

[54] **LASER SYSTEM FOR WEAPON FIRE SIMULATION**

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[51] **Int. Cl.** **F41g 3/26**

[58] **Field of Search**..... 35/25; 273/101.1

[56] **References Cited**

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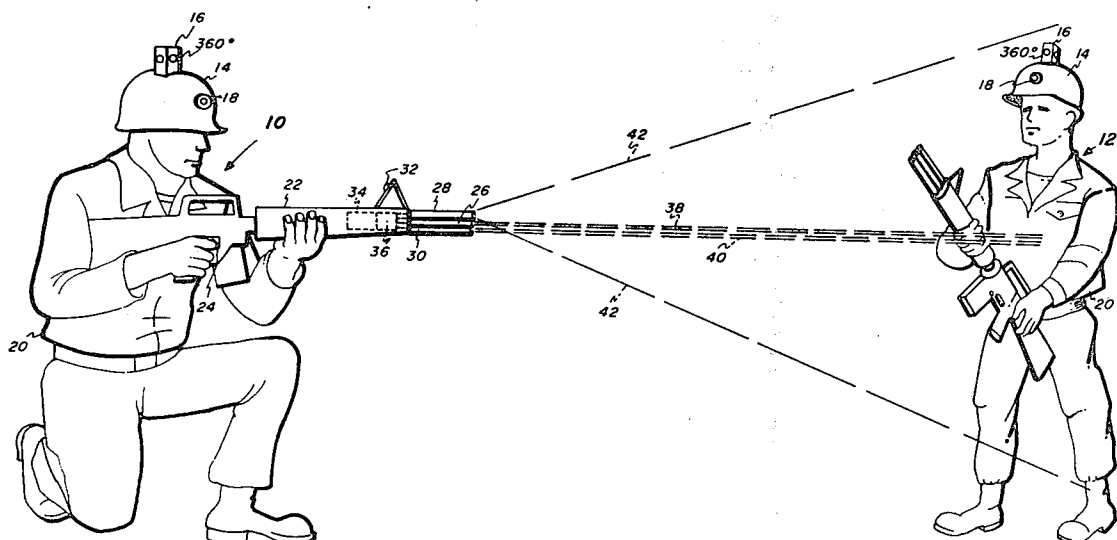
[57] ABSTRACT

