Sept. 14, 1948. H. E. EDGERTON 2,449,063

ELECTRIC SYSTEM

Filed Nov. 19, 1943 2 Sheets-Sheet 1

Fig. 1

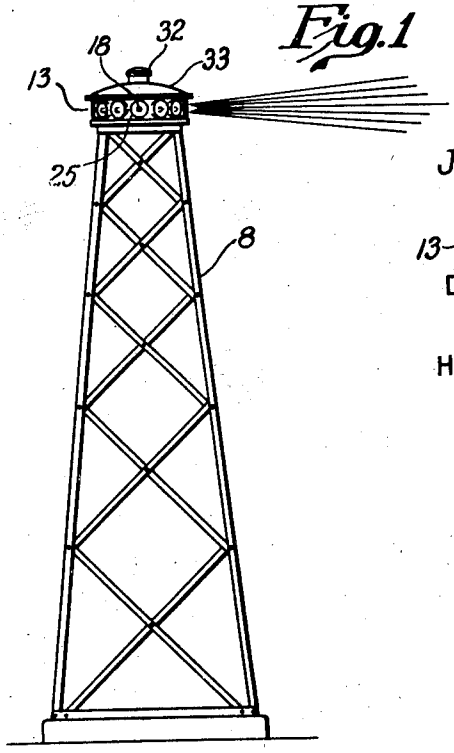


Fig. 2

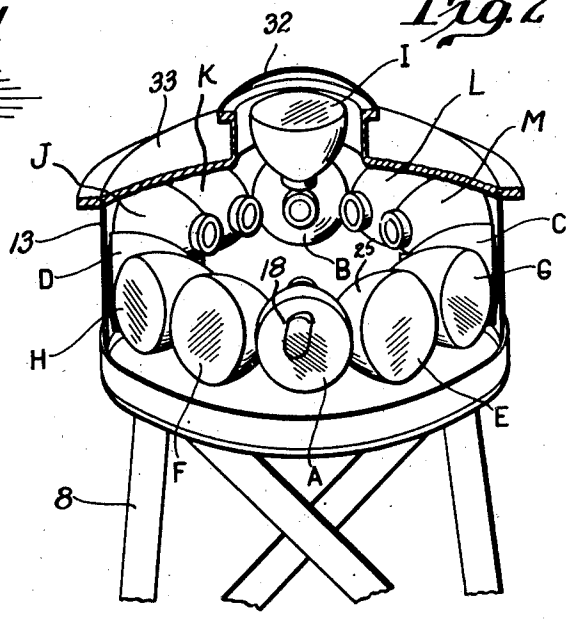
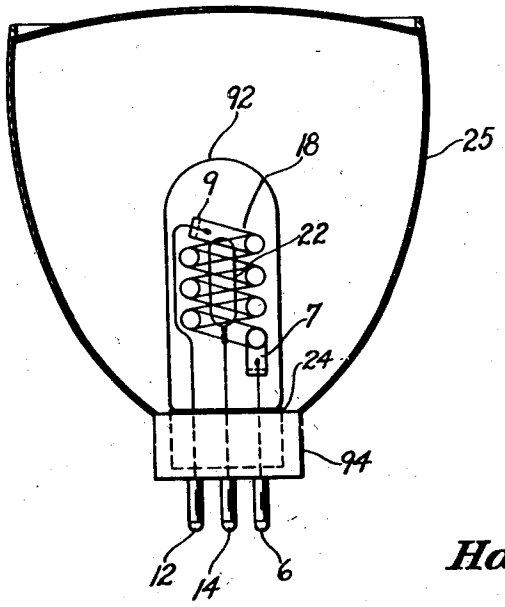


