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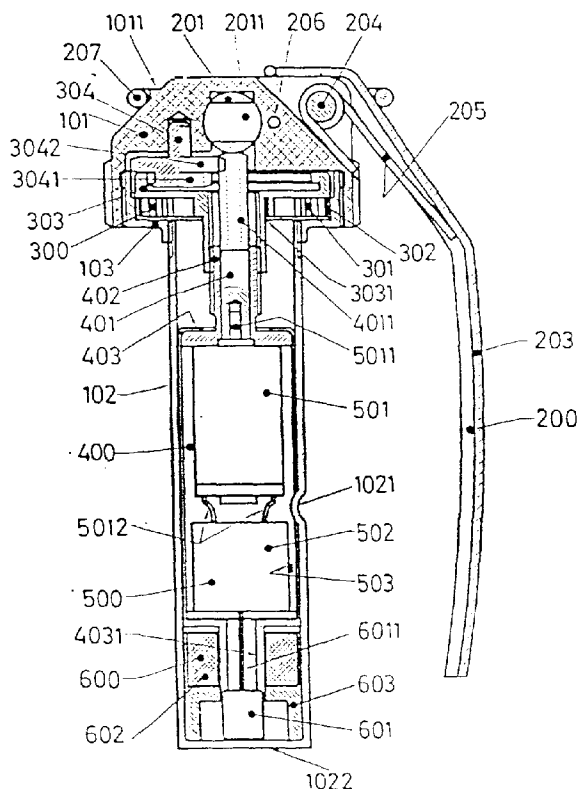
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E-50002 Zaragoza (ES)(54) **Mechano-electronic fuze for hand grenade**

(57) It consists of conventional mechanical carriage and handling safety-devices and safety-devices functioning mechanically and electronically. An original autonomous electric supply system. An electronic rather than a pyrotechnic delay. An explosive chain that changes from being misaligned to being in line, and able to

trigger the detonation of the main charge in a hand-grenade. The energy required for it to function is stored in a spring (205) driving an electric generator (501), which improves storage, handling and use safeties, and the repeatability of the delay at any temperature, concurrently very substantially extending its useful life.

FIG.4**EP 0 781 975 A2**

Description

FIELD OF THE INVENTION

MECHANO-ELECTRONIC FUZE FOR HAND-GRENADE.

The object of the present Patent application is a Mechano-Electronic Fuze for hand-grenade, which, in addition to the function for which it was designed, affords a number of advantages described hereinafter, and others that are inherent in its organisation and constitution.

BACKGROUND OF THE INVENTION

One of the most widespread ammunition types in all the armies of the world is, as it has been for a long time, the hand-grenade.

The utility of this ammunition is dependent on the power of its explosive charge and on the characteristics of its fuze. The fuze must be absolutely safe during storage, carriage and launching. It must also fire the explosive charge either after a delay once the grenade is launched, or upon the grenade striking a solid object.

Typical solutions to provide a delay have until now consisted of using either pyrotechnic elements based upon the use of mixtures of materials with which to reach a particular rate of combustion, or mechanical or clock-work delays.

Elements of this kind have the following drawbacks, inter alia:

- The delay achieved is irregular.
- Their characteristics are degraded due to an exposure to extreme environmental conditions.
- Capacity to endure vibrations, shocks, etc is small.
- Useful life is limited.
- Safety is not absolute in storage conditions.

The above have resulted in manifold accidents due to both spontaneous explosions under inoperative conditions and unexpected shortenings of the delay upon use.

SUMMARY OF THE INVENTION

The current state of the art of electronics, which enables reliable, efficient and very economical solutions with regard to both space and price requirements, on the one hand, and the use of conventional and over-tested mechanical elements, on the other hand, have enabled the object of the present Patent application, which refers to a Mechano-Electronic Fuze for hand-grenade of original conception.

The energy supply for this Mechano-Electronic Fuze for hand-grenade comprises a simple spring which, upon being released from any mechanical safety devices, actuates a minute electric generator whose

power supplies an electronic safety and timer assembly and finally an electric detonator which, by either changing its position relative to a multiplier or removing a protective barrier, or otherwise howsoever, takes up a position to trigger a multiplier which shall in turn set off the main explosive charge.

