# PART 1

# SECTION 7 — WEAPONS

## CHAPTER 1 — FIRESTREAK

*(Completely revised at AL3)*

### Contents



### Introduction

1. Firestreak is an infra-red (IR) homing weapon designed for launching in a stern cone of 20°. Carriage and firing limitations are given in Pilot's Notes and the Release to Service. Under ideal conditions it has a snap-up capability of 10,000 feet after launching and homes effectively by day or night in clear skies; it is less effective in cloud or when the target is up sun. The weapon is powered by a solid propellant motor (cordite) for about 1·8 seconds of its flight, and it coasts towards the target after burn-out. The warhead is detonated by either a proximity or contact fuze, and is self-destroying 12 seconds after launching (13 seconds after pressing trigger) in the event of a miss; this is not normally used except on range firings. Fig 1 shows a Firestreak missile and launching shoe, and indicates the location of the missile components.

2. The Firestreak pack (Fig 2) contains the arming and launching equipment, and carries two weapons, one to port, one to starboard. Hot air, tapped from the engines, is directed through the pack to the missile control actuators to prevent freeze-up during flight. During arming, both weapons are supplied with electrical power from a hydraulically driven alternator in the pack, and weapon cooling takes place. The weapons can be jettisoned in an emergency.

### Guidance and Control Systems

3. The guidance system incorporates the weapon homing ahead and the associated electronics to perform the slaving functions of the homing eye at the pre- and post-launch phases. The error signals generated by the guidance system are also used as command signals after launch to move the missile control surfaces in pitch and yaw to satisfy the demands. Accelerometers and rate gyros are used in the control system to smooth the response. The roll-rate is controlled to less than 30°/sec.

4. *Pre-Launch.* After arming is complete the guidance and control systems perform the following functions.

a. Cause the homing eye in each missile to carry out a circular scan of 1° radius which increases

its total field of view from the normal 5° to 7°. The line of look is along the missile line (longitudinal axis) if the AI is not locked on in angle (but see Part 2, Sect 1, Chap 5), and during GW radar ranging. If AI angle lock is achieved, the homing eye is slaved to the steering dot which offsets the line of look up to a maximum of 5° from the missile line; it performs the 1° scan about this offset. Therefore, the maximum angle from the missile centre line at which the homing eye can detect and lock on to a target is 8·5° but at the maximum angle there is a possibility of loss of lock.

b. Direct a signal to the related event marker on the B-Scope and armament indicator panel and, when LFS is selected, to the 'target seen' (Acquired) indicator on the LFS.

c. When the trigger is pressed, lock the homing eye on to the target and circular scan ceases.

5. *Post Launch.* When the missile is launched, the guidance and control systems perform the following functions:

a. Increase the offset limit of the line of look to 30° from the missile line.

b. Maintain lock-on to the target and, when the missile is clear of the aircraft, direct the missile towards the target using the error signals produced by the homing head.

c. Limit the lateral acceleration to 15g and maintain the roll rate to less than 30°/sec.

**Fuzing Systems**

6. Contact and proximity fuzing systems are provided to detonate the warhead. The contact fuzes, in the leading edge of each wing, operate if a wing contacts the target. The proximity fuze, an optical IR system, functions if the missile approaches within the lethal range of the warhead.

7. In the event of a miss, a time-delayed self-destruct mechanism, if used, detonates the warhead 12 seconds after launching (13 seconds after pressing the trigger to initiate the launch).

**Power System**

8. The power source is air compressed to 3500 PSI contained in a bottle at the rear of the missile. The air operates the control surface actuators during free flight, and drives the turbo alternator which provides the missile's electrical supply.

9. *Pneumatic System.* Air flow is controlled by two starter valves. No 1 valve is energised open by the aircraft supplies to start the turbo-alternator, and No 2 by the missile's own electrical supply after launch initiation to admit air to the actuators. Both valves are held open by air pressure once air flow starts.

10. *Electrical System.* The turbo alternator starts at launch initiation and provides the missile with 115 volt, single phase, 2400 Hz supplies; the homing head gyro and chopper motor supplies pass through a rotary converter to become 80 volt, two-phase, 400 Hz power. From arming start until the missile alternator output becomes available, the missile's gyro and electronics are powered from an alternator in the pack (para 18). Changeover from one alternator to the other is made just before launch by a sequence selector switch (para 27).

