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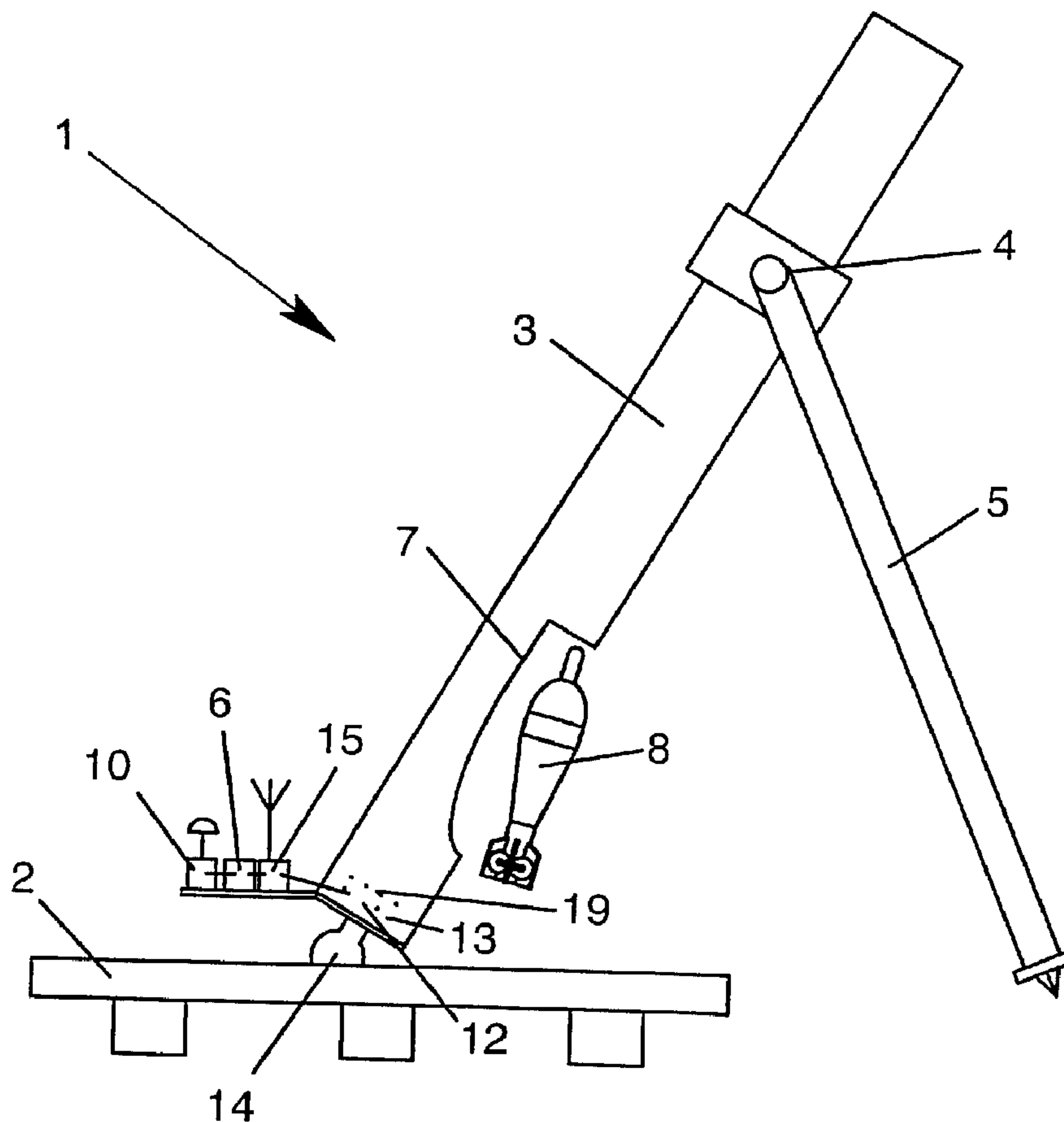
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(54) Titre : SIMULATEUR POUR ARMES A TUBE CHARGEES PAR DEVANT

(54) Title: SIMULATOR FOR FRONT-LOADED BARREL WEAPONS



(57) Abrégé/Abstract:

A simulator for front-loaded barrel weapons, e.g. a mine thrower simulator (1), is provided with an outlet opening (7) at the lower end of the launcher tube (3) through which the shots, e.g. grenades (8), re-exit the launcher tube (3), thus allowing realistic training



(57) **Abrégé(suite)/Abstract(continued):**

conditions. Both the ammunition (8) and the simulator (1) preferably comprise sensors (6, 10; 32, 37, 44) and controls (12; 41) which collect the data from the sensors and perform a first evaluation. The results are transmitted to a computer (16) in the custody of the trainer, which delivers the final evaluation and the calculation of the point of impact, inter alia.

Abstract

A simulator for front-loaded barrel weapons, e.g. a mine
thrower simulator (1), is provided with an outlet opening
5 (7) at the lower end of the launcher tube (3) through which
the shots, e.g. grenades (8), re-exit the launcher tube (3),
thus allowing realistic training conditions. Both the
ammunition (8) and the simulator (1) preferably comprise
sensors (6, 10; 32, 37, 44) and controls (12; 41) which
10 collect the data from the sensors and perform a first
evaluation. The results are transmitted to a computer (16)
in the custody of the trainer, which delivers the final
evaluation and the calculation of the point of impact, inter
alia.

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(FIG. 1)

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SIMULATOR FOR FRONT-LOADED BARREL WEAPONS

The present invention refers to a simulator for front-loaded barrel weapons according to the preamble of claim 1, as well
5 as to suitable ammunition therefor.

Simulation systems for the training of the operation of military weapons systems offer different advantages and are therefore of increasing interest. Amongst other things,
10 fewer security precautions or none at all are required while in the training with real large-range weapons systems, in addition to the severe security precautions for the trainees, large areas, which in some cases can be difficult to find, have to be closed in order to avoid personal and
15 material damages. Ultimately, the training on simulators generally involves lower costs and may therefore be performed more intensely. Also, simulators allow the practice of situations which can only be trained in reality with great complications or not at all, such as the
20 influence of the weather, or shooting in developed areas. In the case of weapons systems requiring relatively expensive ammunition, e.g. front-loaded barrel weapons such as mine throwers, shell throwers, and rocket launchers, reusable ammunition is particularly advantageous.

25

Inter alia, known mine thrower simulator projects suffer from the fact that decisive aspects of the simulation do not correspond to reality, thereby inducing dangerous errors in the operation of real systems. In known constructions,
30 after firing, the shot, i.e. the mine, grenade, illuminating grenade etc. is still in the barrel, from where it must be removed. To this end, it is suggested to pull out the shot from the barrel by means of a suitable tool. On one hand,

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in reality, this manipulation is extremely dangerous, and on the other hand, such a mine thrower simulator does not allow to practice serial fire where the shots are fired in the fastest possible succession.