The Mechano-Electronic Fuze for hand-grenade subject of the present Patent application provides improvements and original elements over fuzes conceived for a similar use because:

- It is absolutely safe under inoperative conditions, during storage and handling.
- It is absolutely safe for some time after launching, this time being pre-set and constant.
- Neither its safety nor its functioning are altered by electromagnetic fields.
- It allows the explosive charge in the hand-grenade to be set off both after a delay and by impact, and further by a combination of delay and impact.
- The delays are electronically controlled which, unlike currently existing pyrotechnic delays, renders them almost entirely independent of external conditions such as atmospheric temperature, and moreover ensures a great repeatability of the set values.
- It can be coupled to most hand-grenades now in service without requiring any significant alterations.
- Its useful life is equivalent to that of conventional explosives used in the main explosive charges of hand-grenades.
- It is wholly maintenance-free.

The present Patent provides the advantages described above as well as others that will follow easily from the embodiment of a mechano-electronic fuze for hand-grenade, which is described hereinafter in detail for an easier understanding of the characteristics set out above, contemporaneously giving a number of details and attaching to the present specification, to such end, some drawings which show a practical example of the object of the present invention that is meant to illustrate and not to limit its scope.

Brief description of the drawings.

In the drawings:

Figure 1 is an external side elevation view of an embodiment of a mechano-electronic fuze adapted to the body of a hand-grenade.

Figure 2 is view rotated 90° in relation to the preceding figure.

Figures 3, 4 and 5 illustrate the same number of internal views of an embodiment of a mechano-electronic fuze.

Figures 6 to 9 illustrate successive stages of the functioning of the mechano-electronic fuze.

Figure 10 is a diagram of the electronic module.

Description of an embodiment of the invention.

The Mechano-Electronic Fuze proposed in the present Patent application has been devised to be used in hand-grenades, albeit without limitation. Its external shape is therefore adapted to be fitted in hand-grenades most widely used nowadays, although it may be adapted to any other shape with only slight alterations.

A particular embodiment of the conception explained, from among the many possible embodiments, is described below. Such would comprise:

- A container (100) including all the parts in sight, saving the parts of the Lever Safety Device (200).
- A Lever Safety Device (200) which keeps the Fuze safe whilst it is handled and launched. This Safety Device is fully conventional and must simply lock the main spring which stores the functional energy required.
- A Drive (300) supplying the functional energy required by the Mechano-Electronic Fuze.
- A Slide (400) in turn containing the Electronic Module (500) and incorporating part of the Explosive Chain (600).
- An Electronic Module (500) producing electric power by means of a generator and using such power for the purposes intended for a fuze.
- An Explosive Chain (600) including the elements needed to detonate the explosive charge in the hand-grenade under a suitable stimulus.

The Container (100) in turn includes:

- A Head (101) being the only part of the Mechano-Electronic Fuze projecting, albeit only partially, from the body of the hand-grenade in which it is fitted. It has the necessary elements to register all the elements it houses, an outer thread to be coupled to the body of the hand-grenade, and an inner thread to be connected to the Neck (103). It is externally provided with a ledge (1011) on which the Ring (207) fits and is therefore locked.
- A Body (102). It is vessel-shaped and made so as to protect the Electronic Module (500) from contingent external electromagnetic influences. The Slide (400) can slide inside the same. It has a thread to be connected to the Neck (103) and an Inner Ledge (1021) preventing the Slide (400) from rotating but allowing it to slide.
- A Neck (103) serving to solidly and sealingly connect the two main parts of the Container (100), the head (101) and the Body (102). It houses and provides register for the Drive (300).

The Lever Safety Device (200) may, as aforesaid, have any conventional design. A possible embodiment thereof is described as an example, which would include:

- A cylindrical Bolt (201) inserted in the Head (101). Its central portion has a hole (2011) that may or may not allow the Pinion (401) through, depending upon its position. It is provided with planes or a slot (2012) on either end at the area lying outside the Head (101) to allow its position to be secured. A flat shape (2013) limits its rotation to 90° from its inoperative position.
- Two O-Rings (202) sealing the hole in the Head (1019) where the Bolt (201) is housed.
- A Lever (203) whose shape adapts to the palm of the hand. Its end fits in the planes or slot (2012) on the Bolt (201) thereby for the Lever (203) and Bolt (201) to turn together. The shape of this Lever (203) and the ends of the Spring Axis (204) projecting from the Head (101) prevent the Lever (203) from prematurely releasing the Bolt (201) even if the hand-grenade is gripped with little strength.
- A Spring Axis (204) fitted in the Head (101).
- A coiled Spring (205) with two arms, turning about the Spring Axis (204) and tending to lift the Lever (203).
- A Pin (206) inserted in the Head (101) and preventing the Lever (203) from turning.
- A Ring (207) designed to expedite removal of the Pin (206). In the embodiment described, albeit without limitation, this part is independent of the pin (206). Its shape and arrangement ensure that no involuntary removal of the Pin (206) may occur. In order to avoid its displacement, it fits in the ledge (1011) of the Head (101) when it is inoperative.

