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[54] ELECTRONIC CHANCE CIRCUIT

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Related U.S. Application Data

[63] Continuation of Ser. No. 782,976, Dec. 11, 1968, abandoned.

[52] **U.S. Cl.** .....**315/209,** 315/245, 331/130, 273/138 A, 328/210

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

[58] **Field of Search** .....315/209, 245; 331/130, 57; 328/210, 245, 75; 273/138 A

[56] **References Cited**

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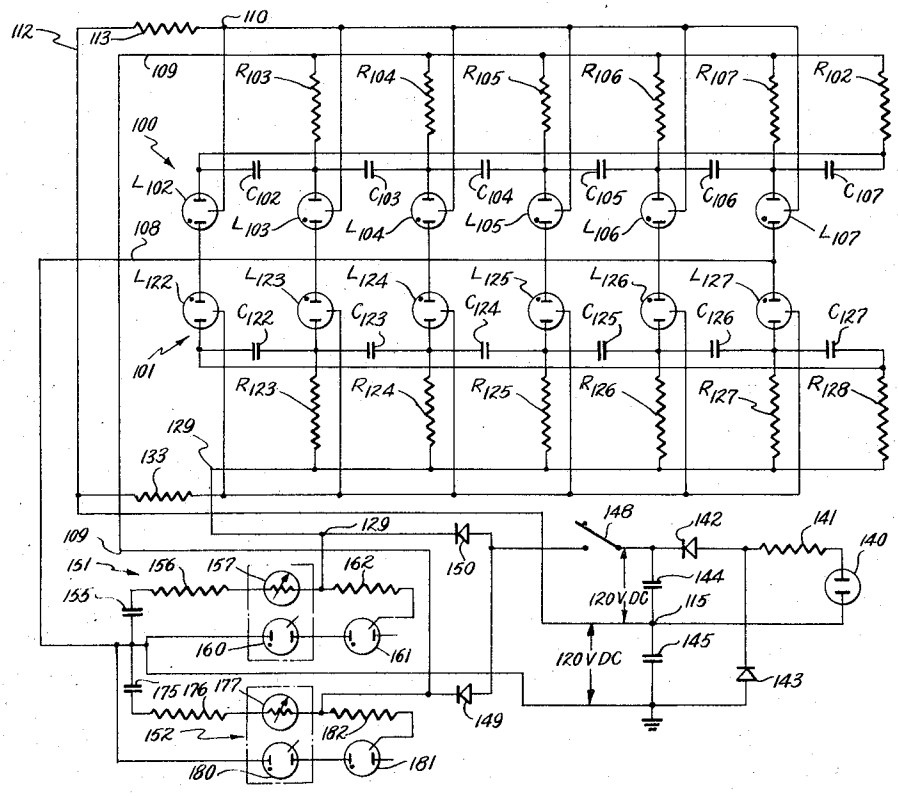
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[57] **ABSTRACT**

A random pattern generator having a plurality of neon indicator lamps which flash in random or pseudo-random sequence for use in electronic games of chance, probability studies or other desired applications. Each neon lamp is connected in series with a resistor to form one of a plurality of identical circuit branches connected in parallel across a switch controlled power source. The neon lamp-resistor junctions of the plurality of circuit branches are connected in a ring configuration by means of a like number of commutating capacitors. When the power switch is closed the neon lamps are energized to breakdown voltage and flash in a random sequence determined by momentary circuit instabilities. A holding circuit is provided to maintain conduction through the neon lamp which is on at the time the power switch is opened. A time delay circuit is incorporated into the holding circuit whereby the random flashing will continue for a predetermined time period after the power switch is opened.

4 Claims, 6 Drawing Figures



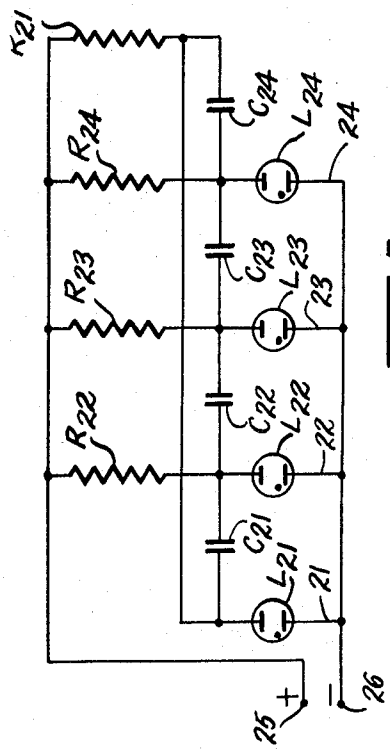


Fig. 2.