Fig. 3



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ELECTRIC SYSTEM

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Fig. 4

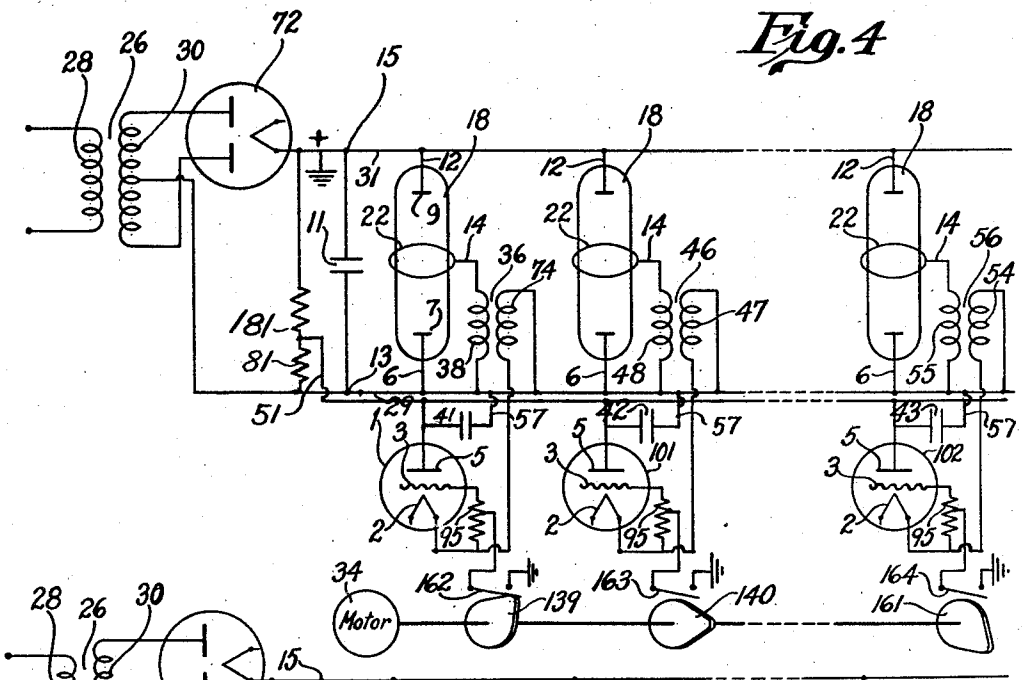
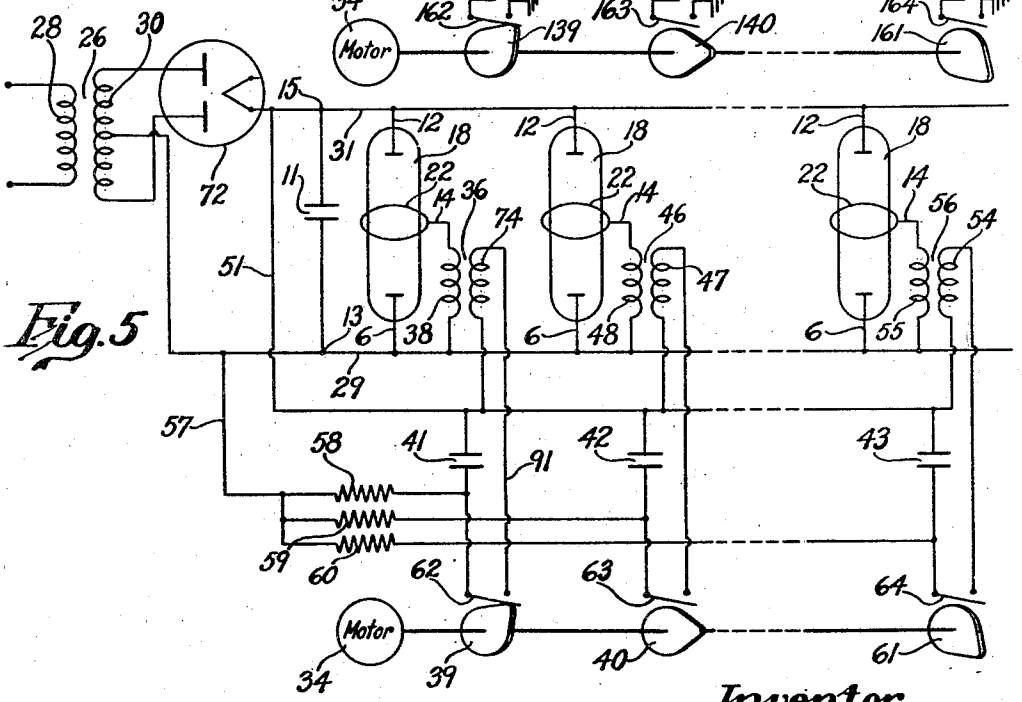


Fig. 5



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ELECTRIC SYSTEM

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Application November 19, 1943, Serial No. 510,984

17 Claims. (Cl. 177—329)

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The present invention relates to electric systems, and more particularly to flash-producers. From a more specific aspect, the invention relates to flash-producing beacons, such as are used at airfields to signal or otherwise attract the attention of aviators in airplanes.

Present-day airway beacon lights are of the rotary beam type, which sweep a beam of light through a complete revolution in about ten seconds. The reflector that produces the beam is rotated mechanically at the top of a signal pole.

An object of the present invention is to produce a beam that apparently rotates, but without any moving parts except, possibly, for a simple timing circuit. Another object is to give the illusion of a beam of light traveling rapidly along some other configuration than in azimuth.

Since power at desired sites is often at a premium, another object is to produce a more efficient beacon.

A still further object is to provide a new and improved beacon that shall have a wider beam, in order that it may be more easily detected from an incoming plane.

Another object is to provide a new and improved beacon that shall be capable of operating at higher flashing rates.

Another object is to provide a new and improved beacon that shall be reliable in operation.

Other and further objects will be explained hereinafter, and will be particularly pointed out in the appended claims.

