



(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 158(3) EPC

(43) Date of publication:
13.09.2006 Bulletin 2006/37

(51) Int Cl.:
F41B 11/14 (2006.01)

(21) Application number: **03768364.6**

(86) International application number:
PCT/JP2003/017054

(22) Date of filing: **26.12.2003**

(87) International publication number:
WO 2005/066575 (21.07.2005 Gazette 2005/29)

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IT LI LU MC NL PT RO SE SI SK TR**

(72) Inventor: **Tsurumoto, Koichi**
Tokyo 112-0012 (JP)

(71) Applicant: **Tsurumoto, Koichi**
Tokyo 112-0012 (JP)

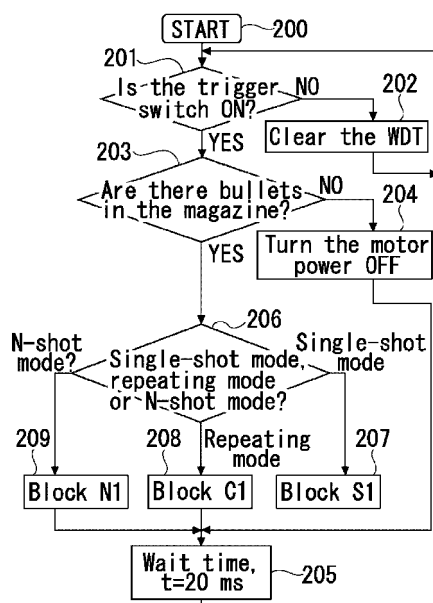
(74) Representative: **Schneider, Günther Martin et al**
Bettinger Schneider Schramm,
Patent- und Rechtsanwälte,
Postfach 86 02 67
81629 München (DE)

(54) **AIR GUN AND NUMBER-OF-SHOTS CHANGE CONTROL METHOD**

(57) This invention relates to electronic control of an air gun in the form of a model gun, and in a repeating mode operation is capable of easily controlling the number of shots, and furthermore is capable of easily switching among single-shot mode, repeating mode and N-shot mode. Also, it is possible to always stop the shooting operation at a specified position.

The present invention is an air gun comprising: a single-shot mode shooting operation that starts when a trigger switch is switched ON, and stops when a reference position is detected; a repeating mode shooting operation that performs the shooting operation continuously when the trigger switch is switched ON, and stops the shooting operation when reference position is detected; an N-shot mode shooting operation that performs the shooting operation only N time when the trigger switch is switched ON, and stops the shooting operation when the reference position is detected; and a switching means for selecting and operating any one from among the single-shot mode, repeating mode and N-shot mode operation.

FIG. 16



Description

BACKGROUND OF THE INVENTION

5 Field of the Invention:

[0001] This invention relates to an air gun in the form of a model gun, and more particularly to electronic control of an air gun that is suitable for arbitrarily switching among single shot mode, repeating mode and N-shot mode.

10 Description of the Related Art:

[0002] An air gun in the form of a model gun that is patterned after an automatic rifle is used as a toy or for shooting practice. Particularly, in the case of being used for shooting practice, it is desired that the air gun have the same appearance and be capable of being handled the same as a real gun. Prior art for this kind of air gun has been disclosed in Japanese Examined Patent Publication H7-43238.

[0003] In this prior art, by pulling the trigger, a motor drives a pump comprising a piston and cylinder, and discharges compressed air through a discharge hole, while at the same time a bullet is fed in synchronization with this, and that bullet is shot. In this prior art, the mechanism that shoots the bullet is electrically powered so that it can be driven by a motor, however, the bullet shooting mechanism is a mechanical mechanism such as a cam. Also, switching between single-shot mode and repeating mode is performed by a mechanical mechanism comprising a mechanical tappet arm or switching lever. Moreover, the power to the motor is turned ON/OFF by a mechanical contact switch. Also, in this prior art it is possible to switch between single-shot mode and repeating mode by switching a lever, and in the case of repeating mode, the motor operates as long as the trigger is pulled, and the series of operations related to repeating mode are repeatedly performed, and by releasing the trigger, the operations stop.

[0004] In the aforementioned prior art, starting and stopping the shooting operation was performed by turning ON/OFF a mechanical switch to the power supply of the motor, so there was a problem in reliability in that defective operation due to burnt contacts or incomplete contacting occurs easily. Also, switching between single-shot mode and repeating mode is performed by a mechanism comprising a mechanical cam and lever, so defective operation occurs easily due to wear or fatigue.

[0005] Moreover, in the repeating mode operation of this prior art, it was not possible to control how many times the bullet was shot.

[0006] Also, in this prior art, there was no way for checking whether or not there were bullets in the magazine, and particularly during continuous shooting, even after the last bullet was shot, there was a problem in that in a state of having no bullets, useless blank shooting continued.

[0007] In this prior art, the trigger was released at arbitrary timing, so in accordance to this, the motor also stopped at arbitrary timing. Therefore, there was a problem in that the rotating shaft (sector gear) also stopped at an arbitrary position, and stopped while still being meshed with the rack formed on the piston. The following problems occur when the rotating shaft (sector gear) stops while still being meshed with the rack:

(1) The air gun is left for a long period of time in the stopped state with stress still being applied to the rotating shaft and rack, which causes mechanical failure of the deceleration mechanism and piston unit to occur.

(2) The air gun is left for a long period of time in the stopped state when the spring compressed. Therefore, the spring effect of the spring becomes weak.

(3) The air gun is stopped with stress still being applied to the rotating shaft and rack, so the meshing between the rotating shaft and rack cannot be easily released. Therefore, it is not possible to easily open up the inside when performing internal inspection such as during maintenance.

50 SUMMARY OF THE INVENTION

[0008] In order to solve the aforementioned problems, the object of the present invention is to make it possible to easily control how many shots are shot in the repeating mode operation, and to easily switch among single-shot mode, repeating mode and N-shot mode.

Also, another object of the present invention is to make it possible to always stop that shooting operation at a specified position.

[0009] The invention according to a first claim of the invention is an air gun that uses compressed air generated by a piston to shoot bullets, comprising: a means for making it possible to arbitrarily set the maximum number of times bullets

are shot when a trigger switch is switched ON one time; a means for counting the number of times bullets are shot; and a means for stopping the shooting operation when the count value of the counter reaches the maximum value.

[0010] The invention according to a second claim of the invention is an air gun that uses compressed air generated by a piston to shoot bullets, comprising: a reference position for a shooting operation that is located on a drive system that drives the piston; a means for starting the shooting operation when a trigger switch is switched ON; a means for stopping the shooting operation when the reference position is detected; and a means for preventing the shooting operation after shooting is stopped by the means for stopping the shooting operation, even when the ON state of the trigger switch continues.

[0011] The invention according to a third claim of the invention is the air gun of claim 2 wherein each time the trigger switch becomes ON, the operation of claim 2 is repeated.

[0012] The invention according to a fourth claim of the invention is an air gun that uses compressed air generated by a piston to shoot bullets, comprising: a reference position for a shooting operation that is located on a drive system that drives the piston; a means for starting the shooting operation when a trigger switch is switched ON; and a means for stopping the shooting operation when the reference position is detected and the trigger switch is OFF.

[0013] The invention according to a fifth claim of the invention is an air gun that uses compressed air generated by a piston to shoot bullets, comprising: a means for making it possible to arbitrarily set the maximum number of times bullets are shot when a trigger switch is switched ON one time.

[0014] The invention according to a sixth claim of the invention is an air gun that uses compressed air generated by a piston to shoot bullets, comprising: a reference position for a shooting operation that is located on a drive system that drives the piston; a counter that makes it possible to arbitrarily set the maximum number of times bullets are shot to a specified value N when a trigger switch is switched ON one time; a means for starting the shooting operation when the trigger switch is switched ON; a subtraction means for subtracting 1 from the set maximum value N when the reference position is detected; and a means for stopping the shooting operation when the subtraction result of the subtraction means becomes 0 and the reference position is detected.

[0015] The invention according to a seventh claim of the invention is an air gun that uses compressed air generated by a piston to shoot bullets, comprising: a reference position for a shooting operation that is located on a drive system that drives the piston; a single-shot mode shooting means for starting a shooting operation when a trigger switch is switched ON, stopping the shooting operation when the reference position is detected, and preventing the shooting operation after the shooting operation is stopped, even when the ON state of the trigger switch continues; a repeating mode shooting means for starting the shooting operation when the trigger is switched ON, and stopping the shooting operation when the reference position is detected and the trigger switch becomes OFF; and a switching means for selecting and operating either the single-shot mode shooting means or the repeating mode shooting means.

[0016] The invention according to an eighth claim of the invention is an air gun that uses compressed air generated by a piston to shoot bullets, comprising: a reference position for a shooting operation that is located on a drive system that drives the piston; a single-shot mode shooting means for starting a shooting operation when a trigger switch is switched ON, stopping the shooting operation when the reference position is detected, and preventing the shooting operation after the shooting operation is stopped, even when the ON state of the trigger switch continues; an N-shot mode shooting means for setting the maximum number of times bullets are shot when the trigger switch is switch ON one time, starting the shooting operation when the trigger switch is switched ON, subtracting 1 from the set maximum value N when the reference position is detected, and stopping the shooting operation when the subtraction result becomes 0 and when the reference position is detected; and a switching means for selecting and operating either the single-shot mode shooting means or the N-shot mode shooting means.

[0017] The invention according to a ninth claim of the invention is an air gun that uses compressed air generated by a piston to shoot bullets, comprising: a reference position for a shooting operation that is located on a drive system that drives the piston; a single-shot mode shooting means for starting a shooting operation when a trigger switch is switched ON, stopping the shooting operation when the reference position is detected, and preventing the shooting operation after the shooting operation is stopped, even when the ON state of the trigger switch continues; a repeating mode shooting means for starting the shooting operation when the trigger is switched ON, and stopping the shooting operation when the reference position is detected and the trigger switch becomes OFF; an N-shot mode shooting means for setting the maximum number of times bullets are shot when the trigger switch is switch ON one time, starting the shooting operation when the trigger switch is switched ON, subtracting 1 from the set maximum value N when the reference position is detected, and stopping the shooting operation when the subtraction result becomes 0 and when the reference position is detected; and a switching means for selecting and operating one of the single-shot mode shooting means, the repeating mode shooting means and the N-shot mode shooting means.

[0018] The invention according to a tenth claim of the invention is an air gun that uses compressed air generated by a piston to shoot bullets, comprising: a reference position for a shooting operation that is located on a drive system that drives the piston; a single-shot mode shooting means for starting a shooting operation when a trigger switch is switched ON, stopping the shooting operation when the reference position is detected, and preventing the shooting operation

after the shooting operation is stopped, even when the ON state of the trigger switch continues; a repeating mode shooting means for starting the shooting operation when the trigger is switched ON, and stopping the shooting operation when the reference position is detected and the trigger switch becomes OFF; an N-shot mode shooting means for setting the maximum number of times bullets are shot when the trigger switch is switch ON one time, starting the shooting operation when the trigger switch is switched ON, subtracting 1 from the set maximum value N when the reference position is detected, and stopping the shooting operation when the subtraction result becomes 0 and when the reference position is detected; and a switching means that selects and operates either a single-shot mode/repeating mode means for performing the single-shot mode shooting operation and the repeating mode shooting operation, or a single-shot mode/N-shot mode means for performing the single-shot mode shooting operation and the N-shot mode shooting operation.

[0019] The invention according to an eleventh claim of the invention is the air gun of claim 10 wherein the switching means for selecting and operating either the single-shot mode/repeating mode means or the single-shot mode/N-shot mode means is a switching means that switches patterns on a printed-circuit board of a control circuit using a jumper wire.

[0020] The invention according to a twelfth claim of the invention is a control method for an air gun that uses compressed air generated by a piston to shoot bullets, comprising: a process of arbitrarily setting the maximum number of times bullets are shot when a trigger switch is switched ON one time; a process of counting the number of times bullets are shot; and a process of stopping the shooting operation when the count value of the counter reaches the maximum value.

[0021] The invention according to a thirteenth claim of the invention is a control method for an air gun that uses compressed air generated by a piston to shoot bullets, comprising: a reference position for a shooting operation that is located on a drive system that drives the piston; and that starts the shooting operation when a trigger switch is switched ON; stops the shooting operation when the reference position is detected; and prevents the shooting operation after shooting is stopped by a method for stopping the shooting operation, even when the ON state of the trigger switch continues.

[0022] The invention according to a fourteenth claim of the invention is the control method for an air gun of claim 13 that repeats the operation of claim 13 each time the trigger switch becomes ON.

[0023] The invention according to a fifteenth claim of the invention is a control method for an air gun that uses compressed air generated by a piston to shoot bullets, comprising: a reference position for a shooting operation that is located on a drive system that drives the piston; and that starts the shooting operation when a trigger switch is switched ON; and stops the shooting operation when the reference position is detected and the trigger switch is OFF.

[0024] The invention according to a sixteenth claim of the invention is a control method for an air gun that uses compressed air generated by a piston to shoot bullets, that: makes it possible to arbitrarily set the maximum number of times bullets are shot when a trigger switch is switched ON one time.

[0025] The invention according to a seventeenth claim of the invention is a control method for an air gun that uses compressed air generated by a piston to shoot bullets, comprising: a reference position for a shooting operation that is located on a drive system that drives the piston; and a counter method that makes it possible to arbitrarily set the maximum number of times bullets are shot to a specified value N when a trigger switch is switched ON one time; and that starts the shooting operation when the trigger switch is switched ON; subtracts 1 from the set maximum value N when the reference position is detected; and stops the shooting operation when the subtraction result becomes 0 and the reference position is detected.

[0026] The invention according to an eighteenth claim of the invention is a control method for an air gun that uses compressed air generated by a piston to shoot bullets, comprising: a single-shot mode shooting process of starting a shooting operation when a trigger switch is switched ON, stopping the shooting operation when a reference position that is located on a drive system that drives the piston is detected, and preventing the shooting operation after the shooting operation is stopped, even when the ON state of the trigger switch continues; and a repeating mode shooting process of starting the shooting operation when the trigger is switched ON, and stopping the shooting operation when the reference position is detected and the trigger switch becomes OFF; and that selects and operates either the single-shot mode shooting process or the repeating mode shooting process.

[0027] The invention according to a nineteenth claim of the invention is a control method for an air gun that uses compressed air generated by a piston to shoot bullets, comprising: a single-shot mode shooting process of starting a shooting operation when a trigger switch is switched ON, stopping the shooting operation when a reference position that is located on a drive system that drives the piston is detected, and preventing the shooting operation after the shooting operation is stopped, even when the ON state of the trigger switch continues; and an N-shot mode shooting process of setting the maximum number of times bullets are shot when the trigger switch is switch ON one time, starting the shooting operation when the trigger switch is switched ON, subtracting 1 from the set maximum value N when the reference position is detected, and stopping the shooting operation when the subtraction result becomes 0 and when the reference position is detected; and that selects and operates either the single-shot mode shooting process or the N-shot mode shooting process.

[0028] The invention according to a twentieth claim of the invention is a control method for an air gun that uses

compressed air generated by a piston to shoot bullets, comprising: a single-shot mode shooting process of starting a shooting operation when a trigger switch is switched ON, stopping the shooting operation when a reference position that is located on a drive system that drives the piston is detected, and preventing the shooting operation after the shooting operation is stopped, even when the ON state of the trigger switch continues; a repeating mode shooting process of starting the shooting operation when the trigger is switched ON, and stopping the shooting operation when the reference position is detected and the trigger switch becomes OFF; and an N-shot mode shooting process for setting the maximum number of times bullets are shot when the trigger switch is switch ON one time, starting the shooting operation when the trigger switch is switched ON, subtracting 1 from the set maximum value N when the reference position is detected, and stopping the shooting operation when the subtraction result becomes 0 and when the reference position is detected; and that selects and operates one of the single-shot mode shooting process, the repeating mode shooting process and the N-shot mode shooting process.

[0029] The invention according to a twenty-first claim of the invention is a control method for an air gun that uses compressed air generated by a piston to shoot bullets, comprising: a single-shot mode shooting process of starting a shooting operation when a trigger switch is switched ON, stopping the shooting operation when a reference position that is located on a drive system that drives the piston is detected, and preventing the shooting operation after the shooting operation is stopped, even when the ON state of the trigger switch continues; a repeating mode shooting process of starting the shooting operation when the trigger is switched ON, and stopping the shooting operation when the reference position is detected and the trigger switch becomes OFF; and an N-shot mode shooting method for setting the maximum number of times bullets are shot when the trigger switch is switch ON one time, starting the shooting operation when the trigger switch is switched ON, subtracting 1 from the set maximum value N when the reference position is detected, and stopping the shooting operation when the subtraction result becomes 0 and when the reference position is detected; and that selects and operates either a single-shot mode/repeating mode process of performing the single-shot mode shooting process and the repeating mode shooting process, or a single-shot mode/N-shot mode process of performing the single-shot mode shooting process and the N-continuous-shooting process.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030]

Fig. 1 shows the air gun in the form of a model gun of this invention that is patterned after an automatic rifle.

Fig. 2 is a drawing showing the shooting control unit of the invention.

Fig. 3 is an enlarged view of the control circuit of the invention.

Fig. 4 is a drawing showing section A-A of Fig. 3.

Fig. 5 is a drawing showing the electronic-control circuit of the invention.

Fig. 6 is a drawing explaining the operation of the invention from setting a bullet until the bullet is shot.

Fig. 7 is a drawing showing the control block of the electronic-control circuit of the invention.

Fig. 8 is a drawing showing the control circuit shown in Fig. 7 shown in more detail.

Fig. 9 is a flowchart of control performed for the single-shot mode operation of the invention.

Fig. 10 is a drawing showing the open gun body of the invention.

Fig. 11 is a flowchart of control performed for the repeating mode operation of the invention.

Fig. 12 is a flowchart of control performed for N-shot mode operation of the invention.

Fig. 13 is a flowchart of control performed for the single-shot mode operation of the invention.

Fig. 14 is a flowchart of control performed when switching between the single-shot mode and repeating mode operations of the invention.

Fig. 15 is a flowchart of control performed when switching among the single-shot mode, repeating mode and N-shot mode operations of the invention.

Fig. 16 is another flowchart of control performed when switching among the single-shot mode, repeating mode and N-shot mode operations of the invention.

Fig. 17 is yet another flowchart of control performed when switching among the single-shot mode, repeating mode and N-shot mode operations of the invention.

Fig. 18 to Fig. 20 are yet another flowchart of control performed when switching among the single-shot mode, repeating mode and N-shot mode operations of the invention.

Fig. 21 is a flowchart of the control performed when counting the number of shootings in the single-shot mode operation of the invention.

Fig. 22 is a flowchart of the control performed when counting the number of shootings in the single-shot mode, repeating mode and N-shot mode operations of the invention.

Fig. 23(a), Fig. 23(b) and Fig. 23(c) are a front view, top view and left side view of the gun magazine of the invention, respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0031] Fig. 1 shows an air gun in the form of a model gun that is patterned after an automatic rifle.

[0032] First, each part of the air gun shown in Fig. 1 will be explained. In the figure, 1 is the air gun body, 21 is a cylindrical barrel through which a bullet passes when being shot, and 3 is a trigger that is pulled when shooting the bullet. Also, 4 is a magazine, 5 is a gun grip, 6 is a gun stock, 7 is a hand-guard liner, 8 is a hand carry and 9 is a hinge.

[0033] As shown in Fig. 23, the magazine 4 is constructed so that a plurality of bullets 19 are stored inside it (details of the inside are not shown), and a spring feeds the bullets 19 from a feed hole 59 that is located on the top surface of the magazine 4. On the side surface of the magazine 4 there is a bullet-detection lever 58 that protrudes from the frame 60 and detects whether or not there are any bullets 19, and when there are bullets in the magazine 4, the bullet-detection lever 58 moves upward, and where there are no bullets, it moves downward. This bullet-detection lever 58 comes in contact with the pressure member of a bullet-detection switch that is shown by the dashed line in Fig. 23, and it is possible for the bullet-detection switch 41 shown in Fig. 3 to detect whether or not there are any bullets in the magazine 4 according to the movement of the bullet-detection lever 58. In other words, the pressure member 42 of the bullet-detection switch is pressed downward by a spring (elastic member not shown in the figure), and when the bullet-detection lever 58 moves upward, it is pressed upward against the spring force by the bullet-detection lever 58, however when the bullet-detection lever 58 moves downward, the pressure member 42 of the bullet-detection switch is pressed downward by the spring force, and this presses the contact of the bullet-detection switch 41 downward and closes the contact. The ON/OFF signal from the contact of the bullet-detection switch 41 is input to the control circuit, and is used to perform control for preventing blank shooting described later.

[0034] Also, as will be described later, with the air gun of this invention, it is possible to open the gun body 1 using the hinge 9 as a rotating shaft as shown in Fig. 10, and perform internal maintenance.

[0035] Fig. 2 shows the inside of the gun body by a cut away view of the control section that controls bullet shooting. In the figure, 10 is a cylinder that houses a piston 12 inside, 11 is a cylinder head that is located on one end of the cylinder 10 and in which a continuous hole 57 is formed through which pressurized air can pass, 12 is a piston that moves back and forth inside the cylinder 10, and 13 is a piston head that is located on one end of the piston 12. Also, 14 is an O-ring that is located around the outside of the piston head 13 so that air cannot leak to the side of the piston 12 from an air space 62 between the piston head 13 and cylinder head 11 that are surrounded by the cylinder 10. Moreover, 15 is a spring that presses the piston 12 toward the left side, 16 is a piston-movement-restriction member that restricts the piston 12 from freely rotating around the center axis of the cylinder 10 in order that a rack 18 can mesh properly with a sector gear 25, 17 is center rod that is located so that the spring 15 is located in line with the center axis of the piston 12, 18 is a rack that is located on the bottom of the piston 12 and meshes with the teeth 33 of the sector gear 25, 19 is a bullet, 20 is a chamber in which that bullet 19 is fed, 21 is a cylindrical barrel through which a shot bullet 19 passes, 22 is a motor that drives and rotates the sector gear 25, 23 is a motor shaft, and 24 is a deceleration gear. The operation of these parts indicated by reference numbers 10 to 25 will be described later.