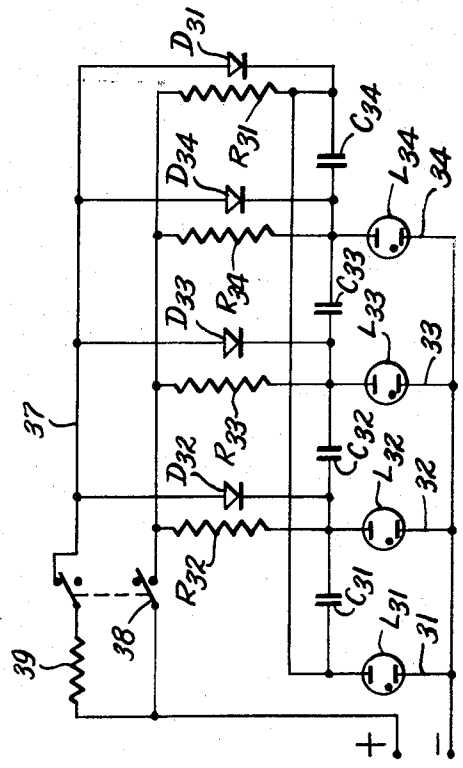


Fig. 3.

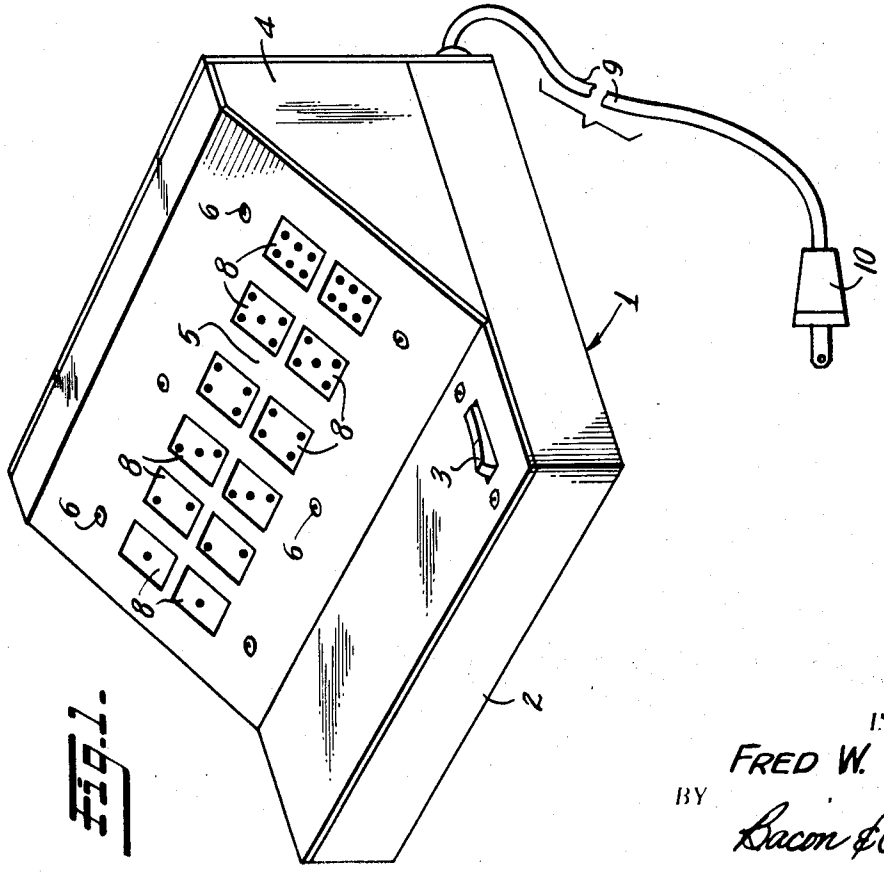


Fig. 1.

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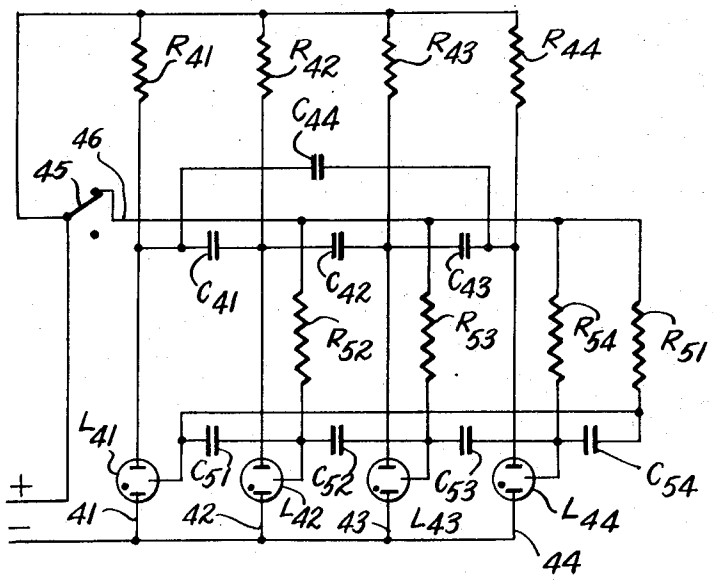


Fig. 4.