With the above ends in view, a feature of the invention resides in employing a number of flash-lamps arranged according to a predetermined configuration, and illuminated rapidly, in predetermined sequence or succession, by discharging high-tension condenser means through the spaced flash-lamps, rapidly in predetermined sequence or succession. As all the energy of the discharge-condenser means is thus expended, at any particular time, in producing a flash, high-intensity flashes are thus produced for very short periods of time. The energy of the condenser means is replenished by charging it before each discharge thereof. The number of flash-lamps is sufficiently large and the flashing is sufficiently rapid to give the illusion of a beam of light traveling rapidly from flash-lamp to flash-lamp following the predetermined configuration. The incoming aviator is thus enabled to receive light flashes continually.

The invention will now be more particularly explained in connection with the accompanying drawings, in which Fig. 1 is a diagrammatic elevation of a beacon embodying the present invention; Fig. 2 is a fragmentary perspective, with parts broken away; Fig. 3 is a view of one of the flash-lamps, the reflector in which it is mounted being shown in longitudinal section; Fig. 4 is a diagrammatic view of circuits and apparatus embodying the invention, in preferred form; and Fig. 5 is a similar view of a modification.

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According to the specific embodiments of the invention that are herein illustrated and described, a number of flash-lamps 18 are spaced uniformly over the beacon throughout the 360 degrees of azimuth. The invention is applicable to other configurations also. In the illustrated configuration, however, the flash-lamps 18 are disposed along a circular row in a horizontal plane, within a housing having a cylindrical transparent wall 13, at the top of a beacon support 8. Each flash-lamp is mounted in a reflector 25 for directing the light of that particular flash-lamp along a particular direction of azimuth. The flash from the lamp positioned at A, for example, may be directed south, in which event the flash from the lamp positioned diametrically opposite, at B, may be directed north. The flashes from the lamps positioned at C and D may similarly be directed east and west, respectively. Two flash-lamps positioned at E and F, on opposite sides of, and adjacent to, the flash-lamp positioned at A, will direct flashes in corresponding directions: the lamp positioned at E will direct a flash between south and south-east, and the lamp positioned at F will direct its flash between south and south-west. The lamp positioned at G will produce a flash in a direction between east and south-east, and the lamp positioned at H in a direction between west and south-west. The lamps positioned at J, K, L and M will send their flashes in directions opposite to the directions of flash of the lamps positioned at G, E, F and H, respectively. As many lamps as desired may be provided, each with a reflector for directing the flash in a particular direction of azimuth. It is convenient to employ also a further flash-lamp, shown positioned at I, for directing its flash upward through a transparent portion 32 of the upper wall 33 of the housing at the top of the support 8. This lamp is particularly useful in foggy weather.

Each flash-lamp 18 is of the gaseous-discharge type. The flashes through the flash-lamps 18 are produced by discharging therethrough the electric energy stored in high-tension dielectric electric-energy-storage or condenser means, illustrated as a condenser 11. The condenser means

constitutes the principal source of energy for effecting the discharge of the flash-lamps; it is first charged and then discharged through the flash-lamps 18 rapidly, in predetermined sequence or succession. Surges of current are thus caused to flow rapidly, in predetermined sequence or succession, through the flash-lamps 18. Each surge of current produces a flash of high intensity in the corresponding flash-lamp 18, followed by prompt extinguishment of that flash-lamp 18 and the flashing of the next flash-lamp 18, in predetermined sequence or succession. Each flash-lamp 18 is thus rendered momentarily luminescent, to produce a flash, by the discharge of the condenser means therethrough.

Assuming, for example, that the flash-lamp positioned at C is the first to flash, the next lamp to flash will be that positioned at G, then the lamp positioned at E, then the lamps positioned at A, F, H, D, J, K, B, L and M. The lamp positioned at I will finally be flashed, after which the other lamps will be again flashed in succession, in the same order.

Let it be assumed that the incoming aviator is directly south of the beacon, and at a considerable distance therefrom. He may, in that event, observe at least the flash from the lamp positioned at A. That single flash alone will guide him to the airport. By reason of the fact that the whole energy of the condenser 11 is concentrated, at the time of the flash, in that one lamp, the flash will be of considerable intensity, with the result that he may see it at a very great distance.

As he approaches closer, the flash from the lamp positioned at A will become more intense, and he may begin to see also, though with less intensity, the flashes from the lamps positioned at E and F. As he comes closer still, he may see the flashes of other lamps also, say the lamps positioned at G and H.

The same remarks apply no matter from what direction the aviator arrives. There will always be at least one lamp flashing along his direction, or nearly so, with the greatest intensity, and perhaps other lamps flashing in slightly different directions with less intensity.

