ROYAL AIR FORCE YEARBOOK 1984

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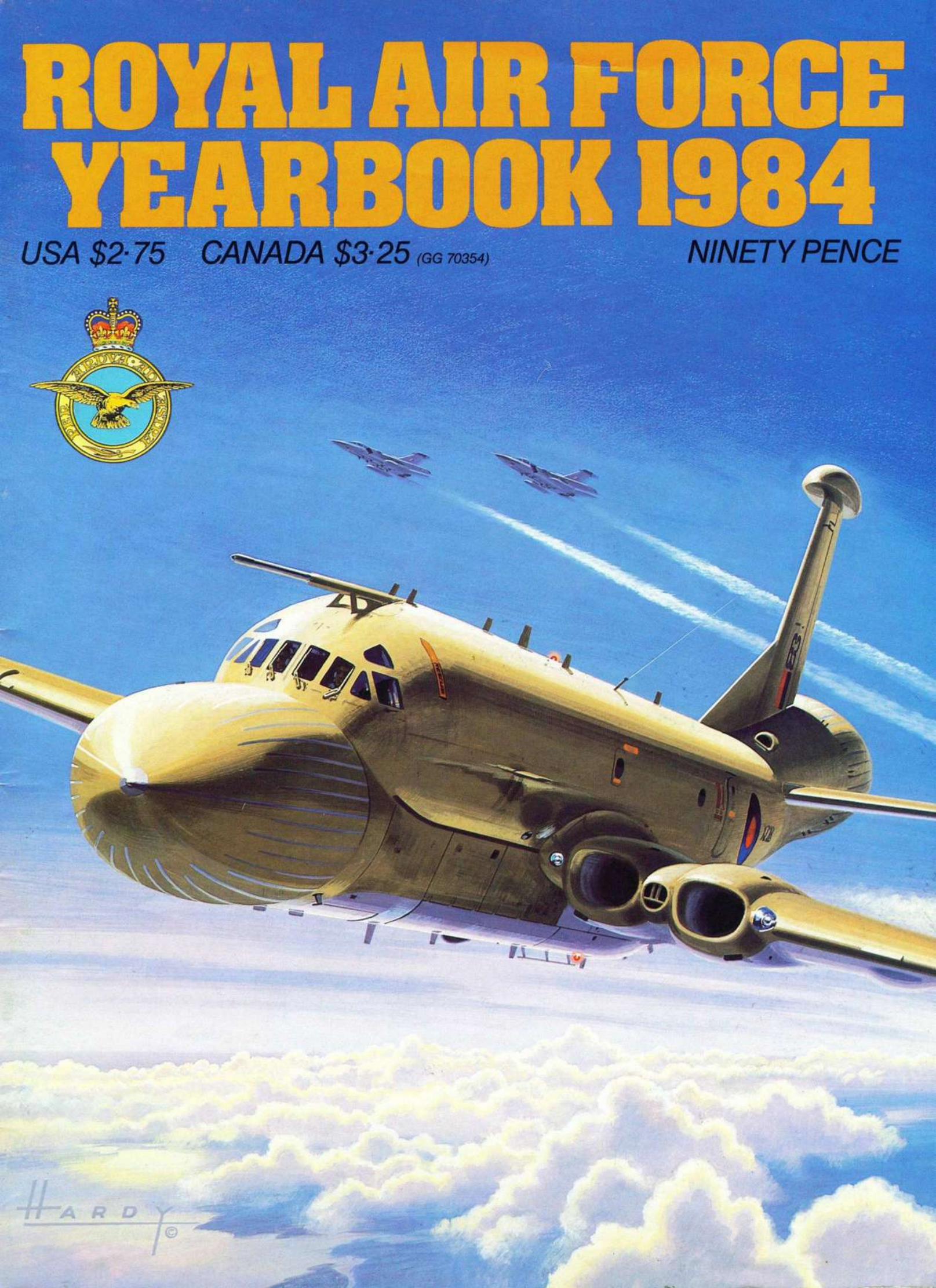
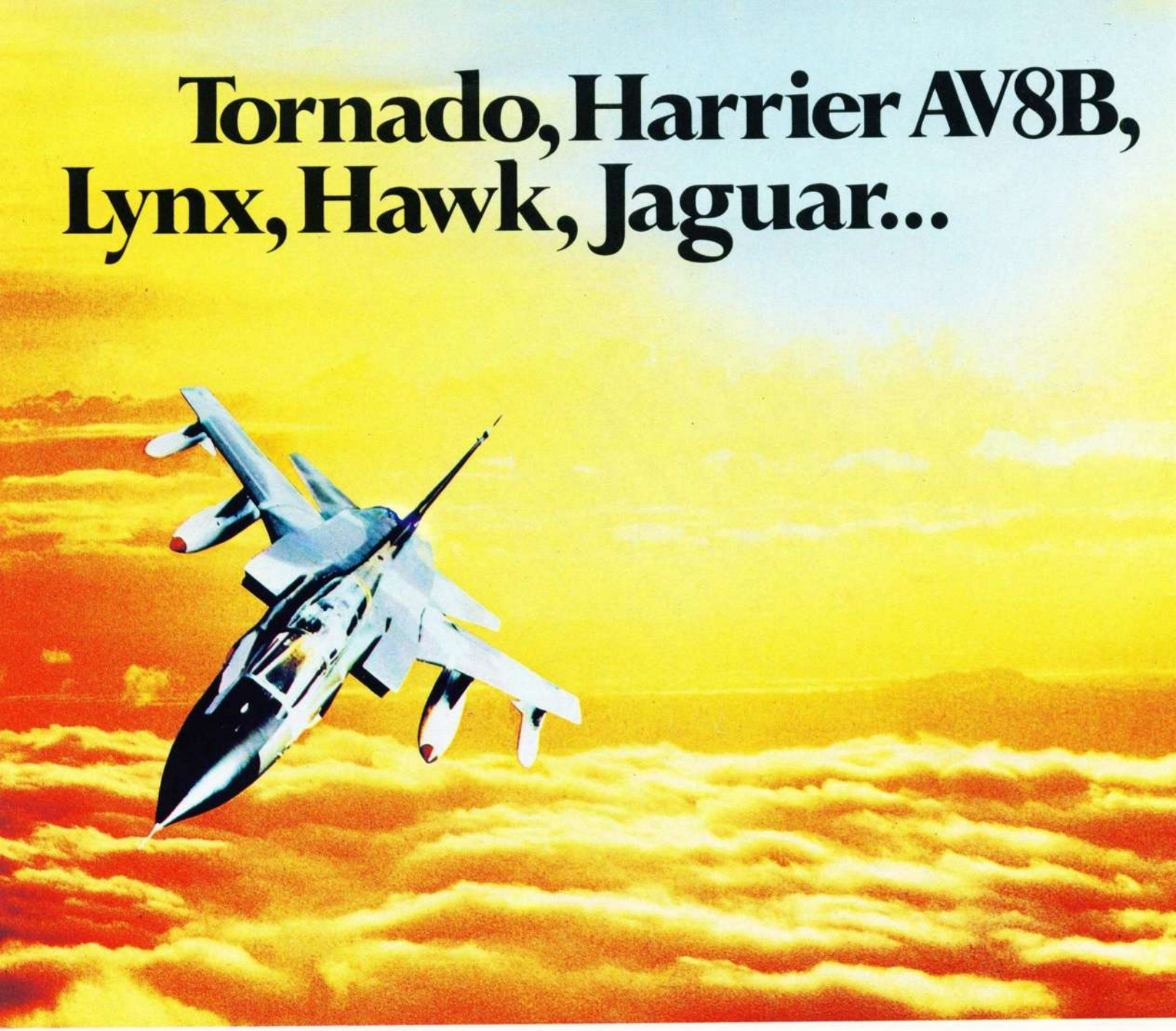


Tornado, Harrier AV8B, Lynx, Hawk, Jaguar...



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ROYAL AIR FORCE YEARBOOK 1984

INTRODUCTION
by the Chief of the Air Staff, Air Chief Marshal Sir Keith Williamson, GCB, AFC

FOR the Royal Air Force perhaps the most satisfying aspect of 1983 was the continued progress that was made in introducing the Tornado into Squadron service. The Tornado is, of course, at the centre of the ambitious modernisation and re-equipment programme that the Royal Air Force has been planning for a number of years and it is particularly gratifying to us to see those plans now being steadily transferred into impressive "hardware". I am therefore very pleased that this issue of the Year Book contains an article on this splendid aircraft and I hope that you will be able to judge for yourself its considerable potential.

Of course, the introduction of new and sophisticated equipment places especial demands on the people who have to service and operate it. But the quality of our men and women has never been in doubt and I have personally taken great pride in the skill and professionalism with which they have tackled their tasks over this last year — the article on Royal Air Force Stanley and the Air Bridge operation from Ascension Island gives just one example of the sort of skill and determination that we are now able to take for granted in the Royal Air Force.

I hope that you will find it possible to visit one of the various "At Home" days that we will be holding throughout the year, for we would like you to see for yourself the Royal Air Force of which we are so proud.

Keith Williamson

RAF YEARBOOK 1984

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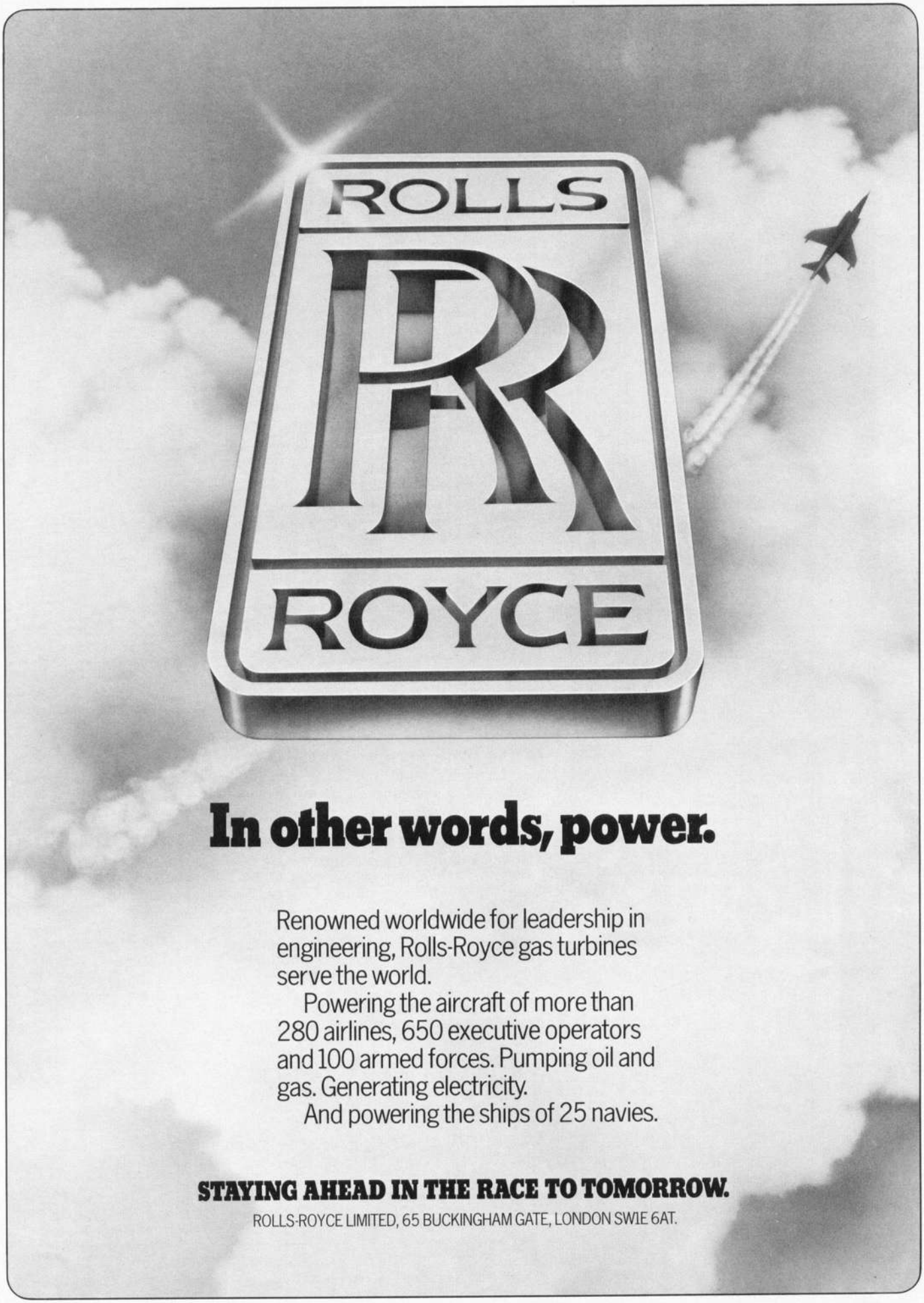

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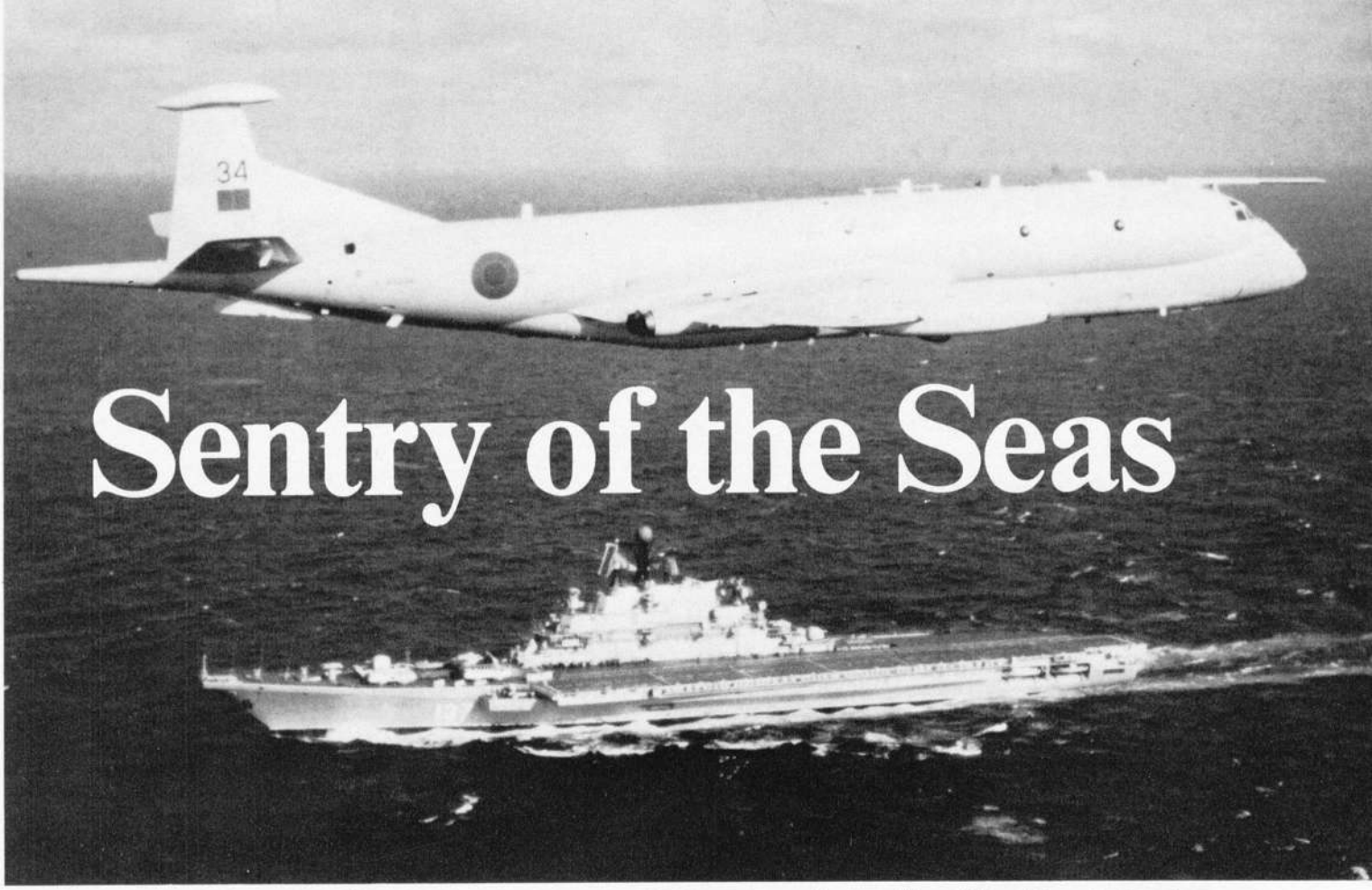


Sentry of the Seas

The status and responsibilities of No 18 Group, described by Paul Jackson

OF THE MANY lessons learnt and re-learnt during the Falklands War two years ago, one of the most vital was confirmation of the fact that Britannia cannot rule the waves without also controlling the air above. Aircraft operating in a wide variety of rôles proved themselves an indispensable adjunct to sea power as long ago as World War II, since which time navies have at their peril ignored air support. Naturally, Britain's ship-based aircraft are operated by the Fleet Air Arm, yet it must not be forgotten that the Royal Air Force also dedicates a sizeable element of its own to maritime operations. These are the aircraft and supporting units of No 18 Group — a unique component of Strike Command which not only works closely with our Navy on a daily basis, but is in harmonious contact with NATO forces and meets components of the Soviet Navy "eyeball-to-eyeball' with equal frequency.

In the national chain of command, the Air Officer Commanding (AOC) No 18 Group (Air Marshal Sir John Fitzpatrick, KBE CB RAF) is one of three Group commanders who report to the Air Officer Commanding-in-Chief (AOC-in-C) Strike Command. With its Nimrod maritime patrol aircraft, Buccaneer maritime strike/attack force and the marine craft units, No 18 Group carries on, in a large measure, the maritime tradition of the earlier Coastal Command. Other forces within the Group are the search and rescue (SAR) units equipped with Wessex and Sea King helicopters and the RAF Canberra force which carries-out photographic reconnaissance, airborne target-towing and electronic warfare training for all three services, and for NATO.

Close ties with the Navy begin at No 18 Group's headquarters, which occupy a part of HMS *Warrior*, a "stone frigate" (or perhaps, in view of its secure underground command centre, a "stone submarine") in the London suburb of Northwood, Middlesex. It is from this nerve-centre — formerly occupied only by HQ Coastal Command — that the Commander-in-Chief Fleet controls the Royal Navy in its national and NATO tasks (and that Britain's operations during the Falklands War were co-ordinated). Operational planning is simplified by the co-location of No 18 Group, this liaison ensuring maximum efficiency with minimal delay in execution. The advantages are repeated in times of tension and war in NATO when the national organisation can easily transfer itself into a NATO command.

In time of war, No 18 Group's aircraft, together with other RAF units and maritime patrol aircraft from the United States, the Netherlands and Norway, would be assigned as maritime air forces under NATO control for use in the Eastern Atlantic and Allied Command Channel (ACCHAN) areas — a vast expanse of ocean extending from northern Portugal to the southern tip of Greenland and from northern Norway to the Pole. Under NATO arrangements, the AOC No 18 Group, assuming the titles of COMMAIREASTLANT and COMMAIRCHAN, would become the maritime air commander for these two areas. As such, he would report directly to the NATO Commander-in-Chief Eastern Atlantic and C-in-C Channel, who in peacetime is the Royal Navy's C-in-C Fleet. The AOC has two regional air commanders, with headquarters at Plymouth and Pitreavie, who are subordinate to him in both his national and his NATO capacities.

The Soviet threat

The threat which must be faced by No 18 Group and its companions who wear dark blue is both surface and sub-surface. Running deep and almost silently, the submarine in either nuclear-powered or diesel-electric form is undoubtedly the most elusive vessel of war, yet its attack potential with torpedoes or missiles against shipping, or

(Heading photo) A Kinloss-based Nimrod MR Mk 2 overflies the Soviet aircraft carrier Novorossiysk *off the west coast of Britain during 1983. (Below) The Group's two principal aircraft types keep company — a Buccaneer S Mk 2B and a Nimrod.*

(Above) The capabilities of the Nimrod have been considerably extended in the wake of the Falklands conflict in 1982, with additional weapons options and the provision of air-to-air refuelling equipment, here demonstrated behind a Victor tanker. (Below) Nimrod MR Mk 2s in formation over the Scottish coastline.

