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M. S. PINCUS  
ELECTRONIC APPARATUS USEFUL IN SIMULATED GUNFIRE  
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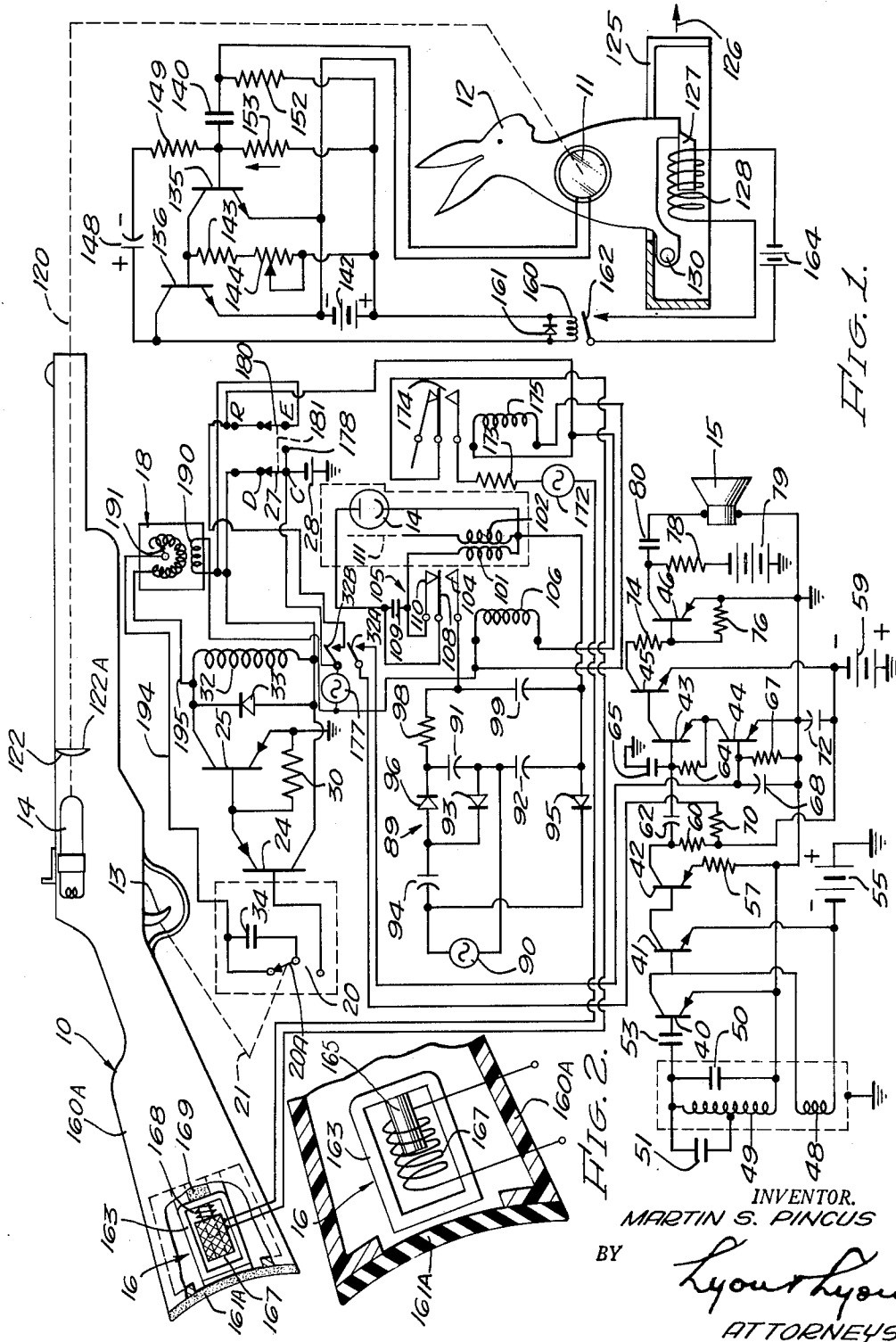


FIG. 1.

FIG. 2.