The successive flashing of the lamps along different directions of azimuth, moreover, gives the illusion of a rotating beam of light, but without the necessity for employing moving parts. The same applies to any other configuration, the nature of the illusion of the beam of light traveling from flash-lamp to flash-lamp depending upon the nature of the configuration. In the event of dense fogs or other weather conditions that would render these flashes not readily perceivable, the upwardly directed flash from the lamp positioned at I would become more visible from the reflection of the fog or other atmospheric conditions.

The preferred gaseous-discharge flash-lamp 18 may contain xenon or other suitable gas. It is shown mounted in an elongated light-permeable glass-bulb jacket or envelope 92, which is shown cemented at 24 to a flat insulating base 94, provided with three terminal pins 6, 12 and 14 projecting exteriorly thereof.

The reflector 25 is mounted upon the base 94. It may, for example, concentrate the light into a cone of approximately 30 degrees. Light so concentrated would be visible at a greater distance than the light from the same lamp without a reflector.

The flash-lamp 18 is shown provided with a cathode 7 and an anode 9, respectively connected

to the terminals 6 and 12. A high-voltage-spark trigger or trip wire control starting electrode 22 is connected to the terminal 14.

Each flash-lamp 18 is shown connected, through the medium of the terminal pins 12 and 6, across the discharge condenser 11. The terminal pins 12 are connected to a grounded terminal 15, at one side of the storage condenser 11, by a conductor 31, and the terminal pins 6 are connected to a terminal 13, at the other side of the condenser 11, by a common conductor 29.

The electric-energy-storage condenser 11 may be subjected to a voltage of, say, 2000 volts, from any direct-current supply. The preferred supply is shown as a transformer 26, the primary winding 28 of which may be connected to any desired source of alternating energy of suitable voltage and frequency, and the secondary winding 30 of which may be connected to the condenser 11 through a full-wave rectifier 72. This conveniently provides a supply of pulsating current for charging the condenser 11. The secondary winding 30 may have a high impedance for performing the normal current-limiting function of a charging impedance.

A motor 34 is illustrated as the motive power for driving a commutator switch, having as many commutating cams 39, 40, . . . 61, or 139, 140, . . . 161, as there are flash-lamps 18 to be flashed. The commutating cam 39 is designed to close a switch 62, the cam 40 a switch 63, and the cam 61 a switch 64. The commutating cams 139, 140, . . . 161 are similarly designed to close switches 162, 163, . . . 164. These switches will become momentarily closed, in sequential succession, by the corresponding cams, in response to the operation of the motor 34, and then will become reopened. The switches may be of the snap or toggle variety so that they may close with a positive action, to insure good contact in a short interval of time.

The voltage to which the condenser means is subjected by the direct-current voltage supply before each discharge thereof is insufficient to cause the condenser means to discharge between the cathodes 7 and the anodes 9 through the normally non-conductive flash-lamps 18, when non-conductive, notwithstanding the connection of the condenser means to the flash-lamps 18. The flash-lamps 18 are rendered conductive, however, to control these discharges under the control of the starting electrodes 22. The starting electrodes 22, in turn, may be energized in any desired manner, as by means of normally ineffective trigger-discharge circuits operable, when effective, to render the flash-lamps 18 conductive irrespective of the state of charge of the condenser means. This will now be explained.

In the system of Fig. 5, condensers 41, 42, . . . 43 are shown connected in respective trigger-discharge circuits to the terminals 13 and 15, in parallel with the condenser 11, by conductors 51 and 57. A resistor 58 is shown connected by the conductors 51 and 57 in series with the condenser 41, a resistor 59 in series with the condenser 42, . . . and a resistor 60 in series with the condenser 43. The condensers of Fig. 5 are all connected to the direct-current source by way of the terminals 13 and 15.

In the system of Fig. 4, however, the corresponding condensers 41, 42, . . . 43 are shown connected by the conductors 51 and 57 across a common impedance, shown as the portion 81 of a bleeder resistor. One end of the bleeder-resistor portion 81 is connected to the terminal 13,

and the other end, through a portion 181 of the bleeder resistor, to the grounded terminal 15. The bleeder-resistor portions 81 and 181 are thus connected in series across the direct-current pulsating-energy supply 26, 72. The condensers 41, 42, . . . 43 of Fig. 4 are therefore supplied with voltage, to store electric energy therein, ultimately from the same direct-current-power supply that charges the condenser 11, but directly from the bleeder-resistor 81, which constitutes their main power supply.

