Jan. 28, 1947. B. ROUS 2,414,898

SHELL

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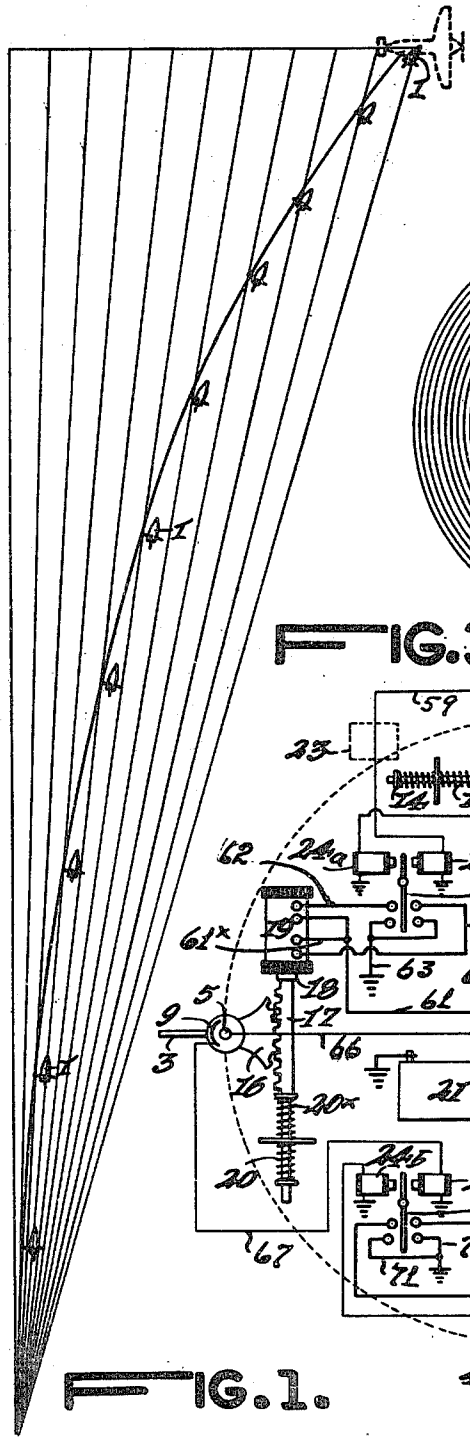


FIG. 1.

FIG. 2.

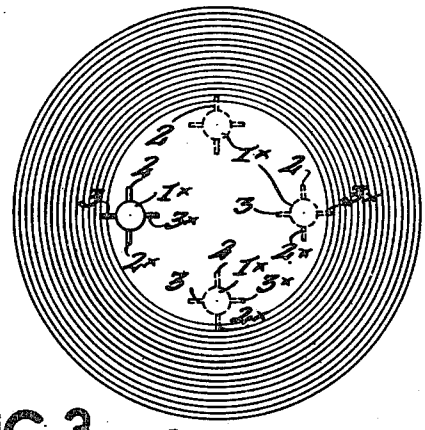
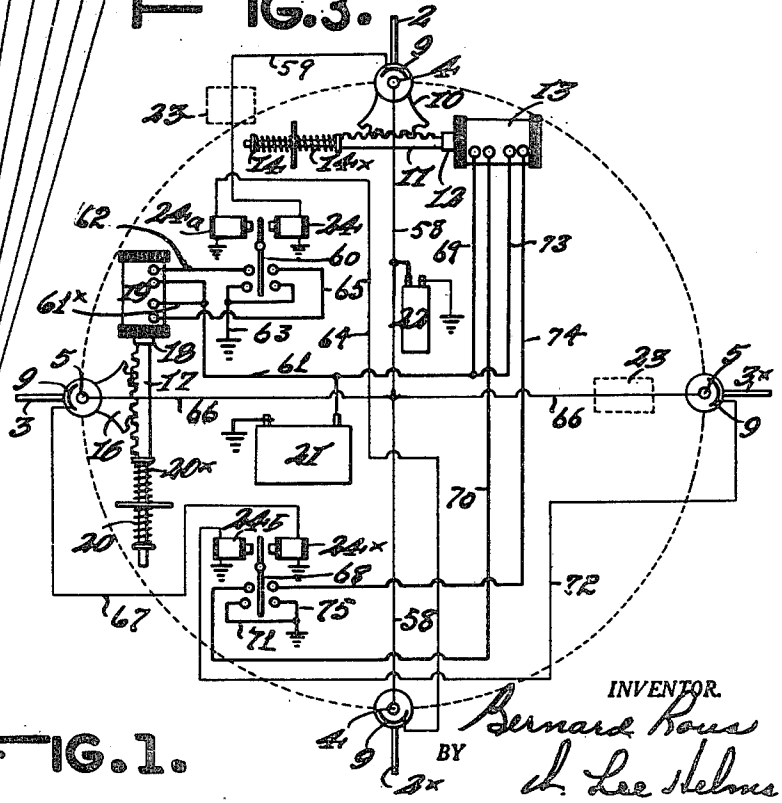


FIG. 3.