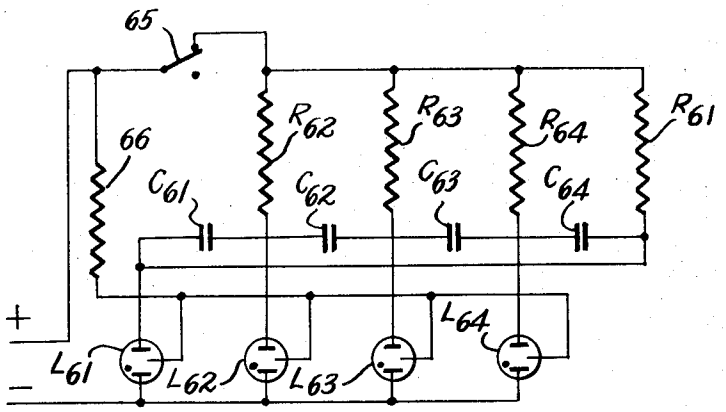


Fig. 5.

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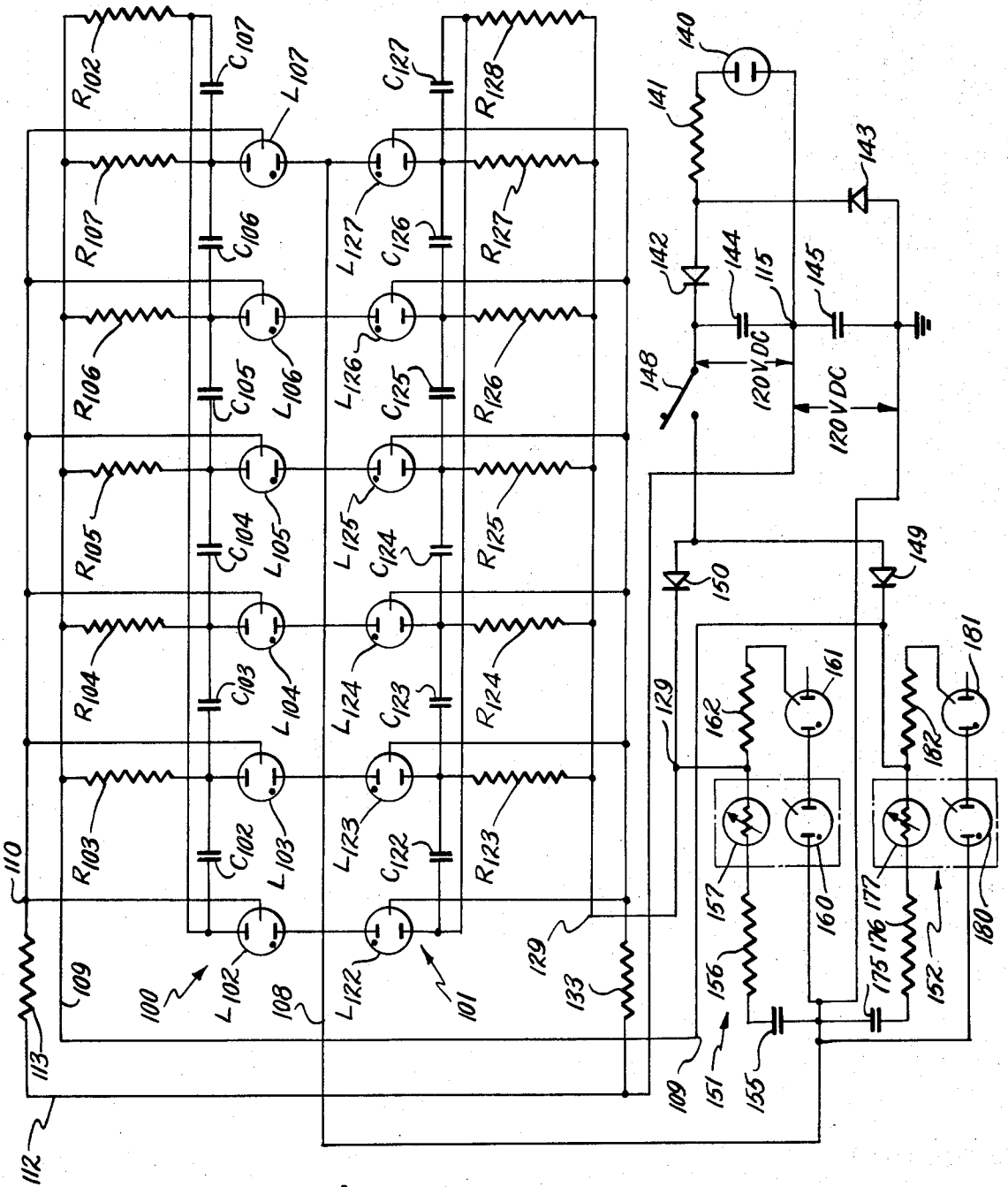


FIG. 6.

