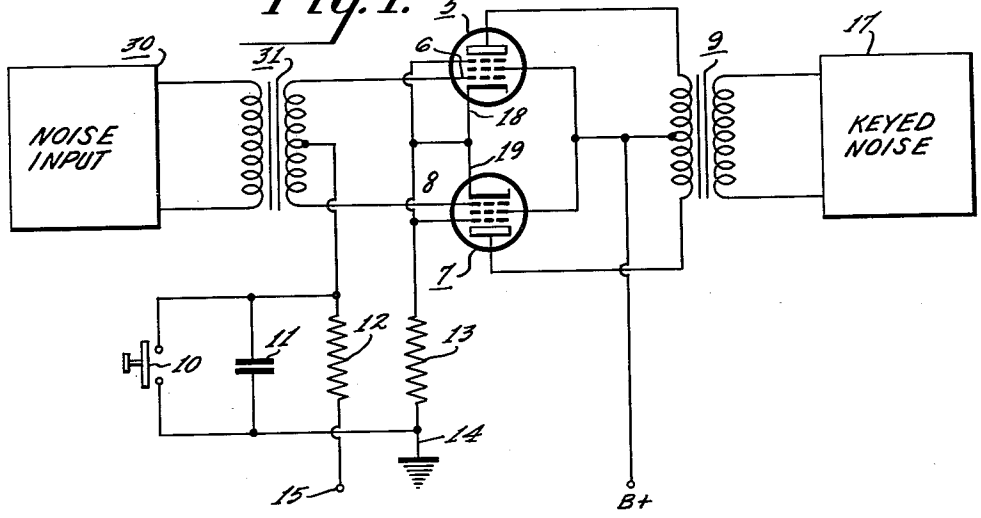
June 19, 1956 J. L. HATHAWAY ET AL 2,751,585

ARTIFICIAL GUN SHOT EFFECTS

Filed Jan. 12, 1953 3 Sheets-Sheet 1

Fig. 1.



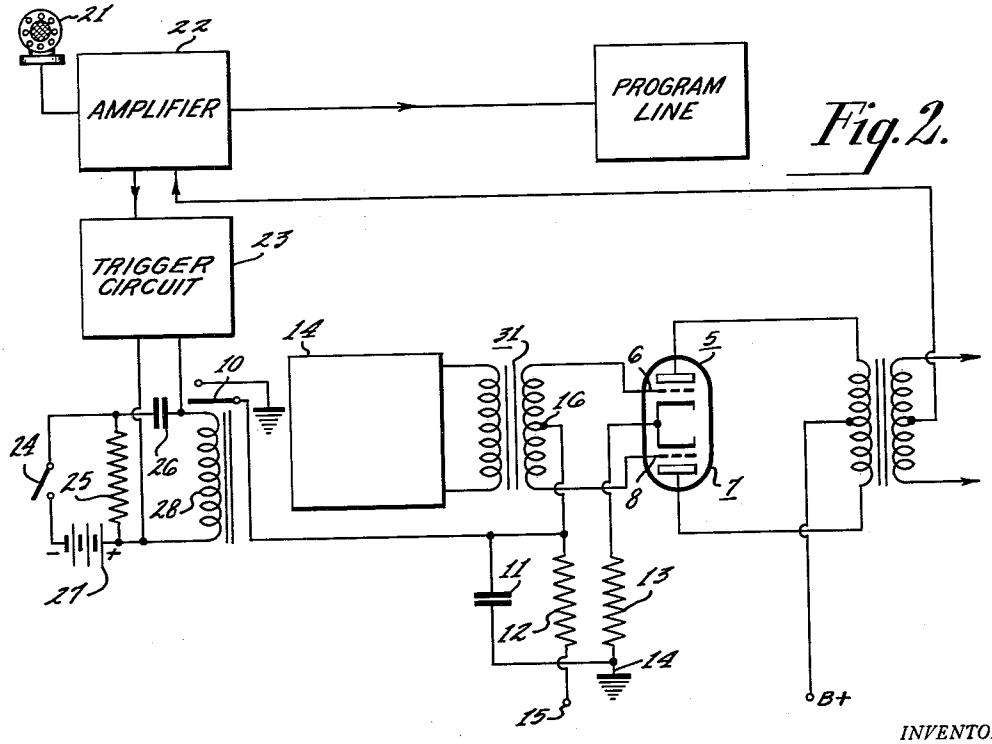


Fig. 2.

INVENTORS.
Jarrett L. Hathaway &
Raymond E. Lafferty
BY H. C. Wooton
ATTORNEY.

