C. J. COOKE.

NON-RECOIL GUN FOR AEROPLANES.

APPLICATION FILED SEPT. 17, 1917.

1,373,381.

Patented Mar. 29, 1921.

2 SHEETS—SHEET 1.

Fig. 1.

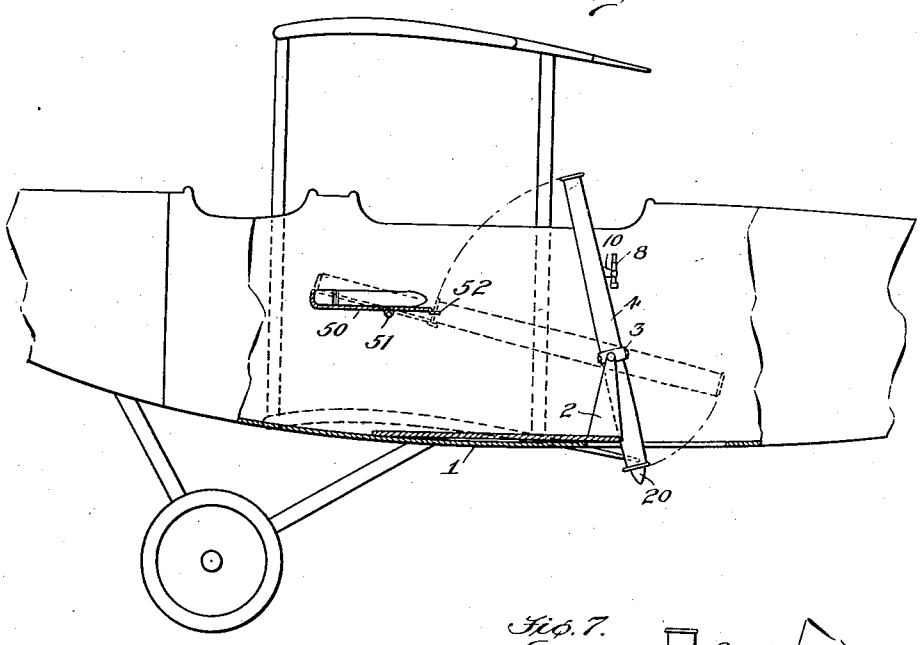


Fig. 7.

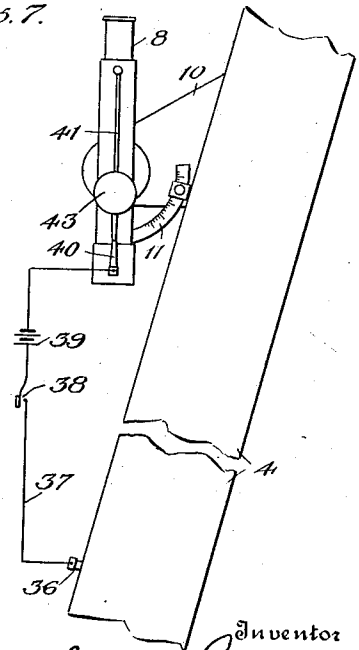
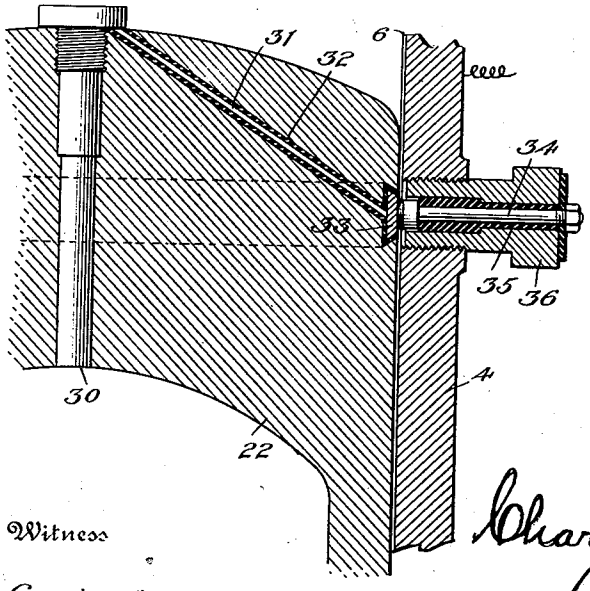


Fig. 6.



