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Design Concept Of Electronic Detonation Of VOG-25 Grenade

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Abstract

Lightweight Small Arms Technologies (LSAT) program is a funded program by the U.S. Joint Service Small Arms Program. The program aims at reducing the weight of small arms and their ammunition. Tactical concepts and the research activities on previous arms have delivered lighter arms and resulted in decrease of soldier lethality. The program developed Light machine gun and its ammunition. This took extensive simulation work before a prototype was developed. Further to that work on previous technologies was on High Ignition Temperature Propellant (HITP). The designers have put relentless efforts for projectile improvements the technology. This has resulted out lighter ammunition like bullets with higher lethal calibre. A demand for Use of electronics in rounds counter, Laser for sighting and Target acquisition has proved a future to have a much smaller but powerful weapons. Make in India program has germinated a concept of developing such automated arms, ammunition which facilitates a vast reduction in soldiers carrying loads. This reduces strain associated to weapon logistics and increasing mobility. A notable demand is to have development of electronics and information technology in arms and ammunition

Keywords: VOG-25, Grenade, Reserve Battery, Atmel AT89C2051, Launcher, Fuze Head.

I. INTRODUCTION

Lightweight Small Arms Technologies (LSAT) program has delivered and is continually delivering developments in lightweight small arms and their ammunition. Effectively LMGs built in the program have reduced caseless weapons by 47% in its weight and cased telescoped weapons by 43%. Further works on LMG have met an improvement in battlefield effectiveness. Elements of it are its simpler and more consistent weapon action, its light weight and low recoil, and its stiffer barrel. The recoil compensation has delivered easy controllability. Simplified mechanism of LMG has become reliable and easier in maintenance. Entry of electronics has delivered rounds counter integrated and improved maintainability. Beyond that electronics has proved the weapon run lighter. Change in material of the chamber and barrel have reduced heat load on the weapon. Of all this the weapon cost has reduced drastically.

Design of an LSAT battle rifle used the same cartridge as developed for the LMG. New designs of rifles came out using both cased and caseless catridges. The designs concepts involve two high capacity magazine approaches. One uses the standard approach of placing inside the magazine springs which feed rounds into the weapon. The other uses weapon powered approach. A rifle design using the swinging chamber mechanism as in LMG, is well suited to a bullpup layout.
As rifle, LMGs and their ammunition are pooled into the program Make in India concept has called for tenders for development of VOG 25 Grenade [1].
This paper aims at proposing development of Electronic VOG 25 Grenade Fuse head to reduce weight and increase accuracy with respect to time in igniting the RDX and sense the impact accurately. Electronics would avoid heavy weight centrifugal switch, impact sensing head and chemical ignition. Reduction of weight of Ammunition is a big benefit as they are carried in numbers and not a single one. Weight reduction on one unit effectively reduces weight of overall numbers carried.
To reduce the weight of the ammunition fuze head is targeted. Fuze head consists of mechanical parts to sense the RPM, sense the impact, time measurement after the trigger. A proposal is made to employ electronic circuitry and a microcontroller to sense impact, sense the trigger, sense the rotations RPM and generate time to detonate explosive material in the shell.

Development activities
1. Design and fabricate Reserve Battery
2. Design a Centrifugal sensor
3. Design and fabricate Piezoelectric impact sensor
4. Design a microcontroller circuit and develop application code
5. Select bridge wire to ignite the explosive material

II. PROCESS

The function of a grenade is to deliver a powerful explosion that can disable or kill enemies or destroy a specific target. Grenades come in various types, such as fragmentation, concussion, smoke, and incendiary, each designed for a specific purpose. For example, a fragmentation grenade is designed to produce shrapnel upon explosion, which can injure or kill people within a certain radius. A concussion grenade produces a loud noise and a shockwave, which can stun or disorient enemies without causing significant physical harm. Smoke grenades create a thick smoke that can provide cover or concealment for military or law enforcement operations, while incendiary grenades can set targets on fire. Grenades are dangerous and potentially lethal weapons, and their use is strictly regulated and controlled by law. It's essential to follow proper safety procedures and receive adequate training before handling or using them.
Vog 25 is a military hand grenade that is used for igniting explosive material. The Vog 25 grenade operates on a chemical reaction. When the safety lever is released, a striker hits a percussion cap which ignites a fuze. The fuze burns down and ignites explosive material mixture, producing a blast.
The term "Vog-25" typically refers to a type of grenade launcher that is used by the Russian military. The Vog-25 is a 40mm grenade launcher that can be mounted on various weapons, including the AK-74 assault rifle and the PKM machine gun [2]. VOG-25 is a type of grenade used in Russian-made grenade launchers, such as the GP-25 and GP-30. It is a high-explosive fragmentation grenade that is designed to be fired from a grenade launcher.