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FIG. 4.

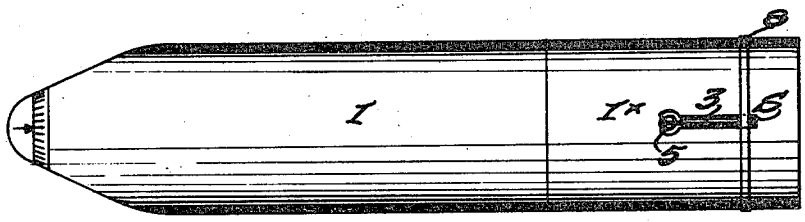


FIG. 5.

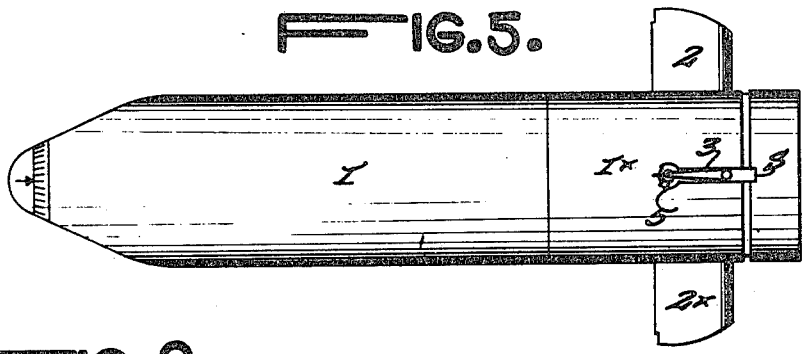


FIG. 6.

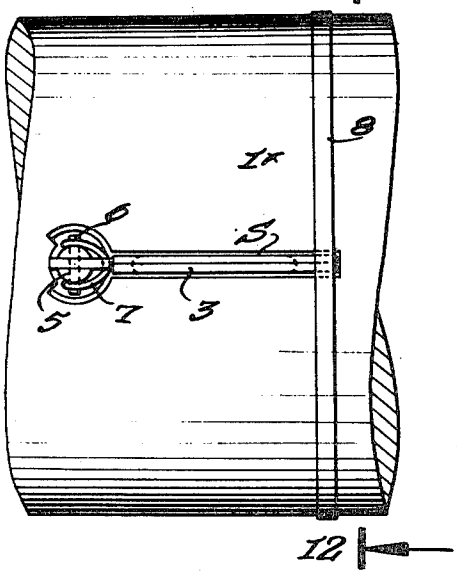
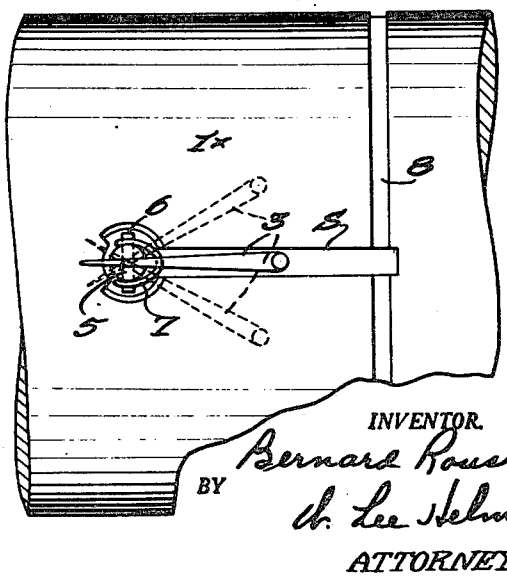


FIG. 7.



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FIG. 8.