5

Another suggestion consists in the automatic ejection of the grenades. One possibility is to use a very weak propelling charge, while another possibility is to provide a spring or pneumatic or hydraulic cylinders or the like. The first
10 possibility is noisy and involves the consumption of propelling charges, and the latter one requires the manual or motorised bending of the spring or the generation of the pneumatic or hydraulic pressure, respectively. However, a power driven bending or respective generation of the pressure in
15 turn requires a relatively strong energy source, which is generally not available in a realistic training in the terrain. In any case, all these ejection techniques again require security precautions as the grenades are ejected to a distance of some meters. Also, in the case of a bad
20 landing e.g. on the tail fin, the expensive simulation grenade may be damaged or destroyed, and the fuse in the point may be damaged even in a regular landing. Ultimately, it will be noted that the practice mines or grenades must be laboriously located and collected after the training.

25

It is an object of the present invention to provide a simulator for front-loaded barrel weapons which allows a realistic training of the operation while avoiding at least one of the above-mentioned drawbacks.

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This object is attained by a simulator for front-loaded barrel weapons, preferably for mine or grenade launchers, wherein the lower end of the launcher tube is provided with an outlet opening allowing a respective
5 projectile to drop out.

In one embodiment the launcher tube and/or the support of the mine thrower are provided with measuring means, comprise at least one of: a position measuring device, more particularly one which operates according to
10 the GPS method, in order to determine the geographic position; an inclination measuring device in order to determine the elevation of the launcher tube; and a direction measuring device, preferably one that operates according to the compass principle; in order to determine
15 the actual alignment of the launcher tube.

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FIG. 1 schematically shows a side elevation of a mine thrower simulator;

FIG. 2 shows the evaluating unit;

FIG. 3 schematically shows a partial cross-section of a mine thrower simulator;

FIG. 4 shows a side elevation of a shot for the mine thrower simulator;

15 FIG. 5 shows a bottom view of the mine thrower simulator
 of FIG. 4;

FIG. 6 shows the block diagram of the electronics of a simulation shot; and

20

FIG. 7 shows the block diagram of the electronics of the mine thrower simulator.

With respect to its appearance, mine thrower simulator 1 of
the invention resembles a "real" mine thrower: launcher tube
3 is pivotably mounted on base plate 2. The upper portion
of launcher tube 3 is movably connected to post 5 by a
sighting and adjusting unit 4. Since for the purpose of the
simulation, the alignment of launcher tube 3 is measured by
an electronic compass, inter alia, the simulator is largely

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made of an antimagnetic material in the area of the compass, especially base plate 2 and launcher tube 3, in order not to disturb the magnetic field of the earth. This material may e.g. be aluminium, an aluminium alloy, or brass.

5

The lower end of launcher tube 3 is provided with outlet opening 7 from which grenade 8 drops out at the lower end of launcher tube after having been inserted by the trainee. The small falling height largely prevents damages of grenade 8. Additionally, a padding such as e.g. a mat may be provided under opening 7 in order to further reduce the risk with respect to grenades 8.

Previously mentioned alignment measuring unit 6 comprises an electronic magnet compass for the direction (azimuth) and an angular measuring system (inclinometer) for the determination of the elevation and the tilting angle of launcher tube 3. The alignment measuring unit is mounted along with a radio data transmitting unit 9 and a GPS unit 10 for the determination of the position of the simulator on a support 11 which is attached to launcher tube 3.

The determination of the geographic position and of the elevation and the tilting angle is easily possible with sufficient precision with currently available components. The determination of the direction, however, is problematic. Up to now, in numerous tests, a sufficient precision could only be achieved by the mentioned magnetic compass sensor. However, it is not excluded that different sensor types are used in the future while the requirements are possibly reduced, as the case may be. The assumed limit with respect to the angular precision is 10 artillery %, equivalent to a

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dispersion of ≤ 10 m at a range of 1 km, or to an angular resolution of $1/2^\circ$ at the launcher tube. As it is well known in Switzerland, the term "artillery ‰" refers to a system of measurement where a full circle is divided into 6400 ‰. Thus, 10
5 artillery ‰ refers to $10/6400$ of angular rotation.

The inside of launcher tube 3 accommodates evaluating unit 12 including a disadjusting device, and a battery 13 serving
10 for the power supply of the mine thrower simulator. All these measuring and control modules 6, 9, 10, 12, 13 are mutually connected by power supply, signalling and data lines 21.

15 The disadjusting device, e.g. in the form of an eccentric drive, simultaneously represents the connection between launcher tube 3 and bearing ball 14 resting on base plate 2. After each shot, the disadjusting device is activated by evaluating unit 12 in order to alter the alignment of the
20 launcher tube. In this manner, the disadjustment is simulated, i.e. the effect of the concussion of a real mine thrower at the time of the shot.

The data obtained by thrower evaluating unit 12 are radio
25 transmitted at every shot by transmitter unit 15 to an evaluating device 16 (FIG. 2). Evaluating device 16 is generally in the custody of the trainer and serves for the supervision of the correct operation of the mine thrower simulator, on one hand, and performs a calculation of the
30 trajectory and of the virtual point of impact of the shot, on the other hand. Device 16 may e.g. be a portable computer ("laptop") provided with a corresponding receiver.

FIG. 3 shows a section of mine thrower simulator 1 in an enlarged illustration. A grenade 8 is in the process of sliding down within launcher tube 3. Its lower end carries an optical transmitter 17 which allows the transmission of

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data from the firing control within grenade 8 in the form of light signals 18. These light signals 18 are detected by optical receiver 19 and supplied to launcher control 12 for evaluation. Since transmitter 17 transmits a light cone of
5 a suitably selected opening angle, the intensity of the light signal detected by receiver 19 increases as grenade 8 is approaching. This dependence of the intensity in function of the distance is used in order to detect a grenade sliding down within tube 3 (as opposed to a grenade
10 which is introduced into the tube end prior to firing and which is still being held). The disappearance of the light signal when grenade 8 falls from outlet opening 7 may serve to trigger the simulation of the shot, i.e. as an equivalent to the ignition of the propelling charge of a real grenade.

15

Guiding plates 20 are provided in the area of outlet opening 7 which guide grenade 8 out of the tube even if launcher tube 3 is in an almost vertical position. Guiding plates 20 comprise a passage or a window for light signal 18.

20

FIGS. 4 and 5 show a grenade 8 in an enlarged view. It is essentially composed of body 31, fuse 32 and tail unit 33 with additional charges in the form of plates 34. As in a real grenade, fuse 32 is screwed into body 31. By a mark at
25 the end of the fuse which is screwed into body 31, firing control 35 (FIG. 7) is capable of recognising the actual type of fuse (contact, retarded, time fuse, etc.). In this manner, the usual types of ammunition and applications can be represented by one and the same grenade model, while
30 illegal combinations may be recognised by firing control 35 or in evaluating device 16, as the case may be, e.g. a contact fuse in an illuminating grenade.