The Drive (300) includes:

- A Spiral Spring (301) supplying the energy for the Mechano-Electronic Fuze to work. One of its ends is fixed to the Vessel (302) and the other to the slot (3031) on the Crown (303).
- A Vessel (302) containing and limiting the Spiral Spring (301). Once mounted, it is locked to the Neck (103).
- A movement transmission system capable of adapting the movement generated by the Spiral Spring (301) to the Generator (501) input needs, and comprising in the case being described, albeit without limitation, a gear train including:
 - A Crown (303) having an inner gearing and an outer thread connecting it to the Screw (402) of the Slide (400). It is actuated directly by the Spiral Spring (301) and is engaged at its slot (3031).
 - An Intermediate Pinion (304) including two cogwheels (3041 and 3042) each having a different number of sprockets. It conveys the rotation of the Crown (303) to the Pinion (401) adequately modifying the number of turns.

The Slide (400) includes:

- A Pinion (401) having a very long gearing (4011) to allow the Slide to travel (400). It is firmly connected to the Shaft (5011) of the Generator (501) and meshes with the output cogwheel (3042) of the Intermediate Pinion (304).
- A Screw (402) which is screwed to the Crown (303). It allows the Pinion (401) to turn inside it.
- A Jacket (403) containing the Electronic Module (500) and locking it to the Screw (402). It is tubular in shape (4031) at its lower end to serve as a position finder for the Detonator (601) and as a closure for the Barrier (603).

The Electronic Module (500) includes:

- A Generator (501) actuated through its shaft (5011) by the Pinion (401) to generate electric power for the Electronic Module (500) to work. It is connected to the Board (502) by means of Conductors (5012).
- A printed circuit Board (502) to which all electronic components, such as condensers, diodes, resistors, transistors and analogue switches are welded, as required for it to function as described in the relevant section (numbered from 511 to 523) and conductor paths to connect such elements.
- A Commutator (503) keeping the Detonator (601) short-circuited when inoperative.

There are alternatives to the embodiment described as the preferred embodiment which could be advantageous. Some are as follows:

Replacing the Commutator (503) with its electric relay forming part of the Electronic Module (500) and keeping the Detonator (601) short-circuited when inoperative. It would thus be possible for the Detonator (601) to remain short-circuited when inoperative, whereas the release of such short-circuit would not depend upon a mechanical type drive.

Eliminating the Commutator (503). The Electronic Module (500) is thereby simplified, and the functioning of the Detonator (601) is not dependent upon mechanical movements. Furthermore, when inoperative, the Detonator (601) remains in closed circuit which, albeit not a short-circuit, is over-safe.

Including an impact detector of any universally known and sufficiently tested types (ball, floating hammer, etc.) adds the possibility of it functioning by impact or a combination of impact and delay, without substantially altering the description of the concept of this Mechano-Electronic Fuze.

The Explosive Chain (600) includes:

- An electrically stimulated Detonator (601). This connects with the Electronic Module through the Conductors (601). It registers in the tubular shape (4031) of the Jacket (403) and is fixed thereto. This element can be any of those available in the market.
- A hollow cylindrical Multiplier (602) allowing the tu-

bular shape (4031) of the Jacket (403) and the Detonator (601) through. It is fixed to the Body (102).

- A Barrier (603) made with shapes and of a resisting material such as to be able to endure the detonation of the Detonator (601) in its inoperative -misaligned-position without such detonation being transmitted to either the Multiplier (602) or the explosive charge in the hand-grenade.

Functioning.

a) During storage and carriage of a hand-grenade equipped with the Mechano-Electronic Fuze subject of the present Patent application, the Pin (206) prevents the Lever (203) from moving, and the Bolt (201) therefore remains lodged against the forward movement of the Pinion (401).

The Bolt (201) therefore prevents the forward movement of the Slide (499) that is in turn screwed to the Crown (303) and thus any movement of the mechanism is fully disabled, although the Spiral Spring (301) tends to turn the Crown (303).

The Detonator (601) is short-circuited through the Commutator (503) and is moreover misaligned with respect to the Multiplier (602) and enclosed between the Barrier (603) and the tubular shape (4031) of the Jacket (403).