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ELECTRONIC CHANCE CIRCUIT

This is a continuation of Ser. No. 782,976, filed Dec. 11, 1968, now abandoned.

SUMMARY OF THE INVENTION

The present invention relates to an electronic circuit adapted to produce random output signals for use in electronic games of chance, probability studies or other desired applications. The random pattern generator of the present invention includes a particular array of neon indicator lamp or other suitable output display devices, which are controlled to flash in a random or pseudo-random sequence. Holding circuit means are provided to stop the flashing sequence at a selected instant and maintain the display device which is on at that instant in a lighted condition. If desired, a time delay means may be provided whereby the flashing sequence will continue for a predetermined period after the holding circuit means are actuated.

In order to construct a dice game two arrays, each comprised of a row of six lamps, are arranged in a suitable enclosure so that each lamp will flash through a separate translucent window in the enclosure. Each of the windows is embossed with a design corresponding to one of the faces of a die whereby the two parallel rows of windows together represent a pair of dice. A power switch is provided to control the energization and flashing sequence of the lamps in order that a dice game may be simulated.

As the switch is operated to apply voltage to the circuit, the lamps in each row or array will flash in a pseudo-random pattern at a rate of several flashes per second. When a stable flashing pattern is established the operator may open the switch and the lamp in each row which is on at the instant the switch contacts are opened will remain lighted. Thus, two of the die faces will remain lighted and the results of the operator's "roll" of the dice will be visible upon the face of the enclosure. Since the lamps flash rapidly and in a pseudo-random pattern the operator cannot anticipate or control the outcome of his "roll." Consequently an output indication is achieved which, for practical purposes, is completely random.

It should be apparent that arrays of flashing lamps may be embodied in games of chance taking many other forms. Likewise the random pattern generator of the present invention has other possible applications in probability studies or as an input device to circuits requiring trains of random or pseudo-random signal pulses.

BRIEF DESCRIPTION OF THE DRAWINGS

Further objects and other advantages of the present invention will become apparent when the following specification is considered along with the accompanying drawings in which:

FIG. **1** is a diagrammatic view of an electronic dice game utilizing the random pattern generator of the present invention;

FIG. **2** is a schematic diagram of a basic random output circuit of the present invention;

FIG. **3** is a schematic diagram of an alternative random circuit of the invention which includes a holding circuit;

FIG. **4** is a schematic diagram of yet another alternative embodiment of the basic circuit which includes a gate triggering circuit for the indicator lamps;

FIG. **5** is a schematic diagram of a preferred basic circuit configuration of the present invention; and

FIG. **6** is a schematic diagram of an embodiment of the present invention designed for use in the electronic dice game shown in FIG. **1**.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIG. **1** an enclosure **1** is shown housing an electronic dice game operated by the random pattern generator circuit of the present invention. The enclosure, constructed of plastic or any other suitable material, generally comprises a base portion **2**, upon which operating switch **3** is fixed, and an upper portion **4** which supports a viewing panel **5**. The viewing panel may also be constructed of plastic and is removably fastened to the upper portion of the enclosure by screws **6** in order to afford easy access to the interior of the enclosure if repair or replacement of the circuits within becomes necessary. The viewing panel includes a plurality of translucent windows **8**, each of which has a design corresponding to one of the faces of a die embossed upon it. A total of twelve windows are shown arranged in two parallel rows of six windows each, whereby all the faces of a pair of dice are represented. The viewing panel may be suitably marked or painted to define the windows **8** or the windows may be fabricated of a translucent material and fixedly mounted in appropriate openings in the panel **5**. The dots representing the spots on the dice are painted, etched or embossed upon the windows or may be reproduced thereon by a suitable reprographic process. A plurality of neon lamps, not shown in FIG. **1**, are housed within the enclosure with a different lamp being mounted behind each of the windows. Thus, when a lamp flashes, its corresponding window will be illuminated and the dots thereon accentuated. Flexible cord **9**, provided with plug **10**, may be connected to a conventional **110** volt a.c. source, not shown, to provide power for the game.

When the game is energized the flashing circuit may be operated by moving switch **3** to a first position. After the flashing sequence of the circuit has operated for several cycles to achieve pseudo-random operation the switch **3** may be moved to a second position to stop the flashing sequence with a single lamp in each circuit remaining on.