Fig 1 VOG-25 Grenade [3]

Fig.1 The VOG-25 grenade [3] contains about 60 grams of explosive material and produces a fragmentation radius of approximately 20 meters. It is effective against personnel, light armored vehicles, and other soft targets. It's worth noting that grenade launchers, including those that fire the VOG-25 grenade, are powerful and potentially deadly weapons. They require specialized training and careful handling to ensure safety and effectiveness in their use. It is essential to follow proper safety procedures and receive adequate training before handling or using such weapons. The VOG-25 grenade works by using a time fuse that is triggered upon firing from the grenade launcher. The fuse ignites the grenade's propellant, which propels it towards the target. Once the grenade reaches its target, it explodes, creating a lethal blast and shrapnel that can cause severe damage to people and objects in the vicinity. The VOG-25 grenade is a high-explosive fragmentation grenade that is designed to be used with Russian-made grenade launchers, such as the GP-25 and GP-30. Its function is to deliver a lethal blast and shrapnel that can cause significant damage to personnel, light armored vehicles, and other soft targets.

The VOG-25 grenade contains approximately 60 grams of TNT explosive material and is activated by a time fuse that is triggered upon firing from the grenade launcher. The fuse ignites the grenade's propellant, which propels it towards the target. Once the grenade reaches its target, it explodes, creating a lethal blast and shrapnel that can cause significant damage to people and objects within a certain radius. The VOG-25 grenade has an effective range of up to 400 meters, with a fragmentation radius of approximately 20 meters. It is designed to be used against enemy troops, light armored vehicles, and other soft targets such as buildings and fortifications.

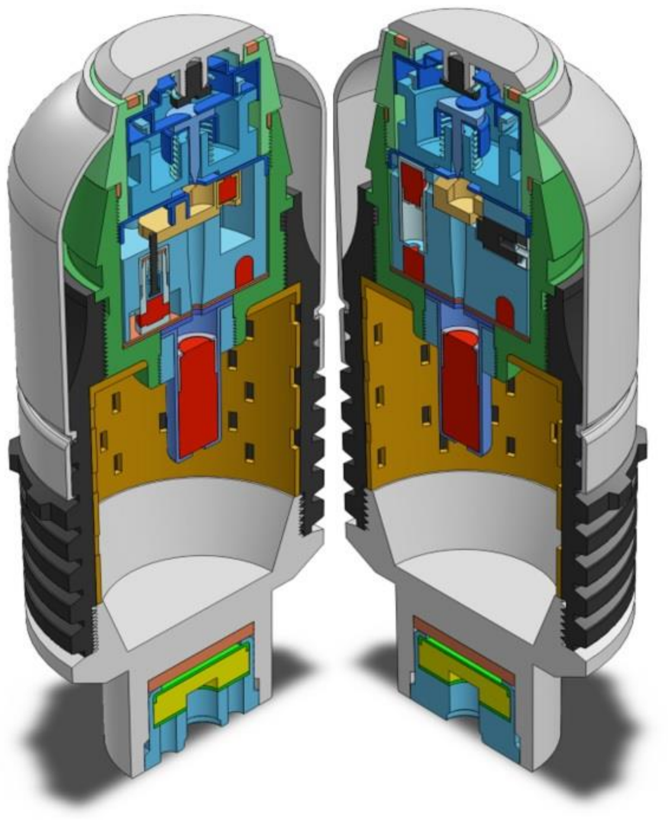


Fig 2 Section view of VOG-25 Grenade [3]

The fuse head of the VOG-25 grenade is a mechanical time fuze that functions by burning down a pyrotechnic delay element at a controlled rate. The delay element is made of a pyrotechnic compound that burns at a consistent rate, producing a flame that travels down a narrow passageway and eventually reaches the detonator of the grenade's explosive charge.

When the grenade is loaded into the launcher and fired, the firing pin of the launcher strikes the primer on the bottom of the grenade's fuze head, initiating the burning of the delay element. The delay time can be adjusted before firing by rotating the fuze head to align a specific time mark on the fuze with an index mark on the grenade's body. The selected time represents the delay between the time the grenade is launched and the time it detonates. Once the delay element has burned down to the detonator, the explosive charge of the grenade detonates, creating a high-explosive blast and releasing shrapnel in all directions. The shrapnel is created by the fragmentation of the grenade's metal casing and other materials in its vicinity. The function of the VOG-25 grenade's fuze head is critical in ensuring that the grenade detonates at the desired time and location, and that it is effective in achieving its intended purpose. It is important to note that proper training and safety precautions are essential when handling and using such devices, as they can cause significant harm if used improperly.

