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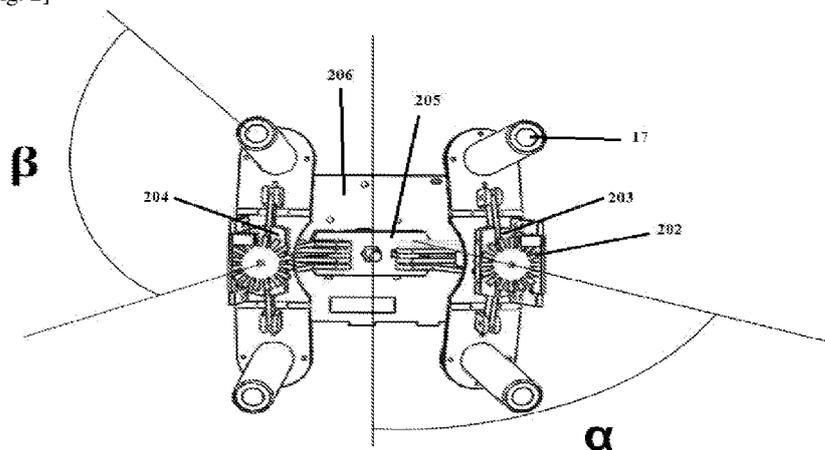
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**Published:**

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(54) Title: MULTI-PURPOSE ROBOTIC NET GUN WITH THE AUTOMATIC AIMING SYSTEM

[Fig. 2]



(57) Abstract: The Multi-purpose robotic net-gun is different from a conventional net system. This robotic net gun calculates the intruder (target) distance to the net by the aiming system, and then the appropriate angle of the gun barrels is calculated by the control and calculation unit. When the bullets' lock is released, the bullets are shot to the target, and after the distance calculated by the aiming system, when fully open they reach the intruder (target) and encompass that/him. (The bullets are well spaced apart and do not slow each other down) In the meantime, a shock system can be set up to prevent the intruder person from moving and makes freeze. The robotic head of the net-gun also allows it to fire direct bullets (without a net at a target). This ability transforms it from a single-purpose gun to a functional and multi-purpose gun.



## Description

### **Title of Invention: Multi-purpose robotic net gun with the automatic aiming system**

#### **FIELD OF THE INVENTION**

[0001] The present invention relates to a net-gun that optimizes shooting the net, automates aiming, and optimizes the dimensions of the net. This invention adds a direct firing capability which converts the single-purpose gun into a multi-purpose robotic gun, and also adds electrical properties to the net when it hits the target.

#### **BACKGROUND OF THE INVENTION**

[0002] The present invention relates to the net-gun, which is used today in many cases, including hunting intruder drones, capturing animals, and capturing and retaining an intruder person and putting riots down in the security field. Net-guns come in various types of propellants, such as gunpowder propellants, pneumatic propellants, and small CO<sub>2</sub> capsules, which are used in conventional air guns. Generally, these weapons are available with quadruple and octamerous barrels for shooting the net, mostly with a 30-degree angle.

[0003] The way the net-gun works is that the police shoot a net from a distance of 3-4 meters to the target, after shooting the net, (usually at a predetermined angle), the net will be opened after a distance. This opening of the net is usually before arriving at the intruder (target) so it will contribute to the reduction of the kinetic energy of the bullets and will encompass the intruder and will prevent him from moving rapidly. These nets are often 2x2 in dimensions, so they are heavy and cause a reduction of progress speed and distance.

[0004] To solve this problem, the nets can carry the electricity that causes preventing from moving and scrambling of the intruder and avoiding him retaliation. By raising gripping power, the cross-section of the net can be reduced. Due to the reduction of the cross-section of the net, the net and gun weight will be decreased and the bullet speed will be increased. By varying the shooting angle of the bullets according to the intruder (target) distance from the gun, the loss of kinetic energy of the bullets which have been shot around can be prevented. This action increases the range, optimizes the aiming, and thereby increases the probability of hitting the net to the intruder (target).

[0005] The changing of the angle of the barrels of the net-gun is controlled by a computational and robotic system, which increases the speed of net throwing. The robotic head of the net-gun also allows it to fire direct bullets, which this capability lead it from a single-purpose gun toward a functional and multi-purpose gun.

#### **SUMMARY OF THE INVENTION**

[0006] The Multi-purpose robotic net-gun is different from a conventional net gun. This robotic net gun calculates the intruder (target) distance to the net by the aiming system, and then the appropriate angle of the gun barrels is calculated by the control and calculation unit. When the bullets' lock is released, the bullets are shot to the target, and after the distance calculated by the aiming system, when fully open they reach the intruder (target) and encompass that/him. (The bullets are well spaced apart and do not slow each other down) In the meantime, a shock system can be set up to prevent the intruder person from moving and makes freeze.) The robotic head of the net-gun also allows it to fire direct bullets (without a net at a target). This ability transforms it from a single-purpose gun to a functional and multi-purpose gun.

### **BRIEF DESCRIPTION OF THE FIGURES**

[0007] [Fig.1] shows the general view of the Multi-purpose robotic net-gun with the location of the proposed net magazine.

[Fig.2] shows the Multi-purpose robotic net-gun head separately. The number 17 shows the gun barrel, and the number 202 shows the motor encoder of the gun head.

[Fig.3] shows the general view of the Multi-purpose robotic net-gun without the proposed location of the net magazine, just with the location of main the magazine.

[Fig.4] shows how the positive and negative electrodes of the embedded shocker gun are wired into the net. The right figure shows the proposed net with wireless activation capability and the left figure shows the proposed net with wire activation capability.

[Fig.5] shows the general view of an electric shocker with two variable voltages at the output which are selected by the microcontroller.

[Fig.6] the schematic on the left shows the opened and calculated distance of a 2x2 net. The schematic on the right shows the location of the angle  $\alpha$  and  $\beta$  when the net is getting open.