The condenser 11 may be discharged through the respective discharge tubes 18, as more fully explained hereinafter, by means of separate trigger circuits. The motor-driven commutator switch effects a current flow through the separate trigger circuits, in predetermined sequence, to energize the triggering transformers in succession, thus to energize the trigger electrodes 22 of the flash-lamps 18 in succession. High-voltage separate triggering sparks are thus produced to effect a discharge of the electric-energy-storage condenser 11 through the corresponding luminescent-discharge devices 18, in succession. This is effected through the medium of separate triggering transformers, three of which are shown at 36, 46 and 56. Each lamp 18 is provided with one such triggering transformer. The transformer 36 is shown provided with a primary winding 74 and a secondary winding 38; the transformer 46 with a primary winding 47 and a secondary winding 48; . . . and the transformer 56 with a primary winding 54 and a secondary winding 55. One side of each of the secondary windings 38, 48, . . . 55, is connected to the terminal 13 by the conductor 29. The other sides of the secondary windings 38, 48, . . . 55 are respectively connected to the terminals 14 of the triggering starting electrodes 22. A separate trigger circuit is thus provided for each control electrode 22. The connections of the primary windings of the transformers are not the same in the systems of Figs. 4 and 5. Referring first to Fig. 5, the primary winding 74 of the transformer 36 is shown connected across the condenser 41, in series with the switch 62, by a conductor 91; the primary winding 47 of the transformer 46 is similarly shown connected across the condenser 42, in series with the switch 63; . . . and the primary winding 54 of the transformer 56 is similarly shown connected across the condenser 43, in series with the switch 64.

Each condenser 41, 42, . . . 43 is thus connected in its discharge circuit with the primary winding of its transformer. Similar connections to the additional flash-lamps 18, not shown, will be made through similar transformers, not shown.

According to the preferred embodiment of the invention shown in Fig. 4, however, the condensers 41, 42, . . . 43 are connected to the respective primary windings 74, 47, . . . 54 by means of triggering circuits comprising normally ineffective, because non-conducting, thyratrons or other gaseous-discharge trigger tubes 1, 101, . . . 102, connected in series with the condensers 41, 42, . . . 43 and with the primary windings 74, 47, . . . 54. A preferred trigger tube may be of the cold-cathode gaseous-discharge type illustrated and described in Letters Patent 2,185,189, 2,201,166 and 2,201,167, issued to Kenneth J. Germeshausen on January 2 and May 21, 1940. It may comprise an evacuated glass envelope containing several electrodes, namely, a solid cold cathode 2, an anode or plate 5 and one or more control electrodes 3. With tubes of this type, the current required by the switches 162, 163, . . . 164 becomes negligible, and wear due to arcing is thereby reduced, so that long life is enjoyed. An impedance 95 is shown connected between the cathode 2 and the control electrode 3.

The discharge circuits of the condensers 41, 42, . . . 43 thus contain the respective tubes 1, 101, . . . 102 and the respective primary windings. These tubes 1, 101, . . . 102 may be operated in succession, in response to the closing of the switches 162, 163 . . . 164, respectively, as hereinafter more fully described, to discharge through the respective primary windings 74, 47, . . . 54, thereby to flash their respective flash-lamps 18 at the desired instants.

In operation, in the systems of both Figs. 4 and 5, the condenser 11 starts to become charged from the direct-current source 26, 72. The tube 1 is at this time non-conductive. The condenser 41 becomes charged, at the same time, through the resistor 81 and the primary winding 74. In the system of Fig. 4, upon the momentary closing of the switch 162, by the commutator cam 139, the potential of the control electrode 3 of the tube 1 becomes raised until the breakdown voltage between the control electrode 3 and the cathode is exceeded, whereupon the trigger tube 1 becomes conducting. The condenser 41, which has previously become charged from the rectifier supply 26, 72 of pulsating current, then discharges through the previously-described trigger-condenser-discharge circuit comprising the tube 1 and the primary winding 74. The same discharge of the condenser 41, through the primary winding 74, takes place in the system of Fig. 5 upon the momentary closing of the switch 62 by the commutator cam 39. In both systems, the resulting voltage-surge pulse of the secondary winding 38 of the transformer 36 will thereupon become applied to energize the trigger electrode 22 of the corresponding flash tube 18; this tripping of the trigger-discharge circuit for the condenser 41 will cause the gas in the corresponding flash-lamp 18 to become ionized, producing a conducting path through the corresponding luminescent-discharge device 18, and permitting the condenser 11 to discharge therethrough, between the cathode 7 and the anode 9 thereof. The resulting high-voltage discharge through this lamp 18 will produce a very brilliant flash of light of short duration. When the condenser 11 becomes fully discharged, this lamp 18 becomes extinguished, and the condenser 11 again becomes charged from the rectifier supply 26, 72 of pulsating current, prior to its next discharge through its flash-lamp 18.

The switch 63 or 163 becomes thereafter momentarily closed, to effect a similar discharge, in similar manner, of the condenser 42 through the primary winding 47 of the transformer 46. The secondary winding 48 of the transformer 46 will thereupon similarly energize the starting electrode 22 of the next lamp 18 to be flashed.

Upon the extinguishment of this next lamp 18, the next commutating cam will effect the closing of the next switch; and so on, until the cam 61 or 161 operates the last switch 64 or 164, whereupon the last condenser 43 will discharge through the primary winding 54 of the transformer 56. The secondary winding 55 will thereupon effect a discharge of the condenser 11 through the last lamp 18, thus causing the flashing of this last lamp 18.