**Rocket Motor**

11. The motor comprises 61 lb of cordite. The rocket burns for 1·8 seconds and gives sufficient thrust to produce a speed increment on launch speed of up to 1·6M. Gases from the rocket tube are discharged through a venturi and a tail pipe passing through the centre of the warhead and air bottle.

**Warhead and Initiator**

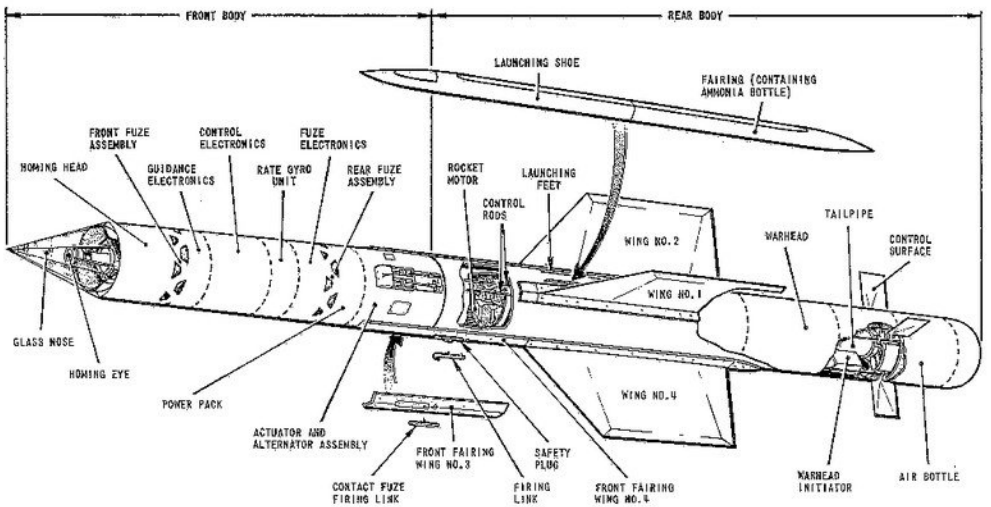
12. *Warhead.* The warhead casing contains 17 lb 6 oz of high explosive in which is embedded an exploder activated by the initiator in the warhead. The outer case is designed to disintegrate into 0·25 oz fragments with a fragmentation beam of 50° inclined forward.

13. *Initiator.* The initiator ensures that the arming process cannot start unless missile boost exceeds 14g for 1·45 seconds. Arming is not completed until approximately 3 seconds after bolt shear. This gives adequate safety clearance from the launching aircraft. During range firings if, after 12 seconds of flight, the fuze system has not exploded the warhead, a self destruct mechanism operates.