[Fig.7] shows the problem-solving assumptions of the Multi-purpose robotic net-gun.  $2x$  is the net length, and  $2y$  is the net width.

[Fig.8] the pneumatic schematic shows the propulsion of the gun. As can be seen, the compressed air is stored in the tank in number 81, and the tanks are added to or removed from the main circuit via a manual valve.

[Fig.9] Block diagram shows how the Multi-purpose robotic net-gun works in direct firing mode.

[Fig.10] the block diagram shows how the gun works in net firing mode without active electricity shock.

### **DETAILED DESCRIPTION OF THE INVENTION**

[0008] The Multi-purpose robotic net-gun showed in [Fig.1] and [Fig.3] is designed in a format with a net magazine ([Fig.1]) and a format without net magazine ([Fig.3]). This

gun consists of two main parts include the mechanical part and the electronic part. The mechanical part consists of three parts: the net-shooting part, the robotic head of gun part, the body part. The main task of the body is to keep the whole set in one unit. In this set, the stock as shown in 11, and the grip as shown in 12, are the most prominent of this set.

- [0009] The stock is movable. This allows the user to easily adjust it according to his work. The robotic head of the gun part, which is clearly illustrated in [Fig.2], includes the gun barrels (17) and a set of three arm mechanisms. These mechanism are utilized by the nut and screw to move the angle of the gun barrels and when the gun is fired it is possible the barrels become fixed in their position. Figs 203, 204, and 205 illustrate the mechanism of each axis separately. This gun contains four barrels for shooting (electric) net bullets. Each bullet is attached to one of the four corners of the net.
- [0010] The way of attaching the net to the shocker electrodes can be performed wirelessly and be controlled remotely, or through the wire and wired control, each of which has its own characteristics. In the wired model, the power of the shock can be at the desired amount through the gun whereas, in the wireless model, the power is more limited because the battery pack is shot with the gun. In [Fig.4] the way of attaching the net to the gun in both wired and wireless models is illustrated. [Fig.4] at the right shows a wireless net containing the shock.
- [0011] The number 41 on the bullet represents the shocker and the number 44 represents the RF receiver with the battery that they are used as the bullet to generate the momentum needed to shoot it. [Fig.4] on the left is a shock wired net containing the shock. The number 41 on the bullet represents the bullet and is used to generate the momentum to shoot. The numbers 42 and 43 are the negative and positive poles of the electric shock system, respectively. It is shown in this figure how to wire the electrical net.
- [0012] Usually, the positive and negative poles can be fabric one after another with a neutral wire in order not to collide together. The same procedure is repeated in the wireless net. The dimensionality of the net for using electric shock systems can be lower than other net-guns because the electric shock system is capable of sufficiently disabling an intruder. Also, at the beginning of the work with the gun, the user can select the dimensions of his desired net to load the appropriate algorithm to shoot that net into the system. Dimensions can be either square or rectangular. In the electronics section of the gun will be explained how this algorithm works.
- [0013] In 205, the rotation of the motor causes both arms to be positioned at an angle  $\alpha$  from the center of the screw. In 203 or 204, rotation of the motor causes each of the barrels to have a  $\beta$  angle relative to the axis of rotation.
- [0014] DC motors with an encoder in 203 and 204 move in sync way, which also creates the desired horizontal angle. These created angles can be seen in [Fig.2]. The horizontal

angle is  $\alpha$  and the vertical angle is  $\beta$ .

[0015] The pneumatic shooting gun consists of two parts. In the first part, the tank, which is a compressed air storage site. The tank can have more pressure than distance, it can be identified in 16. In 15 is a gauge that shows the amount of pressure required in the tank and the user can realize that the tank is empty or full. The desired pressure for the shooting is adjustable by using the output pressure adjustment valve. The second part comprises a set of pneumatic valves connecting hoses and quick pneumatic connectors. The set has the task of transmitting compressed air flow to the gun barrels without any leakage for shooting the Multi-purpose robotic net-gun bullets. 18 is the location of the (electric) net. The (electric) net is made of silk yarn or Kevlar fiber that has copper wires of 0.3 diameters in some strings, which conduct the electric current through these wires.

[0016] The net shooting section has a completely pneumatic structure that can be replaced with a gunpowder model base on its usage that eventually increases its range and reduces the weight of the gun. Also it can be used in a variety of applications to capture intruder drones. This, along with the aiming system, will result in greater accuracy. As you can see in [Fig.8], the schematic of the pneumatic part of the gun is summarized. In 81, there is a gun tank in which compressed air is placed and can be recharged through a one-way valve or check valve (84) and the gauge can be used to monitor the air pressure, which is shown in 83. As can be seen in 82, this device has been used to isolate tanks from each other, which increases the number of firing opportunities. In 85, the outlet pressure of the tank can be changed, which can finally be exited through the solenoid valve (86), and this compressed air finally reaches the gun through the outlet of Fig. (87) and finally throw the gun bullets (88).

[0017] The electrical part of the gun consists of three main parts, 1- The shocker part 2- The user interface (section of the LCD and the joystick) 3- The control unit, and the rangefinder unit. The shocker section shown in [Fig.5] includes different voltage outputs and it is variable based on the voltage multiplier circuit.

[0018] In [Fig.5], an IC 555 is used as an astable square wave oscillator with a frequency of 50 kHz at the pin output 3. The pin 3 output signal is amplified by a current transistors amplifier circuit and fed to a power transistor called IRF840. Finally, this signal is amplified by a multiplier transistor whose coil ratio is  $n_2 = 10n_1$ . It is then amplified by a voltage multiplier circuit (capacitor and diode model) in one line twice and four times in the other.

[0019] Circuit flow can be amplified by a capacitor parallel to the multiplying circuits. In this circuit, the two voltages are finally fed to the voltages of 2000 and 4000 volts, which are accessible by two RL1 and RL2 relays, both of which are controlled by PB1 and PB2 signals from the ARM microcontroller. RL3 is related to power the oscillator

circuit that must be activated by the microcontroller PB3 signal before applying electric shock. Note that depending on the usage, the voltage of the lines and their number can be changed.