(Above) The Buccaneer, no longer in service in RAF Germany, is expected to continue to play a significant rôle in No 18 Group's inventory for a number of years yet, with the addition of Sea Eagle to its armament fit. (Below) The anti-radar Martel ASM and AN/ALQ-101 jamming pod on a Buccaneer.

nuclear missiles against land targets, makes it a prime target for unceasing surveillance. NATO closely monitors submarine deployments, searching for any unusual activity that could indicate preparations for East-West confrontation. Surface forces are more easily found, although there is still plenty of room in the East Atlantic to provide them with freedom of manoeuvre.

Regular plotting of ship movements would take on a grim new meaning in the event of increased tension or outright war in Europe. In any future conflict, as in the last, the free nations would look to the United States for assistance, and even with the air transport fleets working at full capacity, supplies would be crossing the Atlantic by sea to sustain the defence at the rate of some 200,000 tons per day. Soviet ships and submarines would inevitably seek to disrupt this vital lifeline, and No 18 Group's task would be to search out and destroy the predators, in conjunction with the NATO Striking Fleet.

Additional NATO aircraft required for defensive and offensive rôles are allocated to UK bases, and for this reason No 18 Group includes the airfields at Stornoway and Macrihanish on the western seaboard of Scotland. Indeed, most of the Group's operational elements are located north of the English-Scottish border for proximity to the strategically important Iceland-Faroes gap, leaving two squadrons of Nimrods (one a peacetime training unit) to watch over the South-Western Approaches from St Mawgan, near the holiday resort of Newquay, Cornwall. To a large extent, daily operations are managed by the two Maritime Air Regions — Northern at Pitreavie Castle, near Edinburgh, and Southern at Plymouth.

Both the regional maritime headquarters (MHQs) are joint RAF-RN establishments, located well below ground level where naval movements are registered on large, vertical maps overlaid with aircraft patrol routes and other relevant information. In peacetime, as well as controlling NATO aircraft operating in their area to monitor surface and submarine movements, the MHQs have other tasks to perform, of which the major are administration of fishery and oilfield patrols and co-ordination of SAR missions. In addition to the regular staffs, both MHQs are able to call upon the services of the Royal Auxiliary Air Force for reinforcement. Trained in their spare time to man all departments of a vital operations centre, the RAuxAF personnel — men and women from all walks of life — are an indispensable component of the MHQs, performing a service much appreciated by their Regular counterparts. Northwood, too, has its Auxiliaries, provided by No 1 (County of Hertford) Maritime Headquarters Unit, whilst Pitreavie is served by No 2 (City of Edinburgh) MHU and Plymouth by No 3 (County of Devon) MHU.

These present control arrangements will remain in effect only until

the autumn of 1984, when Northwood will assume direct control of all No 18 Group operations. Although to be diminished in importance, Pitreavie and Plymouth are to remain in being as Rescue Co-ordination Centres, and the former is destined to become, in due course, the wartime alternative HQ to Northwood, with similar facilities.

Mighty (submarine) hunter

The administrative changes will have little effect on the everyday work of the RAF's maritime squadrons, and the Nimrods will continue to make their long and lonely patrols of the Atlantic wastes, ever alert for potentially hostile vessels on or beneath the waves. Nimrod — the "mighty hunter" of the Book of Genesis — was produced as a successor to the Avro Shackleton and entered service in 1969, production amounting to 46 Nimrods in the maritime reconnaissance rôle for No 18 Group (plus two prototypes). Eleven of these are in process of being refitted as AEW Mk 3s for the airborne early warning rôle, and the remainder have been phased through a modernisation programme to MR Mk 2 standard for continued service in the maritime rôle. Nimrod MR Mk 2s have been operating with No 18 Group since August 1979, the modification programme being due for completion late this year to bring the total of MR Mk 2s in service to 34.

The Nimrod MR Mk 2 has greatly improved capabilities, stemming

from new internal equipment. In the nose, the old ASV Mk 21 radar (a descendant of the H2S set used in World War II) has been replaced by long-range EMI Searchwater which has the facility to locate an object the size of a submarine's mast. More remarkable still, it provides a readout of track and speed and will even paint a silhouette of a target and state its length — very useful information when the requirement is to identify a high-value vessel (such as an aircraft carrier) sailing in convoy out of visual range. The picture provided by the radar is computer controlled, meaning that the operator's display can be filtered to cut out distracting clutter and unwanted returns.

From its rear-fuselage chutes, the Nimrod can eject a variety of sonobuoys including the Australian-developed SSQ-801 Barra, which is a passive directional sensor and is used singly or in patterns to detect submarine targets. When stowed, Barra is of the original "A" size for sonobuoys; on reaching the water it separates, the upper portion containing radio transmission equipment rising to the surface, while the acoustic sensor array sinks to a predetermined depth, with a cable linking the two parts. Other types of buoy, operating in a similar way to Barra, that are available for use comprise the Jezebel for large area search; DIFAR (Directional Frequency and Recording) as a complement to Barra; CAMBS (Command-Activated Multi-Beam Sonobuoy), which is unique in being controllable after ejection and can operate in active or passive modes; and the omni-directional active Ranger, used for chance encounters in peacetime on account of its relative cheapness. Preceding any or all of these, however, is the Bathy Buoy, whose task it is to signal to the Nimrod the water temperature at various depths, because temperature changes have a dramatic effect on the propagation of sound under water.

Later this year, the Nimrod's ability to detect and classify radar and other electromagnetic transmissions will be enhanced when Loral ESM (Electronic Support Measures) pods are attached to both wingtips, replacing the equipment already carried in the bulged fin-tip. ESM provides bearings on potential targets, and these are transferred to the Tactical Navigator's situation screen to appear alongside information collected by radar, sonobuoys and the still important Mk 1 eyeball. It is the tactical navigator who controls the aircraft as a fighting system, also having call on the MAD (Magnetic Anomaly Detector) mounted in the long tailboom to confirm the presence of metallic objects beneath the surface of the sea.

Management of inputs from the Nimrod's sensors is in the capable microchips of four main on-board computers, giving a total computing power at least 50 times greater than in the MR Mk 1. It is therefore with justification that experienced maritime reconnaissance crews claim that the distance between the two Nimrod variants is greater than that separating the Shackleton and Nimrod Mk 1. This should not give the impression that operating the Mk 2 Nimrod is now merely a machine-minding exercise. The modified aircraft requires an extra systems operator, and individual skill on the part of operators is as important as ever because increased sensor information means more human decisions, not fewer.

The crew of a Nimrod (ten, plus three flight crew) comprises more specialist members than any other RAF aircraft. The Nimrod is a development of the Comet airliner and the flight deck crew of two pilots and an engineer fly the aircraft and manage all its basic systems in the same way as any airliner crew. In addition the pilots, one of whom may be the aircraft captain, need to be fully trained in all aspects of maritime tactics. They are involved in tactical decisions and must fly the aircraft into a position to attack; this includes some tight manoeuvering only a few hundred feet above the sea. The vast array of electronic and acoustic detection systems is managed and integrated by seven air electronics operators plus an air electronics officer in the tactical area. They pass information from each sensor to the large tactical display screen in front of the tactical navigator. Here all the information is combined to give an overall picture and from it the best tactical options are decided.

Expanded weapon options

In its capacious weapons bay, the Nimrod may carry a variety of loads, from anti-submarine weapons to Lindholme kit, the latter an SAR package developed in World War II and comprising a dinghy and two supply containers joined by 600 yards (550 m) of buoyant rope for survivors to grasp. More normal loads include the Mk 46 homing torpedo and the latest addition — officially handed-over to the Kinloss squadrons and the Royal Navy simultaneously on 29 September 1983 — the very capable, British-developed Stingray torpedo. In fact, a few Stingrays were rushed into service for the Falklands war — a time when the Nimrod's weapon load was rapidly

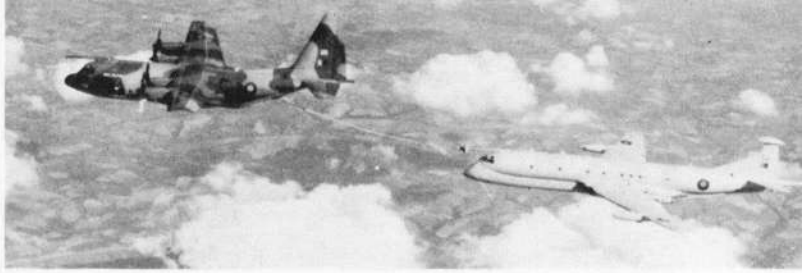
expanded in several ways, both internally and externally.

First to be installed in the emergency programme were 1,000-lb (454-kg) bombs, followed by the McDonnell Douglas Harpoon anti-ship missile in the weapon's bay. Provision was also made for four self-defence AIM-9G Sidewinder air-to-air missiles to be carried in pairs on the previously unused wing strongpoints. All are valuable options, the Harpoon, for example, bestowing for the first time an ability to attack from outside the range of ships' defences. Likewise, refuelling probes were rapidly added to Nimrods to enable them to undertake sorties of some 19 hrs over the South Atlantic. The air-to-air refuelling capability is not used on regular operations, but all aircraft will be probed eventually, and some crews will remain current in AAR, as demonstrated, for example, in November 1983 when an MR Mk 2 of No 120 Squadron completed a detachment to RAF Stanley during which nine AAR hook-ups were made, including a non-stop return flight from Stanley to Kinloss.

Four squadrons fly the maritime reconnaissance version of the Nimrod, of which Nos 120, 201, and 206 operate Mk 2s at Kinloss, on the southern shores of the Moray Firth, east of Inverness. At the opposite end of Britain, No 42 Squadron flies from St Mawgan, its transition from Nimrod MR Mk 1s now in the final stages following the start of crew conversion in June 1983. During a particularly successful final year with the original aircraft, No 42 virtually swept the board of maritime reconnaissance competition prizes.

Teaching personnel how to operate the Nimrod is the rôle of No 236 Operational Conversion Unit (OCU), which is once again back at St Mawgan (officially since 1 November last) after a period at Kinloss*. On arrival at the OCU, students from a wide variety of backgrounds, together with some on their first tour, operate as a crew both in the air and for most of their training on the ground. The training syllabus includes 115 hrs' flying, and for all but the three crew members concerned with flying the Nimrod, another 90 hrs in one of the Maritime Crew Trainers, while the flight crew spend an additional 52 hrs in a simulator. The OCU also has responsibility for training the flight deck crews of the Nimrod AEW Mk 3s for No 11 Group.

**In the event of war, the OCU would become another front-line unit, No 38 Squadron, using the instructor crews to fly operational missions.*

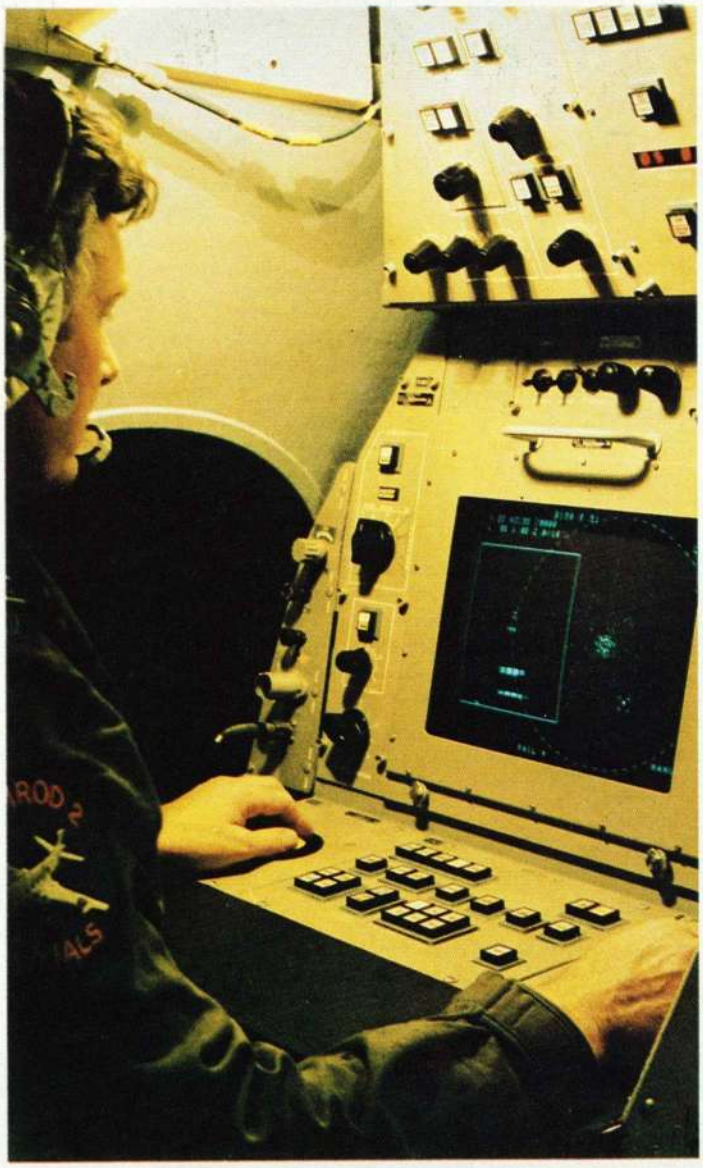


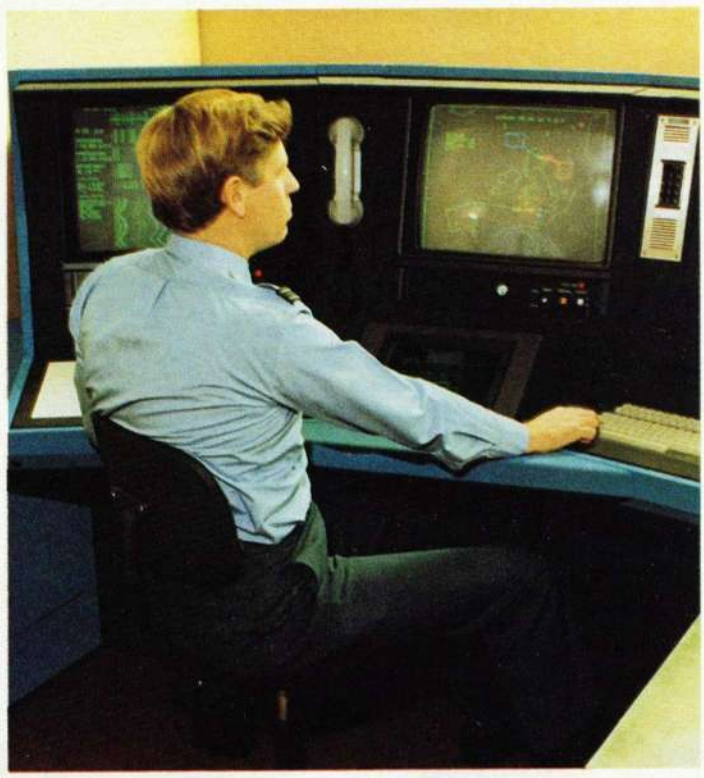
Nimrods demonstrated, during 1983, their ability to deploy non-stop from the UK to the Falklands, refuelling in flight from Victors and Hercules (above) tankers.

Second only in importance to keeping tabs on the Soviet Navy is the regular patrol of Britain's Exclusive Economic Zone (EEZ). For this task, Nimrod squadrons take turns in covering the four EEZ sub-areas, logging and photographing fishing vessels for the Ministry of Agriculture, Fisheries and Food or Department of Agriculture and Fisheries, Scotland, and patrolling the oilfields for the Department of Energy. As it entails a large amount of weaving-about over the sea, the operation is appropriately named "Offshore Tapestry", and is reported to require two Nimrods full-time (paid for by the Government departments concerned). The main requirement, generating some 160 hrs of flying each month, is for identification of vessels fishing illegally, and others —sometimes inquisitive Soviet ships — encroaching into the statutory 400-yard (365-m) limitation zone around each oil rig, but aircraft will also overfly sub-surface pipelines checking for leaks and be on the look-out for bulk carriers flushing their tanks at sea — just one of the public services provided by No 18 Group.

Rejuvenated strike force

Thirty years ago, when a team at the Brough offices of Blackburn and General Aircraft was finalising the design of a tender to requirement NR/A.39 for a carrier-borne strike aircraft, none of its members is likely to have foreseen that the British Aerospace Buccaneer S Mk 2B would now be flying on anti-ship missions in RAF markings — and looking forward with confidence to another decade or so of useful service in the front line. It was only after the TSR-2 had been terminated (more emotive language is more normally used) and replacement F-111Ks cancelled on cost grounds that the RAF began





Something in common

The RAF has a long tradition of excellence and continues to play a vital role in safeguarding national security and UK interests overseas. Today, that role is shared with a major British company — THORN EMI Electronics. For some years, THORN EMI has been building on its own reputation for excellence by providing the sophisticated electronic systems upon which modern defence depends.

For instance Searchwater, THORN EMI's versatile airborne maritime surveillance radar, has been in service with the RAF since 1979 in its Nimrod MR2 aircraft. The company is now supplying advanced mission support systems which will enable the Nimrod's sensor data to be processed on the ground eight times faster than its recorded speed.

THORN EMI Electronics has also just delivered systems which will form the vital links between the improved UK air defence ground environment and AEW aircraft operated by both the RAF and NATO. The systems will enable early warning radar data to be passed to the ground directly by Nimrod AEW and Sentry AWACS aircraft.

These are just some of the successful defence products designed and manufactured by THORN EMI Electronics. Like the RAF, we too are proud of our record — and of our continuing contribution to national and international defence.

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to acquire the Buccaneer; a procedure started in 1969 and not completed until 10 years later when HMS *Ark Royal* was decommissioned and the last RN Buccaneer squadron disbanded.

Designed for low-level penetration beneath the horizon of enemy radar, the Buccaneer was almost literally carved out of a solid block of metal to provide it with the structural strength necessary to withstand the rigours of flying in turbulent air*. At its peak, the Buccaneer equipped five RAF front-line squadrons, but Tornadoes are now replacing the two squadrons in RAF Germany and Nos 12 and 208 remain as the two home-based maritime Buccaneer squadrons, both based at Lossiemouth, a few miles from Kinloss. They are supported by No 237 OCU, the training unit that is currently based at Honington in Suffolk but is planned to join the squadrons at Lossiemouth before the end of this year. It can be assumed that the withdrawal of the Buccaneers from Germany (where they equipped Nos XV and 16 Squadrons) will make additional aircraft available to keep the Lossiemouth units up to strength.

Both squadrons expect their main "trade" to be warships, operating in the North Atlantic and Norwegian Sea. Air-to-air refuelling (AAR) — which can be provided by the "Buddy Pack" system beneath the starboard wing of suitably modified Buccaneers or by other tanker aircraft — can be used to extend the range of the aircraft to meet its operational task. Normally flying at a mere 100 ft (31 m) above the sea, the aircraft would in many instances be guided to their targets by a patrolling Nimrod able to plot the position of both hunter and hunted on its Searchwater radar and which uses the silhouette and length-measuring capabilities to home the Buccaneers straight onto the high-value ships.

The two Buccaneer units undertake different forms of attack for which they can carry a variety of weapons. No 12 Squadron usually carries one or other variant of the Anglo-French Martel missile: anti-radar- or TV-guided. The former homes onto radar signals transmitted by the target, whilst the latter has a TV camera in the nose and is steered by the navigator after release.

No 208 Squadron, which is new to the maritime rôle (after having been an overland unit until its move to Scotland on 1 July 1983), has as its prime weapon the Paveway laser guided bomb (LGB) and associated Pavespike laser designator that illuminates the target.

A possible attack formation would comprise four aircraft, two of which would each carry a pair of LGBs, a Martel and an AN/ALQ-101(V)-10 jamming pod on the wing pylons plus four 1,000-lb (454-kg) bombs in the internal bay. Their escorts would each carry a Pavespike pod for stand-off designation, ECM, and (since last September) possibly also an AIM-9L Sidewinder for self-defence, plus the four internal bombs.