June 19, 1956 J. L. HATHAWAY ET AL 2,751,585

ARTIFICIAL GUN SHOT EFFECTS

Filed Jan. 12, 1953 3 Sheets-Sheet 2

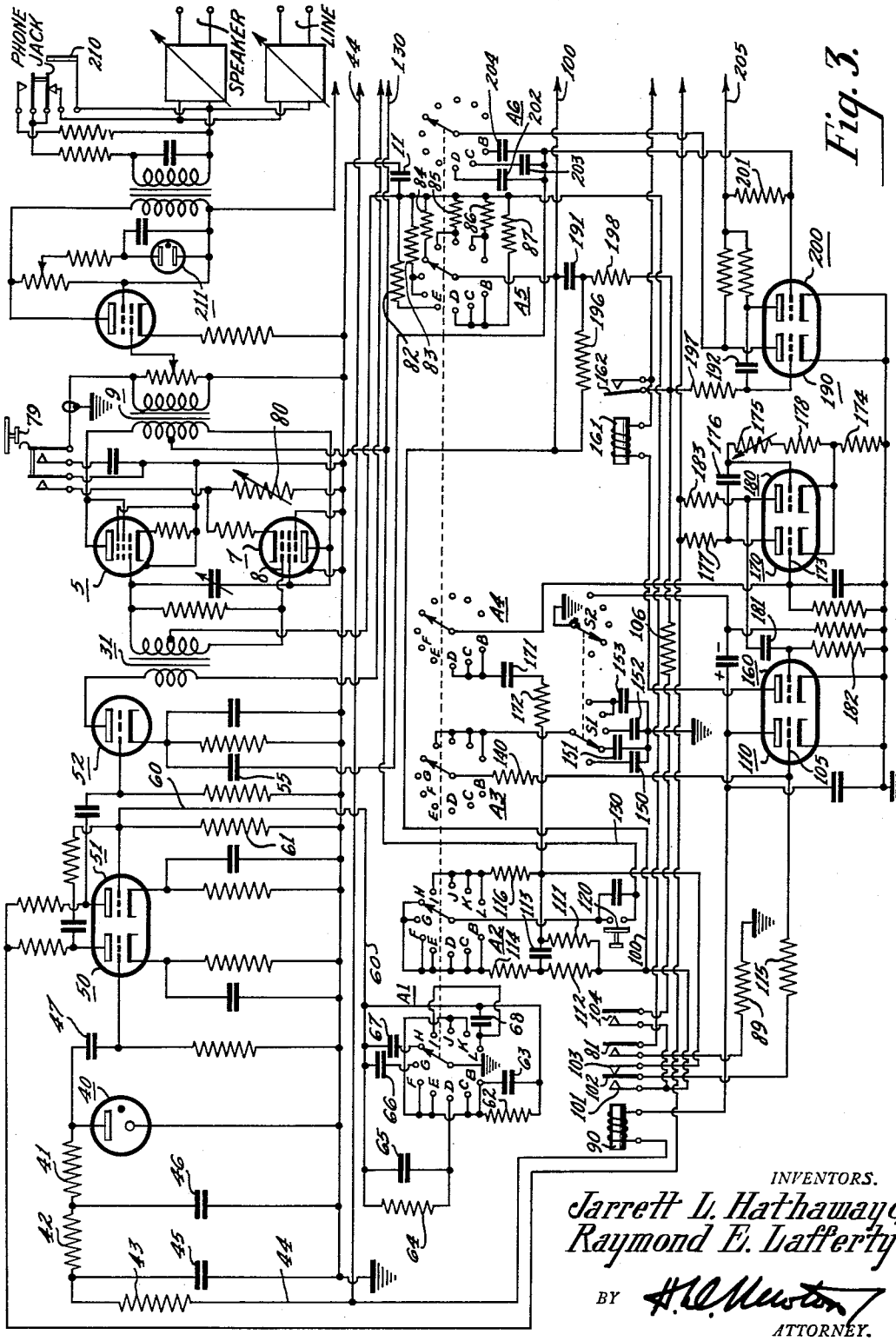


Fig. 3.

INVENTORS.
Jarrett L. Hathaway &
Raymond E. Lafferty
BY H. C. Weston
ATTORNEY.

June 19, 1956 J. L. HATHAWAY ET AL 2,751,585

ARTIFICIAL GUN SHOT EFFECTS

Filed Jan. 12, 1953 3 Sheets-Sheet 3

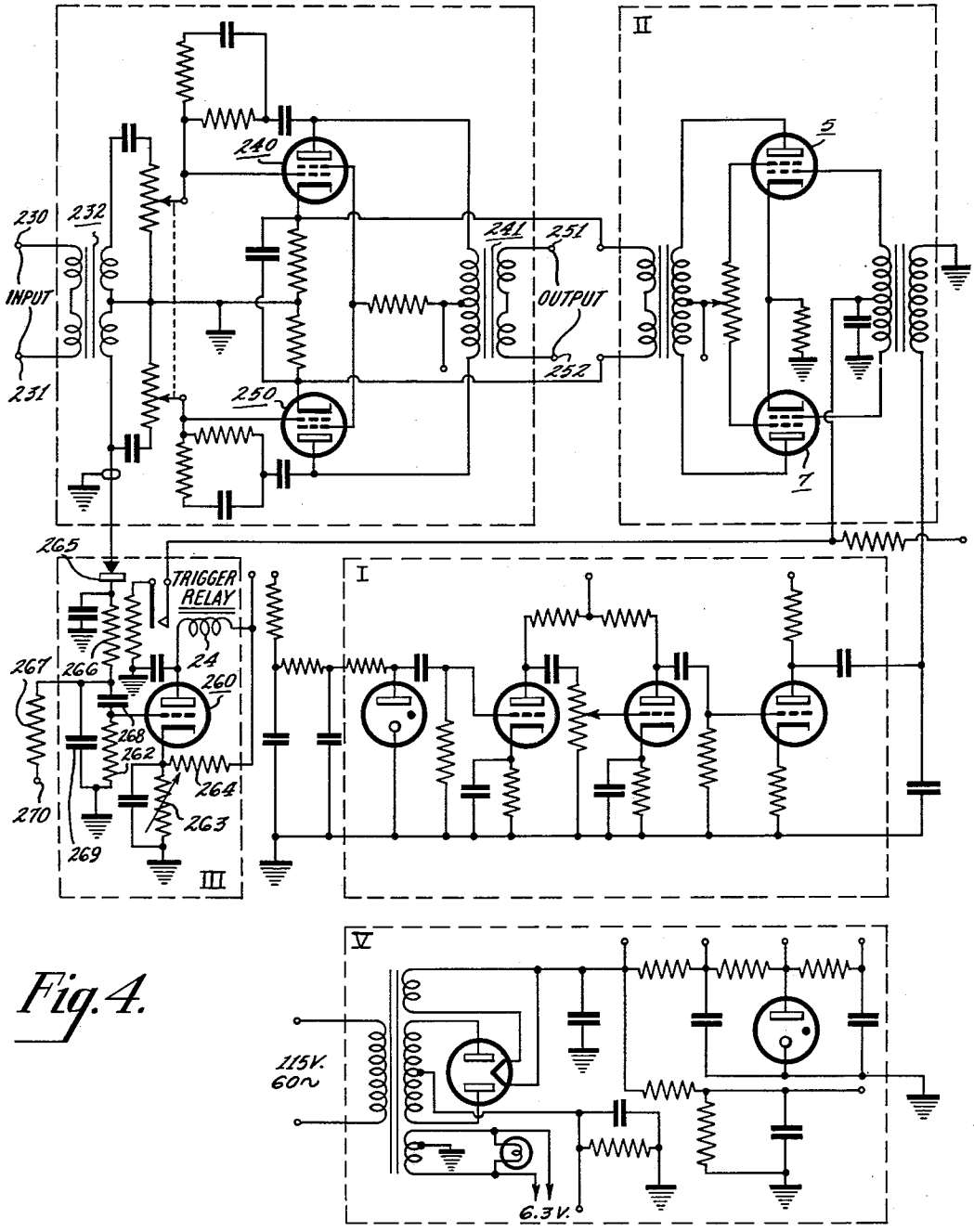


Fig. 4.

INVENTORS.
Jarrett L. Hathaway &
Raymond E. Lafferty

BY H. O. Newton

ATTORNEY.