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Additional charge plates 34, in the case of the simulation shot in the form of simple plates which preferably resemble additional charges, are inserted in respective seats between two fins 36. In order to allow firing control 35 to
5 recognise how many additional charge plates have been attached, which allows to calculate the length of the trajectory, respective sensors 37 for the additional charge plates are disposed between each pair of fins 36. Sensors 37 may e.g. be optical (reflection light barrier) or
10 inductive sensors. In the case of inductive sensors, plates 34 are made of metal or of a metallised support material.

Transmitter 17 is disposed at the lower end of tail surfaces 33.

15

The description of this exemplary simulation shot also shows that an ejection by a reduced propelling charge involves additional difficulties: even a reduced propelling charge would produce high temperatures in the tail surfaces, the
20 propelling gases resulting from the combustion of the propellant are very hot and under high pressure, and firing control 35 within the grenade is subject to a high acceleration, thus exposing firing control 35, sensors 37, and transmitter 17 to the risk of being damaged and
25 correspondingly requiring an expensive temperature-, pressure-, and acceleration-resistant design of these components.

FIG. 6 shows a block diagram of firing control 35. It
30 includes a central unit 41 which essentially consists of a microcontroller. As an energy source 43, a capacitor of an extremely high capacity is used, e.g. a gold-cap capacitor known per se. On account of the nevertheless small

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available energy, the firing control is switched on by an inclination sensor 42 only when the angle of the grenade with respect to the horizontal direction is in the range of the elevation of the mine thrower simulator (e.g. 45° to 5 90°).

The energy source is preferably charged while the grenade is stored in a special transport container (not shown). For this purpose, the transport container is provided with a 10 battery, inter alia. The energy may be transmitted by electric contacts on grenade 8 and in the container or in a wireless manner e.g. by inductive means.

As energy source 43 is so dimensioned that its energy is 15 essentially used up after a shot, the unrealistic immediate reuse of the grenade after its "firing" is excluded. Rather, after firing, the grenade must be returned to the transport container and left therein until the energy source is recharged.

20

In the case of energy sources having a greater capacity, it is necessary for a realistic simulation that the grenade is deactivated after firing or generates a special signal which indicates that the grenade has been reused.

25

Central unit 41 actuates transmitter 17 which generates light signals 18 for the transmission of data.

Further, optional sensors 44 may be provided in addition. 30 For example, a luminosity sensor responding to the absence of light in tube 3 could be used in combination with inclination sensor 42 in order to detect a shot, or an acceleration sensor which detects the shot by the impact of

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grenade 8 on the bottom of the launcher tube, on the deflecting device or on the base plate individually or in combination with inclinometer 42. Furthermore, it is possible to use other sensors incorporated in the grenade, 5 e.g. switches, optical, inductive or capacitive sensors, individually or in combination in order to determine whether the grenade is in the launcher tube.

The control system 51 (FIG. 7) of the thrower consists of 10 evaluating unit 12 and of position sensor 10 (GPS unit), elevation/tilting sensor 52 (inclinometer) and direction sensor 53 (compass) connected thereto. The light signals transmitted by a grenade 8 in launcher tube 3 are received by light detector 19 whose output signals both represent a 15 measure of the distance of grenade 8, i.e. of its position in launcher tube 8, and provide information with respect to the grenade which is transmitted by the firing control.

The firing data, i.e. all data which are necessary in order 20 to calculate the shot, are transmitted to evaluating unit 16 by transmitting unit 15. Energy source 54 is a battery or an accumulator.

Furthermore, by means of control unit 55, the mine thrower 25 simulator can be set to represent different real thrower types which are e.g. characterised by different calibre.

Hereinafter, a typical training sequence will be described. The mine thrower simulator is set up and directed to a 30 target. The trainer continuously surveys the operations by means of the data indicated by the evaluating unit. According to the aimed (virtual) target and the firing parameters, the mine thrower simulator is aligned and the

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required number of grenades is prepared by the gunner. As the grenades are lifted up and tilted according to the inclination of the tube, firing control 35 is activated, provided that a fuse is screwed in and (virtually) armed.

5 While the grenade slides down in launcher tube 3, the characteristic data of the grenade are transmitted to thrower control 51, which delivers them to evaluating device 16 along with the data concerning the orientation of the launcher tube. The evaluating device calculates the

10 trajectory and the point of impact on the base of these data and/or delivers a message in the case of illegal operating conditions.

When the grenade drops out through outlet opening 7, it is

15 deactivated either by lack of energy or by the fact that the firing control is automatically blocked after the simulation of a shot. It is also possible that data are transmitted from the mine thrower simulator to the grenade in the launcher tube for this particular purpose.

20

Since the described mine thrower simulator neither produces a firing noise -- although it could be generated, as the case may be, by a noise generator, however at a substantially lower level, in view of a realistic simulation

25 -- nor are the grenades ejected, the device allows to practice almost anywhere, e.g. also in developed areas or in halls.

In a real mine thrower, the grenades in the launcher tube

30 are slowed down by an air cushion formed under them on account of the necessary, relatively tight contact with respect to the tube wall. Due to the outlet opening, such an air cushion cannot form in the simulator. In view of a

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more realistic sliding time of the grenades in the tube, in particular for the training of serial fire, the friction of the grenades on the tube wall may be increased by suitable measures such as a tighter fit at least locally, special
5 material combinations, or the attachment or insertion e.g. of felt surfaces or similar materials on or in surface sections of the grenades which are in contact with the tube wall, and/or in the tube wall. In addition, it is possible to keep outlet opening 7 closed by a cover, to drop the
10 grenade on the bottom of the launcher tube in the free fall or in a retarded manner, and to open the cover preferably after the typical delay between the insertion and the ignition of the grenade. The cover may e.g. be opened by the action of the own weight of the grenade, by an auxiliary
15 drive (motor), or by the stored energy of the descending grenade. If it is suitably shaped, the cover may additionally serve to remove the grenade from the launcher tube in a relatively gentle and defined manner.

20 The cover may also be kept closed by an electromagnet, so that the control system of the mine thrower simulator can release the cover by an electric signal. Under the weight of the grenade, possibly reinforced by its kinetic energy, the cover is forcibly opened and the grenade slides out.

25 Subsequently, the cover is automatically closed by a return spring.

A possible alternative of the controlled opening could be to dimension the closing spring in such a manner that the cover
30 is automatically opened by the own weight of the grenade. Besides, it is sufficient if the cover only closes the outlet opening in such a manner that the grenades can no longer fall out of the tube.

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In simulators for mine throwers which do not fire automatically but where a grenade within the launcher tube is externally fired, e.g. by means of a release line, a
5 cover of this kind or an equivalent closure device must be provided. Only when the release is actuated, the simulation is triggered, on one hand, and the cover opened, on the other hand, so that the grenade can drop out.

10 In order to slow down the grenade while it is falling out, the return spring element can be made so strong that an effective braking of the grenade results from a squeezing action between the launcher tube and the cover. In
15 addition, the cover may be provided with a kind of guide, e.g. in the form of a short tube section, and/or with a lining for an increased friction (felt or spring strips) in order to reduce the falling velocity of the grenades.