The Buccaneer squadrons retain a small land commitment, as evidenced by deployment of aircraft from both units to Akrotiri in September 1983 to support the British contingent of UN troops in troubled Lebanon. Earlier the same year, two Buccaneers made a short-notice flight to Port Stanley as a test of rapid reinforcement plans for the Falkland Islands. Each squadron, and the OCU, operates a pair of Hunter T Mk 7 trainers for pilot continuation training, one of these being a standard aircraft whilst the other is a T Mk 7A equipped with Buccaneer flight instruments, as there is not a dual-control version of the latter aircraft.

**Even so, problems arose, and fatigue cracks were discovered in 1980, causing the grounding of the Buccaneer fleet for six months for inspection and repair.*

In its T Mk 7A variant, the two-seat Hunter remains operational with the Buccaneer OCU (No 237), fitted with the Integrated Flight Instrumentation System (IFIS) to represent some features of the Buccaneer.

In January 1985, a modification programme will begin, to enable the Buccaneer to carry the very capable Sea Eagle missile now in the flight-test stage. The first of these missiles will go into service with one of the two squadrons some six months later. A long-range weapon, Sea Eagle will allow the Buccaneer to undertake its attacks at a much safer distance from lethal ship defences, but this, in turn, will require an updating of the aircraft's navigation equipment and sensor fit, expected to begin early in 1986. Changes will include modification of radar data presentation and the opportunity will be taken to install chaff/flare equipment (already under test) and improved jamming apparatus to confuse the defences. Thus rejuvenated, 40 or so Buccaneers will carry Sea Eagles and Paveway bombs well into the 1990s, their crews doubtless as appreciative as ever of the aircraft's sturdiness and fine handling qualities.

Sharpening the defences

Another jet bomber — indeed, Britain's *first* jet bomber — continues to provide a valuable service within No 18 Group, having been transferred from No 1 Group on 1 December 1982 as part of planned RAF re-organisation. Once the backbone of Bomber Command, the ageing Canberra's sole maritime commitment in the RAF is now visual maritime reconnaissance, but its peacetime duties ensure that front-line elements are maintained at peak efficiency. Four units operate Canberras from Wyton, near Huntingdon, some of their aircraft having very distinctive characteristics.

Certainly the most grotesque in appearance of these is the Canberra T Mk 17, with its bulbous nose covered in further bulges, and other protuberances in the extreme tail. Flown by No 360 Squadron, the Mk 17s sharpen the skills of radar and communications operators, surface and airborne, of the RAF and Royal Navy, by simulating the intense jamming which would accompany any attack against the West (the Soviet forces devote a staggering 30 per cent of their offensive effort to this duty). Carrying 2,000 lb (910 kg) of transmitters in the bomb bay, the T Mk 17s disrupt radar screens with what is known in the trade as "music" and render communications almost unintelligible with "chatter", whilst the former can also be dosed with chaff — a weapon which is still effective, despite having been first used in July 1943 with the code-name "window". No 360 Squadron has a further notable feature in that it is manned jointly by RN and RAF personnel and every fourth CO is a Royal Navy officer.

Target facilities of a more traditional kind are supplied by No 100

During 1983, No 18 Group provided support for British forces engaged in the Lebanon, detaching six Buccaneers to RAF Akrotiri, Cyprus. Two aircraft of No 208 Squadron and one from No 12 are seen here at Akrotiri during the crisis.


ROYAL NAVY

Squadron, in which Canberra B Mk 2s, PR Mk 7s and E Mk 15s act as subjects for interception or to tow targets: banner-type for RAF fighters and sleeve-shaped for naval gunners. The specially-modified Canberra TT Mk 18, easily identified by its garish underside colour scheme of yellow with diagonal black stripes, carries a Flight Refuelling Ltd Rushton winch pack under each wing, from which it can trail targets at distances up to a remarkable 4¾ miles (7,6 km) — although 3¾ miles (6,0 km) is more usual. Apart from a sleeve, the Mk 18 will tow a Rushton target for surface-to-air missile training, this taking the form of a finned torpedo fitted with a radar reflector and flares.

A famous unit returned to the RAF's order of battle on 2 June 1982 when No 1 Photographic Reconnaissance Unit was re-born to operate five modified Canberra PR Mk 9s inherited from No 39 Squadron — the last front-line Canberra unit — which had disbanded two days before. Principal task of the PRU is aerial survey, mainly with the 6-in (15-cm) focal length F49 Mk 4 camera, although it can be called-out to assist operations associated with flooding or other civil disasters, where photographic assessment of the situation is of value to the rescue services. No 1 PRU's aircraft began to go through a refurbishment programme at Short's Belfast plant late last year and will therefore remain in service for some time to come.

Canberra crews are trained on B Mk 2s and T Mk 4s by No 231 OCU, this unit claiming the longest continuous operation of a single aircraft type in the RAF, begun in December 1951 and unlikely to end until shortly before the last Canberra is withdrawn around the end of the present decade. Replacement plans for the Canberra in its various rôles have yet to be announced, some sources suggesting unofficially that a modified BAe 125 Srs 800 business jet might be chosen.

For those in peril . . .

The Canberra's work is routine; the Buccaneer's largely unsung; and the Nimrod's silent and in some aspects, secret; yet in one area, No 18 Group's activities rarely fail to make news. Shipwrecked seamen, stranded climbers, isolated persons in urgent need of medical attention: many have been on the brink of death when a bright yellow helicopter has appeared out of a stormy or pitch-black sky to snatch them to safety*.

During the early days of World War II, dedicated rescue aircraft were outnumbered by high-speed launches. The RAF still has its own "private navy", this being a much-depleted force, no longer declared to SAR, and most often used for helicopter winching training, aircrew sea survival training and towing targets for bombing and gunnery training. The main unit is at Mountbatten, Plymouth, and the other units are No 1100 Marine Craft Unit at Alness, in the Cromarty Firth; No 1102 MCU at Gibraltar and No 1113 MCU at Holyhead; of these, only No 1102 MCU now has a first-line SAR commitment.

Helicopters began assuming full-time SAR tasks 30 years ago, and a total of nine Flights from two Squadrons now cover Britain's coastline. Both units have their headquarters at Finningley, trained crews coming from the SAR Training Unit operating Westland Wessex HC Mk 2s at Valley, Anglesey and from the Sea King Training Unit at RNAS Culdrose, Cornwall, operating Sea King HAR Mk 3s. No 22 is the SAR Wessex squadron, which has "A" to "F" Flights at Chivenor, Leuchars, Valley, Leconfield, Manston and Coltishall respectively. Westland Sea King HAR Mk 3s equip No 202 Squadron, with "A" Flight at Boulmer; "B" Flight, Brawdy; and "D" Flight, Lossiemouth. The missing "C" Flight was re-named as No 1564 Flight last August and is now stationed in the Falkland Islands with the Sea Kings in an overall grey finish and fitted with radar warning receivers and other equipment appropriate to the potentially hostile environment. Diversion of aircraft to the South Atlantic will be made good when three new Sea King HAR Mk 3s are delivered, to augment the 16 supplied to the RAF from 1977 onwards.

Re-mustered from troop transport duty to replace the veteran Whirlwind (the last of which retired from SAR in November 1981), the Wessex has a 100-nautical mile (185-km) unrefuelled radius of action, but needs to make intermediate stops during a long-distance

**Although the rescue helicopters are established to assist aircrew, it is often unfortunate, or foolhardy, civilians who benefit from the service.*

call-out. Fuel dumps are therefore located in remote areas of the country where airfields are not always available, whilst during sea rescues, oil rig facilities are often used. Crewed by a pilot, navigator/winch operator and NCO winchman, the Wessex has minimal navigation aids for its demanding rôle, but is reckoned to have advantages over the Sea King in mountain rescues because of its smaller size.

Sea Kings, by way of contrast, have three times the radius of action of the Wessex, two pilots and a host of nav-aids, not least of which is radar. Autohover provides a means of bringing the aircraft down to a pre-determined height in all weathers to pick-up a survivor, the winch/radar operator having a small control stick in his doorway position for pinpoint manoeuvering of the helicopter. Normal establishment in an SAR Flight is two aircraft and four crews to meet the commitment of one helicopter on 15 minutes' standby and the other at one hour during daylight, or a single aircraft at 45 minutes' notice at night. This places a considerable burden on the hard-worked groundcrew for maintenance of the helicopters in a permanent state of readiness.

Naturally, helicopters can be despatched in much shorter times, and crews pride themselves that they can usually beat the times laid down by quite a margin. The first step when a call is received from the Rescue Co-ordination Centre at Plymouth or Pitreavie is careful planning of the route and assessment of the requirements and dangers of the mission. Sometimes, take-off may be delayed deliberately to allow a Nimrod — one of which is always on one hour's SAR stand-by — to position itself over a sea incident and direct what may be a large operation by several vessels and helicopters. The Wessex and Sea King crews are firm believers in the maxim "more haste; less speed", the many awards for bravery which they have deservedly won providing ample proof of an ability to react to emergencies with rapidity, professionalism — and a generous measure of good, old-fashioned courage.

Nor too, must it be forgotten that their official obligation is solely to airmen, and the many hazardous operations undertaken to rescue sailors, climbers and others in danger remain a bonus to the community. Last year, for example, RAF helicopters were called-out on no fewer than 897 occasions and assisted 771 persons (to which must be added 23 in Mountain Rescue Team operations). Some 89 per cent of these were civilians, so it is perhaps as well that the RAF does not release details of the proportion of that total who endangered themselves and their rescuers by near-criminal stupidity. Responding to 76 SOS calls, No 18 Group Nimrods flew a total of 272 hours searching for vessels and individuals at sea.

Though each person saved by the SAR units is acutely conscious of the fact, whole nations in Western Europe remain unaware of the contribution made to their defence by NATO's maritime forces. Air support is as vital to a navy as canvas to a sailing ship, and any surface force lacking this facility may as well be back in the days of the man o'war and cannon-ball. More efficient sensors installed in the Nimrod have sharpened the Navy's eyes, whilst pending improvements to the Buccaneer will maintain its ability to strike an enemy fleet far from shore and keep Europe's sea lanes open. This is no less a deterrent than the strategic nuclear force, for the North Atlantic Treaty will be rendered worthless if the Ocean after which it is named is ever closed to Allied shipping. □

Distinctive in their overall yellow finish (above) a Sea King HAR Mk 3 of No 202 Squadron and (below) a Wessex HC Mk 2 of No 22 Squadron's B Flight, the latter on an SAR training mission with an RNLI inflatable.

The RAF's remaining Canberras are now concentrated in No 18 Group at RAF Wyton. Variants in use include (above left) the T Mk 17 of No 360 Squadron, (below left) a PR Mk 9 of No 1 PRU and (below right) the TT Mk 18 of No 100 Squadron.

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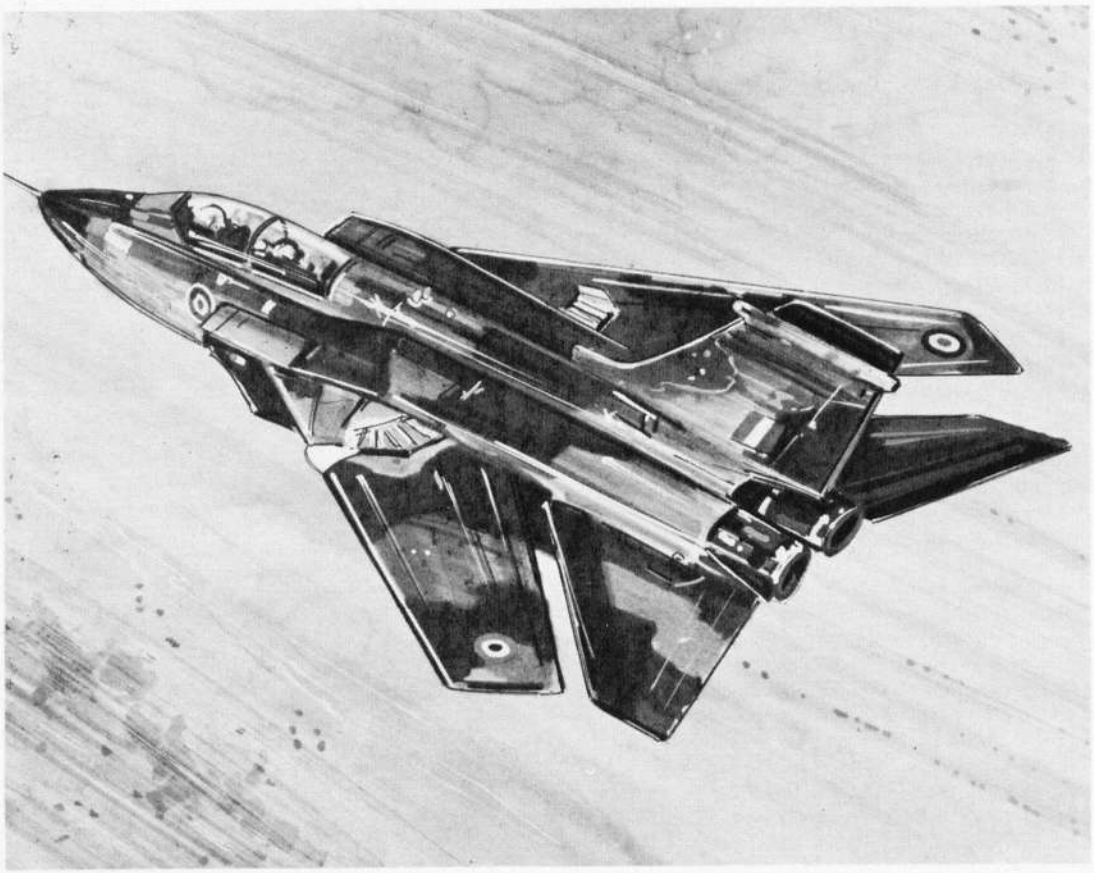

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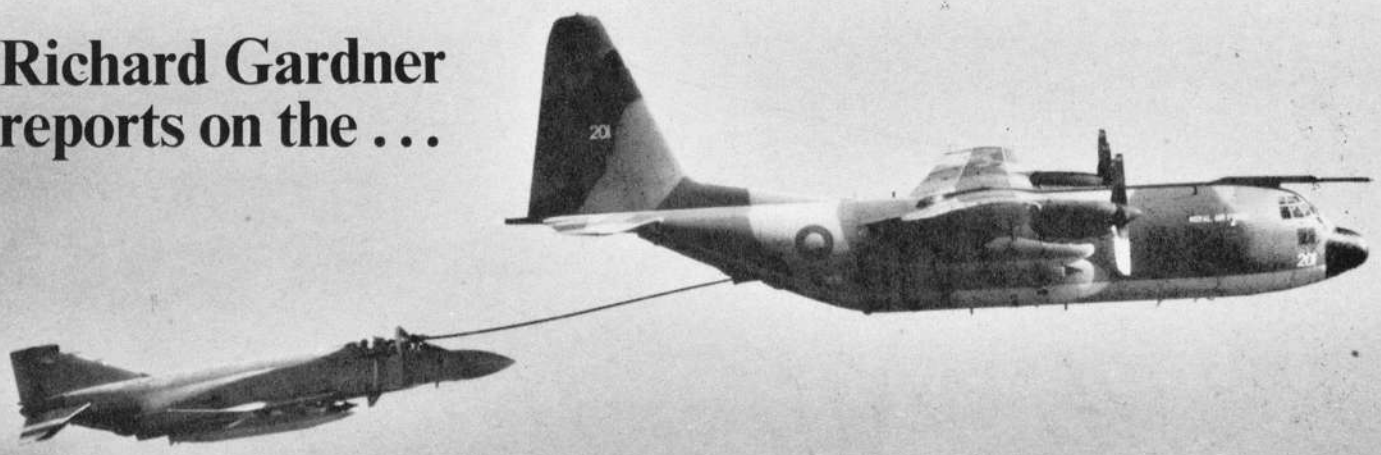
Richard Gardner reports on the . . .



RAF Down South

WHILE the world's attention may have been diverted back in recent months to the Middle East and Central America, the military threat to the Falkland Islands is a continuing reality, despite encouraging political developments in Argentina. The islands' geographical position and the rapid replacement of war-losses by Argentina both dictate a need for vigilance by Britain.

The widely used term "Fortress Falklands" is apt yet at the same time misleading. The British Government has repeatedly affirmed that it will defend the Falklands as long as there remains a threat to the freedom of the people living there. But the level of defence is geared to the threat, and is capable of being scaled up or down accordingly. To talk therefore of the "fortress" is perhaps to imply a rather more inflexible defensive structure than is in fact the case. The British military presence today is representative of the minimal force necessary to deter any repeat of the invasion of April 1982. Any such operation would clearly be impossible so long as adequate British forces remain — and with the completion of a new airport which is now under construction, long-distance reinforcement from Britain will become easier and more cost-effective than is possible at present using temporary facilities.

For the Royal Air Force, the Falklands commitment has placed a great strain on existing assets, although this has been recognised and the government has placed appropriate orders for the extra equipment and provided the funding required to perform the new tasks without seriously reducing military commitments to NATO and other "out of area" operations.

In many ways, the Falklands conflict of May/June 1982 was a watershed in post-Second World War military history. For 25 years, British forces had been engaged in a gradual withdrawal from a traditional world rôle in order to concentrate on supporting NATO. As a result, when the Falklands were invaded, British Forces found themselves equipped for combat nearer home; the RAF, in particular, was flying aircraft for the most part optimised for short or medium range operations. Only the Victor tankers retained a built-in strategic capability and so it became a race against time to refit Vulcan bombers for in-flight refuelling, along with Hercules transports and Nimrod maritime patrol aircraft (as described in detail in *RAF Yearbook 1983*).

As the world now knows, the Falkland Islands were retaken in what turned out to be one of the most remarkable long-range military operations in history. As a "spin-off" from the conflict, the RAF has benefited from the clear recognition of the value of in-flight refuelling. Daily strategic flights over water have helped the Service to amass a vast amount of expertise in this field and many lessons have been learned — or relearned — as a result. Non-stop flights by Nimrod all the way from the Falklands to Scotland have been demonstrated in 18 hours — a remarkable achievement — and 13-hour Hercules flights between Ascension Island and the Falklands are a daily occurrence. Given that the Falklands will be capable of rapid reinforcement once the new Mount Pleasant airport is completed, it is easy to see why a high level of alert must be maintained in the meantime by units based at RAF Stanley and elsewhere on the islands.

RAF Stanley is the official designation of the base now established at what was the original Stanley Airport in the Falklands. The 6,200-ft (1 890-m) runway built by the Royal Engineers over the bomb-damaged former civil runway at Stanley was completed in October 1982 — just in time for the arrival of the Phantom FGR Mk 2s of No

(Heading photo) "Down South", a Phantom FGR Mk 2 of No 23 Squadron, permanently based at RAF Stanley, refuels from one of the Hercules C (K) Mk 1 tankers that are also based in the Falklands. Armament on the Phantom comprises a centreline gunpod, two Sparrows under the fuselage and four AIM-9L Sidewinders on the wing pylons. (Below) A Phantom deploys its braking parachute and picks up the arrester gear on the Stanley runway.

(Above) A Lockheed Hercules at RAF Stanley, where the type is now operated by No 1312 Flight. (Left) The ubiquitous Boeing Vertol Chinook HC Mk 1, the "wokka wokka" of the Falklands, in operation.

29 Squadron, RAF, which had flown down from Ascension Island.

For the first Falklands winter, the aircraft at Stanley including a detachment of Harrier GR Mk 3s now designated as No 1453 Flight, had enjoyed no covered accommodation save for a few highly wind-vulnerable shelters. Alongside the new aluminium matting (AM2) runway and parking areas a "village" of more robust aircraft shelters was therefore erected as rapidly as possible. Produced by Rubb Engineering, Ltd, the new accommodation can hold up to two Harriers or a single Phantom, together with all the usual assortment of maintenance and servicing equipment, power generators and armament trollies. These shelters transformed the working environment at a stroke.