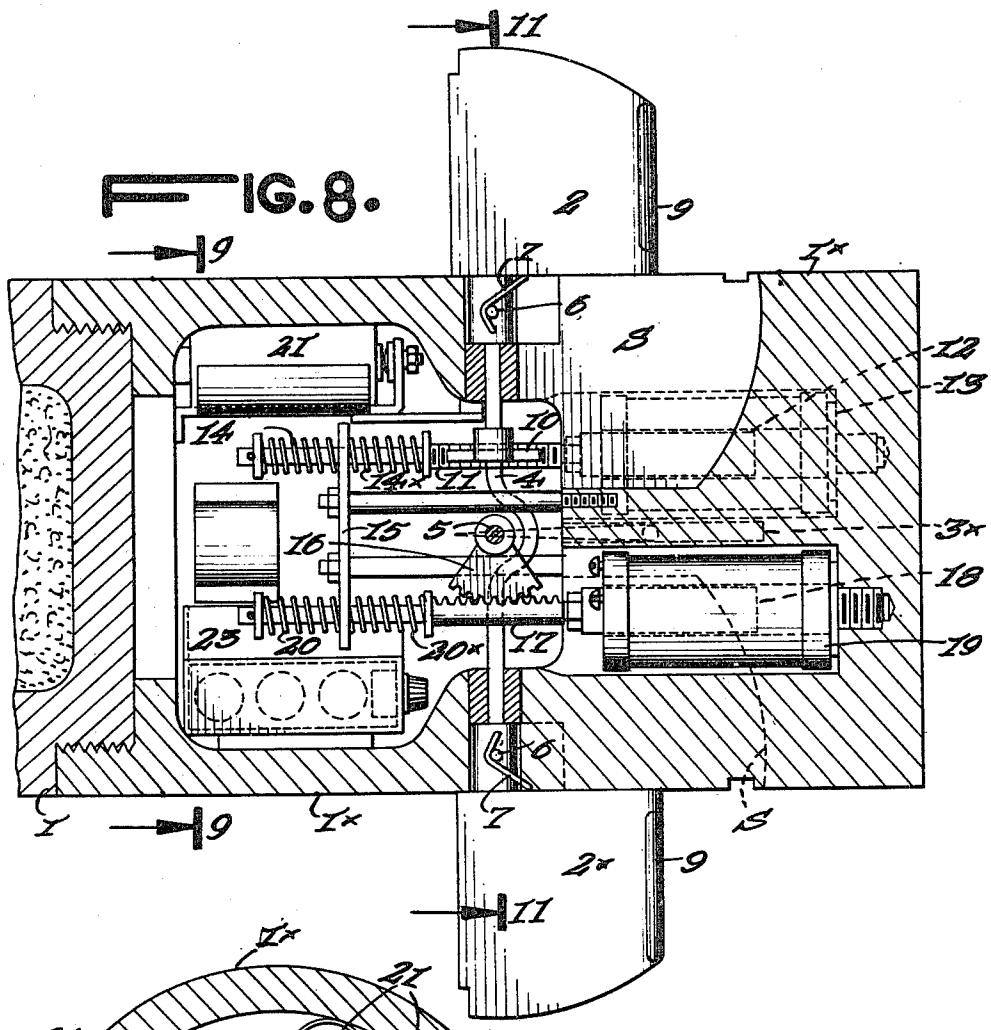
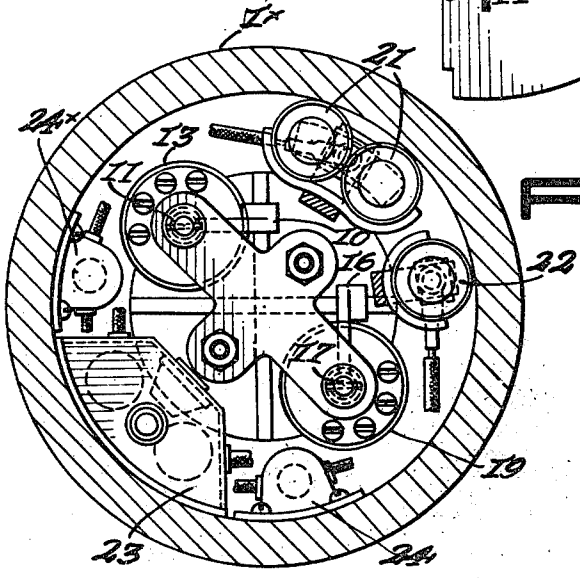


FIG. 9.



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FIG. 10.