- [0020] Another part of this is the user interface unit, which includes the display components (20) that have been installed in order to follow the work process of the gun by the user, and the joystick (14), that is used to apply user commands to the weapon. In this section, there are two main menus that the user enters the weapon into the subroutine by confirming each one. The direct fire menu allows the gun to use the robotic arms to turn the head of each barrel (17) straight so that the bullets hit the target directly in case of firing. The block diagram in [Fig.9] explains how the gun works in this section. The automatic firing menu makes gun barrels take proper angles for appropriate orientation and throw the net optimally by using the optimal net throwing algorithm. This algorithm will be explained in the next section. In addition, in the gun menu, there are options for calibrating different axes of the gun and measuring the distance of the target, also there is option for applying electrical shock separately.
- [0021] The control unit and the rangefinder have the task of controlling the pressure of the gun tank, controlling the pneumatic valve for shooting, calculating the necessary angles of the head of the gun, applying the control voltage to be at the appropriate angle of barrels, and finally applying the shock based on the predetermined voltage to the intruder (target). In general, the gun mechanism can be summarized in this control section, which is explained below.
- [0022] In previous net throwing systems, the gun's shoot angle is constant and this angle is at 30 degrees mostly. In the 2x2 dimensional net, the distance to the net's opening to the target, assuming a 30-degree angle, can be easily calculated as follows ([Fig.6]- left side). Full net opening point:  $1^2 + x^2 = 2^2 \rightarrow x^2 = 3 \rightarrow x = \sqrt{3} = 1.71$
- [0023] Traditional net-guns aren't equipped with robotic distance and shooting calculators. They can only shoot at a predetermined angle. This wastes much kinetic energy of the bullets due to being pulled to the sides.
- [0024] In this gun at first, the length and width of the net enter the memory by programmer. In this gun microcontroller is ARM stm32f108c8.  $2x$  is the length of the net, and  $2y$  is the width of the net and they are considered to solve the problem. After the initial setting, the user can send the distance to the microcontroller by aiming at the intruder via the laser rangefinder module. Given the tangent relation,  $\tan\alpha$  and  $\tan\beta$  are obtained.
- [0025] The angular values of  $\alpha$  and  $\beta$  can be obtained from the inverse trigonometric functions, which are horizontal and vertical angles, respectively, and can be seen in [Fig.6] on the right and [Fig.7].

$$\tan\alpha = \frac{x}{R}$$

$$\tan\beta = \frac{y}{R}$$

$2x$  is the length of the net, and  $2y$  is the width of the net.  $R$  is the distance from the (head of the) gun to the target, which is obtained by the laser rangefinder.

- [0026] After calculating the angles, by applying pulses to the encoder motors (high-speed step motor can also be used), at the head of the gun, desired angles on the head of the gun can be adjusted (shown in [Fig.2]). In this invention, instead of using the electronic protractor, it is used the angle-to-round lookup table and tried for finding an approximate formula through interpolation so as to find the desired distance ratio. This action reduces one of the electronic measurement from the cost time and weight of the gun is very useful.
- [0027] After this step, the red RGB LED turns on green, this shows that the gun is ready to shoot. When the user decides to shoot, he/she has to press the electrical trigger (13). At this time, the microcontroller opens the valve connected to the compressed air tank. The compressed air goes through the gun barrels and causes the bullets to be shot (it should be noted that before the solenoid valve becomes open, the bullets-retaining magnet also becomes deactivated in order to the bullets can easily be ejected from the gun barrel). In shooting an (electric) net, the bullets are initially shot at the desired angle, and then the bullets bring out the (electric) net from the tank. The bullets, after horizontal a distance, completely open the net when they reach the intruder (target) and encompass him/that ([Fig.6] on the right). [Fig.10] block diagram shows how the gun works when launching a net without electric shock. After encompassing the intruder via the electric net, the user can apply high or low voltage shock on the intruder if struggled to escape. This voltage can be designed differently depends on the weapon usage.
- [0028] As a conclusion, it can be said that shooting the bullets via an inventive robotic head of the gun, removes kinetic energy of the bullets which are getting away from each other. (This kinetic energy was due to shooting the net at a constant angle in conventional net-guns). This kinetic energy is used for further getting away the net from the gun, which helps to capture the enemy drones. By reducing the size of the net due to being electrified, the weight of the net also becomes reduced, this increases the range of the guns. The robotic head of the gun also allows direct firing on the gun, which changes the weapon from a single-task mode to a multi-purpose mode. Electrifying the net allows it to be used against a person or a group of intruders simultaneously in rebellions or riots.

## Claims

[Claim 1]

What is claimed is a net-gun with optimum aiming system capable of catching or capturing an intruder person or a drone by shooting an electrical or conventional net. This gun consists of the following components:

- A robotic head made of four aluminum barrels with an expandable mechanism that can be opened in two axes of azimuth and elevation.
- Two DC motors with gearbox and encoder or two step motors on top of the gun to move the barrels at elevation angle
- A step motor (or a DC motor with gearbox and encoder) to move at an angle created in azimuth
- A laser rangefinder to measure the distance between the gun and the target
- A microcontroller (ARM) to control the input and output signals
- (cross) Laser pointer target display
- Dc motor driver modules
- Step motor driver module
- Joystick module
- LED indicates battery charger
- Fast charger circuit and control of lithium ion batteries
- limit switches
- Pneumatic valve
- Compressed air tank
- Adjustable stock
- Pneumatic fittings
- Pneumatic hose
- LCD
- Tank pressure gauge
- Battery
- Shocker
- Location of the net
- Electric net with bullet

[Claim 2]