[0036] In the figure, 47 is an electronic-control circuit that comprises a microcomputer 49 and other electronic parts. Also, 27 is a battery that is used as the drive power source for the motor 22, and is the control power source for the

electronic-control circuit 47. Moreover, 28 is a motor-power-supply-control unit that turns the motor ON/OFF according to an ON/OFF instruction from the microcomputer 49, and turns ON/OFF the power supplied to the motor 22 from the battery 27. There is a switch in the motor-power-supply-control unit 28, and taking into consideration the controllability and life of the switch, a semiconductor switch is used for this switch, and particularly in this invention, power saving is taken into consideration, so an MOS-FET (MOS field-effect transistor) is used. In the figure, 29 and 30 are power lines for supplying power to the motor 22 from the battery 27. Also, 31 is a control line that transmits an ON/OFF signal from the electronic-control unit 47 to the motor-power-supply-control unit 28. Moreover, 32 is a control-circuit-housing case that houses the deceleration mechanism, which rotates the sector gear 25 to decelerate the rotation from the motor 22, and the electronic-control unit 47.

[0037] Fig. 3 is an enlarged view of the control circuit portion.

[0038] In Fig. 3, 33 is the toothed section of the sector gear 25, and 34 is the non-toothed section of the sector gear 25. The sector gear 25 has a toothed section 33 and non-toothed section 34 in this way, and the toothed section 33 meshes with the rack 18. When the rack 18 is in a position that faces the non-toothed section, the piston 12 becomes free from the sector gear 25 and is pressed toward the side of the cylinder head by the pressure of the spring 15. In the figure, 35 is a first printed circuit board for the control circuit on which the electronic-control circuit 47 is located, and 36 is a second printed circuit board for the control circuit. Also, 37 is a trigger switch, and this trigger switch 37 is turned ON by pulling the trigger 3. Moreover, 38 is signal line for transmitting signals between the first printed circuit board 35 for the control circuit and second printed circuit board 36 for the control circuit, and as shown in Fig. 5, is a conductor having enough strength for maintaining the position and shape of the first printed circuit board 35 for the control circuit and second printed circuit board 36 for the control circuit. In the figure, 39 is a photodiode that is paired with a phototransistor 44, and they form a photo detector for detecting the rotation reference position of the sector gear 25. Also, 40 is a hole for detecting the rotation reference position of the sector gear. Moreover, 41 is a bullet-detection switch for detecting whether or not there are any bullets 19 in the magazine 4. In the figure, 42 is a pressure member for the bullet-detection switch. When there are bullets 19 in the magazine 4, the bullet-detection lever 58 described above presses the pressure member 42 of the bullet-detection switch upward, and turns the bullet-detection switch 41 to the OFF state, and when there are no more bullets 19 in the magazine 4, the bullet-detection lever 58 moves downward, and a spring (elastic member not shown in the figure) presses the pressure member 42 of the bullet-detection switch downward and turns the bullet-detection switch 41 to the ON state. In the figure, 43 is a first connector mounted on the first printed circuit board 35 for the control circuit, and it is connected to a signal line from a selector switch 51 to be described later.

[0039] Fig. 4 is a sectional view of the section A-A of Fig. 3. In the figure 44 is a phototransistor and it is paired with the photodiode 39 to form a photo detector that detects the rotation reference position of the sector gear 25. As shown in Fig. 4, the photodiode 39 and phototransistor 44 face each other with the sector gear 25 in the middle, and the sector gear 25 is capable of rotating between the photodiode 39 and phototransistor 44, and when positioned at the position of the rotation reference position of the hole 40 shown in Fig. 3 for detecting the rotation reference position of the sector gear 25, light from the photodiode 39 passes through the hole 40 for detecting the rotation reference position and is received by the phototransistor 44.

[0040] In the figure, 45 and 46 are installation holes for attaching the control-circuit-housing case 32 to the gun body 1. Here, 47 indicates the electronic-control circuit.

[0041] Fig. 5 shows the external appearance of the electronic-control circuit 47. In the figure 48 is a second connector that connects to the signal line that controls the motor-power-supply-control unit 28. Also, 49 is a microcomputer. The microcomputer 49 is mounted on this electronic-control circuit 47, and it controls the shooting operation to be described later. Also mounted are the trigger switch 37, photodiode 39, phototransistor 44, bullet-detection switch 41, first connector 43, etc.

[0042] Fig. 5(a) is a bird's eye view of the overall electronic-control circuit 47. Fig. 5(b) is a front view as seen from the left front of Fig. 5(a), and Fig. 5(c) is a view as seen from the direction of the arrow B in Fig. 5(b). The electronic-control circuit 47 is positioned by fitting the side of the first printed-circuit board 35 and second printed-circuit board 36 for the control circuit in a groove 55 formed in the sidewall of the control-circuit-housing case 32 so that it slides in the groove 55. This positioning is important in order to set the relative positions of the photodiode 39, phototransistor 44 and sector gear 25.

[0043] Next, the bullet shooting operation will be explained. Fig. 6 is a drawing for explaining the operation from after the bullet 19 is set until it is shot.

In Fig. 6, the cylinder 10 comprises a cylinder head 11 on its right end section, and a piston 12 that fits inside it. A rack 18 is formed on the bottom section of the piston 12, and it is such that it meshes with the toothed section 33 of the sector gear 25. Also, one end of a spring 15 comes in contact with the bottom end 61 of the cylinder and is arranged so that the other end presses the piston head 13 toward the right. The piston head 13 is formed on the right end section of the piston 12, and when shooting a bullet 19, air in a space 62 surrounded by the cylinder 10, piston head 13 and cylinder head 11 is pushed outward in the direction of the barrel 21 from a center hole 57 in the cylinder head 11. The sector gear 25 is driven so that it decelerates the rotation of the motor 22 by way of a bevel gear on the tip end of the motor

shaft 23 and a deceleration gear 24.

[0044] Fig. 6(a) shows the state immediately after the sector gear 25 meshes with the rack 18, and shows the state immediately before the piston 12 begins moving to the left. In Fig. 6 the sector gear 25 rotates to the left. At this time, a bullet 19 is supplied from the magazine 4 (not shown in the figure) and is set inside the chamber 20 that is located between the cylinder head 11 and barrel 21. Also, a photodiode 39 and phototransistor 44 are located as shown in Fig. 6(a). At this time, a hole 40 for detecting the rotation reference position of the sector gear 25 is located as shown in Fig. 6(a), so the rotation reference position of the section gear 25 is not detected.

[0045] Fig. 6(b) shows the state of the sector gear 25 meshed with the rack 18, and furthermore shows the state of the sector gear 25 rotated against the pressure of the spring 15. At this time, the piston 12 moves to the left and a space 62 is formed between it and the cylinder head 11, and air indicated by the dashed arrow 56 is supplied to this space 62. It is not shown in Fig. 6, however, there is a check valve on the piston head 13, and when the piston 12 moves to the left side, air is supplied through this check valve as shown by the dashed arrow 56 in Fig. 6(b). The check valve (not shown in the figure) on the piston head 13 operates so that air is prevented from flowing when the piston 12 moves to the right (see Fig. 6(d)).

[0046] Fig. 6(c) shows the state when the meshing between the sector gear 25 and the rack 18 has reached the end position, and is the state immediately before the sector gear 25 rotates beyond this point and the toothed section 33 no longer meshes with the toothed section of the rack 18. Also, at this time, the hole 40 for detecting the rotation reference position of the sector gear 25 rotates to the photo detector position that is formed by the photodiode 39 and phototransistor 44, and this photo detector detects the rotation reference position of the sector gear 25. When a motor OFF signal for stopping the motor 22 is sent from the electronic-control circuit 47 to the motor-power-supply-control unit 28 according to this detection signal of the rotation reference position, the power to the motor 22 is turned OFF, and the motor decelerates and stops. When this happens, the sector gear 25 rotates a little due to the inertia of the motor 22, deceleration-gear mechanism and friction loss and stops. How much it rotates before it stops is determined according to the relationship of the actual construction, so in Fig. 6(c) how to show the positional relationship between the toothed section 33 of the sector gear 25 and the hole 40 for detecting the rotation reference position is difficult to find accurately by calculation, so it is set experimentally.

[0047] Fig. 6(d) shows the state where the sector gear 25 has stopped in this way. At this time, the non-toothed section 34 of sector gear 24 faces the rack 18, and is in a state where the sector gear 25 does not mesh with the rack 18 and is separated, and the piston 12 is released from being pressed by the sector gear 25 and rack 18, and is pressed toward the right by the pressure force of the spring 15. At this time, the air in the space 62 between the piston head 13 and the cylinder head 11 is compressed, and is discharged with great force from the center hole 57 in the cylinder head 11 in the direction of the barrel 21. This pushes the bullet 19 with great energy in the right direction through the barrel 21, and the bullet 19 is shot.

[0048] When the rotation reference position of the sector gear 25 is detected and the shooting operation is stopped in this way, it is possible to always stop the non-toothed section 34 of the sector gear 25 so that it faces the rack 18. Also, the piston 12 always returns to the starting position of the shooting operation.

[0049] Even though the rotation reference position of the sector gear 25 is detected as shown in Fig. 6(c), if the motor OFF signal for stopping the motor 22 is not sent from the electronic-control circuit 47 to the motor-power-supply-control unit 28, operation continues and the operation shown in Fig. 6 is repeated, and the shooting operation is performed.

[0050] Next, the construction of the electronic-control circuit 47 that controls the repeating mode operation will be explained.

[0051] Fig. 7 shows the control blocks of the electronic-control circuit 47. In the figure, 49 is a microcomputer. Signals from the bullet-detection switch 41, signals from the trigger switch 37, signals from the single-shot mode/repeating mode and single-shot mode/N-shot mode switch 52 and selector switch 51, and rotation-reference-position-detection signals from the rotation-reference-position-detection unit 50 of the sector gear 25 are input to the microcomputer 49, and it outputs a motor ON/OFF signal to the motor-power-supply-control unit 28 by way of an amplifier 53. In the figure, 43 and 48 described above indicate connectors. When a motor ON signal is output from the microcomputer 49, the semiconductor switch of the motor-power-supply-control unit 28 is turned ON, and the voltage from the battery 27 is applied to the motor by way of the power-supply-control unit 28, and the motor 22 operates when power is supplied, however, when a motor OFF signal is output from the microcomputer 49, power from the battery 27 is cut off by the power-supply-control unit 28 and the motor 22 stops. Also, in the figure, 50 is a rotation-reference-position-detection unit that comprises a photo detector made up of the photodiode 39, phototransistor 44, and the sector gear 25. A detailed explanation of the operation of the microcomputer 48 will be given later with reference to the flowcharts given in Fig. 9 on.

[0052] Fig. 8 will be used to explain the construction of the electronic-control circuit 47 in more detail.

[0053] In Fig. 8, 49 is a microcomputer, and it operates according to a control voltage V_{cc} that is generated from a battery. Light that is emitted from the photodiode 39 passes through the hole 40 for detecting the rotation reference position of the sector gear 25 and is received by the phototransistor 44. The output from the phototransistor 44 is amplified by an operational amplifier 54 and input to the microcomputer 49. When light emitted from the photodiode 39 passes

through the hole 40 for detecting the rotation reference position of the sector gear 25 and is received by the phototransistor 44, the phototransistor 44 is turned ON, and the output from the operational amplifier 54 also changes, and a rotation-reference-position-detection signal is obtained.

[0054] A contact signal from the trigger switch 37 is input to the microcomputer 49, making it possible to detect whether the trigger 3 has been pulled. Also, a contact signal from the bullet-detection switch 41 is input, making it possible to detect whether there are any bullets 19 in the magazine 4.

[0055] Also, the single-shot mode/repeating mode and single-shot mode/N-shot mode switch 52 is constructed so that it is possible to insert a jumper wire on the printed-circuit board of the control circuit. For example, depending on whether a jumper wire has been inserted in the switch 52, when a jumper wire has been inserted, single-shot mode/repeating mode is designated, and when a jumper wire is not inserted, it is possible to switch so that single-shot mode/N-shot mode is designated. Needless to say, distinguishing between single-shot mode/repeating mode and single-shot mode/N-shot mode according to the state of the jumper wire can be performed opposite that of the example described above.

[0056] In the figure, 51 is a selector switch and is a 3-point switch. This switch can switch to each respective contact position, 'single-shot mode', 'repeating mode' and 'safety'. Here, when 'safety' is selected, the shooting operation is not performed even when the trigger 3 is pulled.

[0057] Also, 53 is an amplifier that amplifies the motor ON/OFF signal that is output from the microcomputer 49. The output from the amplifier 53 is input to the gate of the MOS-FET of the motor-power-supply-control unit 28. The MOS-FET functions as a switch that switches the motor 22 voltage ON/OFF. Therefore, when the MOS-FET is turned ON by the motor ON signal from the microcomputer 49, voltage is applied to the motor 22 and power is supplied from the battery 27 causing the motor 22 to operate. Also, by turning OFF the MOS-FET in accordance to a motor OFF signal from the microcomputer 49, power from the battery 27 is cut off and the motor 22 stops operating. A deceleration gear 24 is formed on the output shaft of the motor 22, and it rotates and drives the sector gear 25.

(First Embodiment of Control)

[0058] Next, control flowcharts will be used to explain the bullet shooting control in detail.

[0059] Fig. 9 shows a first embodiment of control, and is a flowchart showing control of the single-shot mode operation.

[0060] First, control is started in step 100, and in step 101 a check is performed to determine whether the trigger switch 37 has been pressed. When the trigger switch 37 has not been pressed, a watchdog timer WDT is cleared in step 102, and operation returns to step 101.

[0061] When the microcomputer 49 is operating properly, this watchdog timer WDT is periodically reset in order that an error signal is not output, however, when the microcomputer 49 is not operating properly, the watchdog timer WDT is no longer reset periodically, but outputs an error signal and stops operation by causing a safety apparatus to function, etc. The timer value of the watchdog timer WDT is set to 1000 ms for example when the power to the microcomputer 49 is initially turned ON. The technology for a watchdog timer is well known, so an explanation of it will be omitted here.

[0062] In step 101, when it is detected that the trigger switch 37 has been pressed, a check is performed in step 103 to determine whether there is a bullet in the magazine 4. This check is executed by inputting the signal from the bullet-detection switch 41 to the microcomputer 49 and determining whether the signal is ON or OFF. When there is a bullet 19 in the magazine 4, the bullet-detection switch 41 is pressed upward by the pressure member 42 for the pressure-detection switch, and turns the bullet-detection switch 41 OFF.

[0063] In step 103, when it is detected that there are no bullets 19 in the magazine 4, the operation advances to step 104 and the power to the motor 22 is turned OFF. At this time, the microcomputer 49 outputs a motor OFF signal to the signal amplifier 53, and the amplifier 53 amplifies the signal and sends it to the motor-power-supply-control unit 28. The motor-power-supply-control unit 28 receives this signal, and by a switch cuts off the power that is supplied from the battery 27 to a motor 22. A semiconductor switch can be used for the switch of the motor-power-supply-control unit 28. A bipolar transistor can be used as the semiconductor switch, however, from the aspect of conserving energy, it is preferred that a MOS-FET be used. By using a MOS-FET (MOS field-effect transistor) it is possible to lengthen the life of the battery 27.

[0064] Next, operation advances to step 105, and after waiting a wait time of 20 ms, returns to step 101. This wait time is used to stabilize control, and is not limited to 20 ms.

[0065] In step 103, when it is detected that there are bullets 19 in the magazine 4, operation advances to step 106 and the motor power is turned ON. At this time, the microcomputer 49 outputs the motor-power ON signal to the signal amplifier 53, and the amplifier 53 amplifies the signal and sends it to the motor-power-supply-control unit 28. The motor-power-supply-control unit 28 receives the signal and turns the MOS-FET signal ON, and supplies power from the battery 27 to the motor 22. From this, the motor 22 starts operating and rotates the sector gear 25 by way of a deceleration mechanism such as a deceleration gear 24.

[0066] Next, in step 107, a check is performed to determine whether the rotation reference position of the sector gear

25 was detected. The rotation reference position is detected when the hole 40 for detecting the rotation reference position of the sector gear 25 passes the position where a photo detector formed by a photodiode 39 and phototransistor 44 is located, and light that is emitted from the photodiode 39 passes through the hole 40 for detecting the rotation reference position of the sector gear 25 and is received by the phototransistor 44, and then this signal is amplified by an operational amplifier 54 and input to the microcomputer 49. When the photo detector is not in the position of the hole 40 for detecting the rotation reference position of the sector 25, the phototransistor 44 does not receive light, so the rotation-reference-position-detection signal is not input to the microcomputer 49. As the motor 22 begins to operate, it is located in a rotation position as shown in Fig. 6(d) or Fig. 6(a) just before the sector gear 25 meshes with the rack 18, and since the photo detector is not in the position of the hole 40 for detecting the rotation reference position, the rotation reference position of the sector gear 25 is not detected. When the rotation reference position of the sector gear 25 is not detected, operation returns to step 106, and step 106 and step 107 are repeated until the rotation reference position of the sector gear 25 is detected.

[0067] In step 107, when the rotation reference position of the sector gear 25 is detected, operation advances to step 108, and a signal is output to turn the motor power OFF. At this time, the hole 40 for detecting the rotation reference position of the sector gear 25 is located in the position of the photo detector as shown in Fig. 6(c). At this time, the microcomputer 49 outputs the motor OFF signal to the signal amplifier 53, and the amplifier 53 amplifies the signal and sends it to the motor-power-supply-control unit 28. The motor-power-supply-control unit 28 receives this signal, and by way of a power switch, cuts off the power being supplied from the battery to the motor 22.

[0068] The motor 22 whose power is cut off does not immediately stop, but due to inertia rotates a certain amount to a position as shown in Fig. 6(d) and then stops. It is important that the stopped position of the sector gear 25 be a position where it does not mesh with the rack 18. Taking into consideration performing maintenance of the gun, it is preferred that construction be such that the gun body 1 can be opened by rotating it around the hinge 9 as shown in Fig. 10 so that the inside can be inspected, and with this invention, it is possible to stop the sector gear 25 in a position so that it does not mesh with the rack 18, so the gun can be easily opened as shown in Fig. 10. In the state where the sector gear 25 meshes with the rack 18, stress is applied to the sector gear 25 and rack 18, so the gun cannot be easily opened, however in this embodiment, this kind of state can be avoided.

[0069] The amount of rotation from after the rotation reference position of the sector gear 25 has been detected until the motor 22 stops changes according to the motor 22 inertia, friction loss of the gear mechanism, etc., however, the amount of rotation is determined to the extent that the motor 22 inertia or friction loss of the gear mechanism is determined, so the amount of rotation can be measured using a test apparatus, and the hole 40 for detecting the rotation reference position can be adjusted so that the sector gear 25 stops in a position where it does not mesh with the rack 18. Also, the stopped position changes depending on fluctuation in voltage from the battery 27, however, by detecting the battery 27 voltage and using a safety apparatus that stops operation when the voltage drops below a threshold value, it is possible to further keep the fluctuating range of the stopped position to a minimum. In regards to voltage drop of the battery 27 voltage, it is possible to install a display that will indicate that the battery 27 needs recharging just before or just when the battery voltage reaches the threshold value.

[0070] In step 108, after a signal is output to turn the motor power OFF, operation advances to step 109 and a check is performed to determine whether the trigger switch 37 is ON. When the trigger switch 37 is ON, operation advances to step 110 and the watchdog timer is reset, after which operation returns to step 109.

[0071] In step 109, when it is detected that the trigger switch 37 is OFF, operation advances to step 105, and after waiting a wait time of 20 ms, operation returns to step 101 and the operation described above continues.

[0072] With the operation shown in the flowchart described above, it is possible to perform the single-shot mode operation by pulling the trigger 3 one time, and so that the single-shot mode operation is performed in the same way the next time the trigger 3 is pulled, it is possible to perform the single-shot mode operation of shooting one bullet each time the trigger 3 is pulled one time.

[0073] With this embodiment, single-shot mode operation is stopped by detecting the rotation reference position of the sector gear 25, so it is possible to stop operation at a position where the sector gear 25 does not mesh with the rack 18. Therefore, it is possible to easily open the gun body 1 as shown in Fig. 10 and easily perform internal maintenance. Also, since it is possible to stop operation at a position where the sector gear 25 does not mesh with the rack 18, a state in which no stress is applied to the spring 15 is possible when storing the gun, and thus it is possible to suppress degradation of the elastic force of the spring 15. Moreover, since it is possible to stop operation at a position where the sector gear 25 does not mesh with the rack 18, a state in which no undesirable stress is applied to the rack 18 or piston 12 when storing the gun is possible, and thus it is possible to improve reliability of the deceleration mechanism or piston unit. Also, with this embodiment, it is possible to stop operation as soon as there are no more bullets 19 in the magazine 4, so there is no unnecessary blank shooting operation.

(Second Embodiment of Control)

[0074] Fig. 11 shows a second embodiment of control, and is a flowchart of the control for the repeating mode operation.

[0075] First, control is started in step 120, and in step 121 a check is performed to determine whether the trigger switch 37 is pressed. When the trigger switch 37 is not being pressed, then in step 122 a watchdog timer WDT is cleared and operation returns to step 121.

[0076] In step 121, when it is detected that the trigger switch 37 is being pressed, then in step 123 a check is performed to determine whether there are bullets 19 in the magazine 4. This check is executed by inputting a signal from the bullet-detection switch 41 to the microcomputer 49 and checking whether the signal is ON or OFF. When there are bullets 19 in the magazine 4, the pressure member 42 for the bullet-detection switch pushes the bullet-detection switch 41 upward so that the switch is OFF.

[0077] In step 123 when it is detected that there are no bullets 19 in the magazine 4, operation advances to step 124 and the power to the motor 22 is turned OFF. At this time, the microcomputer 49 outputs a motor-OFF signal to the signal amplifier 53, and the amplifier 53 amplifies the signal and sends it to the motor-power-supply-control unit 28. The motor-power-supply-control unit 28 receives the signal, and by way of a MOS-FET, cuts off the power that is supplied to the motor 22 from the battery 27.

[0078] Next, operation advances to step 125, and after waiting a wait time of 20 ms, operation returns to step 121. This wait time is for stabilizing control and is not limited to 20 ms.

[0079] In step 123 when it is detected that there are bullets 19 in the magazine 4, operation advances to step 126 and the power to the motor is turned ON. At this time, the microcomputer 49 outputs a motor-ON signal to the signal amplifier 53, and the amplifier 53 amplifies the signal and sends it to the motor-power-supply-control unit 28. The motor-power-supply-control unit 28 receives the signal, and turns ON the MOS-FET to supply power from the battery 27 to the motor 22. By doing this, the motor 22 begins to operate and turns the sector gear 25 by way of a deceleration mechanism comprising the motor shaft 23 and deceleration gear 24.