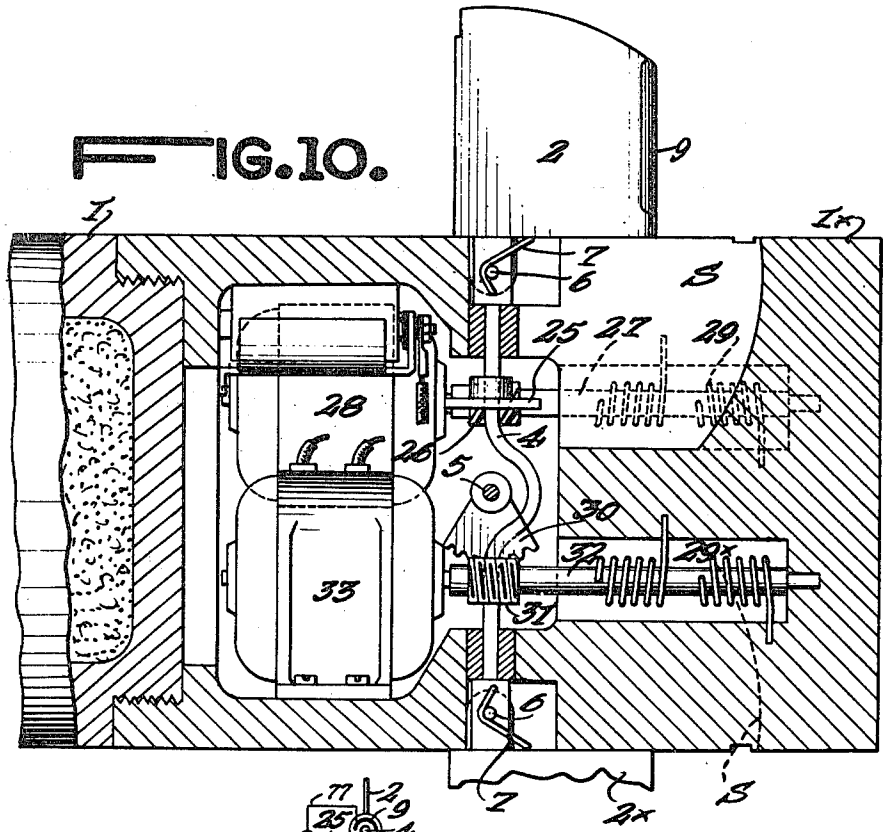
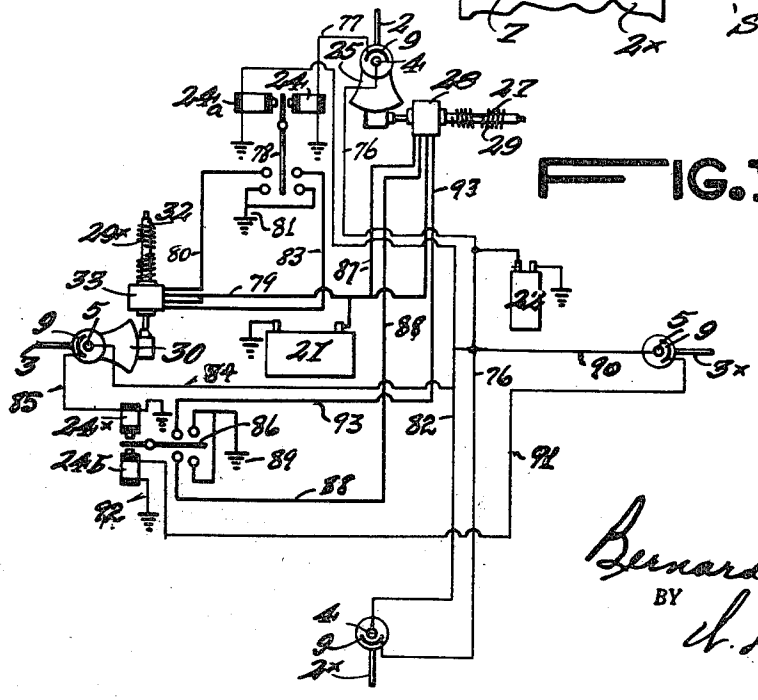


FIG. 10a.



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FIG. 11.

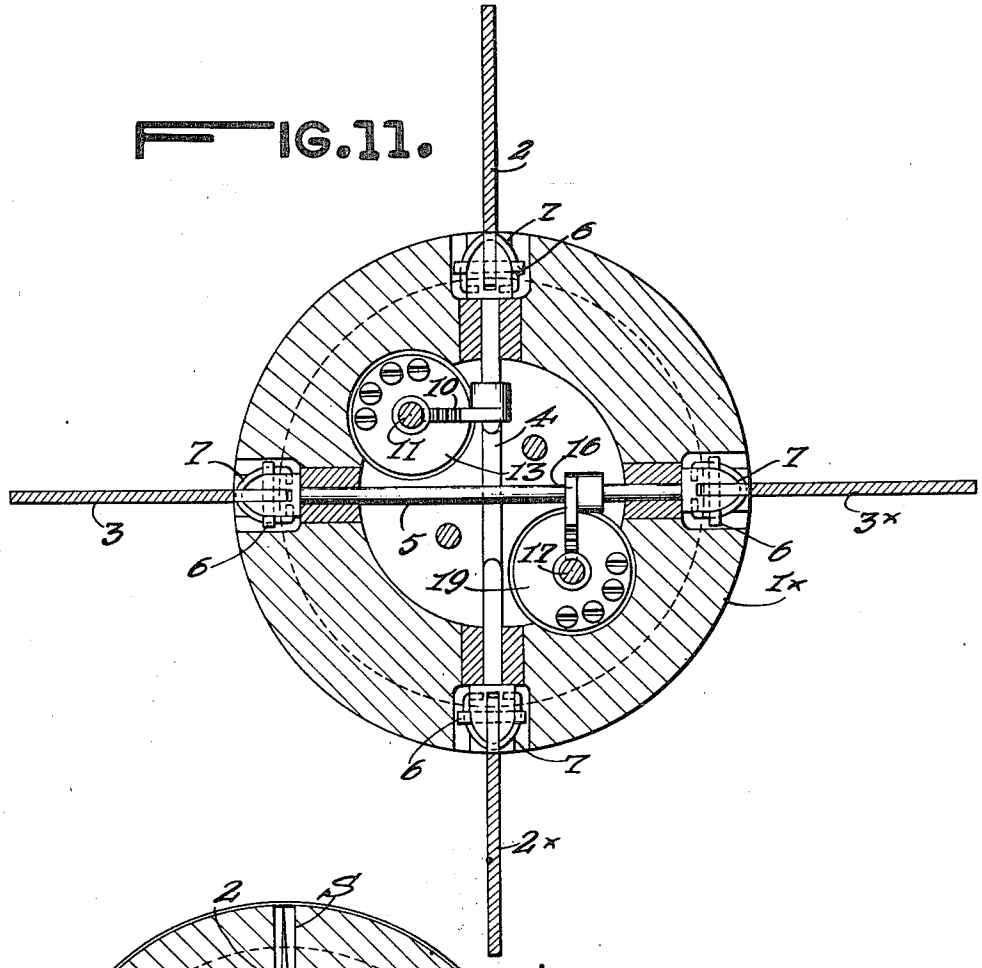
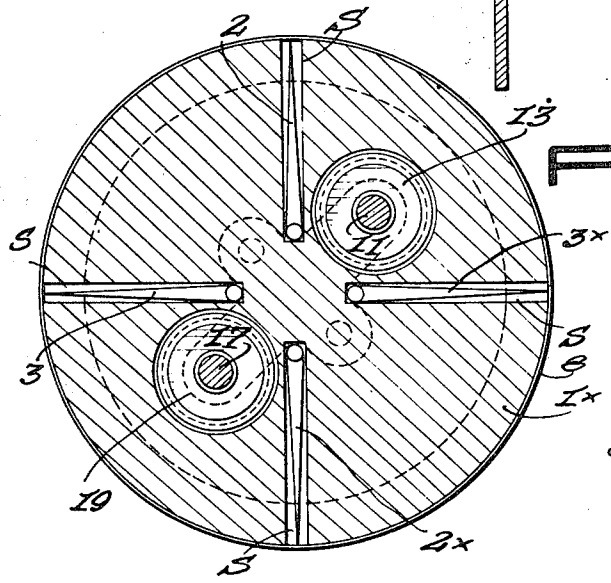


