# Module 2: Lecture 6
# Proximity Fuze; Propulsion System; Warhead

**Keywords.** RF Proximity Fuze, Laser Proximity Fuze, Warhead, Detonator, Booster, Sustainer

## 3.4 Proximity Fuze

The proximity fuze is a vital component of the missile since it seldom so happens that a missile actually hits the target. The more likely occurrence is that the missile comes very close to the target. This event is *sensed* by the missile and its warhead is detonated. The proximity fuze performs precisely this function. The kind of proximity fuze which is used in most tactical missiles are of the *active* kind.

The *RF proximity fuze* consists of two CW radars placed diametrically opposite on two sides of the missile, a little behind the guidance subsystem. The mainlobes generate a saucer-shaped pattern around the missile (Figure 3.12).

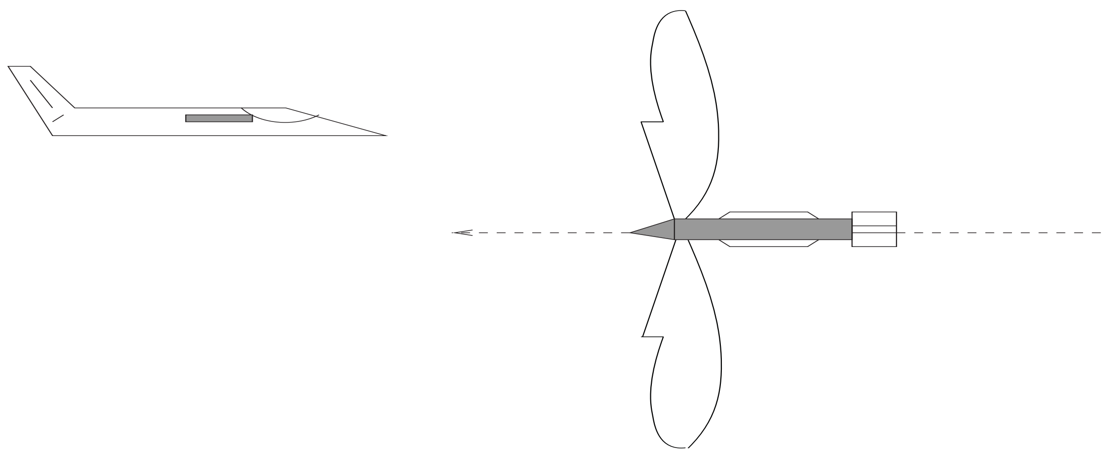

Figure 3.12: *The RF fuze pattern*

When the target enters this pattern, the reflected energy is received by the receiving antennas. The *doppler frequency* is extracted from this signal and is used to generate the *fuze pulse*. There is an *in-built range cut-off*, implemented through a *delay reference*, which suppresses reflected signals from objects at larger distance than the *lethal radius*

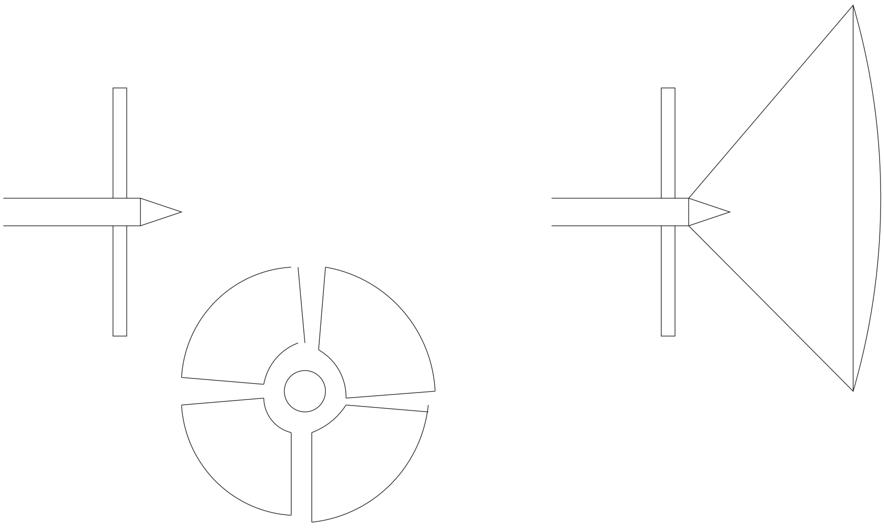


Figure 3.13: *The Laser Fuze Pattern (a) Circular (b) Circular-Conical*

of the warhead (the maxium distance at which the warhead is effective). This ensures that no fuze pulse is generated for signals reflected from the ground or the sea or from other nearby objects like foliage, buildings, etc. There are two other checks which help in preventing a false alarm. The doppler signal is passed through a *bandpass filter* to ascertain whether the signal is within a specified bandwidth, and then through a *threshold detector* to check if it satisfies the minimum level of reflected signal which identifies a target. The threshold detector also suppresses the *second-time-around echoes* and eliminates the possibility of *ambiguous range measurements*.