Witness

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2 SHEETS—SHEET 2.

Fig. 2.

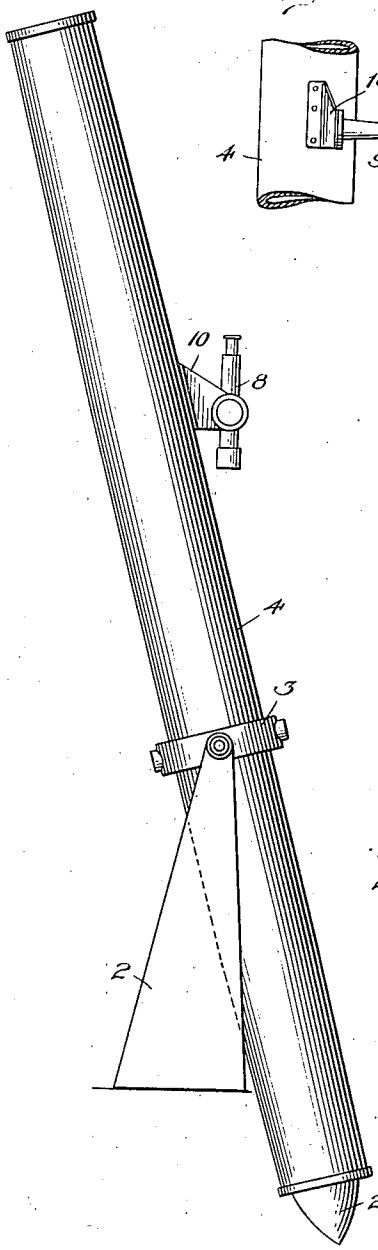


Fig. 5.

Fig. 3.

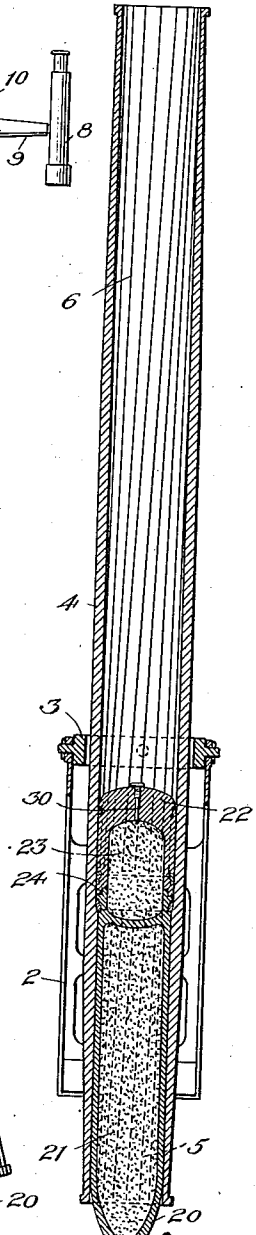
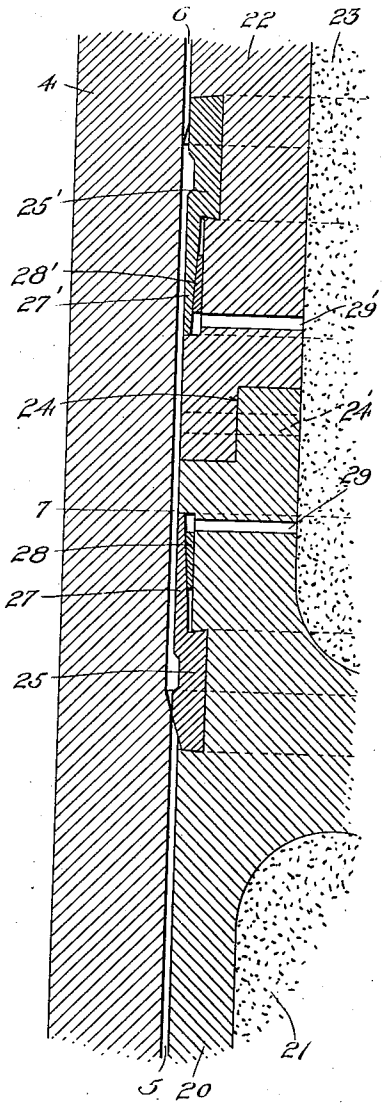


Fig. 1.



