PART 1

SECTION 1 — INTRODUCTION TO THE WEAPON SYSTEM

CHAPTER 2 — THE HOMING MISSILE

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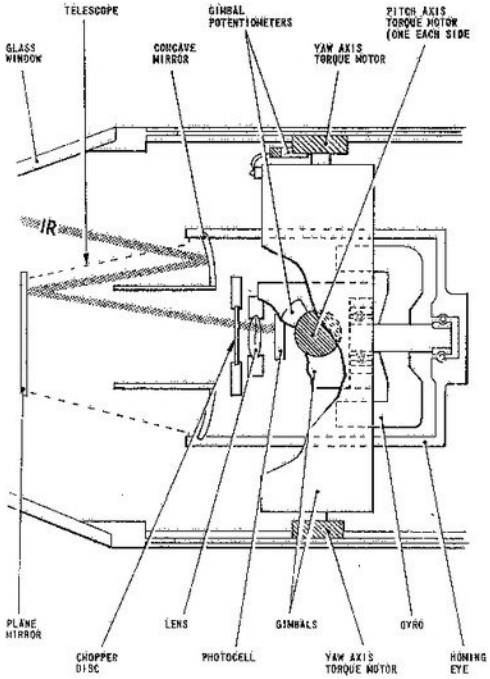
Illustrations

General

1. The two missiles fitted to the Lightning Mk. 3, 5 and 6 are both infra-red ((IR) sensing. In the nose of the missile is the sensing (homing) head which detects the IR radiation emitted by the target. The IR is mainly emitted by the jet pipe and jet efflux, but at supersonic speeds a considerable amount is emitted by the skin of the target.

The Homing Head

2. A cross-sectional view of a simple homing head is shown in Fig. 1. The concave and plane mirrors form a simple telescope so that the incident radiation is focussed on to the chopper disc. The lens spreads the radiation uniformly over the surface of the photo-cell. The chopper is a rotating disc with radial slots cut in it and it frequency modulates the output



1—1—2 Fig. 1 Homing Head

of the photocell by an amount proportional to the angular error between the axis of the eye and the IR source. This signal is compared with two reference signals and this produces demands to the torque motors. These precess the homing eye about its two gimbal axes to follow the source.

Guidance and Control

3. The homing eye is precessed so as to keep it pointing towards the target. The rate of turn of the sightline in space (sightline spin Ω) is determined from the drives into the torque motors. The missile flies a form of proportional navigation and for this, only the sightline spin need be known accurately. The angular tracking error between the eye axis and the sightline does not affect the weapon homing.

4. In proportional navigation the rate of turn of the missile flight path is proportional to the rate of turn of the sightline. If $\dot{\phi}$ is the rate of turn of the missile flight path

$$\dot{\phi} \propto \Omega$$

For missile homing the lateral acceleration (Lat. G) is proportional to the sightline spin

$$\therefore \text{Lat. } G \propto \Omega$$
$$\text{or Lat. } G = k\Omega$$

where k is known as the k factor (navigational constant). The effect of k on the course flown is shown in Fig. 2.

5. In practice, values of k between 3 and 8 are used. The effect of the proportional navigation course is that the sightline rate is constantly decreasing in the absence of target manoeuvre and so, in the later stages of the trajectory, the sightline spin is reduced to zero.

6. It is desirable to launch the missile with some lead angle. This makes the homing task easier since the missile requires less turning to get on to course. For Firestreak this is less important as the missile can only be launched from the rear zone ~~and, in this case, the restriction introduced by slaving requirements precludes launching with lead~~. AL3

Homing

7. A missile tends to home in a plane which contains the target's track and the sightline. This plane is

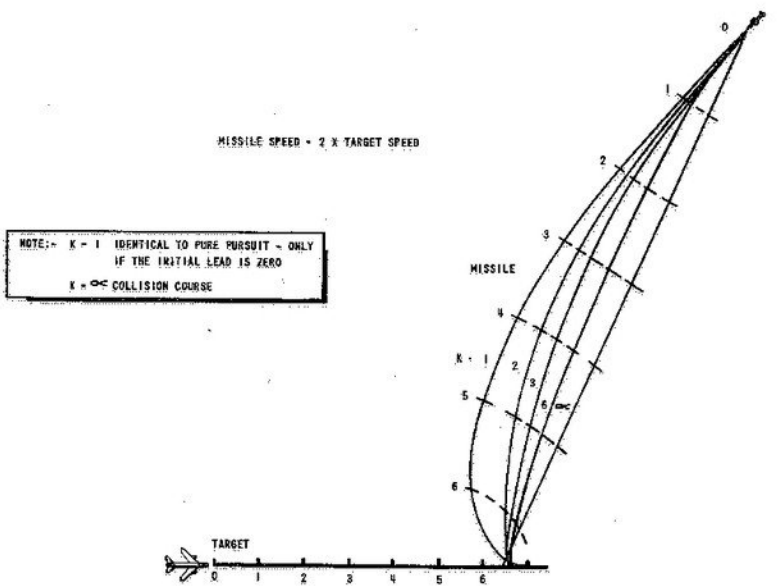
called the flyplane and is illustrated at launch in Fig. 3.