[0080] Next, in step 127 a check is performed to determine whether the rotation reference position of the sector gear 25 has been detected. When the rotation reference position of the sector gear 25 has not been detected, operation returns to the beginning of step 127, and step 127 is repeated until the rotation reference position of the sector gear 25 is detected.

[0081] In step 127, when the rotation reference position of the sector gear 25 is detected, operation advances to step 128, and in step 128 when the trigger switch 37 is not ON, operation advances to step 129 and outputs a signal to turn the motor power OFF. At this time, the hole 40 for detecting the rotation reference position of the sector gear 25 is located in the position of the photo detector as shown in Fig. 6(c). At this time, the microcomputer 49 outputs a motor-OFF signal to the signal amplifier 53, and the amplifier 53 amplifies the signal and sends it to the motor-power-supply-control unit 28. The motor-power-supply-control unit 28 receives the signal, and by way of a power switch, cuts off the power that is supplied to the motor 22 from the battery 27.

[0082] In step 129, after outputting a signal to turn the motor power OFF, operation advances to step 125, and after waiting a wait time of 20 ms, operation advances to step 121 and the operation described above continues.

[0083] In step 128, when the trigger switch 37 is ON, operation advances to step 130, and a check is performed to determine whether there are any bullets 19 in the magazine 4. When it is detected that there are bullets 19 in the magazine 4, operation advances to step 131, the watchdog timer WDT is cleared, and operation returns to step 127.

[0084] In step 130, when it is detected that there are no bullets 19 in the magazine 4, operation advances to step 129 and turns the power to the motor 22 OFF. In step 129, after outputting a signal to turn the motor power OFF, operation advances to step 125, and after waiting a wait time of 20 ms, operation returns to step 101, after which the operation described above continues.

[0085] With this embodiment, it is possible to shoot bullets 19 continuously while the trigger 3 is pulled, and by releasing the trigger 3 to stop the shooting operation, after the trigger 3 is released, the rotation reference position of the sector gear 25 is detected and the stop operation starts. Therefore, the final stopped position of the repeating mode operation can be controlled with good precision in the same way as in the single-shot mode operation of the first embodiment, and it is possible to always have the sector gear 25 stop in a state where it does not mesh with the rack 18.

[0086] Therefore, as in the first embodiment, it is possible to easily open the gun body 1 as shown in Fig. 10, and to easily perform internal maintenance. Also, it is possible to stop operation at a position where the sector gear 25 does not mesh with the rack 18, so when storing the gun, a state in which there is no stress applied to the spring 15 is possible, and thus it is possible to suppress degradation of the elastic force of the spring 15. Moreover, since it is possible to stop operation at a position where the sector gear 25 does not mesh with the rack 18, a state in which no undesirable stress is applied to the rack 18 or piston 12 when storing the gun is possible, and thus it is possible to improve reliability of the deceleration mechanism or piston unit. Also, with this embodiment, it is possible to stop operation as soon as there are no more bullets 19 in the magazine 4, so there is no unnecessary blank shooting operation.

(Third embodiment of control)

[0087] Fig. 12 shows a third embodiment of control, and is a flowchart for N-shot mode control that is performed when performing the repeating mode operation N times. N can be any arbitrary positive integer 2 or greater. The inventors manufactured a gun with N as 3, however it is not limited to this.

[0088] First, control is started in step 140, and in step 141 a check is performed to determine whether the trigger switch 37 is being pressed. When the trigger switch 37 is not being pressed, then in step 122, the watchdog timer WDT is cleared and operation returns to step 121.

[0089] In step 141, when it is detected that the trigger switch 37 is being pressed, then in step 143 a check is performed to determine whether there are bullets in the magazine 4. This check is executed by inputting a signal from the bullet-detection switch 41 to the microcomputer 49, and checking whether this signal is ON or OFF. When there are bullets 19 in the magazine 4, the pressure member 42 for the bullet-detection switch pushes the bullet-detection switch 41 upward to turn the switch OFF.

[0090] In step 143, when it is detected that there are no bullets 19 in the magazine 4, operation advances to step 144, and the power to the motor 22 is turned OFF. At this time, the microcomputer 49 outputs a motor-OFF signal to the signal amplifier 53, and the amplifier 53 amplifies the signal and sends it to the motor-power-supply-control unit 28. The motor-power-supply-control unit 28 receives this signal, and by way of a MOS-FET, cuts off the power being supplied to the motor 22 from the battery 27.

[0091] Next, operation advances to step 145, and after waiting a wait time of 20 ms, operation returns to step 141. This wait time is for stabilizing control and is not limited to 20 ms.

[0092] In step 143, when it is detected that there are bullets 19 in the magazine 4, operation advances to step 146, and a counter CNT1 is set to N. N is the number of shootings, and is a positive integer 2 or greater.

[0093] Next, operation advances to step 147, and the motor power is turned ON. At this time, the microcomputer 49 outputs a motor-ON signal to the signal amplifier 53, and the amplifier 53 amplifies the signal and sends it to the motor-power-supply-control unit 28. The motor-power-supply-control unit 28 receives this signal and turns ON the MOS-FET, and supplies power from the battery 27 to the motor 22. By doing this, the motor 22 begins to operate, and rotates the sector gear 25 by way of a deceleration mechanism that comprises a motor shaft 23, deceleration gear 24 or the like.

[0094] Next, in step 148, a check is performed to determine whether the rotation reference position of the sector gear 25 has been detected. When the rotation reference position of the sector gear 25 is not detected, operation returns to the start of step 148, and step 148 is repeated until the rotation reference position of the sector gear 25 is detected.

[0095] In step 148, when the rotation reference position of the sector gear 25 is detected, operation advances to step 149, and in step 149 a check is performed to determine whether there are bullets 19 in the magazine 4. When it is detected that there are no bullets 19 in the magazine 4, operation advances to step 129 and the power to the motor 22 is turned OFF. In step 129, after a signal to turn the motor power OFF is output, operation advances to step 125, and after waiting a wait time of 20 ms, operation returns to step 101 and the operation described above continues.

[0096] In step 149, when it is detected that there are bullets 19 in the magazine 4, operation advances to step 151, and 1 is subtracted from the value of the counter CNT1. Next, a check is performed to determine whether the result became 0 after 1 was subtracted. If the value is not 0, operation returns to step 148 and processing from step 148 to step 151 is repeated until the value becomes 0.

[0097] In step 151, when it is detected that the value of the counter CNT1 has become 0, operation advances to step 152 and the power to the motor 22 is turned OFF.

[0098] Next, operation advances to step 153, and when the trigger switch 37 is ON, the watchdog timer WDT is cleared and operation returns to the beginning of step 153.

[0099] When the trigger switch 37 is not ON, operation advances to step 145, and after waiting a wait time of 20 ms, operation returns to step 141, and the operation described above continues.

[0100] With this embodiment, it is possible to perform repeating mode an arbitrary number of times N, and by releasing the trigger 3 during N-shot mode, it is possible to stop the N-shot mode operation. Also, in the same way as in the single-shot mode operation of the first embodiment, the last operation is capable of detecting the rotation reference position of the sector gear 25 and stopping. Therefore, as in the case of the single-shot mode operation of the first embodiment, it is possible to accurately control the final stopping position of the N-continuous operation, and it is possible for the sector gear 25 to always stop in a state in which it does not mesh with the rack 18. Moreover, as in the first embodiment, it is possible to easily open the gun body 1 as shown in Fig. 10, and to easily perform internal maintenance. Also, it is possible to stop operation at a position where the sector gear 25 does not mesh with the rack 18, so when storing the gun, a state in which there is no stress applied to the spring 15 is possible, and thus it is possible to suppress degradation of the elastic force of the spring 15. Moreover, since it is possible to stop operation at a position where the sector gear 25 does not mesh with the rack 18, a state in which no undesirable stress is applied to the rack 18 or piston 12 when storing the gun is possible, and thus it is possible to improve reliability of the deceleration mechanism or piston unit. Also, with this embodiment, it is possible to stop operation as soon as there are no more bullets 19 in the magazine 4,

so there is no unnecessary blank shooting operation.

(Fourth Embodiment of Control)

[0101] Fig. 13 shows a fourth embodiment of control in which it is possible to switch operation between single-shot mode and repeating mode. The single-shot mode operation is based on the first embodiment, and the repeating mode operation is based on the second embodiment.

[0102] First, control is started in step 160, then in step 161 a check is performed to determine whether the trigger switch 37 is being pressed. When the trigger switch 37 is not being pressed, in step 162, the watchdog timer WDT is cleared and operation returns to step 161.

[0103] In step 161, when it is detected that the trigger switch 37 is being pressed, then in step 163 a check is performed to determine whether there are any bullets 19 in the magazine 4. This check is executed by inputting a signal from the bullet-detection switch 41 to the microcomputer 49, and checking whether this signal is ON or OFF.

[0104] In step 163, when it is detected that there are no bullets 19 in the magazine 4, operation advances to step 164, and the power to the motor 22 is turned OFF. At this time, the microcomputer 49 outputs a motor-OFF signal to the signal amplifier 53, and the amplifier amplifies the signal and sends it to the motor-power-supply-control unit 28. The motor-power-supply-control unit 28 receives the signal, and by way of a MOS-FET, cuts off the power being supplied to the motor 22 from the battery 27.

[0105] Next, operation advances to step 165, and after waiting a wait time of 20 ms, operation returns to step 161. This waiting time is for stabilizing control, and is not limited to 20 ms.

[0106] In step 163, when it is detected that there are bullets 19 in the magazine 4, operation advances to step 166, and a check is performed to determine whether the operation is single-shot mode or repeating mode.

[0107] Switching between single-shot mode and repeating mode is performed by a selector switch 51. The selector switch 51 is located on the side surface of the gun body 1 as shown in Fig. 1. As shown in Fig. 8, the selector switch 51 is a switch that has contacts on a single-shot mode side, repeating mode side and safety side, and when it is switched to the single-shot mode side, +5V is input to the microcomputer 49, and when it is switched to the repeating mode side, -5V is input to the microcomputer 49, and when it is switched to the safety side, 0V is input to the microcomputer 49. From these three values, the microcomputer 49 determines whether operation is single-shot mode or repeating mode. Shooting is not performed when set to the safety side. Needless to say, the combinations of these three values are not limited to those of this embodiment.

In step 166, when it is determined that the operation is single-shot mode, operation advances to step 167. Step 167 performs processing of the single-shot mode operation of block S1 indicated by the dashed line in Fig. 9. When leaving step 167, operation returns to step 165, and after waiting a wait time of 20 ms, operation returns to step 161, and the operation described above continues.

[0108] In step 166, when it is determined that operation is repeating mode, operation advances to step 168. Step 168 performs processing of the repeating mode operation of block C1 indicated by the dashed line in Fig. 11. When leaving step 168, operation advances to step 165, and after waiting a wait time of 20 ms, operation returns to step 161 and the operation described above continues.

[0109] With this embodiment, it is possible to easily switch between single-shot mode and repeating mode operation. Also, since the single-shot mode operation is based on the first embodiment 1, and the repeating mode operation is based on the second embodiment, at the end of either the single-shot mode or repeating mode operation, the rotation reference position of the sector gear 25 is detected, and operation stops. Therefore, it is possible to obtain the effect of both the first and second embodiments.

(Fifth Embodiment of Control)

[0110] Fig. 14 shows a fifth embodiment of control in which it is possible to switch operation between single-shot mode and N-shot mode operation. The single-shot mode operation is based on the first embodiment and the N-shot mode operation is based on the third embodiment. The operation flow shown in Fig. 14 is similar to that of the fourth embodiment shown in Fig. 13. It differs in that in the third embodiment shown in Fig. 13, step 166 determines whether operation is single-shot mode or repeating mode, and step 168 executes the repeating mode process of block C1 indicated by the dashed line in Fig. 11, however, in this embodiment shown in Fig. 14, step 186 determines whether operation is single-shot mode or N-shot mode, and step 188 executes the N-shot mode process of block N1 indicated by the dashed line in Fig. 12. The switching judgment for determining whether operation is single-shot mode or N-shot mode in step 186 is executed by inputting the switching state of the selector switch 51 to the microcomputer 49. The other processing is the same as that shown in Fig. 13. In other words, steps 160 to 165 and step 167 correspond to steps 180 to 185 and step 187, respectively.

[0111] With this embodiment it is possible to easily switch between single-shot mode operation and N-shot mode

operation. Also, the single-shot mode operation is based on the first embodiment and the N-shot mode operation is based on the third embodiment, so after the single-shot mode or N-shot mode operation is complete, the rotation reference position of the sector gear 25 is detected and operation stops. Therefore, it is possible to also obtain the same effects as in the first and third embodiments.

(Sixth Embodiment of Control)

[0112] Fig. 15 shows a sixth embodiment of control in which it is possible to switch operation among single-shot mode, repeating mode and N-shot mode operation. The single-shot mode operation is based on the first embodiment, the repeating mode operation is based on the second embodiment, and the N-continuous operation is based on the third embodiment. In the operation flow shown in Fig. 15, first operation is determined to be either single-shot mode and repeating mode operation, or single-shot mode and N-shot mode operation, then depending on the result, the single-shot mode and repeating mode operation of embodiment four is performed as shown by block A1 in Fig. 13, or the single-shot mode and N-shot mode of the fifth embodiment is performed as shown by block B1 in Fig. 14.

[0113] First, control starts in step 190, and in step 191 a check is performed to determine whether the operation is single-shot mode and repeating mode, or single-shot mode and N-shot mode. This is performed by inputting a signal from the single-shot mode and repeating mode/single-shot mode and N-shot mode selection unit 52 shown in Fig. 7 or Fig. 8 to the microcomputer 49, and determining the set state. In step 191, when it is determined that operation is single-shot mode and repeating mode, operation advances to step 192, and the single-shot mode and repeating mode operation of embodiment 4 shown by block A1 in Fig. 13 is performed. In step 191, when it is determined that operation is single-shot mode and N-shot mode, operation advances to step 193, and the single-shot mode and N-shot mode operation of embodiment 5 shown by block B1 in Fig. 14 is performed. Determining in block A1 or block B1 whether operation is single-shot mode or repeating mode is performed by the microcomputer 49 determining the state of the selection switch 51 the same way as in embodiments 4 and 5.

[0114] With this embodiment, ultimately it is possible to switch operation among single-shot mode, repeating mode and N-shot mode. Also, since the single-shot mode operation is based on the first embodiment, the repeating mode operation is based on the second embodiment and the N-shot mode operation is based on the third embodiment, regardless of whether single-shot mode, repeating mode or N-shot mode is selected, operation ends by detecting the rotation reference position of the sector gear 25 and stopping. Therefore, it is possible to obtain the effect of the first thru fifth embodiments as well.

(Seventh Embodiment of Control)

[0115] Fig. 16 shows a seventh embodiment of control in which it is possible to switch operation among single-shot mode, repeating mode, and N-shot mode. The aspect that the single-shot mode operation is based on the first embodiment, the repeating mode operation is based on the second embodiment and the N-shot mode operation is based on the third embodiment is the same as in the sixth embodiment.

[0116] In the operation flow shown in Fig. 16, first a check is performed to determine the ON/OFF state of the trigger switch 37, and a check is performed to determine whether there are any bullets 19 in the magazine 4, and then switching is performed to select the single-shot mode, repeating mode or N-shot mode operation.

[0117] First, control starts in step 200, and in step 201 a check is performed to determine whether the trigger switch 37 is being pressed. When the trigger switch 37 is not being pressed, in step 202 the watchdog timer WDT is cleared and operation returns to step 201.

[0118] In step 201 when it is detected that the trigger switch 37 is being pressed, then in step 203 a check is performed to determine whether there are any bullets 19 in the magazine 4. This check is performed by inputting a signal from the bullet-detection switch 41 to the microcomputer 49 and determining whether the signal is ON or OFF.

[0119] In step 203, when it is detected that there are no bullets 19 in the magazine 4, operation advances to step 204 and power to the motor 22 is turned OFF.

[0120] Next, operation advances to step 205, and after waiting a wait time of 20 ms, operation returns to step 101.

[0121] In step 203, when it is detected that there are bullets 19 in the magazine 4, operation advances to step 206 and a check is performed to determine which of single-shot mode, repeating mode and N-shot mode is selected. This is executed by determining the switching state of a 3-contact selection switch (not shown in the figure). Depending on the determination result in step 206, the processing of step 207, 208 or 209 is executed. Step 207 is the processing of block S1 shown by the dashed line in Fig. 9, step 208 is the processing of block C1 shown by the dashed line in Fig. 11, and step 209 is the processing of block N1 shown by the dashed line in Fig. 12.

[0122] The operation flow shown in Fig. 16 is simplified so that processing of checking of the ON/OFF state of the trigger switch 37, and the determining whether there are bullets 19 in the magazine 4 that is common in the embodiments 1 to 3 are lumped together. Also, in the operation flow shown in Fig. 15, the aspect of switching among the single-shot

mode, repeating mode and N-shot mode operation is the same as in the sixth embodiment. In the sixth embodiment, single-shot mode and repeating mode were handled as one large block, and single-shot mode and N-shot mode were handled as another large block, and in the case of this method of handling, operation was selected by using a single-shot mode and repeating mode/single-shot mode and N-shot mode selection unit 52 and selection switch 51 as shown in Fig. 7 or Fig. 8. However, in this seventh embodiment single-shot mode, repeating mode or N-shot mode operation is selected by a 3-contact switch, which is preferable. Also, the switch for determining switching can be one 3-contact switch that switches among the single-shot mode, repeating mode and N-shot mode operation.

[0123] With this seventh embodiment, ultimately it is possible to switch operation among single-shot mode, repeating mode or N-shot mode. Also, since the single-shot mode operation is based on the first embodiment, the repeating mode operation is based on the second embodiment and the N-shot mode operation is based on the third embodiment, regardless of whether single-shot mode, repeating mode or N-shot mode is selected, operation ends by detecting the rotation reference position of the sector gear 25 and stopping. Therefore, it is possible to obtain the effect of the first thru fifth embodiments as well.

(Eighth Embodiment of Control)

[0124] Fig. 17 shows an eighth embodiment of control in which it is possible to switch among single-shot mode, repeating mode and N-shot mode operation. The aspect that the single-shot mode operation is based on the first embodiment, the repeating mode operation is based on the second embodiment and the N-shot mode operation is based on the third embodiment is the same as in embodiments 6 and 7.

[0125] In the operation flow shown in Fig. 17, repeating mode and N-shot mode are first lumped together as repeating mode and separated from single-shot mode, and then repeating mode and N-shot mode are separated.

[0126] First, control starts in step 220, then in step 221 a check is performed to determine whether the trigger switch 37 is being pressed. When the trigger switch 37 is not being pressed, then in step 222 the watchdog timer WDT is cleared and operation returns to step 221.

[0127] In step 221, when it is detected that the trigger switch 37 is being pressed, then in step 223 a check is performed to determine whether there are any bullets 19 in the magazine 4. This check is executed by inputting a signal from the bullet-detection switch 41 to the microcomputer 49 and determining whether the signal is ON or OFF.

[0128] In step 223, when it is detected that there are no bullets 19 in the magazine 4, operation advances to step 224 and the power to the motor 22 is turned OFF.

[0129] Next, operation advances to step 225, and after waiting a wait time of 20 ms, operation returns to step 221.

[0130] In step 223 when it is detected that there are bullets 19 in the magazine 4, operation advances to step 226 and determines whether the operation is single-shot mode or repeating mode/N-shot mode. This determination can be executed by using a selector switch as in Fig. 7 and Fig. 8 and having the microcomputer 49 determine the switching state.

[0131] In step 226, when operation is determined to be single-shot mode, operation advances to step 227 and the processing block S1 shown by the dashed line in Fig. 9 is executed. This is the processing flow for performing the single-shot mode operation.

[0132] In step 226, when operation is determined to be repeating mode/N-shot mode, operation advances to step 228, and a check is performed to determine whether operation is repeating mode or N-shot mode. This check is performed by using the single-shot mode/repeating mode and single-shot mode/N-shot mode switch 52 shown in Fig. 7 and Fig. 8 and having the microcomputer 49 determine the switching state. In step 228, when operation is determined to be repeating mode, operation advances to step 229 and the processing of block C1 shown by the dashed line in Fig. 11 is executed. This is the processing flow that performs the repeating mode operation. Also, in step 228, when operation is determined to be N-shot mode, operation advances to step 230 and the processing of block N1 shown in Fig. 12 is executed. This is the processing flow that performs the N-shot mode operation.

[0133] As in the case of the seventh embodiment, in this eighth embodiment operation flow is simplified so that processing of checking the ON/OFF state of the trigger switch 37 and checking whether there are any bullets 19 in the magazine 4, which is common with other embodiments, are lumped together and performed.

[0134] With this eighth embodiment, ultimately it is possible to switch operation among single-shot mode, repeating mode or N-shot mode. Also, since the single-shot mode operation is based on the first embodiment, the repeating mode operation is based on the second embodiment and the N-shot mode operation is based on the third embodiment, regardless of whether single-shot mode, repeating mode or N-shot mode is selected, operation ends by detecting the rotation reference position of the sector gear 25 and stopping. Therefore, it is possible to obtain the effect of the first thru fifth embodiments as well.

(Ninth Embodiment of Control)

[0135] Figs. 18 to 20 show a ninth embodiment of control. Operation will be explained with reference to the drawings.

[0136] Control starts in step 240 shown in Fig. 18, after which operation advances to step 241 to perform initial setting. Here, the initial value of the watchdog timer that will be used in the following processing is set to 1000 ms, and processing is performed to turn the power to the motor 22 OFF. As previously stated, the initial value of the watchdog timer is not limited to 1000 ms. Moreover, the reason for performing the process of turning the power to the motor 22 at the beginning is to first set the motor 22 in a stopped state.

[0137] Next, operation advances to step 242 and a check to determine whether the operation is single-shot mode/repeating mode, or single-shot mode/N-shot mode is performed. This check is performed by using the single-shot mode/repeating mode and single-shot mode/N-shot mode switch 52, and having the microcomputer 49 determine the switching state.

