A Non-Lethal Electric Shock Generator with Wireless Control Function

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Abstract. A Non-lethal electric shock generator is presented and tested. This non-lethal electric shock generator without trail wires, is different from Taser series stun guns or Husha TX series electric shock guns which all have trail wires. And the intensity of electric shock can be adjusted by remote control device according to the status of the target. This no-lethal electric shock generator extends the range of application of electric shock from about 9 meters to 30 meters. The manner of using electric shocks of single intensity is also changed by telecontrol adjustment. It can provide electric shocks of different intensities for different conditions, such as different distances from special electrodes to targets, different targets with different clothes and different height or weight. Basic functions of the non-lethal electric shock generator are tested. Results show that the prototype projectile can be launched from a barrel stably, and the flight range is over 30 meters. When it captured the target, it can be triggered via the telecontrol adjustment. The prototype projectile can support a series of pulses at a rate of 20 r/s with the peak voltage of 30kV.

1. Introduction

As early as in the 1970s, the first generation of electric shock guns came out in the United States. Stun gun works with firing two tethered barbs at a target and sending electric pulses into the target through tether wires. Electronic stun guns have been developed as non-lethal devices that people can employ to defend or control potentially dangerous conditions. These stun guns support high voltage, low amperage, pulsatile electric shocks to the target, which causes involuntary skeletal muscle contraction and renders the target unable to further threat. The duration of these discomfort with electric shock is short in time, and human body can quickly return to normal. Now, common stun guns in Europe and America, such as Taser M18, M26, X26 and in China, such as Husha TX200, all have trail wires, which limit the distance of application. Two insulated conductive wires of Taser X26 trail behind for up to 9 meters, to make contact with their target and complete the electrical circuit. Wires play an essential role in sending muscle-locking electric pulses into the target and fix the application scope of electric shock within 9 meters [1–6]. Song Yansheng gave design ideas and parameters of a new type of electric shock bullet. Its designed working range is 30 meters with 5kV shock voltage [7]. While Taser X26 provides an open-circuit peak voltage of 50kV and delivers a peak voltage of 1.2kV to the targets body. Lei Hailiang put forward a concept of a long-range electric shock bullet for
Rifle shot gun to increase the range by using electromagnetic induction [8].
In this paper, a non-lethal electric shock generator is designed and tested. The special electrodes in the generator is designed to support electric shocks of different densities after flying out from the launcher via a remote control device. This non-lethal electric shock generator can extend the range of application of electric shock to tens meters. Three non-lethal electric shock generator prototypes are manufactured and some tests as the corresponding discharge test, remote control test, preliminary flight test and integrated launch test are introduced to estimate the reliability and stability of the non-lethal electric shock generator.

2. A non-lethal electric shock generator
The non-lethal electric shock generator includes a firing element, propellant, a battery, a boost module, a high voltage rectifier control and discharge module (HVGCM), a telecontrol module (signal receiving circuit), a proximity module, two barb electrodes, etc. The schematic diagram of the non-lethal electric shock generator is shown in figure 1. The design value of the mass is about 30g. The diameter of the main part is 25mm. And the distance between two electrodes is 14mm.

![Figure 1. Schematic diagram of the non-lethal electric shock generator.](image1)

Working process of the non-lethal electric shock generator is as following. Firstly, the non-lethal electric shock generator is put into the launcher and the inertia and firing safety is turned on. Then the battery charges the high voltage generating module. Getting the signal from firing sensor, propellant is ignited by firing element. With the combustion of propellant, the chamber pressure increases, and the non-lethal electric shock generator is accelerated to fly to the target. Then proximity switch is turned on. The telecontrol module works with receiving signal from the remote-control device. Finally, the high voltage rectification and discharge module releases electric shock to the target through the barb electrodes according to the control command.