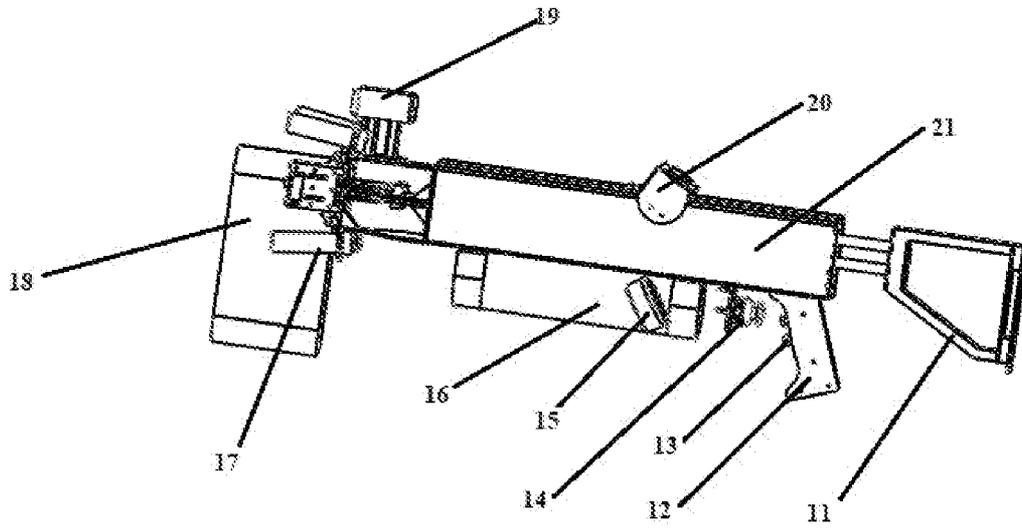
According to claim 1, robotic head of the gun complies with the robotic expandable and retractable arm mechanism to open and close gun barrels in order to create angles in azimuth and elevation. This can be done by a step motor or a DC motor with a gearbox and encoder attached to the gun (to create an azimuth angle) and angle in the

- altitude axis also done by two DC motors attached to the encoder. The encoders count the number of pulses and after reaching the desired value, they send the stop signal pulse to the microcontroller for run so that the microcontroller stops the motors. This number is obtained through the algorithm mentioned in the description of the invention.
- [Claim 3] According to claim 2, the head of the gun which has the robot arm mechanism is designed to get away the gun barrels from each other to make an elevation angle ( $\beta$  angle described in the invention), and finally, become parallel during approaching each other.
- [Claim 4] According to claim 2, the head of the gun which has the robot arm mechanism is designed to get away the gun barrels from each other to make an azimuth angle ( $\alpha$  angle described in the invention), and finally, become parallel during approaching each other.
- [Claim 5] According to Claims 3 and 4 and as mentioned in the description of the invention, this gun does not use an electronic Protractor, but by measuring the distance value relative to the desired angle from table, this created table called a lookup table for each angle (meaning angle  $\alpha$  and  $\beta$  are in the description of the invention). By using the interpolation method, an equation is calculated for each of the axes to convert the value of the angle to the motor revolution, which converts the number obtained from the angle to the approximate value of the number of revolutions, and this The number of laps through the closed-loop is verified by the encoder.
- [Claim 6] According to claim 1, to shoot an (electric) net, the gun has a laser rangefinder system that sends the amount of distance taken as described in the invention to the microcontroller for processing and obtaining the appropriate angle for shooting, and then these commands are executed by three motors in the head of gun.
- [Claim 7] According to Claims 2, 3 and 4, the head of gun can be placed in a position where all the barrels are straight. This enables the gun to shoot bullets (without net) directly. According to the description of the invention, presented in the weapons menu, this mode is called direct firing.
- [Claim 8] According to claim 2, the net location is among the barrels for shooting. The net location can include a net or multiple nets with the bullets attached to it as an alternative magazine.
- [Claim 9] According to claim 1, the gun is designed for shooting the nets, so this gun comprises two net types. The first net type is a conventional net

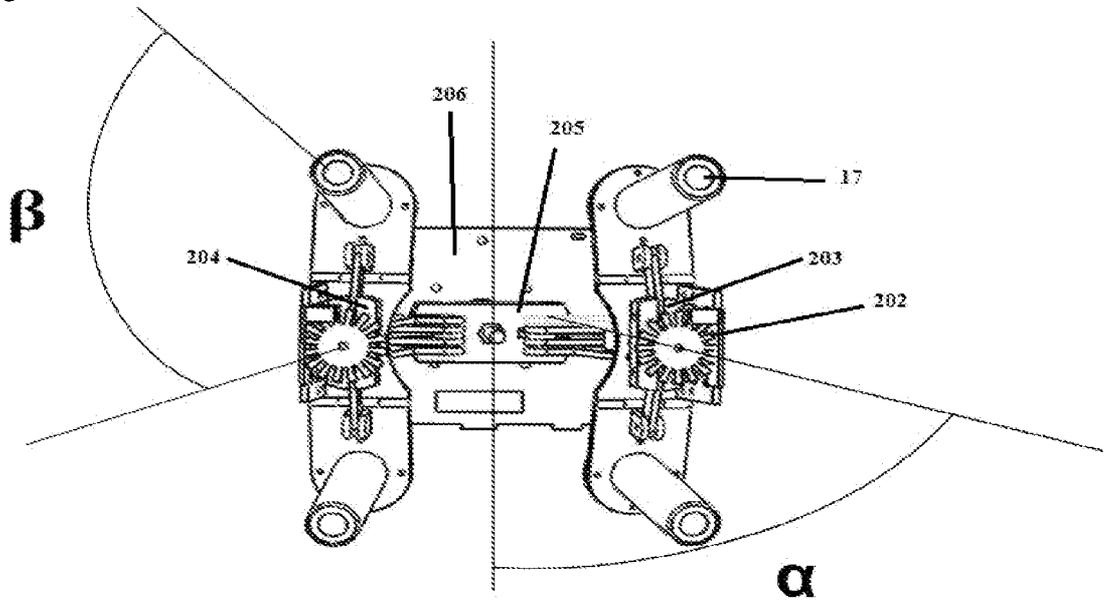
which can be rectangular or square. The second net type is an electric net consisting of a combination of conventional net and conductive wire (according to the invention description) which can be square or rectangular in any dimension.