The *laser proximity fuze* uses a laser source as the *active transmitter* and an *infrared detector* as the *receiver*. The high frequency energy helps in obtaining very accurate information about the target position. *Four emitters* are mounted on the missile at 90 degrees from each other. Each produces a *sector-shaped pattern* with 90 degrees angular spread. The combination of the four patterns produces a *circular pattern* of a definite radius and very small thickness (Figure 3.13(a)).

A *receiver* is mounted next to each emitter. The signal received from the target is passed through some simple circuitry to extract the necessary information to generate the fuze pulse. Due to its inherent accuracy the *possibility of false alarm in laser fuzes is* *very small* compared to the RF fuze.

Using a *different number and arrangement* of transmitters, various other laser beam patterns can be obtained. One of these is shown in Figure 3.13(b). The advantage of having these patterns is that the warhead explosion can be timed suitably to ensure that the blast occurs nearer to the center of the target. This can be done by using the time instants at which the target intercepts the two beams.

## 3.5 Propulsion System

The propulsion system of the missile provides the required initial thrust to the missile to enable it to fly with sufficient velocity during the subsequent engagement period with the target. There are two phases in missile propulsion:

- *Boost*
- *Sustain*

During *boost* the propulsion system provides a high level of missile acceleration over a relatively short period of time (1-15 secs). The purpose of *sustain* propulsion is to maintain the missile at a desired velocity for the majority of the remaining missile flight. Various combinations of boost and sustain propulsion (like *all-boost, boost-sustain, all sustain*) may be used in different missile systems. However, in principle, the all-sustain configuration is never used, since it usually requires a very short boost phase. An example is the air-to-air missile which does not have a booster motor but a short boost is provided by the sustainer motor itself. The thrust and velocity profiles of various propulsion systems are shown in Figure 3.14.

The booster motor is typically a *solid propellant motor* while the sustainer motor could either be a *solid propellant* one or a *jet engine*. Some modern missiles nowadays use *integrated rocket-ramjet propulsion*.

## 3.6 Warhead

The warhead is the payload of the missile and consists of a *shell*, *explosives*, and a *detonator*. The weight of the warhead depends on the size of the missile. The fuze pulse

