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D. G. GRESHAM

3,495,128

RANDOM POWER GATE

Filed Jan. 7, 1966

FIG. 1.

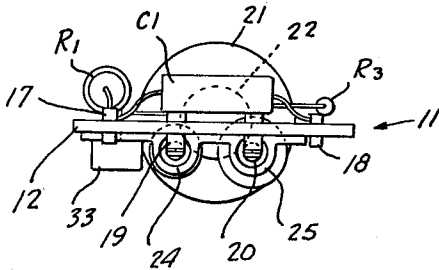


FIG. 3.

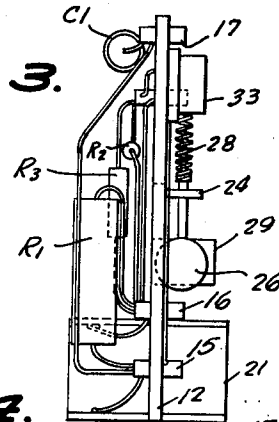


FIG. 2.

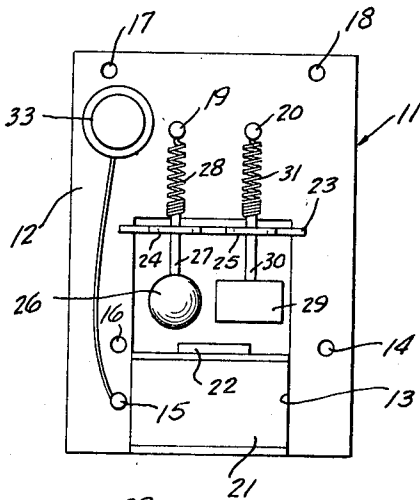


FIG. 4.

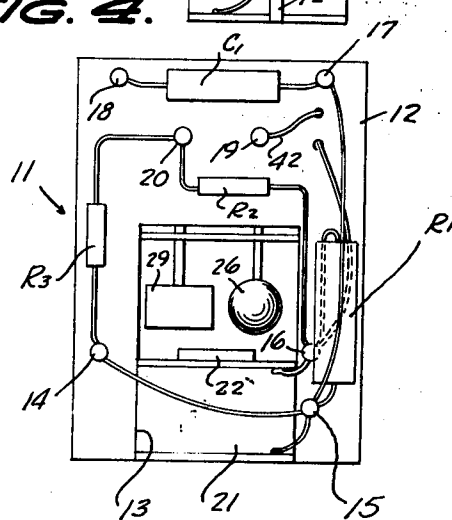


FIG. 5.

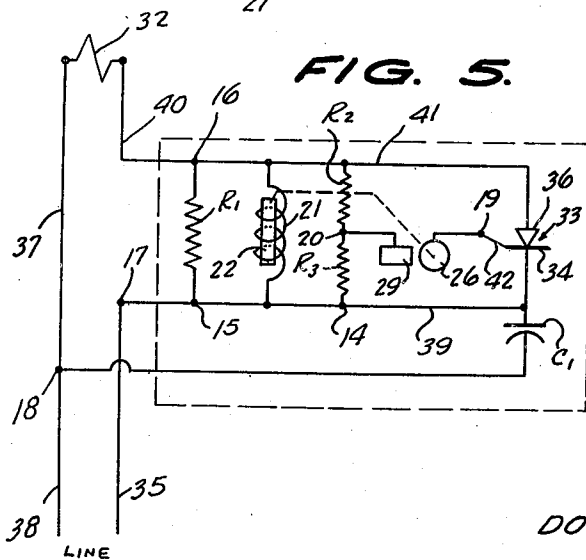
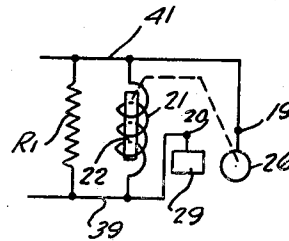


FIG. 6.



INVENTOR.
DOUGLAS G. GRESHAM,
BY

Berman, Davidson & Berman
ATTORNEYS.