United States Patent Office 2,751,585 Patented June 19, 1956

2,751,585

ARTIFICIAL GUN SHOT EFFECTS

Jarrett L. Hathaway, Manhasset, N. Y., and Raymond E. Lafferty, Fairlawn, N. J., assignors to Radio Corporation of America, a corporation of Delaware

Application January 12, 1953, Serial No. 330,678

12 Claims. (Cl. 340—384)

This invention relates to sound effects generating systems, and more particularly to systems for electrically generating a multitude of sounds representative of firearm discharges, waves crashing on a beach, roar of the wind and the like.

Apparatus in accordance with the invention is particularly applicable for use as a generator of sound effects for television or radio broadcasting studios and the like. Heretofore sound effects associated with the firing of guns and the like in both radio and television broadcasting have been uncertain and unrealistic. Moreover, certain effects are difficult to obtain, for instance, machine gun fire and ricochet effects.

In broadcasting, recording, and the like, the sound effects representative of firearm discharges or explosions have generally been obtained by the firing of blank cartridges and with sound pick-up from a microphone. This method of obtaining sound effects has not been satisfactory in many respects as is obvious, and for the further reason that blank cartridges are not reliable. In some cases a cartridge may detonate with an ineffectual "pop," and at other times, fail to detonate at all.

Another system extensively used for providing sound effects in broadcasting and the like is to reproduce from a recording of the actual sound or facsimile thereof, the particular sound effect desired. One disadvantage of this system is the problem of indexing the records, and placing of the phonograph stylus in the proper record groove at the proper time. In reference to firearm discharge, the transduction from sound energy to electrical energy and transmission through normal broadcast equipment does not produce a realistic report when converted back to sound energy because of the normal amplitude limitation of the transmitting and receiving equipment. In such a system where the amplitude must be controlled to prevent overload, the high intensity sound of extremely short duration representative of a firearm discharge is heard, when reproduced, as a lower intensity sound of short duration. The apparent loudness of such a discharge may be increased by the persistence of a certain amount of reverberation, or increasing the duration of the lower intensity sound. However, in the case of television studios, the special acoustical treatment necessary to deaden the background noise results in lack of reverberation. This deadening effect coupled with the amplitude restrictions of the audio system is deleterious to realistic percussion reproduction.

It is accordingly an object of this invention, to provide a realistic and reliable sound effects system which effectively may utilize the output of a generator of random electrical signals in a predetermined manner.

Another object of this invention is to provide a sound effects system for certain sounds which has a signal channel including a generator of random electrical voltages, and means for controlling the amplitude pass characteristic of the system in relation to a predetermined time interval to simulate the wave envelope of the desired sound effect.

Another object of this invention is to provide a system for electrically synthesizing and controlling random, electrical signals to produce reliable and realistic artificial gun shot effects and the like.

Another object of this invention is to provide a system for generating and controlling random electrical signals to produce reliable and realistic firearm discharge effects in a repetitive manner to simulate machine gun fire.

Another object of this invention is to provide a system for electrically generating sound effects simulating single or multiple firearms discharge followed by sounds of ricocheting bullets.

A further object of this invention is to generate realistic artificial gun shot effects which may be triggered by signals representative of actual firearm discharges to supplement and reinforce said signals in a program line for broadcast studios and the like.

In carrying out this invention in one form, it has been found desirable to provide a signal channel comprising a generator of random electrical signals or noise, and an amplifier for the noise signals. The signal channel may be connected with the program line of a broadcast studio. By selectively controlling the transmission characteristics of such a channel a multitude of sound effects may be synthesized.

For firearm discharges or other percussion sound effects, the signal channel is normally blocked. When it is desired to initiate the production of signals representative of firearm discharge, the signal channel may suddenly be unblocked to key on the noise signals as a sudden burst followed by a gradual decrease at a rate corresponding to the acoustical decay of the firearm discharge being simulated. If desired, special effects may be injected with the synthesized gun shot signals such as a signal from an oscillator whereby a ricocheting bullet is simulated, or the keying may be made repetitive so that the signals developed will simulate machine gun firing. The band pass frequency of the noise generator may be controlled to provide various gun shot effects ranging from the crack of a small rifle to the boom of a distant cannon.

The keying or unblocking of the signal channel may be accomplished in different ways. It suffices for radio or recording work that a button or other switch may be depressed or actuated to key the signal channel. However, for television, where the actor is frequently televised firing a gun, to achieve proper coordination between vision and sound, circuitry may be provided whereby the signal channel may be keyed in response to signals representative of an actual gun shot. Thus the signals representative of an actual gun shot may be combined with, and reinforced by the synthesized gun shot signals.

Other sound effects may be obtained from the normally unblocked signal channel, for instance the roar of airplane engines, crash of surf on a beach, the roar of the wind and the like. These sound effects can be generated by controlling the frequency of the noise signals and selectively varying the transmission characteristics of the signal channel in such a manner to simulate the wave envelope of the desired sound. For example, if some of the high frequency components are eliminated and the transmission characteristics is set at a given level, signals simulating a fleet of bombers may be produced. If the gain of the channel is advanced and then dropped rapidly, a signal simulating the building up and crash of waves on a beach may be produced. The transmission characteristics of the signal channel may be controlled in many ways, such as manually or by means of a cam arrangement.

The random electrical signals from the noise generator may have wave lengths within the audio spectrum or

within any higher frequency range. If the wavelengths are in a higher frequency range, a heterodyne oscillator may be used to beat with the noise signals to produce a band of noise signals having wavelengths within the audio spectrum.

Further features, objects and advantages will become apparent from a consideration of the following description in conjunction with the accompanying drawings, in which:

Figure 1 is a simplified block and schematic circuit diagram of a sound effects generator for generating signals representative of firearm discharges;

Figure 2 is a block and schematic circuit diagram showing a system for automatically keying a sound effects generator in response to an actual gun shot whereby the signals in the program line representative of the actual gun shot may be reinforced by the synthesized gun shot signals;

Figure 3 is a detailed schematic diagram showing a sound effects generator having circuits for generating signals representative of firearm discharges, discharges and ricochets, machine gun fire, and various degrees of each in accordance with the setting of a master switch; and

Figure 4 is a detailed schematic circuit diagram of an electronic gun shot generator having a system for automatically keying the generator in response to a predetermined high level signal from the program line.

Referring now to the drawings wherein like reference characters designate like components, Figure 1 shows a gun shot generator having a signal channel comprising a source of random electrical signals **30** coupled with an amplifier section including tubes **5, 7** which are connected in push-pull. The output of the amplifier section may be coupled to the program line or other utilization means **17**.