[0138] In step 242, when operation is determined to be single-shot mode/repeating mode, operation advances to step 243 shown in Fig. 19. In step 243, a check is performed to determine whether the trigger switch 37 is being pressed. When the trigger switch 37 is not being pressed, in step 244 the watchdog timer WDT is cleared and operation advances to step 243.

In step 243 when it is detected that the trigger switch 37 is being pressed, operation advances to step 245 and a check is performed to determine whether operation is single-shot mode or repeating mode. This check can be executed by inputting the switching state of the selector switch 51 to the microcomputer 49. In step 245, when it is determined that operation is single-shot mode, operation advances to step 246 and a check is performed to determine whether there are any bullets 19 in the magazine 4. This check is performed by inputting a signal from the bullet-detection switch 41 to the microcomputer 49, and determining whether the signal is ON or OFF. When there are bullets 19 in the magazine 4, the pressure member 42 for the bullet-detection switch pushes the bullet-detection switch 41 and turns the switch ON.

[0139] In step 246, when it is detected that there are no bullets 19 in the magazine 4, operation advances to step 249 and the power to the motor 22 is turned OFF.

[0140] Next, operation advances to step 248, and after waiting a wait time of 20 ms, operation returns to step 243.

[0141] In step 246, when it is detected that there are bullets 19 in the magazine 4, operation advances to step 247. This step 247 indicates the single-shot mode process of block S1 shown by the dashed line in Fig. 9. After leaving the processing of step 247, operation advances to step 248, and after waiting a wait time of 20 ms, operation returns to step 243.

[0142] In step 245, when operation is determined to be repeating mode, operation advances to step 250 and a check is performed to determine whether there are any bullets 19 in the magazine 4. In step 250, when it is detected that there are no bullets 19 in the magazine 4, operation advances to step 249 and the power to the motor 22 is turned OFF, after which operation advances to step 248, and after waiting a wait time of 20 ms, operation returns to step 243.

[0143] In step 250, when it is detected that there are bullets 19 in the magazine 4, operation advances to step 251. This step 251 is the repeating mode process of block C1 shown by the dashed line in Fig. 11. After leaving the processing of step 251, operation advances to step 248, and after waiting a wait time of 20 ms, operation returns to step 243.

(Tenth Embodiment of Control)

[0144] Fig. 21 and Fig. 22 show a tenth embodiment of control in which it is possible to count the number of bullets that have been shot.

[0145] Fig. 21 is a drawing in which a counter is used in the single-shot mode operation flow shown in Fig. 9 that counts the number of bullets 19 that have been shot. Similarly, it is possible to use a counter in the repeating mode operation flow shown in Fig. 11, and in the N-shot mode operation flow shown in Fig. 12. The counter in the case of repeating mode and N-shot mode is the same as that shown in Fig. 21, so no drawings are provided. Moreover, Fig. 22 shows a flowchart of the process for counting the number of bullets 19 that have been shot in single-shot mode, repeating mode or N-shot mode. Operation will be explained below with reference to Fig. 21 and Fig. 22.

[0146] In Fig. 21 the same reference numbers will be used for parts that are the same as in Fig. 9.

[0147] First, control starts in step 100, and in step 300 the value n1 of the counter C2 is reset to 0. Next, operation advances to step 101, and processing up to step 107 is the same as in the first embodiment shown in Fig. 9. Also, in step 107 a check is performed for determining whether the rotation reference position of the sector gear 25 has been detected.

[0148] In step 107, when the rotation reference position of the sector gear 25 is detected, operation advances to step 301. Here, 1 is added to the value n1 of the counter C2. In the case of single-shot mode, only one bullet 19 has been shot, so the value n1 of the counter C2 becomes $n1 = 0 + 1$.

[0149] Next, operation advances to step 108 and outputs a signal to turn the power to the motor 22 OFF. Passing steps 109, 110 and 105, operation returns to step 101.

[0150] Furthermore, when the trigger switch is ON, the operation described above is repeated, and 1 is further added to the value n1 of the counter C2 so that $n1 = 1 + 1 = 2$.

[0151] Each time the trigger switch 37 goes ON and a bullet 19 is shot, the value n1 of the counter C2 is counted up.

In other words, after a bullet 19 is shot, correspondingly the value n_1 of the counter C2 is counted up.

[0152] Similarly, in the case of repeating mode, it is possible to count the number of bullet 19 that have been shot. In other words, taking the counter to be C3 in the case of repeating mode, as shown in Fig. 21, after step 120 in Fig. 11, the counter C3 is reset to 0, and after step 127, the value of the counter C3 is counted up one at a time. This case is for repeating mode, so the loop from step 127 to step 131 is continued and bullets 19 are shot, and each time the process goes through step 127, the counter counts up by 1. Therefore, it is possible to accurately count the number of bullets 19 that were continuously shot.

[0153] Also, similarly, in the case of N-shot mode as well, it is possible to count the number of bullets that have been shot. In other words, by taking the counter in the case of N-shot mode to be C4, as shown in Fig. 21, after step 140 in Fig. 12, the counter C4 is reset to 0, and after step 148, the value of the counter C4 is counted up 1 at a time. This case is for N-shot mode, so the loop from step 127 to step 131 is continued and bullets 19 are shot, and each time the process goes through step 127, the counter counts up by only 1, and the number is counted up until it reaches a maximum of N shots shot. Therefore, it is possible to accurately count the number of bullets 19 that were continuously shot in the case of N-shot mode.

[0154] The embodiment shown in Fig. 22 is another form of embodiment 7 of single-shot mode, repeating mode and N-shot mode shown in Fig. 16, in which the total number of bullets 19 shot in single-shot mode, repeating mode or N-shot mode operation is found and displayed.

[0155] First, control starts in step 200, and in step 400 the values n_1 , n_2 and n_3 of the counters C2, C3 and C4 are reset to 0. Next, operation advances to step 201 and the process to step 406 is the same as in the seventh embodiment shown in Fig. 16. In step 206 a check is performed to determine which of single-shot mode, repeating mode and N-shot mode is selected, and then the processing of steps 401, 402 and 403 is executed. Step 401 is the processing of block S2 shown by the dashed line of Fig. 21. Step 402 is a process in which the counter C3 is used in the repeating mode operation previously explained, and step 403 is a process in which the counter C4 is used in the N-shot mode operation previously explained, and more specifically, C2 is the block C1 in Fig. 11 in which the counter C3 is inserted after step 127, and N2 is the block N1 shown in Fig. 12 in which the counter C4 is inserted after step 148.

[0156] After passing the processing of steps 401 to 403, step 404 is executed. Step 404 calculates and displays the total of n_1 to n_3 that were counted by the counters C2 to C4 in steps 401 to 403. The display is not shown in the figure, however, it can be easily made using control technology that uses a normal microcomputer, for example a liquid-crystal display or the like can be used, and it is possible to use this liquid-crystal display to display the total value of the number of bullets 19 shot. In this embodiment, separate counters were used for single-shot mode, repeating mode and N-shot mode, making it possible to perform counting for single-shot mode, repeating mode and N-shot mode, respectively, however, it is also possible to perform counting using a common counter. In this case, regardless of the route, single-shot mode, repeating mode or N-shot mode passed, the total value for single-shot mode, repeating mode and N-shot mode is counted. Step 404 is not necessary in this case, and it is possible for step 400 to just reset the common counter.

[0157] Also, the count value described above counted the number of bullets 19 shot, however, by initially setting the number bullets 19 loaded and counting down as the bullets 19 are shot, it is possible to know how many bullets 19 are remaining. In this case, it is possible to input a numerical value, however, since the number of new bullets 19 in a magazine 4 is known, by detecting that value when a magazine is set, it is possible to automatically set that value as the initial value of the number of bullets 19. When the initial value is set, then the initial value when a new magazine 4 is set is stored in internal memory. Also, when it is desired to set an arbitrary value as the initial setting, it is possible to use key input for entering numerical values. This key input is not shown in the figures, however, could be easily formed by using control technology that uses a normal microcomputer.

[0158] In the tenth embodiment described above, the means of counting the number of bullets 19 shot was performed by having the photo detector count the number of times the rotation reference hole on the sector gear 25 passes, however, the means of counting is not limited to this. For example, it is possible to perform the same counting by counting the movement of the piston 12 or hammer that goes through one cycle in correspondence to the operation of shooting one bullet 19.

[0159] It is preferred that the ON/OFF state of the trigger switch 37, bullet-detection switch 41, selector switch 51 and single-shot mode/repeating mode and single-shot mode/N-shot mode switch 52 explained in the various embodiments above be determined according to the fail-safe means, however it is not limited to this. The ON/OFF states can be opposite this, and what is important is that it be possible to determine the switch state.

[0160] Also, the electronic-control circuit and control flow are not limited to that explained above, and can be changed within the main scope of the invention.

Also, in the explanation above, a free run stop occurred after the rotation reference position of the sector gear 25 was detected. This means was used because inexpensive construction of the invention was taken into consideration, however if expensive construction is allowable, it is also possible to employ a servomotor as the means for positioning the sector gear 25.

[0161] Moreover, as mentioned above, it is possible for the value N in N-shot mode to be set to any arbitrary positive

integer 2 or greater. The invention manufactured a gun with N as 3, however the invention is not limited to this.

Industrial Applicability

- 5 **[0162]** This invention can be used in the place of a real gun for shooting practice or maintenance training. Also, it can be used as a model gun for a toy.
- [0163]** Also, with this invention, there is the effect in the repeating mode operation of being possible to easily control how many shoots are shot.
- 10 **[0164]** Moreover, with this invention there is the effect of easily being able to switch among single-shot mode, repeating mode and N-shot mode operation.
- [0165]** Furthermore, operation is stopped by detecting a reference position, so it is possible to always stop at a specified position.

15 Claims

1. An air gun that uses compressed air generated by a piston to shoot bullets, comprising:
 - 20 a means that makes it possible to arbitrarily set the maximum number of times bullets are shot when a trigger switch is switched ON one time;
 - a means for counting said number of times bullets are shot; and
 - a means for stopping the shooting operation when the count value of said counter reaches said maximum value.
2. An air gun that uses compressed air generated by a piston to shoot bullets, comprising:
 - 25 a reference position for a shooting operation that is located on a drive system that drives said piston;
 - a means for starting the shooting operation when a trigger switch is switched ON;
 - a means for stopping said shooting operation when said reference position is detected; and
 - 30 a means for preventing said shooting operation after shooting is stopped by said means for stopping said shooting operation, even when the ON state of said trigger switch continues.
3. The air gun of claim 2 wherein each time said trigger switch becomes ON, the operation of claim 2 is repeated.
4. An air gun that uses compressed air generated by a piston to shoot bullets, comprising:
 - 35 a reference position for a shooting operation that is located on a drive system that drives said piston;
 - a means for starting the shooting operation when a trigger switch is switched ON; and
 - a means for stopping said shooting operation when said reference position is detected and said trigger switch is OFF.
 - 40
5. An air gun that uses compressed air generated by a piston to shoot bullets, comprising:
 - a means that makes it possible to arbitrarily set the maximum number of times bullets are shot when a trigger switch is switched ON one time.
 - 45
6. An air gun that uses compressed air generated by a piston to shoot bullets, comprising:
 - a reference position for a shooting operation that is located on a drive system that drives said piston;
 - a counter means that makes it possible to arbitrarily set the maximum number of times bullets are shot to a specified value N when a trigger switch is switched ON one time;
 - 50 a means for starting the shooting operation when the trigger switch is switched ON;
 - a subtraction means for subtracting 1 from said set maximum value N when said reference position is detected; and
 - a means for stopping said shooting operation when the subtraction result of said subtraction means becomes 0 and said reference position is detected.
 - 55
7. An air gun that uses compressed air generated by a piston to shoot bullets, comprising:

a reference position for a shooting operation that is located on a drive system that drives said piston;
 a single-shot mode shooting means for starting a shooting operation when a trigger switch is switched ON,
 stopping said shooting operation when said reference position is detected, and preventing said shooting operation after said shooting operation is stopped, even when the ON state of said trigger switch continues;
 5 a repeating mode shooting means for starting the shooting operation when said trigger is switched ON, and
 stopping said shooting operation when said reference position is detected and said trigger switch becomes
 OFF; and
 a switching means for selecting and operating either said single-shot mode shooting means or said repeating
 10 mode shooting means.

8. An air gun that uses compressed air generated by a piston to shoot bullets, comprising:

a reference position for a shooting operation that is located on a drive system that drives said piston;
 a single-shot mode shooting means for starting a shooting operation when a trigger switch is switched ON,
 15 stopping said shooting operation when said reference position is detected, and preventing said shooting operation after said shooting operation is stopped, even when the ON state of said trigger switch continues;
 an N-shot mode shooting means for setting the maximum number of times bullets are shot when the trigger
 switch is switch ON one time, starting the shooting operation when said trigger switch is switched ON, subtracting
 20 1 from said set maximum value N when said reference position is detected, and stopping the shooting operation
 when the subtraction result becomes 0 and when said reference position is detected; and
 a switching means for selecting and operating either said single-shot mode shooting means or said N-shot
 mode shooting means.

9. An air gun that uses compressed air generated by a piston to shoot bullets, comprising:

a reference position for a shooting operation that is located on a drive system that drives said piston;
 a single-shot mode shooting means for starting a shooting operation when a trigger switch is switched ON,
 stopping said shooting operation when said reference position is detected, and preventing said shooting operation after said shooting operation is stopped, even when the ON state of said trigger switch continues;
 30 a repeating mode shooting means for starting the shooting operation when said trigger is switched ON, and
 stopping said shooting operation when said reference position is detected and said trigger switch becomes OFF;
 an N-shot mode shooting means for setting the maximum number of times bullets are shot when the trigger
 switch is switch ON one time, starting the shooting operation when said trigger switch is switched ON, subtracting
 35 1 from said set maximum value N when said reference position is detected, and stopping the shooting operation
 when the subtraction result becomes 0 and when said reference position is detected; and
 a switching means for selecting and operating one of said single-shot mode shooting means, said repeating
 mode shooting means and said N-shot mode shooting means.

10. An air gun that uses compressed air generated by a piston to shoot bullets, comprising:

a reference position for a shooting operation that is located on a drive system that drives said piston;
 a single-shot mode shooting means for starting a shooting operation when a trigger switch is switched ON,
 stopping said shooting operation when said reference position is detected, and preventing said shooting operation after said shooting operation is stopped, even when the ON state of said trigger switch continues;
 45 a repeating mode shooting means for starting the shooting operation when said trigger is switched ON, and
 stopping said shooting operation when said reference position is detected and said trigger switch becomes OFF;
 an N-shot mode shooting means for setting the maximum number of times bullets are shot when the trigger
 switch is switch ON one time, starting the shooting operation when said trigger switch is switched ON, subtracting
 50 1 from said set maximum value N when said reference position is detected, and stopping the shooting operation
 when the subtraction result becomes 0 and when said reference position is detected; and
 a switching means that selects and operates either a single-shot mode/repeating mode means for performing
 said single-shot mode shooting operation and said repeating mode shooting operation, or a single-shot mode/N-
 shot mode means for performing said single-shot mode shooting operation and said N-continuous-shooting
 55 operation.

11. The air gun of claim 10 wherein said switching means for selecting and operating either said single-shot mode/
 repeating mode means or said single-shot mode/N-shot mode means is a switching means that switches patterns
 on a printed-circuit board of a control circuit using a jumper wire.

12. A control method for an air gun that uses compressed air generated by a piston to shoot bullets, comprising:

a process of arbitrarily setting the maximum number of times bullets are shot when a trigger switch is switched ON one time;
a process of counting said number of times bullets are shot; and
a process of stopping the shooting operation when the count value of said counter reaches said maximum value.

13. A control method for an air gun that uses compressed air generated by a piston to shoot bullets, comprising:

a reference position for a shooting operation that is located on a drive system that drives said piston; and that starts the shooting operation when a trigger switch is switched ON; stops said shooting operation when said reference position is detected; and prevents said shooting operation after shooting is stopped by a means for stopping said shooting operation, even when the ON state of said trigger switch continues.

14. The control method for an air gun of claim 13 repeats the operation of claim 13 each time said trigger switch becomes ON.

15. A control method for an air gun that uses compressed air generated by a piston to shoot bullets, comprising:

a reference position for a shooting operation that is located on a drive system that drives said piston; and that starts the shooting operation when a trigger switch is switched ON; and stops said shooting operation when said reference position is detected and said trigger switch is OFF.

16. A control method for an air gun that uses compressed air generated by a piston to shoot bullets, that:

makes it possible to arbitrarily set the maximum number of times bullets are shot when a trigger switch is switched ON one time.

17. A control method for an air gun that uses compressed air generated by a piston to shoot bullets, comprising:

a reference position for a shooting operation that is located on a drive system that drives said piston; and a counter means that makes it possible to arbitrarily set the maximum number of times bullets are shot to a specified value N when a trigger switch is switched ON one time; and that starts the shooting operation when the trigger switch is switched ON; subtracts 1 from said set maximum value N when said reference position is detected; and stops said shooting operation when the subtraction result becomes 0 and said reference position is detected.

18. A control method for an air gun that uses compressed air generated by a piston to shoot bullets, comprising:

a single-shot mode shooting process of starting a shooting operation when a trigger switch is switched ON, stopping said shooting operation when a reference position that is located on a drive system that drives said piston is detected, and preventing said shooting operation after said shooting operation is stopped, even when the ON state of said trigger switch continues; and a repeating mode shooting process of starting the shooting operation when said trigger is switched ON, and stopping said shooting operation when said reference position is detected and said trigger switch becomes OFF; and that selects and operates either said single-shot mode shooting process or said repeating mode shooting process.

19. A control method for an air gun that uses compressed air generated by a piston to shoot bullets, comprising:

a single-shot mode shooting process of starting a shooting operation when a trigger switch is switched ON, stopping said shooting operation when a reference position that is located on a drive system that drives said piston is detected, and preventing said shooting operation after said shooting operation is stopped, even when the ON state of said trigger switch continues; and an N-shot mode shooting process of setting the maximum number of times bullets are shot when the trigger switch is switch ON one time, starting the shooting operation when said trigger switch is switched ON, subtracting 1 from said set maximum value N when said reference position is detected, and stopping the shooting operation

when the subtraction result becomes 0 and when said reference position is detected; and that selects and operates either said single-shot mode shooting process or said N-shot mode shooting process.

20. A control method for an air gun that uses compressed air generated by a piston to shoot bullets, comprising:

a single-shot mode shooting process of starting a shooting operation when a trigger switch is switched ON, stopping said shooting operation when a reference position that is located on a drive system that drives said piston is detected, and preventing said shooting operation after said shooting operation is stopped, even when the ON state of said trigger switch continues;

a repeating mode shooting process of starting the shooting operation when said trigger is switched ON, and stopping said shooting operation when said reference position is detected and said trigger switch becomes OFF; and

an N-shot mode shooting process of setting the maximum number of times bullets are shot when the trigger switch is switch ON one time, starting the shooting operation when said trigger switch is switched ON, subtracting 1 from said set maximum value N when said reference position is detected, and stopping the shooting operation when the subtraction result becomes 0 and when said reference position is detected; and that selects and operates one of said single-shot mode shooting process, said repeating mode shooting process and said N-shot mode shooting process.

21. A control method for an air gun that uses compressed air generated by a piston to shoot bullets, comprising:

a single-shot mode shooting process of starting a shooting operation when a trigger switch is switched ON, stopping said shooting operation when a reference position that is located on a drive system that drives said piston is detected, and preventing said shooting operation after said shooting operation is stopped, even when the ON state of said trigger switch continues;

a repeating mode shooting process of starting the shooting operation when said trigger is switched ON, and stopping said shooting operation when said reference position is detected and said trigger switch becomes OFF; and

an N-shot mode shooting means for setting the maximum number of times bullets are shot when the trigger switch is switch ON one time, starting the shooting operation when said trigger switch is switched ON, subtracting 1 from said set maximum value N when said reference position is detected, and stopping the shooting operation when the subtraction result becomes 0 and when said reference position is detected; and that selects and operates either a single-shot mode/repeating mode process of performing said single-shot mode shooting process and said repeating mode shooting process, or a single-shot mode/N-shot mode process of performing said single-shot mode shooting process and said N-continuous-shooting process.