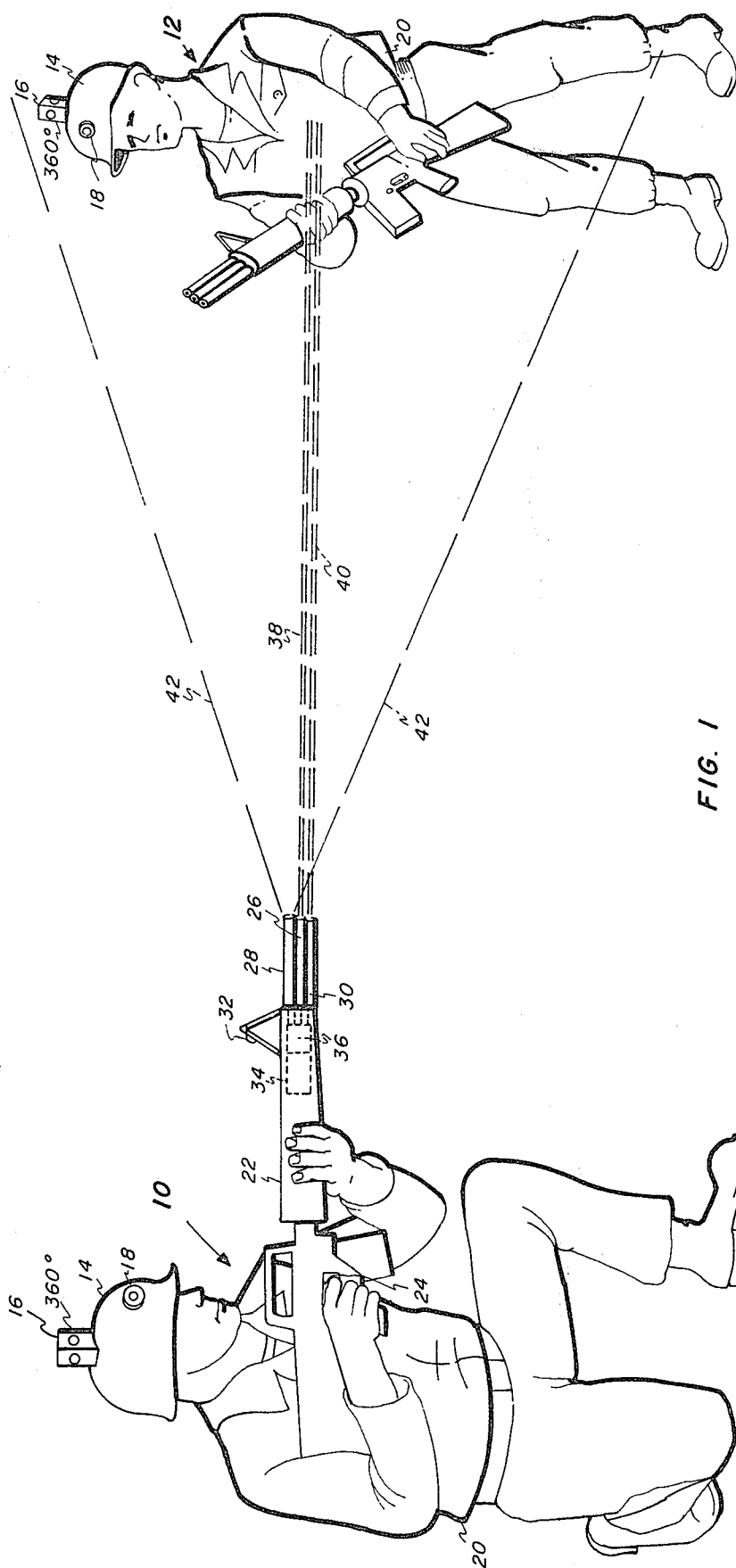
A weapon direct fire kill simulator system in which a laser transmitter means of dual mode, narrow and broad beam projection, capability, a hit receiver-actuator means and hit indication means all fixed to a weapon to be simulated and having a trigger switch are combined with a man target means having retroreflective apparel or patches to reflect the narrow fire beam back to the hit receiver-actuator and combined also with a 360° kill detector-actuator means to receive the kill beam to actuate a kill indicator alarm also made a part of the man target wearing apparel.

The invention also contemplates a timing means and adjustable range gate means to disable the system when the target is beyond the simulated weapon's range, comparator means to eliminate noise signals below the value of the hit indicator signals, and disabling means to inactivate a man target once hit.

In composite, the system provides immediate hit indication to the trainee and kill indication to the man target while also correcting for weapon characteristics.