FIG. **2** is a schematic diagram of a basic random output circuit of the present invention. Referring now to that figure, four identical circuit branches **21–24** are shown connected in parallel across the terminals **25, 26** of a d.c. voltage source, not shown. Each circuit branch includes an identical neon lamp having its cathode connected to the negative terminal **26** of the d.c. source and its anode connected through a resistor to the positive terminal **25** of the d.c. source. The anode of neon lamp L_{21} is connected to the anode of L_{22} by a commutating capacitor C_{21}. In like manner commutating capacitors C_{22}–C_{24} connect the anodes of the other lamps in a ring configuration.

In the circuit shown, the values of the resistors are identical, as are the values of the capacitors. Consequently when voltage is applied to the circuit, the

anode to cathode voltages across each of the tubes will increase at closely corresponding rates. Although the neon lamps are identical there are slight variations between their voltage characteristics and between the instantaneous impedances of the respective branches whereby the anode to cathode path of one of the lamps will break down before any of the other lamps, causing that lamp to ignite.

After ignition, the anode to cathode voltage across the first ignited lamp drops to an operating value, significantly lower than the breakdown voltage. At that time the resulting difference, between the potential of the anode of the ignited lamp and the anodes of the other lamps in the array, causes current to flow across each of the commutating capacitors in the direction of the anode of the ignited lamp. These current pulses reduce the voltage across the other lamps momentarily preventing them from igniting. As the charge on the commutating capacitors approaches a steady state condition, however, the voltage across the extinguished lamps will rise again toward the breakdown value and a second lamp will ignite. Current will then flow across the commutating capacitors toward the anode of the second lamp, again preventing the remaining extinguished lamps from igniting. The current pulses also momentarily reduce the voltage across the first ignited lamp below its minimum operating voltage value, thereby causing it to extinguish. The foregoing cycle of operation will then be repeated in a continuing sequence at a flashing rate controlled by the time constant of the circuit, as determined by the values of the resistors and capacitors.

If the values of the circuit components are well matched, the lamp which ignites upon any given cycle will be determined solely by random instantaneous instabilities within the circuit. Therefore, in overall operation there is nearly an equal probability that each lamp will light during a particular cycle and the desired pseudo-random output obtained. However, an important feature of the circuit design of the present invention is that it is self-compensating to achieve the desired random output, even if the respective circuit branches are not perfectly balanced. Thus, the value of the breakdown voltage of a neon lamp tends to increase with the total lamp temperature or time due to a decrease in the lamp's gas pressure caused by ion bombardment of the cathode and other cathode charges. Consequently, if one of the lamps of the instant circuit has a breakdown voltage slightly lower than the other lamps of the same array, it will initially tend to ignite more often. However, this frequent ignition will cause an increase in the total lamp operation time accompanied by an increase in its breakdown voltage until random operation is reinstated in the circuit. However, as the compensating feature is applicable only to relatively small circuit parameter changes, the probability of lamps in the circuit may be altered if desired by purposely varying the values of the regenerative components.

An array of four neon lamps has been shown in the embodiment described above. However, it should be apparent that any number of lamps may be used in a single array simply by extending the basic circuit shown.

Referring now to FIG. 3, a schematic diagram of an alternative embodiment of the basic random circuit is shown. The circuit of FIG. 3 differs from that shown in FIG. 2 in that it further includes holding circuit means for arresting the flashing sequence at a selected instant and maintaining the lamp which is on at that instant in an ignited condition. Thus, FIG. 3 shows circuit branches **31–34** including resistors R_{31}–R_{34}, capacitors C_{31}–C_{34} and lamps L_{31}–L_{34} all corresponding to like elements of FIG. 2. In addition, a holding circuit is shown including line **37**, switch **38** and resistor **39**. Diodes D_{31}–D_{34} are shown, connected between line **37** and the anodes of tubes L_{31}–L_{34}, respectively; poled to permit current conduction from line **37** through the anode to cathode circuit of the lamps. Switch **38** is a single pole double throw switch which, when moved to its lower position, permits current flow through lamps L_{31}–L_{34} via their respective resistors. When switch **38** is in the lower position the back resistance of diodes D_{31}–D_{34} effectively isolates the CRL junctions from one another and the flashing sequence is established in essentially the same manner as was described in connection with FIG. 2. However, when switch **38** is operated to its upper position, current is permitted to flow through the lamps L_{31}–L_{34} via their respective diodes. Furthermore, the value of resistor **39** is selected so that the voltage on the common diode line **37** will exceed the operating voltage of an extinguished lamp. Consequently, the lamp which is on when switch **38** is moved to an upper position will be maintained in its ignited condition.

