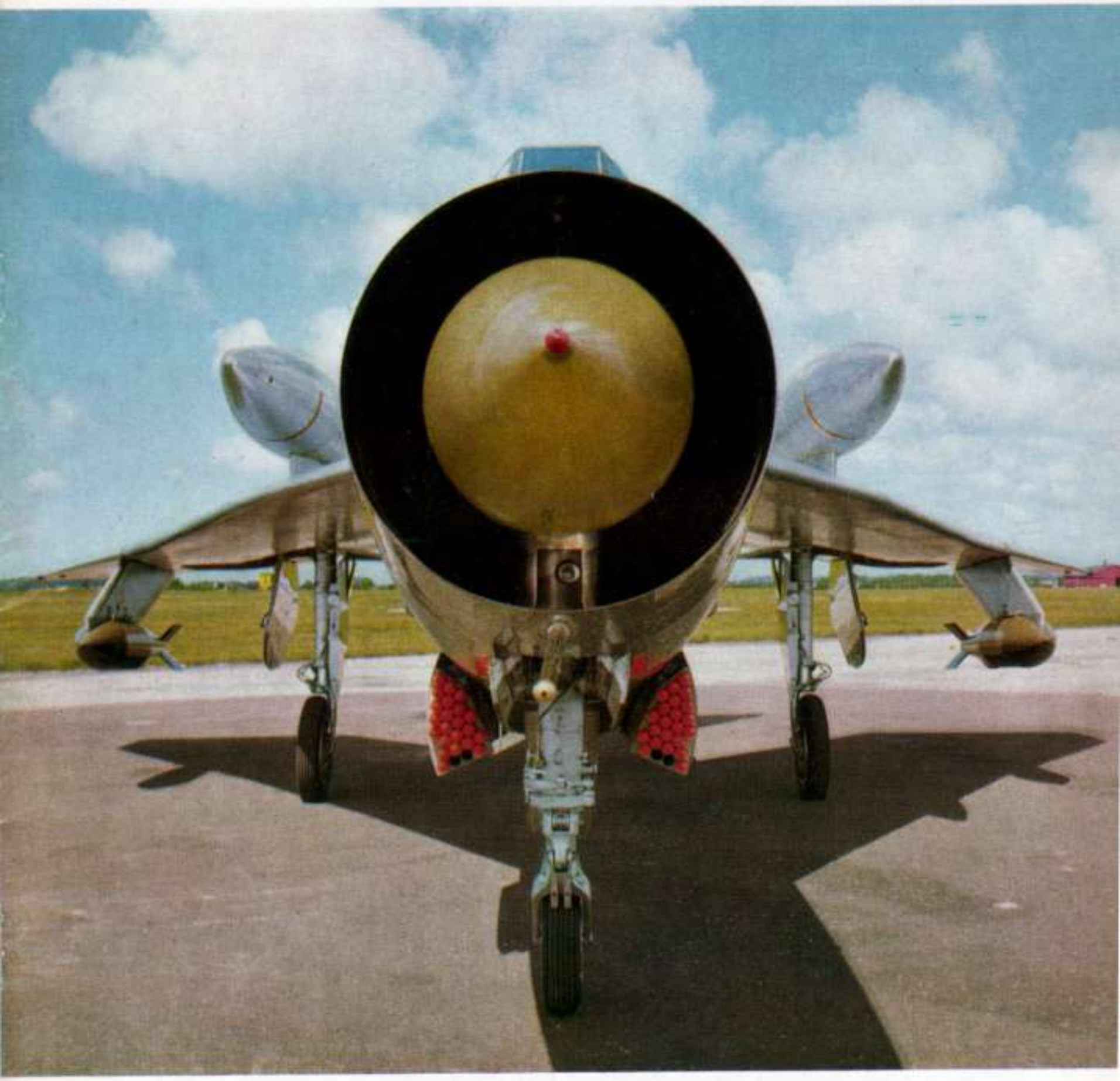
STRIKE LIGHTNING



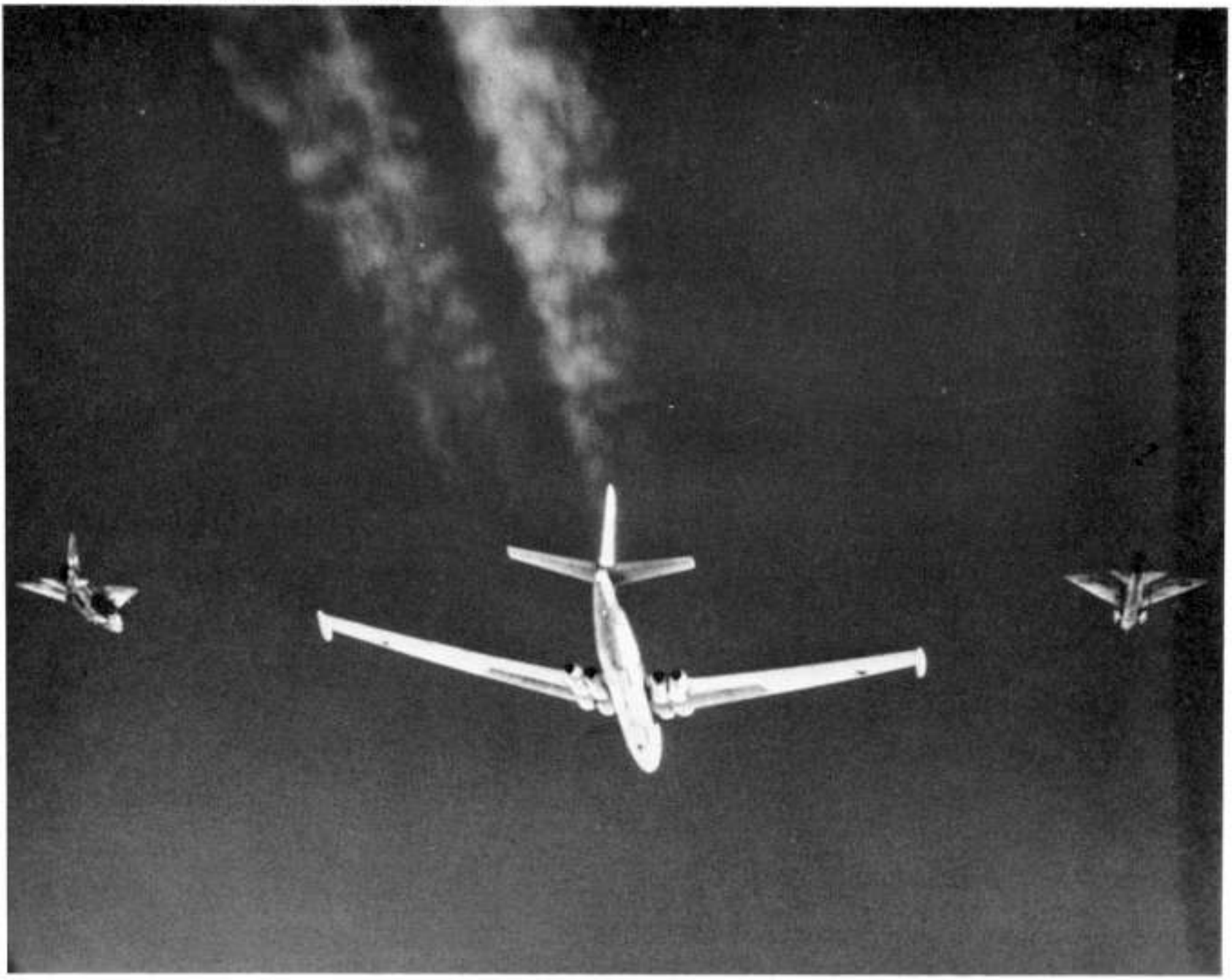
FLIGHT INTERNATIONAL describes development of the world's finest intercepter into a formidable

MULTI-ROLE FIGHTER

LIGHTNING MULTI-ROLE FIGHTER

The Lightning remains the most lethally effective intercepter in service anywhere in the world. Its reliability and unrivalled operational effectiveness in finding, tracking and intercepting an intruder by day or night in any weather have been thoroughly proved in Royal Air Force service since 1960.