![Figure 2. Schematic diagram of the discharging circuit.](image2)

![Figure 3. Simulation curve of output voltage of the HVGCM.](image3)
The HVGCM is the core part of the non-lethal electric shock generator. It plays a crucial role in sending the electric shock to the target. Figure 2 is the schematic diagram of the discharging circuit. The high voltage input A is provided by previous boost circuit. Its value is about 1kV. After high voltage A is input, a capacitor $C$ is charged through a resister $R$. When the voltage on the capacitor $C$ reaches a certain value, a controller $B$ sends a control command to the electronic control switch $K$. The capacitor $C$ discharges the high voltage to transformer $T$ through the electronic control switch. After the boosting transformation, the voltage between two electrodes would be 30kV to 40kV. Figure 3 is a simulation diagram of the output voltage. The input voltage of battery is 7V. And the peak voltage and pulse width of the gap discharge is about 30kV and 50ms, respectively.

3. Tests and discussions

3.1. Static discharge test

The non-lethal electric generator prototypes are manufactured after the components are completed. The static discharge test is introduced to evaluate the discharge characters of the non-lethal electric generator prototypes. Figure 4 is the photograph of the static discharge test.

![Figure 4. Photograph of the static discharge test.](image1)

![Figure 5. Test curve of output voltage of the HVGCM.](image2)

Volatges at electrodes is attenuated by a high voltage probe and displayed on the oscillographic digital multimeter. The magnification of the high voltage probe is 1000. The static discharge test steps are shown as following. (1) Connect the positive and the negative poles of the high voltage probe with the discharge electrodes. (2) Connect the high voltage probe to the oscillographic digital multimeter. (3) Turn on the multimeter and adjust the horizontal coordinate to the center of the screen. Set the sensitivity of oscillographic digital multimeter to 5V. Set the trigger level of the oscillographic digital multimeter to 0.5V. Set the time interval of the oscillographic digital multimeter to 5ms. (4) Turn on the charging switch. (5) Press the control button. (6) Store the waveform recorded by the oscillographic digital multimeter.

By pressing the white button in the remote-control device, a brief arcing pulse was generated, which ionizes the intervening air to establish a conductive path for the electricity. The red circle in figure 4 marks out the discharge arc. Figure 5 is the test curve of the voltage between two electrodes. As shown in figure 5, the peak voltage fluctuates between -20kV and 40kV. The average forward peak voltage is nearly 30kV and pulse width is about 50ms, similar to the simulation results in figure 4. The difference between test and simulation curves is that the peak voltage of test curve is less stable than the simulation curve. That is because the actual air resistance is more complex than the analog resistance.
3.2. Simulated projectile launch test
In order to test the flight stability of the non-lethal electric generator, a simulated projectile with the same quality and external shape is manufactured.

![Figure 6. Photograph of the launch device and simulated projectiles.](image)

The photograph of the launch device and simulated projectiles is shown in figure 6. The caliber of the launcher is 25mm. And the barrel length is 517mm. The average mass of the simulated projectiles is 30.1g. A set of this launch tests are executed. All five simulated projectiles reached the target 30m far from the barrel muzzle. Hence, the firing range of this projectile is more than 30m.

3.3. Integrated launch test
The integrated launch test of the non-lethal electric shock generator prototypes are executed after the above tests. Figure 7 is the photograph of the launch device and the non-lethal electric shock generator prototype. The launch device is the same with in the simulated projectile launch tests. The average mass of the non-lethal electric shock generator prototypes is 30.0g.

![Figure 7. Photograph of the launch device and the non-lethal electric shock generator prototype.](image)

![Figure 8. Photograph of the integrated launch test.](image)

Figure 8 is the photograph of the integrated launch test scene. The launch device is placed on the wooden box at the upper right of figure 8. The bright spot in the lower left corner of figure 8 is the non-lethal electric shock generator prototype. And it is supporting the high voltage pulses right now in figure 8. Therefore, the basic functions had been verified.

4. Summary
A Non-lethal electric shock generator is presented and tested. It can provide electric shocks of different intensities for different conditions, such as different distances from special electrodes to targets, different targets with different clothes and different height or weight. A long range
discharge is provided by a 25mm barrel launcher. The basic functions of the non-lethal electric shock generator are tested. Results show that the prototype projectile can be launched from a barrel stably, and the flight range is over 30 meters. When it captured the target, it can be triggered via the telecontrol adjustment. The prototype projectile can support a series of pulses at a rate of 20 r/s with the peak voltage of 30kV.

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