INVENTOR,  
MARTIN S. PINCUS

BY  
*Lyon Lyon*  
ATTORNEYS

1

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**ELECTRONIC APPARATUS USEFUL IN SIMULATED GUNFIRE AND SIMULATED RIFLE RANGES**

Martin S. Pincus, 121 S. Sweetzer Ave.,  
 Los Angeles 48, Calif.  
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The present invention relates to means and techniques useful in the production of simulated gunfire as, for example, in shooting galleries.

In the present system disclosed herein an electronic gun is provided resembling in shape a conventional gun for use in aiming and "shooting" moving targets. Actuation of the trigger of the gun results in first, projection of a beam of light in the direction of the target; second, production of a recoil action at the butt of the gun; and third, the production of sound which realistically simulates the noise of gunfire. Each of these three functions is accomplished electronically using new means and techniques embodying important features of the present invention.

It is therefore a general object of the present invention to provide a new system of this character in which these functions are accomplished.

Another object of the present invention is to provide a system of this character which incorporates novel electrical circuitry and specifically novel transistor circuitry.

Another object of the present invention is to provide a system of this character which gives the customer of the shooting gallery simulated gunfire experiences which are realistic in character.

Another object of the present invention is to provide novel circuitry involving a noise generator that simulates the noise of actual gunfire.

Another object of the present invention is to provide a novel control circuit for developing a trigger-like pulse which in this case is developed by actuation of the trigger of the gun.

Another object of the present invention is to provide an improved structure mountable in the butt of a gun for simulating recoil of a gun.

Another object of the present invention is to provide a system of this character in which a "strobe" lamp is controlled in a novel manner to produce a high intensity beam of light with fast recycling.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. This invention itself, both as to its organization and manner of operation, together with further objects and advantages thereof, may be best understood by reference to the following description taken in connection with the accompanying drawings in which:

FIGURE 1 illustrates a system embodying features of the present invention.

FIGURE 2 is a cross-sectional view through the butt of the gun illustrating in more detail constructional features of the electronic recoil mechanism.

The system illustrated includes a light gun 10 resembling in shape and appearance an actual firearm for aiming a beam of light onto a photocell 11 mounted on the moving target 12. Operation of the trigger 13 of the gun results in energization of the "strobe" lamp 14 (shown twice in FIGURE 1), also the development of simulated gunfire sound at speaker 15, also a recoil action by the mechanism 16 in the butt end of the gun, and also operation of a stepping switch 18 which serves to disable the system after a predetermined number of "shots" have been fired. For these purposes the trigger 13 is actually the operating member of a single-pole double-throw switch 20 which is mechanically ganged to the switch 20 as

2

indicated by the dotted line 21. The switch 20 is shown in its normal or unactuated condition and is connected in a transistor circuit for developing a so-called trigger pulse in the manner described under the next heading.

*Trigger voltage generator*

The trigger voltage generator is operated by the switch 20 and includes the two transistors 24 and 25 of the PNP type. The transistor 24 has its base electrode connected to the normally open contact of switch 20, its collector electrode connected through the now closed reset switch 27 to the negative ungrounded terminal of source 28; and the emitter electrode of transistor 24 is connected to the base electrode of transistor 25 which is returned to ground through the biasing resistor 30. The emitter electrode of transistor 25 is grounded and the collector electrode of transistor 25 is connected to the negative terminal of source 28 through the relay winding 32 and the previously mentioned reset switch 27. A diode 33 shunts the relay coil 32 for protection of transistor 25 when coil 32 is deenergized. The collector electrode of transistor 25 is also connected through the normally closed stepping switch 18 to the normally closed contact of switch 20. A capacitor 34 is connected between the normally closed contact of switch 20 and its movable arm 20A, such condenser 34 normally being short circuited.

In operation of this trigger generator, transistor 25 is normally in a nonconductive state, being maintained in that state by the voltage developed across the resistance 30. When the trigger 13 is actuated, i.e. when switch arm 20A is moved to engage the normally open stationary contact of switch 20, both transistors 24 and 25 conduct and remain in such conducting condition for a predetermined time established by the time required to charge the condenser 34, after which the transistors 24 and 25 return to their normal nonconducting condition. For this purpose the condenser 34 may have a value of 2 microfarads and the resistance of relay winding 32 may, for example, be 25 ohms. It is noted that in this operation when the switch arm 20A initially engages the normally open contact of switch 20, a relatively high voltage is applied to the base electrode of transistor 24 to cause it and the transistor 25 to conduct and such conduction continues until the condenser 34 is charged. During such conduction of transistor 25 the relay coil 32 is, of course, energized to close its associated normally open switches 32A, 32B. It will also be noted that these switches 32A and 32B are closed only for a predetermined short period of time. The switch 32A controls the noise generator described later and the switch 32B, when closed, causes the "strobe" lamp 14 to be illuminated and the recoil mechanism 16 to be operated.