9 Claims, 5 Drawing Figures





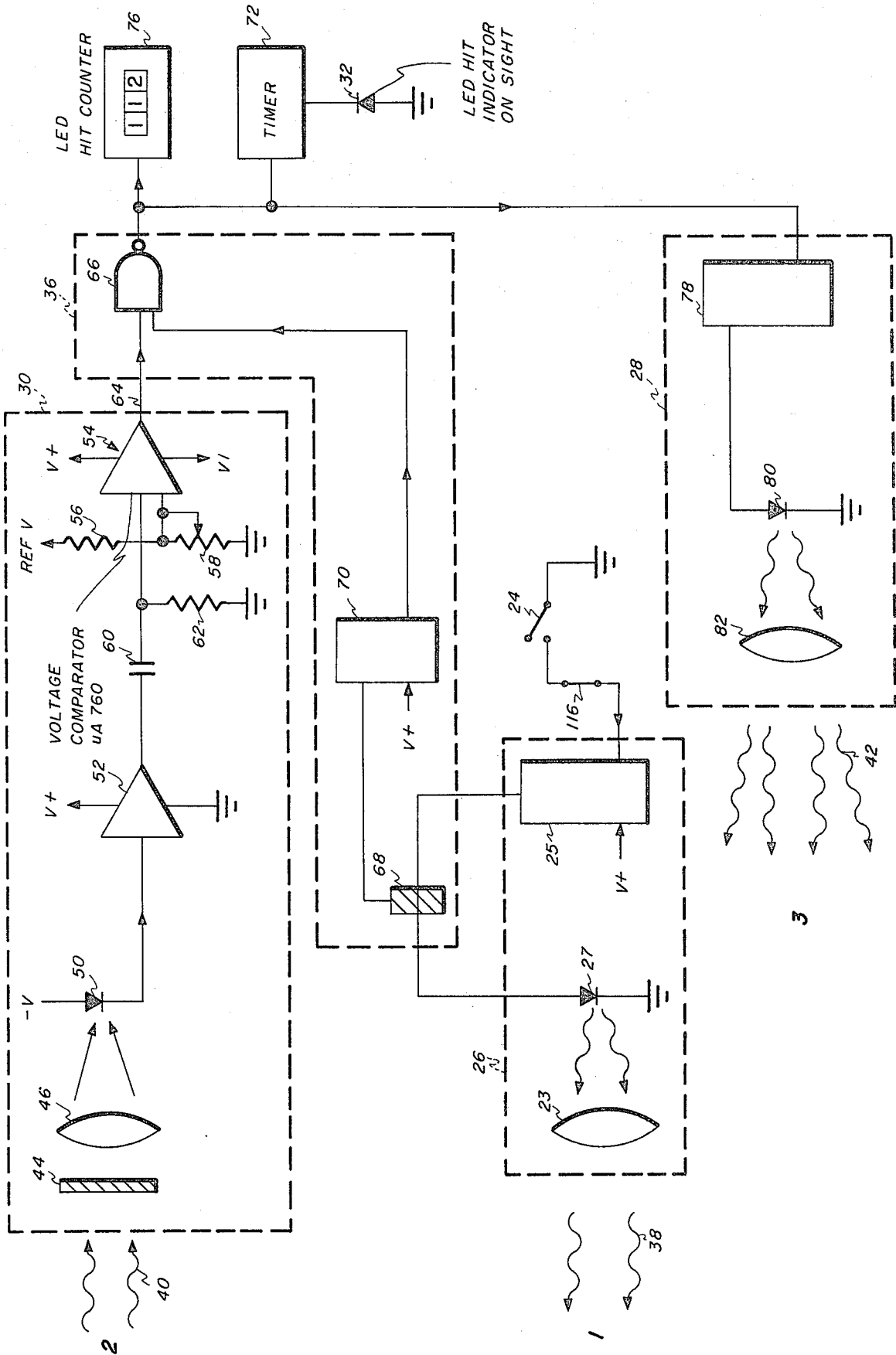
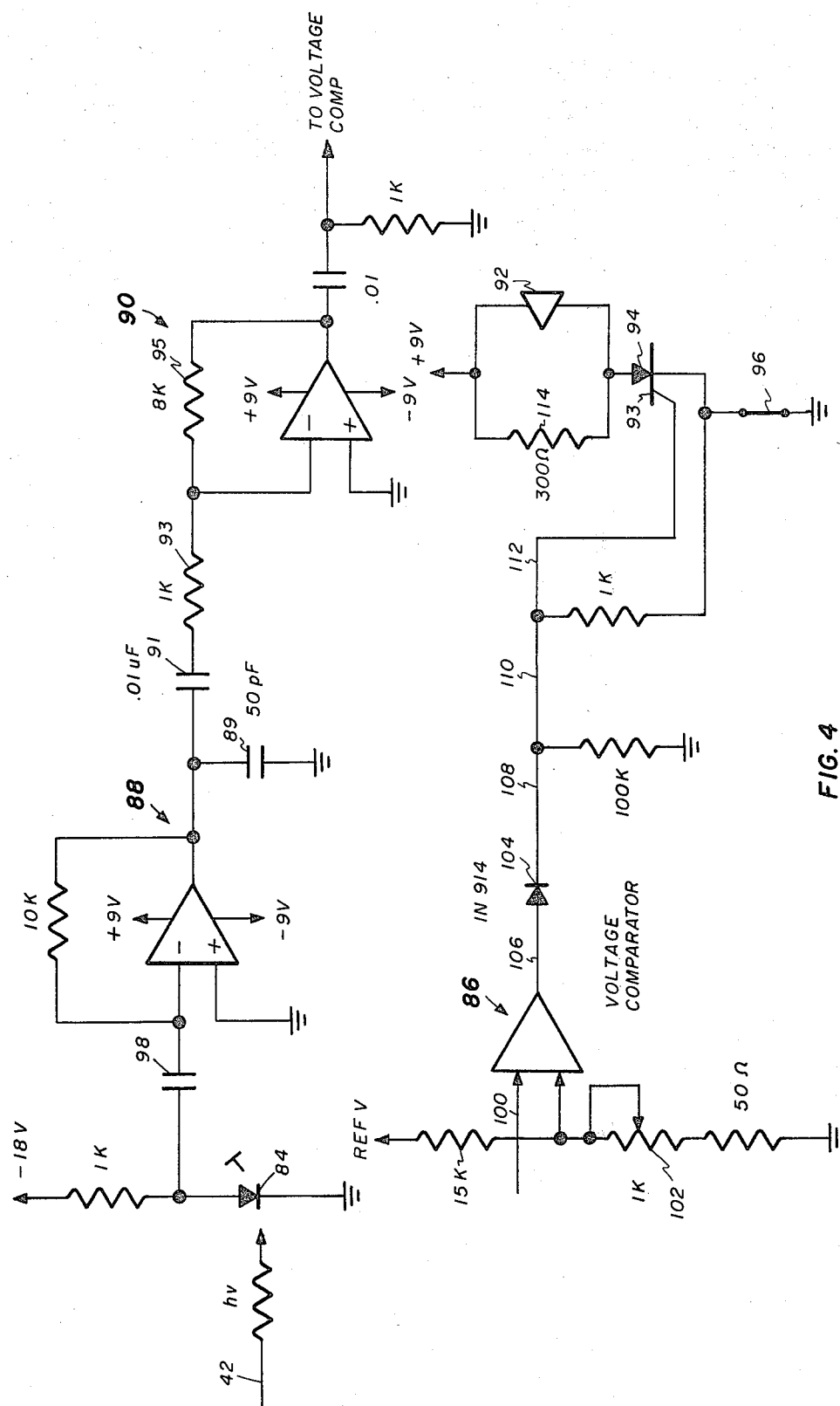