Two Lightning fighters of the Royal Air Force escorting from British airspace a Russian bomber intercepted at 37,000 feet 100 miles beyond the coast. Such interceptions have taken place up to ten times in a single week.



Continuous development and the introduction of later marks with longer range, higher performance and more advanced radar, navigation and fire-control equipment have kept the Lightning in the forefront of this role, and now the addition of a very powerful ground-attack punch and five-camera day or night reconnaissance facilities have turned the Lightning into a highly versatile multi-role fighter—economically combining in a single mark of aircraft the ability to mix or interchange the roles of Interception/Ground Attack/ Reconnaissance.

MULTI-MISSION LIGHTNING

The potent F.53 development of the F.6 Lightning for interception, strike and reconnaissance

A MODERN DEFENCE FORCE must be able to cope with rapidly changing situations. One of the most valuable tools for this purpose is a first-class multi-role airborne weapons system that can quickly switch from the interception role—capable of tackling both high-altitude supersonic marauders and older, slower but manœuvrable aircraft—to carry out reconnaissance, and/or ground attack against a variety of targets. The multi-role aircraft is not only operationally versatile, but also simplifies problems of spares holdings and maintenance, compared with those for separate fleets of more specialised aircraft. Although the latter may appear to be cheaper in first cost, in overall usefulness and value for money the multi-role defence aircraft may well prove a better investment. History has provided many examples of this, the most noteworthy being the F-104 and the Phantom.

Such is the reasoning behind the development of the latest versions of the Lightning, the private-venture export multi-mission F.53 now in production at the Preston division of the British Aircraft Corporation, and a still more heavily armed proposal recently announced by BAC and illustrated in this article. These aircraft are not only quick-change artists, but are able to combine two or more different roles during the same sortie.

Heading picture: foe's-eye view of the strike Lightning, with overwing tanks, drop-down rocket launchers under forward fuselage and 1,000lb bomb on each under-wing pylon. The pronounced leading-edge kink is noteworthy in this attitude

Evolution

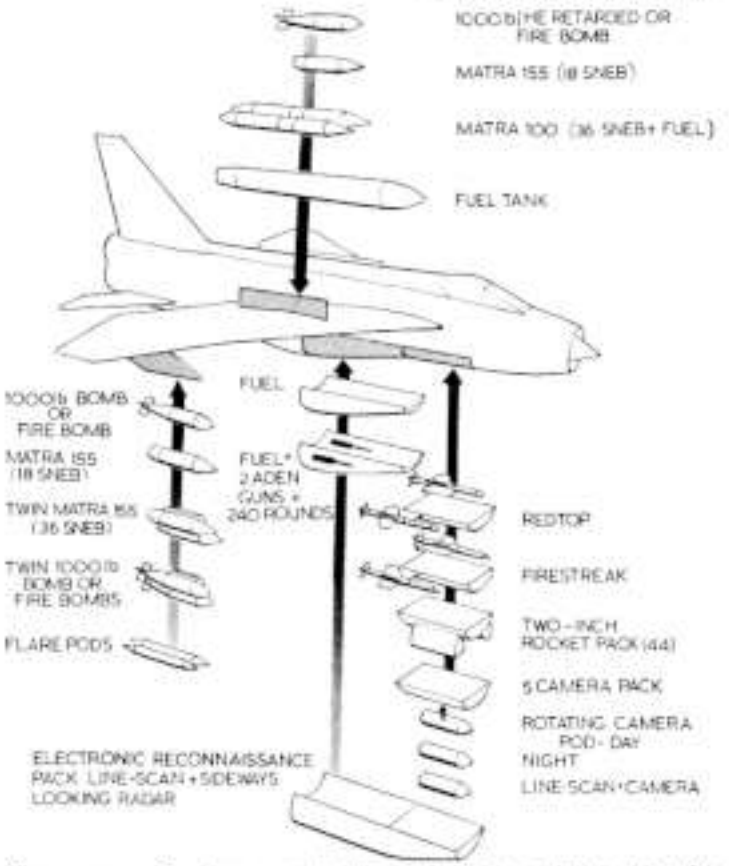
The Lightning was originally developed to fulfil a requirement for a specialised all-weather intercepter for defence of the United Kingdom against high-altitude, supersonic bombers, operating from well-equipped airfields in a temperate climate. Today the Lightning is still supreme in the high-altitude supersonic interception role—but is now operating in the severe winter conditions of Western Germany, and in the heat and humidity of Singapore and Saudi Arabia; and, in addition to its high-altitude role, is asked to function as a low-level strike aircraft bristling with offensive weapons for ground attack. In each of these missions it must be ready for action at a moment's notice. How has this evolution come about? Largely because the initial conception of the aircraft, and its subsequent development as a complete weapons system, was a typical Warton blend of inspiration and perspiration—pinpointing the right design, systematic and exhaustive research in the wind tunnels, and intensive development on the P.1A and P.1B aircraft—the latter programme embracing every aspect of the weapons system. Over 150 aircraft-years of development flying have now been clocked up by the Warton test pilot team, four of whom have completed 1,000 Lightning flights, while two others are in the 900s. Vital contributors to the weapons system were, among others, Ferranti, Elliott Brothers (London) Ltd (now Elliott-Automation), and de Havilland Propellers Ltd (now Hawker Siddeley Dynamics).

The prime factor that has given the Lightning its outstand-

MULTI-MISSION LIGHTNING . . .

ing versatility of performance was the early decision that a supersonic intercepter must have ample reserve of power at altitude for acceleration and manœuvring, and that this implied two engines. Inspired design led to the unique Lightning staggered-engine configuration—both engines being installed on the aircraft centre line, viewed from above, but with the upper engine to the rear of the lower engine, thereby giving an effective powerplant frontal area only 1½ times that of a single powerplant. This configuration not only minimises drag but also eliminates asymmetric engine-cut effects and allows the possibility of low-altitude cruising on one engine, as well as providing the only chance of getting home to base after an engine failure. It also simplifies the duplication of essential services, allowing increased reliability.

The fact that earlier Government decisions had retarded Britain's entry into the supersonic era may possibly have been an asset to the Warton team: although it had to put in a lot of basic effort, it doubtless profited by the mistakes built into earlier supersonic aircraft. Be that as it may, the result of all the aerodynamic investigations and trials was a honey of an aeroplane, responsive and sweet to handle from ground level to operating height, from low speeds of 130kt to Mach 2 plus, and inherently stable over the whole speed range—a first-class platform for the precision-delivery of lethal weapons from high altitude or below radar cover, and equally effective in the photographic reconnaissance role.



