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## (54) A HAND GRENADE

(71) We, TECHNICO DEVELOPMENT AND FINANCING S.A., of 3, rue de l'Hôpital, CH-1700 Fribourg, Switzerland; a Swiss body corporate, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 This invention relates to a hand grenade with an electrical firing system and an activatable electric energy source.

15 For electronically firing or priming projectiles, electronic priming methods and devices are known, for instance from US-Patent No. 3 712 218 disclosing an electronic firing device for hand grenades wherein contacts are closed during the free flight of the grenade by means of an electrolyte, where-  
 20 by the one contact is connected to a battery and the second contact is connected through resistors, condensers and transistors with the detonator. The activation of this device is obtained by completing a connection be-  
 25 tween the battery and a contact.

Such a firing device has heavy drawbacks. The grenade cannot be stored for a long time, because the life time of the battery is limited. Further, the explosion may occur 30 immediately after the activation, because the connection between the contacts has already been established either because the grenade is held in a wrong position or it is shaken during its activation.

35 If activation and/or firing of the grenade shall occur by the impact in the aim after being thrown, whereby the electrolyte is contained in a capsule which only bursts during a certain impact of the grenade and thus 40 releases the electrolyte, it is not excluded that firing occurs immediately after the activation of the hand grenade because due to inadvertent dropping of the grenade or due to unsuitable transport thereof the electrolyte has already been released, it being impossible for the operator to know or check whether the electrolyte has been 45 released.

The German Patent Application No. 50 1 948 381 discloses a firing device which may

be preset either as a time fuse or as an impact fuse, an impact switch being provided in its circuitry for delayed or undelayed impact firing. A timing switch with a timing circuit for presettable delayed firing is connected in parallel with said impact switch. Further, switch means are provided for unabling or for preventing closure of the timing switch and of the impact switch. In this manner this prior grenade should have a high versatility of use. However, the time during which such a grenade may be stored is limited due to the limited lifetime of the electric source, and once a grenade has been activated it can no longer be reset 55 into its initial state.

The German Patent Application No. 1 513 113 discloses a system for separate successive firing or firing in groups of several detonators by means of a stepping switch and of an ignition generator. A current bridge responding at a predetermined voltage is provided and a rotating magnet is connected in parallel with the end contacts of the stepping switch, said magnet driving 70 the switching arm of the stepping switch, a condenser being connected in series with the rotating magnet, a rest relais adapted to be mechanically operated being provided with a condenser connected in series therewith, and an adjustable resistor being connected to the generator for adjusting the firing interval. This system also has drawbacks. It is well known that stepping switches 75 are complicated and sensitive and need particular protection for transport. However, it is practically impossible to carefully handle hand grenades during their transport, there being thus a high probability of damaging.

In order to prevent the drawbacks of the devices described above, the German Patent Application No. 1 080 440 and in a similar manner also the German Patent Application No. 2 217 052 discloses devices having an electric detonator for non-twisting projectiles with a condenser adapted to be charged by a generator driven by a propeller at the outside of the projectile. A contact rotating with the generator shaft is radially displaced against an elastic resetting force due to the 80 85 90 95 100

centrifugal force and touches a fixed contact only when the speed of the generator exceeds a predetermined limit value. Such a device is not suitable for hand grenades 5 because the required centripetal forces cannot be obtained by rotation round an axis of the grenade. The hand grenade is thrown by a person and thereby moves along a path having a relatively large radius with a relatively low angular speed. 10

It is an object of this invention to provide a device for electronic firing of hand grenades, which prevents premature firing, which allows particularly unlimited storage 15 and easy transport of the grenade and which does not change its operation with different starting conditions such as different initial speeds, centrifugal forces and so on.

According to the present invention there 20 is provided a hand grenade with an electrical firing system and an electric energy source which is capable to be manually activated shortly before throwing the hand grenade, wherein for arming the firing system a first 25 arming acceleration sensor is provided, responding to the centripetal force provided by the swinging of the hand grenade about points outside the hand grenade body for operating a first switch, said first arming 30 acceleration sensor responding also to the disappearing of said centripetal force for operating a second switch when the hand grenade is released and thrown, said hand grenade further comprising an impact 35 acceleration sensor which is energized by said electric energy source through said first and said second switches, said impact acceleration sensor comprising an electronic delay circuit and being adapted to trigger the 40 release of the firing on expiration of a time interval determined by said electronic delay circuit.