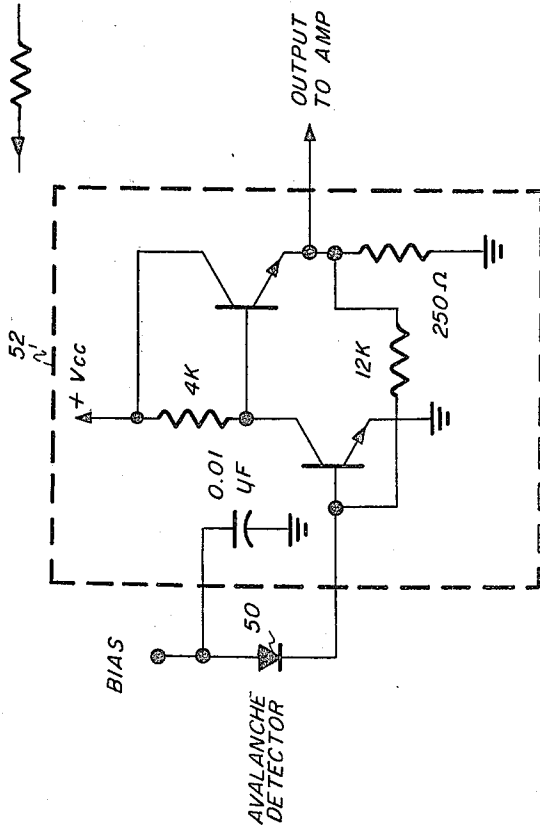
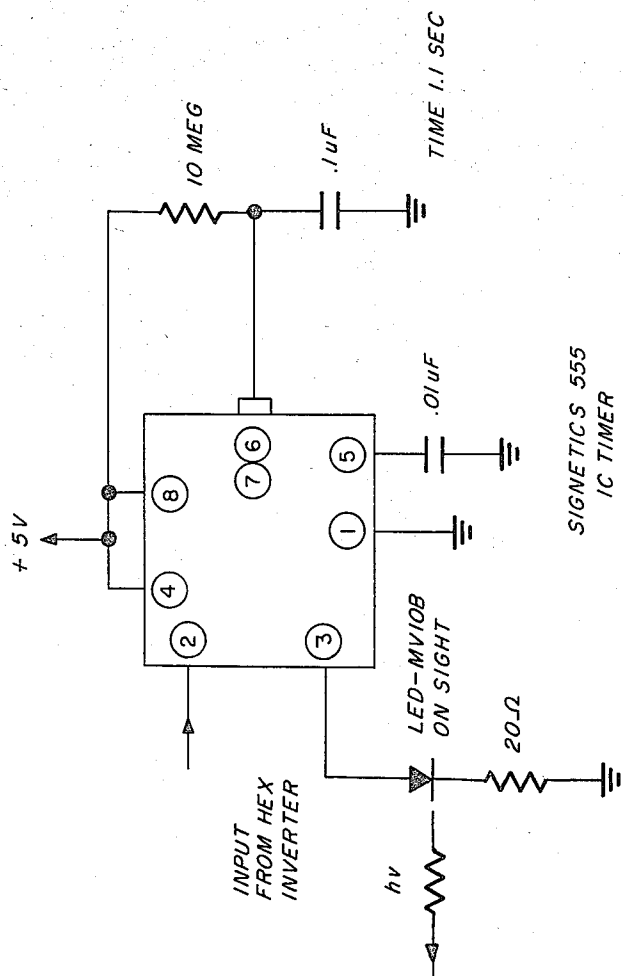