The control electrodes 22 will also become energized, in very rapid succession, in this manner, to cause the flash-lamps 18 to become flashed very rapidly in succession, as before described. The flashing cycle will then recommence.

Instead of employing the switches 102, 103 and 104, the tubes 1, 101, . . . 102 may be controlled through the medium of well known electrical time-delay circuits for rendering each lamp responsible for starting the succeeding lamp after a predetermined time delay.

In accordance with the present invention, therefore, a very effective beacon is provided, far more powerful than present-day beacons, yet requiring less power and maintenance, and employing only a single small condenser 11 for providing the flashing energy in all directions, both in azimuth and upward.

Further modifications will occur to persons skilled in the art and all such are considered to fall within the spirit and scope of the present invention as defined in the appended claims.

What is claimed is:

1. A flash-producing system having, in combination, a plurality of flash-lamps each provided with a cathode, an anode and a control electrode, each flash-lamp being provided with a transformer for energizing the corresponding control electrode, a condenser for discharging through the flash-lamps between the anodes and the cathodes thereof to cause the flash-lamps to flash, means for charging the condenser before each discharge, and a motor-driven switch for energizing the transformers in succession to energize the corresponding control electrodes in succession, thereby to discharge the condenser through the flash-lamps in succession.

2. A flash-producing system having, in combination, a plurality of flash-lamps each provided with a cathode, an anode and a control electrode, each flash-lamp being provided with a transformer for energizing the corresponding control electrode, a discharge device for controlling the corresponding transformer, a condenser for discharging through the flashlamps between the anodes and the cathodes thereof to cause the flash-lamps to flash, means for charging the condenser before each discharge, and means for controlling the discharge devices rapidly in succession to energize the transformers in rapid succession, thereby to energize the corresponding control electrodes rapidly in succession, whereby the condenser will be discharged through the flash-lamps rapidly in succession.

3. An electric system having, in combination, a plurality of discharge devices each having a control electrode, the discharge devices being each adapted to produce a light flash in response to the discharge of energy therethrough, dielectric storage means constituting the principal source of energy for effecting the discharge of said discharge devices and adapted to discharge substantially all the energy stored therein at each discharge, means for charging the storage means before each discharge, separate trigger circuits for the respective discharge devices, a plurality of storage means, one corresponding to each trigger circuit, and means for effecting discharges of the plurality of storage means in the respective trigger circuits in a predetermined sequence to control the respective control electrodes in order to effect the discharge of energy through the respective discharge devices from the dielectric storage means in a predetermined sequence.

4. A flash-producing system having, in combination, a plurality of flash-lamps each provided with a cathode, an anode and a control electrode, condenser means for discharging through the flash-lamps between the anodes and the cathodes thereof to cause the flash-lamps to flash, means for charging the condenser means before each discharge, and motor-driven switch means for energizing the control electrodes in succession, thereby to discharge the condenser means through the flash-lamps in succession.

5. A flash-producing system having, in combination, a plurality of flash-lamps, electric-energy-storage means for discharging electric energy through the flash-lamps to cause the flash-lamps to flash, means for directing the flashes in different directions of azimuth, means for storing electric energy in the electric-energy-storage means, and means for discharging electric energy from the electric-energy-storage means through the flash-lamps in succession, the number of flash-lamps being sufficiently large and the electric-energy-discharging means being operated rapidly enough to give the illusion of a rapidly rotating beam of light.

6. A flash-producing beacon having, in combination, a support, a plurality of flash-lamps each provided with a cathode, an anode and a control electrode, electric-energy-storage means for discharging electric energy through the flash-lamps between the anodes and the cathodes thereof to cause the flash-lamps to flash, the flash-lamps being spaced uniformly on the support in a horizontal plane and being provided with reflectors for directing their respective flashes along different directions of azimuth in the plane, means for storing electric energy in the electric-energy-storage means, and means for energizing the control electrodes in succession, thereby to discharge electric energy from the electric-energy-storage means through the flash-lamps in succession, the number of flash-lamps being sufficiently large and the energizing means being operated rapidly enough to give the illusion of a rapidly rotating beam of light.

7. An electric system having, in combination, a circuit including condenser means and a plurality of normally non-conductive discharge devices, means connecting the condenser means to the discharge devices to discharge the condenser means through the discharge devices when conductive, means for charging the condenser means before each discharge to a voltage insufficient to cause the discharge of the condenser means through the discharge devices while non-conductive notwithstanding the connection of the condenser means to the discharge devices, normally ineffective means operable when effective to render the discharge devices conductive irrespective of the state of charge of the condenser means, and means for rendering the normally ineffective means effective rapidly in sequence to render the discharge devices conductive rapidly in sequence to discharge the condenser means through the discharge devices rapidly in sequence.