Although the rugged Harriers were built for field operations — and are accustomed to spending much time on exercise under netting in German woodland — it was clear that the harsh local conditions (frequently with below-freezing temperatures and 100-mph/161-km/h winds) would be too severe for acceptable levels of serviceability to be maintained over a longer period. The Rubb hangars now enable all types of maintenance to be tackled in comfortable heated shelter, with overhead lighting. Aircraft can be quickly scrambled from the shelters, with engines started inside, but while they are on the ground they are protected from the worst of the

(Below) Detached as "C" Flight from No 202 Squadron in the UK, the SAR Sea King HAR Mk 3s now sport an overall grey finish, unlike their canary-yellow home-based counterparts, and form No 1564 Flight at Stanley. RWR equipment, on the nose and under the tailboom, is an addition for Falklands operations.

(Above) Phantom FGR Mk 2s, originally supplied by No 29 Squadron, are now constituted as No 23 Squadron for the defence of the Falklands. (Below) The detachment of Harriers at RAF Stanley, on the other hand, form only a Flight (No 1453), rather than a squadron, and are manned in rotation by crews from the UK and Germany.

(Below) Troops embark in one of the Chinook HC Mk 1s provided by No 1310 Flight for a training exercise. Based at Kellys Garden, the Chinooks provide essential heavy lift service throughout the Falklands, as well as giving specific support to the Army units in their daily routine.

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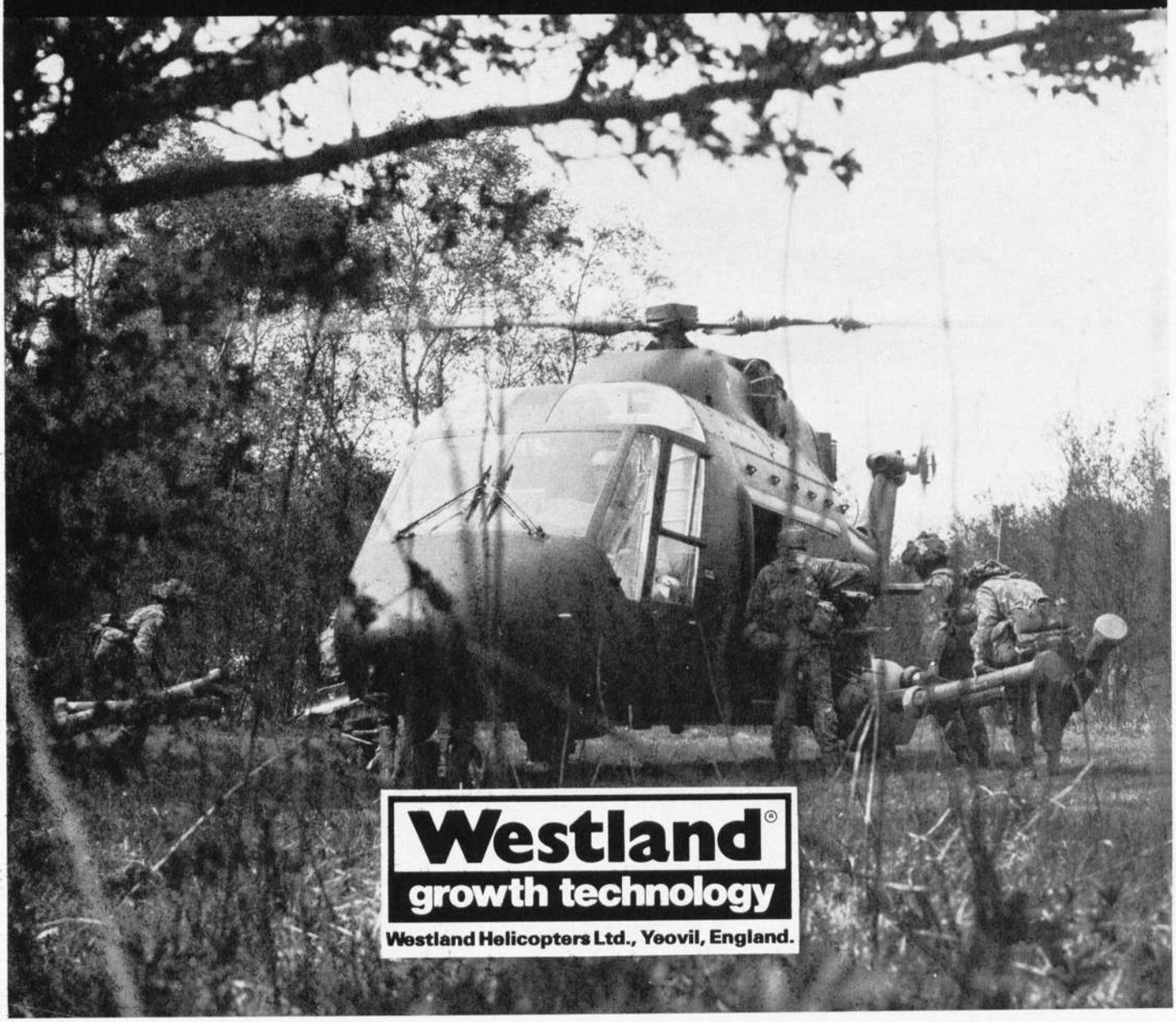

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weather, which in winter is particularly important. The Phantom is a complex aircraft to service, with advanced weapons systems and radar, so the sheltered hangar space is of great value.

The Phantom force

Since the arrival of the Phantoms in 1982, the identity of the squadron has changed. In place of the original No 29 Squadron detachment (Phandet), RAF Stanley now hosts No 23 Squadron; the former No 29 Squadron machines remained in the Falklands, but their red and white unit markings have now given way to a more locally-flavoured No 23 Sqn badge consisting of that unit's traditional red and blue bars flanking a Falklands badge on the nose of each Phantom. Crews for the squadron come on rotation from existing units in Strike Command and RAF Germany, so there is now a very thorough spread of South Atlantic experience in the RAF's front line fighter squadrons nearer home. The training potential available in the Falklands is exploited to the full, with daily patrols around the islands and far out to sea, aided by the Hercules tankers.

Quick Reaction Alert (QRA) is maintained by the Phantom force, and round-the-clock stand-by is occasionally interrupted by identification missions flown against suspect shipping in the seas around the Falklands. During 1983, Phantoms intercepted an Argentine Air Force Lockheed Electra patrol aircraft which had entered the Protection Zone. It was soon escorted away by the Phantoms, which were visibly loaded with Skyflash and Sidewinder missiles.

The runway at RAF Stanley has several sets of arrester gear fitted and the Phantoms use it on every recovery. This is a valuable safety factor which also cuts down wear on aircraft brake systems, although conventional landings are possible in an emergency. Duplication of the arrester gear at both ends of the runway gives a high degree of confidence in continuing operations regardless of wind conditions and fast aircraft turnrounds are standard practice. An aircraft returning from a sortie is refuelled and checked out by the armourers and other ground crew, and can be back in the air within minutes if need be.

Although the arrival of the Rubb hangars considerably upgraded the standard of accommodation for the aircraft at Stanley, this care for machines has not been provided at the expense of the men who work with them. The bleak conditions facing most personnel detached to the Falklands in 1982 have largely been "tamed" by the mass importation of Portakabins and accommodation containers of all shapes and sizes. All the usual facilities have been provided, and in view of the lack of conventional entertainment in the islands the provision of libraries, educational services and videos is much appreciated.

Most units have similar cabin arrangements for working during the day and for accommodation, and in some respects the sites are more convenient than back at the home base, where the operational areas may well be far removed from the catering or messing areas. At RAF Stanley, personnel have some accommodation close at hand for shift duties and sections, where a high state of alert must be maintained; but for the majority the previous make-shift use of accommodation ships out in the harbour has been ended with the commissioning of several "coastels". These huge barges are firmly moored alongside the harbour's edge, and provide excellent hotel-type standards of living for several thousand personnel. Designed for use by oil-rig workers, they are ideally suited for their new military rôle. The cost of building to similar standards on dry land would be prohibitive, and of dubious long-term value to the military or local islanders. The coastels, on the other hand, not only offer air-conditioned comfort, with spacious cafeteria decks and shops, squash courts and even a small swimming pool, but can also, if need be, be towed to another site. They are highly self-contained yet compact with their own power sources. New roads link the coastels to Stanley and surrounding military sites.

The Hercules support

Supporting the fighters in the Falklands are the Lockheed Hercules C Mk 1(K)s of No 1312 Flight. Equipped for in-flight refuelling, the Hercules greatly expand the effective range and patrol time of both the Phantoms and Harriers, and can also refuel other Hercules, enabling long maritime patrols to be undertaken. Typical of the latter are the regular sorties to South Georgia, where there are few more welcome sights than that of the big four-engined transports dropping mail by parachute to the ground forces stationed in this desolate, but magnificent, island.

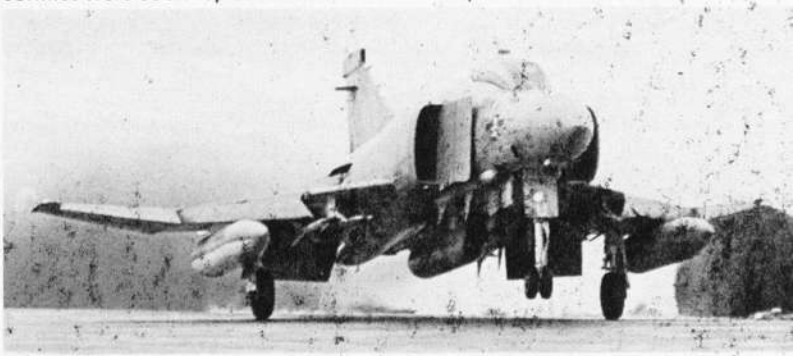
Hercules are also detached from the UK to Ascension Island and have been flying the air bridge on an almost daily basis since the re-opening of Stanley's runway. The system has worked well and very few flights — which normally require the support of two Victor K Mk 2s and a Hercules C Mk 1(K) tanker — have had to be cancelled for technical reasons. Bad weather in the Falklands winter remains the critical factor, but the new airport will offer more flexibility to cope with any rapid local deterioration, and the new site is better placed to avoid local weather difficulties. Work on the Mount Pleasant site for the airport is now well underway. It is situated to the west of Port Stanley on the "road" to Goose Green, and will consist of a main and subsidiary runway with all the usual taxiways and dispersals associated with a modern operational airfield. Capable of handling the current generation of wide-bodied jets, it will involve considerable engineering effort before the first aircraft can start to use it sometime in 1985.

The magnitude of development work to be undertaken to convert a desolate granite ridge into the major link for the Falklands with the outside world is not too difficult to imagine. There are no existing surfaced roads or port facilities and everything from quarrying machinery to portable cabins for the construction workers is having to be shipped in from Britain. The first shipments arrived in late October 1983 and maximum advantage was being taken of the better weather and longer daylight hours in the Falklands summer to get the preliminary work in hand as soon as possible. By the time the new airport is operational, the temporary runway surface of aluminium matting at RAF Stanley will have served its purpose.

Helicopters in their element

Providing search and rescue cover, and also undertaking many logistic support missions, have been the Sea King HAR 3s of the No 202 Squadron detachment. Unique in the RAF SAR fleet, they are painted in a toned down colour scheme of overall dark sea grey rather than the customary bright yellow. When prepared at RAF Finningley for the detachment, the aircraft were fitted with warning aids and the heavy cargo lifting frame as carried by the Commando Sea King HC Mk 4. This has been much used, especially during the period in late 1982 when the Chinooks were undergoing transmission changes in the field, following a fault discovered as a result of the fatal crash in Germany of a US Army Chinook. The Sea Kings are in the Falklands to aid the military as a primary rôle, but are also available to assist the civilian community or any ships in need of help.

The three Chinooks lost aboard *Atlantic Conveyor* during the conflict were soon replaced in the Falklands by aircraft destined for



(Above) A fully-armed Phantom — with gun pods, Sparrows and Sidewinders, as well as two drop tanks — returns to Stanley's single runway. (Below) Two guns and two Sidewinders are carried by this Harrier GR Mk 3 as it refuels from one of Stanley's Hercules. (Photo, SAC Lloyd Davies.)

Nos 18 and 7 Squadrons which were forming at the time. Initially the detachment was based at Port San Carlos. Facilities were less than perfect as all servicing had to be carried out in the open, in all weathers, and personnel lived under canvas. A few sheep-shearers' cottages came into use, but the lack of shelter for the aircraft made a move inevitable.

Since early 1983, the Chinooks, which are now formed into No 1310 Flight, have enjoyed much better conditions at their new Kellys Garden base. Here, a Rubb hangar has been erected and the aircraft can now receive attention in heated surroundings using normal ground support equipment — a far cry from the step ladders and farm tractors that were used in 1982. The personnel reside in a Portakabin city erected alongside the hangar and the now-standard comforts such as showers, NAAFI shop and messes can be found conveniently placed close to the operational facilities.

At any one time in the vicinity of Port Stanley it is often possible to see up to half-a-dozen helicopters in the air, at least two of which will probably be Chinooks. The lack of conventional harbour cranes at Stanley might have caused very serious cargo-handling problems for the British Forces were it not for the fact that the Chinooks were available as "flying cranes". Outsize loads such as ISO containers, Portakabins, large vehicles and even other helicopters and crated civil aircraft have been lifted straight off ship decks to the appropriate reception points. As there are no surfaced roads outside the capital, it can be appreciated just how valuable it is for these large loads to be lifted directly to the eventual site.

Over the past year-and-a-half, the Chinooks have established military sites all over the islands, ranging from radar and signals units to power stations and equipment containers. Triple external load suspension soon became in vogue, though care had to be exercised with certain loads so as to avoid the cargo "flying" the Chinook! In this context, the removal of damaged Argentine fixed-wing aircraft had its own dangers — especially in a strong wind.

Apart from acting as a rotary-winged crane, the Chinook is tasked with support of Army units in the Falklands. One of the most important of these tasks is flying in complete batteries of 105-mm field guns. Guns plus ammunition can be externally slung, with the gun crews travelling inside the same aircraft. Turn-round times on exercises show just how remarkably quickly the Royal Artillery can be ready for action, and this mobility has revolutionised battlefield tactics.

Another vital cog in the defensive gearwheel of Falklands defences is the point air defence provided by the RAF Regiment Rapier squadrons, which are rotated regularly from their normal bases in Europe. Rapier is also manned by Army units, but the RAF is tasked with defending RAF facilities, mostly in the Stanley area, while the Army is located elsewhere. Equipped with Blindfire, the Rapier sites are carefully sited to give maximum defensive coverage against any potential aerial attack. Compared to the relatively luxurious surroundings of their bases in RAF Germany, the Rapier operators in the Falklands face the bleakest conditions of any British military units on the islands. Most sites are perched on desolate rocky outcrops, well dug in and beneath camouflage netting. Inside their shelters, the men have become experts in the art of decoration: there are homely touches everywhere, and while the gales rage outside, the inner rooms of the sites resemble English cafes, some with half-timbered effects, bookshelves, videos and paintings on the wall! The Rapiers are well established at their positions, but an advantage of their mobile concept is that the fire units and support equipment can be airlifted at short notice — and this is exercised from time to time. They remain fully mobile and at a high alert state.

The Royal Air Force in the Falklands could not function without those support personnel behind the scenes actually in the islands, and all along the back-up line to the UK. All the usual services that would be expected in the UK are to be found "down south" — from cooks and RAF police to air traffic controllers, the Meteorological Office detachment, MT drivers and fitters and a host of specialist technicians and administrators. They are an integral part of the new "front line", 8,000 miles (12 900 km) from home. At the close of 1983, there were few signs that the military threat to the Falklands was over. For many, this will mean that the rugged splendour of the islands will become a familiar detachment. Demands on some units are already inevitably resulting in return postings occurring with some frequency, but morale is high, and with facilities improving all the time the Royal Air Force will continue defending the South Atlantic islands for as long as the threat remains. □

SOVIET AIR POWER . . .

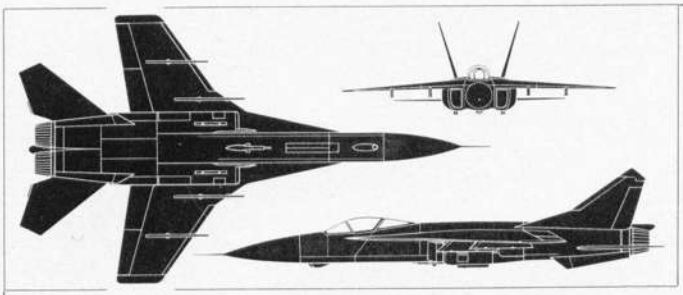
The Lengthening Shadow

THREE YEARS have elapsed since Soviet air power was last surveyed by the RAF YEARBOOK; a relatively brief period, perhaps, yet one that has witnessed profound changes markedly enhancing the air threat posed NATO. Since the beginning of the 'eighties, the Soviet air forces have been the focus of comprehensive modernisation and reorganisation now seen as significantly upgrading their capabilities, both offensive and defensive.

A new generation of combat aircraft stemming from a concerted effort to close the technology gap with the West has begun to appear, betokening qualitative weaponry improvements that indisputably place continued western technological superiority in question. Paralleling these re-equipment programmes have been sweeping organisational changes that, together with major alterations in tactics and training methods, have potentially an even greater influence on the effectiveness of SovAir and its increasingly offensive stance.

Interceptor fighters possessing for the first time true lookdown/shootdown faculties to which are now being added beyond-visual-range engagement ability have begun to intensify Soviet strategic defences. New, longer-ranging, more survivable tactical aircraft with all-weather low-level penetration potential are manifestly increasing SovAir ability to strike deeply into NATO rear areas. Substantial upgrading has been seen in SovAir theatre attack and maritime strike capacities; expansion of the helicopter forces and heliborne armament improvements have dramatically increased anti-armour potency and battlefield mobility; thoroughgoing modernisation of air transport elements has got into its stride, and new and impressive

(Head of page) A Sukhoi Su-15 Flagon-F photographed by the Swedish Coast Guard over the Baltic and fitted with IR-guided AA-3 Anab missiles on the outboard wing pylons and twin cannon pods beneath the fuselage. One of the older Soviet fighters, some 700 Flagon interceptors are believed to remain in the Soviet air defence organisation. The MiG-25 Foxbat-E (immediately above) is a conversion of the Foxbat-A which is reportedly fitted with uprated engines similar to those installed in Foxhound and to possess limited look-down/shoot-down capability.

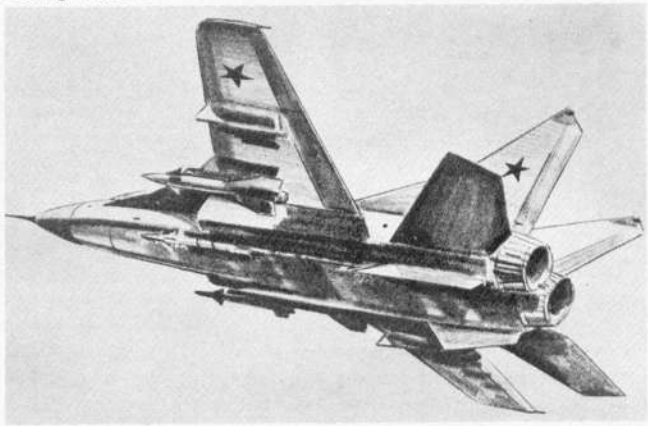


Mikoyan-Gurevich MiG-29 Fulcrum

Expected to attain IOC (Initial Operational Capability) this year and to be widely deployed in the Western Theatre by the late 'eighties, Fulcrum is closely comparable in both size and weight with the F-18 Hornet, but is believed to have a marginally better thrust-to-weight ratio of the order of 1·2:1·0. Representative of the results of the concerted effort by the Soviet Union in recent years to close the technology gap with the West, Fulcrum, like its larger and heavier contemporary, Flanker, has a new long-range track-while-scan radar, a pulse Doppler look-down/shoot-down weapons system, infrared search and tracking, a digital data link and a head-up display.