1

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RANDOM POWER GATE

Douglas G. Gresham, 138 Eastholm Road,
Schenectady, N.Y. 12304

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10 Claims

ABSTRACT OF THE DISCLOSURE

A random-gated power controller for generating a flickering action in an electric lamp simulating candlelight. The controller consists of a pair of freely swingable conductive massive bodies, one of them magnetic, suspended adjacent and offset from an electromagnet. When the electromagnet is energized, it drives the magnetic conductive body into striking contact with the other conductive body, causing mutual rebound. The bodies are connected so as to shunt the electromagnet when they engage each other. The bodies also shunt a resistor in series with the lamp, causing corresponding variations in the current supplied to the lamp. The bodies swing in orbital paths relative to the electromagnet.

This invention relates to electrical power-gating devices, and more particularly to a device for providing random-gating action to an electrical load, for example, to an incandescent electric light bulb to provide a flickering action intended to simulate the flickering action of an open flame such as that which is obtained from a candle.

A main object of the invention is to provide a novel and improved gated-power controller possessing electrical characteristics which are truly random in all three parameters of amplitude, frequency and phase, and which is particularly suitable for random modulation of a predetermined portion of the power connected to an incandescent lamp, whereby the resulting power fluctuations produce an unsteady faltering light output from the lamp, creating the illusion of open flame, the random-gating device being applicable for use with appropriate lighting fixtures, such as candelabras, outdoor post lanterns, wall-mounted coach lamps, and similar decorative sources of illumination, the result obtained by the use of the random power-gating device enhancing, to a very significant degree, the decorative effects provided by the associated fixtures.

A further object of the invention is to provide an improved random power-gating device which is especially useful in conjunction with light-producing loads, such as incandescent electric lamps to produce a flickering or unsteady light output, creating the illusion of open flame, and which is also useful, when connected to capacitive or conductive loads or in combinations thereof, to generate broad-band radio-frequency energies having random, non-repetitive characteristics, namely, for generating "white noise."

A still further object of the invention is to provide an improved random power-gating device which is relatively simple in construction, which is compact in size, which employs relatively inexpensive components, which is durable in construction, which is capable of operating lamp loads over a very wide range, which requires no adjustments throughout its life, and which is operable over wide ambient temperature ranges so that it can be used outdoors under the most severe weather extremes with practically no perceptible change in its operational characteristics.

A still further object of the invention is to provide an improved random power-gating device which is reliable in operation, which is relatively insensitive to ordinary ambient conditions of vibration and shock, which provides

2

consistent reliable operation over long periods of time, which provides a truly random power supply to its load, whereby the output thereof is truly random in form, containing a relatively gentle flicker rather than a relatively continuous sputtering effect, and which produces relatively negligible radio-frequency interference.

A still further object of the invention is to provide an improved random power-gating device for use in modulating the power supply to a light-producing source, such as an incandescent lamp, to cause the source to generate a flickering or wavering light output simulating that provided by an open flame, the power-gating device maintaining a high level of light output while, at the same time, providing the desired flame-simulation, as well as sufficiently limiting the range of power fluctuations and the rate of such power fluctuations so as not to cause deterioration or reduction in life of the lamps with which it is employed.

Further objects and advantages of the invention will become apparent from the following description and claims, and from the accompanying drawing, wherein:

FIGURE 1 is a top plan view of an improved random power-gating device constructed in accordance with the present invention.

FIGURE 2 is a front elevational view of the power-gating device shown in FIGURE 1.

FIGURE 3 is a side elevational view of the power-gating device of FIGURES 1 and 2.

FIGURE 4 is a rear elevational view of the power-gating device of FIGURES 1, 2 and 3.

FIGURE 5 is a wiring diagram schematically illustrating the electrical connections of the various components of the random power-gating device of FIGURES 1 to 4.

FIGURE 6 is a partial circuit diagram showing a modification of the present invention.

Referring to the drawing, **11** generally designates an improved random power-gating device constructed in accordance with the present invention. The device **11** comprises a generally rectangular main supporting plate **12** of insulating material formed with a large rectangular notch **13** opening at its bottom end. Secured to the plate **12** are a plurality of metal terminals **14** to **18** which are employed as terminal connections for the respective electrical components of the apparatus. A pair of additional terminal members **19** and **20** are secured to plate **12** above the notch **13**, the terminals **19** and **20** being spaced horizontally and being employed both as supports for certain mechanical components of the apparatus, and also as electrical terminals, as will be presently described.