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UNITED STATES PATENT OFFICE.

CHARLES JOHN COOKE, OF HONG KONG, CHINA.

NON-RECOIL GUN FOR AEROPLANES.

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To all whom it may concern:

Be it known that I, CHARLES JOHN COOKE, a subject of the King of the United Kingdom of Great Britain and Ireland, and resident of Hong Kong, China, have invented certain new and useful Improvements in Non-Recoil Guns for Aeroplanes; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The invention relates to improvements in guns for firing projectiles from aeroplanes and the like, associated with means for loading, laying and firing the gun that will insure a minimum of labor and a greatly increased accuracy; the gun and its charge being so related that with a relatively small increase in the weight of the gun a relatively large number of charges may be carried by an air craft of given capacity. To these ends the invention contemplates the provision of a gun open at both ends, operating to fire a charge, comprising a shell, preferably of the explosive penetration type, associated with a propelling charge and a reaction mass or recoil weight adapted to be discharged from the rear end of the gun at a higher initial velocity than the projectile proper, the relation of the weights and initial velocities of the projectile and the reaction mass being such that the kick or recoil of the gun is practically nullified and no strain is transmitted to the aeroplane or other supporting structure for the gun.

Referring to the drawings:—

Figure 1 is a fragmentary sectional view of an aeroplane with the improved gun and its loading mechanism shown in firing position and charge holding relation respectively.

Fig. 2 is a side elevation of the gun and its mount.

Fig. 3 is a vertical sectional elevation of the gun.

Fig. 4 is an enlarged fragmentary sectional elevation showing the relation of the gun and its charge.

Fig. 5 is a detail of the telescope sight and its attachment to the gun.

Fig. 6 is an enlarged fragmentary sectional elevation of the rear portion of the charge and the gun showing the firing means and the circuit connections between the charge and the gun.

Fig. 7 is a diagram illustrating the firing circuit and its controlling devices.

As heretofore constructed and operated guns of this general character employed a reaction mass or body having substantially the same weight and therefore acquiring the same initial velocity as the projectile in the firing operation, so that one-half of the weight discharged not only represented a dead loss but meant a greatly decreased weight or number of effective instrumentalities in the form of shells that could be carried by the aeroplane or other vehicle upon which the gun was mounted. Applicant has discovered that by making the reaction mass of less weight than the shell and elongating that portion of the gun barrel traversed by said mass, a practically perfect balancing of the recoil may be effected, due to the higher initial velocity imparted to the reaction mass, as compared with that of the shell. The reaction or recoil of a gun in firing is directly proportional to the inertia of the moving projectile and said inertia is proportional to the weight and velocity of the projectile. Therefore if a reaction mass be chosen of such weight and the gun barrel be chosen of such relative lengths in its shell and reaction mass ends, respectively, that the inertia of the shell and the reaction mass is the same, as these bodies leave the respective ends or muzzles of the gun, there will be no resultant recoil, kick or longitudinal strain imposed on the gun and its support and, what is quite as important, a relatively larger number of shells or the same number of relatively heavier shells may be carried by a machine of given weight carrying capacity.