FIG. 2





LASER SYSTEM FOR WEAPON FIRE SIMULATION

BACKGROUND OF THE INVENTION

The invention relates to the field of education and training in direct fire weapons and to the field of simulation relating to a man vs man combat system.

In order that military combat practices in the field of direct fire weaponry may be carried out in a realistic, yet economical fashion, such as to provide effective training comparable to the use of operational equipment and live round ammunition, past efforts have been directed to various forms of simulation equipment of substantial weight, bulk and complexity. Thus, in the past radiation transmitters have been employed for emitting a narrow beam of optical radiation, the transmitter being mounted to be aimed with the weapon simulated and combined with detector means oriented to a target screen and hit or miss indicator means in the form of audio or visual signal means. In man-to-man combat simulation systems of this type the man must be covered with numerous detectors which are easily destroyed or interfered with on military maneuvers. Also a radio pack is required to transmit kill data to the trainee firing his weapon. The use of a woven vest of optic fibers to reduce the number of detectors has been tried with lack of success because the vest becomes fragile and presents a more stringent signal-to-noise problem. A basic system of laser beam transmitter and man target apparel of retroreflective material provides only an indication of kill to the trainee firing the weapon but provides no kill data or indication to the man target and no disablement of the man target.

SUMMARY OF THE INVENTION

The invention comprises an arrangement of a dual mode laser transmitter and a receiver, together with hit indicator means in integral relationship with a weapon to be simulated having switch means for operating the transmitter in hit mode beam when the trigger switch is actuated. The invention comprises in association therewith a man target (simulating man to man engagement) wherein the man target is provided with apparel or patches of retroreflector material to reflect the fire beam to the receiver-actuator and thereby actuate the transmitter to the second or broad beam kill mode. The broad beam is received by kill receiver-actuator (detector) means on the helmet of the man target to actuate an alarm system which can only be shut off by turning a key in a circuit which eliminates the man target from further competition.

The invention also contemplates range gate means for inactivating the laser transmitter when the target is beyond the weapon range, and voltage comparator means for eliminating noise signals of a level below the hit signal level.

DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic functional presentation of a man-to-man weapon fire kill simulator system incorporating the invention;

FIG. 2 is a schematic diagram of circuit details of the system of FIG. 1;

FIG. 3 is a schematic diagram of a suitable amplifier and avalanche detector employed in the system of FIGS. 1 and 2;

FIG. 4 shows a suitable circuit for the kill detector, alarm system and key interlock employed to indicate a kill; and

FIG. 5 is a schematic of a suitable integrated circuit timer and light emitting diode used in the circuit of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, there is shown two fighting men, trainees, equipped with a weapon fire simulator system incorporating the invention. The trainees 10 and 12 are identically equipped and for convenience in reference, identical equipment will be given the same numerical identification for each item of equipment. Thus, trainees 10 and 12 are provided with helmets 14 having 360° kill receiver-actuators 16 for laser beams, alarm means 18, jackets 20 of retroreflective material and a laser type weapon simulator 22 having a trigger 24, a fire beam (narrow beam) laser 26, kill beam (wide angle) laser 28, hit receiver-actuator 30, hit indicator 32, power source means 34, and comparator and gating circuit means 36 to exclude noise signals and input signals beyond the intended range of the weapon.

Also shown in FIG. 1 are the several rays which result from the firing and hitting of a man target. Thus, actuation of the trigger 24 energizes the fire beam laser 26 which produces a narrow fire beam 38 which upon striking the retroreflective jacket 20 of the target man is retroreflected (beam 40) to actuate the hit receiver-actuator 30. Receiver-actuator 30 then actuates the hit indicator 32 to give an immediate hit indication to the trainee firing the weapon but also activates the kill beam laser 28 which produces a broad angle kill beam 42. The latter actuates the 360° kill receiver-actuator 16 on the helmet 14 of the man target which in turn activates an alarm means 18 on the man target indicating to him that he is out of action.