8. Fig. 3 shows that the launching conditions can be resolved into a lead angle in both the flyplane and at right angles to it, i.e. in-plane and out-of-plane lead angles. It is desirable to launch with some in-plane lead angle but with the minimum of out-of-plane angle. Out-of-plane angles cannot truly be called lead or lag but are error angles.

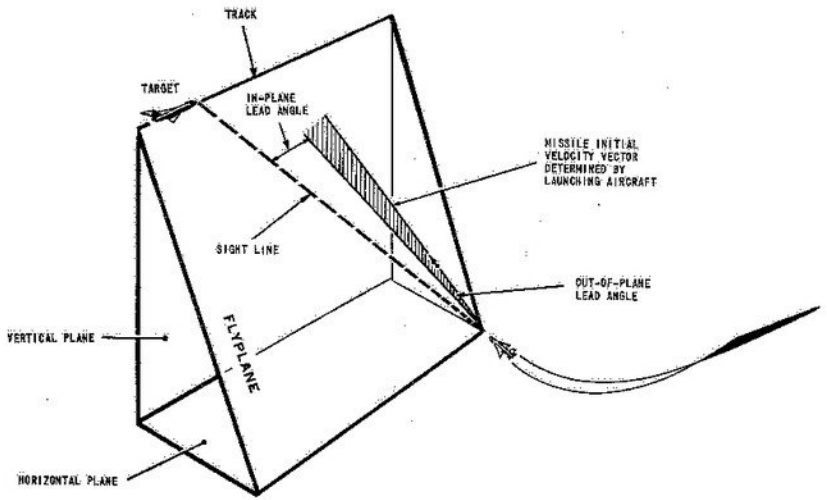
9. For head-on or tail launches, the flyplane is vertical and lead angle in elevation becomes in-plane lead angle. If the missile is launched from other angles-off, the flyplane is no longer vertical but is inclined from the horizontal plane. If this angle of inclination is small the azimuth lead angle closely approximates the in-plane lead angle.

Fuzing

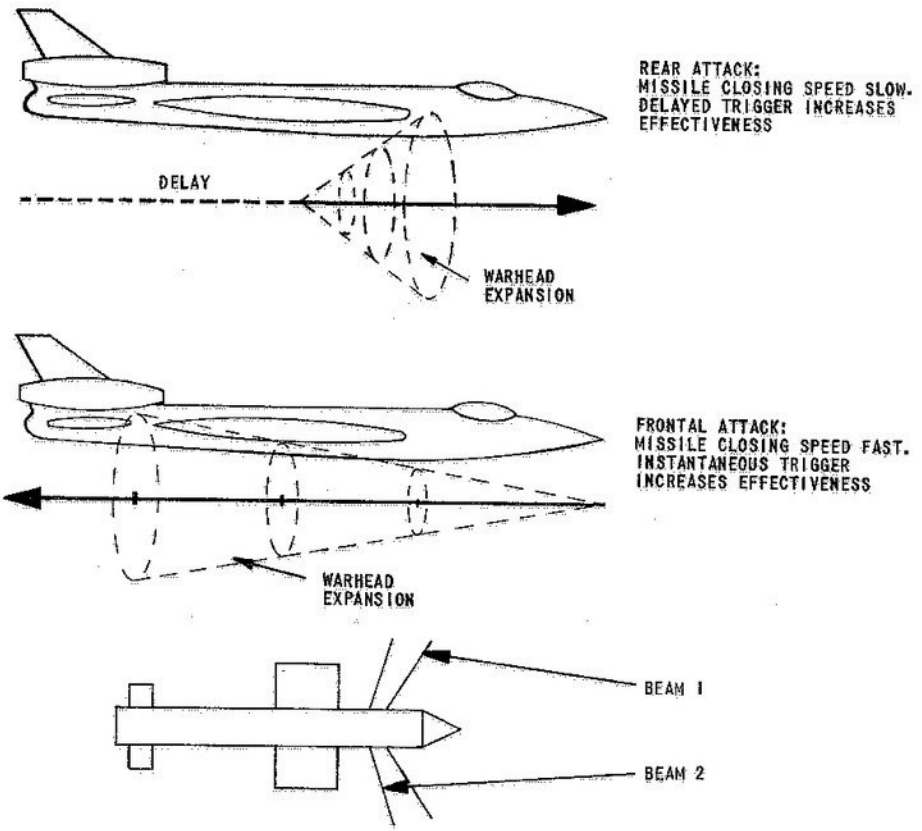
10. The missile fuzing system consists of IR detectors that determine when the missile passes the IR source (the target). There are two detectors set at different angles (Fig. 4) both of which must suffer a sharp change of signal in rapid succession to trigger the warhead. In all but Red Top-frontal attacks there is a delay between cutting the latter (wide angle) detector ring and warhead firing. The warhead, fragmentation for Firestreak or continuous rod for Red Top, expands outwards towards the target thereby destroying it.



1—1—2 Fig. 2 Homing Missile using Proportional Navigation



1—1—2 Fig. 3 Missile Flyplane



1—1—2 Fig. 4 Missile Fuzing