A typical gun of this character is indicated in the accompanying drawings, in which 1 indicates an aeroplane of any approved type on the body of which is secured a pedestal or mount 2, which if desired may be pivoted to move about a vertical axis, so that the gun may be aimed or trained in any direction about such axis. Mounted in a gimbal 3 on the standard 2 is a gun 4 open at both ends and provided with rifling 5 and 6 at its respective ends separated by a smooth or unrifled section 7. The rifled forward or shell end of the gun

is relatively short as compared with the reaction mass end, the relative lengths being substantially as 1 to 3 in the gun illustrated, so that the shell travels only one-third as far in the barrel as the reaction mass and the velocity of the latter will be three times as great as that of the shell when both are discharged from the gun. Therefore, the weight of the reaction mass should be approximately one-third of that of the shell, in order that the recoil of the gun in either direction may be eliminated or nullified. The sizes and proportions indicated are merely exemplary and obviously may be changed to suit varying conditions, provided, however, that any selected proportions and arrangements of the gun and its charge shall subserve the ultimate object of eliminating the longitudinal strain or recoil of the gun, which can only be effected by developing the same inertia in the shell and the reaction mass or body when these two elements are discharged from the respective muzzles of the gun.

This arrangement will necessitate making the total length of barrel of the gun slightly greater than a similar gun employing equal weights of shell and reaction body, but this added gun weight will be far more than compensated by the additional number of charges or shells, which may be carried. In order to keep the weight of the gun down as low as possible, the barrel may be made of any of the well known steel alloys possessing high tensile strength, which will admit of the gun barrel being reduced to a very moderate thickness at the explosion chamber. It has been found that a gun of the size indicated in the drawings, to wit approximately 6 ft. 2 ins. long and 5 inch caliber will be safe with an extreme thickness of metal surrounding the explosion chamber of one quarter of an inch, with the outside of the barrel tapering gradually toward the muzzles. If found necessary or desirable, additional strength may be imparted to the gun barrel by winding the same with wire or providing it with the usual forms of bands or jackets.

The rifling of the gun at both ends is preferably in the same direction so that the shell and the reaction mass spin in opposite directions, thereby stabilizing the gun and its mount in a horizontal direction. The caliber of the gun in the rear portion or the reaction body chamber is slightly greater than that in the shell end. For example, if the gun is adapted for a 5 inch shell, the diameter of the forward end will be 5 inches measured diametrically between the inner surfaces of the rifling ridges or lands, and the height of the ridges, or conversely, the depth of the grooves of the rifling may be .04ths of an inch; the caliber of the reaction end of barrel should then be approximately 5.04 ins. and the depth of the grooves .04 ins. The diameter of the firing chamber between the rifled sections in a gun of the size indicated, may be 5.08 ins. The particular advantage of these relative proportions of the rifled ends of the gun will be explained later.

A typical charge for a gun of the character described comprises a shell 20, preferably chambered to receive an explosive charge 21, which shell is provided at its rear end with a generally cup-shaped reaction mass or weight 22, which may be made of cast iron or the like, the two parts being connected by a telescoping joint 24, and locked together by one or more wires or severable pins 24′. The rear end of the shell and the forward end of the reaction weight are chambered to receive an explosive charge 23, which when ignited will drive the shell and the reaction weight in opposite directions through the bore of the gun. The caliber of the shell is, of course, the same as that of the shell end or chamber of the gun and in order to impart the desired rotation to the shell when the latter is discharged from the gun, the rear end of the shell is banded with a copper or other soft metal ring 25, the extreme diameter of which is substantially equal to the bore of the gun measured between two diametrically opposite rifling grooves. This arrangement admits of the charge being dropped into the rear end of the gun and slid along the bore, without obstruction, until the band 25 engages the rifling on the interior of the shell chamber, when the charge will be arrested and held in proper relation for firing. In order to increase the contact between the band 25 and the rifling in the shell end of the gun, the rear end of the band 25 is tapered interiorly as at 27 and preferably fitted with a wedge-shaped ring 28, which lies between the interior of the band and the exterior of the shell. The body of the shell to the rear of this wedge-shaped ring is provided with one or more radial passages 29 opening at one end into the firing charge chamber and at the other end in the recess formed between the tapered end 27 of the ring 25 and the coacting shoulder on the rear of the shell, so that when the charge is exploded, the pressure of the gases will be transmitted through the passage 29 and against the rear of the ring 28, forcing the latter forward and expanding the tapered end of band 25 radially into engagement with the ridges and grooves of the rifling, thereby insuring a positive rotation of the shell on its longitudinal axis as it leaves the muzzle of the gun. Preferably similar provisions are made for expanding the band 25′ encircling the reaction weight, said band being provided with a tapered end 27′ coacting with a wedging ring 28′ and subject to

the action of the gases of the exploded charge through radial passages 29'.