Considering now details of circuitry suitable to implement the functions described above, reference is made initially to FIG. 2. The rifle trigger switch 24 when closed activates a laser pulser 25 and gallium arsenide laser diode 27 which together with collimating lens 23 constitute the fire beam laser 26 of FIG. 1. Squeezing the trigger switch 24 thus initiates the firing of the narrow fire beam 38 at the man target 12. If the narrow fire beam pulse 38 strikes the retroreflective target 12, it is reflected back to the hit receiver-actuator 30 which comprises an interference filter 44, collecting lens 46, avalanche photo diode 50, transimpedance amplifier 52 and an RC filter-comparator circuit, indicated generally at 54. The retroreflected fire pulse 40 is filtered, collected and focused on the avalanche photo diode 50 via the filter 44 and the collecting lens 46, the photo diode 50 being a high gain detector and the output thereof is amplified by the transimpedance amplifier 52. To prevent noise signals from affecting hit indication and count, the output of the amplifier 52 is threshold detected by a voltage comparator circuit 54. Comparator circuit 54 includes an adjustable reference voltage source provided from reference voltage V and potentiometers 56 and 58 connected to ground as indicated. An RC circuit including capacitor 60 and resistor 62 is provided to couple the amplifier 52 to comparator 54.

When the output from the amplifier 52 exceeds the set reference voltage, thus eliminating noise signals up

to that set level, the voltage comparator 54 generates a logical "one" signal pulse which is passed via line 64 as one input to an AND gate 66 which forms part of the gating circuit means 36. The other portion of the gating circuit means 36 includes a current transformer 68 and one shot range gate (multivibrator) 70. The current pulse from the laser pulser 25 is sensed by the current transformer 68 which triggers the one shot multivibrator range gate 70 which in turn provides a logical one input as a second input to the AND gate 66 for a time duration equivalent to the weapon's maximum range. That is, the range gate multivibrator holds the AND gate in potential conducting condition for a time period up to that time which would match the ballistic flight time at maximum range.

In end result then, if the "ones" from reflected target pulse and range gate current transformer pulse are present simultaneously at the two inputs to AND gate 66, the AND gate 66 generates a one at its output.

This AND gate signal triggers three actions. First, the rifle as indicated in FIG. 1 and in FIG. 2 is provided with a lamp, actually a light emitting diode (LED) 32, and the output signal from gate 66 activates a timer 72 which activates the LED hit indicator 32 on the rifle sight. Secondly, the rifle is, in a preferred embodiment, provided with a hit counter 76 which can be built into the rifle stock and which provides a record of target hits. Thirdly, the output signal from the AND gate 66 triggers the kill beam (broad beam) laser 28. Laser 28 comprises a laser pulser 78, gallium arsenide diode 80 and collimating lens 82, and produces the diverging broad angle kill beam 42 which in turn actuates the 360° kill receiver-actuator 16 (FIG. 1) on the helmet 14 of the man target 12 and turns on the hit alarm 18 indicating to the man target and to referees that the man is out of action.

The kill receiver-actuator 16 may comprise four photodiode detectors located on four sides of a rectangular box type holder in turn mounted on the helmet 14 as shown in FIG. 1. The number of detectors on the helmet can be reduced from four if a prism or optical fiber means are utilized.

One suitable receiver and alarm circuit for the helmet receiver equipment is shown in FIG. 4. The circuit comprises a photo diode 84 coupled to a comparator circuit 86 via an operational amplifier 88 operating in the current to voltage amplifier mode and a voltage gain amplifier 90. The remainder of the circuit comprises an alarm, which could be a horn 92 operated through a silicon-controlled rectifier (SCR) 94 which is actuated to "on" condition responsive to the output signal of the voltage comparator 86 and to "off" condition by operating a key switch indicated at 96.