- [Claim 10] According to claim 1, for shooting the (electric) net, the system has a pneumatic shooting mechanism that is connected to the solenoid valve from the pneumatic tank, and the solenoid valve receives its instruction from the microcontroller. However, this pneumatic tank can be used of a compressed air tank or compressed carbon dioxide. The propellant system as described in the invention can be replaced by the gunpowder propellant system.
- [Claim 11] According to claim 1, a high voltage circuit is used to apply the shock and stun the intruder, and if it is needed the circuit connects to the electrical net input and exerts voltage. The exertion order is sent from the microcontroller to the selective relays of voltage.
- [Claim 12] According to Claim 1, a cross-shaped laser pointer has been installed for aiming the target to select the best aiming by the user to throw the net.
- [Claim 13] According to Claim1, a micro-switch is used to limit the range of motion of the barrels at the initial points on each axis to inform the microcontroller of the zero points of motion. In the begging, each axis at program algorithm must be zero, and then its work to start.
- [Claim 14] According to Claim 1, the multi-purpose robotic net-gun has a joystick and an LCD, which is installed for the user to communicate properly with the weapon. This makes weapon more user-friendly than other weapons. You can use the joystick to enter the menus of direct firing or automatic aiming.

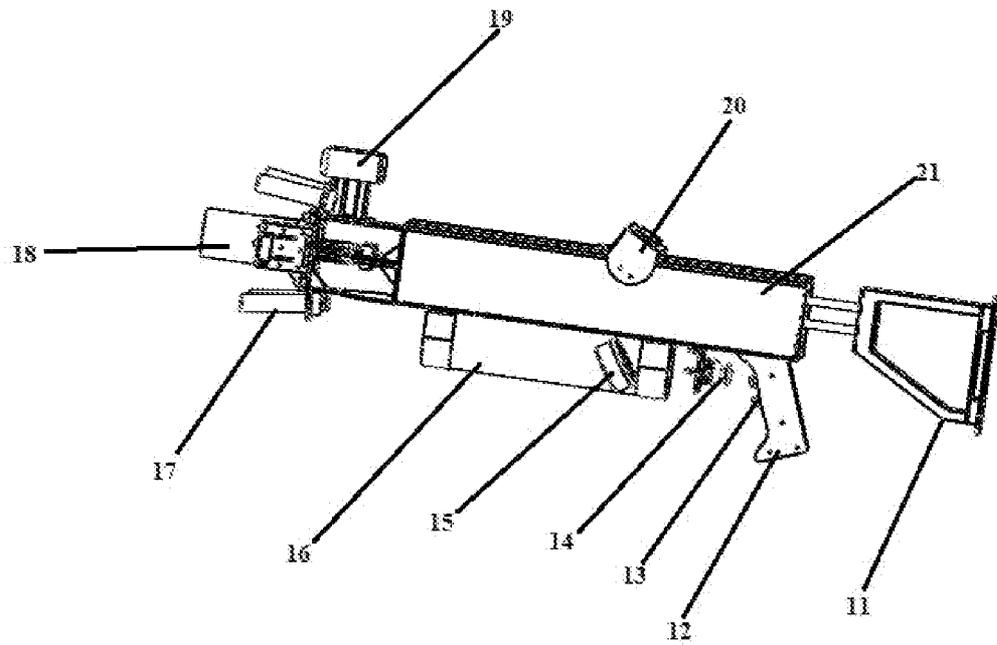
[Fig. 1]



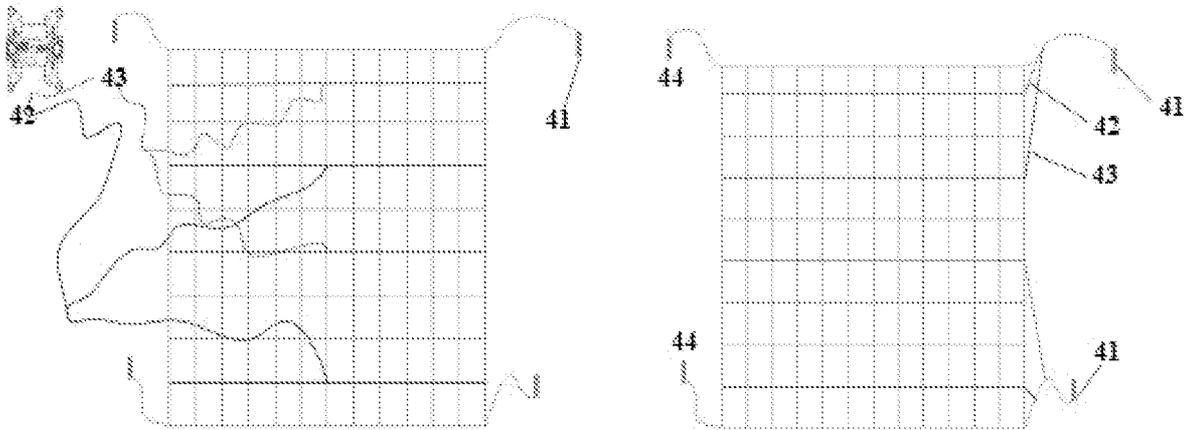
[Fig. 2]