The source of random electrical signals or noise **30** may be any of the several known types, but is has been found that the noise source of the variety as described hereinafter in connection with Figure 3, performs very well for the sound effects purposes to be described. The random electrical signals or noise may have wavelengths, substantially within the audio spectrum. However, it is possible to utilize noise with wavelengths within the higher frequency spectrums and to provide means for heterodyning the higher frequency signals with signals from a local oscillator to bring the frequency range noise components within the audio spectrum. The noise is coupled from the source **30** through a coupling transformer **31** to the grids **6, 8** of the push-pull amplifier tubes **5, 7**. If desired additional amplifiers may be added to provide further amplification of the noise signals before these signals are fed to the push-pull amplifiers **5, 7**.

The amplifier section including the tubes **5, 7** of the signal channel is shown by way of example as push-pull, but other types of amplifiers could be used as well. In the generation of gun shot signals the signal channel is normally maintained blocked. This may be accomplished as shown in Figure 1 by maintaining the amplifier tubes **5, 7** normally cut-off. A negative voltage from a bias source **15** may be connected through a resistor **12** and by way of a center tap **16** on the secondary of the coupling transformer **31** to the control grids **6, 8** of the amplifier tubes. The cathodes **18, 19** of the tubes are connected to a point of fixed reference potential or ground **14**, through a cathode bias resistor **13** which supplies operating bias voltage when the tubes conduct.

One side of a push-button **10** is connected to the center tap **16** of the secondary winding of transformer **31**, and the other side is connected to the point of fixed reference potential or ground **14**. Thus, when the push-button is depressed, the center tap **16** is placed at ground potential. The negative bias voltage is thereby removed from the grids **6, 8** of the amplifier tubes **5, 7** causing the tubes to conduct and amplify the noise signals. When the push-button **10** is released, the current from bias source **15** begins to charge capacitor **11** which is connected across the terminals of switch **10**. As the condenser becomes charged, an increasing negative potential is applied through center tap **16** to control grids **6, 8**. The time required for charging capacitor **11** to a potential sufficient to cut-off tubes **5, 7** is dependent on the RC time constant of resistor **12** and capacitor **11**, and the potential of bias source **15**.

In the operation of the device, when signals representative of firearm discharges are desired to be fed into the program line from the secondary of transformer **9**, push-button **10** is depressed to unblock the signal channel. During the time that the push-button **10** is depressed, the tubes **5, 7** conduct as hereinbefore described, and the maximum amplification of the noise is effected. After the switch **10** is released, the decaying amplification simulates the effect of reverberation. The reproduced effect of the sudden noise pulse with a relatively slower decay is essentially that of a gun shot. If the push-pull keyer tubes **5, 7** are purposely unbalanced to a slight degree, the D. C. "thump" component which results when the bias is suddenly removed, produces an impact with the shot to further enhance its realism.

In the production of signals representative of firearm discharges it has been found that the acoustical energy within the wave envelope is generally heterogeneous, and resembles noise. The difference in the sound of gun shots such as a pistol shot at close range and one at longer range is a function of the wave envelope of the shots or discharges and the frequency range of the signals within the envelope. The envelopes of most shots have very steep fronts and trailing edges that decay relatively more slowly. By controlling the frequency components present within the wave envelopes, the sound effects can be even more reliably reproduced. Thus the pistol shot at close range has a rapid attack followed by a gradual decay and the wave envelope includes many high frequency noise components. The pistol shot at longer ranges has a less rapid attack than the shot described above, and has a longer decay time due to reverberation effects, and many of the high frequencies components of the noise are attenuated by the air.

It has been found that the most desirable length of time for the switch **10** to remain closed is from 6–16 milliseconds. For best results, the decay time after the switch **10** is opened is on the order of one quarter second and may be adjusted by proper selection of the values of resistor **12**, and condenser **11** and the operating potentials applied to the amplifier tubes **5, 7**.

In general, manual operation of the switch **10** is undesirable because precise control of its closure period is necessary to produce reliable and realistic results. A method hereinafter described utilizes current responsive switches to control the hold-up period of switch **10**. Other methods not using manual switches could undoubtedly be used to trigger the push-pull amplifiers **5, 7**. One such method might be the development of an unblocking voltage of a predetermined waveform for direct application to grids **6, 8**. However, for purposes of simplicity and understanding, the description will be limited to relay control switch **10**.

Figure 2 shows a system for triggering the gun shot generator either manually or in response to an actual gun shot.

In the studio, sound transducing means such as microphone **21** is provided to convert sound signals to electrical signals. These electrical signals from the microphone **21** are fed to an amplifier **22** for amplification in a conventional manner. Amplifier **22** may include means for combining and controlling the outputs of other microphones not shown here for simplicity. The output from amplifier **22** is fed into the program line and eventually to a utilization means containing a transducer or loud speaker where the sounds are reproduced.

Connected with amplifier **22** is a trigger circuit **23** for detecting signals having high levels or having extremely steep wavefronts or a combination of both. It has been found that a properly designed trigger circuit will actuate

on signals representative of firearm discharges but is unaffected by screams, or shouts only a foot from the microphone.

The output from trigger circuit **23** in response to a high level signal may be a signal impulse and is shown in the drawings as connected across a relay energizing winding **28**. The voltage pulse causes a current to flow in the relay winding **28** and a switch **10** which is responsive to current flow in the winding **28** is thereby closed. The closure of switch **10** keys the normally blocked amplifier section as described with reference to Figure 1. The length of time that current flows through relay winding and hence the hold-up time of switch **10** may be controlled by proper choice of circuit constants in the trigger circuit **23**.

If desired, the keying of the noise burst may be initiated manually by closing the contacts of switch **24**. With switch **24** closed, a source of potential such as from battery **27** may be applied to condenser **26** through the relay winding **28**. As the condenser **26** charges, energizing current will flow in relay winding **28** thereby causing switch **10** to close. The hold-up period of switch **10** in this instance depends on the value of the relay winding **28** inductance, the capacitance of capacitor **26** and the battery potential of battery **27**. The closure of the switch **10** keys the random noise as previously described. A resistor **25** serves to discharge a condenser **26** after the contacts of switch **24** are opened.

For the purpose of firearm discharges the character of the noise voltage was found to have a bearing on the quality of the final reproduced result. Tests show that a smooth type of hiss gives the best results. Generators having spikes of high amplitude, even when followed by some degree of limiting in succeeding amplifiers, do not produce as good an effect as those having smooth, random electrical noise output.