8. A light-flash-producing system having, in combination, a circuit including condenser means and a plurality of normally non-conductive flash-lamps each adapted to produce light flashes in response to the discharge of electric energy therethrough when conductive, means connecting the condenser means to the flash-lamps to discharge the condenser means through the flash-lamps when conductive, means for charging the condenser means before each discharge to a voltage

insufficient to cause the discharge of the condenser means through the flash-lamps while non-conductive notwithstanding the connection of the condenser means to the flash-lamps, normally ineffective means operable when effective to render the flash-lamps conductive irrespective of the state of charge of the condenser means, and means for rendering the normally ineffective means effective rapidly in sequence to render the flash-lamps conductive rapidly in sequence to discharge the condenser means through the flash-lamps rapidly in sequence, thereby to cause the flash-lamps to produce light flashes rapidly in sequence.

9. A light-flash-producing system having, in combination, a circuit including condenser means and a plurality of normally non-conductive flash-lamps each provided with a cathode, an anode and a control electrode and each adapted to produce light flashes in response to the discharge of electric energy therethrough between its anode and its cathode when rendered conductive under the control of its control electrode, means connecting the condenser means to the anodes and the cathodes of the flash-lamps to discharge the condenser means through the flash-lamps when conductive between the anodes and the cathodes thereof, means for charging the condenser means before each discharge to a voltage insufficient to cause the discharge of the condenser means through the flash-lamps while non-conductive notwithstanding the connection of the condenser means to the anodes and the cathodes of the flash-lamps, and means for energizing the control electrodes rapidly in sequence to render the flash-lamps conductive rapidly in sequence to discharge the condenser means through the flash-lamps between the anodes and the cathodes thereof rapidly in sequence, thereby to cause the flash-lamps to produce light flashes rapidly in sequence.

10. A light-flash-producing system having, in combination, a circuit including condenser means and a plurality of normally non-conductive flash-lamps each adapted to produce light flashes in response to the discharge of electric energy therethrough when conductive, each flash-lamp being provided with a transformer, means connecting the condenser means to the flash-lamps to discharge the condenser means through the flash-lamps when conductive, means for charging the condenser means before each discharge to a voltage insufficient to cause the discharge of the condenser means through the flash-lamps while non-conductive notwithstanding the connection of the condenser means to the flash-lamps, and means for energizing the transformers rapidly in sequence to render the flash-lamps conductive rapidly in sequence to discharge the condenser means through the flash-lamps rapidly in sequence, thereby to cause the flash-lamps to produce light flashes rapidly in sequence.

11. A light-flash-producing system having, in combination, a circuit including condenser means and a plurality of normally non-conductive flash-lamps arranged according to a predetermined configuration and each adapted to produce light flashes in response to the discharge of electric energy therethrough when conductive, means connecting the condenser means to the flash-lamps to discharge the condenser means through the flash-lamps when conductive, means for charging the condenser means, and means for rendering the flash-lamps conductive rapidly in sequence to discharge the condenser means through the flash-lamps rapidly in sequence, thereby to cause the flash-lamps to produce light flashes rapidly in sequence, the number of flash-lamps being sufficiently large and the operation of the rendering means being sufficiently rapid to give the illusion of a beam of light traveling rapidly from flash-lamp to flash-lamp following the predetermined configuration.

12. A light-flash-producing system having, in combination, a circuit including condenser means and a plurality of normally non-conductive flash-lamps arranged according to a predetermined configuration and each adapted to produce light flashes in response to the discharge of electric energy therethrough when conductive, means connecting the condenser means to the flash-lamps to discharge the condenser means through the flash-lamps when conductive, means for charging the condenser means before each discharge to a voltage insufficient to cause the discharge of the condenser means through the flash-lamps while non-conductive notwithstanding the connection of the condenser means to the flash-lamps, and means for rendering the flash-lamps conductive rapidly in sequence to discharge the condenser means through the flash-lamps rapidly in sequence, thereby to cause the flash-lamps to produce light flashes rapidly in sequence, the number of flash-lamps being sufficiently large and the operation of the rendering means being sufficiently rapid to give the illusion of a beam of light traveling rapidly from flash-lamp to flash-lamp following the predetermined configuration.

13. A light-flash-producing system having, in combination, a circuit including condenser means and a plurality of normally non-conductive flash-lamps arranged according to a predetermined configuration each provided with a cathode, an anode and a control electrode and each adapted to produce light flashes in response to the discharge of electric energy therethrough between its anode and its cathode when rendered conductive under the control of its control electrode, means connecting the condenser means to the anodes and the cathodes of the flash-lamps to discharge the condenser means through the flash-lamps when conductive between the anodes and the cathodes thereof, means for charging the condenser means before each discharge to a voltage insufficient to cause the discharge of the condenser means through the flash-lamps while non-conductive notwithstanding the connection of the condenser means to the anodes and the cathodes of the flash-lamps, and means for energizing the control electrodes rapidly in sequence to render the flash-lamps conductive rapidly in sequence to discharge the condenser means through the flash-lamps between the anodes and the cathodes thereof rapidly in sequence, thereby to cause the flash-lamps to produce light flashes rapidly in sequence, the number of flash-lamps being sufficiently large and the energizing of the control electrodes being sufficiently rapid to give the illusion of a beam of light traveling rapidly from flash-lamp to flash-lamp following the predetermined configuration.