In the highly unlikely event of the Detonator (601) exploding in such position, the Multiplier (602) is protected by the Barrier (603) and the shock wave generated by the Detonator (601) shears the bottom (1022) of the Body (102) and the bottom of the body of the hand-grenade, being lost into the open air without causing further damage. This is why the detonation of the explosive charge in the grenade would never be induced, i.e. negative functioning is disabled.

Given the superposition of safeties described hereinbefore, the Mechano-Electronic Fuze for hand-grenade subject of the present Patent application is wholly safe in negative. Since the possibility of the hand-grenade exploding by chance becomes dependent only on the main charge, this possibility is hugely minimised.

b) In order to use the hand-grenade, the latter is taken making sure that it is held firmly and with the Lever (203) directed towards the palm of the hand.

The Ring (207) is removed from the housing (1011) and is used to remove the Pin (206). Thereafter, all that prevents the Spring (205) from turning the Lever (203) is the palm of the launcher's hand.

The process is absolutely conventional up to this point.

c) When launching takes place and the hand-grenade leaves the launcher's hand, the Spring (205) pushes the Lever (207), making it turn, and due to its fit within the planes or slot (2012), the Bolt (201) also turns.

When the Bolt (201) reaches the limit imposed by the plane (2013), the hole (2011) is directed so as to allow the Pinion (401) through.

When the Pinion (401) is released, the entire Slide (400) may move forward and this allows the Crown (303) to turn.

Since the Spiral Spring (301) forces the Crown (303) to turn at all times, the latter starts to turn.

The rotation of the Crown (303) has two simultaneous and independent effects. On the one hand, and through the thread connecting it with the Screw (402), it pulls from the latter until both parts abut. Since the Screw is firmly connected to the Slide (400) both of them move together. Given that the Detonator (601) is connected to the Jacket (403), it moves together with the whole Slide (400) and on reaching the end of its travel is aligned with the Multiplier (602) -inserted therein-

d) At the same time, when the Slide (400) reaches the end of its travel, the Inner Ledge (1201) actuates the Commutator (503) which opens the short-circuit of the Detonator (601).

e) Furthermore, and by means of the Intermediate Pinion (304), the rotation of the Crown (303) causes the Pinion (401) to rotate. This rotation is independent of the forward movement of the Slide (400) due to the length of the gearing (4011) of the Pinion (401).

Given that the Pinion is firmly connected to the shaft (5011) of the Generator (501), it forces it to turn and the Generator (501) generates electric power.

In another possible embodiment of this Mechano-Electronic Fuze for hand-grenade, the electric power can be supplied by an electric cell or battery, but this solution would be hampered by restrictions as to useful life, maintenance requirements, environmental influences, etcetera, and the embodiment described is therefore preferred.

The power reaches the Board (502) through the Conductors (5012).

f) The Diode (511) prevents the electronic circuit from being discharged if there is a short-circuit outside the Board (502).

The Condenser (512) stores the power generated by the Generator (501).

The Resistor (513) works as a drain for the Condenser (512).

The Resistor (514) and the Condenser (515) form an first-rate analogue delay which regulates a time after launching in which no power is available for the Detonator (601).

g) After the time pre-set in the analogue delay (514-515) elapses, the latter actuates the Analogue Switch (516) which allows the power to pass to the Condenser (521). The Resistor (518) and the Condenser (519) form another first-rate analogue delay which controls the time at which the Mechano-Elec-

tronic Fuze must set the Detonator (601) going.

This delay (518-519) is now mentioned to improve the understanding of the circuit, but actually begins to count at the same time as the one (514-515) described above.

h) When the time pre-set by the analogue delay (518-519) elapses, the latter actuates the Analogue Switch (520).

The Analogue Switch (520) causes the Transistor (522) to be commutated.

i) When the Transistor (522) is commutated, it has all the power stored in the Condenser (521) discharged to the Detonator (601).

j) As already described above, the Commutator (503) which shall have kept the Detonator (601) short-circuited to earth during all the storage, carriage and handling time, shall have changed its state when the Slide (400) completes its forward movement, breaking the short-circuit and connecting the Detonator (601) to the Transistor (522).

If the Commutator (503) has indeed changed its state, when the Condenser (521) discharges through the Transistor (523), this discharge will, in parallel, reach the Resistor (523) and the Detonator (601), which is actuated.