FIG. 1

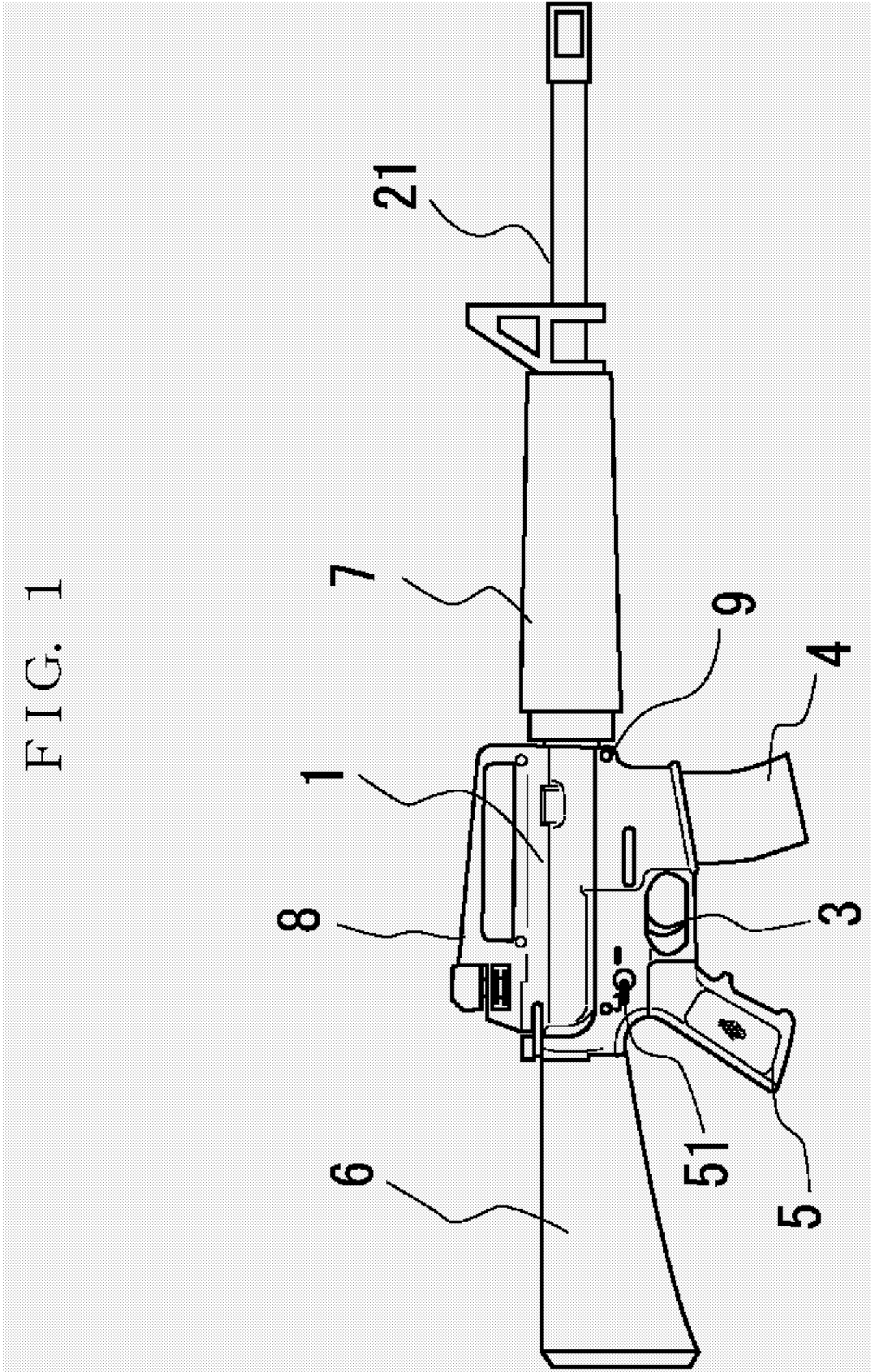
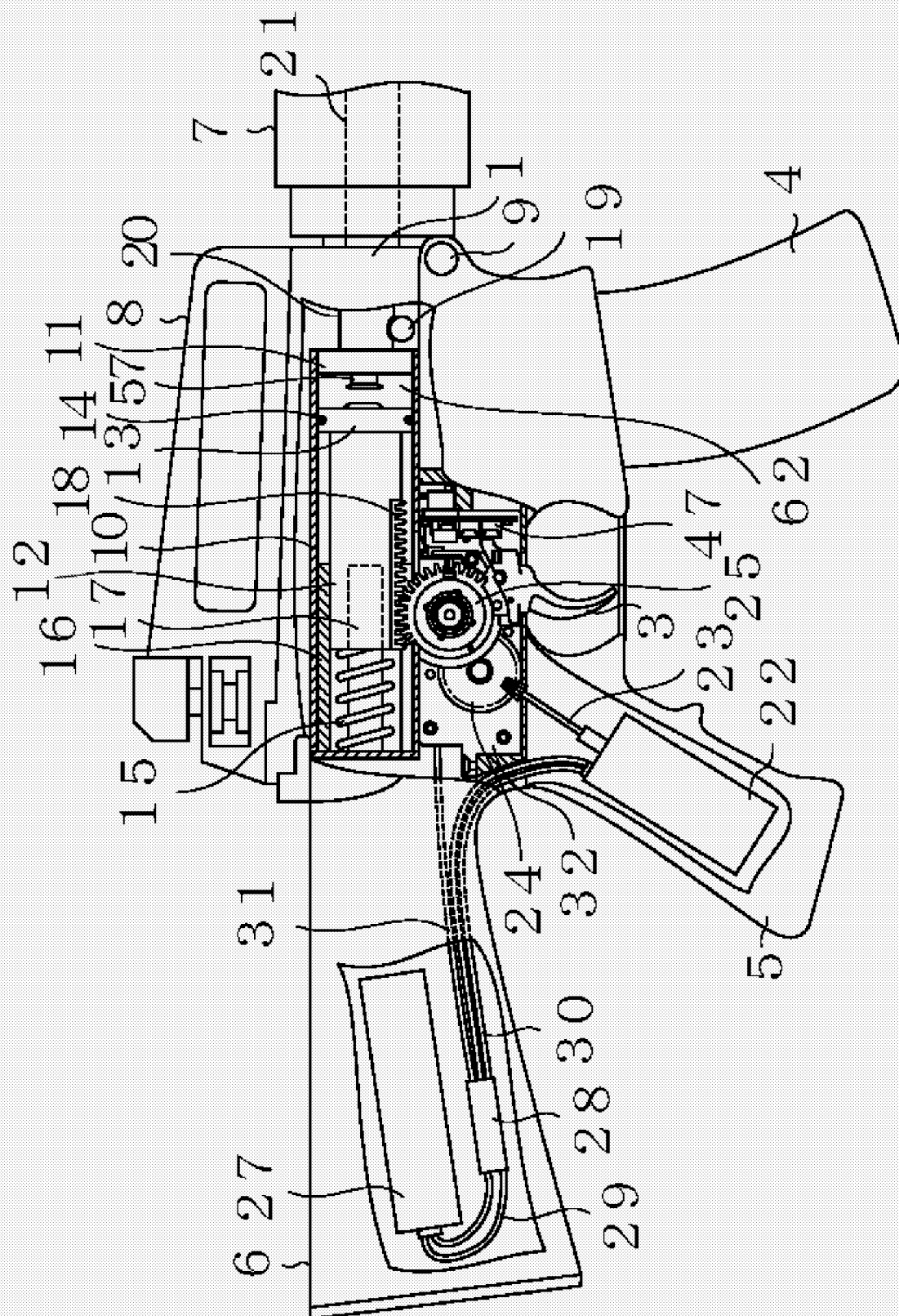


FIG. 2



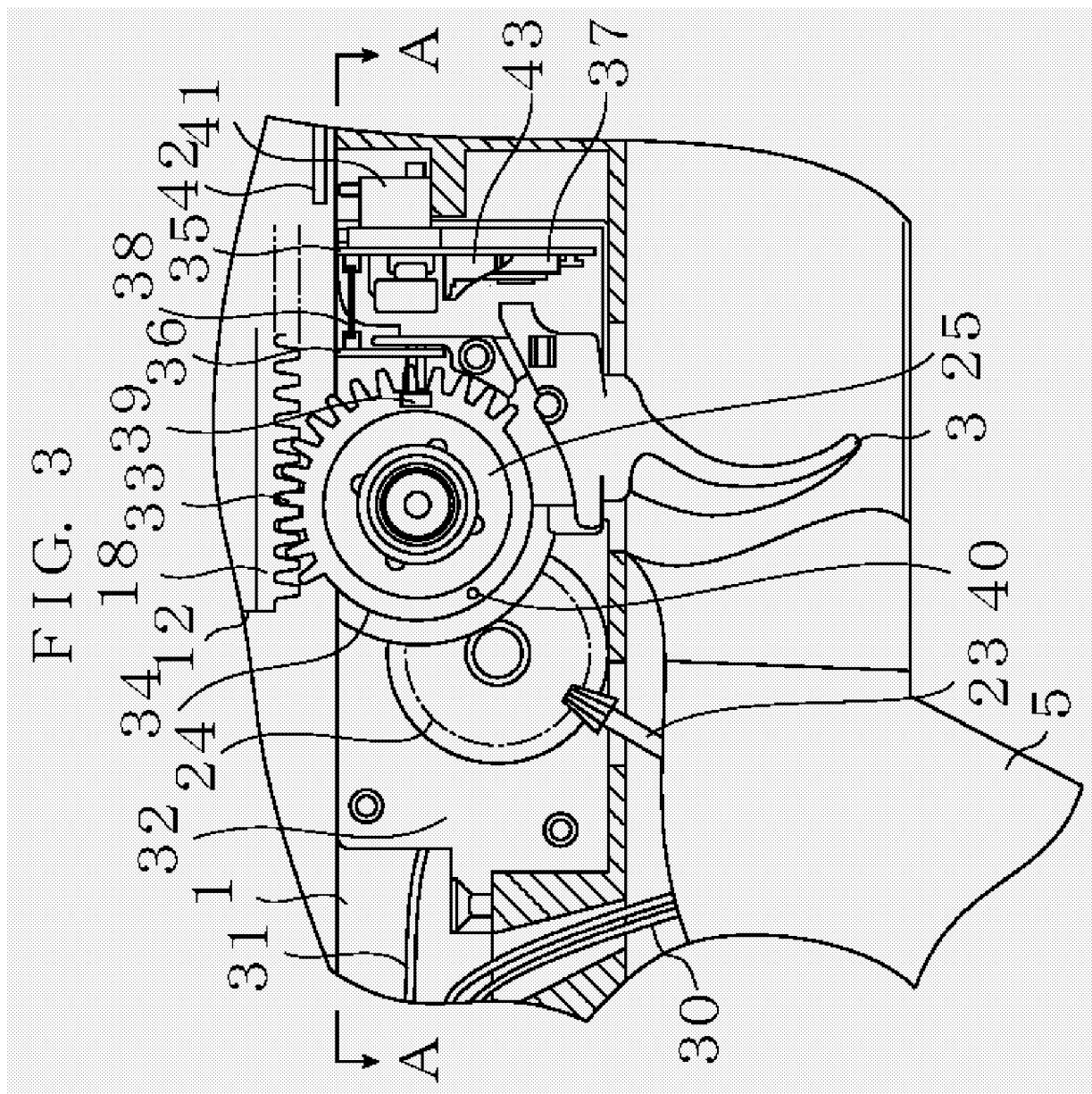


FIG. 4

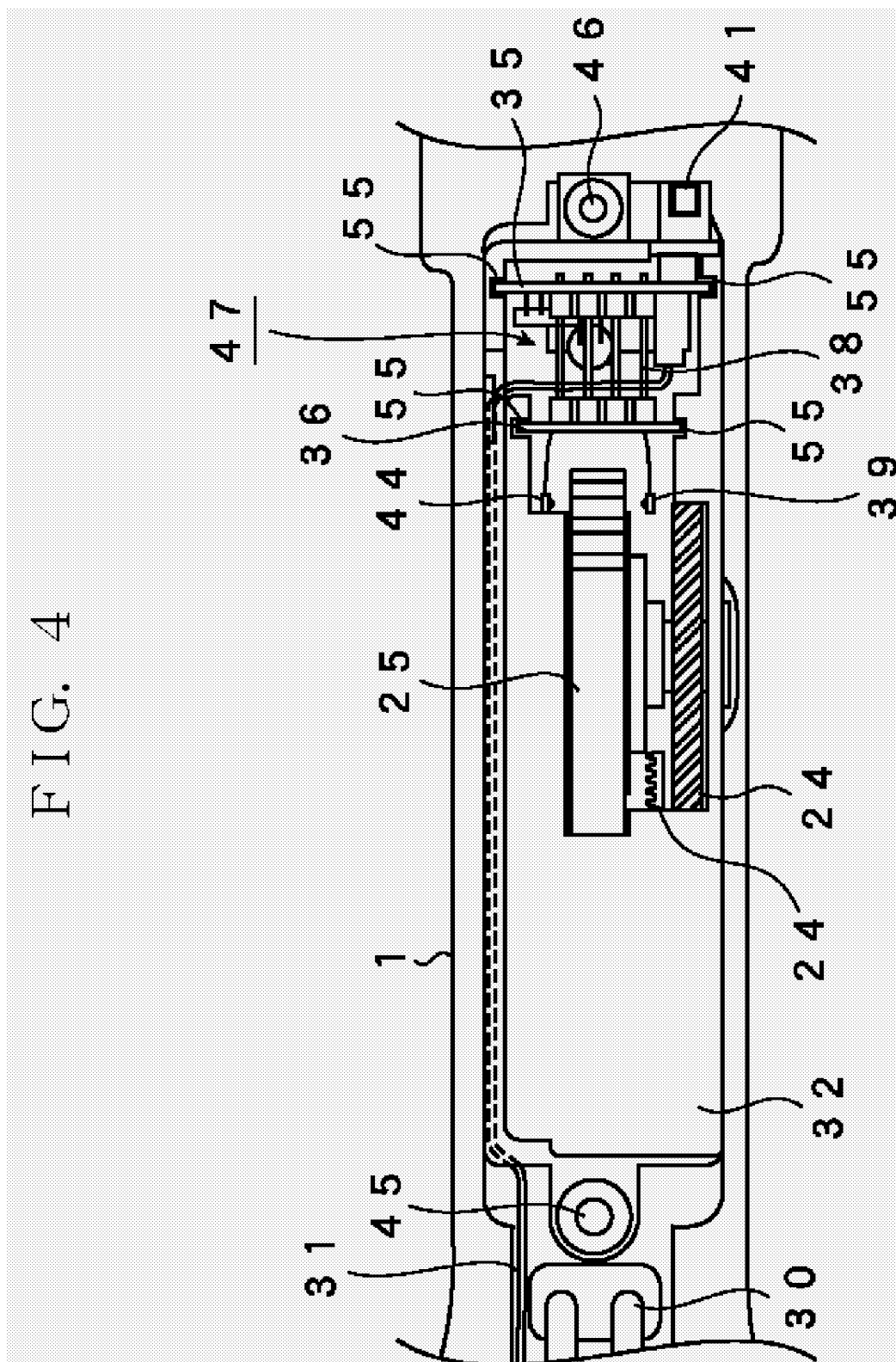


FIG. 5A

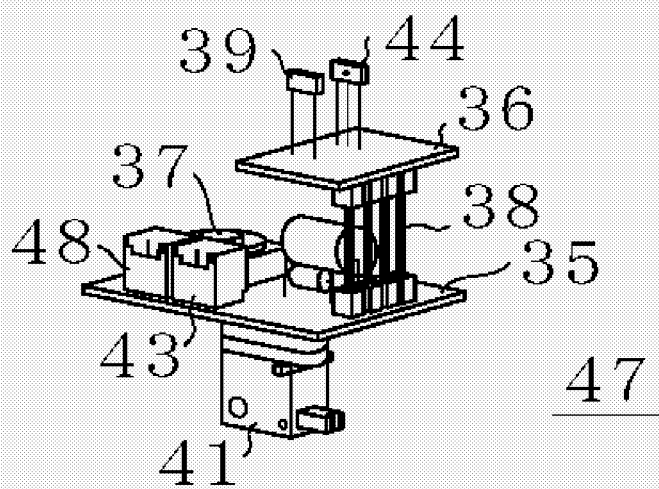


FIG. 5B

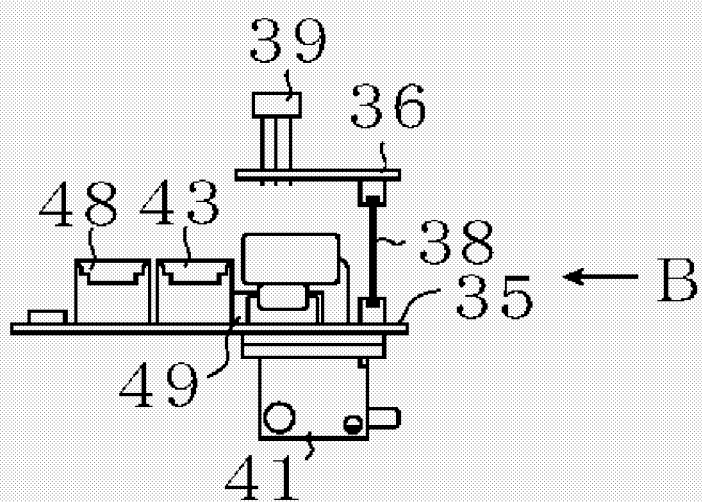


FIG. 5C

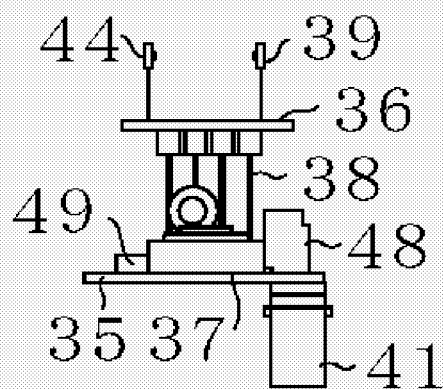


FIG. 6A

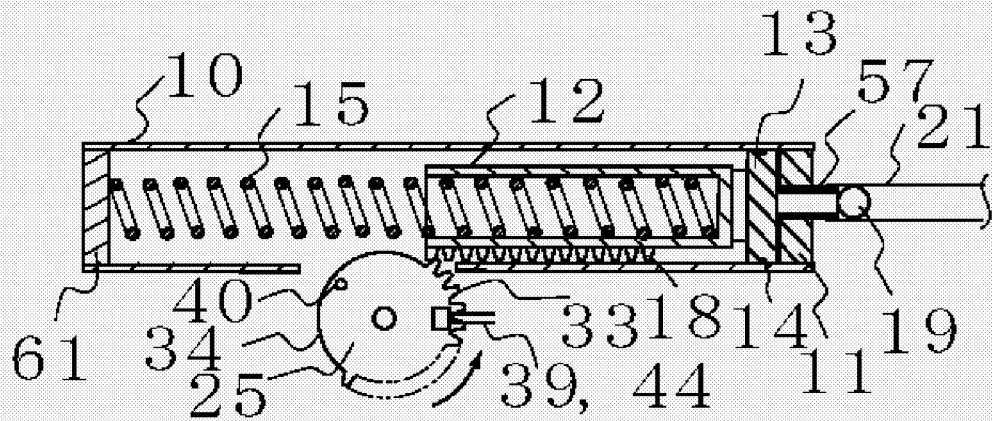


FIG. 6B

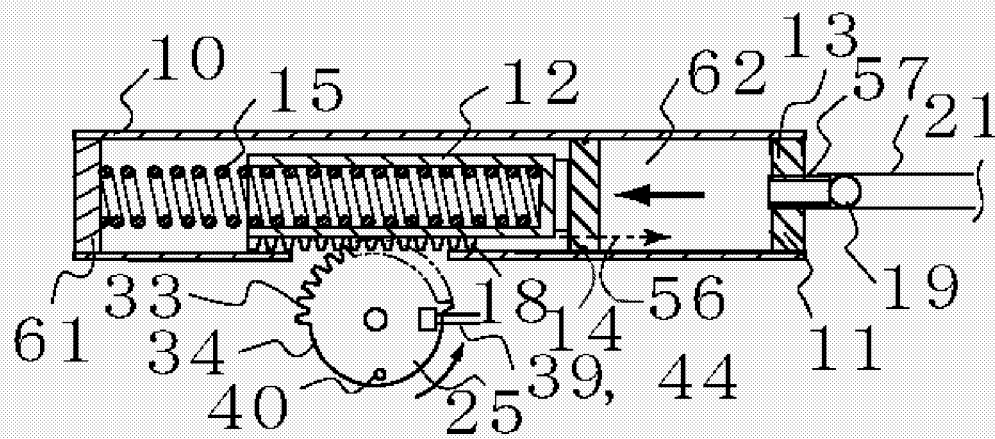


FIG. 6C

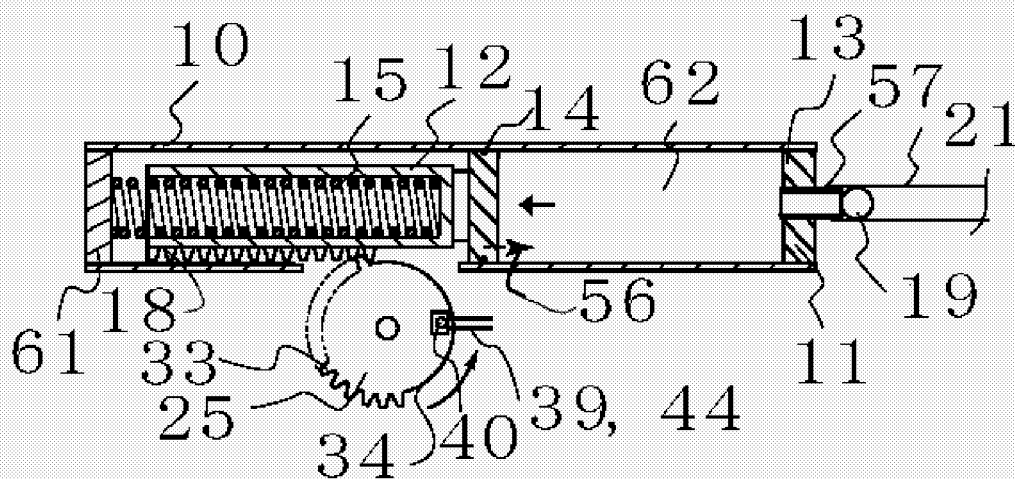
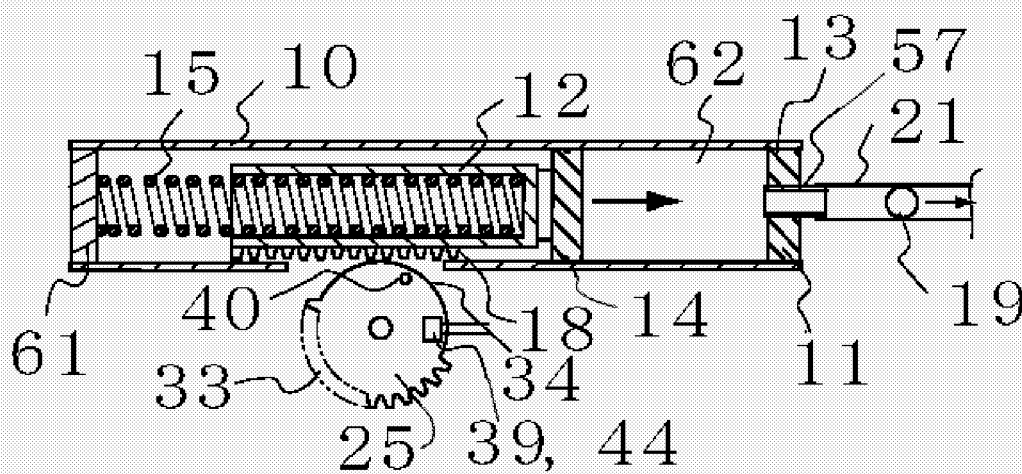