Though the mechanical and chemical design works well and the design is proved in the field, weight reduction of the ammunition is necessary to make it portable and safe to operate. Design phases go as indicated earlier.

Reserve battery is most critical and process starts from it [4]. An electronic fuze, which depends on events of an electronic nature for its safety, arming and firing functions, requires electrical energy for operating as a component of ammunition. Designing a power source is therefore indispensable in the development of the electronic fuze. For small-caliber electronic fuze applications, an in-flight power source should satisfy the following requirements: miniaturized size, sufficient electrical energy having certain current and voltage characteristics for a given period of time, shock survivability in high-*g* environments and a 20-year shelf life. With advances in micromachining technology, MEMS has been a very powerful means for fabricating the miniaturized power sources for electronic fuzes.

A reserve battery generally consists of an electrode stack, a glass ampoule, an electrolyte within the glass ampoule, and a housing assembly. The *g*- and spin-activated miniaturized reserve battery (MRB) breaks the glass ampoule using the setback acceleration of gunfire and then distributes the electrolyte onto the reaction sites using the in-flight spin force, thereby activating

The MRB and providing electrical energy to the electronic fuzes. The MRB is an electrochemical system composed of Pb, HBF4 and PbO2. To make long-term storage possible, the HBF4 electrolyte is stored in the glass ampoule and isolated from the electrode stack because the Pb and PbO2 electrodes in general are severely corroded by the HBF4 electrolyte. On gunfire, the electrolyte in the glass ampoule is released and distributed into the electrode stack, thereby making the Pb/HBF4/PbO2 electrochemical system complete.

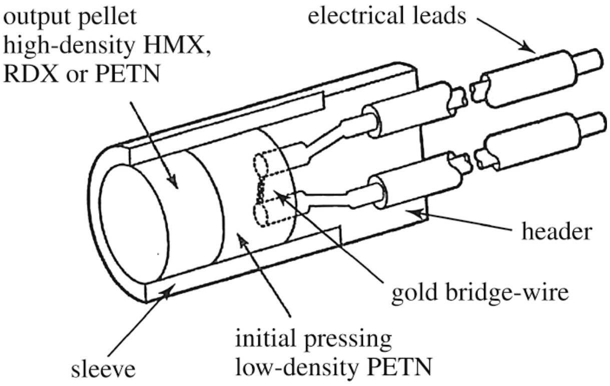
Centrifugal switch is a simple leaf switch loaded on a spring and mounted on PCB. During rotation of the ammunition the leaf throws pressure on the spring compressing on it. At a position and desired RPM, leaf reaches to give connection. This is sensed as centrifugal action.

Piezoelectric Impact Sensor employs a piezoelectric element which generates voltage signal on impact. These signals are amplified and are interfaced to microcontroller. Amplification factor is decided on the impact to be sensed.

Microcontroller and code are specific to the application. A microcontroller circuit is designed to sense the centrifugal switch, impact sensor and the timer built into it [5]. Microcontroller is operated on Reserve battery. When the Reserve battery gets initiated and starts delivering power microcontroller gets energised and takes control of all the sensors and bridge wire. Microcontroller is ported with a code specific to the application. Code goes as following.

Gets activated on Reserve battery power and first senses the centrifugal switch. Once the centrifugal switch gets activated the timer is started. Parallel to this impact is sensed. If impact occurs within the time limit the bridge wire is ignited on Reserve battery.

Bridge wire is a thin wire fixed on two terminals and dipped into the explosive material. The wire acts as an igniting element activated by the microcontroller. The wire is thin enough to carry small current to generate a spark when it breaks open carrying the current. The wire is mere selection depending on the power delivered by the Reserve battery. Usually it is a nichrome wire of thickness 40 SWG and length of 3mm maximum.



As seen in the fig 3. Bridge wire is attached between the two electrodes and these electrodes are applied with the reserve battery power during explosion.

The above process guides the development cycle of electronic Light weight fuze head. This reduces the weight of grenade by 120 grams. It adds much higher safety and transportability. The electronics gives more accuracy with respect to sensing and time delay. The code ensures and holds wrong triggering of the grenade.

III. OBSERVATIONS

As observations are not possible in the proposal an expectation of observations can be made. Repeatability of sensing the elements or MEMs can be listed to find the accuracy. Time accuracy can be counted to ensure 100% accuracy. Latency in response to the power up can be observed. Finally reduction in weight is ensured.

IV. CONCLUSION

Weight reduction is the major achievement. 20 years shelf life is definite as there is no chemical to degrade in quality as time goes. Only chemical reaction is in the Reserve battery. This is enclosed and is away from any other chemically reacting materials till it is triggered.

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