FIG. 12.



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FIG. 13.

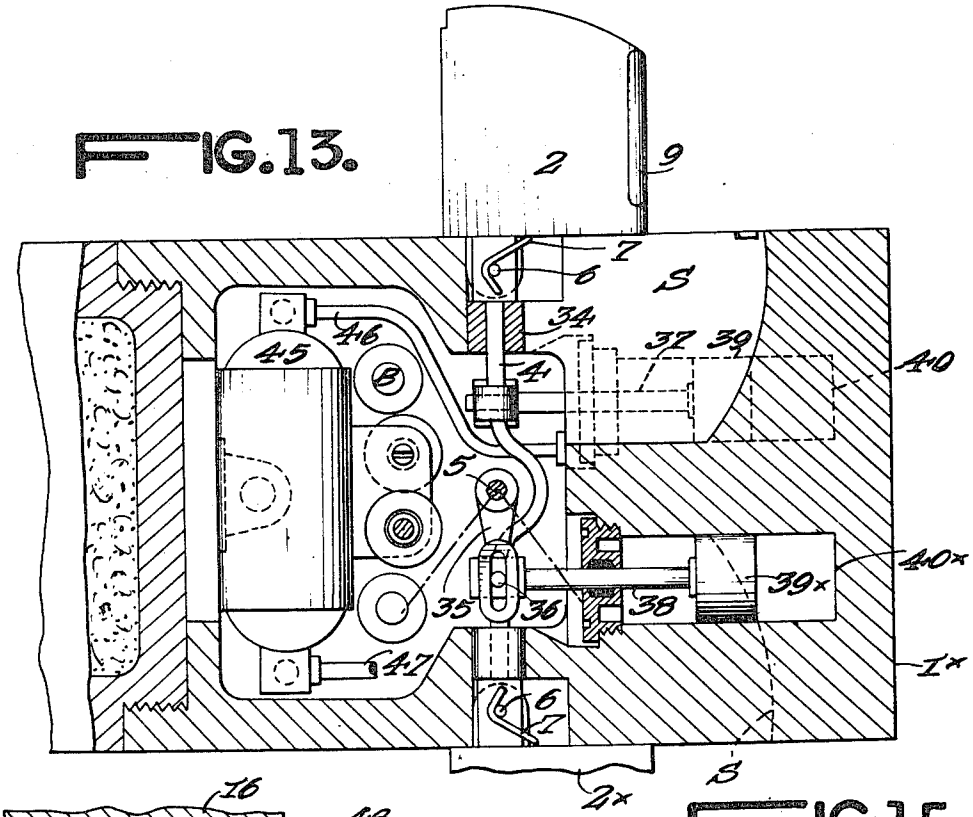


FIG. 15.

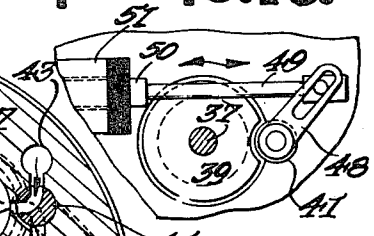


FIG. 14

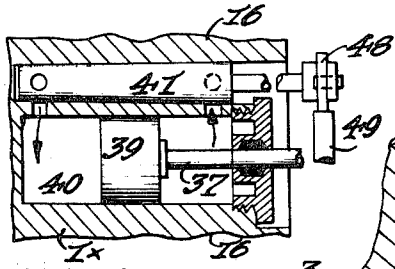


FIG. 16.