Alternatives of the exemplary embodiment are accessible to
20 those skilled in the art from the description without leaving the scope of the invention as claimed.

It is possible, for example, to provide an additional detection unit operating according to the echo method, e.g.
25 an ultrasonic detector in the tube which allows to detect the presence and movement of a grenade in the launcher tube independently, and/or inductive sensors for this purpose on the launcher tube.

30 With respect to the distinct external shape of different types of ammunition, particularly of illuminating and explosive ammunition, it may also be advantageous to make the body variable, e.g. by an interchangeable envelope.

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The measuring and evaluating units provided on the simulator may be arranged differently. It is e.g. possible that all parts are disposed inside the launcher tube, so that only
5 the antenna of transmitting unit 15 is possibly mounted on the outside. It is also conceivable to dispose the compass at another suitable location, e.g. on base plate 2, in which case, however, the angular difference between base plate 2 and bearing ball 14 of the launcher tube must be measured by
10 a suitable measuring device, e.g. an optical angular transmitter, and taken into account in the evaluation. Also, in the reactivation or respective recharging of the grenades, e.g., as suggested, in the transport container, a possibility of reprogramming the grenades e.g. as explosive
15 or illuminating ammunition could be provided. In this manner, only one kind of programmable ammunition would be sufficient for the simulation of a large number of real ammunition types. The programming, and maybe even the connection of a fresh energy source, could also be effected
20 by the exchange of the envelope (see above).

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CLAIMS:

1. Simulator for front-loaded barrel weapons,
preferably for mine or grenade launchers, wherein the lower
end of the launcher tube is provided with an outlet opening
5 allowing a respective projectile to drop out.
2. Simulator according to claim 1, wherein the outlet
opening is closed by a closure device at least to such a
degree that a grenade cannot fall through the outlet
opening, and in that the closure device is provided with a
10 release device which allows to open the closure device and
thus the outlet opening.
3. Simulator according to claim 2, wherein the
closure device in the open condition is pushed into the
closed position by pressure means, preferably by elastic
15 spring elements, and/or comprises means which exert a
braking action on the exiting grenade in order to ensure a
controlled drop out of the grenade from the outlet opening.
4. Simulator according to any one of claims 1 to 3,
wherein at least one guiding means is provided, more
20 particularly in the form of a ramp extending to the lower
end of the outlet opening, in order to ensure a disturbance-
free drop out of the projectiles from the outlet opening.
5. Simulator according to any one of claims 1 to 4,
wherein braking means, more particularly at least one area
25 or several areas providing increased friction, or
restrictions are disposed in the launcher tube in order to
adapt the falling time of a projectile in the launcher tube
to realistic conditions.
6. Simulator according to any one of claims 1 to 5,
30 wherein the launcher tube and/or the support of the mine

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thrower are provided with measuring means, comprise at least one of:

- a position measuring device, more particularly one which operates according to the GPS method, in order to
5 determine the geographic position;

- an inclination measuring device in order to determine the elevation of the launcher tube; and

- a direction measuring device, preferably one that operates according to the compass principle;

10 in order to determine the actual alignment of the launcher tube.

7. Simulator according to any one of claims 1 to 6, wherein receiving means for data signals are provided at the lower end of the launcher tube, particularly for
15 electromagnetic, acoustic, and/or optical radiation, in order to receive a data signal transmitted by a projectile in the launcher tube.

8. Simulator according to claim 7, wherein the receiving means are capable of generating a signal at least
20 one parameter of which, particularly the amplitude, is a function of the position of at least one of the projectile in the tube and the presence of a projectile in the launcher tube, in order to release a firing simulation by the detection of a projectile descending in the launcher tube.

25 9. Simulator according to any one of claims 1 to 8, wherein means for the detection of a projectile are provided, preferably within the launcher tube at the lower end thereof, in order to determine the presence and preferably also the approximate position and/or movement of
30 a projectile in the tube.

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10. Simulator according to any one of claims 1 to 9,
wherein the launcher tube is provided with a displacing
device allowing to disadjust the launcher tube and thus to
simulate the effect of real fire with respect to the
5 alignment.

11. Simulator according to any one of claims 1 to 10,
wherein a control device monitors at least one of the
following operating conditions:

- the firing of a projectile;
- 10 - the alignment of the launcher tube, particularly
its elevation, tilting and/or direction;
- the geographic position;
- the type of ammunition used for each shot.

12. Simulator according to any one of claims 1 to 11,
15 wherein a sensor responding to the magnetic field of the
earth is coupled to the launcher tube in order to determine
the direction of the tube, and in that the metallic parts of
the simulator are at least preponderantly made of an
antimagnetic material, more particularly of aluminum or of
20 an aluminum alloy, in order to avoid a local perturbation of
the earth magnetic field.

13. Projectile for a simulator according to any one of
claims 1 to 12, comprising transmitting means as well as a
control unit, the control unit being capable of transmitting
25 data signals by means of the transmitting means whose
content indicates the type of ammunition simulated by the
projectile.

14. Projectile according to claim 13, wherein the
projectile is essentially composed of the tall surfaces, the

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body, and of the fuse, of which at least the fuse is detachably mounted, thus allowing to simulate at least one of the function and the shape of different types of ammunition for mine throwers by exchanging at least one of
5 the body and the fuse.

15. Projectile according to claim 13 or 14, wherein an intensity of said emitted data signal decreases as a distance of the projectile increases, thus allowing a determination of a distance of the projectile from a
10 receiving means of the data.

16. Projectile according to any one of claims 13 to 15 or for a simulator according to any one of claims 1 to 12, wherein the projectile includes at least one device capable of receiving additional charge simulation units, the device
15 comprising detection means to determine the number of attached additional charge simulation units.

17. Projectile according to claim 16, wherein the additional charge simulation units comprise small plates which are attachable to the tail surfaces of the projectile,
20 the projectile further comprising attachment provisions for a certain maximum number of additional charge simulation units, and in that a detector, each said attachment provision including a detector for detecting a presence of each said additional charge simulation unit in each
25 respective said attachment.

18. Projectile according to any one of claims 13 to 17, wherein the projectile comprises a projectile control unit and detection means, the detection means allowing detection of a simulated firing of the projectile and
30 transmission of corresponding information to the projectile control unit, the projectile further comprising first transmitting means for the transmission of a signal, the

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projectile control unit being adapted to transmit a first signal when the projectile is fired for the first time, and a second signal which differs from the first signal, no signal being transmitted when the projectile is fired for at least a second time and a further time, thus allowing a determination to be made whether the same projectile is being used more than once.

19. Projectile according to claim 18 and container for at least one projectile, wherein the condition of the projectile control unit prior to being fired for the first time is restored when the projectile is placed in the container, the latter comprising second connecting means that are capable of contacting complementary third connecting means in the projectile, and in that the resetting procedure is enabled by the contact and/or the signals exchanged during the contact of the second and third connecting means.