In order to ignite the explosive charge in chamber 23, any suitable detonating means may be employed, but the following construction and arrangement has been found most effective. Mounted in the rear end of the reaction weight 22 is a detonator or spark plug 30, constructed generally like the spark plug of an internal combustion engine. A conductor 31 incased in a suitable insulating sheath 32 is embedded in the end of the reaction weight and is connected to the interior terminal of the plug 30. The opposite end of the conductor 31 is electrically connected with an insulated band or ring 33 which encircles the end of the reaction weight and is adapted to be engaged by the end of a contact pin 34, mounted in an insulating sleeve 35 carried by a hollow screw plug 36, which is let into the barrel of the gun at one side thereof. Connected to the pin 34 is a conductor 37, in which is interposed a hand switch 38 and a battery 39, the opposite end of the conductor 37 being grounded upon some metallic portion of the gun, preferably the sighting apparatus, to be hereinafter described, so that when the switch 38 is closed, the circuit will be completed or partially completed, as the case may be, to cause the spark to pass from the active terminal of plug 31 through the metallic body of the shell, thence to the gun, from which it passes by way of an auxiliary contact device carried by the sighting apparatus to the battery, whence it emanated. The passage of the spark ignites the explosive charge in chamber 23 and propels the shell from the forward end of the gun and the reaction weight from the rear end thereof, the pressure generated being sufficient to rupture the frangible connections between the shell and reaction weight, and also serving to expand the rifling bands into engagement with the lands, as hereinbefore explained. Inasmuch as the initial velocity of the shell is not required to be very high, owing to the fact that the gun is usually fired from high elevations, it is not necessary that excessive explosive charges be employed to expel the shell and the reaction weight.

In mounting guns of this character upon aeroplanes, it has been customary heretofore to train the guns in a forward and downward direction. This arrangement necessitated the gunner calculating not only the speed and direction of the aeroplane with respect to the target, but rendered it necessary that he actually fire the gun before the aeroplane was actually over the target, and as it approached the latter. These factors coupled with the necessary allowance for wind velocity, side drift and variations of the aeroplane from a true horizontal rendered accurate gunnery very difficult and uncertain. With the present invention, however, most of these difficulties are completely obviated and the preferred arrangement renders it possible for the gunner to fire when the areoplane is directly over the target, in a vertical direction, and to prevent the gun being fired until this relative position of the aeroplane and target has been attained. These objects are accomplished by mounting the gun on the aeroplane so that its muzzle is trained downward and backward when in firing position, whereby the gun may be so trained that the forward speed of the aeroplane will be exactly compensated and the projectile driven downward in a substantially vertical direction toward the target, thereby greatly increasing the probability of a direct hit without preliminary or trial shots. Knowing the speed of the aeroplane through the air, the velocity and direction of the wind, the gunner adjusts the gun at a proper angle to compensate these factors, by swinging the barrel of the gun in the gimbal ring 3 toward or from a true vertical position, as will be understood.

To effect this result, there is mounted upon one side of the gun a telescope sight 8, provided with the usual cross hairs and capable of being swung on an axis 9 carried by a support 10, the degree of inclination of the telescope with respect to the inclination of the longitudinal axis of the gun being accurately indicated upon a sector 11 carried by the telescope 8 and coöperating with a suitable stop or gage on the support 10 and the telescope and gun locked together by the usual set screw engaging the sector. Pivotally mounted on one side of the telescope is a pendulum-like rod 41 having a weight 43 which tends to maintain a normal vertical position. The lower end of the rod 41 coöperates with a fixed contact 40 mounted upon and insulated from the telescope casing and connected to conductor 37 in which is interposed battery 39 and switch 38. The gunner estimates the speed of the aeroplane over the earth and the velocity and direction of the wind and sets the telescope by means of gage 11 to compensate for these factors. He then centers the cross hairs of the telescope 8 on the target and holds the apparatus in this relation by moving the telescope and the gun barrel until the aeroplane is directly over the target in a vertical direction. If the aeroplane is horizontal at this time, the end of pendulum rod 41 engages contact 40 and completes the circuit from battery 39 through switch 38 and conductor 37 to contact rod 34, conductor 31, sparking plug 30, through the air gap of said plug to the body of the reaction weight 22, thence to the gun barrel and the sighting telescope, pendulum

rod 41 thereon and contact 40, back to the battery, exploding the charge and driving the shell forward and the reaction weight backward from the gun as heretofore described.