Referring to the gun shot sound effects generator shown in Figure 3, the present equipment avoids the undesirable spikes by using an ordinary gaseous discharge tube **40** as a noise generator. This type of tube in combination with proper circuitry, is found to be non-critical and to develop a spike free noise voltage having frequencies substantially within the audio spectrum. A load resistor **41** and a pair of direct current dropping resistors **42, 43** connect the anode of a gas tube **40** to a direct voltage supply lead **44**. The voltage supply lead **44** provides a positive potential which is only a few volts greater than necessary to cause and maintain conduction in the gaseous discharge tube and must be well filtered to avoid hum components in the noise voltage output. A pair of condensers **45, 46** respectively connect the junction of the resistors **41, 42**, and **42, 43** to ground and serve as further filter elements to bypass audio frequencies including hum and noise components to ground. The cathode of gas tube **40** may be directly connected to ground to complete the D. C. current path. A coupling condenser **47** couples the noise voltage output developed across load resistor **41** to the control grid of an amplifier tube **50**. Since the level of the output from the noise tube of the type shown is rather low, appreciable amplification should be provided before coupling with the program line. To this end amplifier tubes **50, 51** and **52** are connected to amplify the noise signal voltages in a conventional manner. The ouput of amplifier tube **52** may be fed through the coupling transformer **31** to the push-pull keyer tubes **5, 7** as shown and described in conjunction with Figure 1.

The frequency band pass of the noise amplifier section may be controlled as shown in the grid circuit of amplifier tube **51**. A grid leak resistor **61** is connected by a conductor **60** to a wafer or a section **A–1** of a ganged switch. By changing the switch positions, circuit components are placed in shunt with the grid leak resistor **61** whereby the frequency band pass may be selectively controlled.

When switch **A–1** is in any of positions B, C, E, F, J, or K, resistor **62** and condenser **63** are both connected in shunt with grid leak resistor **51**. With the switch in any of these positions there is provided a relatively wide band pass of frequencies in the audio spectrum including sufficient high frequency components of the noise signals to give the impression of light firearm discharges at several yards. In switch position D resistor **64** and condenser **65** are both connected in shunt to resistor **61**. This RC combination is adjusted so the amplifier will pass an even wider band of audio frequencies including more of the high frequency components. At switch position G and H condensers **66** and **67** are respectively connected between the grid of the amplifier tube **51** to ground. These condensers bypass some of the high frequency components of the noise to ground so that for position G the noise components will have only the necessary quality to produce distant rifle etc. discharges or near cannon fire, and for position H the noise components passed will be predominantly the low frequency elements having that quality for simulating distant cannon fire. In position L and I, condenser **86** is connected between the grid of tube **51** and ground to bypass enough of the high frequency components to ground to allow repetitive firing to sound like a pom-pom.

The operation of the push-pull keyer tubes (**5, 7**) is substantially the same as that described in Figure 1. However, in this embodiment the cathode circuit of one of the tubes **5, 7** may have additional variable resistance **80** to selectively unbalance the operation of the tubes. As hereinbefore discussed, a slight unbalance will produce a D. C. thump component when the bias is suddenly removed to produce an impact with the shot to further enhance its realism. In the case of cannon fire where reduced impact is desirable (positions G and H of the ganged switch), push-button **79** provides switching contacts to short out unbalancing resistor **80**.

The amplifier tubes **5, 7** of Figure 3 are held cut-off by a negative bias potential on a lead **100** which is applied through one of the resistors **82** to **87** depending on the position of the wafer or section switch **A–5**, and through the secondary of transformer **31** to the grids **6, 8** of the tubes. A connection is made from one of the contacts **81** of a relay **90** to the center tap of the secondary of transformer **31**, and the other of contacts **81** is connected through a small resistor **89** to ground. When the relay contacts **81** are closed in response to the energization of relay winding **90**, the blocking bias is removed from the grids **6, 8**. The RC time constant of the resistors selected at switch **A–5** and the condenser **11** determines the length of time that the keyer tubes will conduct after contacts **81** have opened as discussed hereinbefore with reference to Figure 1.

For optimum conditions to produce reliable and consistently realistic gun shots, the keyer tubes should be allowed to conduct for maximum level for a selected predetermined time preferably from 6–16 milliseconds. As shown in Figure 3, the length of this time is determined by the hold-up period of contacts **81**. It is the purpose of the circuitry connected with tube **110** to automatically control this hold-up time, so that human errors, which would be present in manual switching, are eliminated. It is recognized that other systems might be used to unblock the keyer tubes and the description herein given is not meant to limit scope of the invention but rather to aid in understanding of this embodiment of the invention.

The operation of the device for single firearm discharges will be discussed first in which the ganged switch should be set to any positions, B, C, D, E, F, G, or H.

A vacuum tube **110**, which is shown here as a triode, is normally maintained cut-off by a negative bias potential from a lead **100** which is connected through a resistor **111**, a pair of relay contacts **102** and **103** and another resistor **115** to the grid of the tube **110**. Relay winding **90** is connected in a space current path of the tube **110**, and is en-

ergized thereby to operate the relay contacts **101**, **102**, **103**, **81** and **104**.

Switch **120**, which is represented here as a push-button, but may be any type of switch to make and break a circuit, is connected on one side to a source of positive potential through a lead **130** and on the other side through switch A–2 and other circuitry hereinafter described to the grid of tube **110**. When push-button **120** is depressed to close its contacts, current flows from positive source of potential **130** through the closed switch **120**, and resistors **114** and **112** to the negative biasing potential **100**. The voltage developed by current flow through resistor **112** is also present across the series combination of condenser **113** and resistor **111** which is connected in shunt with resistor **112**. The condenser **113** charging current flowing through resistor **111** will produce a voltage pulse thereacross. This pulse is taken from the junction of resistor **111** and condenser **113** and is fed through contacts **102** and **103** and resistor **115** to the grid of tube **110**. The pulse is of positive polarity with respect to ground and of sufficient amplitude to unblock tube **110** which then conducts to energize relay winding **90** thereby closing contacts **81**, **104** and **101–102**.

The negative potential from bias source **100** is now applied directly to the grid of tube **110** through contacts **101** and **102** thereby blocking the tube. Since the relay winding **90** is in the space current path of the tube **110**, the relay is energized to open contacts **81**, **104** and **101—102**. Only one pulse is produced across resistor **111** so that when relay **90** is deenergized, the negative biasing potential **100** is applied to tube **110** through resistor **111**, contacts **102**, **103**, and resistor **115**, and the normal cut-off operation is resumed. No matter how long push-button **120** is closed, only a single positive pulse will be produced to trigger tube **110**.