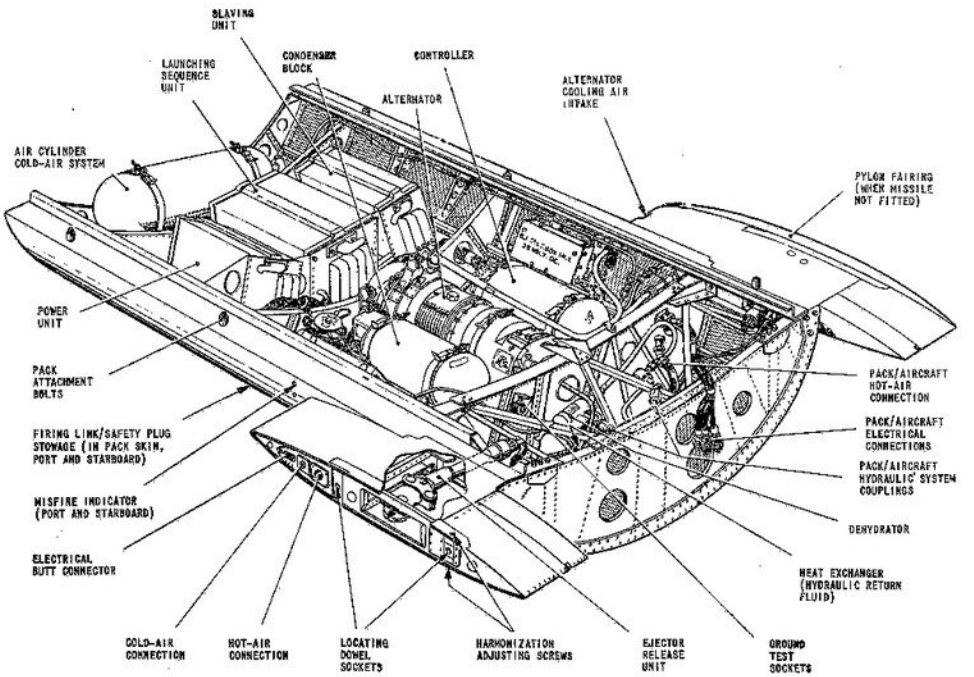
**Heating and Cooling**

14. Engine air is directed over moving parts to prevent the formation of ice during pre-launch flight. Heat soak prior to launch maintains component temperatures above minimum during free flight.

15. Prior to launch, cooling is required by the missile's electronics and homing head photocell to




**1—7—1 Fig 1 Components Location — Firestreak**




**1—7—1 Fig 2 Firestreak Pack**

prevent excessive temperature rises during free flight. A 15 minute supply of liquid ammonia at the rear of each shoe (Fig 1), and a 600 cu in air bottle stowed in the pack (Fig 2) are used for cooling. Air pressure is indicated on a skin gauge below the starboard pylon, normally indicating 3300 PSI when two missiles are fitted and 2600 PSI with one missile. The cooling supplies become available when ARM is selected.

**Launching Shoes**

16. The launching shoes connect the various services from the pack to the missiles. A stainless steel bottle containing the ammonia supply for the related missile is attached to the rear of the shoe and covered by a fairing. The missile is secured to the shoe by a bolt which shears when the missile is launched.

**Firestreak Pack**

17. The missile pack, shown in Fig 2, includes the following main units:

a. An air bottle used for cooling.

b. A hydraulically-driven alternator and associated components, and supply lines by which connection is made with the aircraft hydraulic system.

c. Target acquisition and fire control units.

d. Ejector release units.

18 *Pack Alternator.* The hydraulically-driven alternator is brought into use when ARM is selected. The alternator supplies both missiles until switched off by the selector switches (para 27), or until no load conditions occur, ie 0·95 seconds after launch initiation when the sequence switch in each missile isolates the respective missile from the pack alternator.

19. One engine must be maintained above fast idling speed for satisfactory operation of the pack alternator. This must be No 1 engine if airbrakes are to be used with the missiles switched to ARM. Loss of electric supply to the missiles will result if, with ARM selected, flaps or undercarriage are operated, or if the airbrakes are operated when flying on No 2 engine only.

20. *Target Acquisition and Fire Control Units.* These comprise a power unit, launching sequence unit and a slaving unit which perform the following functions.

a. Admit aircraft services system hydraulic pressure to the pack alternator.

b. Modify the pack alternator output to suit missile requirements.

c. Start the gyro in each missile.

d. Supply the circular scan signals for the homing eyes, and ensure that they are not effective until the gyros run up.

e. Light the ARMING window in the armament indicator panel.

f. Ensure that neither missile can be fired until it is armed (gyros run up, cooling complete), has been selected for firing, and also has a target in its field of view (has acquired).

g. Cause the ARMED window in the armament indicator panel to flash under the following circumstances.

(1) When the pack alternator runs up (for the first 2 seconds after selecting ARM).

(2) If the pack alternator fails to start or stops after starting. Under either condition, a second attempt to arm should be made.

(3) When both missiles cease to draw power from the pack alternator, indicating changeover to the missile alternator.

h. Indicate when arming is complete (steady ARMED light).

j. Apply slaving signals to both missiles so that the homing eyes look along a line defined by the steering dot, but only up to a maximum of 5°.

k. Indicate that the missile(s) sees a target (illuminates the EVENT 1 and/or EVENT 2 windows on the B-Scope, and the LFS acquisition light when LFS is selected).

l. Isolate the circular scan signals from the homing eye(s) when, with the target in sight, the trigger is pressed, so that the homing eye(s) locks on the target.

m. Adjust the missile control system so that control responses are appropriate for launch altitude.

n. Fire one or both missiles (para 23).

21. *Ejector Release Units.* A unit is fitted in each pylon to hold the launching shoe against the pylon, or jettison the shoe and missile in an emergency. The unit consists of a barrel holding two telescopically arranged gas operated pistons and a plunger, a breech cap and cartridge fitted at the inboard end of an installed unit, and store retaining jaws at the outboard end which pivot open to receive or release the launching shoe suspension lug. When jettison action is taken the cartridge fires causing the gases to unlock the jaws and force the piston outwards to throw shoe and missile laterally away from the aircraft.