If, however, the Slide (400) does not complete its travel, the Commutator (503) will continue to keep the Detonator (601) short-circuited and separated from the Condenser (521) and the power will therefore be lost through the Resistor (523), which acts as a drain.

Now, therefore, the Mechano-Electronic Fuze subject of the present Patent application guarantees a safety time after launching during which no power is available to set off the detonation, and a very reliable functioning after a delay, adjustable by design, and precisely controlled.

Furthermore, the Mechano-Electronic Fuze subject of the present Patent application ensures that, if the Detonator (601) is detonated and given that the latter must have been kept aligned with the Multiplier (602), the detonation shall pass to the Multiplier (602) and thereafter to the explosive charge in the hand-grenade.

The functioning of the alternative solutions noted in the System Description would be as follows:

Replacement of the Commutator (503) with an electric relay: this coincides with that of the preferred solution up to point g), whereupon, in addition to allowing the power through to the Condenser (521), the relay is also actuated, changing its state and releasing the Detonator (601) short circuit, connecting it to the Transistor (523). Points d) and j) are eliminated.

Eliminating the Commutator (503): When inoperative, the Detonator (601) is in closed circuit through the Resistor (523). In operation, points d) and j) are eliminated.

Inclusion of an impact detector: this switch may be

arranged instead of the analogue delay (518-519). Thus, after the safety-devices are released, the fuze would be ready to function by impact against the ground or against any obstacle.

It can also be arranged in parallel with the analogue delay (518-519). Thus, after releasing the safety-devices, the fuze would be ready to function by impact against the ground or against any obstacle, and in the event of the impact not taking place or not being sufficient to trigger the impact detector, the explosion would take place after the pre-set delay.

Given that the concept of an impact detector is widely disseminated, that manifold specific embodiments of such device are known, and that the inclusion of such element acting as a switch would not alter the substance of the object of the present Patent application, it is not described at length.

Claims

1. A Mechano-Electronic Fuze for hand-grenade, characterised because its mechanical drive is based upon the energy stored in a conventional spring.
2. A Mechano-Electronic Fuze for hand-grenade, as in claim 1, characterised because the electric power required to actuate the detonator is obtained from a generator included in the actual Mechano-Electronic Fuze, and it therefore requires no external power supplies and is maintenance-free.
3. A Mechano-Electronic Fuze for hand-grenade, as in claims 1 and 2, characterised because it consists of mechanical and electronic elements coupled to each other so as to enable their functioning by delay, by impact or by a combination of impact and delay.
4. A Mechano-Electronic Fuze for hand-grenade, as in claims 1, 2 and 3, characterised because its mechanical elements include a container, lever safety-device, drive, slide and explosive chain, allowing the electronic components to be coupled, the Mechano-Electronic Fuze to be handled and the latter to function by delay.
5. A Mechano-Electronic Fuze for hand-grenade, as in claims 1, 2, 3 and 4, characterised because it has an electronic circuit comprising condensers, diodes, resistors, transistors and switches mounted on a printed circuit, allowing the Mechano-Electronic Fuze to function by delay.
6. A Mechano-Electronic Fuze for hand-grenade, as in claims 1, 2, 3, 4 and 5, characterised because its electronic circuit provides a double timing which

firstly prevents the functioning of the Mechano-Electronic Fuze during the first instants of flight of the hand-grenade in which it is fitted, and then ensures the functioning of the Mechano-Electronic Fuze after a pre-set time.