Several systems might be used to repeatedly trigger the keyer tubes to simulate machine gun fire. Such a system might have utilized a relay actuated by a low frequency oscillator, or the relay could have been made to vibrate at the desired rate either with or without a controlling vacuum tube.

For repetitive operation of this circuit to simulate the machine gun fire, the gang switch may be in one of the positions I, K, J, or L. In these switch positions the grid of tube **110** is connected through resistor **140**, switch A–3, a second switch B–1 and a condenser to ground. The grid is also connected through the resistor **115**, relay contacts **102**, **103** and resistor **111** to the negative bias potential lead **100** to maintain the tube **110** normally cut-off. When push-button **120** is operated, current flows from the positive potential lead **130** through the push-button **120**, resistors **116**, **111**, to the negative bias potential lead **100**. The positive voltage developed by the current flow through the resistors **116** and **111** is taken from the junction point of these resistors and is connected through the contacts **102**, **103** to the grid of tube **110** to unblock the tube. Tube **110** conducts to energize relay winding **90** thus closing contacts **81**, **104** and **101—102**. The high negative potential of lead **100** is then applied through contacts **101** and **102** to the tube **110**. Depending upon the position of switch S–1 one of the condensers **150** to **153** which may be selectively connected in the grid circuit of the tube **110** will be charged by this negative voltage through the small resistor **140**.

When the high negative voltage cuts off tube **110**, relay winding **90** is deenergized and contacts **102**, **103** are closed, and the positive voltage from the junction of the resistor **116** and **111**, is again connected through the relay contacts and resistor **115** to the grid **105**. However, the tube is not unblocked immediately as the negative charge in the selected capacitor (**151** as shown), must leak off through resistors **140**, **115** and **111** and the positive potential source **130** to ground. When the condenser **151** is sufficiently discharged, the tube will conduct again repeating the cycle. The time between the shots of the machine gun fire is thus dependent upon the time constant of capacitor **151** and resistors **140**, **115**, and **111**. By changing the position of switch S–1, a capacitor of different value is placed in the grid circuit of tube **110**, and thus the time interval between the shots can be varied.

Another effect which is useful and desirable in gun shot synthesising apparatus is that of ricocheting bullets. For realism and versatility, the ricochet tone should be a distorted whine which can be triggered following a gun blast by any desired interval of time. Actual ricochet notes generally start at a medium or high pitch when the bullet has been deflected by a solid object which has caused an abnormal spin. The note usually falls off because of down doppler and reduced spin rate while the sound fades away.

An adjustable electronic type delay for such ricochet sounds is shown in triodes **170** and **180** which have a common cathode resistor **174**. The plate load resistor **183** of triode **180** is much smaller than the plate load resistor **177** of triode **170**. Thus the greater tube current in triode **180** causes a cathode bias voltage to be developed across the common cathode resistor **174** which is sufficient to maintain triode **170** substantially cut-off.

For operation of the ricochet and delay circuit, the ganged switch must be in one of the positions shown as B, C, D. When the push-button **120** is depressed, a positive voltage pulse is developed across the resistor **111** which triggers tube **110** as hereinbefore described. The same pulse is fed through an isolating resistor **172**, a condenser **171**, and a switch A–4 to the grid **173** of the tube **170**. This positive pulse unblocks triode **170** and causes conduction therein, thereby reducing the plate voltage of that tube so that a negative voltage pulse is fed through condenser **176** to the tube **180**, cutting it off. The delay time from the start of the synthesized shot to the start of the ricochet oscillations is equal to the time tube **180** remains cut-off, and is a function of the RC time constant of condenser **176** and variable resistor **175**. Resistor **175** may be preset or may be brought out as a front panel control to selectively vary the ricochet delay time. When capacitor **176** discharges sufficiently through resistors **175**, **178**, and **174**, to bring the grid of tube **180** into the conduction region, the cycle is completed and tube **180** is snapped into heavy conduction. By virtue of the interconnection of the cathodes as previously described, triode **170** is returned to cut-off.

Relay tube **160** normally conducts to maintain energized a relay winding **161** which is connected in the space current path of the relay tube. When tube **180** snaps back into conduction, a large voltage surge appears in the plate circuit of that tube. This surge is differentiated through a condenser **181** and a resistor **182** to produce a negative pulse at the grid of the relay tube **160**. The relay tube then amplifies the negative pulse to effect a momentary deenergization of the relay winding **161**.

The relay winding **161** controls a pair of contacts, **162** which are connected in the grid circuit of tube **190** of the ricochet tone multivibrator. The tone multivibrator comprises tubes **190** and **200**. Tube **190** is normally cut-off by the high negative bias voltage from lead **100**, which is connected to its grid through resistors **196**, **197** and **198**. Tube **200** normally conducts by virtue of the high positive voltage from lead **205** which is connected to its grid through resistor **201**. When the relay **161** is momentarily deenergized to close its contacts **162**, a condenser **191**, which is connected in the grid circuit of the tube **190**, is charged by a positive voltage from lead **195**. The positive voltage across the condenser **191** is presented to the grid of tube **190** and causes that tube to conduct. The tube conduction causes a drop in plate voltage, and a negative pulse is thus delivered through switch A–5, and through one of the condensers **202**, **203**, **204** to the grid of tube **200**. This negative pulse cuts off tube **200** for a period of time depending on the RC time constant of the condenser selected and resistor **201**. As soon as

the charge leaks off the selected condenser sufficiently, tube 200 snaps back to conduction, and a negative pulse is delivered through condenser 192 to the grid of tube 190 driving it into cut-off again. The period of cut-off of tube 190 depends on the RC time constant of the condenser 192 and the resistor 197, and the potential across the condenser 191. When condenser 192 discharges sufficiently, the positive voltage from condenser 191 will cause 190 to conduct again, thus repeating the cycle. The cycle is designed to continue at an audio rate.

As has been stated the condensers 202, 203, 204 may be selectively connected into the circuit through switch A–6, thus allowing control of the initial frequency of oscillation. However, to make a realistic ricochet the tone must fall off because of down doppler, and the sound should fade away. To accomplish this, a resistor 196 is connected to serve as a discharge path for condenser 191, so that the positive voltage delivered to the grid of tube 190 gradually decreases, and thus the frequency of operation and the amplitude of output of the ricochet multivibrator are decreased. The output from the ricochet multivibrator is fed from the grid circuit of the tube 200 through a condenser 55 to the cathode circuit of the amplifier tube 52 of the noise amplifier section. Because the ricochet oscillator continues to function until the voltage as condenser 191 drops below ground potential, a means is provided to quickly discharge this capacitor to permit other ricochet shots to follow in rapid sequence. Otherwise, during the delay period between the second shot and its ricochet, low pitched oscillations remaining from the previous shot would be heard. The pair of open contacts 104 on the triggering relay 90 are therefore connected across this capacitor so that each time a shot is fired contacts 104 close to quickly discharge condenser 191.