With a primary armament of medium-range air-to-air missiles with active terminal guidance coupled with internal gun armament — probably a single 30-mm weapon — Fulcrum has two engines each possessing an approximate military power rating of 13,000 lb (5 900 kg) and a max reheat rating of about 19,000 lb (8 620 kg). Internal fuel capacity is calculated at some 8,800 lb (3 990 kg) which may be supplemented with 2,000 lb (910 kg) of external fuel, empty equipped and gross take-off weights being of the order of 28,000 lb (12 700 kg) and 36,000 lb (16 330 kg), the latter being for the air superiority mission with half fuel and four AAMs. Approximate overall dimensions include a wing span of 34·45 ft (10,50 m), a length of 50·85 ft (15,50 m) and a wing area of 380 sq ft (35,30 m²).

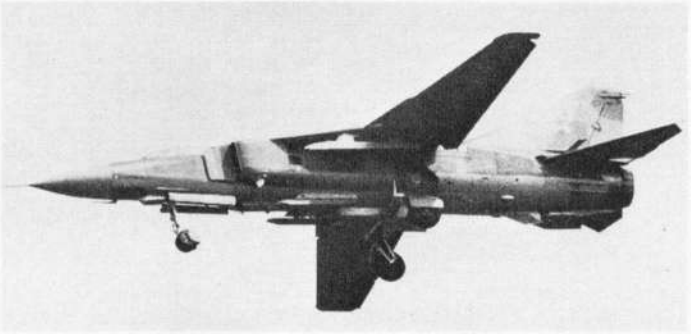
Performance of Fulcrum is believed to compare closely with that of the General Dynamics F-16, estimated maximum speed ranging from Mach=1·2 at sea level to Mach=2·3 above 36,000 ft (10 975 m). Sustained turn rate at Mach=0·9 at 15,000 ft (4 570 m) is calculated at 16 deg/sec with an instantaneous turn rate pulling 7-9 *g* of 21 deg/sec. Likely to possess a true dual-rôle air combat/attack capability, Fulcrum has a tactical radius on internal fuel of about 325 nm (600 km) when carrying four 1,102-lb (500-kg) bombs, increasing to some 360 nm (670 km) when armed with four AAMs and to 380 nm (705 km) in clean configuration.



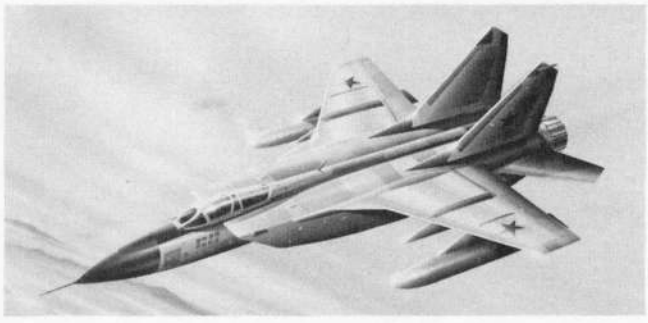
systems for intelligence gathering and electronic countermeasures have evolved and are now being fielded.

Major reorganisation of the SovAir command organisation has resulted in creation of a peacetime structure that closely approximates to the anticipated Soviet wartime organisation for the employment of air power. This allows a more rapid transition to a wartime posture, and enhances operational flexibility and co-ordination through centralised control of air assets at front and theatre levels. These organisational changes, which became fully effective from the autumn of 1981, have affected virtually every facet of SovAir. There have been mergers, restructuring and rationalisation of all elements, paralleling similar changes that have taken place within the ground forces, and the establishment of new levels of supra units and formations. This transmutation has been accompanied by barely less draconian changes in air combat tactics and training programmes, far greater emphasis now being placed on pilot independence and initiative. □

(Above and immediately below) The Sukhoi Su-17 Fitter-H attack aircraft, the example below having a centreline reconnaissance pod which appears to incorporate forward-facing panoramic cameras, an infra-red linescanner and possibly side-looking radar. Some 800 of the variable-geometry Fitter are in Soviet service, together with a similar number of the very much more capable Sukhoi Su-24 Fencer (below right) two-seat deep penetration interdictor and strike aircraft.



Numerically the most important combat aircraft in the Soviet Air Force inventory, Flogger serves in both air-air and air-ground rôles. The MiG-27 Flogger-J (head of page) is a tactical strike and close air support version capable of carrying a 4,400-lb (1 996-kg) ordnance load with a combat radius of 400 nm (740 km) flying a LO-LO-HI profile. Current service air superiority versions include the MiG-23 Flogger-B (left) seen with AA-7 Apex radar-guided missiles on the wing glove pylons and AA-8 Aphid infra-red homing missiles on the fuselage stations, and the MiG-23 Flogger-G (immediately above) seen on the landing approach.

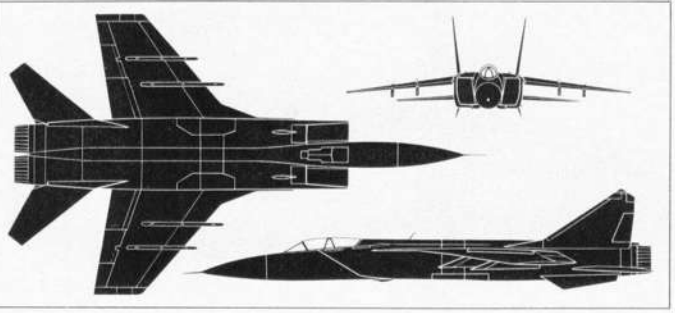


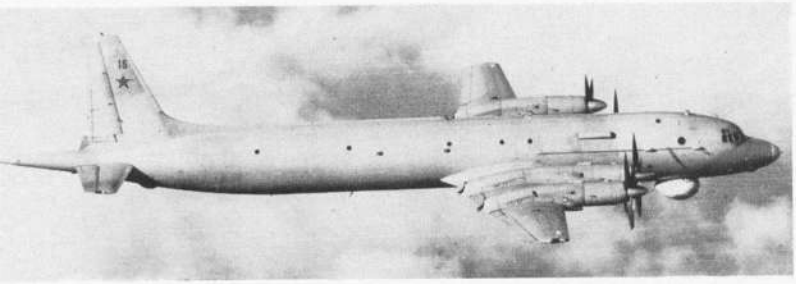
Mikoyan-Gurevich MiG-31 Foxhound

An evolutionary follow-on to Foxbat (MiG-25) and aerodynamically the most conservative of the new generation of Soviet fighters, Foxhound first attained IOC (Initial Operational Capability) last year, and is now reported to equip at least four air regiments. The first Soviet fighter offering true look-down/shoot-down capability to enter service, Foxhound has apparently been optimised for the extended-range intercept mission in concert with Mainstay, cruising at high altitudes and engaging fighter targets in the look-down/shoot-down mode with radar-guided missiles.

Externally, Foxhound differs comparatively little from the early 'sixties vintage Foxbat. The currently fashionable wing root leading edge extensions have been introduced and the new forward fuselage, which provides tandem seating for the pilot and systems operator, accommodates a pulse Doppler weapons system, infrared search and tracking, and digital data link. Foxhound is apparently capable of carrying up to eight AA-9 medium-range missiles with active terminal guidance and is believed to have internal cannon. Power is provided by two Tumansky turbojets — referred to by one western intelligence agency as R-15-300s — apparently similar to those installed in Foxbat-E, these each providing a reheat thrust of some 30,865 lb (14 000 kg).

Performance includes a max speed of Mach=2·3 and a ceiling of the order of 80,000 ft (24 385 m), and take-off weight in normal loaded condition is reportedly of the order of 65,200 lb (29 575 kg), but with max internal *and* external (on outboard wing hardpoints) fuel, with which mission radius is calculated at 1,025 nm (1 900 km), the overload take-off weight is probably of the order of 80,000 lb (36 290 kg). Estimated dimensions include a span of 45·75 ft (13,95 m), a length of 68·9 ft (21,00 m) and a wing area of 602·8 sq ft (56,00 m²).



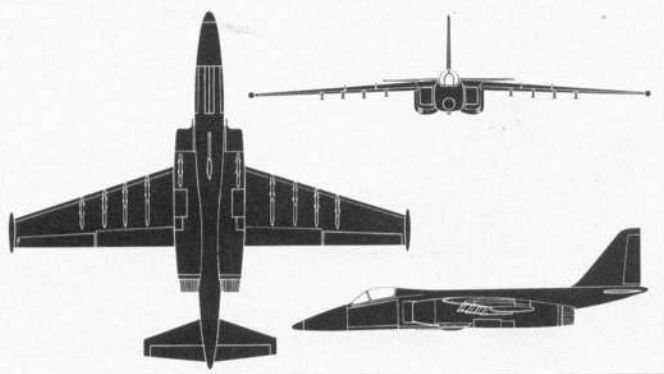


Two derivatives of the mid-'fifties vintage Il-18 Coot medium-range airliner currently perform important rôles in the Soviet Air Force and Soviet Naval Aviation, these being the Il-20 Coot-A (above) and the Il-38 May (left). Coot-A is a conversion of the standard airliner for electronic countermeasures and electronic intelligence tasks. May is a maritime surveillance derivative of the airliner and is seen (immediately left) in its initial May-A form and (above left) in its more recent May-B version with an additional radome under the forward fuselage. The Soviet Navy is believed to be deploying about 60 May maritime surveillance aircraft.

Sukhoi Su-25 Frogfoot

A single-seat close air support fighter equivalent to the USAF's A-10A Thunderbolt II, Frogfoot has been deployed in Afghanistan since 1981, presumably with an operational trials unit, and is expected to see large-scale deployment in the Western Theatre from this year. Reportedly powered by a pair of 11,240 lb (5 100 kg) Tumansky R-13-300 turbojets, Frogfoot is fitted with a heavy-calibre Gatling-type cannon and has 10 external stores stations which are believed to be capable of carrying a max of 8,820 lb (4 000 kg) of ordnance, including laser-guided munitions. Marginally smaller and somewhat lighter than the A-10A, it is believed to have a generally similar performance to that of its US counterpart, with a max speed with six 551-lb (250-kg) bombs of about 440 mph (708 km/h) at 10,000 ft (3 050 m). Combat radius with a 10,000-lb (4 535-kg) warload is believed to be some 300 mls (480 km).

Possessing a max take-off weight of approximately 38,000 lb (17 237 kg), Frogfoot is heavily armoured, its estimated dimensions including a span of 55 ft (16,75 m) and a length of 49 ft (14,95 m). Flying in support of Soviet forces in mountainous Afghan terrain, Frogfoot has apparently been used to perfect the integration of low-level tactics of this fixed-wing aircraft with those of Hind (Mi-24) gunship helicopters.



Several versions of the An-12BP Cub military transport adapted for electronic intelligence and electronic countermeasures tasks are in service, usually carrying civil registrations, one such being the Cub-B Elint aircraft illustrated above.

Other variants of the An-12 include the Cub-D electronic countermeasures aircraft, illustrated above, and what appears to be a test and evaluation anti-submarine warfare model, seen below, with electronic extensions forward of the nose and aft of the tail.

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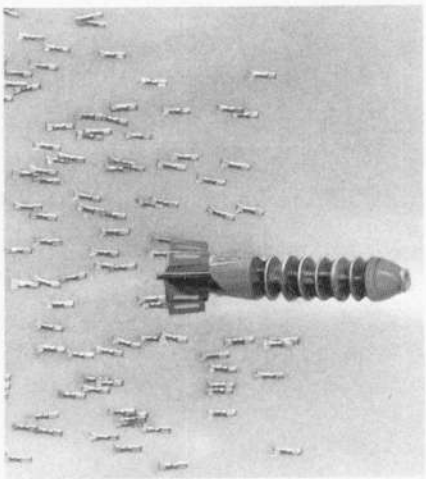
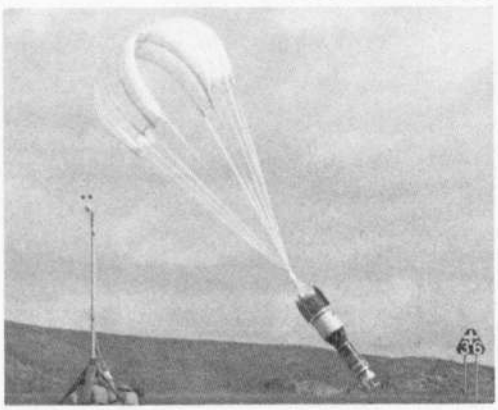


BL755 anti-armour weapon



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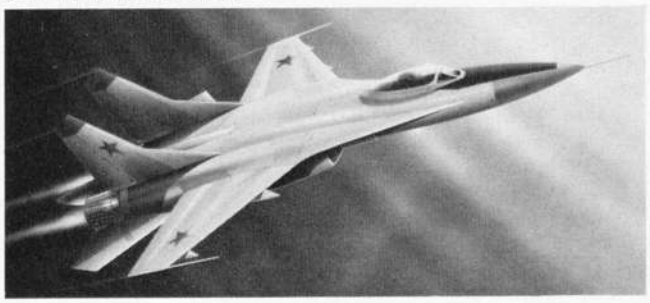
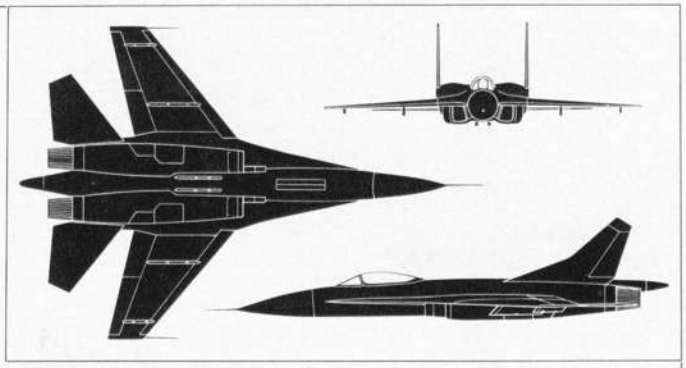
Sukhoi Su-27 Flanker

Comparable in size and weight with the F-15 Eagle and of generally similar configuration to that of Fulcrum, although appreciably larger and heavier, Flanker is expected to attain IOC (Initial Operational Capability) next year. Equipped with a new track-while-scan radar with a track range of up to 100 nm (185 km) and a search mode range of the order of 130 nm (240 km), a pulse Doppler look-down/shoot-down weapons system, infrared search and tracking and a digital data link, Flanker has paired engines each having military and reheat thrust ratings estimated at 20,000 and 30,000 lb (9070 and 13610 kg) respectively. Armament is believed to comprise a 23-mm or 30-mm cannon system and up to eight air-to-air missiles, or, in Flanker's secondary attack rôle, up to 12 1,102-lb (500-kg) bombs or equivalent ordnance loads. Primary AAM is likely to be the AA-9 which is a radar-guided missile with active terminal seeker with a launch range of 21-24 nm (40-45 km) at high altitude or 11 nm (20 km) at low altitude.

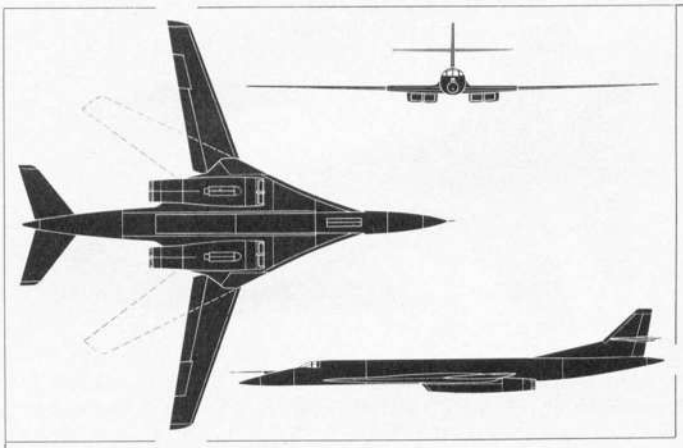




With a max speed ranging from Mach=1·1 at sea level to approximately Mach=2·3 above 36,000 ft (10 975 m), Flanker is believed to offer better turn rates than its smaller MiG contemporary, Fulcrum, with a sustained rate of 17 deg/sec at Mach=0·9 at 15,000 ft (4 570 m) and an instantaneous rate of 23 deg/sec pulling 7-9 *g*. Acceleration is expected to be some 20 per cent better than that of Flogger (MiG-23). The empty and gross take-off weights of Flanker are estimated at 39,000 lb (17 690 kg) and 63,500 lb (28 805 kg), and internal fuel capacity at some 15,500 lb (7 030 kg) which may be supplemented by about 7,000 lb (3 175 kg) of external fuel. High-altitude tactical radius in clean condition is calculated at 450 nm (835 km), reducing to 350 nm (650 km) when carrying a full complement of eight AAMs. Approximate overall dimensions include a span of 41·0 ft (12,50 m), a length of 65·6 ft (20,00 m) and a wing area of 500 sq ft (46,45 m²).

The Soviet Air Force and Army Aviation possess an immense fleet of helicopters, the principal of these being the Mi-8 Hip and the Mi-24 Hind. The former is seen above left in Hip-C and immediately left in Hip-E assault transport versions, and the latter in Hind-D gunship form above right.

The latest addition to the Soviet Navy's helicopter inventory is the Ka-27 Helix-A (right) for anti-submarine warfare tasks, this apparently being the successor to the Ka-25 Hormone-A (below right) aboard Soviet naval vessels. The Soviet Naval Air Forces utilise the Mi-14 Haze (below left) for shore-based ASW duties.

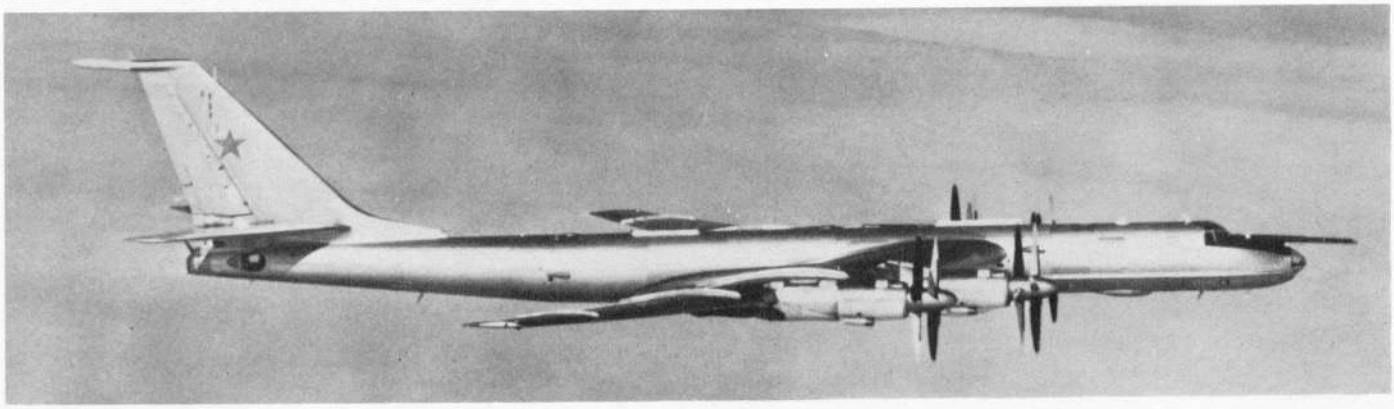


Tupolev Blackjack

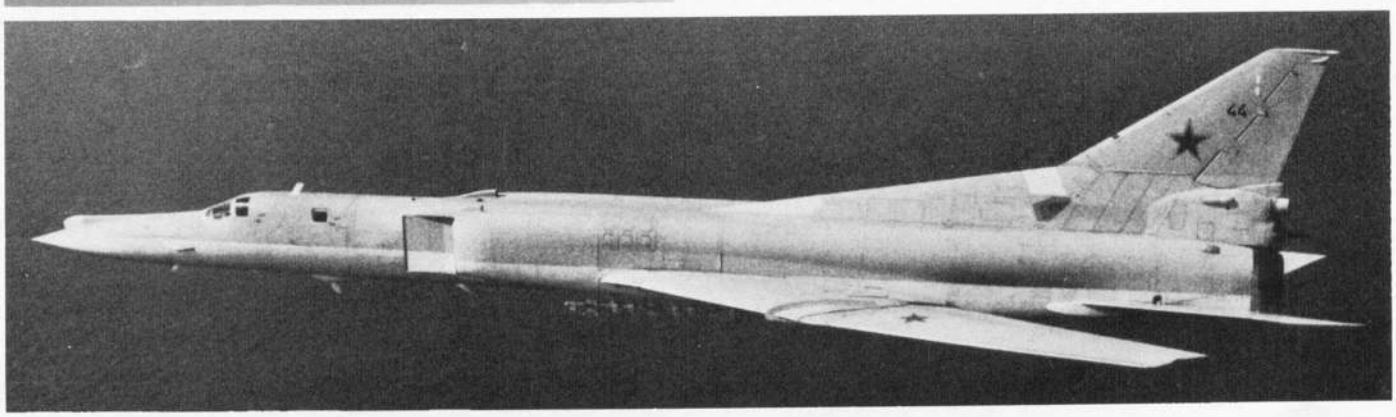
Unlikely to attain IOC (Initial Operational Capability) before 1987 as a replacement for the intercontinental attack versions of the obsolescent Bear, Blackjack is known to have been under test since the late 'seventies and is certainly a multiple-rôle aircraft capable of delivering both free-fall bombs and air-launched cruise missiles. There can be little doubt that Blackjack is to be mated with a new missile with a range of the order of 1,600 nm (3 000 km) currently at an advanced stage of development and expected to be available by the time that this new product of the Tupolev design bureau achieves IOC.