Secured in the bottom of notch **13**, namely, secured in the open bottom end of said notch, is a vertically-arranged electromagnet **21** provided at its top end with the exposed pole piece **22**. Transversely-secured over the top portion of the notch **13** is a horizontal bar member **23** of suitable insulating material formed with spaced outwardly-projecting guide ring elements **24** and **25** located below and substantially in vertical registry with the terminal members **19** and **20**. A spherical ball **26** of ferrous magnetic material is suspended resiliently from the terminal member **19**. Thus, the ball **26** is provided with the upwardly-extending supporting rod **27**. A coiled spring **28** connects the top end of rod **27** to the terminal member **19**. Thus, the ferrous sphere **26** of magnetic material is suspended from the terminal element **19** and normally is located in a position above and adjacent to the pole piece **22**, but displaced laterally a short distance from the vertical center line of the pole piece namely, spaced laterally to the left of the pole piece vertical center line as viewed in FIGURE 2.

Similarly mounted over the pole piece **22**, but spaced to the right of the vertical center line of the pole piece **22** is a vertically-arranged cylindrical block **29** of non-

3

magnetic metal, the block 29 being provided with the upwardly-extending, axially-connected supporting rod 30 whose top end is connected by a coiled spring 31 to the terminal member 20. The vertical cylindrical block 29 is thus supported adjacent to the sphere 26 over the pole piece 22, being located in the path of oscillation of the sphere 26 and thus being subject to impact by said sphere. Conversely, the sphere 26 is subject to impact by the non-magnetic metal block 29 when said metal block oscillates.

The rod element 27 and the spring 28 are electrically-conductive, and similarly, the rod element 30 and the spring 31 are electrically-conductive, so that the spherical member 26 is electrically-connected to the terminal 19 and the cylindrical block 29 is electrically-connected to the terminal 20. The springs 28 and 31 bias the members 26 and 29 to normal positions similar to that illustrated in FIGURE 2, the top ends of the springs being rigidly-connected to the respective terminal members 19 and 20 and the lower ends of the springs being clampingly-secured on the top ends of the rods 27 and 30. The springs 28 and 31 thus serve as flexible supports for the members 26 and 29 and also as means to develop a restoring torque for urging the members 26 and 29 toward their normal positions when said members are displaced therefrom. The spherical member 26 is sufficiently offset from the center line of the pole piece 22 so that it tends to swing toward said center line responsive to the energization of the solenoid 21, and has sufficient inertia to engage the non-magnetic cylindrical block 29 with substantial impact as it swings to the right from the position thereof shown in FIGURE 2. When the impact is delivered to the block 29, the block 29 responds thereto by also swinging to the right from its normal position shown in FIGURE 2. The spring 31, however, acts upon block 29 to return it to the left from its outwardly-swung position. Spring 28 also acts in a similar manner to return the spherical member 26 toward its normal position when it has been displaced either to the right or to the left of the position thereof shown in FIGURE 2.

Mounted on remaining portions of the main supporting plate 12 are additional elements interconnected with the solenoid 21, the spherical member 26, and the block 29 to form a driving circuit arranged to cause the spherical member 26 and the cylinder block member 29 to interengage and disengage in a random manner. FIGURE 5 illustrates the circuitry of the device 11, showing the device connected to a typical load, namely, an incandescent lamp 32. Designated at 33 is a silicon-controlled rectifier. The silicon-controlled rectifier 33 is mounted on the upper portion of the main supporting plate 12, as shown in FIGURE 2. The base electrode 34 of the silicon-controlled rectifier 33 is connected to a first alternating current-supply wire 35 and the output electrode 36 of the rectifier is connected to one terminal of the incandescent lamp 32, as shown at 16. The remaining terminal of the incandescent lamp 32 is connected to terminal 18 by a wire 17, the remaining line wire 38 being connected to said terminal 18. As shown in FIGURE 5, the first-mentioned supply-line wire 35 is connected to the terminal 17 to which is connected a conductor 39 leading to the base 34 of the silicon-controlled rectifier 33, the terminals 15 and 14 being likewise connected to said wire 39. Thus, the line wires from the supply source of alternating current are connected across the terminals 17 and 18 and the load, namely, the incandescent lamp 32, is connected across the terminals 16 and 18. The lead wires from the load 32 are shown at 37 and 40.