**Arming and Firing**

22. Arming must be started at least 2·25 minutes before the intended firing time by selecting ARM on the ARM-SAFE switch; both weapons are armed simultaneously and the period of elapsed time is indicated in the cockpit. If arming is discontinued, cooling and electrical supplies are shut off. On subsequent re-arming it should be anticipated that at least 2 minutes arming time will be required. On selecting ARM:

a. The services pressure should drop momentarily and then return to normal.

b. The ARMING light on the armament indicator panel illuminates.

c. The ARMED light on the armament indicator panel flickers momentarily and then goes out. If the ARMED light continues to flicker, only one more attempt to arm should be made.

After approximately 2 minutes, the ARMED light(s) illuminates indicating that the missile(s) are armed. The EVENT 1 and EVENT 2 lights also illuminates momentarily and then go out. After 15 minutes of ARMED and ARMING time, the ARMED light begins to flicker. The ARM/SAFE switch must then be selected to SAFE to prevent overheating of the missile.

23. Firing of either a single weapon or both, as selected, takes place provided the homing eyes have acquired, the fire signal is present, and the trigger is pressed. A sequence switch, driven by the missile alternator, introduces the various operating functions of the missile at the appropriate time during its flight (para 27).

Note 1: *SINGLES Selected.* When firing the weapons singly, the first weapon to acquire the target is fired. If simultaneous acquisition by both weapons occurs, the starboard weapon is fired. The second weapon can be fired 4·3 seconds after the first, providing it has acquired and is still in range, by releasing and again pressing the trigger. Firing of the first missile generates a lock out pulse which, for 4·3 seconds, removes and inhibits the other acquisition, and consequently the EVENT light.

Note 2: *PAIRS Selected.* If only one weapon acquires when PAIRS is selected, only that weapon fires, but if the second weapon acquires before the break-away signal is passed, whilst still within range limits, it launches automatically provided that the trigger is still depressed. When both weapons acquire the target prior to firing, a 0·5 second delay occurs between the launch of each weapon, to prevent the second weapon acquiring the first and their collision in flight.

24. *Launch Requirements*

a. *In CRT.* The requirements for launching Firestreak in the CRT mode are as follows:

(1) The aircraft must be within the computed range bracket (automatic attack) or the Fire Signal generated in an AI23C attack.

(2) The missile or missiles must have acquired.

(3) The fire committal switch (trigger) must be pressed.

b. *In LFS.* The requirements for launching Firestreak in the LFS mode are:

(1) The missile or missiles must have acquired.

(2) The fire committal switch (trigger) must be pressed.

25. *Trigger Press.* The trigger should be pressed on the first attack of a PI sortie to exercise the firing circuits. If the system is functioning correctly, the misfire indicator will operate.

26. *Delayed Launch (Hang Fire).* A delayed missile launch, often incorrectly called a 'hang fire', can occur because of:

a. A malfunction of one of the relays in the firing circuit.

b. The pilot pressing the trigger twice during the launch sequence.

A delayed launch can result in the missile leaving the pylon with the fins unlocked. This creates a dangerous situation because the missile may be overstressed and break up, possibly in the path of the fighter. This is more probable at lower levels where a given fin deflection is more effective than a high altitude. However, failures of relays in the firing circuit are now thought to be most unlikely. The probability of a delayed launch can therefore be almost eliminated by the pilot ensuring that he presses the trigger very deliberately and holds it pressed until the missile leaves the pylon.

27. *Sequence of Events from Selecting ARM.* In the following table, zero time is the moment of launch initiation, ie the trigger pressed and the fire signal present.