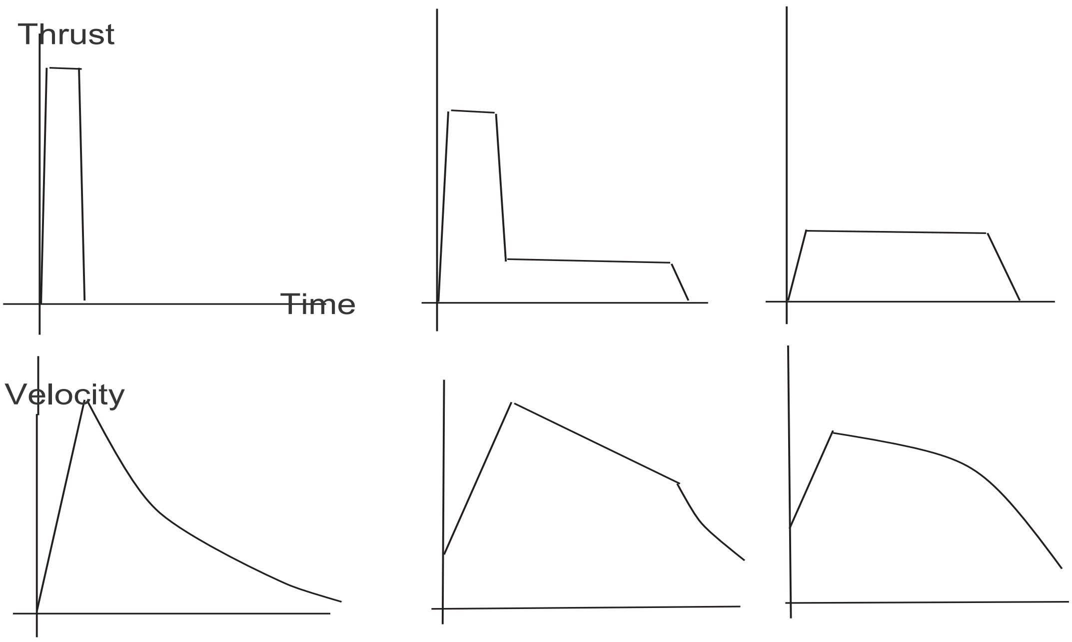


Figure 3.14: *Thrust and velocity profiles*

activates the detonator which in turn triggers the explosive. The shell breaks into numerous fragments which are propelled outward in a 60-90 degrees spread and achieves target kill by penetrating target components. Apart from the basic *fragmentation* type of warhead the other kinds of warheads are: *continuous-rod* warhead, *annular blast fragmentation* warhead, *selectively aimable* warhead.

In the selectively aimable warhead, four detonators are embedded in the explosive. The fuze pulse is first sent to the detonator which is closest to the target or in the direction of the target. The fuze pulse to the other detonators are slightly delayed. Because of this the warhead explosive around the first detonator explodes first, bursting or weakening the outer shell at this point. when the explosive in the rest of the warhead explodes, the effect of the explosion rushes out through the weakened spot in the shell and the full force of the explosion hits the target. This way the effectiveness of the warhead is increased many times over the conventional warhead in which the effect of the explosion is dispersed in all directions and is wasted (see Figure 3.15).

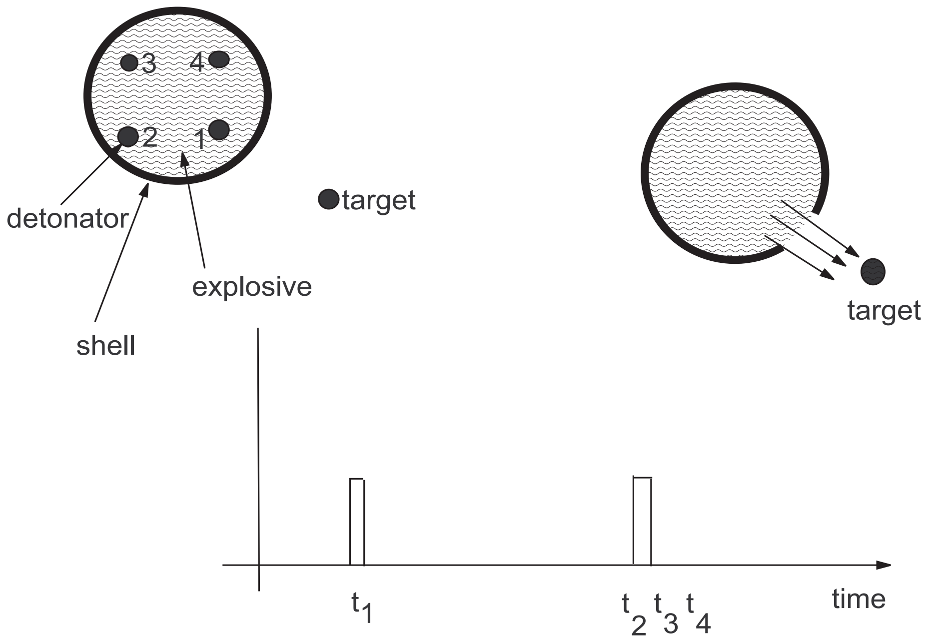


Figure 3.15: *Selectively aimable warhead*

## 3.7 Concluding Remarks

In this chapter we gave a brief overview of the various components of a tactical missile which together aid in the functioning of the guidance system and ultimately help in achieving the mission of a tactical guided missile. The level of discussions was kept at a fairly elementary level since it is important to understand the exact contribution that each of these subsystems makes in the overall functioning of the missile, without getting involved in the intricate details.

*Questions*

1. What is a proximity fuze?
2. How does a RF proximity fuze work?
3. How does a laser proximity fuze work?

4. What are the different types of propulsion systems used in tactical missiles? What are the corresponding missile velocity profiles?

5. What are the different types of warheads used in a tactical missile?

6. Describe the operation of a selectively aimable warhead.

*References*

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