The range of stores available and their relation to the under/over wing pylons and under-fuselage bays (shown shaded)

Left, general-arrangement drawing of the Lightning F.53. Right, the aircraft as it appears with a few of the many combinations of stores which may be carried

FERRY TANKS
RECONNAISSANCE POD
RE-FUELLING BOOM

2 RETARDED 1000lb BOMBS OVER WING
4 H.E. OR FIRE BOMBS UNDER WING

188 ROCKETS

TWO REDTOP
36 SNEB ROCKETS
TWO 30 MM ADEN CANON

TWO FIRESTREAK
72 SNEB ROCKETS

The sturdy airframe has taken engine developments in its stride, and has made possible the carriage of today's external wing stores with very little beefing-up of the original structure. Because of the compact complexity of the Lightning weapon system, great care has been focused on reliability and maintainability; the Lightning has an outstanding record of early-warning reaction time and full utilisation capability. The RAF's first Lightning, the F.1A, was described in detail in *Flight*, July 13, 1961, and the significant developments since then are recorded in the table on page 377.

Although in fact the Warton design team had been convinced of the Lightning's wider potentialities since the early flights of the three prototypes, and had already carried out background studies, it was around 1963 that the definitive, multi-role version was conceived, when the F.3 intercepter was being built for the RAF. This version represented a great advance on earlier marks, with more powerful engines and a much more advanced weapon system capable of delivering collision-course Red Top missiles, involving closing speeds of the order of 3,000 m.p.h. At this stage an RAF requirement to increase the reinforcement range of the F.3 led to two developments already foreseen and planned by BAC: first, jettisonable tanks carried above the wing on pylons; and secondly, a ventral tank of double the capacity of the standard F.3 ventral tank which would not require to be jettisoned during combat. Both these items were built into the "developed" F.3, which was first flown in 1964 and which later became the F.6. Another important innovation was the cambered leading-edge extension which, by reducing drag, increases range in the subsonic régime by nearly 20 per cent, with no significant supersonic drag penalty, and which improves on the already exceptional subsonic and low-speed handling qualities. Thus these features greatly widened the subsonic scope of the Lightning, and they came to fruition at a time when there was an urgent overseas demand for low-level strike performance; and so the T.53 and its future developments were born. To date, orders for the Lightning F.53 and its associated trainer T.55, already stand at over £80 million. Deliveries under the main contract to the Royal Saudi Air Force have begun, and the first delivery to the Kuwait Air Force is scheduled for this year.

The export Lightning

These export Lightnings are derived from the F.6 intercepter, deliveries of which have recently been completed to the RAF. Lightnings are now in service with squadrons based in the United Kingdom, Germany, Cyprus and Singapore. The Lightning F.53 is powered by two Rolls-Royce Avon 302-C turbojets each developing 11,100lb static thrust cold, and up to 16,300lb with maximum reheat. Like the F.6, the F.53 is a long-range aircraft with a low-drag, cambered leading edge, a large ventral fuel tank, provision for a flight-refuelling probe and carrying additional fuel for ferrying in two 260 gallon jettison-tanks mounted on overwing pylons. There have been few structural changes other than local strengthening of the wing for the carriage of underwing stores, but—with the Middle East and South American markets in mind—better air conditioning has been provided for the pilot. Equipped with Ferranti Airpass II radar fire-control and bomb-aiming system, Elliott autopilot and flight-data computers, the Lightning in its intercepter role can be directed either by a ground-controlled air-defence system, or it can carry out its own radar search, lock on to its target and track it automatically, and deliver its homing missiles, under computer-controlled guidance, with great accuracy. When using guns, rockets, or bombs, an optical light-fighter sight is used for aiming, with target range being fed automatically from the radar; the computer signals the optimum firing point to the pilot.

Armament versatility is achieved by fitting self-contained weapon packs which can be interchanged in less than an hour. For interception and destruction of supersonic targets, the F.53 carries a twin-Firestreak missile pack in the forward fuselage weapons bay. The infra-red homing system developed by Hawker Siddeley Dynamics for their Firestreak (a pursuit-course missile) has been proved in service to be more accurate, under certain conditions, than radar guidance, and immune from jamming; Firestreak cannot be misled as can radar-guided missiles. Later, when the more powerful and versatile

An excellent study of the two-seat T.55 for Kuwait (with Firestreaks), an F.6 of the RAF (with Red Tops) and an F.53 for Saudi Arabia (guns and 1,000lb bombs)

HSD Red Top collision-course missile becomes available for export, it will be possible to fit a twin Red Top pack as an alternative to Firestreak. Both Firestreak and Red Top missiles have a "jump" capability for attacking target aircraft several thousand feet above or below the launching aircraft.

Another alternative ventral pack which can be used either for air-to-air or air-to-ground attack is a rocket pack comprising 44×2in spin-stabilised rockets housed in twin retractable launchers. These high-explosive rockets are designed to give a high scatter and are useful against dispersed targets such as enemy troops or vehicles advancing over untracked ground. They are fired—two rockets at a time—in ripple salvos every 25 milliseconds. Single ripple salvos can be fired first from one pack and then from the second, or a double salvo can be released.

Interception duties are not always concerned with destruction—in RAF service, for instance, Lightnings are the police force of the upper air, used regularly for investigating inquisitive trespassing aircraft and escorting them off the premises. For some police duties it may be useful to warn off intruders with a non-lethal warning shot, and for this purpose the T.53 can be equipped with a gun pack containing two 30mm Aden guns each with 120 rounds of ammunition, in place of the forward portion of the large ventral fuel tank. This gun pack can be carried in addition to the missile or rocket packs. The Aden guns can also be used for air-to-air combat, particularly useful against older aircraft of lower performance and heat output which the infra-red noses of the guided missiles are not designed to detect; and the guns are also useful for ground-strafing of troops and light targets.

For delivering a heavier punch, accurately positioned against concentrations of troops or against armed strong points on the ground, the production Lightning F.53 can carry, on a pylon under each wing, a Matra 155 launcher housing 18 SNEB 68mm rockets, which can be fired individually or according to a pre-arranged firing pattern. Alternatively, a 1,000lb bomb can be carried under each pylon. These underwing weapons can be carried in addition to the fuselage rocket pack and gun pack, and after releasing bombs or SNEB rockets the aircraft can revert to its supersonic performance and interception role with secondary armament.

For reconnaissance missions, the F.53 Lightning carries, in place of the fuselage missile or rocket pack, a camera pack containing five Vinten Type 360 70mm cameras, combined to give vertical, oblique and forward coverage. Interchangeable lenses can be used to provide continuous surveillance from 200ft up to 30,000ft. Reconnaissance sorties can be flown at supersonic speed at all altitudes, and the Aden gun pack can be retained for defence or offence against targets of opportunity. It is also possible to carry underwing weapons for use against targets detected during a reconnaissance flight. Alternative packs for night use (with underwing flares) and line-scan equipment combined with cameras are also available.