FIG. 6D



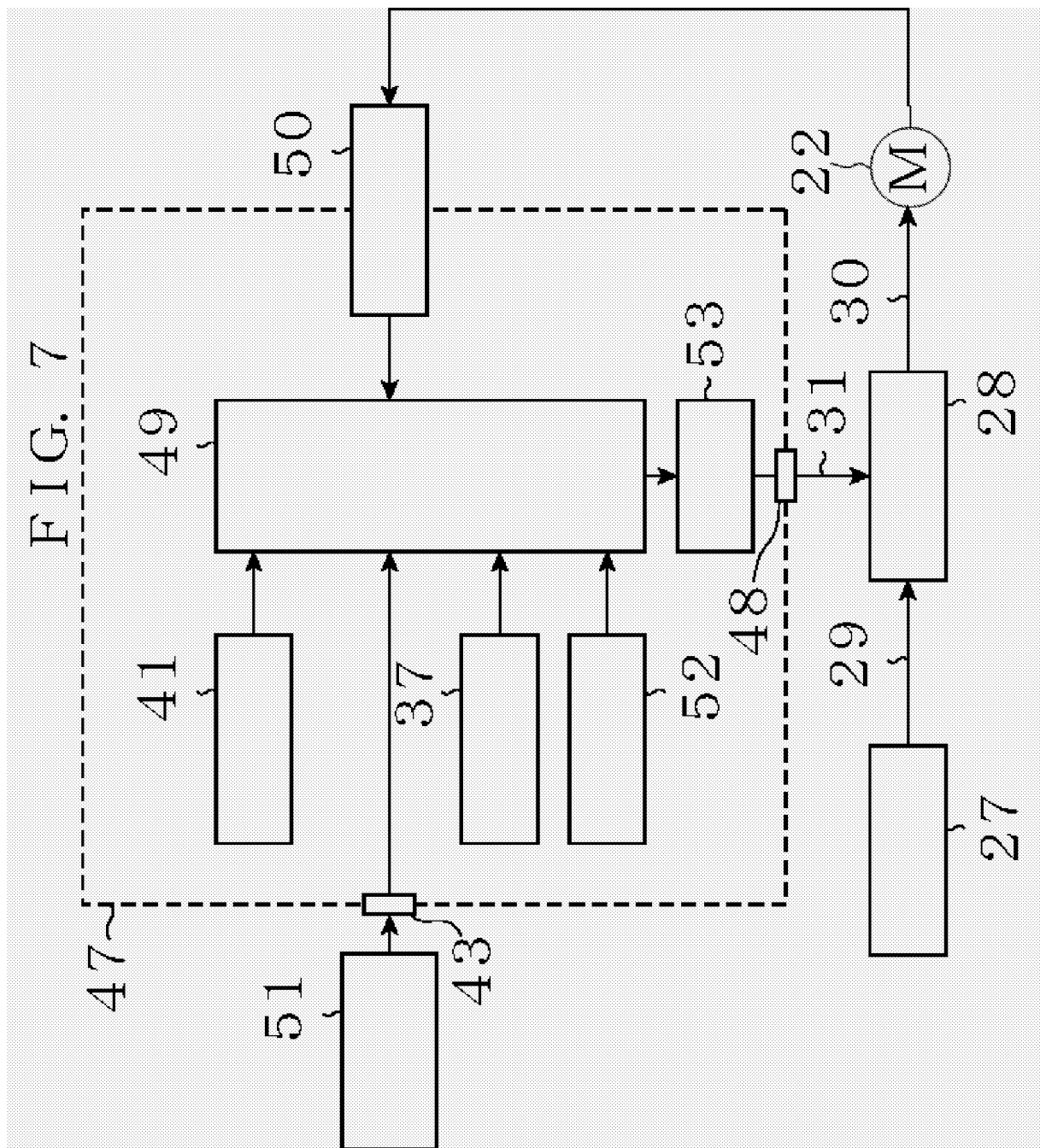


FIG. 8

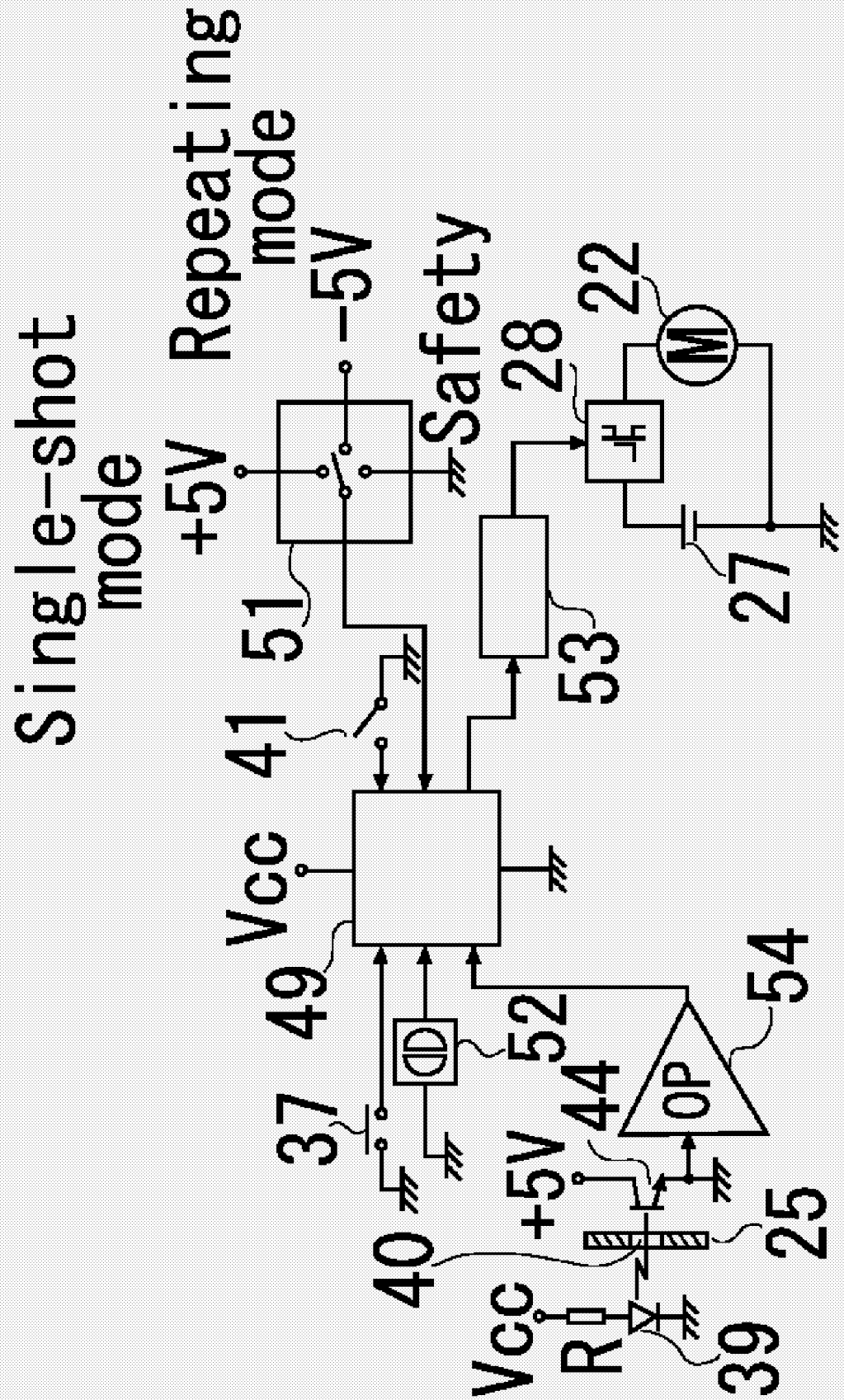
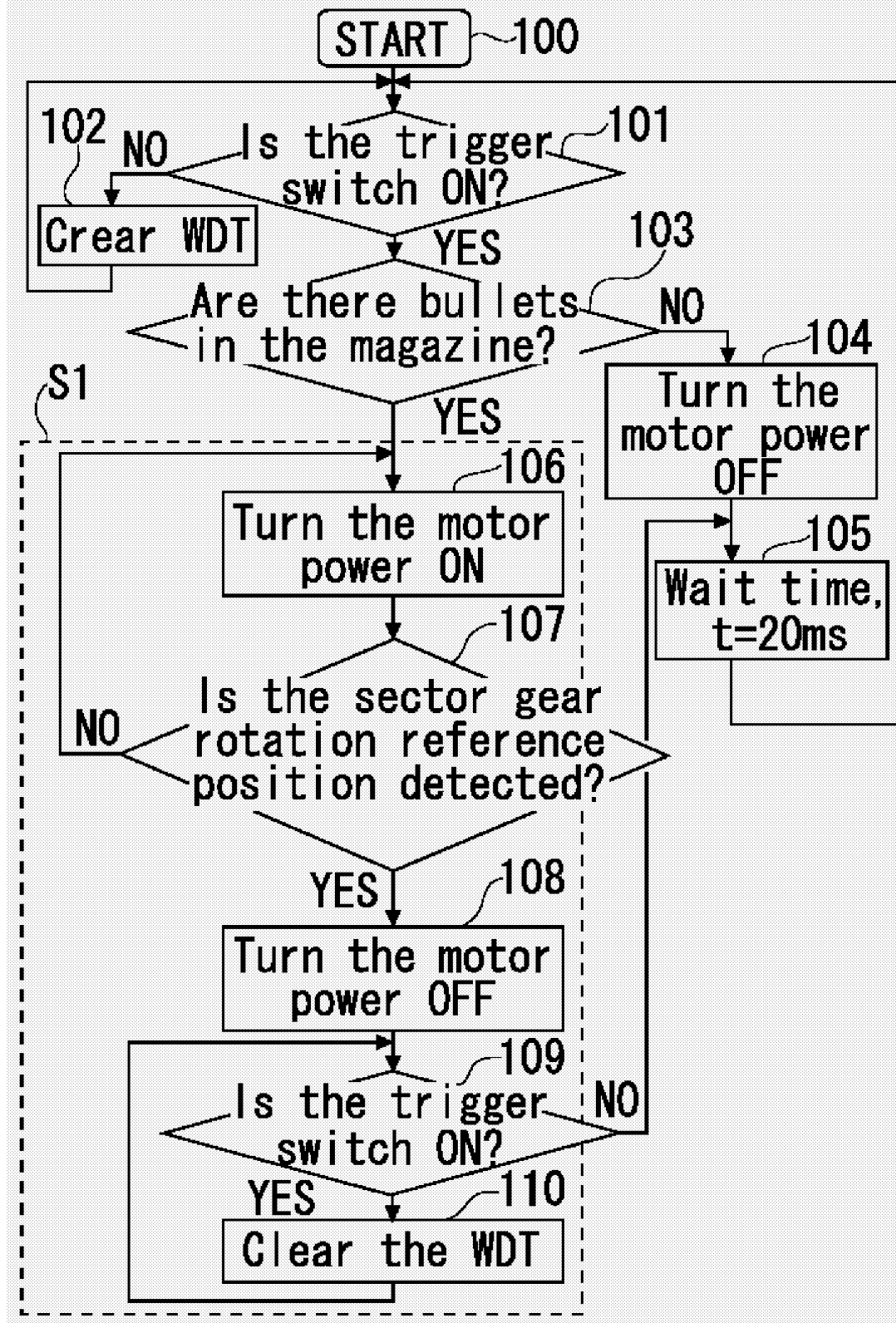