This device is entirely safe in storage, it 45 may easily be manufactured in a miniaturized compact unity and may be used in many kinds of grenades.

The present invention will now be explained in more detail, by way of example, with reference to the drawing schematically illustrating one embodiment of the firing 50 device of a hand grenade.

A catch member 20 is mounted in an aperture 24a of the casing 24 of the hand grenade. A flexible element such as a string 55 21 having a handle 22 is fixed to the member 20. The catch member 20 is held by balls 23a engaging into catch grooves 20a or 20b respectively, such balls 23a being loaded by springs 23 accommodated in bores 24b of the casing 24. Catch member 20 is shown in its initial position with the balls 23a engaging groove 20a. In order to shift member 20 from this initial position into an external, activated position, a pull has to be exerted 60 thereon whereby the balls 23a leave the groove 20a and later fall into groove 20b. Shoulders projecting outwardly at the inner end of member 20 prevent pulling of member 20 out of the aperture 24a. 70

A control element 25 is loosely inserted into a central bore 20c of member 20 and rests with its inner end 25a on the ground of bore 20c. The control element 25 has a conical shoulder 25b and a pin-shaped end portion 25c. This end portion 25c operates as an actuating element and as an electrical contact. A contact plate 25d is mounted on actuating pin 25c, a pressure spring 25e being inserted between this plate 25d and a fixed wall 24c of the grenade body. This wall 24c has an aperture 24d through which the actuating pin 25c may pass for actuating a switch 27. Once switch 27 has been pushed upwards into its closed position it is supported in this position by a boss 24e of wall 24c. Element 25 is made of insulating material and electrically separates contacts 26 of a switch when it is in its initial position as shown in the drawing. However, as well switch contacts 26 as switch contact 27 may be electrically connected to the actuating pin 25c and plate 25d respectively for activating electronic units 28 and 29 as soon as this is required and desirable. 75

The switches 26 and 27 are connected in series, and they serve for applying energy through a switch  $S_1$  to the bus bar 34, for an impact acceleration transducer 31, an electronic unit 29 and through a switch  $S_2$  to the firing unit 32. The impact acceleration 80 transducer 31 may be arranged in the plane of the tangential acceleration of the hand grenade or to respond to the acceleration of the latter in the three axes of the space. The battery 33 includes a manually operable 85 device, for instance a crackable container by means of which the electrolyte packed separately may be introduced into the elements of the battery immediately prior to throwing the hand grenade, whereafter the 90 electrical and electronic circuits are energized. An arming acceleration transducer 30 and the electronic arming circuit 28 are directly connected to the battery. The arming acceleration transducer 30 is adapted for 95 detecting any drop in the amounts and/or gradients of the tangential and/or centripetal acceleration of the hand grenade below a lower value. The transducer 30 may be arranged in the plane of the tangential 100 acceleration of the hand grenade or to respond to the acceleration of the latter in the three axes of the space. An electrical control circuit 35 is provided between electronic arming unit 28 and the actuating pin 25c 105 and plate 25d respectively. 110

Operation of the illustrated device is as follows: 115

For normal use container 33a is first broken and the battery activated. The hand 120 grenade 125

grenade is then grasped at the handle 22 and is swung and then released and thrown. During swinging of the hand grenade the pull exerted on string 21 by the centripetal force of the grenade body pulls the catch member 20 from its rest position as illustrated outwardly into its activated position determined by engagement of the balls 23a into groove 20b. At the same time, element 25 is displaced upwardly until its actuating pin 25c touches switch 27 and moves it upwardly into its closed position. As mentioned above, the switch 27 now remains in this closed position and energizes the one contact of switch 26. Since switch 26 is still open the bus bar 34 is not energized.