The lead wire from the output electrode 36 of the silicon-controlled rectifier 33 is shown at 41. Connected across the terminals 15 and 16, and thus, connected across wire 39 and 41 is a resistor R1, and also connected across wires 41 and 39 is the electromagnetic winding 21. Connected across terminals 20 and 16, namely,

4

between terminal 20 and conductor 41, as shown in FIGURE 5, is a resistor R2, and connected between terminals 20 and 14 is another resistor R3. The cylindrical block member 29 is connected to the junction terminal 20 through the rod 30 and the spring 31 as shown in FIGURE 2. The spherical magnetic ball 26 is connected to the terminal 19 through the rod 27 and the spring 28, as shown in FIGURE 2. A radio-frequency filter-capacitor C1 is connected across the terminals 17 and 18, serving as a shunt for radio-frequency energy so as to substantially eliminate radio-frequency interference from the device.

The gate electrode of the silicon-controlled rectifier 33 is connected by a wire 42 to a terminal 19, and thus, is connected to the magnetic spherical ball 26.

In operation, when the conductors 35 and 38 are connected to the terminals of the alternating current-power source, current flows through the load 32 and also through the electromagnetic winding 21, generating a magnetic field at the pole piece 22 which attracts the magnetic ball 26 causing it to move rapidly toward the center line of the pole piece. In so doing, it collides at an oblique angle with the cylindrical block 29, accelerating the block 29 into an orbital path and also causing alteration of the path of movement of the spherical ball 26. When ball 26 engages block 29 the gate electrode of the silicon-controlled rectifier 33 is connected to the junction terminal 20 between resistors R2 and R3 which applies gating voltage to the silicon-controlled rectifier, which turns on the silicon-controlled rectifier for a portion of a half-cycle of current. During this period, substantially all of the current flow of the branch circuit between conductors 41 and 39 is through the silicon-controlled rectifier. Consequently, the current through resistor R1 and the electromagnetic winding 21 is reduced to nearly zero, causing the magnetic field at pole piece 22 to collapse substantially to zero. The rebound inertia of the bodies 26 and 29 disengages them and moves them away from each other, and hence, removes the control voltage from the gate electrode of the silicon-controlled rectifier, thus returning the silicon-controlled rectifier to a non-conductive state, which restores current flow through the electromagnetic winding 21, restoring the magnetic field at the pole piece 22. Hence, the magnetic field again affects the path of movement of the spherical ball 26 which causes it to swing back and again collide with the block 29. Repeated collisions of this type occur at different times and at different orbital positions of the members 26 and 29 and producing changes in the elliptical orbits which shift their vectors continuously over complete 360° cycles.

Due to the many dependent variables which are present in the system, namely, acceleration, inertia, contact resistance, velocity, and magnetic orbital flight paths, associated with the magnetic ball 26, collisions constantly occur, correspondingly gating the silicon-controlled rectifier 33 so as to cause a fluctuating magnetic field at the pole piece 22, which correspondingly acts on the magnetic ball 26, which, in turn, affects the magnitude of its impact at collision with the block 29, producing a random dynamic condition wherein the silicon-controlled rectifier 33 is gated by a multiplicity of random collisions. This causes random conduction of the silicon-controlled rectifier 33, producing a random low-resistance path for the current flowing to the incandescent lamp load 32. These variations in current flow and voltage drop appear as random variations in the light output from the lamp 32.

While it is quite difficult to analyze the action of the device above-described, it is to be noted that the primary and secondary moving parts 26 and 29 are continually seeking a naturally steady state. Under the influence of the fluctuating magnetic field, the variations of which are determined by the frequency of the collisions between the members 26 and 29, the members are directly and indirectly forced away from their steady-state positions,

The opposing forces between them being directed in accordance with their proximity to their steady-state points. In other words, the further the bodies 26 and 29 are away from their steady-state positions, the less the average opposing force between them becomes; the closer to their steady-state positions, the greater the average opposing force between them becomes. The members 26 and 29 are continually orbiting between these two extremes. Their interaction results in a highly unstable electro-mechanical condition which is reflected in the random gating of the silicon-controlled rectifier 33. The resulting power fluctuations produce an unsteady faltering light output from the lamp 32 creating the illusion of an open flame. When the lamp 32 is employed with an appropriate lighting fixture, such as in a candelabra, an outdoor post lantern, a wall-mounted coach lamp, or a similar decorative fixture, the end effect enhances to a very significant degree the charm and beauty for which these fixtures were originally designed.