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UNITED STATES PATENT OFFICE

2,414,898

SHELL

Bernard Rous, New York, N. Y.

Application June 11, 1942, Serial No. 446,575

5 Claims. (Cl. 102—50)

1

The object of the present invention is to provide a method for controlling the directional movement of a shell after it has left the muzzle of a gun, and to provide a shell for use in the method.

By means of the present method and shell the gun may be aimed at the target—not necessarily above it in calculated degree in accordance with present practice—and in case of moving targets, such as aircraft and ships, the movement of the shell may be coincided with the movement of the target, whether vertically or laterally.

The trajectory of the shell describes a straight line until gravitational force causes the shell at a point in its flight to move in a downward arc. Thus it is necessary in gun sighting to rapidly calculate, with reference to the particular gun, its caliber, and the speed of the projectile, the distance from the gun of the target, and the height of the target, to properly aim the gun—hence the need for range finders and delicate calibrating instruments for aid in accuracy of fire. The difficulty is largely increased in night firing.

By means of the present method and shell, an intense shell encompassing beam of light may be projected, which beam encompasses the straight line path of the shell, as when its source surrounds a gun muzzle. The position of this beam changes with the movement of the gun muzzle in following the target and acts upon sensitive elements carried by the shell which control directional devices.

The gun is smooth bored, not rifled. The shell when it emerges from the gun throws out two horizontal fin rudders and two vertical fin rudders, and the position of these rudders relative to the longitudinal axis of the shell is, in night firing, controlled by the beam of light. These rudders are operative to cause the shell to veer to the left, to the right, to more rapidly descend, or to retard normal descent, as by an upward rise in a normally down trajectory curve.

By maintaining the gun sights directly on the target from the instant of firing, the shell will reach the target, and calculations as to range are unnecessary, the time for training skilled gunners is very substantially reduced, and waste of ammunition may largely be avoided, because one effective gun of 75 mm. caliber, or of a larger caliber, is better than fifty non-effective guns of any caliber.

The invention will be described with reference to the accompanying drawings, in which:

Figure 1 is a schematic view in plan illustrating the lateral directional control of the shell, as when the control beam is shifted to the right to follow a fast moving airplane.

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Figure 2 is a schematic view, in elevation, showing the relative position of a control beam and the beam-sensitive elements of the shell.

Figure 3 is a wiring diagram for the motor control (solenoid) form of the shell illustrated in Figures 4 to 12 inclusive.

Figures 4 and 5 are, respectively, side views of the shell prior to and after firing.

Figure 6 is an enlarged fragmentary view of the rear portion of the shell in its form as shown in Figure 4.

Figure 7 is an enlarged fragmentary view of the shell in its form as shown in Figure 5, dotted lines showing positions to which the rudder fin, in view, may be moved.

Figure 8 is a longitudinal section through that embodiment of the shell, at its rear portion, which is controlled by the wiring and elements shown in Figure 3.

Figure 9 is a vertical section on the line 9—9, Figure 8.

Figure 10 is a longitudinal section through the rear portion of the modified form of shell.

Figure 10*a* is a wiring diagram for the structure shown in Figure 10.

Figure 11 is a vertical section taken on the line 11—11, Figure 8.

Figure 12 is a vertical and transverse section on the line 12—12, Figure 6.

Figure 13 is a longitudinal section through the rear portion of a modified form of shell employing compressed air as the power for effecting the movement of the rudder fins.

Figure 14 is a fragmentary section taken longitudinally through one of the two cylinders showing a piston and piston rod therein and an adjacent oscillatory control valve for the compressed air.

Figure 15 is a fragmentary view, largely schematic, showing the solenoid actuator for the oscillatory valve.

Figure 16 is a view in elevation and transverse section, partly broken away, taken through the shell generally on the line 16—16, Figure 14.

The primary shell casing containing the explosive charge is indicated at 1, and threaded thereon at the rear, is the control casing 1*x*. Two sets of opposed and angularly related slots are formed in the control casing 1*x* as shown at *s*, for containing two sets of rudder fins, which, for convenience in description, are herein termed vertical rudder fins 2, 2*x* and horizontal rudder

fins 3, 3x. In each form of the invention, the vertical rudder fins 2, 2x are carried by a single shaft 4 and the horizontal rudder fins 3, 3x are carried by a single shaft 5. These shafts are the same in function in all forms and hence bear the same reference characters although they may be driven by specifically different means. The rudder fins are pivoted to their respective shafts by a pivot 6 and springs 7 are employed to normally project the rudder fins outwardly to the position shown in Figure 11 and in other figures.

Prior to firing the fins are held inward against the tension of their springs by any means which will become inoperative when the shell is fired as, for example, a friction fusible ring 8 as indicated in Figures 4 and 6.