Continued on page 376, after cutaway drawing of Lightning

BAC LIGHTNING F.53

This drawing by "Flight" artist Frank Munger emphasises the development which has been applied since the basic Lightning entered service eight years ago. The weapons and the lower engine are shown "dropped" for clarity. Although proposed for a totally different role, the new airframe in fact has needed surprisingly little strengthening

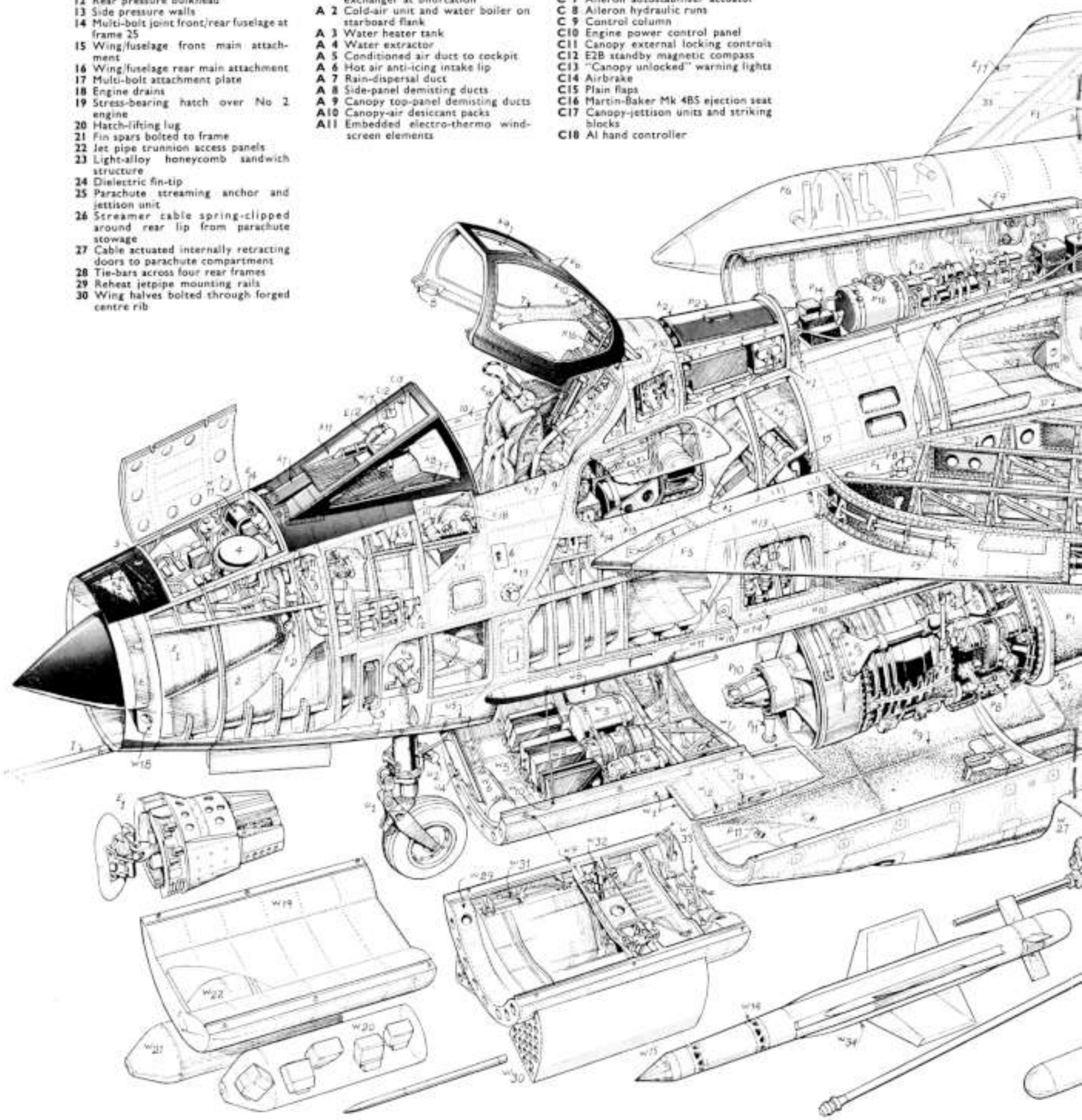
Structure
1 Pitot boom
2 Intake bullet stalk housing nose gear
3 Top bullet spigot access
4 Lox container
5 Evaporator coil
6 Attachments for cockpit ladder
7 Magnesium-forged canopy top frame
8 Shoot-bolts
9 Canopy latches
10 Inflatable canopy seal
11 Front pressure bulkhead
12 Rear pressure bulkhead
13 Side pressure walls
14 Multi-bolt joint front/rear fuselage at frame 25
15 Wing/fuselage front main attachment
16 Wing/fuselage rear main attachment
17 Multi-bolt attachment plate
18 Engine drains
19 Stress-bearing hatch over No 2 engine
20 Hatch-lifting lug
21 Fin spars bolted to frame
22 Jet pipe trunnion access panels
23 Light-alloy honeycomb sandwich structure
24 Dielectric fin-tip
25 Parachute streaming anchor and jettison unit
26 Streamer cable spring-clipped around rear lip from parachute stowage
27 Cable actuated internally retracting doors to parachute compartment
28 Tie-bars across four rear frames
29 Reheat jetpipe mounting rails
30 Wing halves bolted through forged centre rib
31 Main wing-box skin machined from 0.2in light alloy plate
32 T-section intermediate-spar booms pre-attached to skins
33 Detachable leading-edge sections
34 Compass unit
35 Aerodynamic l.e. slots
36 Corrugated-sandwich skin over wheel bays

A Air systems
A 1 Ram intake to cabin-air heat exchanger at bifurcation
A 2 Cold-air unit and water boiler on starboard flank
A 3 Water heater tank
A 4 Water extractor
A 5 Conditioned air duct to cockpit
A 6 Hot air anti-icing intake lip
A 7 Rain-dispersal duct
A 8 Side-panel demisting ducts
A 9 Canopy top-panel demisting ducts
A10 Canopy-air desiccant packs
A11 Embedded electro-thermo windscreen elements
A12 De-icing and de-misting air
A13 Cockpit-emergency ram-air intake (open)

C Controls
C 1 Aileron powered flying-control unit
C 2 Tailplane spigot
C 3 Tailplane drive triangular frame
C 4 Aileron mass-balance
C 5 Aileron control push/pull tubes
C 6 Triple-roller guides
C 7 Aileron autostabiliser actuator
C 8 Aileron hydraulic runs
C 9 Control column
C10 Engine power control panel
C11 Canopy external locking controls
C12 E2B standby magnetic compass
C13 "Canopy unlocked" warning lights
C14 Airbrake
C15 Plain flaps
C16 Martin-Baker Mk 4BS ejection seat
C17 Canopy-jettison units and striking blocks
C18 Al hand controller

F Fuel
F1 Integral fuel tank in wing
F2 Integral tank in flap
F3 Collector tank with booster pumps
F4 Ventral tank
F5 Leading-edge tank
F6 260gal ferry tank
F7 Detachable flight refuelling probe
F8 Vent
F9 Tank pressurising intake/vent in l.e. slot