Now believed somewhat larger than at first calculated, with an overall span of some 177 ft (53,95 m) with wings at minimum sweep angle reducing to 101 ft (30,78 m) with wings swept fully aft, a wing area of approximately 2,500 sq ft (232,25 m^2) and an overall length of about 175 ft (53,35 m), Blackjack presents less of a design compromise than the very much smaller Backfire. The fineness ratio of its fuselage is consistent with a high supersonic dash speed, and Blackjack is likely to be able to reach the USA from Soviet bases unrefuelled at fuel-conserving altitudes before dropping to low altitude for a high-speed dash through the continental air defences.

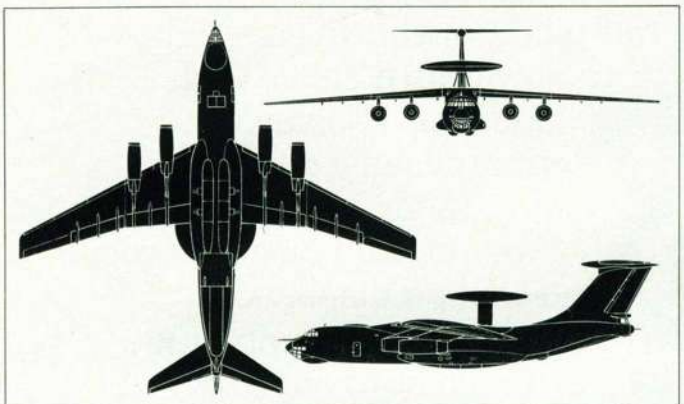
Some 25 per cent larger than the Rockwell B-1B and likely to be following a comparable delivery timescale, Blackjack has an estimated take-off gross weight of some 590,000 lb (267 625 kg), or about 20 per cent more than that of its US contemporary, and its long fuselage affords plenty of space for internal weapons, the estimated max weapons load being of the order of 36,000 lb (16 330 kg). Blackjack is expected to be powered by new turbofans, each of its four engines giving 30,000 lb (13 610 kg) dry thrust and up to 50,000 lb (22 680 kg) with max reheat. Supersonic high-altitude dash speed is likely to be Mach=2·1 and its estimated unrefuelled combat radius is 3,940 nm (7 300 km), or almost double that of Backfire.



Originally developed as a strategic bomber, Bear is extensively used for maritime reconnaissance by the Soviet Navy, two current versions being the Bear-F (above) and the Bear-D (left). Known as Tu-142 in naval form, Bear has been in continuous production for some 30 years. Like Bear, the Tu-22M Backfire (below) serves with both the Soviet Air Force and Naval Aviation in the medium range bombing and maritime strike/reconnaissance rôles respectively. Production rate is currently some 30 annually. About 120-125 are in Soviet Air Force service and a similar quantity serves with Soviet Naval Aviation.



The Su-15 Flagon-F (above and immediately right) is now giving place in the air defence rôle to newer-generation fighters, such as the MiG-31 Foxhound, but is unlikely to be withdrawn from the Soviet Air Force's first-line inventory much before the end of the decade.

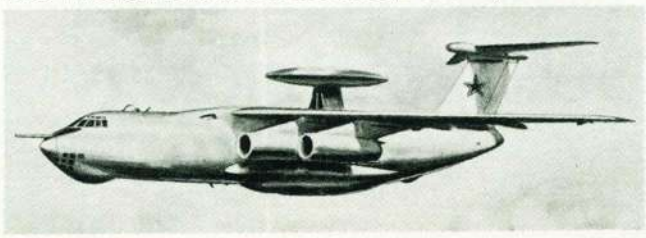


Ilyushin Mainstay

One of the principal deficiencies of the Soviet air defence system is currently a lack of a competent airborne early warning and control system (AWACS) aircraft, Moss (Tu-126) being comparatively ineffectual over land. This need is expected to be fulfilled by the service introduction of Mainstay, an AWACS aircraft which has been under development since the late 'seventies, based on the excellent Candid (Il-76) heavy-duty medium/long-haul freighter. Externally, Mainstay apparently differs from Candid primarily in having a conventionally-located rotating "saucer" radome, some nominal lengthening of the forward fuselage and provision of a flight refuelling probe.

Promising a significant improvement in the ability of Soviet tactical aircraft to conduct longer-range operations, Mainstay is likely to operate primarily in concert with advanced fighters, such as Foxhound, locating incoming strike aircraft and directing the intercept force towards them. Mainstay is expected to attain IOC (Initial Operational Capability) this year or next, with some 30 being in service by the late 'eighties. It may be assumed that Mainstay is being produced on the same line as Candid which is currently delivering the transport for both military and commercial use at a rate of about 30-35 annually.

Mainstay is likely to be powered by four similar Soloviev D-30KP turbofans to those used by Candid, these each having a maximum thrust of 26,455 lb (12 000 kg). It probably has a flight crew of four with tactical and air direction teams totalling 9-10 personnel. Possessing a max take-off weight of the order of 380,000 lb (172 370 kg), Mainstay has an estimated max cruise speed of 475 mph (764 km/h) at 29,500-42,650 ft (9 000-13 000 m) and is likely to be able to remain on station unrefuelled for 6-7 hours at a distance of 930 miles (1 500 km) from base.



The Yak-36MP Forger-A, seen above on the deck of the carrier Minsk, fulfils the air defence and strike fighter rôles from three Kiev-class carriers which are expected to be joined by a fourth vessel of this class during the course of this year. Seen below with an AS-4 Kitchen missile on the fuselage centreline, the Tu-22M Backfire is one of the most potent of current Soviet combat aircraft, and a more advanced version, Backfire-C, is currently entering service.

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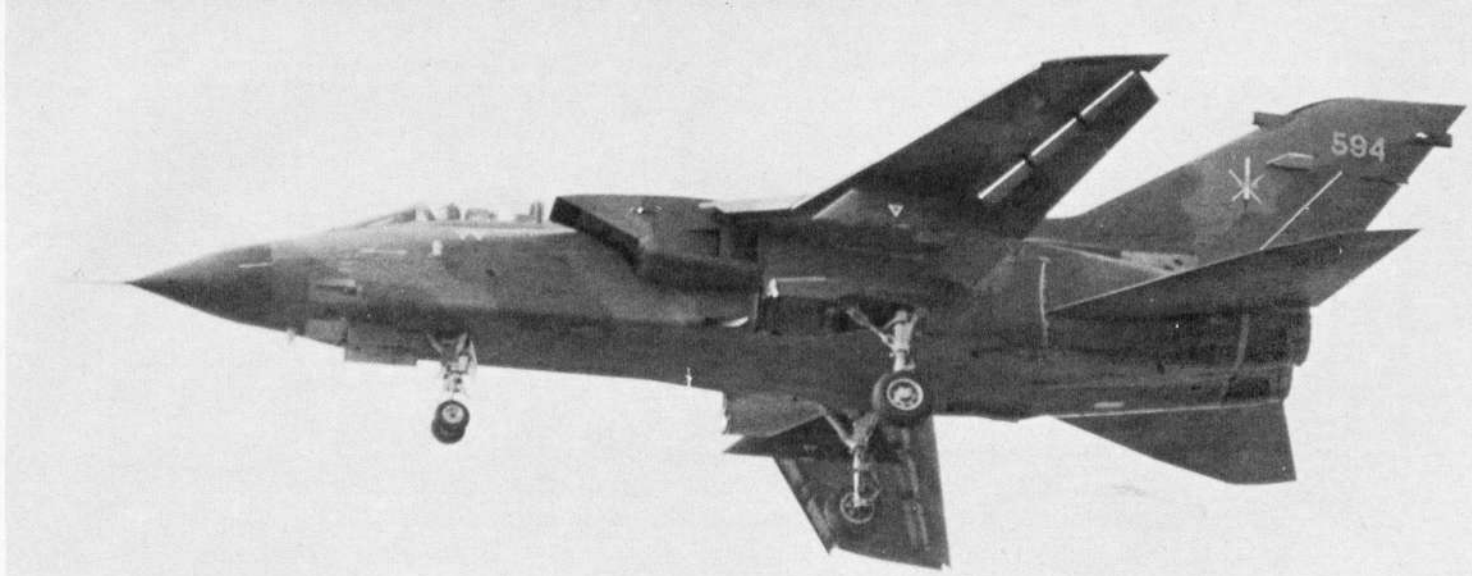

"If you look to your left . . . "

Squadron Leader Geoffrey Roberts (38) is one of the Royal Air Force Tornado display pilots. He is a former member of the RAF Poachers Aerobatic Display Team and has logged more than 3,500 hours on fast jet aircraft, including Hunters, Hawks and Phantoms. He converted to the Tornado in 1982. Although he appears at air displays throughout the country — mainly at weekends — his first rôle is as an operational pilot. He is the training officer with No 9 Squadron at RAF Honington. His navigator (at the time of writing) was Flight Lieutenant Tim Price (36), then No 9 Squadron's weapons instructor and now an instructor with the Tornado Weapons Conversion Unit. Flight Lieutenant Price previously flew in Canberras and Buccaneers in the naval strike attack rôle. The two men here describe a display flight.

"LADIES and gentlemen, if you look to your left you will see the latest aircraft to enter front-line service with the Royal Air Force, the Tornado GR1 — flown this afternoon by Squadron Leader Geoff Roberts and his navigator Flight Lieutenant Tim Price, of No 9 Squadron . . ."

The metallic voice echoes from the tannoy system over the heads of the crowds at the air display. There is a carnival buzz of excitement as thousands of pairs of eyes turn to search the sky for the approaching jet. As the Tornado begins its run-in, pilot and navigator are working hard . . .

"Flaps down . . . wheels down . . . five seconds to run . . . right on time! Now, overshoot . . . gear up . . . reheat to combat power . . . flaps up and leaning on manoeuvres . . ."

It is a spectacular entry, timed to the second and a reason for satisfaction for the aircrew. Arriving "on stage" at precisely the right time is not just a matter of professional pride, however. "It is Tim's job to put me in a position where we can make the exact display time (in order not to conflict with other display aircraft and to give maximum spectator appeal) and at exactly the right speed for the first manoeuvre. If you are too fast or too slow as a result of trying to catch up or lose time, then it is likely that the whole of the first part of the display will be affected," explains Geoff Roberts.

Tim Price adds: "We aim to have an eight-minute holding time; flying two complete racetrack patterns out of sight and sound of the display area. Then we adjust the length of the pattern to hit our run-in mark, 10 miles from the display, at 200 knots (370 km/h). We use all of the aeroplane's sophisticated navigational aids — but we also check precise times with a watch and a map . . ."

"As we are running in," Geoff Roberts explains, "Tim is also shouting out to me our approach checks. I am looking for the centre point of the display. Our entrance is designed for maximum crowd appeal, to demonstrate the sheer power of the Tornado."

"Level maximum rate turn . . . speed building up . . . 'g' coming on . . . hold the turn all the way round . . . running in again . . . and pull up for a barrel roll . . . wing over and engines to idle power . . ."

"At this stage we have the wings at 25 degrees of sweep with manoeuvre flap. As we descend and run-in for another pass I begin to sweep the wings back and Tim checks that the flaps and wings are moving correctly. It is very encouraging to have someone in the back to monitor systems functions. On this next run we will be travelling at 350 knots (648 km/h), showing off the aircraft with its full 67 degrees of wing sweep.

"Our complete display has been designed to show our audience not only a flying spectacle but also the unique capabilities of the aircraft. The Tornado is a swing-wing, supersonic, highly manoeuvr-

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Photographed on a training mission from RAF Honington, each of these Tornado GR Mk 1s (above and bottom right) carry a typical load comprising four 1,000-lb (454-kg) retarded bombs, two 330-Imp gal (1 500-l) drop tanks and two Marconi Sky Shadow electronic countermeasures pods.

able bomber. So we make frequent use of the wing sweep, demonstrate the aircraft's speed and agility and, most important, fly with a representative combat load of underwing fuel tanks and ECM pods. We are probably unique in displaying an aircraft in its combat configuration rather than 'clean' of stores, which most display flyers go for."

"Level off ... wings sweep to 67 degrees ... reheat ... speed 350 knots ... passing the crowd line ... reheat off ... pull up ... wing over right ... wings to 45 degrees and select manoeuvre slats ... coming in from the right ... and a taileron roll in front of the crowd ..."

"The first part of our display is largely in the horizontal plane. The second part could be described as the 'vertical' phase."

"Out of the roll ... combat power ... wings to 25 degrees and climb ... 5,500 feet ... a roll off the top ... 60 degree dive ... throttles idle (Tim calls the heights, 4,000 feet, 3,000 feet, 2,000, 1,000, 900, 800, 700) ... pull out ... minimum height 500 feet ... combat power ... climb and another roll off the top at the other end of the crowd line ..."

"At this stage of the display, Tim is checking fuel and time to run and he begins to call out times. The aeroplane begins to transfer fuel automatically from the wings to the fuselage. This is the critical point in the display as we build up to the finale."

"Wings to 45 degrees ... wing over right ... heading towards the crowd ... pull up ... sweep to 25 degrees ... engage burner ... roll off the top away from the crowd ..."

Says Tim Price: "As we go up I can see the crowd line in the mirror. That is an indication that we are in exactly the right position for maximum effect. I tell Geoff 'They'll like that!'"

"Up to 7,500 feet ... 45 seconds to go ..."

"Now we will present the Tornado at high speed and at a lower height, showing the topside of the aircraft to the crowd line. Tim calls out 'They'll like that even more!!' In the final run-in the acceleration is fantastic."

"Wings fully swept ... height 300 feet ... full reheat ... 550 knots ... past the crowd line and ... pull up for vertical climb ..."

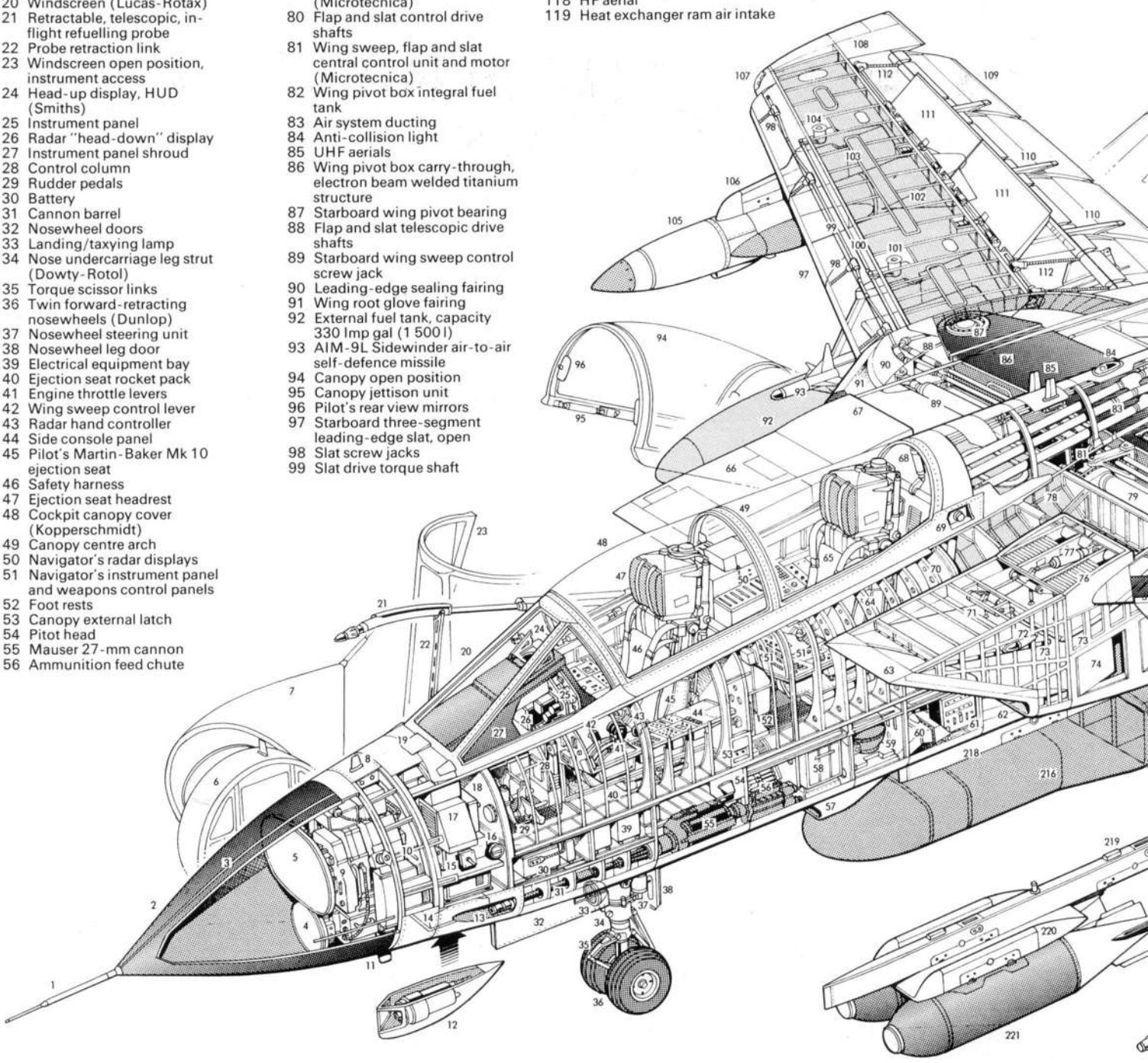
Thr Tornado departs rolling vertically and disappears as a speck at 15,000 ft (4 572 m).

"Display flying is a secondary part of our job. First and foremost we are an operational crew. Most of our display flying is at weekends and this means that our ground crews have to work Saturdays and Sundays to give us the necessary support. But it is great fun. Moreover, we believe that display flying is important. Most of our flying is done away from our base so the ground crews who prepare the aircraft for each flight rarely get the opportunity to see the results of their work, except at a display. It is also right that members of the public should be able to see what they are getting for their taxes.