Each time that push-button 120 is depressed and relay 90 is momentarily actuated to close the contacts 81 the keyer tubes are unblocked momentarily. The output of these tubes is fed through transformer 9 to the program line. In order to permit head set monitoring or last minute selection and adjustments, a phone jack 210 is provided which disconnects both the shown output channels. Thus, the control settings, as well as overall performance, may be checked during a show. Output level may be adjusted by means of an indicator such as a neon tube 211 if necessary.

Figure 4 is a schematic diagram of a circuit for automatically triggering the keyer tubes in response to signals from an actual gun shot. The program input is connected to terminals 230 and 231, and fed through a transformer 232 to a pair of tubes 240, 250 connected in conventional push-pull relation. The output of these amplifier tubes may be taken from the output terminals 251, 252 on the secondary winding of transformer 241.

Block I includes the noise generator and amplifier which feeds the noise signals to keyer tubes shown in block II and which was hereinbefore described in reference to Figure 3. Block V represents a power supply which may be used for operation with this circuit.

The keyer tubes of block II are triggered into operation by the trigger circuit shown in block III which is in turn actuated by signals of predetermined high level representative of actual gun shots. A trigger relay winding 261 is connected in the space current path of the trigger tube 260 and the contacts controlled thereby constitute a switching arrangement connected with the grids of the keyer tubes. A cathode resistor 263 and a resistor 264 are connected between ground and a source of positive potential and form a voltage divider network. The trigger tube is normally maintained cut-off by virtue of the bias potential developed across the cathode resistor 263.

The grid of the trigger tube 260 is connected to ground through a resistor 262. When voltage is developed across the grid resistor 262 which is of sufficient amplitude, tube 260 is driven out of cut-off and relay 261 is energized.

A rectifier 265 is connected from one end of the secondary winding of the signal input transformer 232, to a source of positive operating potential 270 through the resistor 267, 266. A coupling condenser 268 connects the junction of resistors 266, 267 to the grid of trigger tube 260. When the incoming signal level reaches a predetermined high level representative of the level of gun shot signals, the rectifier 265 will become conductive causing current to flow in resistor 266, 265.

This current flow produces a voltage change or pulse at the junction of the resistors 266, 267 which is integrated across the RC combination of the grid resistor 262 and the coupling capacitor 268, to produce a voltage pulse across the grid resistor 262 of such polarity and magnitude to unblock trigger tube 260. When the tube 260 conducts, the relay winding 261 is energized to close the relay contacts. The relay contacts connect the grids of keyer tubes 5, 7 to ground through a small resistor thereby removing the blocking bias. In this manner the keyer tubes are actuated in response to high level signals to produce synthetic signals representative of gun shots.

In the operation of the device as shown in Figure 4, high level signals representative of an actual gun shot are fed together with the regular program signals to the amplifier section shown in block IV.

The trigger circuit is coupled to the input of the amplifier section and is so designed that it is responsive to signals over a predetermined amplitude, such as the actual shot signals. A signal of such character causes the tube 160 to conduct as described thereby energizing the relay winding 261 whereby the relay contacts are closed.

Upon closure of the relay contacts the keyer tubes shown in block II conduct and a signal representative of a gun shot is developed and fed to the grid circuit push-pull of the amplifiers 240, 250. The signals representative of an actual gun shot are thereby reinforced by the synthesized signals, and the composite output may be obtained from the output terminals 251, 252 of the amplifier section. Tests indicate that hand-clapping, shouts, and screams within six inches of the microphone will not trigger a device constructed in accordance with Figure 4, but gun shots will operate the circuit satisfactorily.

While exemplifications of the invention have been indicated and described above, it will be apparent to those skilled in the art that other modifications may be made without departing from the scope of the invention as set forth in the appended claims.

What is claimed is:

1. In a sound effects system for electrically generating signals representative of firearms discharge, a signal conveying channel comprising a generator of random electrical voltages, an amplifier for said voltages connected with the generator, transducing means for converting electrical energy to sound energy connected with said amplifier, a first control means connected with said amplifier to maintain said amplifier blocked, and a further control means connected with said amplifier for momentarily rendering said amplifier unblocked in time duration and amplitude such that random electrical voltages from said generator are passed through said system to said transducer in an envelope which simulates signals representative of said firearms discharge.

2. A percussion sound effects system comprising a signal generator for providing noise voltages, an amplifier for said voltages including at least one electron tube having an anode, a grid and a cathode, an output circuit connected with said anode and cathode, a source of blocking bias potential connected with the grid and cathode of said tube to maintain said tube substantially cut-off, circuit means including a switch device and a capacitor connected between said grid and a point of reference potential to render said tube conductive in response to momentary actuation of said switch whereby said noise voltages are amplified to produce a signal in said output circuit, said capacitor having a value and being controlled in

charge and discharge to impart to said signal a waveform which rises relatively rapidly to a maximum level during said momentary activation, and thereafter declines to a lower level relatively slowly.

3. A percussion sound effects system as defined in claim 2, wherein said switch device is current responsive, and wherein there is provided a second circuit means for actuating said switch device including a control switch and a source of operating current for said device connected therewith such that in response to actuation of said second switch current flows in said circuit for a predetermined length of time, thereby actuating said current responsive switch device for a predetermined length of time.

4. In a system for producing percussion sound effects, a signal channel comprising a generator of random electrical voltages, an implifier for said voltages, an output circuit connected with said amplifier, a first means to maintain said system normally blocked, further means for unblocking said system for a predetermined length of time, a second signal channel, a trigger circuit connected with said second signal channel, said trigger circuit being responsive to high level signals representative of actual gun shots, said trigger circuit further being connected with said unblocking means such that said signal channel is unblocked in response to actuation of said trigger circuit, whereby said random electrical voltages are passed having a waveform simulating the waveform of signals representative of firearms discharge.