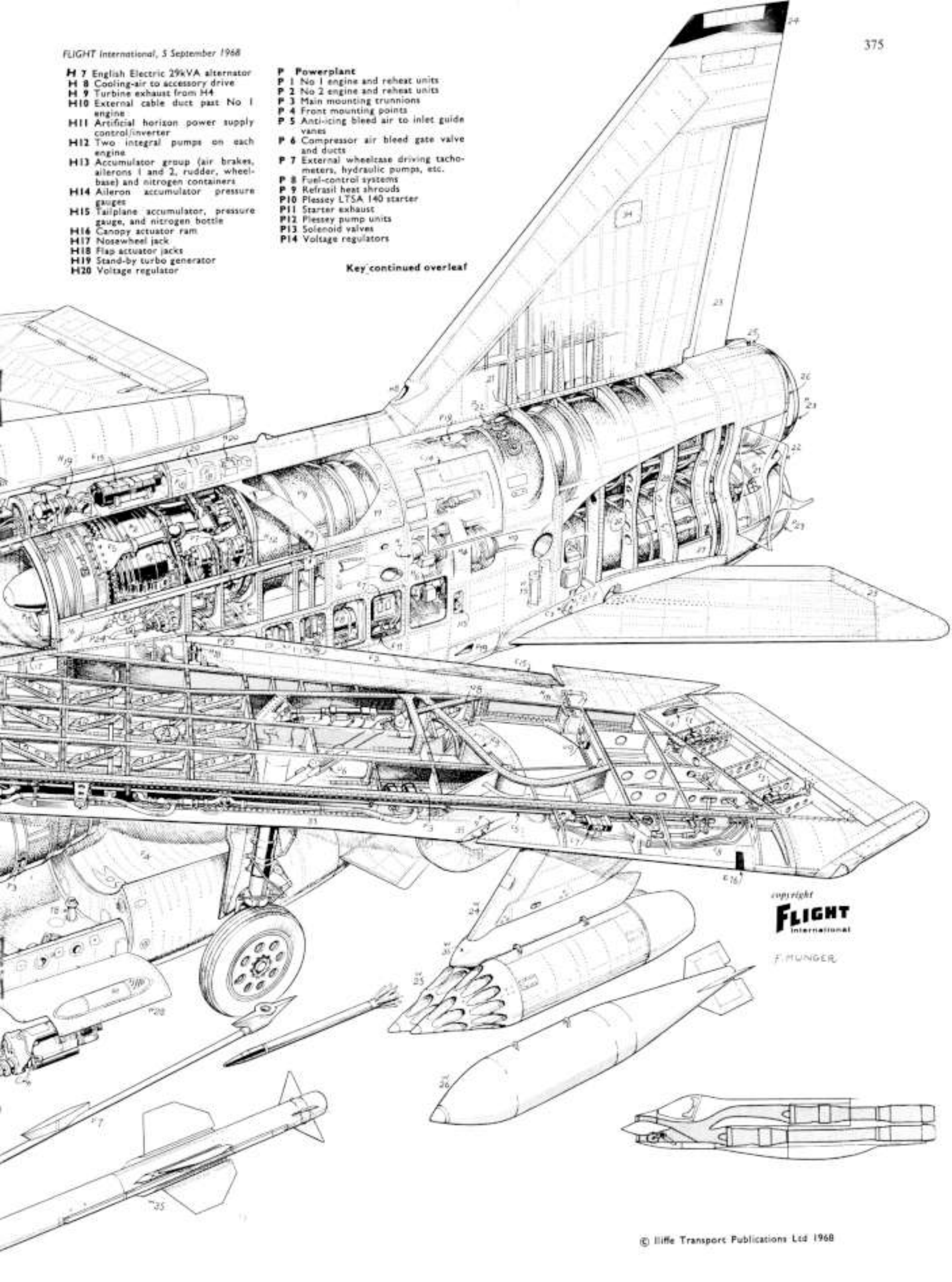
H Hydraulics and electrics
H 1 Varley 28V battery
H 2 a.c. fuse and relay box
H 3 External a.c./d.c. socket in wheel well
H 4 Main-accessory-drive unit, driven by bleed air turbine
H 5 Gearbox oil filler
H 6 Rotax 28V d.c. generator



H 7 English Electric 29kVA alternator
H 8 Cooling-air to accessory drive
H 9 Turbine exhaust from H4
H10 External cable duct past No 1 engine
H11 Artificial horizon power supply control/inverter
H12 Two integral pumps on each engine
H13 Accumulator group (air brakes, ailerons 1 and 2, rudder, wheelbase) and nitrogen containers
H14 Aileron accumulator pressure gauges
H15 Tailplane accumulator, pressure gauge, and nitrogen bottle
H16 Canopy actuator ram
H17 Nosewheel jack
H18 Flap actuator jacks
H19 Stand-by turbo generator
H20 Voltage regulator

P Powerplant
P 1 No 1 engine and reheat units
P 2 No 2 engine and reheat units
P 3 Main mounting trunnions
P 4 Front mounting points
P 5 Anti-icing bleed air to inlet guide vanes
P 6 Compressor air bleed gate valve and ducts
P 7 External wheelcase driving tachometers, hydraulic pumps, etc.
P 8 Fuel-control systems
P 9 Refrasil heat shrouds
P10 Plessey LTSA 140 starter
P11 Starter exhaust
P12 Plessey pump units
P13 Solenoid valves
P14 Voltage regulators

Key continued overleaf



MULTI-MISSION LIGHTNING . . .

KEY TO MAIN DRAWING

(continued from previous page)

P15 Starter control unit
P16 Start tank
P17 HF igniter units
P18 No 2 engine HE igniter unit
No 1 engine HE igniter unit on duct access panel
P19 Reheat cooling
P20 Reheat "hotshot" igniter box
P21 Air-driven nozzle actuator
P22 Reheat unit
P23 Variable propelling nozzle
P24 Lucas bleed-air turbopump for reheat fuel (No 1 under front spar)
P25 Turbopump exhaust
P26 Firewalls

E Electronics
E 1 Ferranti Airpass AI23B radar fire-control in bullet
E 2 Radar ground cooling air coupling
E 3 Cooling fan
E 4 Bullet conditioning-air desiccant pack
E 5 Tacan T/R unit
E 6 IFF aerial
E 7 IFF T/R unit
E 8 IFF coder
E 9 Communications aerials
E10 Communications T/R
E11 Glide-path receiver
E12 AI display unit
E13 Master reference gyro
E14 Nav display
E15 Airpass recorder
E16 Localiser aerial
E17 Glide-slope aerial

U Undercarriage
U1 Dowty forward-retracting nose gear
U2 Shimmy damper and centring unit
U3 Downlock frame
U4 Door linked to leg
U5 Access to nose pivot
U6 Radius rod, breaks inwards
U7 Floating jack directs pressure against top of leg, and to radius-rod bellcrank
U8 Wheeldoor jack and sequence valve
U9 Door latch linkage

W Weapons
W 1 Pack and pylons (Firestreak)
W 2 Alternator: hydraulically driven from aircraft system
W 3 Control unit
W 4 Condenser unit
W 5 Launching sequence unit
W 6 Air bottle missile cooling
W 7 Explosive ejector-release units and attachment point on shoe
W 8 Electrical distribution boxes
W 9 Six attachment bolts
W10 Hoisting points and cables
W11 Winchbrace sockets
W12 24-way electrical connection
W13 Hot and cold air connection
W14 Fuse "windows"
W15 Seeker cell in segmented glass nose
W16 Armament safety break panel (ground arming link, rocket launchers ground extend/retract switch)
W17 Airpass pilots attack sight
W18 G90 camera in "stalk"
W19 Reconnaissance pack interchangeable with missile packs (camera carrier rotates to cover camera ports)
W20 Daylight camera carrier
W21 Night camera carrier
W22 Line scan and camera carrier
W23 Over-wing pylon (twin Matra JL100R Launcher, 36x68mm rockets + 100gal/pair fuel single Matra 155 launcher 18 x 68mm, 1,000lb retarded bomb, fire bomb or 260gal fuel tank)
W24 Wing pylon stressed 2,000lb (not used when Red Top or Firestreak carried)
W25 Twin Matra 155 launchers (two 18 x 68mm)
W26 1,000lb bomb (can be twin mounted as W25)
W27 Twin Aden gun pack interchangeable with forward ventral fuel tank (30mm, 120 rounds per gun export versions)
W28 Access hatch
W29 Rocket pack
W30 Retractable glass-fibre rocket launchers, 22 rockets per side
W31 Hinge-pin with drawing lever (container removal)
W32 Actuator
W33 Hydraulic and electric lines to fuselage
W34 Firestreak
W35 Red Top
W36 Twin carrier shoe