7. A Mechano-Electronic Fuze for hand-grenade, as in claims 1, 2, 3, 4, 5 and 6, characterised because the detonator of the explosive chain is, under inoperative conditions, connected in short-circuit by means of a mechanically or electrically actuated commutator, the functioning of such detonator being prevented during storage, carriage and handling of the hand-grenade in which the Mechano-Electronic Fuze is fitted.
8. A Mechano-Electronic Fuze for hand-grenade, as in claims 1, 2, 3, 4, 5, and 6, characterised because the detonator of the explosive chain is, under inoperative conditions, connected in closed circuit, the accidental functioning of such detonator being prevented during storage, carriage and handling of the hand-grenade in which the Mechano-Electronic Fuze is fitted.
9. A Mechano-Electronic Fuze for hand-grenade, as in claims 1, 2, 3, 4, 5, 6 and 7 or 1, 2, 3, 4, 5, 6 and 8, characterised because the multiplier is misaligned with respect to the inoperative position of the detonator and is protected by a barrier.
10. A Mechano-Electronic Fuze for hand-grenade, as in claims 1, 2, 3, 4, 5, 6, 7 and 9 or 1, 2, 3, 4, 5, 6, 8 and 9, characterised because the detonator is aligned with the multiplier after the hand-grenade in which the Mechano-Electronic Fuze is fitted, is launched.
11. A Mechano-Electronic Fuze for hand-grenade, as in claims 1, 2, 3, 4, 5, 6, 7, 9 and 10 or 1, 2, 3, 4, 5, 6, 8, 9 and 10, characterised because the short-circuit that inhibits the detonator under inoperative conditions opens only some time after the hand-grenade in which the Mechano-Electronic Fuze is fitted, is launched.
12. A Mechano-Electronic Fuze for hand-grenade, as in claims 1, 2, 3, 4, 5, 6, 7, 9, 10 and 11, characterised because the detonator is aligned by means of the relative rotation between two threaded parts.
13. A Mechano-Electronic Fuze for hand-grenade, as in claims 1, 2, 3, 4, 5, 6, 7, 9, 10, 11 and 12 or 1, 2, 3, 4, 5, 6, 8, 9, 10, 11 and 12, characterised because the generator is actuated through a gear train that adjusts the rate of rotation of the element storing the energy required by the generator.

14. A Mechano-Electronic Fuze for hand-grenade, as in claims 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12 and 13 or 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12 and 13, characterised because the electric power required for the detonator to be active is only generated after the hand-grenade in which the Mechano-Electronic Fuze is fitted, is launched. 5
15. A Mechano-Electronic Fuze for hand-grenade, as in claims 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13 and 14 or 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13 and 14, characterised by having devices which, in the event that after generation of the electric power required to drive the detonator, the latter is not detonated, ensure that the electric power is self-discharged within a period of time that is adjustable by design. 10 15