5. A system for producing gun shot sound effects, comprising a generator providing noise voltages which have wave lengths substantially within the audio frequency spectrum, an amplifier for said voltages including a first electron tube having an anode, a grid, and a cathode, transducing means for converting electrical energy to sound energy connected with said amplifier, a source of biasing potential coupled with the grid and cathode of said first tube to maintain said amplifier blocked, means including a current responsive switch for removing said biasing means from the grid and cathode of said first tube amplifier for a predetermined length of time whereby said amplifier is rendered conductive, means for controlling said current responsive switch including a second electron tube, said switch being responsive to the space current flow of said second tube, means including a manually operated switch for changing the state of conductivity of said second tube for a predetermined length of time, whereby said current responsive switch is actuated, further circuit means including a resistor and a condenser connected with said first tube and operable after said predetermined time to gradually reduce the conductivity of said first tube to cut-off, whereby said sound energy from said transducing means rises sharply to a high level for said predetermined length of time, and decays to a lower level during a relatively longer period of time.

6. A system for producing machine gun shot sound effects comprising an electrical generator of random noise voltages, an amplifier and said voltages, transducing means for converting electrical signals corresponding to said voltages to sound signals connected with the generator through said amplifier, control means for said amplifier including a source of biasing potential connected with said amplifier for normally maintaining said amplifier blocked to restrict the flow of said voltages therethrough, circuit means including a switch device and a capacitor connected to render said control means inoperative for a predetermined time interval thereby to render said amplifier conductive at a high level over said time intervals, means for momentarily actuating said switch device at successively spaced intervals of time, and further control means for said amplifier including a resistor and a capacitor connected with said amplifier and operable after each of said predetermined time intervals to gradually reduce the conductivity of said amplifier to cut-off whereby sound signals which have risen sharply to relatively high levels for each of said time intervals are caused to decay during relatively long periods of time to a lower level.

7. A sound effects system for generating firearm discharges followed by ricocheting sounds including an electrical generator of random electrical voltages, an amplifier for said voltages, transducing means connected with the generator through said amplifier for converting electrical signals corresponding to said voltages to sound signals, control means for rendering said system conductive to supply said voltages to operate said transducer for a predetermined time interval, additional control means in said system and connected between said generator and tranducer for modifying said voltage whereby the sound level produced by said transducing means rises sharply near the beginning of said interval and subsequently decays at a relatively slower rate, audio oscillator means connected with said amplifier, and means to delay the application of oscillations from said oscillator to said amplifier for a predetermined time after said system is rendered conductive.

8. A sound effects system for generating firearm discharges as defined in claim 7 wherein the means to delay the application of oscillations from said oscillator to said amplifier include a single shot multivibrator.

9. A sound effects system for generating firearm discharges as defined in claim 7 wherein said audio oscillator has means for changing the frequency of oscillations thereof including a capacitor provided with a discharge circuit connected with said audio oscillator whereby the potential across said capacitor controls the frequency of said oscillations, a source of potential for normally charging said capacitor and means for removing said source of charging potential during said predetermined time interval whereby the charge on said capacitor may gradually leak away.

10. A system for reinforcing and supplementing electrical signals representative of gun shot sounds, comprising a first signal channel including input and output circuits, means for transducing sound energy from actual shot sounds to electrical signals connected with said input circuit, and sound energy reproducing means connected with said output circuit; a second signal channel having input and output circuits for generating synthetic gun shot signals comprising a generator of random electrical voltages connected with said input circuit, control means connected with the second channel for rendering the channel conductive to pass said random electrical voltages from said generator therethrough for a predetermined time interval, and additional control means in circuit with said second channel for controlling the amplitude-pass characteristic of the system in relation to said time interval to simulate a wave envelope of a gun shot; means responsive to signals of a predetermined high level connected with said first signal channel for actuating the control means connected with said second channel whereby said second channel is rendered operative by said high level signals, and means connecting the output circuit of said second signal channel with said first signal channel, whereby the signals representative of the actual gun shot sounds are reinforced and supplemented by the controlled random electrical signals.

11. In a system for generating signals representative of gun shot sound effects and reinforcing signals representative of actual gun shot sounds, a first signal channel comprising means for transducing sound energy from actual shot sounds to electrical energy, an amplifier for said electrical energy connected with said first named means, and sound energy reproducing means connected with said amplifier; a generator of synthetic gun shot signals comprising a source of noise voltages, an amplifier for said noise voltages, an output circuit for said amplifier, control means for normally maintaining said noise voltage amplifier cut-off and further means for rendering said noise voltage amplifier conductive for a predetermined length of time and additional control means

in said system connected between said generator and transducer for modifying said voltages whereby said noise voltages are amplified by said noise voltage amplifier such that a signal having a wave envelope representative of gun shot signals is produced in said output circuit, a trigger circuit having output terminals and responsive to signals of a predetermined high level connected with said first named amplifier, means connecting the output terminals of said trigger circuit with said means for rendering said amplifier conductive whereby the noise amplifier is unblocked in response to activation of said trigger circuit; and means for connecting said output circuit of the noise voltage amplifier with said first mentioned amplifier, whereby the signals representative of the actual gun shot sounds are reinforced by the synthetically generated signals.

12. In a system for generating signals representative of gun shot sound effects and reinforcing signals representative of actual gun shot sounds; a first signal channel comprising means for transducing sound energy from actual shot sounds to electrical energy, an amplifier for said electrical energy connected with said transducing means, and sound energy reproducing means connected with said amplifier; a generator of synthetic gun shot signals comprising a source of noise voltages, an amplifier for said noise voltages having an input circuit and an output circuit, a source of biasing potential connected with the input circuit of said noise amplifier to normally maintain said amplifier blocked, means including a current responsive switch connected between said input circuit and a point of reference potential, said amplifier being unblocked for a predetermined time interval in response to the activation of said switches, further means including a resistor and a capacitor connected with said input circuit and operable during said time interval to gradually reduce the conductivity of said amplifier to cut-off whereby sound signals which rise sharply to a relatively high level decay to a lower level during a relatively longer time thereafter; a trigger circuit including an electron tube responsive to signals of a predetermined high level, said trigger circuit being connected with said first named amplifier whereby the state of conductivity of said electron tube is controlled by high level signals in said amplifier, said current responsive switch being responsive to the current flow in said tube whereby change in the state of conductivity of said tube operates said switch to unblock the noise amplifier; and means for connecting said output circuit of the noise voltage amplifier with said first mentioned amplifier, whereby the signals representative of the actual gun shot sounds are reinforced by the synthetically generated signals.

References Cited in the file of this patent

UNITED STATES PATENTS

2,455,472	Curl et al.	Dec. 7, 1948
2,483,226	Newman	Sept. 27, 1949
2,500,063	Crane	Mar. 7, 1950