Thus, selective movement of switch **38** by an operator will result in a random output indication from the circuit. Although the circuit described above has been found to operate satisfactorily, the diodes therein must have a high back resistance and are therefore relatively costly. In addition large and therefore expensive capacitors are required in order to achieve a satisfactory brightness and flashing repetition rate of the lamps.

For this reason the novel circuit shown in FIG. 4 is preferable. FIG. 4 shows a schematic diagram of an alternative circuit utilizing a three electrode type of indicator lamp. For example, a three electrode lamp, manufactured by Signalite, Inc. under the designation LTG 27-2 is suitable for use in the circuit of FIG. 4, wherein four identical circuit branches **41–44** are shown connected in parallel between the positive and negative terminals of a d.c. source, not shown. Each circuit branch includes one of the resistors R_{41}–R_{44} connected in series with the anode to cathode path of one of the neon lamps L_{41}–L_{44}. The anodes of the respective lamps are connected in ring configuration by commutating capacitors C_{41}–C_{44} and a single pole single throw switch **45** is provided for selectively connecting the positive terminal of the d.c. source to line **46**. The gate electrodes of the lamps are connected, respectively, through resistors R_{51}–R_{54} to line **46**, while gate commutating capacitors C_{51}–C_{54} connect the lamp gates in a ring configuration.

If the above circuit is energized when switch **45** is in an upper position a rising d.c. voltage is applied to the gate electrodes of the neon lamps through resistors R_{51}–R_{54}. As this voltage increases to a sufficient level the gate to cathode circuit of one of the lamps will break down, in turn causing conduction in the anode to cathode circuit and igniting the lamp. The gate commu-

tating capacitors function as previously explained to momentarily ensure that no other lamp will be triggered. As steady state conditions prevail across the respective gate commutating capacitors, the voltage in the lamp gate circuits will again increase to trigger and ignite a second lamp in the same manner as before. As ignition occurs in the second lamp, current flowing in the gate commutating capacitors will momentarily decrease the gate to cathode voltage of the first ignited lamp, while corresponding current in the anode commutating capacitors will reduce the anode voltage of the same lamp below ignition maintenance level and extinguish it.

The above flashing cycle will repeat in a continuous sequence until switch **45** is moved to its lower position, open circuiting the gate triggering circuits of the lamps, whereby voltage is applied only across the anode to cathode circuits of the lamps, by means of anode resistors R_{41}–R_{44}. The values of these anode resistors are again chosen so that the supply voltage of this circuit is less than the anode to cathode breakdown voltage of the individual lamps with switch **45** in an open position and the lamp gate to cathode paths nonconducting; but greater than the anode to cathode breakdown voltage of the lamps when the gate to cathode paths are conducting. Under these conditions, movement of switch **45** to its open position will arrest the flashing cycle, but the lamp which is on at that instant will be supplied with a maintaining voltage through its anode resistor.

The replacement of a common current limiting resistor with separate anode resistors for each lamp in FIG. **4** permits the advantageous use of the anode commutating capacitors. This circuit, using a neon lamp with a gate electrode, allows the use of much smaller and less expensive components as the diodes are eliminated and capacitors C_{51}–C_{54} need only be large enough to provide reliable gate commutation because the brilliance of the lamps is separately controlled by the anode resistors R_{41}–R_{44}. The voltage at the junction of the R_{41}–C_{41}–C_{42}, etc., can never rise to a value sufficient to trigger a lamp independently because supply voltage is held below the cathode to anode breakdown voltage with the gate nonconducting. Thus the sole purpose of the anode capacitors is to insure that the anode to cathode discharge is turned off when another lamp is turned on by regenerative action at the gates. The value of C_{41}–C_{44} needs only to be large enough to insure anode turn off and the time constant of the anode resistor capacitor combination is considerably less than that of the gate circuit.

FIG. **5** is a schematic diagram of an alternative circuit of FIG. **4** which has improved turn-on characteristics. Referring now to the drawing, it should be apparent that the triggering pulses are applied to the anode to cathode path of the neon lamps while the operating voltage is applied across the gate to cathode path of the lamps. Thus, an operating voltage path is shown from the positive terminal of the d.c. source, through load resistor **66** to a common junction of the gate electrodes of lamps L_{61}–L_{64} and on through the respective cathodes of the lamps to the negative terminal of the source. The triggering circuits for the lamps, comprising resistors R_{61}–R_{64} and anode commutating capacitors C_{61}–C_{64}, are energized from the positive terminal of the d.c. source through switch **65** and connected to the respective anodes of lamps L_{61}–L_{64}.