When the kill beam laser pulse 42 (FIG. 4) is received by the diode 84 the amplifier 88 is actuated via the capacitor coupling 98. The output of the amplifier 88 acting as a current to voltage converter is inverted and further amplified in the series connected second operational amplifier 90. Capacitor coupling 91 is provided to ac (alternating current) couple the two amplifiers. Capacitor 89 connected to ground indicated provides a noise filter and the ratio of resistance values of feedback resistor 95 and series resistor 93 determines the voltage gain. The high speed voltage comparator 86, responsive to an input from amplifier 90 on input line 100, produces a high output voltage when the input voltage exceeds the reference voltage (indicated). The

reference voltage is set just above noise level by a potentiometer 102 in the reference level circuit. The high voltage output when produced by the comparator 86 is passed via diode 104 and lines 106, 108, 110 and 112 to the base 93 of SCR 94 to trigger the latter to on condition. The voltage drop across resistor 114 actuates the hit alarm 92 which could be an audio or visual alarm. A key is required to operate the switch 96 to shut the alarm off. It is contemplated that this key will be a key removable from the rifle circuit as indicated at 116 in FIG. 2 such that the rifle held by the man hit is thereafter inoperative. When switch 96 is opened the SCR 94 is turned off and the alarm 92 is inactivated.

In FIG. 3 is shown a schematic of a suitable amplifier 52 and diode detector 50 of FIG. 2. The avalanche photo diode is a high-impedance device with avalanche gain. The avalanche detector is a current source. The detector 50 output goes to a low-noise high-speed transimpedance amplifier 52 designed for current sources. The amplifier 52 provides an output voltage which is linearly proportional to the detector's input current.

In reference to the timer 72 and LED 32 shown in FIG. 2, a suitable timer is the Signetics 555 IC Timer, and a suitable circuit for connecting the same to the LED is shown in detail in FIG. 5, including suitable element values.

In the FIGS. 2 through 5, specific values of suitable elements are provided.

It will be understood that various changes in the details, values and arrangement of parts, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

What is claimed is:

1. A weapon fire kill simulator system comprising:
 - a. laser transmitter means for producing a narrow fire beam and a wide angle kill beam,
 - b. laser power source means and hit detector-actuator means,
 - c. a weapon having a trigger switch and means for mounting all said above mentioned means integral with said weapon and in position to direct said laser means and said hit detector-actuator means in the direction in which said weapon is aimed,
 - d. a man target carrying equipment including apparel or patches of retroreflective material, a 360° kill beam detector-actuator means and an alarm system actuated from said kill detector-actuator means upon energization of the latter,
 - e. said laser means being connected for producing said fire beam when said trigger switch is closed to direct said fire beam to said target and a retroreflected fire beam from said apparel to said hit detector-actuator means,
 - f. said hit detector-actuator means being connected to actuate said laser means to produce said wide angle kill beam to actuate said kill detector-actuator and hence said alarm system.
2. Apparatus according to claim 1, including
 - a. hit indicator means fixed to said weapon and connected to respond to actuation of said hit receiver-actuator to indicate a hit to a trainee firing said weapon.
3. Apparatus according to claim 2, in which

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- a. said hit indicator means includes a light emitting diode counter and a light emitting diode visible lamp, both fixed to said weapon.
- 4. Apparatus according to claim 1, including
 - a. AND gate means, 5
 - b. range gate means comprising a timing pulse source connected to provide an initiating actuating pulse to said laser transmitter means responsive to actuation of said trigger pulse and an additional pulse of selected time length commensurate with the range of said weapon and provided as an enabling input to said AND gate to exclude from said hit indicator means any hit signal whose propagation time delay is greater than the time of laser pulse return from maximum target range of the weapon being simulated. 10 15
- 5. Apparatus according to claim 1,
 - a. said hit receiver-actuator including a voltage comparator with adjustable reference voltage input to selectively adjust the sensitivity of said hit receiver-actuator to amplify only target hit signals and exclude noise level signals up to the strength of a target hit signal. 20
- 6. Apparatus according to claim 5,
 - a. said hit receiver-actuator including an avalanche 25

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- type detector and amplifying means connected to provide a hit signal input to said voltage comparator.
- 7. Apparatus according to claim 6, including
 - a. AND gate means,
 - b. range gate means comprising a timing pulse source connected to provide an initiating actuating pulse to said laser transmitter means responsive to actuation of said trigger pulse and an additional pulse of selected time length commensurate with the range of said weapon and provided as an enabling input to said AND gate to exclude from said hit indicator means any hit signal whose propagation time delay is greater than the time of laser pulse return from maximum target range of the weapon being simulated.
- 8. Apparatus according to claim 1,
 - a. said laser transmitter means being two laser transmitters respectively for said hit and kill beams.
- 9. Apparatus according to claim 1,
 - a. said laser transmitter means being a single laser of dual mode capability for producing said hit and kill beams.

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