Each rudder fin carries at its trailing edge a beam-sensitive circuit closer indicated at 9. By "beam-sensitive circuit closer" is meant any element adapted to close an electric circuit in generally the manner of a selenium cell, and the beam may be of light, or of any radiant energy.

In the structure of Figures 8 to 12 inclusive, the power for moving the rudder fins is derived from small but powerful solenoids fed from a battery or batteries. Shaft 4 carries a rack 10 which is in mesh with a rack bar 11 (Figure 8) connected to the core 12 of the solenoid 13, which solenoid is double acting so that the core is positively moved either to the right or to the left. Balancing springs 14, 14x which engage an intermediate fixed plate 15 act upon the rack and core 12 to normally hold the latter in an intermediate position relatively to the solenoid 13, although this is not essential since wind pressure on the rudder fins 2, 2x will tend to maintain them strictly parallel to the vertical plane which intersects the axis extending longitudinally through the shell.

Shaft 5 also carries a rack, shown at 16 in mesh with a rack bar 17 (Figure 8) carried by the core 18 of a solenoid 19, the rack bar and core being balanced by springs 20, 20x in the same manner as previously described with reference to rack bar 11 and core 12.

Referring to Figures 8 and 9, I have shown at 21 the main plural-cell battery, at 22 the relay battery, at 23 an amplifier and at 24 and 24x two relays.

Referring to Figures 2 and 3 showing various positions of shell relative to the encompassing beam, Figure 2, and the wiring diagram, Figure 3, it will be seen from Figure 2 that at 1x is shown the control casing of the shell, the encompassing beam being shown by circular lines. It will be seen that the gunner has, in following the moving target by the gun muzzle or any other beam control, shifted the beam to the right, causing the beam to strike the sensitive cell of rudder 3. Instantly relay 24x is energized, closing a circuit through one side of solenoid 13, causing the solenoid to act upon shaft 4 to turn the vertical rudders in such direction that the shell is directed to the right.

If the beam had been shifted to the left so that horizontal rudder 3x was met by the beam, the sensitive cell would close a circuit through the side 24b of the relay, closing a circuit through the opposite end of the solenoid 13 and thus reversing the action of shaft 4 and the vertical rudders, directing the shell to the left. Likewise, should the beam meet the cell on vertical rudder 2x, a circuit will be closed through relay side 24a closing a circuit through one end of solenoid 19, causing the rotation of shaft 5 in such direction as to move the horizontal rudders upwardly. Also, should the beam meet the sensitive cell on the upper rudder 2, a circuit would be closed through the right hand side of relay 24, closing a circuit through the opposite end of solenoid 19 and turning shaft 5 to move the rudders downwardly so as to direct the shell downwardly.

It will be understood that the wiring diagram of Figure 3 shows the mechanical elements merely in schematic relation, the sector racks 10 and 16 and the shafts 4 and 5 having been turned out of normal position for clarity of illustration.

Referring more particularly to the wiring shown in Figure 3, the circuit closing operations are as follows:

When the beam-sensitive cell 9 on the uppermost of the two "vertical" rudders is met by the control beam a circuit is closed from the solenoid battery 22 through wires 58, 59 and the solenoid 24 operates switch 60 to close one side of power solenoid 19 via battery 21 and wires 61, 62, 63. When the lower one of the two "vertical" rudders meets the beam a circuit is closed from solenoid battery 22 via wires 58 and 64 acting upon solenoid 24a to close a circuit through the opposite end of power solenoid 19 via wires 61, 61x, 65 and thence to the ground wires 63.

When the beam meets the cell on the left horizontal rudder 3 current is passed from the solenoid battery 22 via wires 58, 66 and 67 to solenoid 24x operating a switch arm 68 to close a circuit from battery 21 via wires 69, 70 and ground wire 71. When the right hand horizontal rudder cell, carried by rudder 3x, meets the beam, the circuit is closed from solenoid battery 22 via wires 66 and 72 energizing relay 24b to close a circuit from battery 21 via wires 73, 74, 75.

It will thus be seen that the power solenoids 13 and 19 are thrown into a circuit with the battery 21 by relay switches of the solenoid type which are independently energized from a low power battery, the four relay switches each leading to its own rudder carried cell which breaks connection with the low power battery until the beam strikes it.

In Figures 10 and 10a the shafts 4 and 5 are worm driven from electric motors. Shaft 4 carries a sector rack 25 driven by a worm 26 on the shaft 27 of motor 28. Inasmuch as the action of rotation of shaft 4 is slight, balancing springs 29 may be employed. Likewise, shaft 5 carries a sector rack 30 in mesh with a worm 31 on the shaft 32 of motor 33 and motor shaft 32 may be provided with balancing springs 29x.