Operation of the above circuit is similar to that occuring in the other circuits. Thus when power is applied with switch **65** closed, the anode voltage of the lamps increases rapidly until one of the lamps is triggered. When conduction is established in one lamp, current begins to flow through the gate to cathode circuit of that lamp, limited by the value of load resistor **66**. At this time the voltage of the ignited lamp drops sharply to the lower operating level, causing current to flow through the commutating capacitors C_{61}–C_{64} toward the anode of the triggered lamp in order to momentarily prevent any of the other lamps from being triggered. As the current across the commutating capacitors returns to a steady state condition, a rising voltage is again present at the anodes of all the extinguished lamps and a second lamp is triggered. Ignition of a second lamp again results in instantaneous current pulses across the anode capacitors whereby all extinguished lamps are momentarily held off while conduction is established in the gate to cathode circuit of the second lamp. Since the voltage drop across the load resistor **66** cannot simultaneously sustain two lamps, the discharge from the anode to cathode path of the second lamp sustains the gate to cathode discharge for a time sufficient to permit the gate to cathode discharge in he first lamp to be extinguished. This cycle of operation will be repeated in a continuous random sequence until switch **65** is opened at which time the flashing sequence ceases and the lamp that is on remains ignited. A unique aspect of this circuit is that lamp brilliance is controlled by the current in the gate to cathode path and not by the current in the anode to cathode triggering circuit. This in turn permits the use of much smaller commutating capacitors than would otherwise be possible. It should likewise be apparent that the circuit operation is distinct from that which is possible with circuits using conventional gas filled thyratron tubes which are gate triggered.

Referring now to FIG. **6**, a preferred embodiment of the invention is shown, designed for use in an electronic dice game. Thus, FIG. **6** includes two arrays, of six lamps each, which are similar in design to the basic flashing circuit of FIG. **5** and are connected in back to back relationship to a common negative line. A time delay circuit is shown for each array in order to delay the stopping of the flashing sequence of each array for a predetermined time after the control switch has been opened, to preclude the possibility of the operator influencing the outcome. The use of such delay circuits is not essential. If the lamps are designed to flash at a reasonably fast rate, it precludes the operator from stopping the flashing sequence with the output at an anticipated, desired output. Also, when the random pattern generator is first energized, a duration of several cycles is necessary before the circuit operation stabilizes and the generator operates in a completely random fashion. Accordingly, when the delay circuit is used the generator always operates for at least a predetermined minimum number of cycles and thereby prevents an operator from influencing the output by rocking the control switch. Finally with the delay circuit, the flashing rate slowly decreases to a rather slow rate before the complete arrest of the flashing sequence. This in turn builds suspense concerning the output of the device and results in greater player interest. The particular circuit shown utilizes two delay circuits with the

component values adjusted so that the lamp array representing one die stops before the array representing the other die. This also tends to increase player interest in the simulated dice game.

In FIG. 6 two identical arrays of lamps **100**, **101** are shown. Referring particularly to array **100**, the cathode to anode paths of lamps L_{102}–L_{107} are connected, respectively, in series with resistors R_{102}–R_{107} between negative line **108** and positive line **109**. Commutating capacitors C_{102}–C_{107} connect the anodes of the lamps in that array in a ring configuration just as in the previously disclosed circuits. The gate electrodes of lamps L_{102}–L_{07} are connected to a common junction **110** which is supplied with current from positive line **112** through load resistor **113**.

Array **101** is comprised of like elements connected in a like manner between positive lines **129**, **132** respectively and negative line **108**. A d.c. power supply for the dice game is shown in the lower right of FIG. **6** to include a.c. source **140**, load resistor **141**, diodes **142**, **143** and filter capacitors **144**, **145**.

The power supply circuit described below is known as a voltage doubler and provides the two required voltages, approximately 120 volt d.c. between ground at 115 and 240 volt d.c. between ground at **148**.

A.C. source **140** is a conventional 120 volt a.c. power source in order to energize the dice game. The combination of diode **142** and capacitor **144** acts to rectify the positive half cycles of a.c. power and establish a d.c. potential through diodes **149**, **150** to lines **109**, **129** whenever switch **148** is closed. The negative half cycles of a.c. power are rectified by diode **143** and capacitor **145**, thus providing the required approximately + 120 volt d.c. at 115 and 240 volt d.c. between ground at **129**, **112** from terminal **115**, regardless of the position of switch **148**.

On the lower left of FIG. **6** a pair of identical time delay circuits **151**, **152** are shown. Delay circuit **151**, controlling lamp array **101**, includes a circuit branch comprised of a capacitor **155**, resistor **156** and a photo conductive cell **157** connected in series between negative line **108** and positive line **129**. A second circuit branch, comprised of a series combination of the cathode to anode path of lamp **160**, the cathode to gate path of lamp **161** and resistor **162**, is connected in parallel with the first branch between negative line **108** and positive line **129**. Lamp **160** and photo conductive cell **157** are shown mounted adjacent to each other in a light tight enclosure.