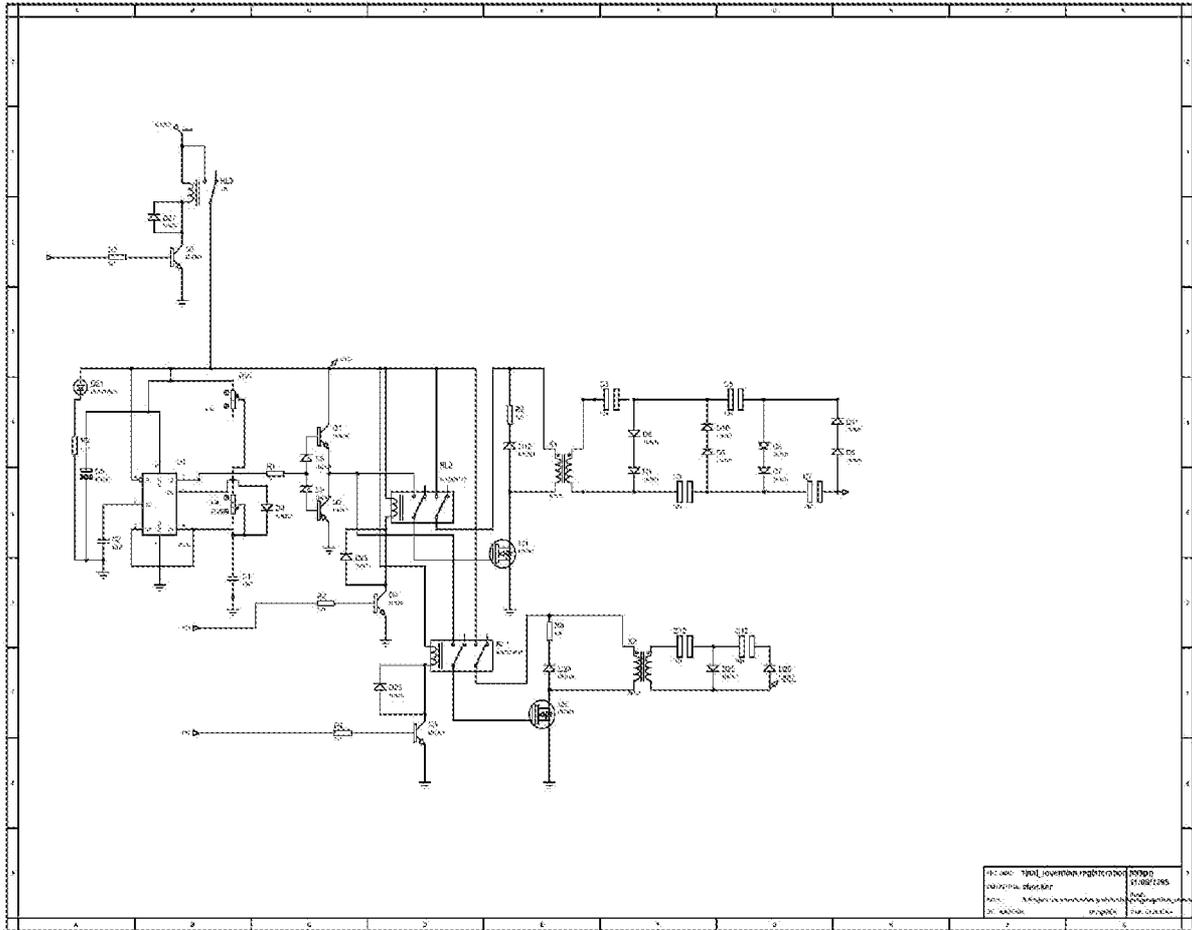
[Fig. 3]



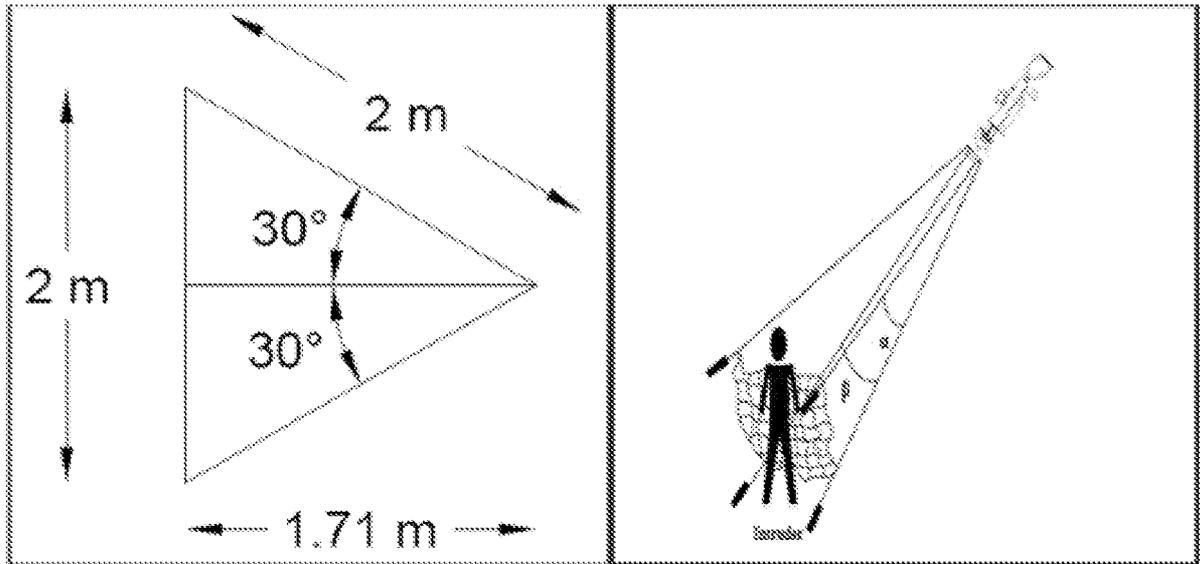
[Fig. 4]