Assume V_1 equals the velocity of the projectile from the gun, V_2 equals the velocity of the aeroplane over the ground, then $V \sin \alpha = V_2$, or $\sin \alpha = \frac{V_2}{V_1}$, where α is the angle between the axis of the gun and the axis of the telescope. The angle between the axis of the gun and the axis of the telescope is set so that $\sin \alpha = \frac{V_2}{V_1}$. The aeroplane is then steered over the object to be bombed, the pilot maintaining the aeroplane in as nearly a horizontal course as possible. In case the machine does not pass directly over the object in an athwartship direction, the gimbal ring mounting of the gun in its pedestal permits the gunner to compensate for the lateral deviation, as well as for any variation of the aeroplane from an even keel athwartship. The gunner meanwhile keeps the cross wires of the telescope on the object to be bombed and as the aeroplane approaches and passes over the target, he swings the gun and telescope bodily toward the vertical. When the telescope is vertical in the fore and aft plane, contact is made between the pendulum rod and the fixed contact 40 and as switch 38 is closed, the circuit through the explosive is completed and the gun is fired.

It will be noted that the factors and precautions to be observed are first, the speed of the aeroplane over the earth, the direction and velocity of the wind, both of which can be readily determined with accuracy by instruments provided for this purpose, the level of the aeroplane, which can be corrected and adjusted by the pilot, and the maintenance of the cross hairs directly centered upon the target. When these factors are properly coördinated, the laying or aiming of the gun becomes almost as simple and effective as a similar operation from a stationary emplacement and a direct hit on the target is practically assured.

The preponderance of weight in the rear portion of the gun barrel causes the latter to cant or tilt forwardly and this normal action is taken advantage of in facilitating the handling of the gun, more particularly the loading operation. To this end, there is provided in the body of the aeroplane, in the path of movement of the rear end of the gun, a loading tray 50, pivoted upon a horizontal axis 51, and having a flanged forward lip 52, which is engaged by the rear muzzle of the gun as the latter moves forward and downward, thereby causing the tray to tilt on its axis into axial alinement with the bore of the gun, so that a charge, consisting of the shell, the reaction weight and the contained explosive will slide automatically into the bore of the gun. As the charge moves downward into the bore of the gun, the center of gravity of the latter is gradually advanced toward the forward muzzle, causing the gun to tip or move toward the vertical so that it will be in proper position for accurate training or sighting as hereinbefore described. The forward muzzle of the gun in firing position extends through and below the body of the aeroplane, and inasmuch as the gun may be adjusted both longitudinally and transversely of the longitudinal axis of the aeroplane, or the direction of flight, it will be apparent that the gun may be not only quickly adjusted, but readily held by the gunner on the target.

It has been demonstrated that with a gun of the character described, employing charges of the size and relative proportions indicated, an increase of from one-third to one-half as many shells or charges can be carried by an aeroplane of given capacity than was possible with similar guns of the former type in which the shell and the reaction mass were of equal weights, so that the gun in addition to its obvious superiority in shooting qualities, facility of loading, training and firing, is far more effective as a weapon of offense and defense, especially in aeroplane work, in which the number of charges that can be carried is of the greatest importance.

What I claim is:—

1. A non-recoil gun, comprising a barrel open at both ends and including a shell discharging chamber and a reaction body discharging chamber, the length of the latter being materially greater than that of the shell discharging chamber, whereby equal inertias may be imparted to unequal weights of shell and reaction body respectively.