20. Simulator according to any one of claims 1 to 10, wherein a control device monitors all of the following operating conditions:

- the firing of a projectile;
- the alignment of the launcher tube, particularly its elevation, tilting and/or direction;
- the geographic position;
- the type of ammunition used for each shot.

21. Simulator according to any one of claims 1 to 12, wherein the projectile comprises a projectile control unit and detection means, the detection means allowing detection of a simulated firing of the projectile and transmission of corresponding information to the projectile control unit,

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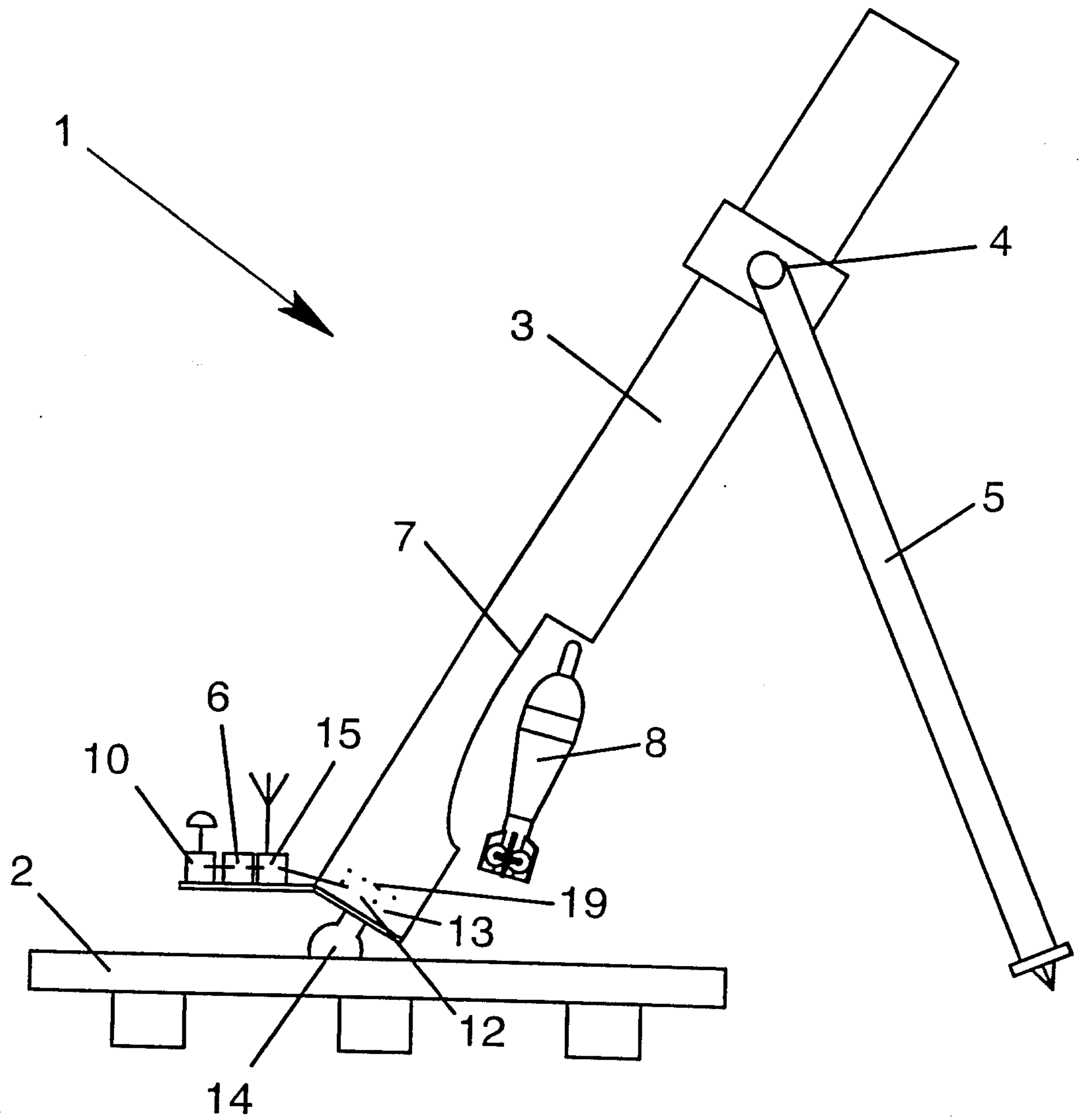
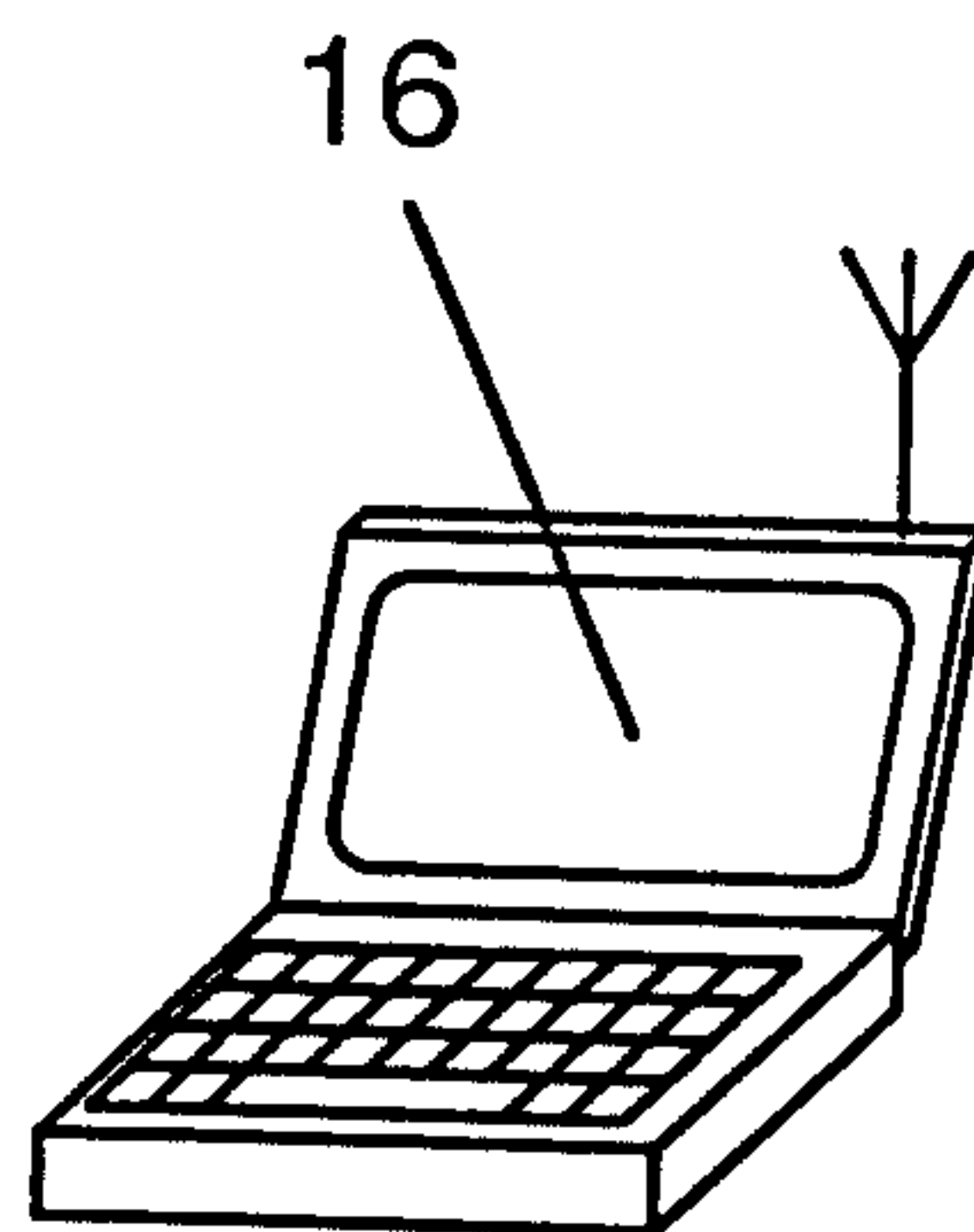
the projectile further comprising first transmitting means
for the transmission of a signal, and the projectile control
unit being adapted to transmit a first signal when the
projectile is fired for the first time, and a second signal
5 which differs from the first signal, no signal being
transmitted when the projectile is fired for at least a
second time and a further time, thus allowing a
determination to be made whether the same projectile is
being used more than once.