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FIG.2

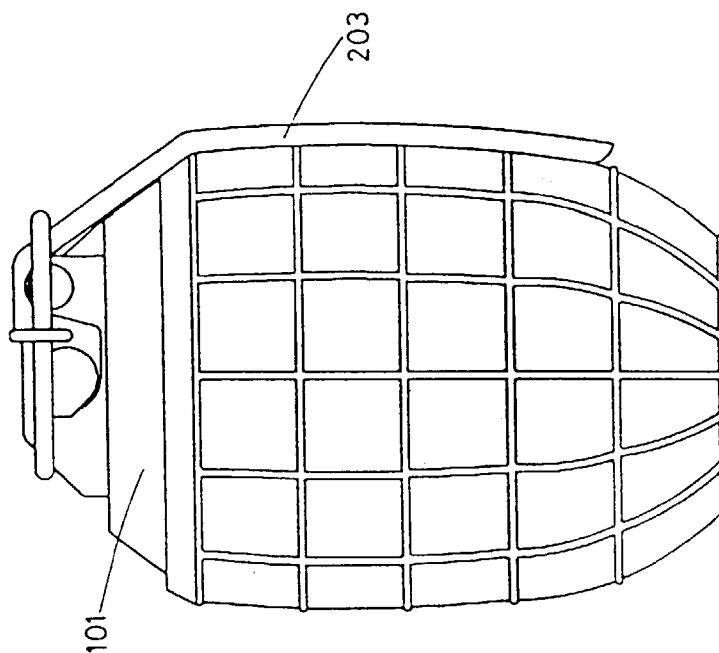


FIG.1

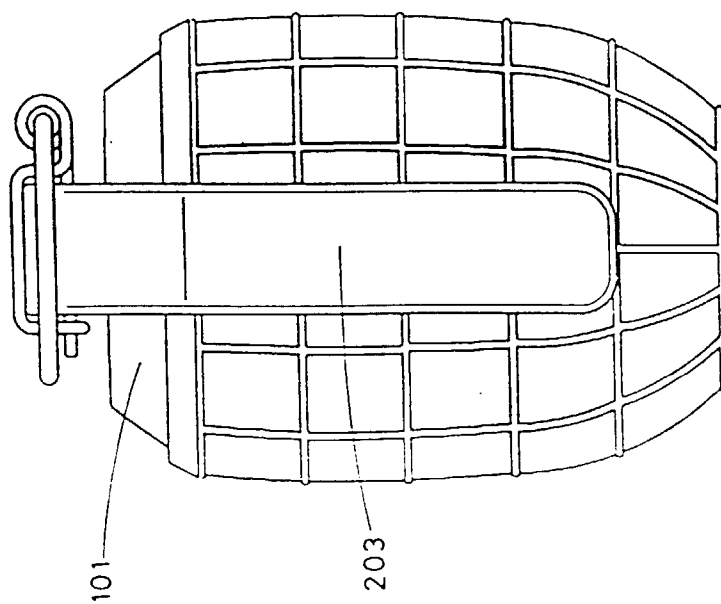


FIG.3

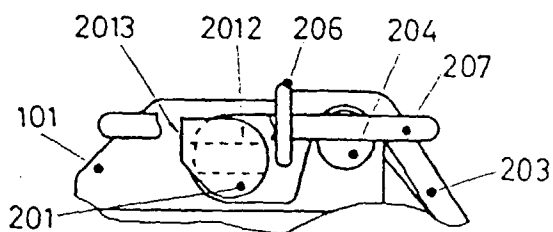


FIG.4

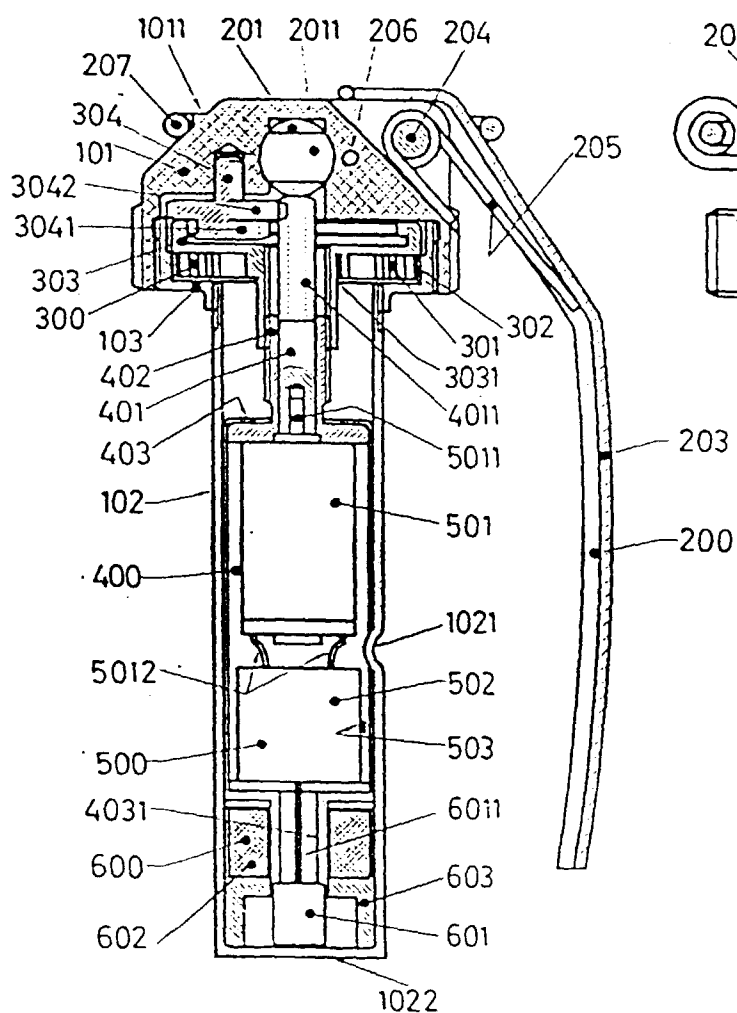
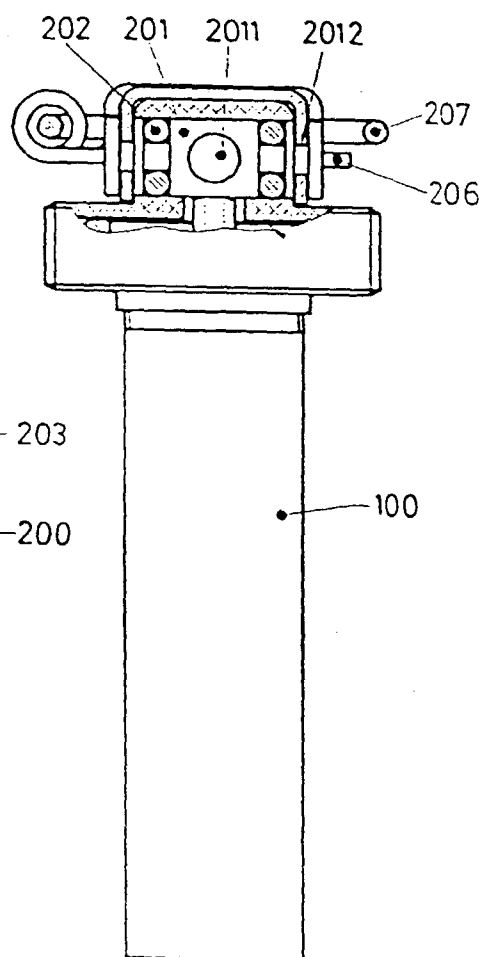