Delay circuit **152** is also comprised of two circuit branches, similar to those of the first delay circuit, connected between negative line **108** and positive line **129** in order to regulate lamp array **100**. Thus, the only difference between delay circuits **151**, **152** is in the values of their respective elements which are selected to give a different time characteristic to each respective circuit.

Considering now only the operation of lamp array **101** and delay circuit **151**; when switch **148** is closed the lamps of that array will operate in a flashing sequence in a manner previously explained in conjunction with FIG. **5**. At this time lamps **160**, **161** also ignite since the supply voltage exceeds the combined breakdown voltage of these lamps, and current flow occurs through the lamps limited by the value of resistor **162**. As the lamps are ignited, light from lamp **160** reaches the light sensitive photocell **157**, lowering its resistance and permitting capacitor **155** to charge through resistor **156** to the level of the supply voltage.

When switch **148** is subsequently opened capacitor **155** immediately begins to discharge through the photocell to array **101** of the random pattern generator. In addition, current from the capacitor **155** also flows in the loop defined through the photocell, resistor **162** and back through lamps **161**, **160** to negative line **108**. So long as sufficient current continues to flow from the capacitor **155** to light lamps **160**, **161** the photocell resistance remains low and array **101** of the random pattern generator will remain energized. However, as C_{155} discharges the current through the lamps decreases and therefore their light output, causing the photocell resistance to rise gradually. This in turn reduces the voltage supplied to the random pattern generator and slows the flashing rate. It should be noted that the discharge of capacitor **155** is modified from a normal exponential discharge pattern and instead resembles a more linear discharge form due to the increase in photocell resistance with decreasing current to the lamp **160** until the lamps finally extinguish and the photocell resistance reverts to a high value. At that time the voltage supply to the random pattern generator is cut off and the flashing sequence is frozen with the lamp which is on at that instant being supplied through holding line **109**.

It should be noted that merely discharging capacitor **155** directly into the random pattern generator would be ineffective for the above purpose since the lamp with the lowest breakdown voltage tends to show preference over the others. The fact that there is no lamp preference shown is because the cutoff or extinguish voltage of the series combination of **160** and **161** is greater than the cut-off voltage of any of the lamps in the display.

The operation of lamp array **100** in conjunction with delay circuit **152** is identical to that described above and is also controlled by switch **148**, though delay **152** has a time response different from circuit **151**. It should be apparent that a single delay circuit could as well be used to control both arrays. It should be further apparent that certain embodiments of the invention may not require the use of any delay circuit.

While the circuits of the present invention have been described in connection with an electronic dice game, it should be emphasized that the same circuits can be adapted for use in any context where a pseudo-random output indication is desired. This would include, but not be limited to, a great number of other games of chance such as "bingo" and "twenty-one." In addition a number of well known communications and electronic testing equipments utilize random or pseudo-random input signals which could be furnished by the generator of the present invention.

I claim:

1. A random electronic oscillator circuit comprising:
   at least three circuit branches each comprising a resistor connected in series with a display neon lamp,
   means connecting the resistor end of each said circuit branch to a first terminal of a dc source,
   means connecting the cathode of the neon lamp of each said circuit branch to a second terminal of a dc souce,

capacitor means connected between each pair of resistor-neon lamp junctions of said circuit branches connecting them in a closed regenerative ring,

switching means connected between one of said source terminals and said circuit branches for triggering said display neon lamps from a non-conducting state to a conducting states whereby closing of said switching means enables random triggering of said display neon lamps in said oscillator circuit, and opening of said switching means prevents further triggering of said display neon lamps,

electrical holding means connected to said circuit branches and said dc source terminals for maintaining one of said display neon lamps in a conducting state when said switching means is open,

a time delay means connected between said switching means and said circuit branches for delaying the stopping of random triggering of said display neon lamps when said switching means is open, said time delay means comprising:

a further neon lamp having a holding voltage greater than that required to trigger said display neon lamps,

a photocell connected in parallel with said further neon lamp and responsive to light from said further neon lamp,

an RC network connected for charging through said photocell and for discharging through said photocell, said circuit branches and said further neon lamp,

whereby said RC network charges upon closing said switching means and discharges to provide triggering voltages to said display neon lamps upon opening said switching means, said triggering voltages blocked by said photocell when light from said further neon lamp is diminished.

2. A random electronic circuit as described in claim **1** wherein said neon lamps are three terminal neon lamps.

3. A random electronic oscillator circuit as recited in claim **2**, wherein said holding means comprises a gate of each display neon lamp connected through resistance means to a terminal of said dc source.

4. A random circuit as described in claim **3** wherein said gate electrodes are connected in ring configuration and a capacitor is provided between each pair of the ring connected gate electrodes.

* * * * *