14. A light-flash-producing system having, in combination, a circuit including condenser means and a plurality of normally non-conductive flash-lamps arranged according to a predetermined configuration and each adapted to produce light flashes in response to the discharge of electric energy therethrough when conductive, each flash-lamp being provided with a transformer, means connecting the condenser means to the

flash-lamps to discharge the condenser means through the flash-lamps when conductive, means for charging the condenser means before each discharge to a voltage insufficient to cause the discharge of the condenser means through the flash-lamps while non-conductive notwithstanding the connection of the condenser means to the flash-lamps, and means for energizing the transformers rapidly in sequence to render the flash-lamps conductive rapidly in sequence to discharge the condenser means through the flash-lamp rapidly in sequence, thereby to cause the flash-lamps to produce the light flashes rapidly in sequence, the number of flash-lamps being sufficiently large and the energizing of the transformers being sufficiently rapid to give the illusion of a beam of light traveling rapidly from flash-lamp to flash-lamp following the predetermined configuration.

15. A light-flash-producing system having, in combination, a circuit including condenser means and a plurality of normally conductive flash-lamps arranged according to a predetermined configuration each provided with a cathode, an anode and a control electrode and each adapted to produce light flashes in response to the discharge of electric energy therethrough between its anode and its cathode when rendered conductive under the control of its control electrode, each flash-lamp being provided with a transformer for energizing the corresponding control electrode, means connecting the condenser means to the anodes and the cathodes of the flash-lamps to discharge the condenser means through the flash-lamps when conductive between the anodes and the cathodes thereof, means for charging the condenser means before each discharge to a voltage insufficient to cause the discharge of the condenser means through the flash-lamps while non-conductive notwithstanding the connection of the condenser means to the anodes and the cathodes of the flash-lamps, and means for energizing the transformers rapidly in sequence to energize the corresponding control electrodes rapidly in sequence to render the flash-lamps conductive rapidly in sequence to discharge the condenser means through the flash-lamps between the anodes and the cathodes thereof rapidly in sequence, thereby to cause the flash-lamps to produce light flashes rapidly in sequence, the number of flash-lamps being sufficiently large and the energizing of the transformers being sufficiently rapid to give the illusion of a beam of light traveling rapidly from flash-lamp to flash-lamp following the predetermined configuration.

16. A light-flash-producing system having, in combination, a circuit including condenser means and a plurality of normally non-conductive flash-lamps arranged according to a predetermined configuration and each adapted to produce light flashes in response to the discharge of electric energy therethrough when conductive, means connecting the condenser means to the flash-lamps to discharge the condenser means through the flash-lamps when conductive, means for charging the condenser means before each discharge to a voltage insufficient to cause the discharge of the condenser means through the flash-lamps while non-conductive notwithstanding the connection of the condenser means to the flash-lamps, trigger-circuit means connected to the flash-lamps, and means for rapidly triggering the trigger circuit means to render the flash-lamps conductive rapidly in sequence to discharge the condenser means through the flash-lamps rapidly in sequence, thereby to cause the flash-lamps to produce light flashes rapidly in sequence, the number of flash-lamps being sufficiently large and the triggering operation being sufficiently rapid to give the illusion of a beam of light traveling rapidly from flash-lamp to flash-lamp following the predetermined configuration.

17. A light-flash-producing system having, in combination, a circuit including condenser means and a plurality of normally non-conductive flash-lamps arranged according to a predetermined configuration and each adapted to produce light flashes in response to the discharge of electric energy therethrough when conductive, means connecting the condenser means to the flash-lamps to discharge the condenser means through the flash-lamps when conductive, means for charging the condenser means before each discharge to a voltage insufficient to cause the discharge of the condenser means through the flash-lamps while non-conductive notwithstanding the connection of the condenser means to the flash-lamps, separate trigger-circuit means connected to the respective flash-lamps, and means for operating the separate trigger-circuit means rapidly in sequence to render the flash-lamps conductive rapidly in sequence to discharge the condenser means through the flash-lamps rapidly in sequence, thereby to cause the flash-lamps to produce light flashes rapidly in sequence, the number of flash-lamps being sufficiently large and the triggering operation being sufficiently rapid to give the illusion of a beam of light traveling rapidly from flash-lamp to flash-lamp following the predetermined configuration.

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