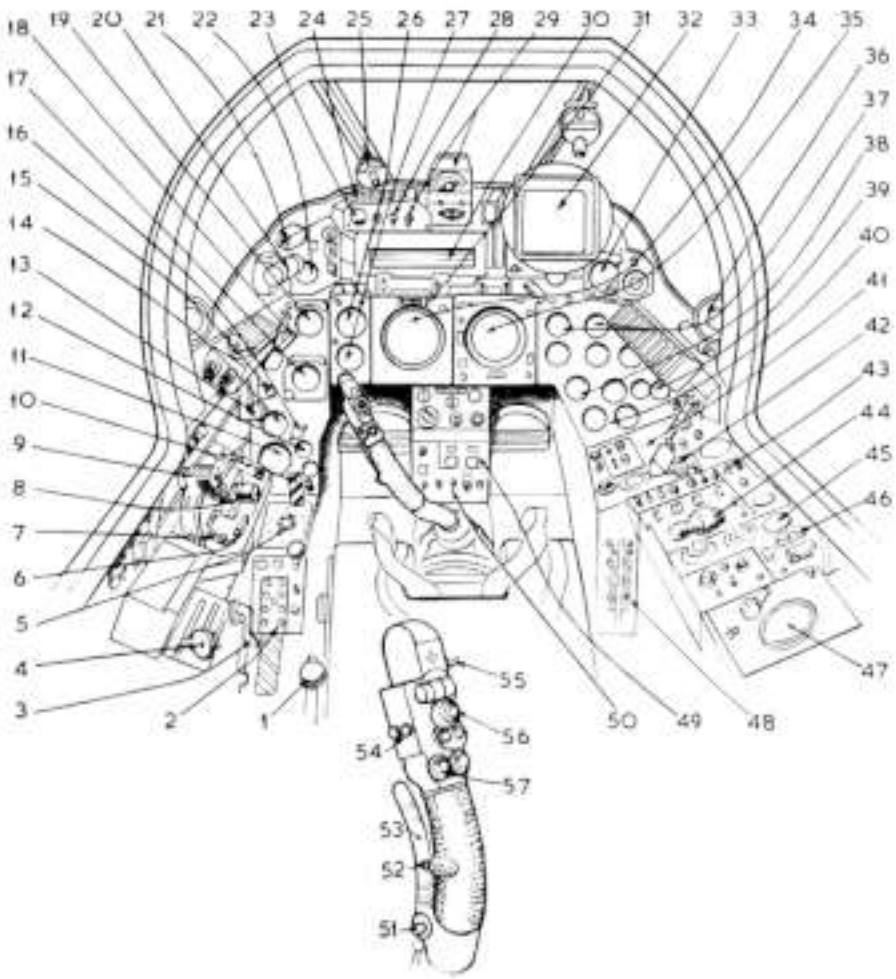
The developed F.53 project will carry identical ventral armament or reconnaissance packs, but its ground attack potentialities have been stepped up three- to fourfold, and a comprehensive electronic reconnaissance pack with both line-scan and sideways-looking radar is also offered. On each underwing pylon can be carried two Matra launchers, each with 18 SNEB 68 mm rockets, or two 1,000lb bombs; and in addition, the overwing pylons for the ferry tanks can also be used for weapons—each carrying one 1,000lb bomb, or two Matra launchers each with 18 SNEB rockets plus 50gal fuel. Thus, in all, the developed F.53 can carry two guns and 44 two-inch rockets plus 144 SNEB 68mm rockets, or six 1,000lb bombs, or various combinations of these loads. The drawings on page 372 show some of the most useful combinations of ground strike weapons and ventral packs. BAC claim that with this latest proposal, more than 400 different combinations of stores can be carried; admittedly some of these combinations may be unnecessary, but all are usable.

With a full load of strike weapons above and below the wings, the drag on the aircraft is considerably increased, but even so the Lightning is capable of high subsonic speed at low level, thanks to its built-in power reserve. Once weapons have been released and only the underwing pylons remain, the Lightning can streak away to safety, rapidly reaching optimum height and an unrestricted supersonic speed.

Using "lay-down" bombs with the parachute retarders developed by Hunting Engineering Ltd (*Flight*, September 14 and 21, 1967, and May 9, 1968) bombs can be dropped from the lower pylons from as low as 200ft. From the overwing pylons, bombs can be "blown off" safely from exceptionally low heights by means of cartridge links.

Performance of all marks of Lightning is still classified, but it can be said that, with no stores carried on the wings, the Lightning can climb to operational height and speed Mach 0.9 in 2½min, and can accelerate from Mach 1 to over Mach 2 in 3½min. At any height, Mach 1 can be attained without reheat. At heights below 25,000ft, the Lightning can cruise on one engine. The aircraft is inherently stable and docile over a 13-to-1 speed range: it can be flown hands-off and rolled at Mach 1.8 without auto-stabilisation (which is used only to confer precision as a weapon platform). The Lightning is still a delightful aircraft to fly when carrying underwing or overwing weapons—even when asymmetrically loaded.

BAC have developed the export Lightnings entirely as a private venture, and on a limited budget. As a result of continuous background thinking over the past ten years, they have been able to clear the multi-mission versions to RAF standards of effectiveness and reliability in a very short time-scale—they have even surprised themselves with the fluent



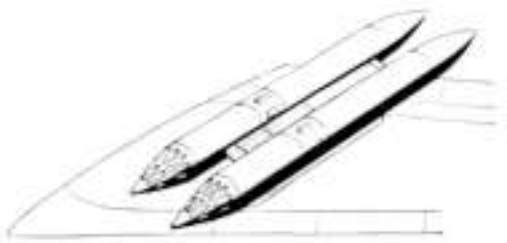
The basic Lightning cockpit. This drawing, for reasons of security, represents neither the F.6 nor the F.53 exactly, but shows a typical layout and is complete in all essentials

Cockpit details
1 Canopy control
2 Tacan controller
3 Throttle servo clutch
4 Demist control
5 ILS selector
6 Rudder trim
7 Engine shut-down switch
8 Throttle and air-brake selector
9 Air-interception hand controller
10 Weapon and tank jettison switch
11 3-axis trim and air-brake indicator
12 Auto-pilot trim indicator
13 Undercarriage selector
14 U/C position indicator
15 Flap position indicator
16 Flap selector
17 Stand-by artificial horizon
18 Tail parachute release
19 Stand-by altimeter
20 Services hydraulic pressures
21 Flight-refuelling switch
22 Stand-by ASI
23 Oxygen flow indicator
24 Air-to-air refuelling lights
25 Stand-by directional indicator
26 Altimeter
27 Rate-of-climb indicator
28 In-flight refuelling switch
29 Light-fighter sight and CRT switch
30 Speed display strip
31 Slip indicator
32 Airborne interception display
33 Accelerometer
34 Attitude indicator
35 Navigation display
36 High-intensity lamp (both sides)
37 Fuel gauges
38 Jetpipe temperature gauges
39 Jetpipe nozzle position indicators
40 RPM indicators
41 Lighting panel
42 Armament indicator panel
43 Armament and camera selector panel
44 Flight-control systems pilot's controller
45 Oxygen contents gauge
46 Engine start switches
47 Oxygen regulator
48 Quick-start panel
49 Tacan offset computer
50 UHF ILS
51 Parking switch
52 Radio telephone
53 Brake lever
54 Flight-system control
55 Armament fire-commitment trigger
56 Two-axis trim switch
57 G.90 camera switch