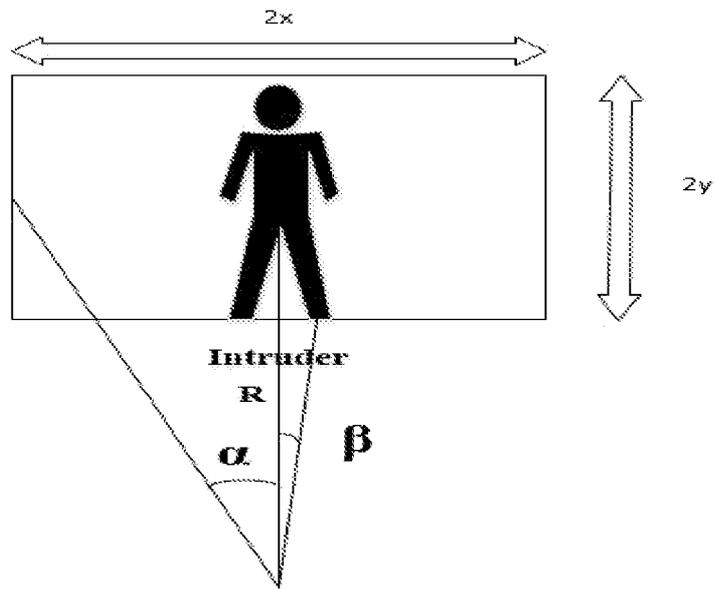
[Fig. 5]



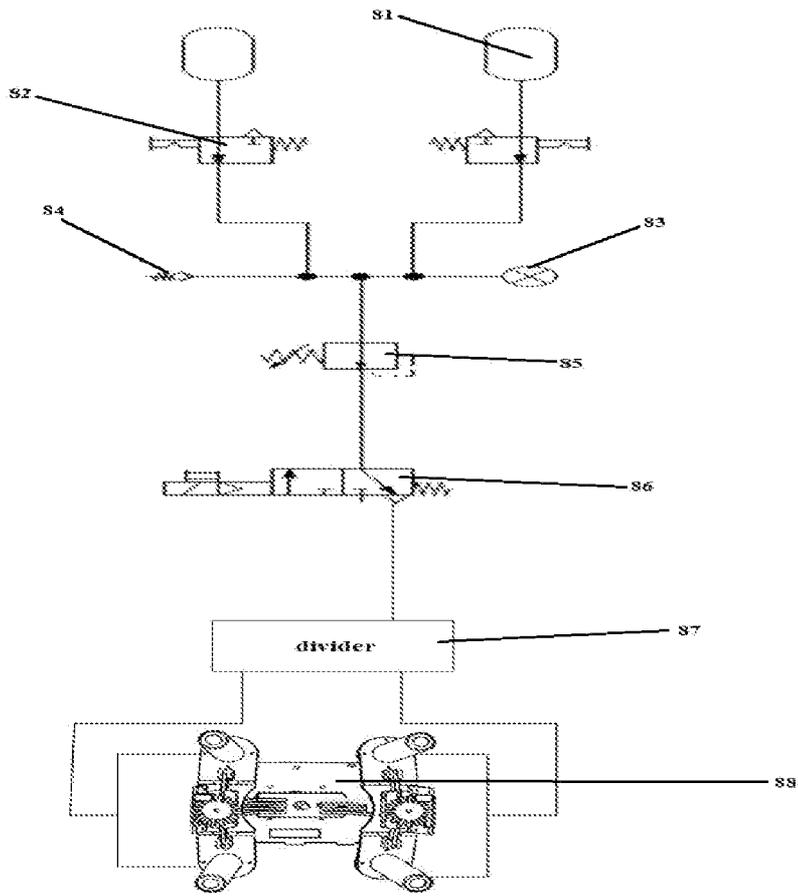
[Fig. 6]



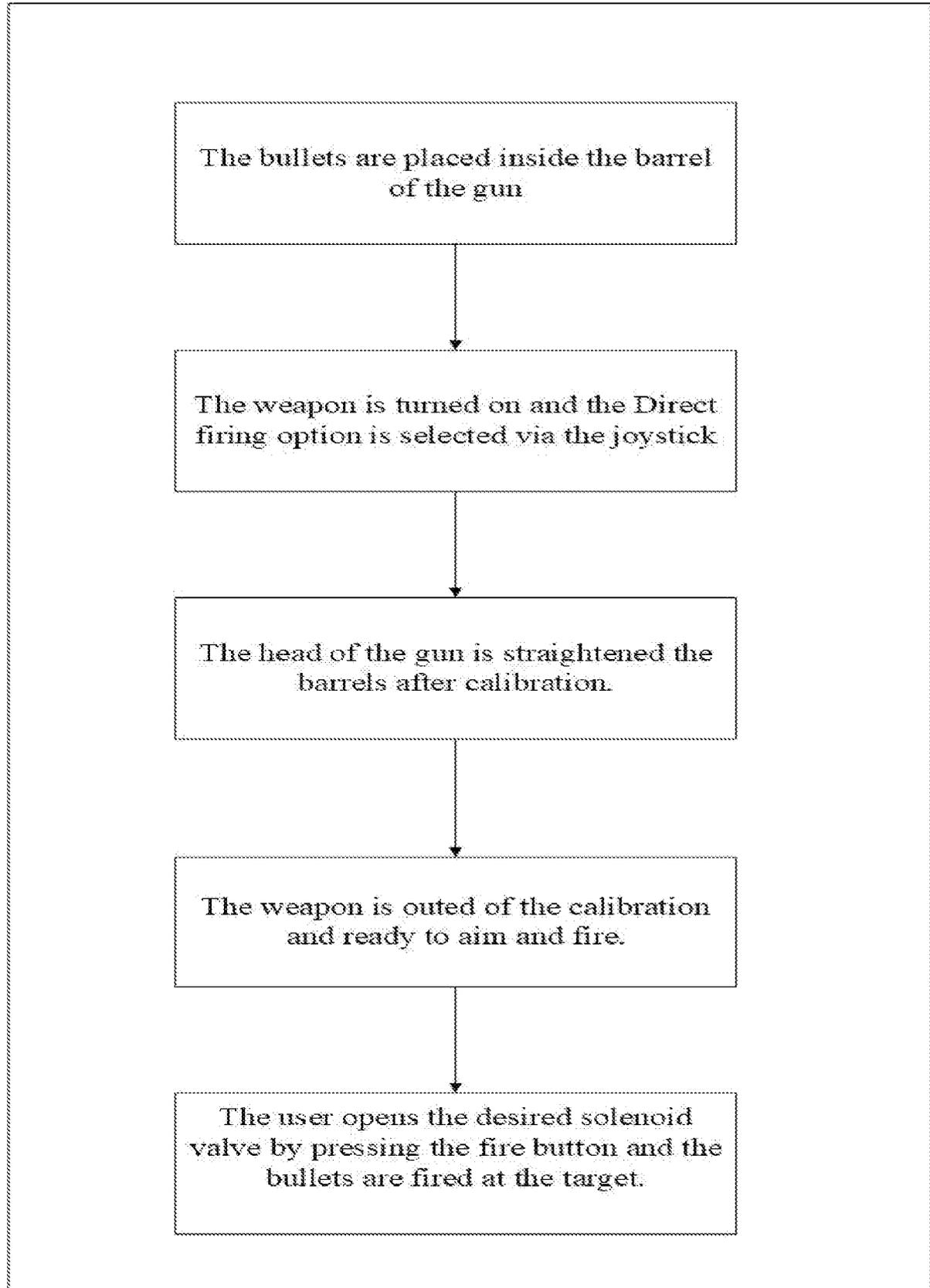
[Fig. 7]