FIG. 9



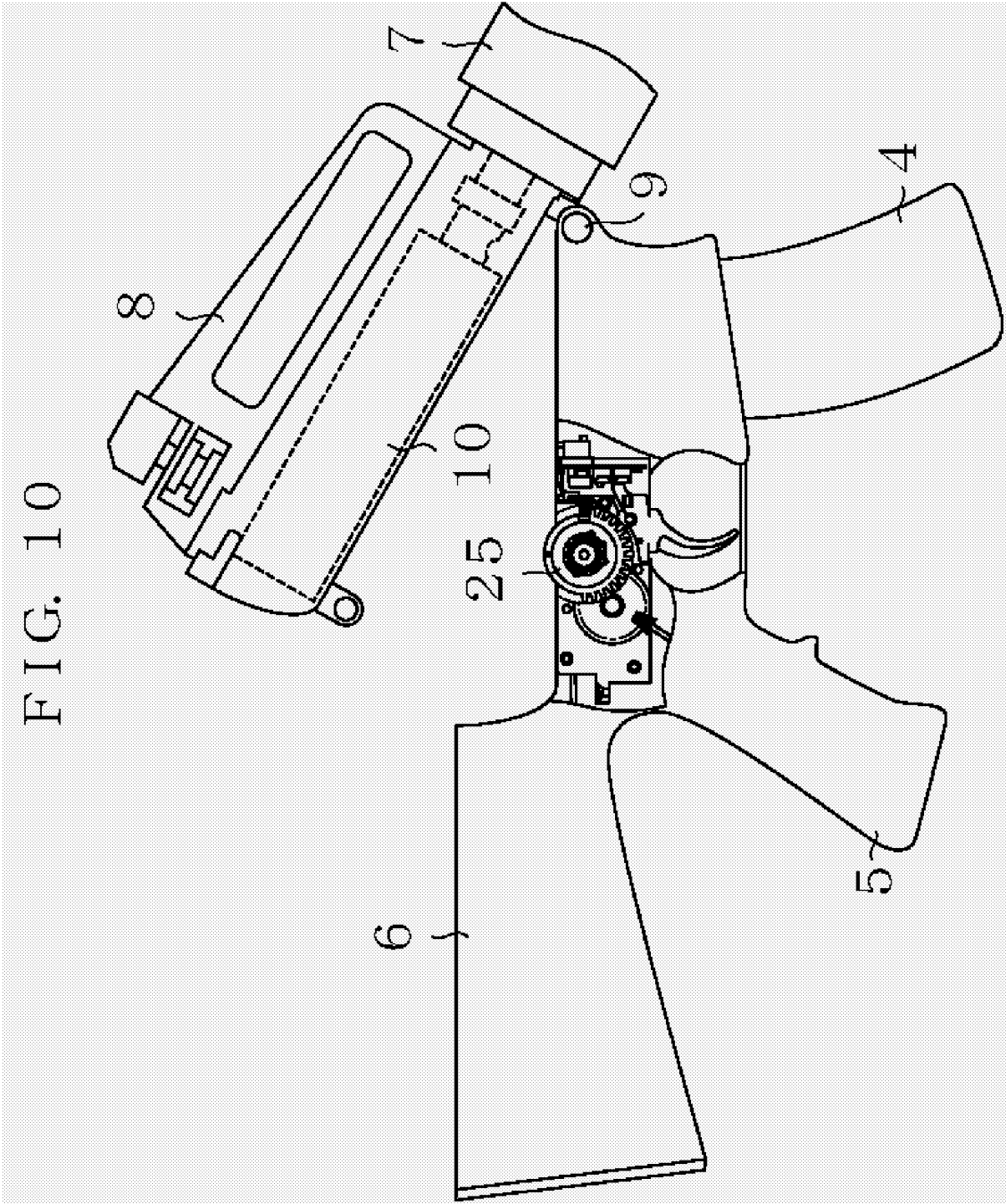


FIG. 11

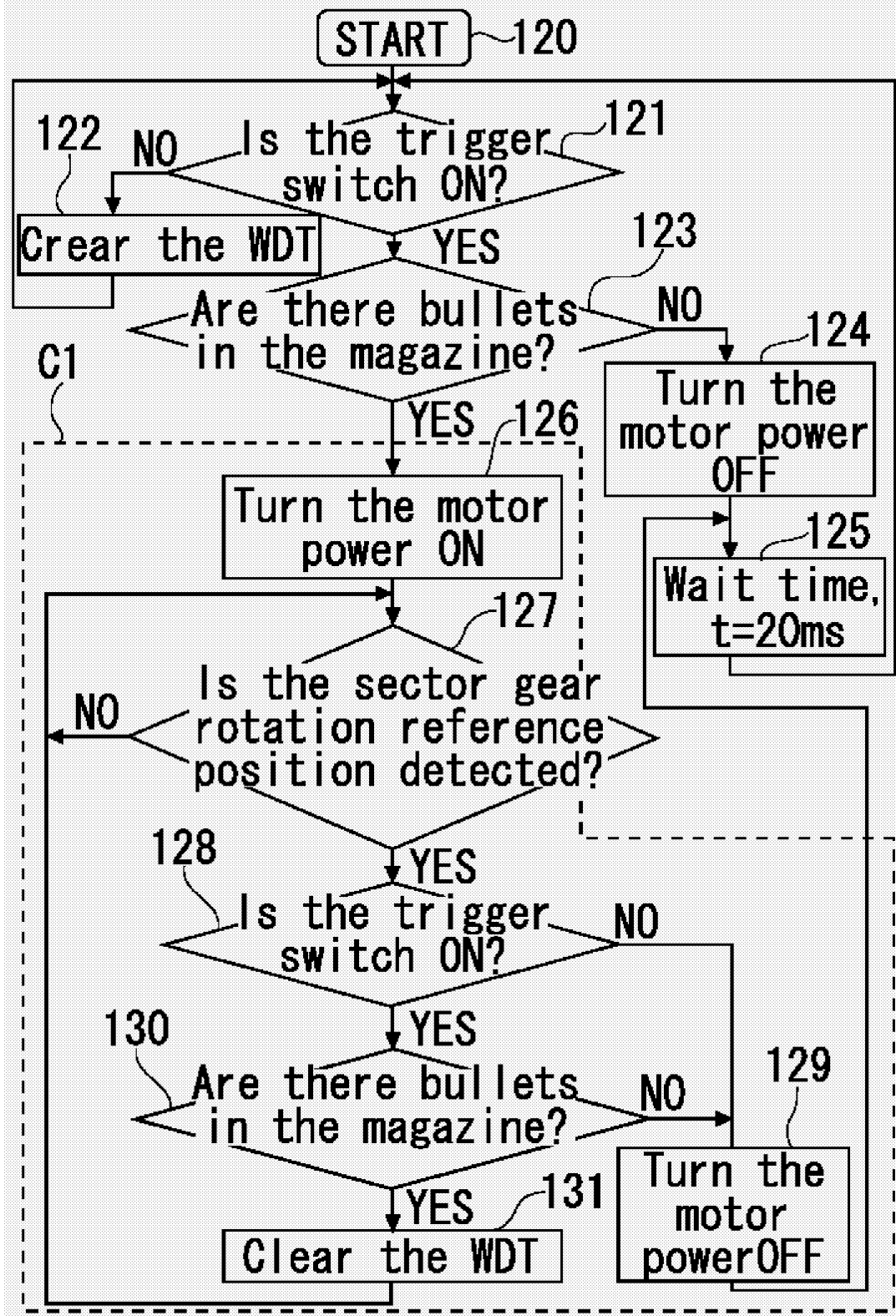


FIG. 12

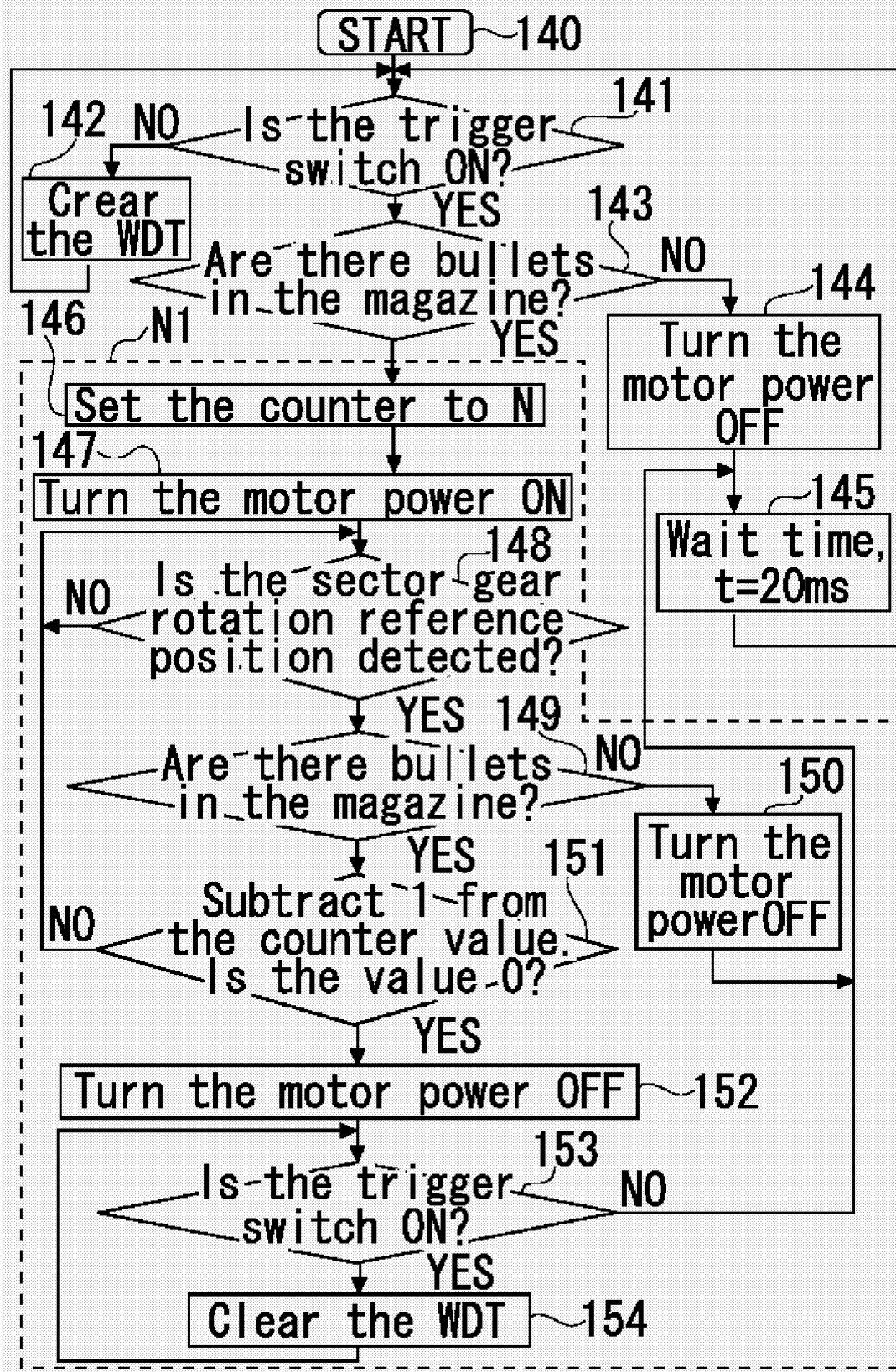


FIG. 13

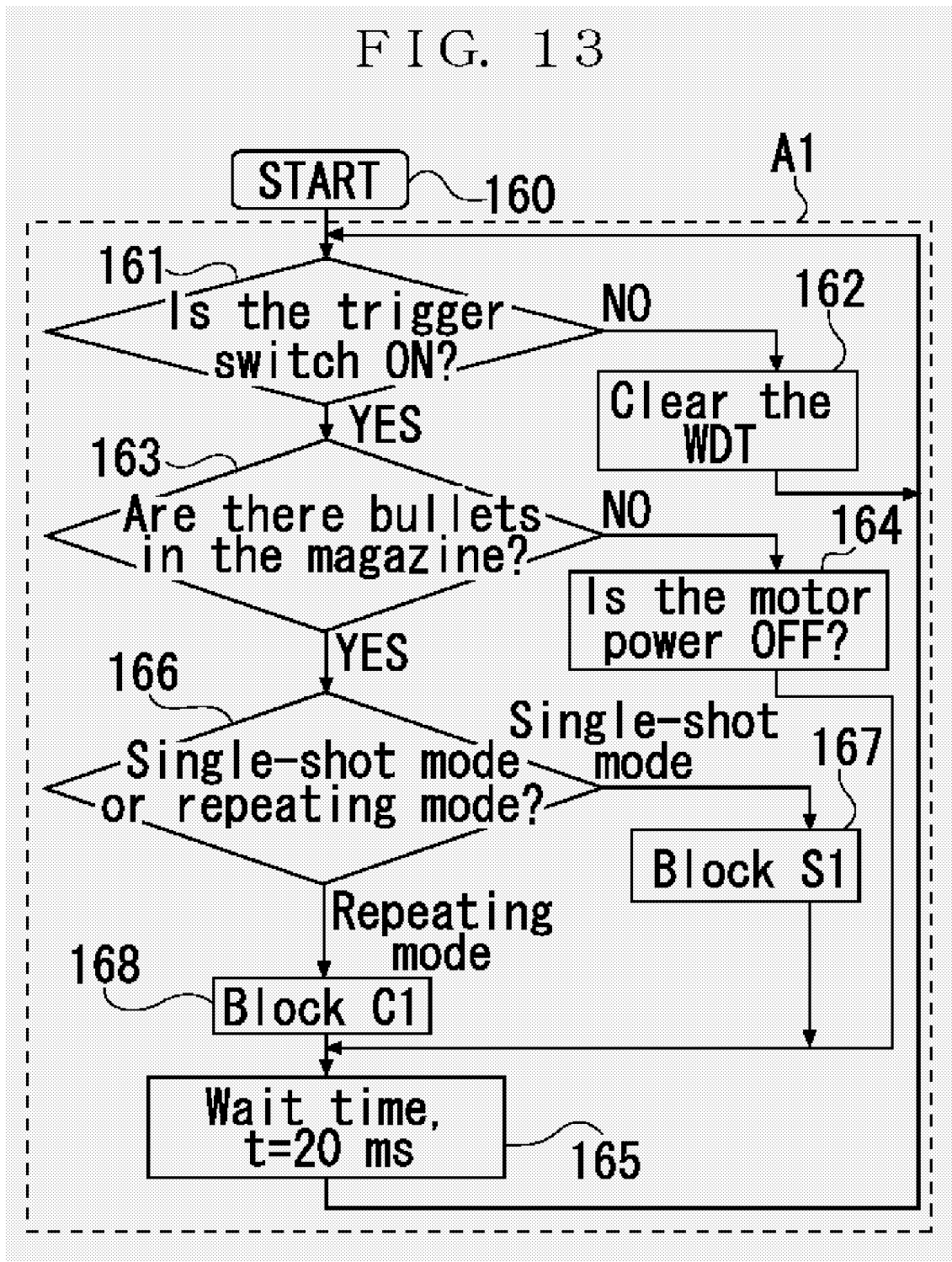


FIG. 14

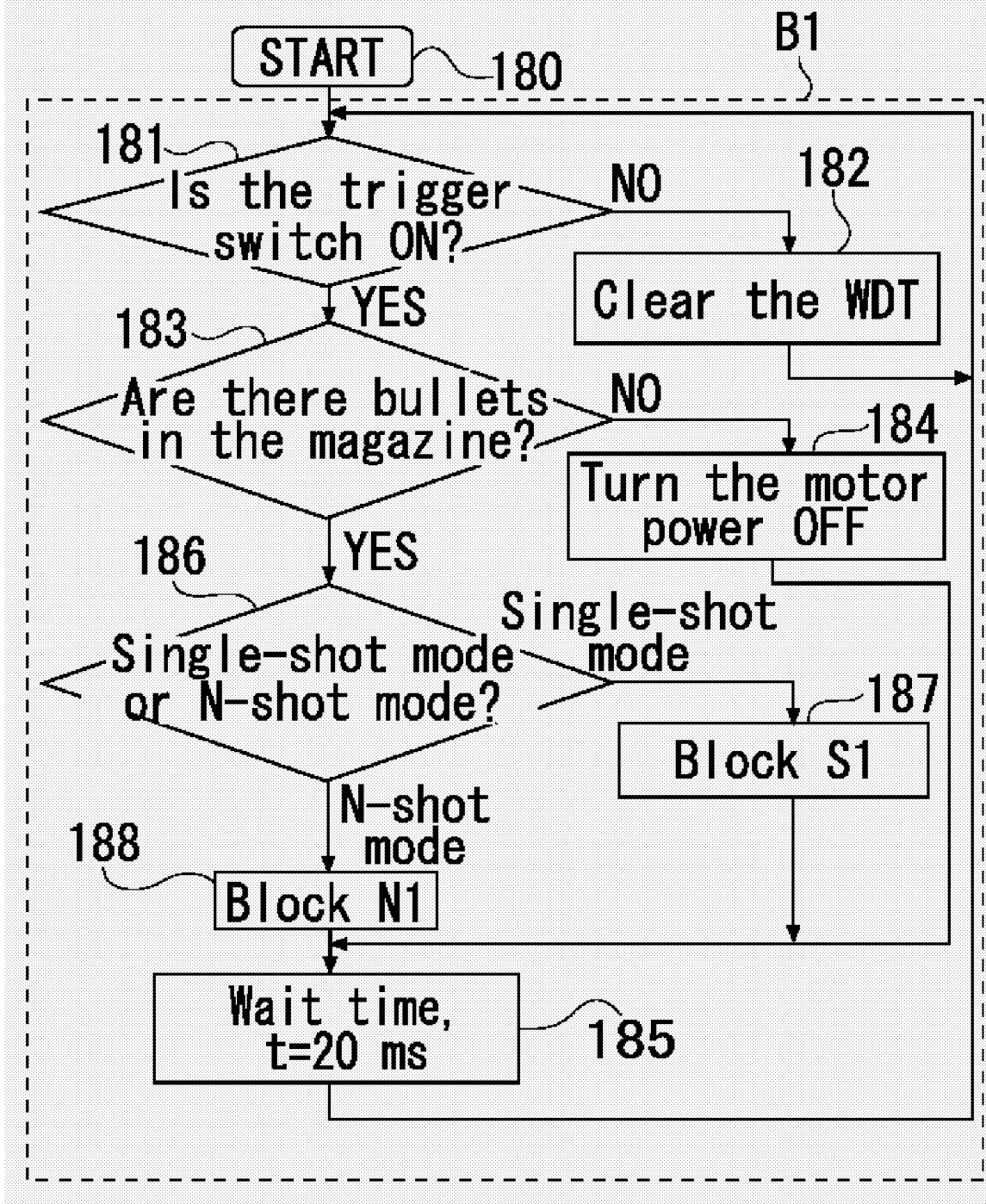


FIG. 15

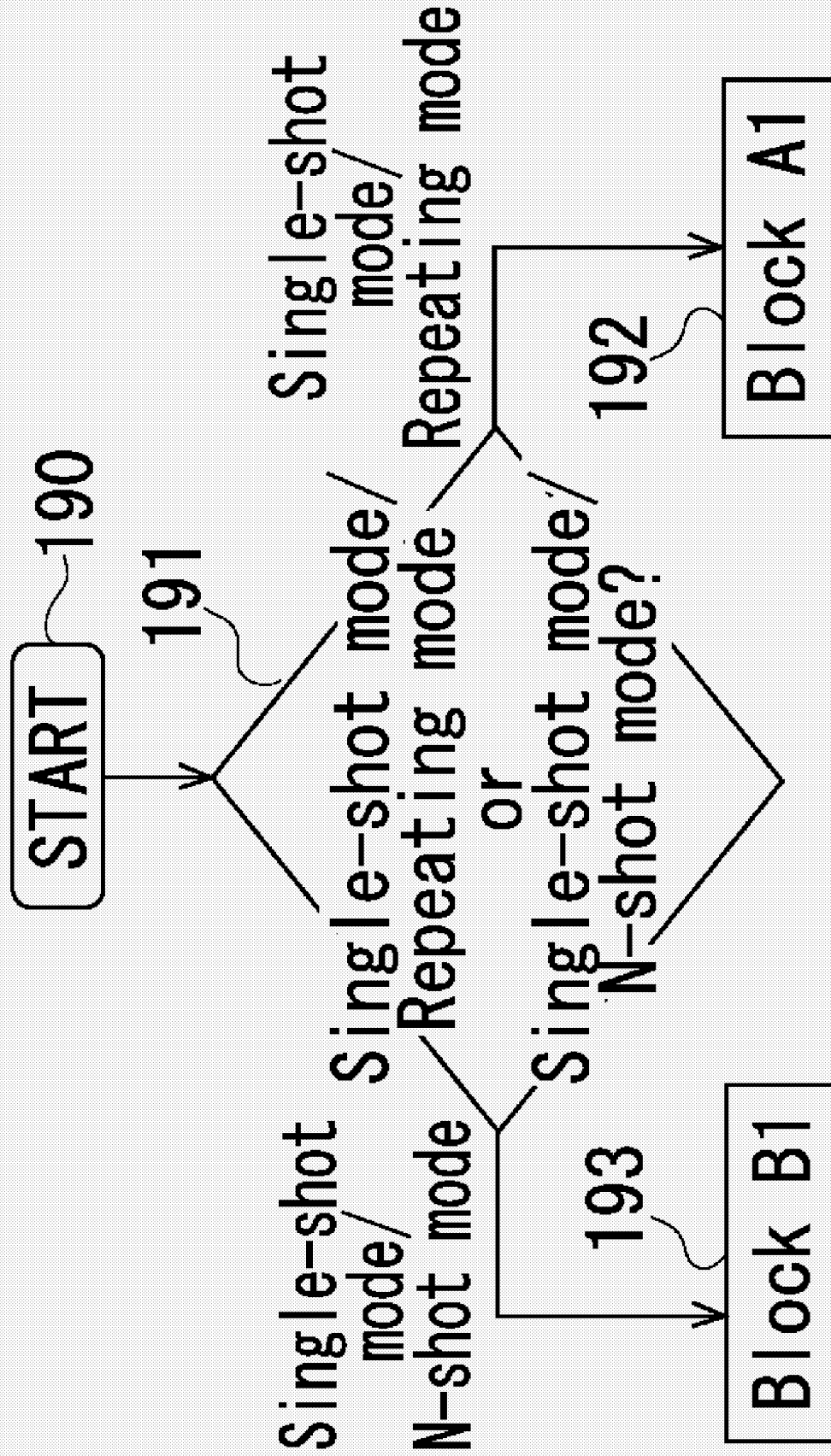


FIG. 16

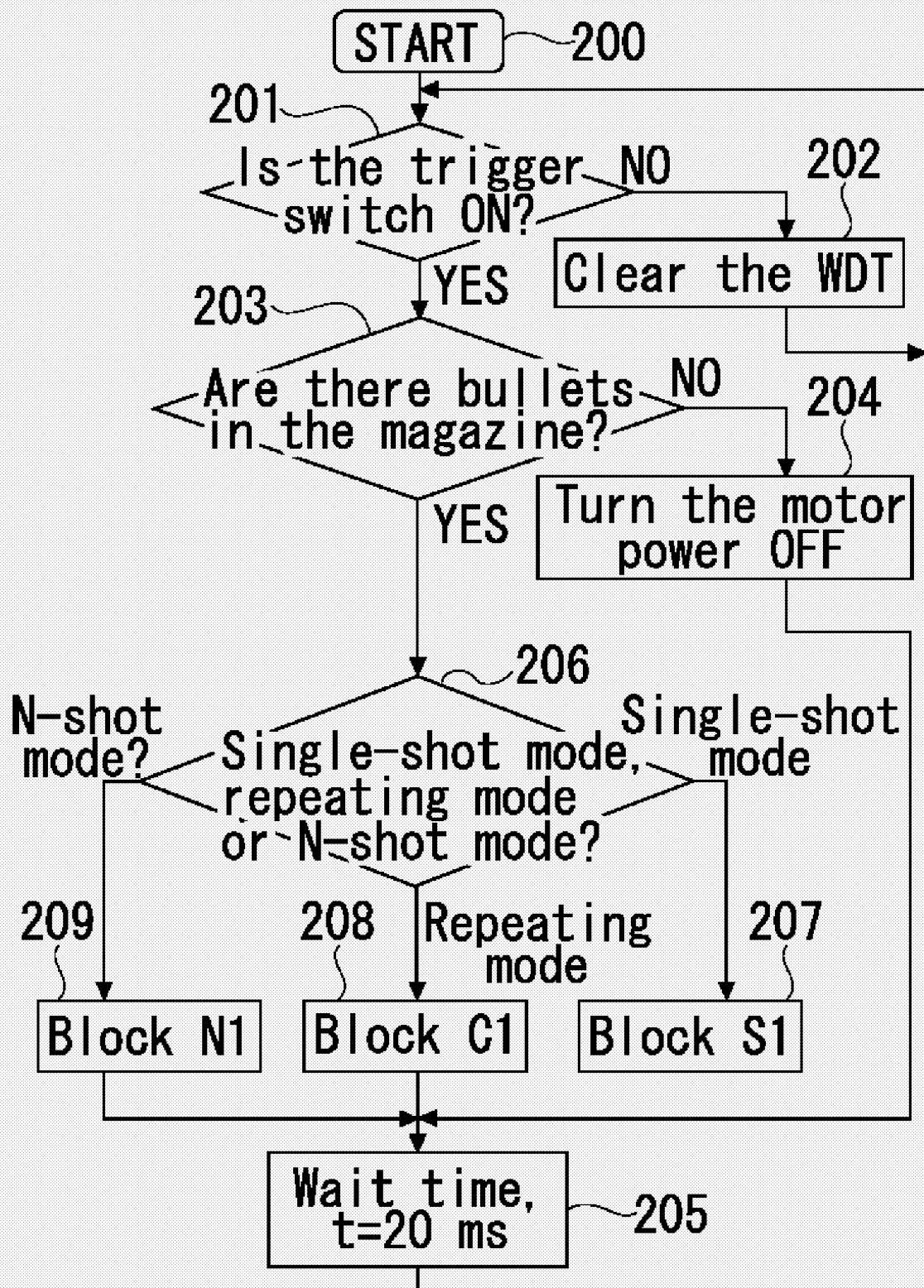


FIG. 17

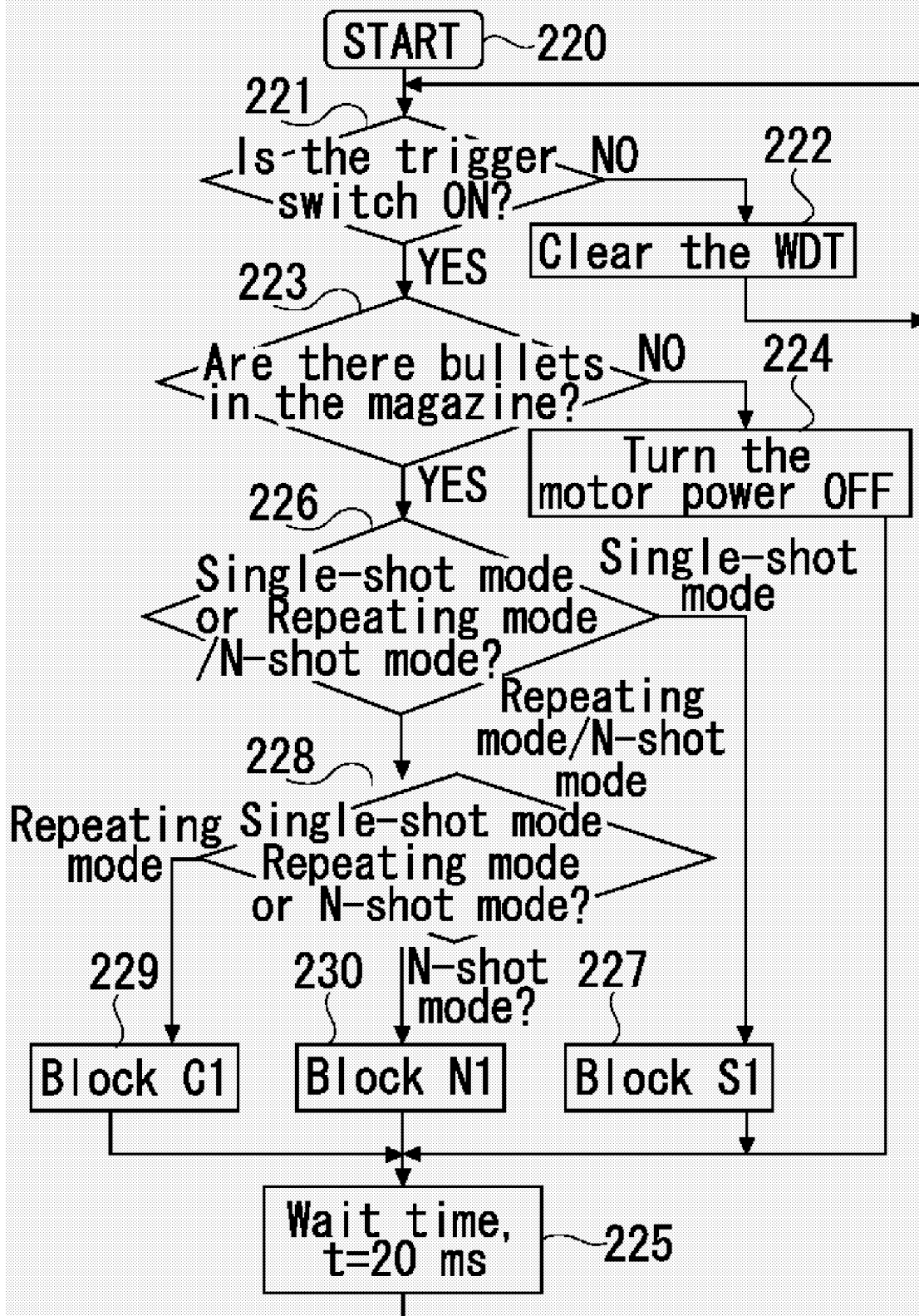


FIG. 18

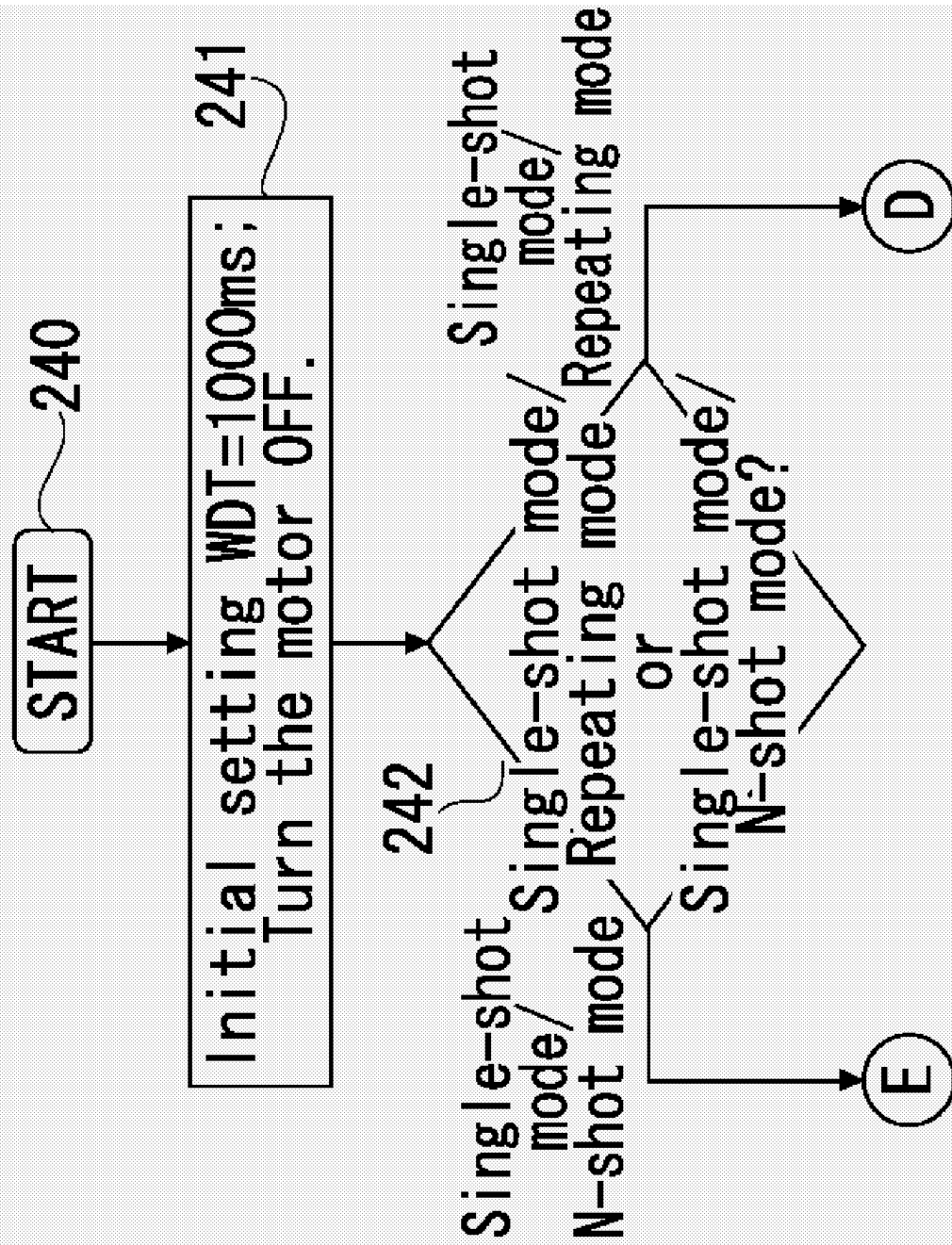


FIG. 19

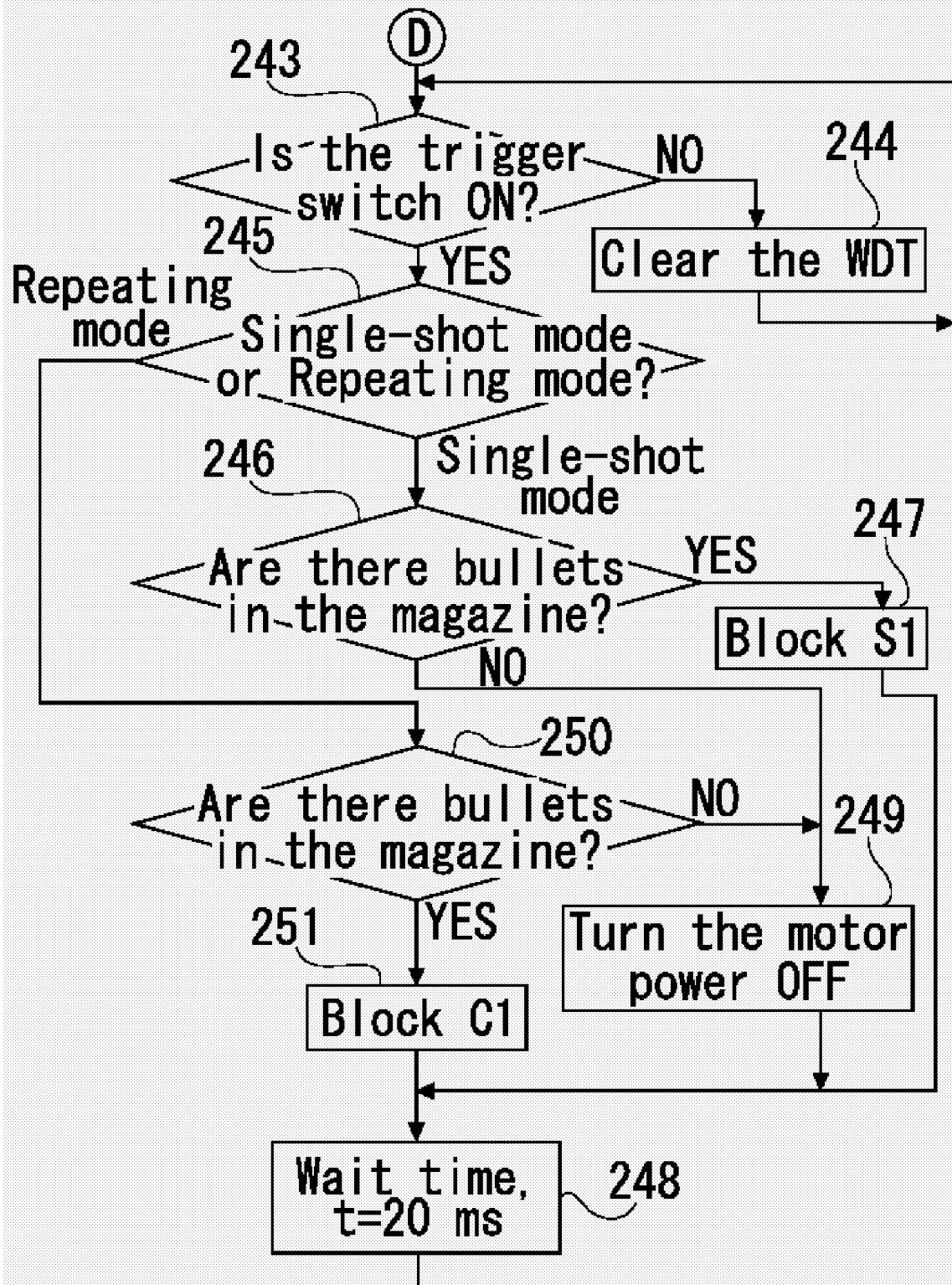


FIG. 20

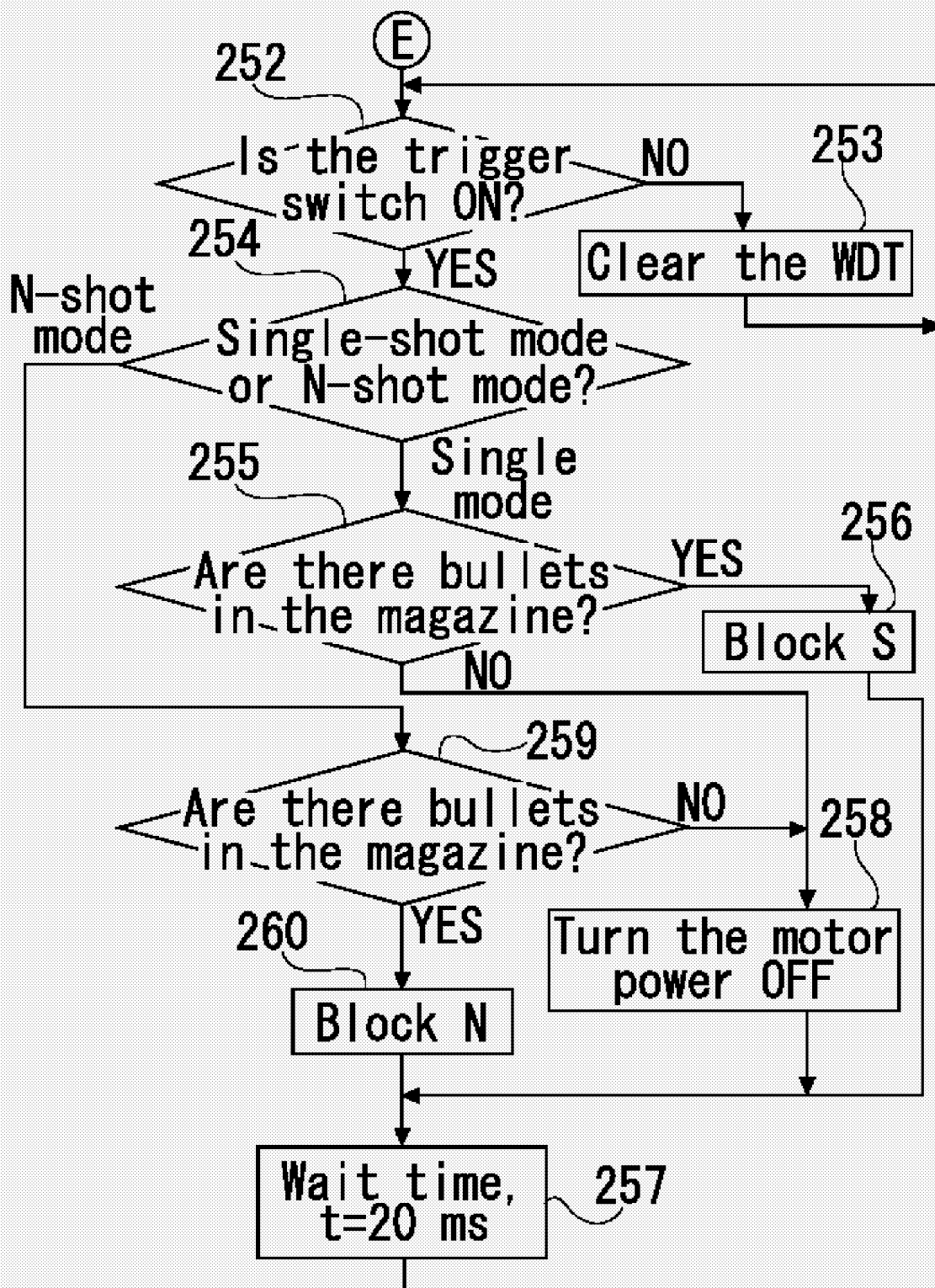


FIG. 21

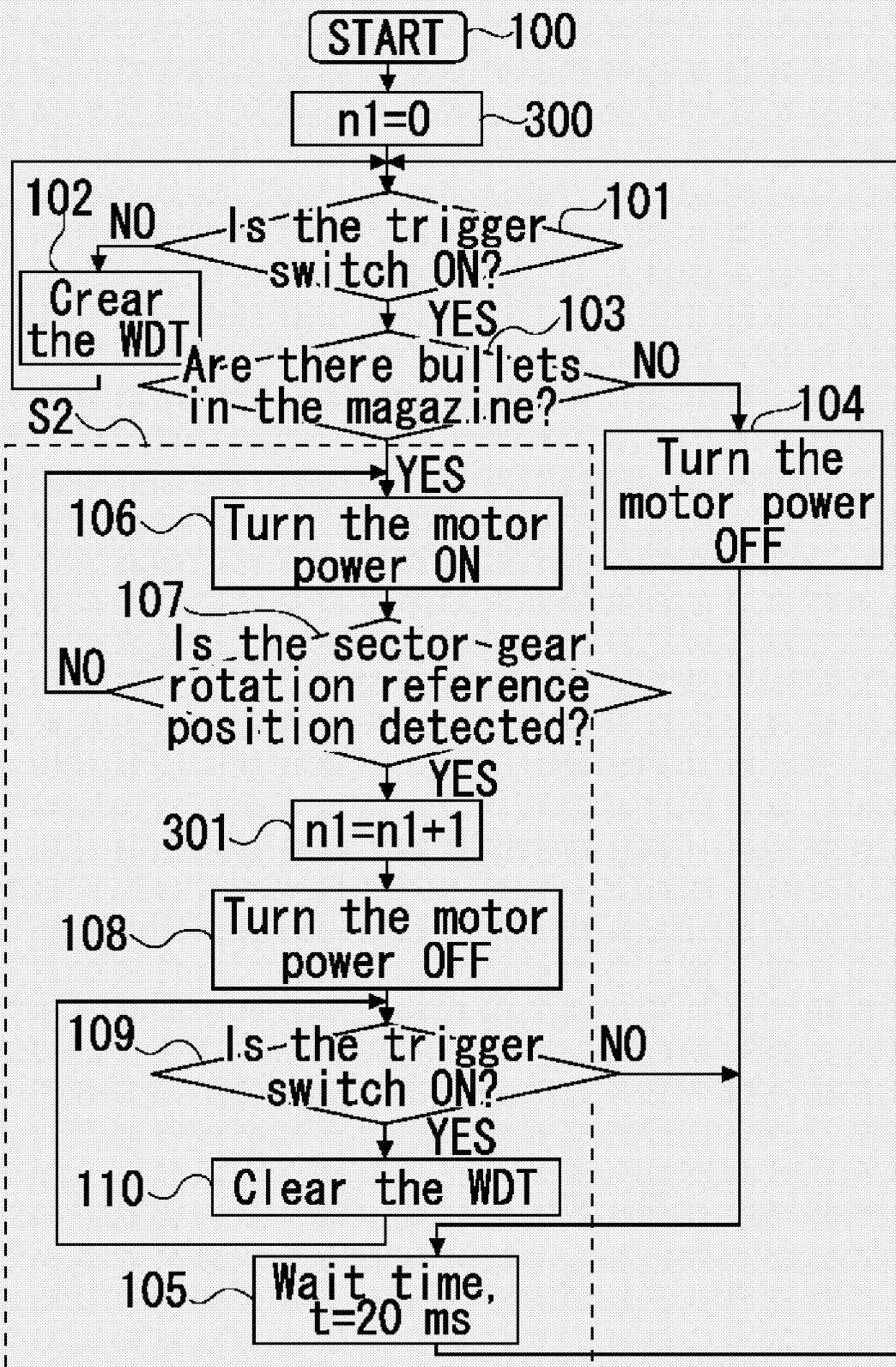
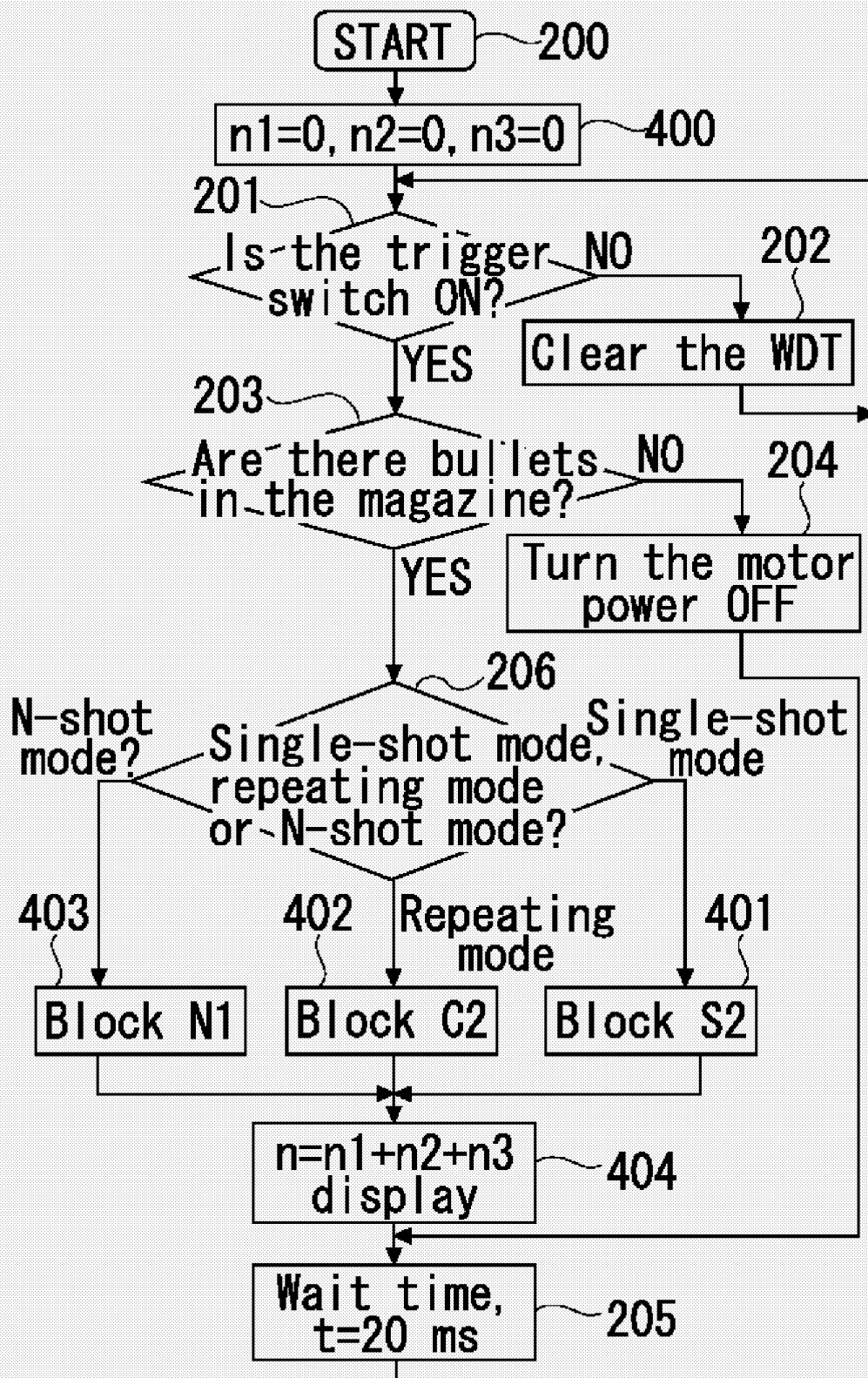
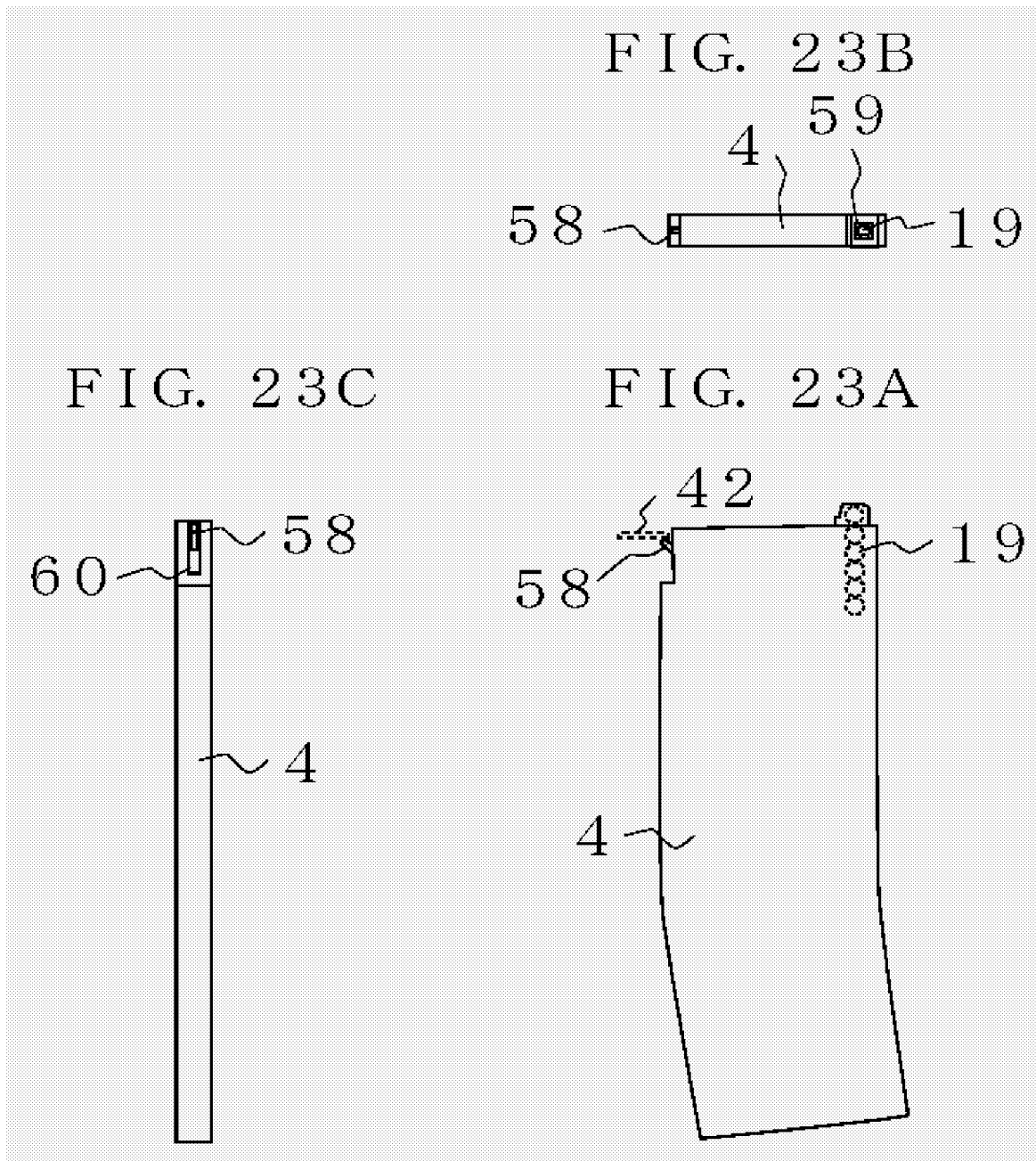


FIG. 22





Reference Numbers

- 1 Gun body
- 3 Trigger
- 4 Magazine
- 5 Grip
- 6 Gun stock
- 7 Handgun liner
- 8 Hand carry
- 9 Hinge
- 10 Cylinder
- 11 Cylinder head
- 12 Piston
- 13 Piston head
- 14 O-ring
- 15 Spring
- 16 Piston movement restriction member
- 17 Center rod
- 18 Rack
- 19 Bullet
- 20 Chamber
- 21 Barrel
- 22 Motor
- 23 Motor shaft
- 24 Deceleration gear
- 25 Sector gear
- 27 Battery
- 28 Motor-power-supply-control unit
- 29 Power line
- 30 Power line
- 31 Control line
- 32 Control circuit housing case
- 33 Sector gear toothed section
- 34 Sector gear non-toothed section
- 35 First printed circuit board for the control circuit
- 36 Second printed circuit board for the control circuit
- 37 Trigger switch
- 38 Control line

39	Photodiode
40	Sector gear rotation reference position detection hole
41	Bullet detection switch
42	Pressure member of the bullet detection switch
43	First connector
44	Phototransistor
45, 46	Installation hole
47	Electronic control switch
48	Second connector
49	Microcomputer
50	Sector gear rotation reference position detection unit
51	Selector switch
52	Single-shot mode /Repeating mode and Single-shot mode /N-shot mode switch
53	Amplifier
54	Operation amplifier
55	Groove
57	Cylinder head center hole
58	Bullet detection lever
59	Feed hole
60	Bullet detection frame
61	Cylinder bottom section