"Perhaps most important is that it gives us an opportunity to demonstrate to a potential enemy that we have a magnificent aircraft in our armoury that would cause him many problems if he attacked. It is part of deterrence," says Geoff. "Somewhere in the crowd there is bound to be a spy!" □

Panavia Tornado GR Mk 1 Cutaway Drawing Key

1 Air data probe
2 Radome
3 Lightning conductor strip
4 Terrain following radar antenna
5 Ground mapping radar antenna
6 Radar equipment bay hinged position
7 Radome hinged position
8 IFF aerial
9 Radar antenna tracking mechanism
10 Radar equipment bay
11 UHF/TACAN aerial
12 Laser Ranger and Marked Target Seeker (Ferranti), starboard side
13 Cannon muzzle
14 Ventral Doppler aerial
15 Angle of attack transmitter
16 Canopy emergency release
17 Avionics equipment bay
18 Front pressure bulkhead
19 Windscreen rain dispersal air ducts
20 Windscreen (Lucas-Rotax)
21 Retractable, telescopic, in-flight refuelling probe
22 Probe retraction link
23 Windscreen open position, instrument access
24 Head-up display, HUD (Smiths)
25 Instrument panel
26 Radar "head-down" display
27 Instrument panel shroud
28 Control column
29 Rudder pedals
30 Battery
31 Cannon barrel
32 Nosewheel doors
33 Landing/taxying lamp
34 Nose undercarriage leg strut (Dowty-Rotol)
35 Torque scissor links
36 Twin forward-retracting nosewheels (Dunlop)
37 Nosewheel steering unit
38 Nosewheel leg door
39 Electrical equipment bay
40 Ejection seat rocket pack
41 Engine throttle levers
42 Wing sweep control lever
43 Radar hand controller
44 Side console panel
45 Pilot's Martin-Baker Mk 10 ejection seat
46 Safety harness
47 Ejection seat headrest
48 Cockpit canopy cover (Kopperschmidt)
49 Canopy centre arch
50 Navigator's radar displays
51 Navigator's instrument panel and weapons control panels
52 Foot rests
53 Canopy external latch
54 Pitot head
55 Mauser 27-mm cannon
56 Ammunition feed chute
57 Cold air unit ram air intake
58 Ammunition tank
59 Liquid oxygen converter
60 Cabin cold air unit
61 Stores management system computer
62 Port engine air intake
63 Intake lip
64 Cockpit framing
65 Navigator's Martin-Baker Mk 10 ejection seat
66 Starboard engine air intake
67 Intake spill duct
68 Canopy jack
69 Canopy hinge point
70 Rear pressure bulkhead
71 Intake ramp actuator linkage
72 Navigation light
73 Two-dimensional variable area intake ramp doors
74 Intake suction relief doors
75 Wing glove Krüger flap
76 Intake bypass air spill ducts
77 Intake ramp hydraulic actuator
78 Forward fuselage fuel tank
79 Wing sweep control screw jack (Microtecnica)
80 Flap and slat control drive shafts
81 Wing sweep, flap and slat central control unit and motor (Microtecnica)
82 Wing pivot box integral fuel tank
83 Air system ducting
84 Anti-collision light
85 UHF aerials
86 Wing pivot box carry-through, electron beam welded titanium structure
87 Starboard wing pivot bearing
88 Flap and slat telescopic drive shafts
89 Starboard wing sweep control screw jack
90 Leading-edge sealing fairing
91 Wing root glove fairing
92 External fuel tank, capacity 330 Imp gal (1 500 l)
93 AIM-9L Sidewinder air-to-air self-defence missile
94 Canopy open position
95 Canopy jettison unit
96 Pilot's rear view mirrors
97 Starboard three-segment leading-edge slat, open
98 Slat screw jacks
99 Slat drive torque shaft
100 Wing pylon swivelling control rod
101 Inboard pylon pivot bearing
102 Starboard wing integral fuel tank
103 Wing fuel system access panels
104 Outboard pylon pivot bearing
105 Marconi "Sky-Shadow" ECM pod
106 Outboard wing swivelling pylon
107 Starboard navigation and strobe lights
108 Wing tip fairing
109 Double-slotted Fowler-type flaps, down position
110 Flap guide rails
111 Starboard spoilers, open
112 Flap screw jacks
113 External fuel tank tail fins
114 Wing swept position trailing edge housing
115 Dorsal spine fairing
116 Aft fuselage fuel tank
117 Fin root antenna fairing
118 HF aerial
119 Heat exchanger ram air intake
120 Starboard wing fully swept back position
121 Airbrake, open
122 Starboard all-moving tailplane (taileron)
123 Airbrake hydraulic jack
124 Primary heat exchanger
125 Heat exchanger exhaust duct
126 Engine bleed air ducting
127 Fin attachment joint
128 Port airbrake rib construction
129 Fin heat shield
130 Vortex generators
131 Fin integral fuel tank
132 Fuel system vent piping
133 Tailfin structure
134 ILS aerial
135 Fin leading edge
136 Forward passive ECM housing
137 Fuel jettison and vent valve
138 Fin tip antenna fairing
139 VHF aerial
140 Tail navigation light
141 Aft passive ECM housing
142 Obstruction light



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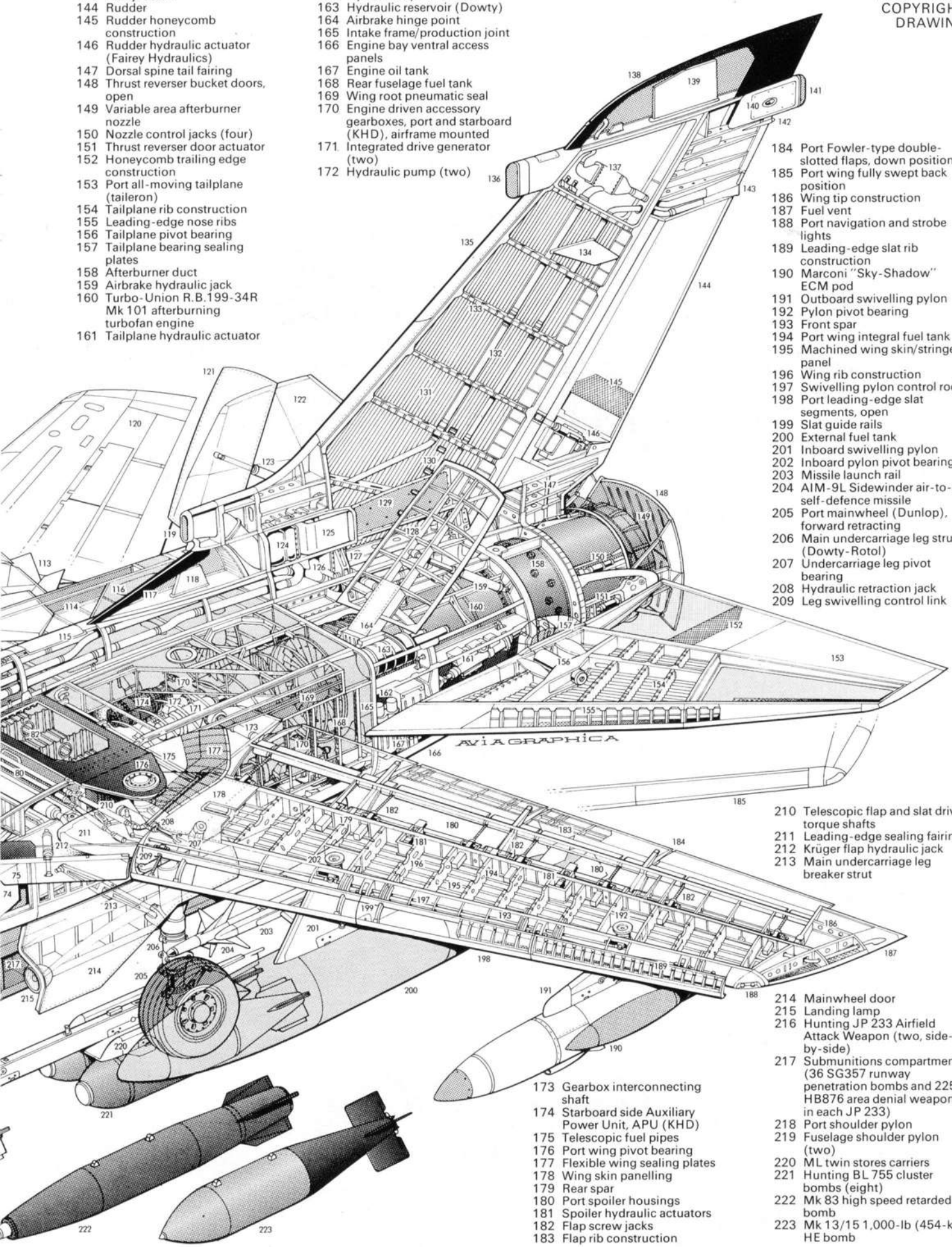
DRAWING

143 Fuel jettison
144 Rudder
145 Rudder honeycomb construction
146 Rudder hydraulic actuator (Fairey Hydraulics)
147 Dorsal spine tail fairing
148 Thrust reverser bucket doors, open
149 Variable area afterburner nozzle
150 Nozzle control jacks (four)
151 Thrust reverser door actuator
152 Honeycomb trailing edge construction
153 Port all-moving tailplane (taileron)
154 Tailplane rib construction
155 Leading-edge nose ribs
156 Tailplane pivot bearing
157 Tailplane bearing sealing plates
158 Afterburner duct
159 Airbrake hydraulic jack
160 Turbo-Union R.B.199-34R Mk 101 afterburning turbofan engine
161 Tailplane hydraulic actuator

162 Hydraulic system filters
163 Hydraulic reservoir (Dowty)
164 Airbrake hinge point
165 Intake frame/production joint
166 Engine bay ventral access panels
167 Engine oil tank
168 Rear fuselage fuel tank
169 Wing root pneumatic seal
170 Engine driven accessory gearboxes, port and starboard (KHD), airframe mounted
171 Integrated drive generator (two)
172 Hydraulic pump (two)

184 Port Fowler-type double-slotted flaps, down position
185 Port wing fully swept back position
186 Wing tip construction
187 Fuel vent
188 Port navigation and strobe lights
189 Leading-edge slat rib construction
190 Marconi "Sky-Shadow" ECM pod
191 Outboard swivelling pylon
192 Pylon pivot bearing
193 Front spar
194 Port wing integral fuel tank
195 Machined wing skin/stringer panel
196 Wing rib construction
197 Swivelling pylon control rod
198 Port leading-edge slat segments, open
199 Slat guide rails
200 External fuel tank
201 Inboard swivelling pylon
202 Inboard pylon pivot bearing
203 Missile launch rail
204 AIM-9L Sidewinder air-to-air self-defence missile
205 Port mainwheel (Dunlop), forward retracting
206 Main undercarriage leg strut (Dowty-Rotol)
207 Undercarriage leg pivot bearing
208 Hydraulic retraction jack
209 Leg swivelling control link



210 Telescopic flap and slat drive torque shafts
211 Leading-edge sealing fairing
212 Krüger flap hydraulic jack
213 Main undercarriage leg breaker strut

214 Mainwheel door
215 Landing lamp
216 Hunting JP 233 Airfield Attack Weapon (two, side-by-side)
217 Submunitions compartments (36 SG357 runway penetration bombs and 225 HB876 area denial weapons in each JP 233)
218 Port shoulder pylon
219 Fuselage shoulder pylon (two)
220 ML twin stores carriers
221 Hunting BL 755 cluster bombs (eight)
222 Mk 83 high speed retarded bomb
223 Mk 13/15 1,000-lb (454-kg) HE bomb

173 Gearbox interconnecting shaft
174 Starboard side Auxiliary Power Unit, APU (KHD)
175 Telescopic fuel pipes
176 Port wing pivot bearing
177 Flexible wing sealing plates
178 Wing skin panelling
179 Rear spar
180 Port spoiler housings
181 Spoiler hydraulic actuators
182 Flap screw jacks
183 Flap rib construction

The Tornado's Year

By the end of 1983, Panavia Tornado GR Mk 1s were serving with four RAF front-line squadrons, and the new warplane was seen increasingly at public events around the world, as well as the home bases and over the training areas. These pages recall some of the highlights of the Tornado's year. They included a visit by three GR Mk 1s of No 9 Squadron to the USA, in company with the Red Arrows; a training flight over the UK provided an opportunity for the combined formation to be photographed (above), while the Tornadoes are shown (below) at the Andrews AFB, Washington, DC, in May 1983. A trio of Tornadoes from No 617 Squadron crossed the North Atlantic again in September to participate in the Toronto Air Show and to make low-level training sorties; one of these aircraft is depicted (above left) over the familiar backdrop of the Niagara Falls. On the last day of October, No XV Squadron formally changed from Buccaneers to Tornadoes at RAF Laarbruch, marking the introduction into service of the new warplane in RAF Germany. One of No XV's aircraft is seen (left) at low-level over a German forest. In the UK, Nos 9, 617 and 27 Squadrons were flying Tornadoes, as well as the multi-national TTTE and the RAF's TWU for training purposes.

Long-sighted Sentinel

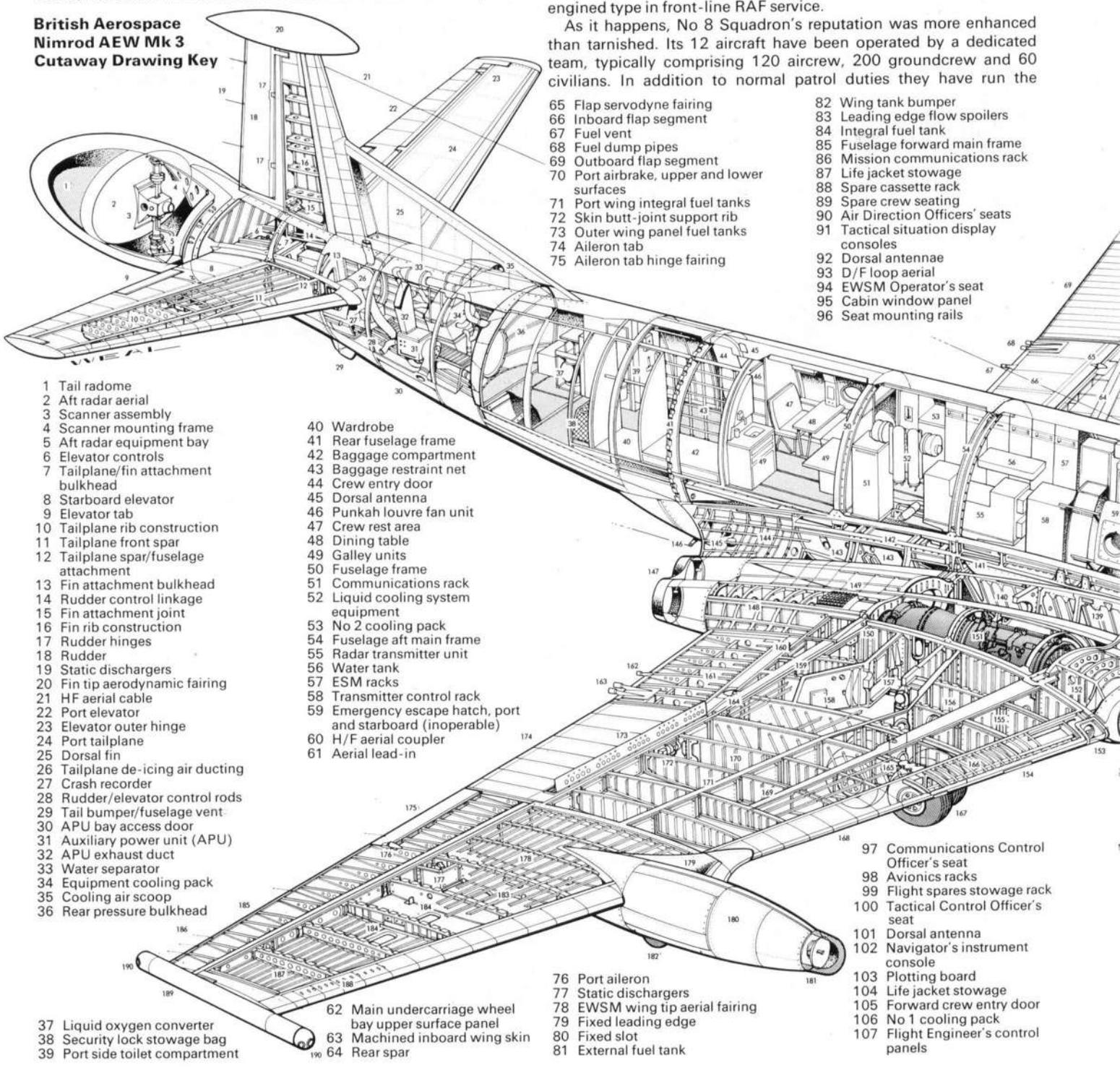
Mike Hirst describes the RAF's eagerly-awaited Nimrod AEW Mk 3 early-warner

AEW NIMROD must be one of the most distinctively-shaped of all the RAF's aircraft. Entering service in 1984, it will fulfil a rôle which has been important since 1972, when the Royal Air Force first introduced land-based airborne early warning (AEW) aircraft. There are few people now who would dare to cast doubts on the sense of having this non-fighting front-line element in the service. The hindsight vows echoed by those who haven't any AEW experience — and often a lot of scars to prove it — and the decade of experience that the RAF has under its belt, amount to testimonies that are second to none.

AEW Nimrod's predecessor, now on the eve of its retirement from duties, has been the Shackleton AEW Mk 2. It was an unlikely hero that came into being because Shackleton MR Mk 2 airframes, although already over 15 years old in 1972, were available and happened to be compatible with the radar taken from the Royal Navy's Fairey Gannet AEW Mk 3, which was in the process of removal from the aircraft carriers HMS *Eagle* and *Victorious*. The ex-Gannet AN/APS-20 radars (made by General Electric in the US, and with a technical history that dates back to 1942) were mated with some British-built radar technology and installed in 12 aircraft. No 8 Squadron was reformed — amid some controversy, it seems, as its former identity as a fighter squadron was felt likely to be tarnished — and began operations in 1972 from Lossiemouth, where the Shackleton AEW Mk 2 went on to carve a niche as the last piston-engined type in front-line RAF service.

As it happens, No 8 Squadron's reputation was more enhanced than tarnished. Its 12 aircraft have been operated by a dedicated team, typically comprising 120 aircrew, 200 groundcrew and 60 civilians. In addition to normal patrol duties they have run the

British Aerospace Nimrod AEW Mk 3 Cutaway Drawing Key



1 Tail radome
2 Aft radar aerial
3 Scanner assembly
4 Scanner mounting frame
5 Aft radar equipment bay
6 Elevator controls
7 Tailplane/fin attachment bulkhead
8 Starboard elevator
9 Elevator tab
10 Tailplane rib construction
11 Tailplane front spar
12 Tailplane spar/fuselage attachment
13 Fin attachment bulkhead
14 Rudder control linkage
15 Fin attachment joint
16 Fin rib construction
17 Rudder hinges
18 Rudder
19 Static dischargers
20 Fin tip aerodynamic fairing
21 HF aerial cable
22 Port elevator
23 Elevator outer hinge
24 Port tailplane
25 Dorsal fin
26 Tailplane de-icing air ducting
27 Crash recorder
28 Rudder/elevator control rods
29 Tail bumper/fuselage vent
30 APU bay access door
31 Auxiliary power unit (APU)
32 APU exhaust duct
33 Water separator
34 Equipment cooling pack
35 Cooling air scoop
36 Rear pressure bulkhead
37 Liquid oxygen converter
38 Security lock stowage bag
39 Port side toilet compartment
40 Wardrobe
41 Rear fuselage frame
42 Baggage compartment
43 Baggage restraint net
44 Crew entry door
45 Dorsal antenna
46 Punkah louvre fan unit
47 Crew rest area
48 Dining table
49 Galley units
50 Fuselage frame
51 Communications rack
52 Liquid cooling system equipment
53 No 2 cooling pack
54 Fuselage aft main frame
55 Radar transmitter unit
56 Water tank
57 ESM racks
58 Transmitter control rack
59 Emergency escape hatch, port and starboard (inoperable)
60 H/F aerial coupler
61 Aerial lead-in
62 Main undercarriage wheel bay upper surface panel
63 Machined inboard wing skin
64 Rear spar
65 Flap servodyne fairing
66 Inboard flap segment
67 Fuel vent
68 Fuel dump pipes
69 Outboard flap segment
70 Port airbrake, upper and lower surfaces
71 Port wing integral fuel tanks
72 Skin butt-joint support rib
73 Outer wing panel fuel tanks
74 Aileron tab
75 Aileron tab hinge fairing
76 Port aileron
77 Static dischargers
78 EWSM wing tip aerial fairing
79 Fixed leading edge
80 Fixed slot
81 External fuel tank
82 Wing tank bumper
83 Leading edge flow spoilers
84 Integral fuel tank
85 Fuselage forward main frame
86 Mission communications rack
87 Life jacket stowage
88 Spare cassette rack
89 Spare crew seating
90 Air Direction Officers' seats
91 Tactical situation display consoles
92 Dorsal antennae
93 D/F loop aerial
94 EWSM Operator's seat
95 Cabin window panel
96 Seat mounting rails
97 Communications Control Officer's seat
98 Avionics racks
99 Flight spares stowage rack
100 Tactical Control Officer's seat
101 Dorsal antenna
102 Navigator's instrument console
103 Plotting board
104 Life jacket stowage
105 Forward crew entry door
106 No 1 cooling pack
107 Flight Engineer's control panels

gauntlet of as many as four scrambles weekly (averaged over one year of operations), either to take part in NATO exercises or to give interceptor guidance against approaching Soviet reconnaissance aircraft. An indication of the AEW's value to modern fighter operations was gained when No 8 Squadron won the Wilkinson Sword Battle of Britain Memorial Trophy for the most significant advance in RAF tactics. The squadron performance has won admiration from operators of the advanced Boeing E-3 Sentry at Keflavik, too, and led to one USAF officer who was seconded to the squadron leaving with the memorable comment "never have I seen so few operating so little produce so much".