HISTORY HIGHLIGHTS

Date	Event	Aircraft Features
1947	MoS specification OR.103 for an experimental supersonic research aircraft issued	
September 1948	Supersonic research programme began	
1949	English Electric proposal submitted	Planned for conversion to fighter
September 3, 1949	MoS specification F23/49 for a supersonic day fighter issued	
1949	P.1A layout explored in 9ft × 7ft wind, and 18in water, tunnels	
April 1, 1950	English Electric awarded contract for two P.1A research aircraft	Two fuselage-mounted Sapphire As Sa.3 turbojets with direct pitot intake. 60° swept wing with saw cuts in leading edge for low-speed lateral control, low-set tailplane. Fully powered controls. Second prototype P.1A fitted two 30mm Aden guns, internal operational equipment and ventral tank
1950	New high-speed wind tunnels (Mach 4 and Mach 6) commissioned	
July 20, 1950	First supersonic run in modified jet-driven wind tunnel	
August 4, 1954	P.1A research aircraft—first flight from A&AEE (Mach 0.85) (WG760)	Prototype research aircraft designed with potential for direct development to a fighter. Three aircraft; two for flight (WG760, WG763), one for structural testing to destruction (WG765)
August 11, 1954	First British aircraft to exceed Mach 1 (WG760) in level flight	
November 1956	Lightning F.1 ordered in quantity for RAF. Further orders 1958	
	RAF Intercepters	
April 4, 1957	First flight of P.1B Lightning aerodynamic prototype from Warton (XA847) (Mach 1.2)	Two Rolls-Royce Avons with variable reheat (four settings) giving virtually double the thrust of P.1A; intake modified by conical centre body; mods to fuselage, nosewheel retraction. First prototype weapons system. Three built, including one for engine, one for weapon development
April 3, 1958	First flight of development batch aircraft (20) (XG307)	These 20 aircraft used for development trials on powerplants, general handling, guns, guided weapons (Firestreak), radar, autopilot, ILS coupling, systems and special duties. After first three aircraft, development batch P.1Bs fitted with fin of increased height and area. Additional fuel storage in flaps introduced
November 25, 1958	First British aircraft to achieve Mach 2 (XA847)	Aircraft named "Lightning" by CAS at RAE on October 23, 1958
October 29, 1959	First flight of Lightning F.1 (XM134)	Production version of P.1B. Armed with two, nose-mounted 30mm Aden guns plus two Firestreak missiles, 48 × 2in rockets, or two additional Aden guns
May 14, 1960	Lightning F.1 released to Central Fighter Establishment (XM135)	
June 29, 1960	Lightning F.1 in service with 74 Sqn, RAF (XM165)	
August 16, 1960	First flight of Lightning F.1A—standard RAF version (XM169)	F.1 fitted with UHF radio, flight-refuelling probe, and external cable duct along fuselage
December 14, 1960	Lightning F.1A enters service with 56 Sqn, RAF (XM172)	
July 11, 1961	First flight of Lightning F.2 (XN723)	Improved performance: speed, range, altitude. Avon 210 engines with fully variable reheat, first phase of more advanced electronic equipment incorporated
November 14, 1962	Lightning F.2 released to CFE (XN771)	
December 17, 1962	Lightning F.2 enters service with 19 Sqn, RAF (XN775)	
June 16, 1962	First flight of Lightning F.3 (XP693)	More advanced weapon system capable of guiding and delivering collision-course Red Top missiles as alternative to pursuit-course Firestreaks. Higher-power Avon 301 series engines with fully variable reheat. Larger, square-topped fin to compensate for larger missiles
January 1, 1964	Lightning F.3 released to CFE (XP695)	
April 14, 1964	Lightning F.3 enters service with 74 Sqn, RAF (XP700)	
April 17, 1964	First flight of "developed" Lightning F.3 (later to become F.6) (XP697)	Longer range F.3 with cambered leading-edge wing for lower drag, large ventral fuel tank with stabilising fins, and arrester hook
June 16, 1965	First flight of production Lightning F.6 (XR752)	Three alternative armament packs; two Red Tops, two Firestreaks, or retractable launchers for 44 spin-stabilised 2in rockets
November 16, 1965	Lightning F.6 released to CFE (XR753)	
December 10, 1965	Lightning F.6 enters service with 5 Sqn, RAF (XR755 and XR756)	
January 1, 1968	Lightning F.2A released—conversion programme for earlier F.2s	Retrospective modifications to RAF F.2 aircraft and incorporation of large ventral tank, cambered leading-edge wing, fin, and arrester hook as on F.6
	Two-Seat Trainers	
May 6, 1959	Lightning T.4 prototype first flight (XL628)	Two-seat dual-control side-by-side operational trainer for F.1 and F.2 fighters, with same armament as F.1A except for upper Aden guns
July 15, 1960	First flight of Lightning T.4 production aircraft (XM966)	
June 29, 1962	Lightning T.4 enters service with RAF, 226 OCU (XM970)	
March 29, 1962	First flight of Lightning T.5 prototype (XM967)	Two-seat dual-control side-by-side operational trainer for F.3 fighter, with same armament as F.3
July 17, 1964	First flight of production Lightning T.5 (XS417)	
April 20, 1965	Lightning T.5 enters service with RAF, 226 OCU (XS419)	
November 3, 1966	First flight of Lightning T.55 (55-710)	Export two-seat operational trainer for F.53 multi-role fighter, with same intercepter armament as F.53
December 18, 1967	Lightning T.55 first delivery to Royal Saudi Air Force (55-711)	
	Export Multi-Role Lightnings	
November 1, 1966	First flight of Lightning F.53 (53-666)	Multi-role version of long-range RAF F.6. Twin Firestreak pack (Red Top packs will become available for export later) or five-camera reconnaissance pack (day or night versions), plus two 30mm Aden gun pack (interchangeable with forward portion of ventral fuel pack). Rockets, guns or recce. fit plus two underwing-mounted 1,000lb bombs or Matra 155 launchers each housing 18 SNEB 68mm rockets. Two overwing fuel tanks for ferrying
December 4, 1967	First Lightning F.53 delivery to Royal Saudi Air Force (53-667)	
1968	First Lightning F.53 scheduled for delivery to Kuwait Air Force	
1968	Improved F.53 proposal	As above, but underwing pylons each carry two 1,000lb HE retarded or fire bombs or twin 18-SNEB/Matra launchers and overwing pylons carry 1,000lb bombs each or twin 18-SNEB/Matra launchers each: equals 144 SNEB. Each overwing Matra also carries 50gal fuel. Total weapon load thus 2 guns + 188 rockets, or 6,000lb bombs—plus 200gal extra fuel

Top left, the F.53 with 1,000lb bombs; top right, disposition of the twin Matra launcher, the disposition of which is dictated by undercarriage operation; below left, Lightning with overwing tanks, 1,000lb bombs and drop-down fuselage rocket pack; and, below it, a detail of the twin rocket-launcher with 36 × 68mm rockets and 50gal fuel per tank



MULTI-MISSION LIGHTNING . . .

progress of development flying. Prior to flight trials, which commenced about the end of 1966, wind tunnel tests enabled optimum pylon geometry to be determined; and flight simulator studies were used to assess flutter characteristics with external stores, and to determine the effect of weapon release on the stability of the whole weapons system, including the pilot as one of the control parameters.

The pylons were positioned to give optimum delivery of weapons at subsonic speeds, but flight trials have shown that they are entirely satisfactory throughout the full speed range, both with and without stores. Thus the Lightning girded up for ground attack can in fact be used for supersonic interception.