62	Space between piston head and cylinder head

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP03/17054

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ F41B11/14, F41B7/08		
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) Int.Cl ⁷ F41B11/00, F41B7/08		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2004 Kokai Jitsuyo Shinan Koho 1971-2004 Jitsuyo Shinan Toroku Koho 1996-2004		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 4-9599 A (Kabushiki Kaisha KSC), 14 January, 1992 (14.01.92), Full text; all drawings (Family: none)	1-21
Y	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 94086/1992 (Laid-open No. 309/1996) (Hiroaki KAN'NO), 16 February, 1996 (16.02.96), Full text; all drawings (Family: none)	1-21
Y	JP 55-150498 A (Howa Machinery, Ltd.), 22 November, 1980 (22.11.80), Full text; all drawings (Family: none)	1-21
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed		"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
Date of the actual completion of the international search 30 January, 2004 (30.01.04)		Date of mailing of the international search report 10 February, 2004 (10.02.04)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP03/17054

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 3-207998 A (Hiroaki KAN'NO), 11 September, 1991 (11.09.91), Full text; all drawings (Family: none)	1-21
Y	JP 62-217100 A (Director General of Technical Research and Development Institute of Defense Agency), 24 September, 1987 (24.09.87), Full text; all drawings (Family: none)	1-21
Y	JP 61-110900 A (Mitsubishi Electric Corp.), 29 May, 1986 (29.05.86), Claims (Family: none)	1

Form PCT/ISA/210 (continuation of second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP03/17054

Box I Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Claims 1, 5, 6, 12, 16, 17, claims 2-4, 13-15, and claims 7-11, 18-21 do not satisfy the requirement of unity of invention.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest ☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP H743238 B [0002]