*Noise generator*

In order to provide an audible sound simulating realistically a gunshot, the transistorized noise generator illustrated in the lower lefthand part of FIGURE 1 is provided, such generator being rendered effective to develop the simulated gunshot sound in speaker 15 upon closure of the previously mentioned relay switch 32A.

The noise generator includes six transistors, the transistor 40 serving as an element of an oscillating stage, the transistor 41 serving as an amplifier, the transistor 42 also serving as an amplifier, the transistor 43 serving also as an amplifier which is triggered in its operation by a trigger stage which includes the transistor 44. The transistor 45 comprises an element of a driver amplifier stage and the transistor 46 is an element of the power amplifier output stage feeding the speaker 15.

The oscillator stage including transistor 40 continuously oscillates as a noise generator. For that purpose there is an inductive feedback path which includes the induc-

tively coupled windings 48 and 49, the winding 49 being shunted by condenser 50 and a portion of such winding 49 being shunted also by the condenser 51. The emitter electrode of the PNP transistor 40 is grounded and the base is returned to ground through a series connection which includes, in turn, the condenser 53 and coil 49. The collector electrode of transistor 40 is connected to the negative ungrounded terminal of voltage source 55 through the coil 48. The collector of transistor 40 is direct connected to the base of the transistor 41 which has its emitter connected to the negative terminal of source 55, the collector electrode of transistor 41 being direct connected to the base electrode of transistor 42 which has its emitter returned to ground through the bias resistance 57 and its collector electrode connected to the negative terminal of the voltage source 59 through load resistance 60; and such collector electrode is coupled to the base electrode of transistor 43 through coupling condenser 62. A bias resistance 64 interconnects the base and emitter electrodes of transistor 43, and a high frequency bypass condenser 65 is connected between ground and the base electrode of transistor 43. The emitter electrode of transistor 43 is also directly connected to the collector electrode of the triggering transistor 44 which has its base electrode returned to ground through a parallel path which includes the bias resistance 67 and condenser 68, the two of which by virtue of the time constant of this R-C network establish the decay time of the amplifier. The emitter electrode of transistor 44 is grounded and the base electrode of transistor 44 is also connectible through the aforementioned switch 32A to one terminal of resistance 70 having its other terminal connected to the negative ungrounded terminal of source 59. Resistance 70 serves to limit the voltage applied to the R-C network 67, 68 so that transistor 44 conducts the proper amount. A bypass or decoupling condenser 72 is interconnected between the negative ungrounded terminal of source 59 and ground. The collector electrode of transistor 43 is direct connected to the base electrode of the driver amplifier transistor 45 which has its emitter electrode connected to the negative ungrounded terminal of source 59 and its collector electrode connected through current- and voltage-limiting resistance 74 to the base electrode of the power amplifier transistor 46 which has its base and emitter electrodes interconnected by bias resistance 76, such emitter being grounded. The collector electrode of transistor 46 is connected through load resistance 78 to the negative ungrounded terminal of source 79. The speaker 15 is interconnected between the collector and emitter electrodes of transistor 46 through capacitor 80.

In this circuit the oscillator stage, which includes the transistor 40 and inductively coupled coils 48 and 49, comprises a noise generator, the same being direct coupled to the amplifier transistor 41. The transistor 44 is normally in a non-conducting state, and being in series with the emitter electrode of transistor 43, the transistor 43 in turn is also in a normal nonconducting state. When the relay switch 32A is momentarily closed, condenser 68, which may have a capacity of 100 microfarads, charges and the transistor 44 conducts, thus allowing transistor 43 to conduct with a very sharp rise time, thus giving the sharp crack of a gunshot. As condenser 68 discharges, transistors 44 and 43 revert back to their normal nonconducting state giving a decay effect established by the R-C network 67, 68. It is noted that transistor 43 is directly coupled to transistor 45 which is the driver stage and such driver stage is directly coupled to the power amplifier stage 46, the same being resistance-capacity coupled to the speaker 15 by means of resistance 78 and condenser 80, the condenser

80 being connected between one terminal of speaker 15 and the collector electrode of transistor 46.