BAC were prepared to encounter some handling problems when carrying pylon-mounted 1,000lb bombs: first, they looked for buffeting which, it was thought, might affect flaps and tailplane; none was found. From this aspect, it is impossible for the pilot to tell whether or not bombs are being carried. The firm also looked for undesirable inertia-coupling effects on manœuvrability when carrying outboard stores: again, they did not find any. Rolling inertia was, of course, increased, but the highly effective ailerons remained so and manœuvrability is more than adequate; and external stores give a bonus in rough air—the higher mass and inertia makes for a more comfortable ride. Thirdly, BAC expected there might be a fairly drastic trim change when carrying a bomb on one side of the aircraft only—and they were pleasantly surprised. Unexpectedly, aeroelastic effects arising from bomb carriage influenced the rolling behaviour of the aircraft so as to offset the bomb's inertia: in other words, the pilot is barely aware that he is flying an asymmetrically loaded aircraft.

After completion of handling trials over Warton, bomb release trials were made over the Irish sea, escorted by a photographic reconnaissance aircraft; there were no problems. Bomb-aiming trials were then done, with MoD co-operation, at the Armament Trials Base at West Freugh, and the accuracy achieved in these trials was rather better than the design target; a test pilot untrained in ground attack was able to deliver his first four bombs within the target area. This high degree of accuracy results from the "depressed sight-line" technique of bomb aiming provided by the Ferranti system incorporated in the export Lightnings.

Having cleared all aspects of bomb carriage, BAC did not expect, nor did they experience, any troubles witth the Matra SNEB-rocket launchers, which are about the same size as the bombs but weigh less. Handling and armament trials were completed in a very short time—and here, as with the bombs, pilots unfamiliar with these weapons were able to hit the target area on every pass. The rather odd wing-top mounting arrangement was adopted to allow clearance during undercarriage retraction.

Minor mechanical troubles with the Aden guns were soon cured and cleared, and the gun installation is pleasing to pilots in that it is relatively quiet and vibration-free.

Aerodynamic effects from the Vinten camera pack were also minimal, and in a very short time the installation was cleared for Mach 2 and for low-altitude operation at maximum IAS.

Future Prospects

The Lightning deserves to be destined for the same pattern of long-term service as Warton's other supreme breadwinner, the Canberra, now in its 18th year, still in service in 15 air forces, and still exporting in refurbished form as fast as they become available from the RAF.

The Lightning is certainly all set for at least another decade—BAC have guaranteed all customers a complete after-sales service for the aircraft and its systems for this period. All the RAF F.2 intercepters will be brought up to Mark 6 standards of subsonic cruising range—and several months ago an "armament improvement" programme was announced: this is interpreted as the fitment of twin 30mm Aden guns. So it seems probable that Lightning will still be in RAF service in the late 'seventies.

The multi-role export Lightning opens up wide new possibilities, and BAC have had numerous overseas inquiries, particularly from the Middle East and South America, for the present production-export Lightnings. The new proposals for the heavy-punch version outlined in this article will surely excite many more potential customers.

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LIGHTNING . . .

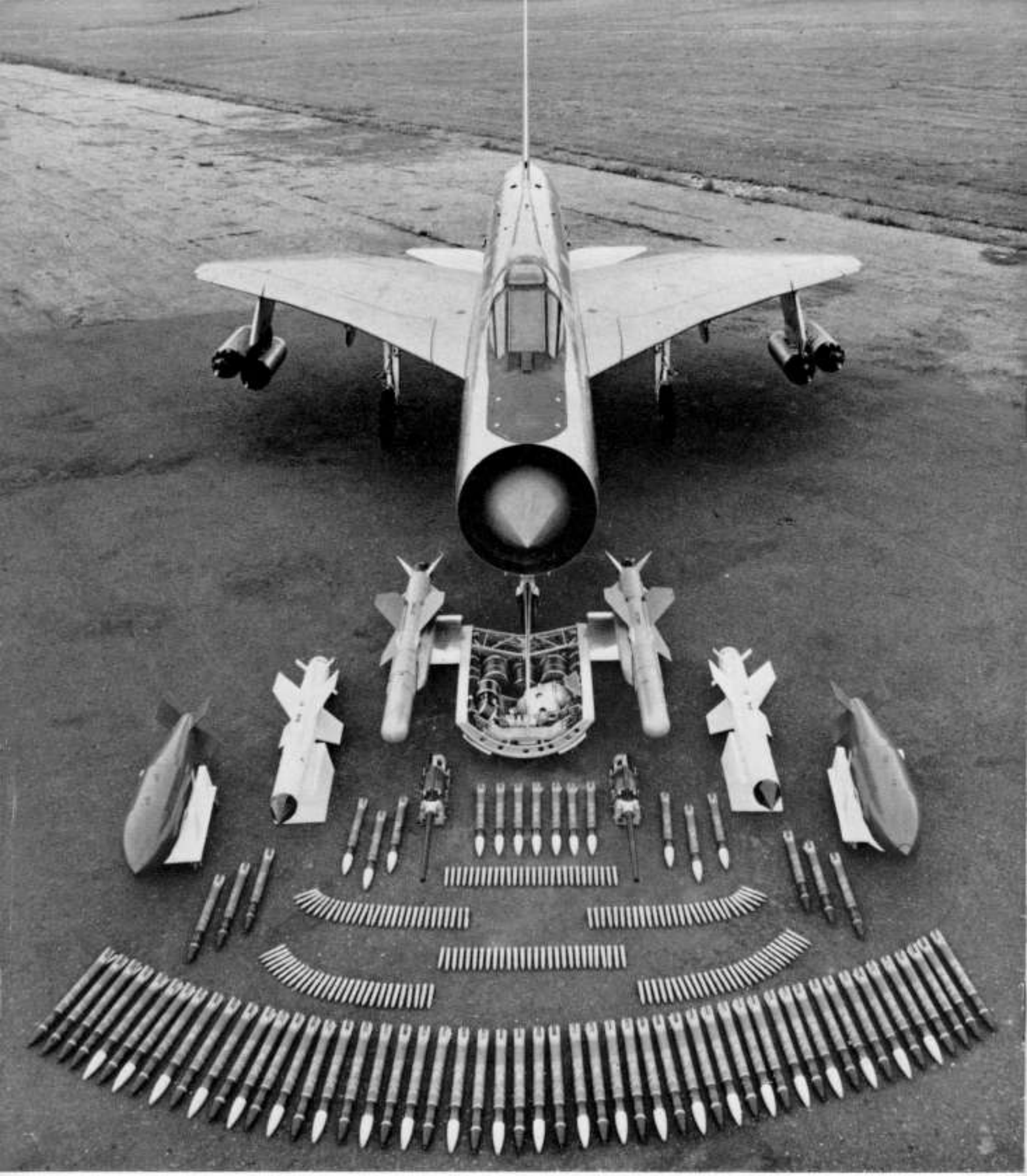
Linchpin of RAF defence since 1960, and now developed into a highly-flexible long-range intercepter for the RAF and a multi-role strike-reconnaissance fighter for export.

Basic Lightning types in formation . . .

Top: Mark 53 multi-role export Lightning carrying guns, two-inch rockets and 1,000lb bombs for ground attack.

Centre: Mark 6 of the Royal Air Force equipped with Red Top missiles for collision-course attacks.

Lower: Mark 55 trainer of Kuwait Air Force carrying Firestreak missiles for interception duties.



The Lightning's formidable fire power—
ranging from two guns to 188 rockets or six 1,000lb bombs.

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