2. A non-recoil gun, comprising a barrel open at both ends and including a shell discharging chamber and a reaction body discharging chamber, the length of the latter being materially greater than that of the shell discharging chamber, whereby equal inertias may be imparted to unequal weights of shell and reaction body respectively, in combination with a charge including a shell or projectile, a reaction body and an explosive interposed between the shell and body, the weights of the shell and body respectively being inversely proportional to the lengths of the barrel sections which they traverse in the discharging operation.

3. An apparatus for firing projectiles, comprising a gun barrel open at both ends having a shell discharging chamber and a reaction body discharging chamber, the latter being of greater length than said shell chamber, a shell, an explosive charge and a

reaction body of less weight than the shell, the lengths of said chambers and the weights of the shell and body being such that the inertias of the shell and body when expelled by the explosive charge are practically equal and the initial velocities of the weight of the shell and body being directly proportional to the length of barrel traversed by each.

4. A non-recoil gun, comprising a barrel open at both ends and including a shell discharging chamber and a reaction body discharging chamber, the length of the latter being materially greater than that of the shell discharging chamber, whereby equal inertias may be imparted to unequal weights of shell and reaction body respectively, and means for firing a charge in the gun including an adjustable sight, an electric circuit adapted to be completed through the charge, and a closer for said circuit including relatively movable contacts controlled by the moving of the sighting apparatus to vertical position.

5. A non-recoil gun, comprising a barrel open at both ends and including a shell discharging chamber and a reaction body discharging chamber, the length of the latter being materially greater than that of the shell discharging chamber, whereby equal inertias may be imparted to unequal weights of shell and reaction body respectively, a mount in which the gun is supported for universal movement, and means for firing a charge in the gun including an adjustable sight, an electric circuit adapted to be completed through the charge, and a closer for said circuit including relatively movable contacts controlled by the moving of the sighting apparatus to vertical position.

6. A non-recoil gun, comprising a barrel open at both ends and including a shell discharging chamber and a reaction body discharging chamber, the length of the latter being materially greater than that of the shell discharging chamber, whereby equal inertias may be imparted to unequal weights of shell and reaction body respectively, an adjustable telescope sight on the gun, and means for firing a charge in the gun involving an electric circuit and a closer for said circuit including relatively movable contacts which are brought into mutual engagement when the telescope is adjusted to a vertical position.

7. A non-recoil gun, comprising a barrel open at both ends and including a shell discharging chamber and a reaction body discharging chamber, the length of the latter being materially greater than that of the shell discharging chamber, whereby equal inertias may be imparted to unequal weights of shell and reaction body respectively, an adjustable telescope sight on the gun, and means for firing a charge in the gun involving an electric circuit and a closer for said circuit including relatively movable contacts which are brought into mutual engagement when the telescope is adjusted to a substantially vertical position.

8. A non-recoil gun, comprising a barrel open at both ends and including a shell discharging chamber and a reaction body discharging chamber, the length of the latter being materially greater than that of the shell discharging chamber, whereby equal inertias may be imparted to unequal weights of shell and reaction body respectively, a pedestal, a gimbal ring by which the gun is supported on said pedestal, a sighting telescope fixed to the gun and a firing circuit including a fixed and movable contact on said telescope adapted to be mutually engaged when the telescope approximates a vertical position.

9. A non-recoil gun, comprising a pedestal, a barrel open at both ends and including a shell discharging chamber and a reaction body discharging chamber, the length of the latter being materially greater than that of the shell discharging chamber, whereby equal inertias may be imparted to unequal weights of shell and reaction body respectively, a gimbal ring connection between the gun and pedestal and connected to the gun beyond the center of gravity of the latter and nearer the projectile muzzle thereof, whereby the gun tends to assume a vertical position with the projectile muzzle downward when loaded, and a reversed position when unloaded, and a loading tray adapted to be engaged by the reaction weight end of the gun in the loading operation to deliver a charge to the gun.

In testimony whereof I affix my signature in presence of two subscribing witnesses.

CHARLES JOHN COOKE.

Witnesses:
WM. E. DYRE,
FRANCIS I. MAGUIRE.