#### "Strobe" light energizing circuit

The "strobe" lamp 14 (which is illustrated twice in FIGURE 1) is energized from a conventional voltage-multiplying rectifier circuit, the energy being obtained from the A.C. source 90 which has one of its terminals connected to one terminal of each of the following elements, namely: capacitor 91, capacitor 92 and rectifier 93; and the other terminal of source 90 is connected to one terminal of each of the following elements, namely: capacitor 94 and rectifier 95. The other terminals of capacitor 94 and rectifier 93 are connected to one terminal of rectifier 96 which has its other terminal connected to the other terminal of condenser 91 and also to one terminal of the resistance 98. The other terminal of capacitor 92 is connected to the other terminal of rectifier 95 and also to one terminal of capacitor 99 and also to the interconnected terminal of windings 101 and 102. The other terminals of resistance 98 and capacitor 99 are connected to the stationary contact 104 of the relay switch 105 having associated therewith the relay coil 106. The cathode of the "strobe" tube 14 is connected to the interconnected terminals of windings 101 and 102 and the anode of tube 14 is connected to the movable arm 108 of relay switch 105 and also to one terminal of capacitor 109 having its other terminal connected to the stationary switch contact 110 and also to the other terminal of winding 101. The other terminal of winding 102 which is inductively coupled with winding 101 is connected to the tube electrode 111. Since the voltage-multiplying rectifier 89, per se, is conventional, the same need not be described in further detail and it will be understood that a positive rectified voltage continuously appears on the stationary switch contact 104. When the relay coil 106 is energized as a result of momentary closing of the aforementioned relay switch 32B, the high rectified voltage appearing across condenser 99 and the stationary contact 104 is applied between the cathode and anode of the "strobe" tube 14 and also through the series circuit which includes the capacitor 109 and the winding 101 to induce a voltage in the winding 102 which is applied to the electrode 111. When the relay switch 105 returns to its normal position shown in FIGURE 1, the condenser 109 is short-circuited to recondition the same. The tube 14 is extinguished rapidly after condenser 99 is discharged through the "strobe" tube, the discharge circuit for condenser 99 extending from one terminal of condenser 99 through switch 104, 108, through tube 14 and to the other terminal of condenser 99 and this discharge circuit being established upon closing of switch 104, 108 as previously described.

It will thus be observed that when the trigger 13 is actuated, the switch 32B is momentarily closed to momentarily energize the relay coil 106 which in turn causes the high intensity light of short duration to be developed by the "strobe" tube 14. Such "strobe" tube 14, as illustrated in the upper part of FIGURE 1, is mounted in the gun with its longitudinal axis coextensive with the "barrel" of the gun to project the light beam 120 onto the photocell 11 of target 12. Preferably a plano-convex lens 122 is interposed in such light path and the rear plano or flat side 122A of the convex lens 122 is frosted, i.e. made translucent.

#### Target circuitry

The targets are of conventional construction and are moved in conventional manner and hence details of the same need not be set forth herein.

Each target 12 is mounted on an individual carrier 125 which is moved in the general direction indicated by the arrow 126. When and as the targets are being

moved in the field of vision, they are held in an upright position, as shown in FIGURE 1, by the solenoid plunger 127 which is movable in the coil 128. When the coil 128 is energized as a result of the light beam 120 impinging on the photocell 11, the plunger 127 is drawn into the coil 128 to allow the target 12 to pivot about the pin 130 on carrier 125, thereby indicating that the target has been "hit." Means not shown are used for restoring the target 12 to its upright position sometime during the return movement of the target to the field of vision.

To energize coil 128, a transistor amplifier which includes the transistors 135 and 136 is used.