FETHERSTONHAUGH & CO.

OTTAWA, CANADA

PATENT AGENTS

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Fig 1Fig 2

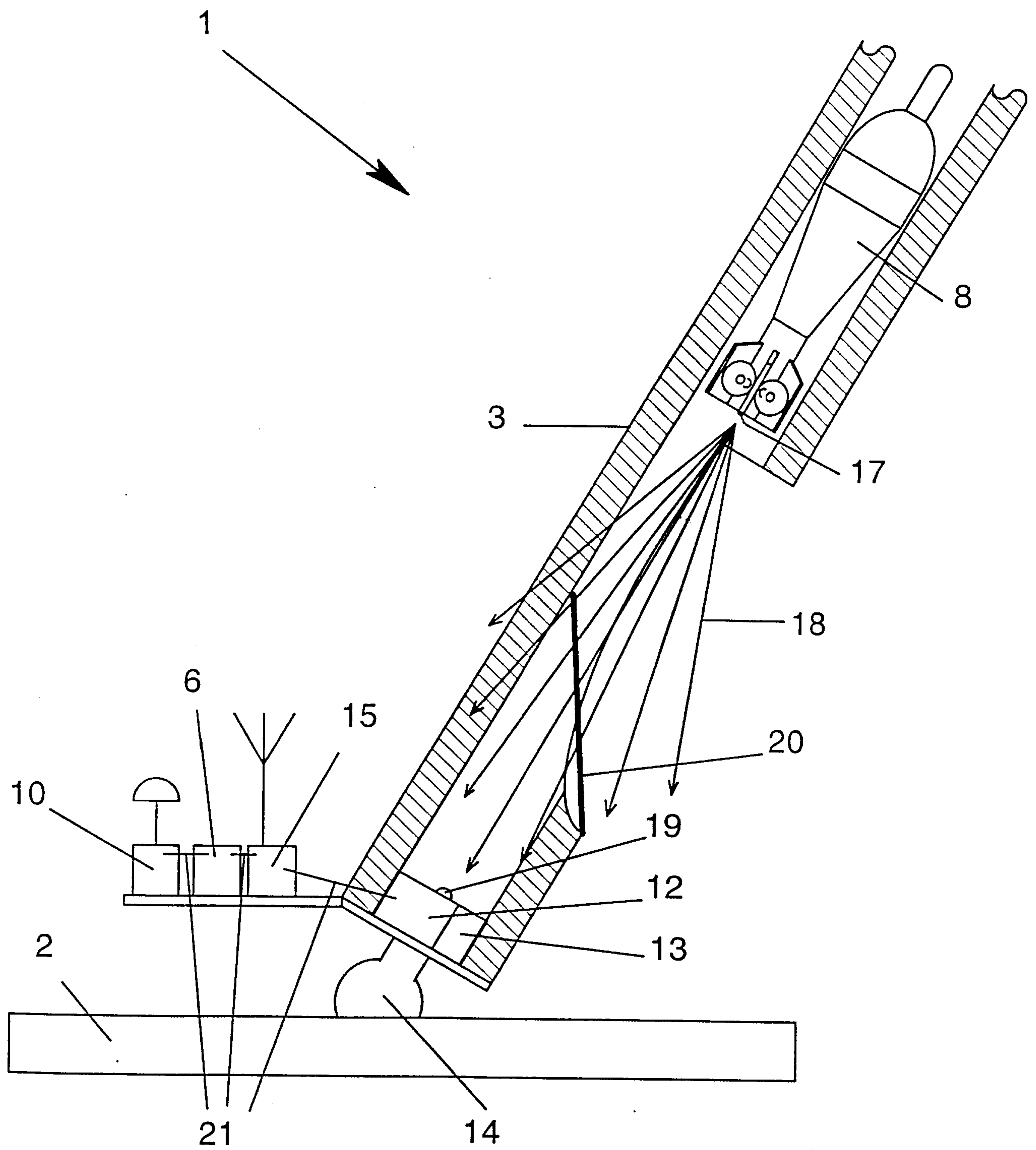


Fig 3

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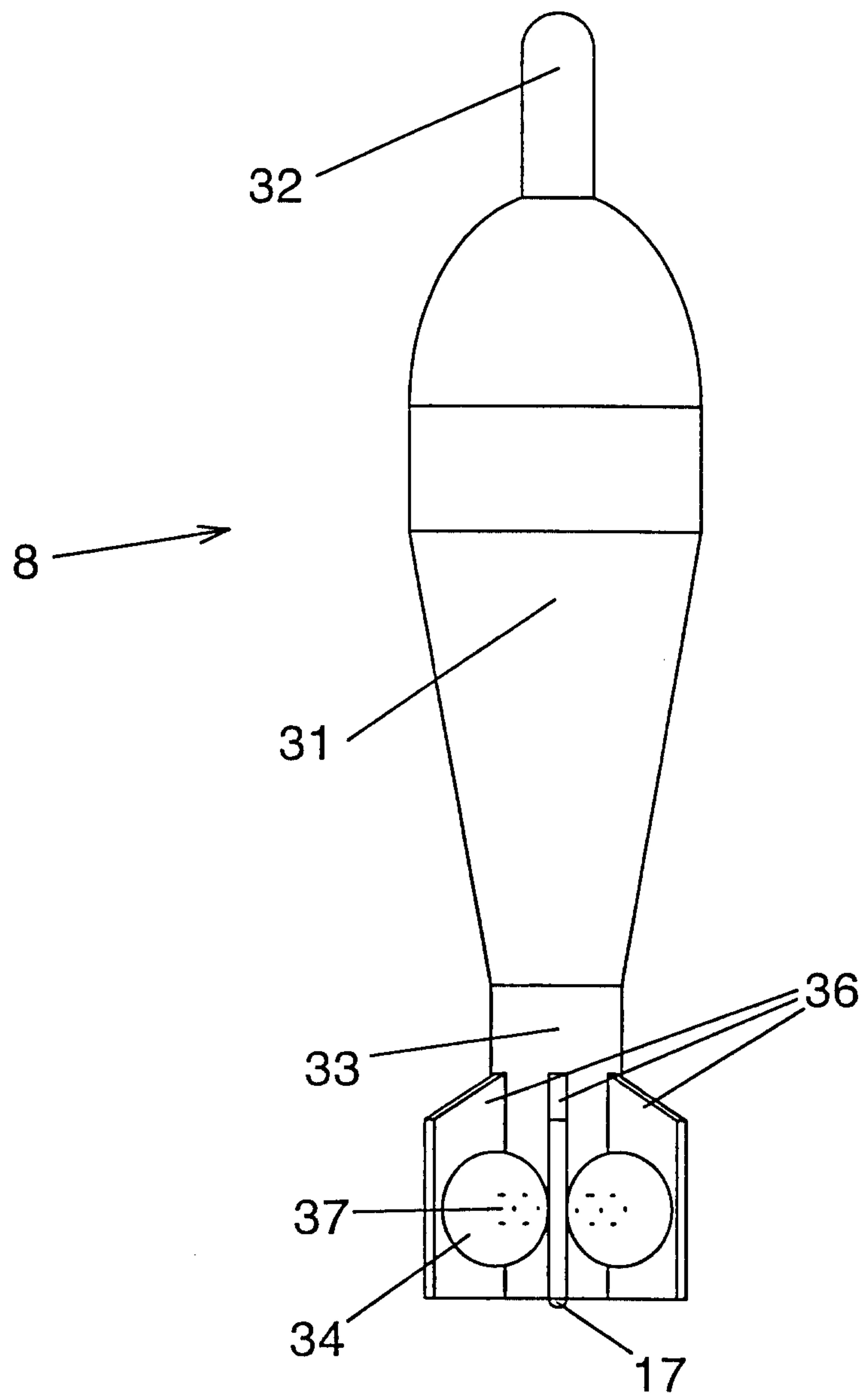