In low-power applications of the random-gate device, such as for use as a radio-frequency noise generator, namely, a "white noise" generator, the silicon-controlled rectifier 33 may be omitted; in this case the members 29 and 26 are connected directly across the electromagnetic winding 21 and the resistors R2 and R3 are omitted. This modification is illustrated in FIGURE 6.

It will be noted that in the arrangement illustrated in FIGURES 1 to 5, a substantial current flows through the load 32 even when the members 29 and 26 are separated, thus maintaining usable light output from the lamp 32, even at the lowest illumination level of the lamp. It is to be further noted that since the range of the power gating never applies more than approximately 90% of the rated voltage to the lamp, the lamp life is significantly extended. Also, since the lamp is never open-circuited completely, and is provided with a substantial amount of current even under its low-level condition, thermal shocks are minimized, providing another advantage with respect to extending the life of the lamp and reducing the necessity for frequent lamp replacements. Also, because the fundamental excitation is from a nonlinear complex mechanism which has an infinite number of degrees of freedom in a horizontal plane, the output to the lamp is truly random in form, containing a gentle waver rather than a relatively continuous sputtering effect.

While certain specific embodiments of an improved random current-gating device have been disclosed in the foregoing description, it will be understood that various modifications within the spirit of the invention may occur to those skilled in the art. Therefore, it is intended that no limitations be placed on the invention except as defined by the scope of the appended claims.

What is claimed is:

1. A random current-gating device comprising a pair of terminals adapted to be connected in series with a load, an electromagnet, means connecting said electromagnet across said terminals, a first movable conductive member, said first conductive member being of substantial mass and being of magnetic material, means swingably supporting said first conductive member to swing in any direction in the field of said electromagnet in a position to cause said first conductive member to swing responsive to energization of the electromagnet, a second movable conductive member of substantial mass and of non-magnetic material, means swingably-supporting said second conductive member to swing in any direction in the path of movement of said first conductive member, whereby to be struck by the first conductive member and

to rebound therefrom responsive to such energization of the electromagnet, the common vertical plane of the conductive members in their rest positions being offset from the axis of the field of the electromagnet, and circuit means to substantially short-circuit the electromagnet responsive to the engagement of the two conductive members, whereby to establish a shunt path across said terminals during said engagement.

2. The random current-gating device of claim 1, and wherein said conductive members have side-by-side rest positions wherein they are spaced from each other.

3. The random current-gating device of claim 2, and wherein said conductive members have substantially orbital paths of swinging movement.

4. The random current-gating device of claim 3, and wherein said first conductive member is substantially spherical in shape and said second conductive member has a rounded impact surface facing the first conductive member and being engageable thereby responsive to the energization of the electromagnet.

5. The random current-gating device of claim 4, and a resistor connected across said electromagnet.

6. The random current-gating device of claim 4, and wherein said second conductive member is substantially cylindrical in shape and is axially-suspended.

7. The random current-gating device of claim 3, and wherein the means to substantially short-circuit the electromagnet comprises a normally non-conducting silicon-controlled rectifier connected across the electromagnet and having a gating electrode, and circuit means to energize said gating electrode to cause conduction of the silicon-controlled rectifier responsive to said engagement of the conductive members.

8. The random current-gating device of claim 7, and wherein the means to energize said gating electrode comprises a pair of resistors connected in series across the electromagnet, means connecting one of the conductive members to the junction of said pair of resistors, and means connecting the other conductive member to said gating electrode.

9. The random current-gating device of claim 8, and a source of current, a load device, and circuit means connecting said source of current in series with said load device and said pair of terminals.

10. The random current-gating device of claim 9, and wherein said load device comprises an incandescent lamp, and a radio-frequency-attenuating filter-capacitor connected across said source of current.

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JOHN W. HUCKERT, Primary Examiner

J. R. SHEWMAKER, Assistant Examiner

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