| *Time* | *Events* |
|---|---|
| Up to minus 2 mins ±15 secs. | MAS to GW, PAIRS/SINGLES switch as required, ARM/SAFE switch to ARM. Pack alternator starts (ARMED window flashes for 2 secs). ARMING window on armament indicator panel lights, armed time indicator starts, missile electronics warm up, and air and ammonia are admitted to missiles for cooling. |
| 2 mins after arming | ARMED window flashes for 2 seconds then remains steady; arming complete. Scan signals applied to homing eyes, via guidance system, to give 7° field of view in a direction along missile axis, or up to 5° off missile axis and parallel to AI scanner axis. When target seen, output from guidance system to EVENT 1 and/or EVENT 2 windows, B-scope event markers and LFS. Control system inhibited. |
| 0 (trigger press) | Launch initiated. Scan/lock switch in missiles changes over and homing eyes lock onto target: control system still unresponsive to guidance system demands. No 1 starter valve energised, missile alternators begin to run up, sequence switch starts rotating to perform all other switching required except warhead arming and self-destruct. |
| + 0·95 sec. | Turbo-alternators reach operating speed, power changeover from pack to missile alternators. Cooling supplies cut off. |
| + 1·01 sec. | Rocket motor(s) fires (0·5 second delay on second missile if firing PAIRS), retaining bolt(s) shears as thrust increases, missile(s) launches. |
| + 1·25 sec. | No 2 starter valve energised, actuators unlock. Control system still inoperative. |
| + 1·35 sec. | Control system commences to roll-stabilise and home the missile. K-factor build-up starts. |
| + 2·35 sec. | Maximum signals from guidance system to control system. Missile fully effective for remainder of flight. |
| + 3·5 sec. | Warhead initiator armed by sustained acceleration. |
| + 13·0 sec. | If fuzing systems have not detonated warhead, time switch in initiator operates to explode warhead, in range firings. |

**Safety Devices**

28. *Missile*

a. *Motor Firing Link.* The motor is made safe by the removal of a firing link in the front fairing of No 4 wing (Fig 1). A safety plug replaces the firing link. Stowage for firing links and safety plugs are at the sides of the pack.

b. *Contact Fuze Firing Link.* This link normally remains in position in the front fairing of No 3 wing when the aircraft is on the ground. It is re-

moved as a safety precaution during certain ground tests on the missile.

29. *Pack*

a. *Ejector Release Units.* Each of the ejector release units is made safe by disconnecting from the breech caps the electrical connecting plugs in the jettison circuits. Access to the plugs is by the removal of panels in the pack skin, one below each pylon. A safety plug is stowed one each side of the aft wall of the pack and these are used to replace the connecting plugs which are stowed in their place. A pennant is attached to each safety plug and hangs down through the access openings. The Ejector Release Units are not normally armed.

b. *Misfire Indicators.* Two indicators are visible through windows forward of the port and starboard pylons. Each indicator is connected into the firing circuits of the related missile and is extended by the ultimate firing signal until it bears against its resetting cam. If the indicator is extended after a misfire the missile is in a dangerous condition as it has received signals from the fire control equipment. Each misfire indicator must be correctly set before flight, indicated by external markings on the pack and the head of the resetting screw forming a black semi-circle.

**Firing Limitations**

30. The infra-red radiation pattern from a target aircraft depends on its engine/airframe design, whether reheat is in use, and on target speed. Piston engine targets present a special problem in obtaining an acquisition and are best attacked in the LFS mode. Limited trials results and theoretical analysis indicate that the best chance of obtaining missile acquisition is at about 45° angle off the target tail, although this angle should be reduced as much as possible if the target evades. It is important for pilots to be familiar with the acquisition zones of piston engine target aircraft which are likely to be encountered.

31. *Aiming.* An accurately flown steering dot ultimately places the fighter within the range brackets. However, the pilot must also be aware of missile firing zones because early acquisition and Range Outer signals can occur in circumstances which result in an unsuccessful firing. As a practical guide, aiming limitations are as follows:

a. The aircraft should be within 20° angle off the target tail when attacking a non-evading target, but within about 10° angle off when attacking an evading target.

b. A maximum look angle of 5° against a non-evading target, but as near zero as possible against an evading target. In an LFS attack, the look angle should be kept as near as possible to zero by accurate tracking.

Pilots must, however, be familiar with the parameters of various success zones as described in Part 1, Sect 9.

32. *Range Brackets.* The AI range brackets for Firestreak come into operation on selection of Computer Mode 1 and are given at Part 1, Sect 8, Chap 1, Fig 4. In the radar ranging mode, the 'in-range' signal does not allow for changes in height or range rate. Corrections should, therefore, be applied to the radar signal, or firing brackets assessed when the radar is inoperative, by applying the information given at Part 1, Sect 8, Chap 1, Fig 5.

**WARNING:** At low level, or when attacking an ECM target, the 'in-range' information may be unreliable.

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