The operation of the structure shown in Figure 10 will be explained by reference to the wiring diagram shown in Figure 10a, as follows:

When the upper of the two vertical rudders meets the beam, current is led from low power battery 22 via wire 76, the cell and wire 77 to switch 24 which throws switch arm 78 to the left closing a circuit through one side of motor 33 via battery 21, wires 79 and 80 and ground 81.

When the beam meets the lowermost of the two vertical rudders, current will flow from battery 22 through wires 76, 82, energizing switch 24a and closing a circuit from battery 21 via wires 79, 83 and ground 81.

When the left hand horizontal rudder meets the beam, current is led from low power battery 22 via wires 76, 84, through the appropriate cell through wire 85 and the switch 24x which operates arm 86 closing a circuit from battery 21 via wires 87, 88 and ground 89.

When the right hand horizontal rudder meets

the beam a circuit is closed leading from battery 22, wires 76, 90, through the appropriate cell of the rudder and via wires 91, 92 through switch 24b to the ground closing a circuit through motor 28 via wires 79 and 93.

In the structure of Figures 13 to 16 inclusive, compressed air is used for the power to move the rudders. Shaft 4 carries a crank arm 34 which is the same in construction as the crank arm 35 shown in Figure 13 as carried by shaft 5. Each of these crank arms has a slotted outer end to receive a stud 36 carried by the appropriate one of the two piston rods, that for crank arm 34 being shown at 37, and that for crank arm 35 being shown at 38. Each piston rod carries a piston 39, 39x disposed normally intermediate the ends of its appropriate cylinder 40, 40x.

Referring to Figure 16, it will be seen that each cylinder is associated with an oscillatory valve, that for cylinder 40 being indicated at 41, and the valve for cylinder 40x being shown at 42. These oscillatory valves are well known in the fluid pressure engine art and require little description. Each valve has two spaced ports, one at each end of the cylinder. When compressed air is led into one end of the cylinder, the port at that end communicates with an air intake duct shown at 43, Figure 16, whereas the second port communicates with an air discharge duct 44, and vice versa. The air discharge duct 44 may be opened to portions of the fin slots so that the exhaust air may pass to the atmosphere. In practice, the compressed air chamber will be directly bounded by walls of the control casing and will receive air under pressure from a suitable source via a normally plug-closed pressure valve of the Schrader type. In the drawings, and for clarity of illustration, compressed air is shown as contained within a separate tank 45 communicating by pipe 46 with pressure duct 43, and communicating by pipe 47 with pressure duct 43 of the second cylinder.

Each valve 41, 42 is oscillated by a double acting solenoid, that for valve 41 being shown in Figure 15, and that for valve 42 being the same in construction. It will be seen that valve 41 carries slotted lever arm 48 engaged by a rod 49 carried by the core 50 of solenoid 51. The solenoids and wiring diagram will be the same as the solenoids 13 and 19 and wiring diagram of Figure 3, which previously have been described.

Having described my invention, what I claim and desire to secure by Letters Patent, is as follows:

1. In a shell, two sets of passageways, the sets lying at right angles to each other, a pair of rudder fins lying in the passageways of each set, a shaft to which each set of rudder fins is pivotally attached, means for projecting the rudder fins out of their passageways upon the firing of the shell, power means for rotating each of the shafts independently and electrical controls for said power means and including a plurality of beam-sensitive circuit-closing elements carried by the rudder fins.

2. In a shell, two sets of passageways, the sets lying at right angles to each other, a pair of rudder fins lying in the passageways of each set, a shaft for and to which each set of rudder fins is pivotally attached, means for projecting the rudder fins out of their passageways upon the firing of the shell, power means for rotating each of the shafts independently, and in reverse directions, electrical controls for said power means and including a plurality of beam-sensitive circuit-closing elements carried by the rudder fins, and a circuit leading from each of said circuit-closing elements to one of the electrical controls.

3. In a shell, two sets of passageways, the sets lying at right angles to each other, a pair of rudder fins lying in the passageways of each set, a shaft for and to which each set of rudder fins is pivotally attached, means for projecting the rudder fins out of their passageways upon the firing of the shell, power means for rotating each of the shafts independently, and in reverse directions, electrical controls for said power means and including a plurality of beam-sensitive circuit-closing elements carried by the rudder fins and four circuits each leading from one of the beam-sensitive circuit-closing elements to one of the electrical controls for said power means.

4. A shell constructed in accordance with claim 3, in which a reversely acting power means is applied to each shaft for turning the same in opposite directions, the circuit leading from one of the circuit-closing elements of a set being connected to an electrical control for effecting operation of the power means for a movement of the shaft carrying the other set of rudder fins, for movement of that shaft in a given direction, the circuit-closing element carried by the second rudder fin of the first-named set having a circuit leading to said power means for rotation of said last-named shaft in reverse direction.

5. A shell carrying two pairs of rudder fins, one pair at right angles to the other pair, means for projecting the rudder fins outwardly upon the firing of the shell, power means for moving the pairs of rudder fins for directional control of the shell, an electric control for the power means, and beam-sensitive circuit-closing elements carried by the rudder fins for said electrical controls.

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