The photocell 11, which is preferably of the cadmium sulfide type, has one of its terminals connected to the emitter electrode of transistor 135 and also to the emitter electrode of transistor 136, the other terminal of the photocell 11 being coupled to the base of transistor 135 through blocking capacitor 140. The collector electrode of transistor 135 is connected to the positive terminal of source 142 through resistance 143 and adjustable sensitivity-control resistance 144 connected in series therewith. This collector electrode is direct connected to the base electrode of transistor 136. The collector electrode of transistor 136 is connected to the positive terminal of source 142 through relay coil 160 shunted by protective diode 161. When relay coil 160 is energized, its switch 162 is closed to energize the previously mentioned solenoid 128 with current supplied by source 164. The series-connected capacitor 148 and resistance 149, connected between the base electrode of transistor 135 and the collector electrode of transistor 136, provide a feedback path, the condenser 148 serving generally the same purpose as the previously mentioned condenser 34.

It will also be observed that the circuit includes the bias or load resistance 152 and resistance 153 each having one of its terminals connected to the positive terminal of source 142, the other terminal of resistance 152 being connected to the junction point of photocell 11 and blocking capacitor 140 and the other terminal of resistance 153 being connected to the base electrode of transistor 135.

This circuit described under this heading constitutes a light pulse amplifier which may have many various uses where a relay coil or solenoid is to be energized in response to a light pulse and particularly in those applications where the device is required to be non-responsive to a steady light as, for example, the steady light produced by a floodlight.

The operation of the circuit is briefly as follows. The transistor 136 is normally non conducting and the transistor 135 is normally conducting, being in that state due to relatively large positive voltage on the base electrode. A relatively small steady current normally flows through the photocell 11 through a series circuit which includes source 142, resistance 152 and photocell 11. When the cell 11 is abruptly illuminated by the "strobe" beam 120, the resistance of the cell 11 is abruptly lowered to produce a relatively rapid change in voltage at the junction point of capacitor 140 and resistance 152 and also at the base of transistor 135 to drive the same into a non-conductive state. When this occurs, the voltage on the base electrode of transistor 136 is increased to a point where the same is rendered conductive with the result that current flows through relay coil 160 to operate switch 162 serving to energize coil 128. The series-connected capacitor 148 and resistance 149 provide a delay time for assuring operation of the relay coil 160. The capacitor 148 is normally charged at a potential which is substantially equal to the voltage drop across resistance 153, and when transistor 135 is rendered nonconductive, the precharged capacitor 148 is discharged through the then conducting transistor 136 to assure its continued conduction for a

time sufficiently long to energize relay coil 160, the discharge rate of capacitor 148 being controlled by resistance 149.

#### *Recoil mechanism*

For simulating the recoil action of an actual firearm, a mechanism is incorporated in the butt end of the gun and this comprises generally a solenoid actuator which is momentarily energized when the trigger 13 is actuated. The stock 160A may be of wood and the butt is a sheet flexible material 161A such as rubber to which is imparted an impact by the movable magnetic structure 163, the same being generally rectangular in shape, of magnetizable material and having a core portion 165 partially extending into the stationary solenoid coil 167. A coil compression spring 168 may optionally be interposed between the coil 167 and the magnetizable member 163 to normally maintain a substantial portion of the core member 165 outside of the confines of coil 167. When the coil 167 is energized, the magnetizable member 163 is drawn to the left in FIGURES 1 and 2 to impart an impact force to the flexible covering 161A which, of course, rests against the user's shoulder, to produce a simulated recoil force. The coil 167 is energized momentarily for this effect and return movement of the magnetizable structure 163 is cushioned by, for example, a sponge pad 169 which is interposed between the magnetizable core structure 163 and a wall defining the cavity 16 in which the solenoid operator is disposed.

The solenoid coil 167 is connected in a series circuit with the A.C. source 172, resistance 173 and the relay switch 174 having associated therewith the relay coil 175. This coil 175 is energized upon momentary closure of the relay switch 32B through a circuit which includes the A.C. source 177, switch 32B, and coil 175.

#### *Reset operation*

Means are provided for allowing the customer of the shooting gallery to fire a predetermined number of shots, after which the system is reset by simultaneous operation of the reset switches 27 and 180, which are ganged at 181, the same being shown in FIGURE 1 in their normal positions.