Fig 4

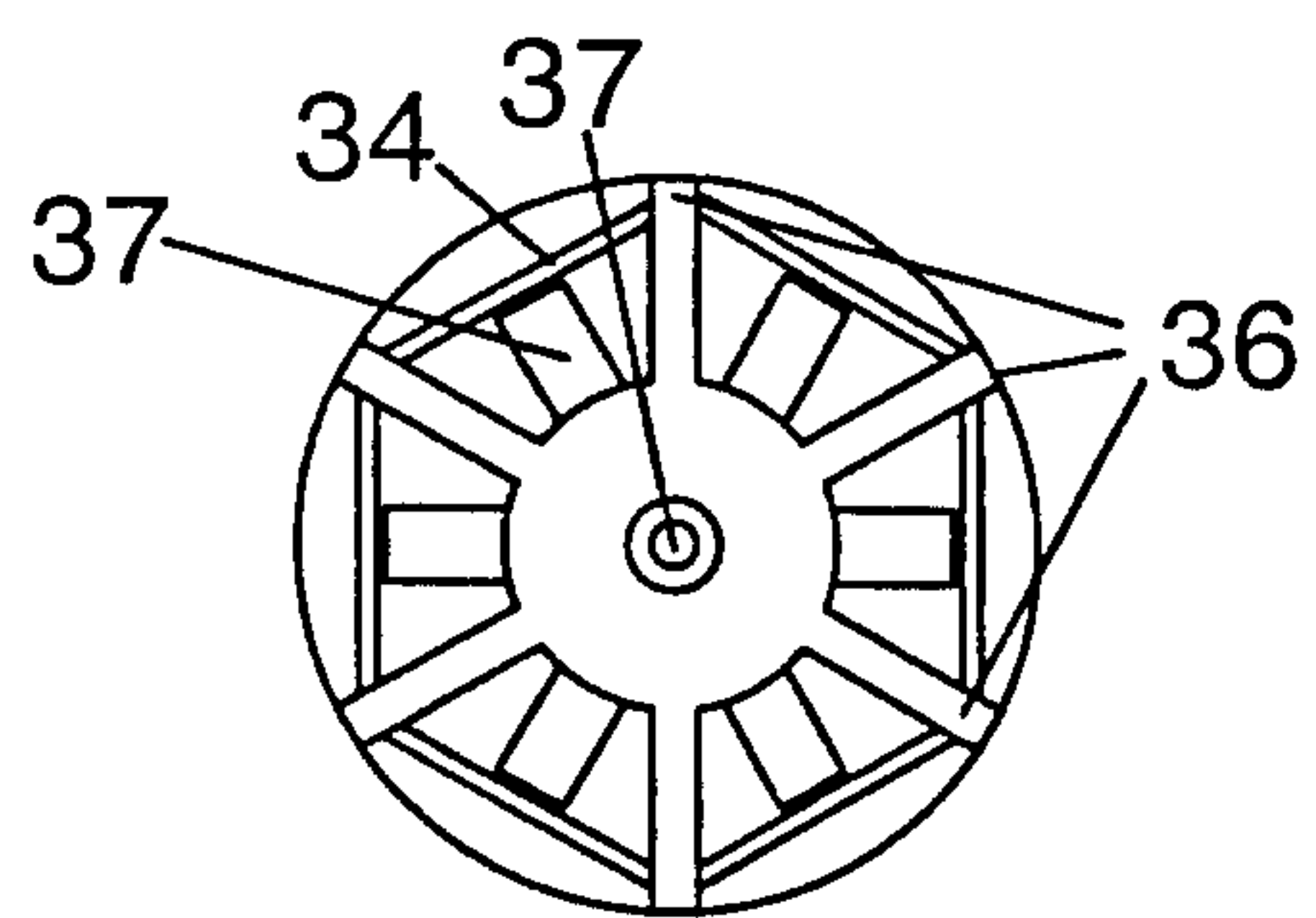


Fig 5

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