When the hand grenade is released and thrown, the centripetal force acting onto member 25 suddenly decreases to zero and springs 25e shifts member 25 back downwards in the drawing. Since the catch member 20 has been displaced into its outer position, member 25 may now slide into a lower position such that its bevelled shoulder 25b leaves the switch contacts 26 and allows them to close. Energy is now applied to the bus bar 34 and to the electronic circuits 29 and 31. Circuit 29 includes a timing circuit of any desired conventional type which may preferably be adjustable. Before the end of this time interval firing is impossible. However, after the end of the time interval, if the acceleration transducer 31 transmits a signal to circuit 29 due to a high negative acceleration during the impact in the aim, circuit 29 actuates switch  $S_2$  and the grenade is immediately fired by circuit 32.

During the above normal operation circuit 28 measures the speed of resetting of the member 25 upon release of the grenade. A time interval is determined from the moment of separation of pin 25c and contact 27 until the switch contacts 26 get into contact with pin 25c which is made of electrically conductive material. The length of this time interval, during which the pin 25c and plate 25d respectively are without connection to the voltage source, depends on the speed with which member 25 is reset upon release of the grenade. If this interval has its usual length, switch  $S_1$  remains closed and the operation is as described above. However, if this time interval is too long, for instance during manipulation of the hand grenade for artificially imitating its normal operation, switch  $S_1$  is opened. Similarly, switch  $S_1$  is opened if the transducer 30 is measuring an amount and/or gradient of the tangential and/or centripetal acceleration which is below a limit value occurring during normal operation.

The transducer 30 may be omitted. Further, instead of actuating a switch  $S_1$  by means of a relay of circuit 29, firing may be controlled electronically.

Circuits 28 and 29 comprise usual monostable flip-flops preferably by combination of flip-flops and register memories. These circuits have to compare memorized values of time intervals and accelerations with measured time intervals and accelerations and have to actuate the switches  $S_1$  and  $S_2$  under the conditions mentioned above. Circuits for memorizing and comparing values in this manner are well known in the art and need no further explanation.

Circuit 29 may also determine a speed integral and may control the switch  $S_2$  and firing circuit 32 respectively for firing the grenade in function of other values and conditions.

#### WHAT WE CLAIM IS:—

1. A hand grenade with an electrical firing system and an electric energy source which is capable to be manually activated shortly before throwing the hand grenade, wherein for arming the firing system a first arming acceleration sensor is provided, responding to the centripetal force provided by the swinging of the hand grenade about points outside the hand grenade body for operating a first switch, said first arming acceleration sensor responding also to the disappearing of said centripetal force for operating a second switch when the hand grenade is released and thrown, said hand grenade further comprising an impact acceleration sensor which is energized by said electric energy source through said first and second switches, said impact acceleration sensor comprising an electronic delay circuit and being adapted to trigger the release of the firing on expiration of a time interval determined by said electronic delay circuit.

2. A hand grenade according to claim 1, in which a transducer element of the first arming acceleration sensor has a pin adapted as contact and which, by the centripetal force caused by the swinging, is inwardly displaceable with reference to the housing and in its inner position closes said first switch and acts on a return spring which tends to retain it against resilient contacts of said second switch, whereby a supply circuit is connected from the energy source through the series connection of the two switches to the delay circuit and a firing unit.

3. A hand grenade according to claim 2, in which a second arming acceleration sensor is provided for detecting any drop in the amounts and/or gradients of the tangential and/or centripetal acceleration below a lower limit value, and an electronic arming circuit is provided for detecting the exceeding of an upper limit value for the period of pushing back the pin, and a switch, provided in the supply circuit of the impact

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acceleration sensor, and the firing unit is closed, and is open when said second arming acceleration sensor detects a value below said lower limit value and/or exceeds said upper limit value.

4. A hand grenade according to claim 3, in which the second arming acceleration sensor for detecting the acceleration is arranged in the plane of the tangential acceleration during the flight of the hand grenade.

5. A hand grenade according to claim 2 having a stop body, and in which the transducer element of the first arming acceleration sensor is displaceably retained in a bore of the stop body in the direction of the centripetal acceleration, whereby the pin mounted on the transducer element in both its end positions acts on one of the said two switches.

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6. A hand grenade according to claim 1, in which the impact acceleration sensor for ascertaining the acceleration is arranged in three spatial axes.

7. A hand grenade with an electrical firing system and an activatable electric energy source, substantially as herein described with reference to and as illustrated in the accompanying drawing.

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COMPLETE SPECIFICATION

1 SHEET

*This drawing is a reproduction of  
the Original on a reduced scale*