FIG.5



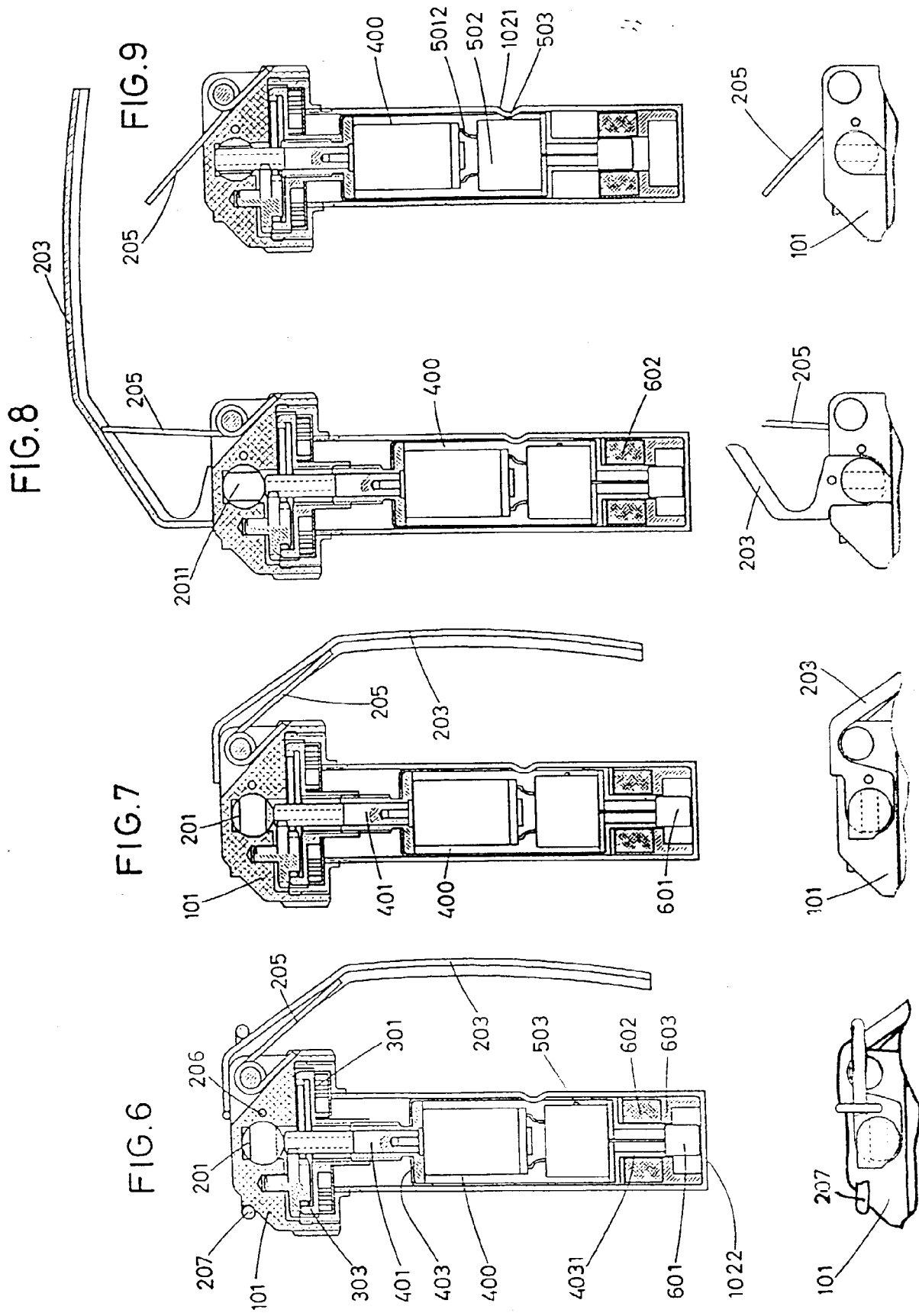


FIG.10