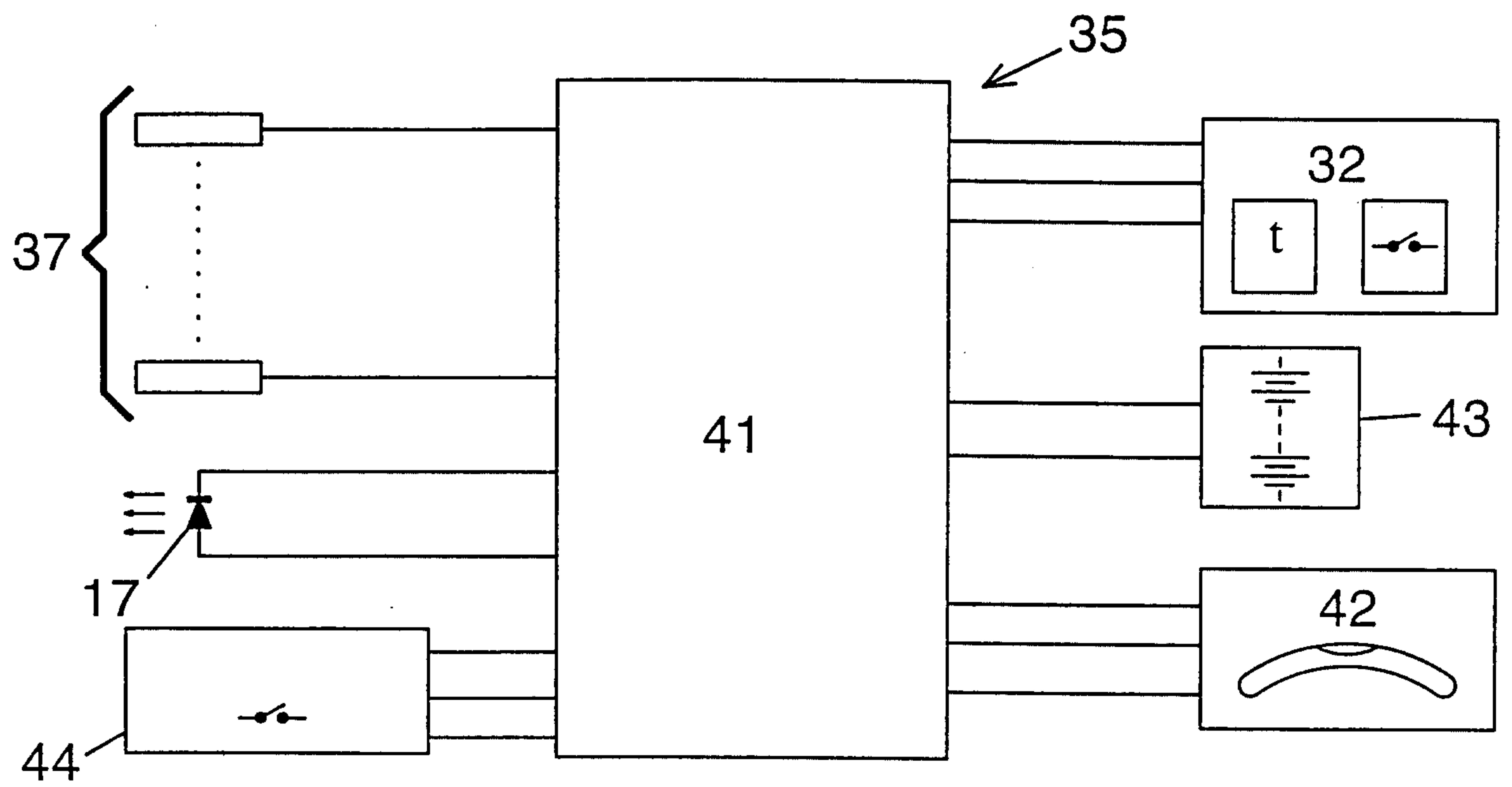


Fig 6

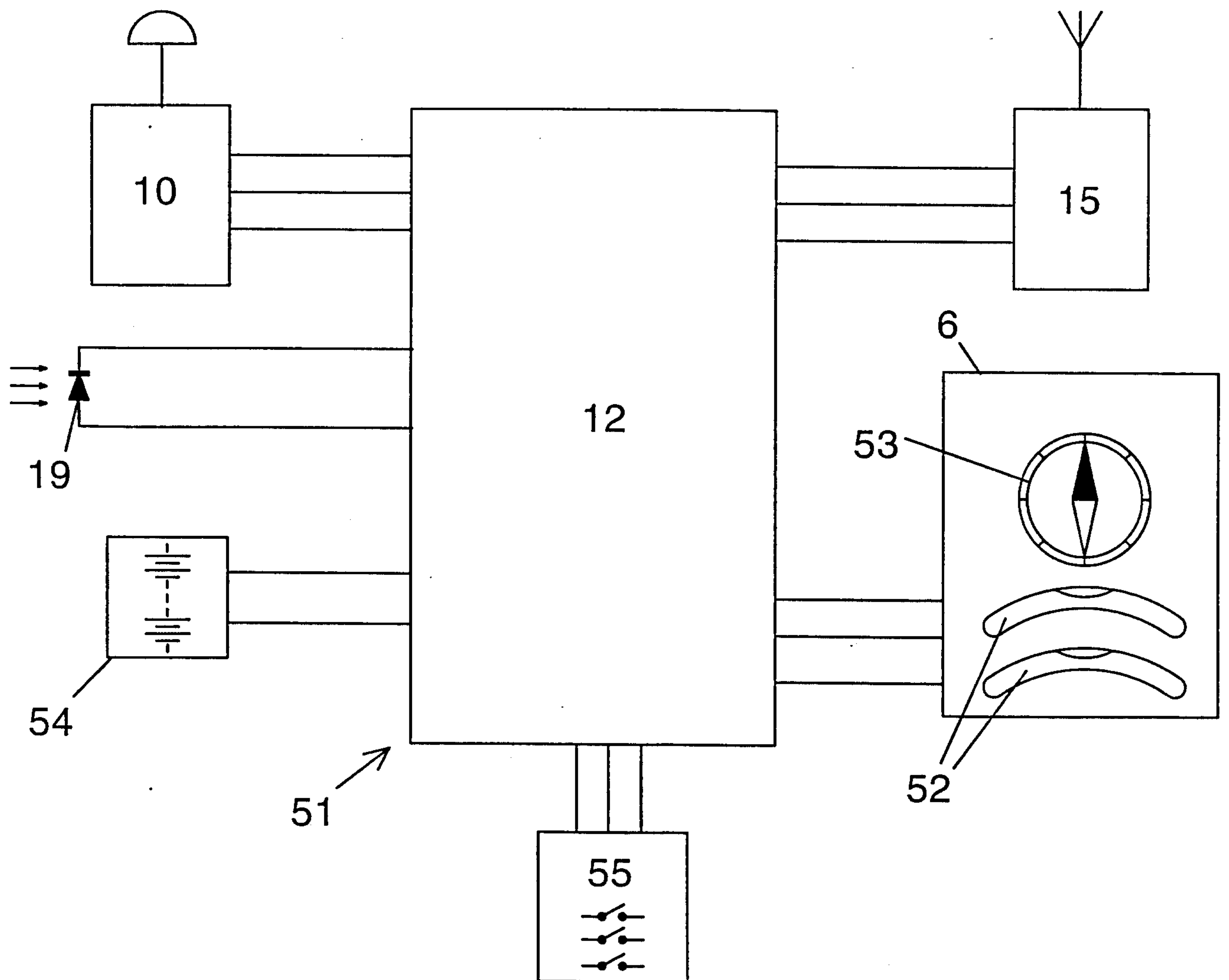


Fig 7