It will be observed that each time the relay switch 32B is closed, i.e. each time the trigger 13 is operated, the coil 190 of stepping switch 18 is energized to move the stepping switch arm 191 through one position or step. The coil 190 is energized through a circuit which includes the A.C. source 177, switch 32B, switch 180 and the coil 190. In the last position, the arm 191 of the stepping switch disconnects the leads 194 and 195, thereby rendering the triggering stage comprising transistors 24 and 25 inoperative, i.e. the trigger 13 may be depressed without production of either the light beam, the recoil action or production of sound. To reset the system, the ganged switches 27 and 180 are operated. When switch 27 is operated, i.e. opened, the terminals C and D are no longer interconnected and energizing source 28 is disconnected from the triggering stage comprising transistors 24 and 25, and switch 180 disconnects terminals E and R and engages the switch contact 178 to interconnect the terminals C and E, with the result that the stepping switch coil 190 is now energized through a circuit which includes the source 177, interconnected terminals C and E and coil 190. The reset switch comprising switches 27 and 180 may be of the momentary type and when thus actuated, advances the arm 191 of the stepping switch one position to again interconnect the leads 194 and 195 and thereby render the trigger circuit including the transistors 24 and 25 operative for the next series of firings.

While particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from this invention in its broader aspects and, therefore, the aim in the appended

claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

I claim:

1. In a simulated shooting gallery system, the combination comprising a simulated firearm having a trigger and a light barrel, a "strobe" lamp on said firearm for projecting a beam of light along said barrel, and means operated by said trigger for energizing said "strobe" lamp, said means comprising a single-pole double-throw switch having two positions, said trigger being mechanically coupled to said switch for operating the same to one of said two positions from the other position of the switch, a first amplifying device having a pair of input electrodes and an output electrode, a second amplifying device having a pair of input electrodes and an output electrode, said switch having a movable switch arm and a pair of stationary contacts, said arm in said one position contacting one of said contacts, a capacitor connected between said arm and said one contact and being normally short-circuited by said arm, one of said input electrodes of said first device being connected to the other of said stationary contacts, the other of said input electrodes of said first device being connected to one of the input electrodes of said second device, a biasing resistance connected between said input electrodes of said second device for normally maintaining said second device in a normally nonconducting condition, a source of voltage connected to the output electrode of said first device, a load impedance, said source being connected to the output electrode of said second device through said load impedance, said second contact being connected to said source through said load impedance to charge said capacitor at a controlled rate when said switch is operated to said other position, a capacitor, a D.C. source, a resistance, said resistance and capacitor being connected in a series circuit with said source to charge the same, and means effective upon energization of said load impedance for discharging said capacitor through said "strobe" lamp, a noise generator and means effective upon energization of said load impedance for operating said noise generator.

2. In a simulated shooting gallery system, the combination comprising a simulated firearm having a trigger and a light barrel, a "strobe" lamp on said firearm for projecting a beam of light along said barrel, and means operated by said trigger for energizing said "strobe" lamp, said means comprising a single-pole double-throw switch having two positions, said trigger being mechanically coupled to said switch for operating the same to one of said two positions from the other position of the switch, a first amplifying device having a pair of input electrodes

and an output electrode, a second amplifying device having a pair of input electrodes and an output electrode, said switch having a movable switch arm and a pair of stationary contacts, said arm in said one position contacting one of said contacts, a capacitor connected between said arm and said one contact and being normally short circuited by said arm, one of said input electrodes of said first device being connected to the other of said stationary contacts, the other of said input electrodes of said first device being connected to one of the input electrodes of said second device, a biasing resistance connected between said input electrodes of said second device for normally maintaining said second device in a normally nonconducting condition, a source of voltage connected to said first device, a load impedance, said source being connected to the output electrodes of said second device through said load impedance, said second contact being connected to said source through said load impedance to charge said capacitor at a controlled rate when said switch is operated to said other position, a capacitor, a D.C. source, a resistance, said resistance and capacitor being connected in a series circuit with said source to charge the same, and means effective upon energization of said load impedance for discharging said capacitor through said "strobe" lamp, a simulated recoil mechanism, means mounting said recoil mechanism in the butt of said gun, and means effective upon energization of said load impedance for operating said recoil mechanism.

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