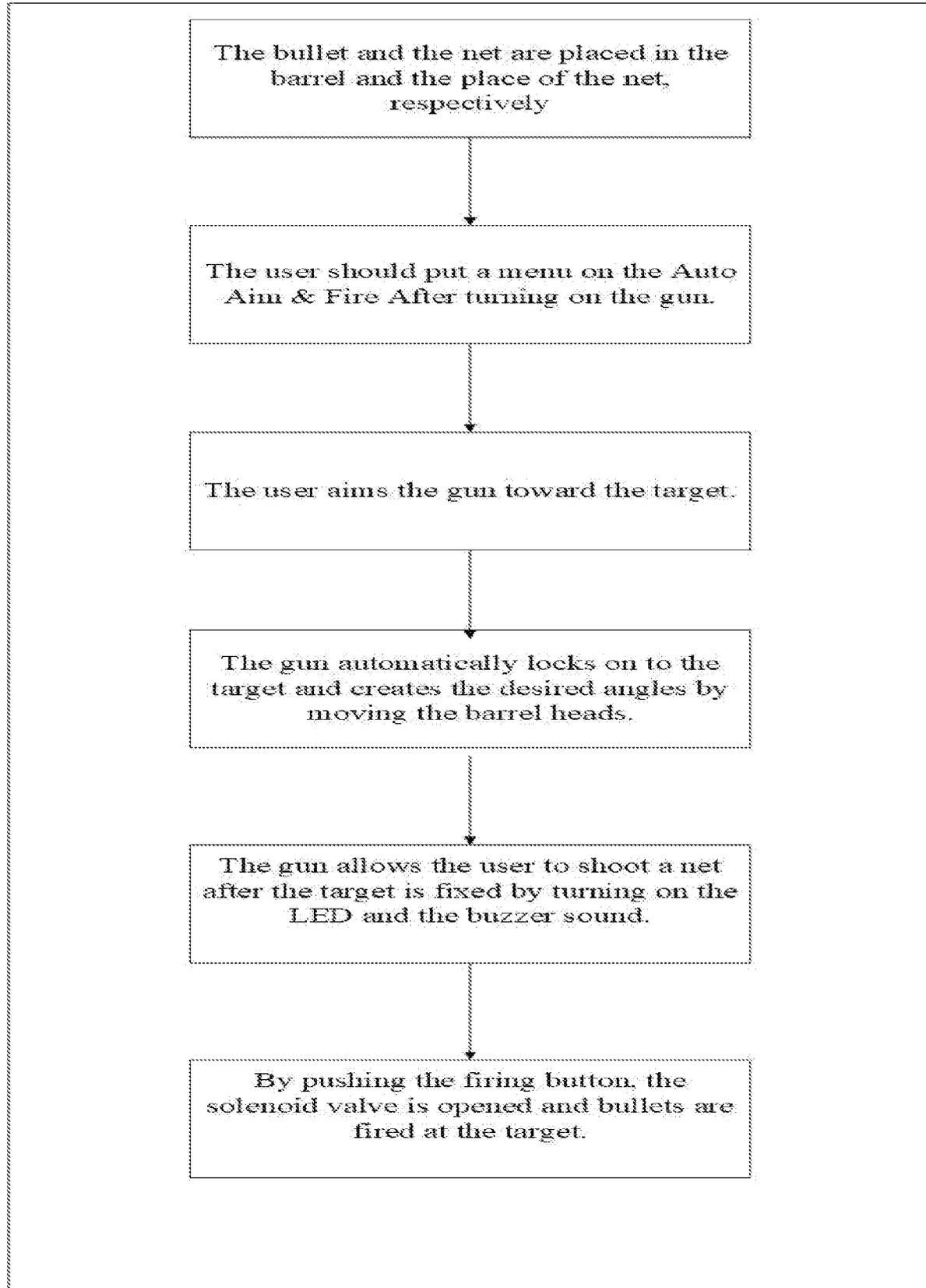
[Fig. 8]



[Fig. 9]



[Fig. 10]



## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/IB2020/060998

A. CLASSIFICATION OF SUBJECT MATTER  
F41H13/00 Version=2021.01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F41H, CPC: F41H 13/0006, G08B 15/007

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

TotalPatent One, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US4912869 A (TETRA INDUSTRIES PTY. LIMITED) 03 April 1990 (03.04.1990) Column 1; line 48 - Column 2; line 41, Figure 1	1-14
A	CN101782351 A (LI, Cunkou) 21 July 2010 (21.07.2010) Para [0015], Figure 1	1-14
A	US20180094908 A1 (DOWN, Christopher David et al.) 05 April 2018 (05.04.2018) Para [0047], [0097]-[0103], [0182], [0184], [0192]	1-14

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Date of the actual completion of the international search

23-02-2021

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23-02-2021

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**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
PCT/IB2020/060998

Citation	Pub.Date	Family	Pub.Date
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