorporated in a common base lamp as will be described below.

Timing pulses at a frequency with which the equipment is required to flash, typically 10Hz, are supplied from additional circuitry (not shown), at **6** to a bistable unit **7** of which the two halves **7^1, 7^2** can be alternately, and mutually exclusively, on and off. Whenever a pulse is applied at **6,** the bistable unit changes state. Although shown as a logic block of integrated-circuit type, the bistable unit **7** may be of any known kind.

The two unit halves **7^1, 7^2** are connected by way of respective delay circuits, comprising resistors **8, 8^1** and capacitors **9, 9^1** respectively, to NAND gates **10, 10^1** which also have imputs directly from **6.** Each gate will provide an output, of negative sign, only if both of its inputs are energized with a signal of positive sign. The outputs of the gates **10, 10^1** are applied to the bases of transistors **11, 11^1** respectively whose outputs are coupled through resistors **12, 12^1** and parallel connected capacitors **13, 13^1** and resistors **14, 14^1** to the gates of thyristors **15, 15^1** which control the discharge of capacitors **16, 16^1** connected to the transformers **5, 5^1** respectively for supplying trigger-pulse energy thereto. The capacitors **16, 16^1** are maintained charged through diodes **17, 17^1,** potential dividers **18, 18^1** and diodes **19, 19^1** respectively.

The manner of operation is as follows, assuming that the bistable unit half **7^2** is on when a timing pulse is supplied at **6.** The pulse will be applied to only one input of the gate **10^1,** but to both inputs of the gate **10** whose output turns on the transistor **11** coupled to the thyristor **15.** The thyristor discharges the capacitor **16** through the primary part of the transformer **5,** thus triggering the tube **2,** through which the condenser **4** is discharged to produce a flash.

The same timing pulse supplied at **6** will also change the state of the unit **7,** turning **7^2** off and **7^1** on. After a delay determined by the components **8^1, 9^1,** the gate **10^1** will energize the transistor **11^1.** The tube **1** will be triggered by the action of the thrysistor **15^1,** but by this time the condenser **4** has been discharged, assuming that the tube **2** fired correctly. If, however, the tube **2** had failed to fire for some reason, the tube **1** will fire, so that the equipment duly functions.

When the next pulse is supplied at **6**, the unit half 7^1 is on, so that the tube **1** will be triggered first, followed after the delay determined by the components **8, 9** by the triggering of the tube **2.**

If either tube **1** or **2** fails completely, the other will thereafter flash for each pulse supplied at **6.**

Capacitors **20** and 20^1 co-operate with the diodes **17** and 17^1 to prevent interaction of the trigger circuits with each other and with the condenser **4.** The capacitors **13,** 13^1, between the transistors **11,** 11^1 and the thyristors **15,** 15^1 respectively prevents damage to the gates of the latter due to the relatively long duration of the pulse applied to the transistor for that tube which is the standby tube for the time being.

As explained, it is advantageous if the connection between each of the discharge tubes **1** and **2** and their associated transformers 5^1 and **5** respectively, is not in the form of a plug and socket connection. In the form of lamp structure shown in FIGS. **2** and **3,** the transformers **5** and 5^1 are positioned in a base housing **20** of the lamp structure, being surrounded by an insulating silicone rubber compound **21.** The transformers **5** and 5^1 and the tubes **1** and **2** are then permanently connected in accordance with the circuit diagram shown in FIG. **1** and then connected to appropriate ones of a series of four pins **22** extending from the base of the housing **20.**

In FIGS. **2** and **3,** the two tubes **1** and **2** are shown in side by side relationship. It is preferable however that both tubes should lie as close as possible to the focal point of any lens system with which they are employed, and at the same time obscure one another to a minimum extent. To achieve this, the two tubes **1** and **2** may be disposed as interwound helices as shown in FIG. **4.** Alternatively, the tubes **1** and **2** may be of inverted U-shape, and arranged in a cross formation as shown in FIG. **5.**

FIG. **6** is a side view of a complete light unit in which a lamp structure **23** containing the two tubes **1** and **2** is plugged into the top of a sealed housing **24.** The capacitor **4** is preferably mounted in the upper part of the housing and the remainder of the circuitry is connected to circuit boards (not shown) positioned in the base of the housing.

We claim:

1. A lighting apparatus including at least two discharge lamps, cyclically operable switching means arranged to send an actuating pulse to each of said lamps at different times respectively during each switching cycle thereby to actuate all of said lamps in turn during each switching cycle, said switching means including means for automatically altering the order in which the said actuating pulses are sent to the respective lamps in successive switching cycles thereby to alter the sequence in which said lamps are actuated in successive ones of said switching cycles, a single rechargeable source of power connected in common to said lamps and arranged to be discharged by the first actuated lamp which correctly operates during a given switching cycle, and means for recharging said single source of power subsequent to discharge thereof, the time interval between the first and last actuating pulses in each switching cycle being shorter than the time required to recharge said source of power once said source has been discharged thereby to assure that one only of said lamps is operated from said single source of power during a given switching cycle notwithstanding that all of said lamps are actuated during said given cycle.

2. Apparatus as claimed in claim **1,** wherein a pair of discharge lamps are provided, said switching means comprising a bistable unit having its input connected to a source of successive timing pulses and being operative to provide an output on one of its two outputs, each timing pulse being also applied to one input of each of a pair of two input NAND gates, the other inputs of said NAND gates being connected via pulse delay circuits to the two outputs of said bistable unit, the output of each NAND gate being connected to the base of an associated switching transistor comprising an actuating circuit supplying an actuating pulse to an associated one of said discharge lamps.

3. Apparatus as claimed in claim **2,** wherein said delay circuits each comprise a series connected resistor and capacitor connected between one output of said bistable unit and ground respectively, the said other input of each NAND gate being connected to the interconnection between the resistor and capacitor in an associated one of said delay circuits.

4. Apparatus as claimed in claim **2,** wherein each of said switching transistors is connected respectively to a thyristor in said actuating circuit for switching on said thyristor when the transistor is rendered conductive, and means responsive to the switching on of the thyristor in said actuating circuit for applying an actuating pulse to the discharge lamp associated with said actuating circuit.

5. The apparatus claimed in claim **4** wherein the acutating circuit for each lamp includes a rechargeable capacitor connected between said thyristor and a transformer, said transformer being connected to said lamp, the switching on of said thyristor being operative to discharge said capacitor through said transformer thereby to apply an actuating pulse to the lamp connected thereto via said transformer.

6. Apparatus as claimed in claim **5,** wherein each discharge lamp and its associated transformer are permanently connected as a unit which is in the form of a plug-in unit to the remainder of the circuit.

7. Apparatus as claimed in claim **1,** wherein a pair of discharge lamps are provided, each of which is positioned closely adjacent the other.

8. Apparatus as claimed in claim **7** wherein said discharge lamps are each of inverted U-shape, and wherein the lamps are positioned in crossed formation.

9. Apparatus as claimed in claim **7** wherein the discharge lamps are interwound in a helical formation.

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