In 1981, airframe fatigue-life limitations made the RAF cull the Shackleton AEW Mk 2 fleet from 12 to six aircraft. Something is better than nothing, but this has been the very minimum force that the service could have wanted to operate, given the vast areas of ocean that have to be surveyed in the quest for low-flying intruders.

The AEW rôle is based on a simple concept. Because radar is unable to detect aircraft that are flying below the horizon — and that means not being able to see an intruder at 5,000 ft (1 525 m) altitude about 80 naut mls (148 km) away — it is advantageous to lift a radar aloft, so that the view to the horizon is greatly increased. A radar at 5,000 ft (1 525 m) will see aircraft at ground level 80 naut mls (148 km) away, and at the same altitude over 150 naut mls (278 km) away. This is the sort of performance that the Shackleton could offer.

When an AEW aircraft looks for intruders that ground-based radars cannot detect, it is always looking down, and that creates difficulties because the earth's surface is as effective in echoing radar waves as any low-flying aircraft, or a ship on the surface of the sea. The earliest AEW radars were therefore very mediocre performers; they could see targets against a calm sea, but not against a rough sea, and certainly not over land. The original Gannet radar was not quite so bad, but neither was it much better. Before it was installed in the Shackleton, an airborne moving-target indicator (AMTI) system was developed for the AN/APS-20. This was a receiver modification which could differentiate between moving and stationary objects and cancel the latter from the radar screen. Developing and proving such a system was an important stepping-stone for the British radar industry, which had had no previous AEW radar experience.

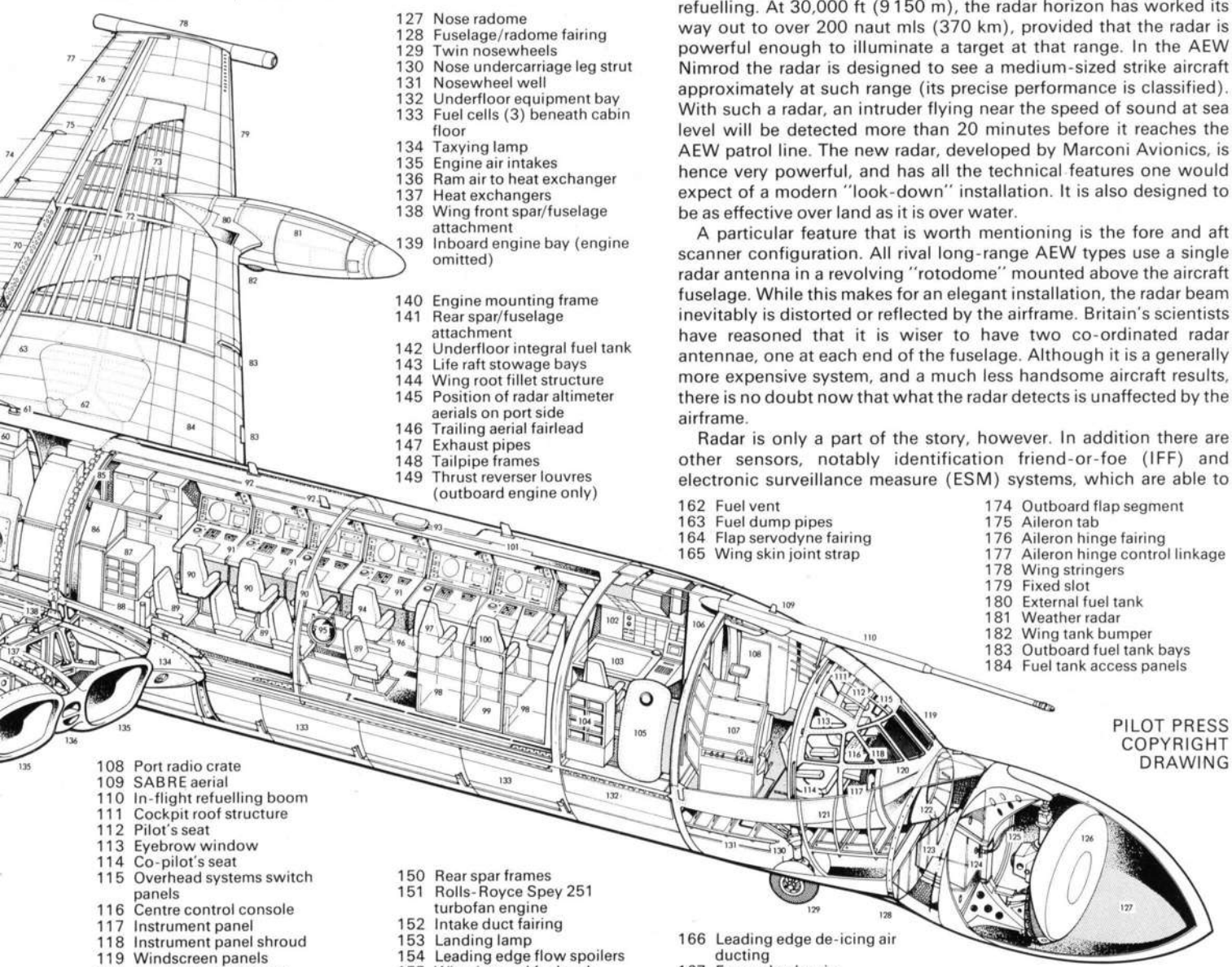
In terms, therefore, of setting a service tradition, and showing how to develop effective AEW systems and tactics, the Shackleton AEW Mk 2 has been an important adjunct to the new Nimrod AEW Mk 3 programme.

The Nimrod emerges

AEW Nimrod, derived from the Nimrod MR Mk 1 maritime reconnaissance aircraft which operate from RAF bases at Kinloss and St Mawgan, is capable of cruising at 30,000 ft (9 150 m) altitude, and of staying aloft for 10 hours or so — even longer with air-to-air refuelling. At 30,000 ft (9 150 m), the radar horizon has worked its way out to over 200 naut mls (370 km), provided that the radar is powerful enough to illuminate a target at that range. In the AEW Nimrod the radar is designed to see a medium-sized strike aircraft approximately at such range (its precise performance is classified). With such a radar, an intruder flying near the speed of sound at sea level will be detected more than 20 minutes before it reaches the AEW patrol line. The new radar, developed by Marconi Avionics, is hence very powerful, and has all the technical features one would expect of a modern "look-down" installation. It is also designed to be as effective over land as it is over water.

A particular feature that is worth mentioning is the fore and aft scanner configuration. All rival long-range AEW types use a single radar antenna in a revolving "rotodome" mounted above the aircraft fuselage. While this makes for an elegant installation, the radar beam inevitably is distorted or reflected by the airframe. Britain's scientists have reasoned that it is wiser to have two co-ordinated radar antennae, one at each end of the fuselage. Although it is a generally more expensive system, and a much less handsome aircraft results, there is no doubt now that what the radar detects is unaffected by the airframe.

Radar is only a part of the story, however. In addition there are other sensors, notably identification friend-or-foe (IFF) and electronic surveillance measure (ESM) systems, which are able to



127 Nose radome
128 Fuselage/radome fairing
129 Twin nosewheels
130 Nose undercarriage leg strut
131 Nosewheel well
132 Underfloor equipment bay
133 Fuel cells (3) beneath cabin floor
134 Taxying lamp
135 Engine air intakes
136 Ram air to heat exchanger
137 Heat exchangers
138 Wing front spar/fuselage attachment
139 Inboard engine bay (engine omitted)
140 Engine mounting frame
141 Rear spar/fuselage attachment
142 Underfloor integral fuel tank
143 Life raft stowage bays
144 Wing root fillet structure
145 Position of radar altimeter aerials on port side
146 Trailing aerial fairlead
147 Exhaust pipes
148 Tailpipe frames
149 Thrust reverser louvres (outboard engine only)
150 Rear spar frames
151 Rolls-Royce Spey 251 turbofan engine
152 Intake duct fairing
153 Landing lamp
154 Leading edge flow spoilers
155 Wing integral fuel tank
156 Front spar
157 Main undercarriage pivot mounting
158 Main undercarriage wheel bay
159 Rear spar
160 Auxiliary spar
161 Flap rib construction
162 Fuel vent
163 Fuel dump pipes
164 Flap servodyne fairing
165 Wing skin joint strap
166 Leading edge de-icing air ducting
167 Four-wheel main undercarriage bogie
168 Wing leading edge
169 Semi-span wing spar
170 Integral fuel tanks
171 Centre spar
172 Airbrake operating jack
173 Starboard airbrake (upper and lower surfaces)
174 Outboard flap segment
175 Aileron tab
176 Aileron hinge fairing
177 Aileron hinge control linkage
178 Wing stringers
179 Fixed slot
180 External fuel tank
181 Weather radar
182 Wing tank bumper
183 Outboard fuel tank bays
184 Fuel tank access panels
185 Starboard aileron
186 Static dischargers
187 Outer wing panel structure
188 Vortex generators
189 EWSM starboard wing tip aerial fairing
190 EWSM aerials
108 Port radio crate
109 SABRE aerial
110 In-flight refuelling boom
111 Cockpit roof structure
112 Pilot's seat
113 Eyebrow window
114 Co-pilot's seat
115 Overhead systems switch panels
116 Centre control console
117 Instrument panel
118 Instrument panel shroud
119 Windscreen panels
120 Self-wipe windscreen wipers/washers
121 Extended nose support frames
122 Front pressure bulkhead
123 Nose radar equipment bay
124 Scanner mounting frame
125 Scanner assembly
126 Forward radar aerial

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determine the electromagnetic features of targets. This is essential to ensure that friendly aircraft are not misidentified, and to safeguard against unfriendly aircraft disguising themselves and entering friendly-controlled airspace unchallenged.

In Western Europe, where any RAF AEW type will spend most of its working life, a radar with an operating range of 200 naut mls (370 km) is liable to detect several hundred movements simultaneously. All of these need to be identified, labelled and tracked. For AEW Nimrod, the operational requirement has demanded that there shall be a system which does all these things; it must also disseminate information, as necessary, to other friendly fighting elements — either ships, aircraft or ground bases. This ensures that within the cabin, for all that it is derived from the 100-seat Comet airliner, there is room for just six radar operators and a navigator. The rest of the aircraft is filled with over 400 individual electronic boxes which handle the radar-data processing and communications tasks.

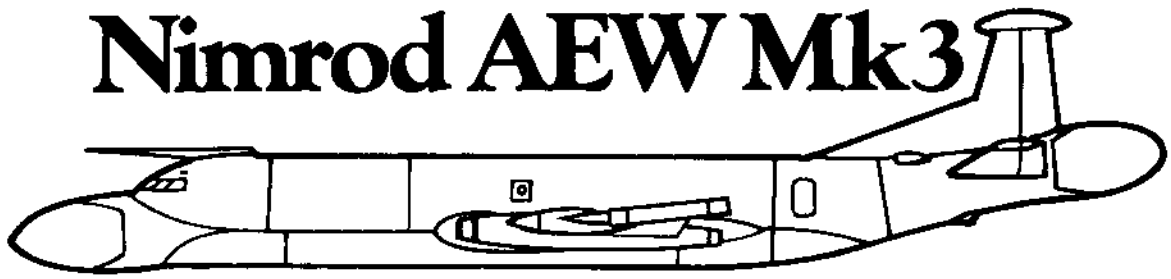
The communication system is compatible with the NATO Joint Tactical Information Distribution System (JTIDS), which will be installed in the NATO-operated Boeing E-3A Sentry fleet. Eighteen of these aircraft will be operated by a multi-national team and based at Geilenkirchen, in West Germany, starting this year. While AEW Nimrods patrol mainly over the West European ocean approaches, the US-built AEW type will be NATO's main overland sentinel, although both types can substitute for the other if necessary. An advantage of the interface commonality is that anyone trying to beat the NATO AEW network has to be prepared to combat two entirely different detection systems, and will not necessarily be sure of which type he will face until the last moment. As both AEW Nimrod and the E-3 Sentry use radars that are relatively difficult to jam, the penalty to an attacker is very considerable.

More than anything else, the complexity of the radar, the galaxy of "computery" and the sheer ingenuity in AEW Nimrod accounts for its large cost. Officially Nimrod AEW Mk 3 is quoted to cost about £60 million per aircraft (at 1983 prices), but it is likely to be even more expensive. The running costs are also substantial, and although an AEW programme can seem vulnerable in terms of total costs, it does do a lot that no equivalent ground-based system could ever do. For the UK, the matter is straightforward: Britain needs airborne early warning, and AEW Nimrod is the instrument that has been designed to provide the required capability.

The most vexed question about the AEW Nimrod programme is that of numbers of aircraft. The RAF had 11 Nimrod MR Mk 1 airframes virtually unused, and so was authorised to convert all of them to the AEW Nimrod configuration. These are currently in process of modification at British Aerospace Woodford, and are to be the complement of aircraft that will be operated by the new-style No 8 Squadron from RAF Waddington, starting later this year. While 11 AEW Nimrods have greatly more capability than just six Shackletons, they represent virtually the minimum number that the RAF can use, given that the aircraft will be required to patrol around the UK coastline and over the North Atlantic out towards Iceland. In many circles it is felt to be not too late, even now, to consider establishing a new production line for the AEW Nimrod — a step that would permit topping up of the RAF's inventory, and make the aircraft more attractive to overseas buyers — who at the moment are faced with the prospect of solely funding the high price of re-opening Nimrod production as an alternative to buying expensively off-the-shelf in the USA.

1984 could have brought a rash of doomsday comments from those who prescribe to the Orwellian view of world affairs, and who feel strongly that the RAF needs more capable aircraft, but they need hardly look at the year so gruesomely now that AEW Nimrod is joining the front-line strength. AEW Nimrod sets new standards in an already established tradition, and for the nation, as well as the service, this new sentinel stands to be an important part of the military fabric well into the 21st Century. □

Nimrod AEW Mk3



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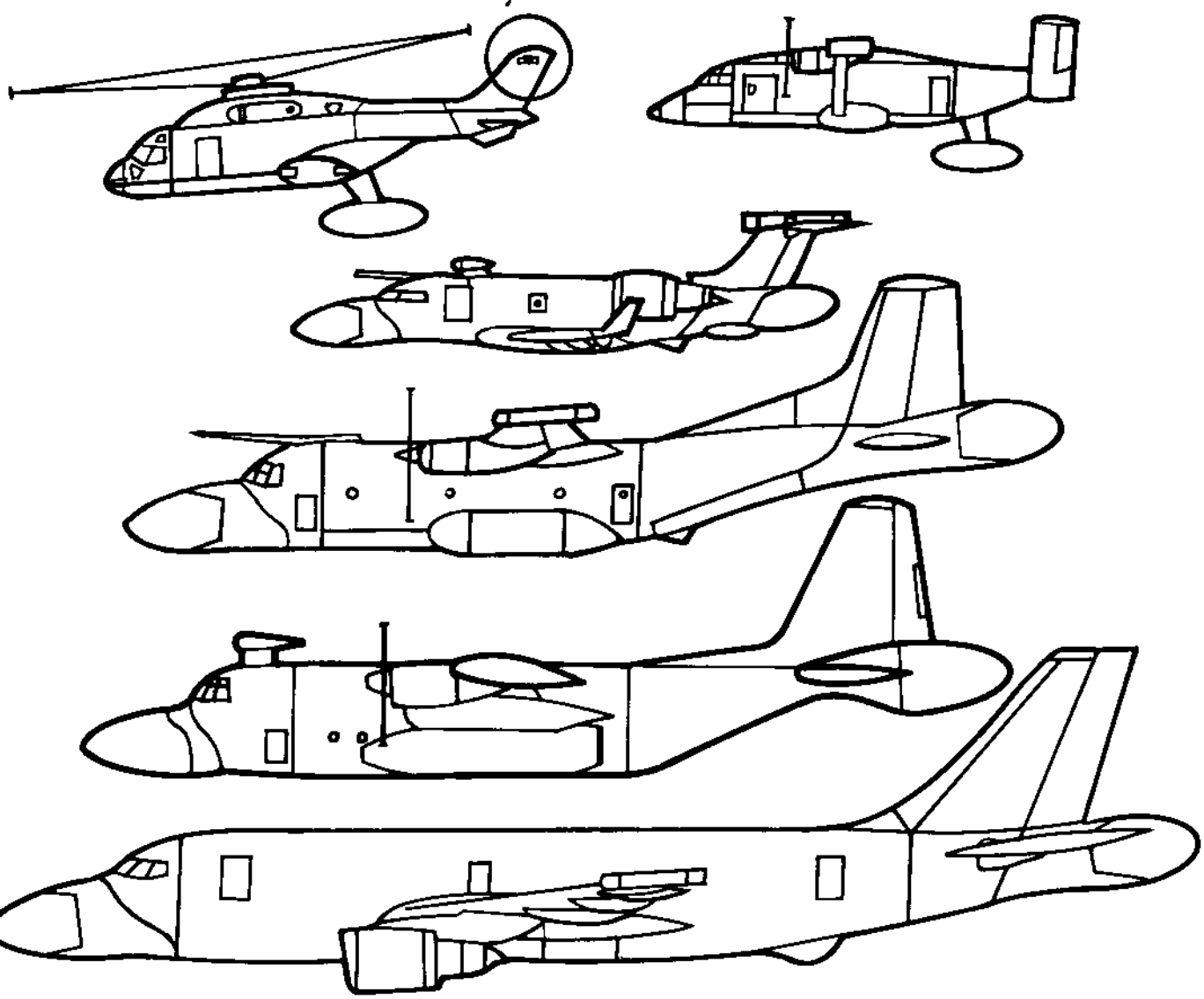

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Telephone: 09276 4757 Telex: 922989.

THE RAF'S YEAR - 1983

January

Falklands Exhibition mounted by RAF at International Boat Show, London.

February

100th Tornado handed over at Warton to RAF.

Figures released showing total number of search-and-rescue missions flown by RAF in previous year to be over 1,100.

March

4: The Chief of the Air Staff, Sir Keith Williamson, flew in Meteor WF791 at Cranwell. The Meteor is the longest serving RAF aircraft of all time — 40 years — and was still employed on target-towing duties until October 1982.

10: Red Arrows depart RAF Kemble for last time before moving, via Cyprus training camp, to RAF Scampton.

21: Orders placed with British Aerospace for four HS 125-700s for use in the communications rôle. Decision taken to drop requirement for Dove/Pembroke replacement and concentrate on Andover/125 fleets for all communications flying in future.

31: Wattisham-based No 23 Squadron disbanded and number-plate transferred to Phantom squadron based at RAF Stanley in the Falklands.

(Above) HRH The Queen Mother opened the Bomber Command Museum, Hendon on 12 April. She is seen here talking with Marshal of the Royal Air Force Sir Arthur "Bomber" Harris at the opening ceremony. (Below) The Chinooks of No 18 Squadron moved back to Gütersloh, RAF Germany on 3 May after working up at Odiham. "Bravo Charlie" is seen carrying three underslung loads of ammunition.

(Above) After displaying before an estimated crowd of 70,000 people at Andrews Air Force Base, USA, the Red Arrows were given the rare privilege of overflying the capital, Washington. Here they are seen flying above the Jefferson Memorial. (Below right) Harrier-equipped No 3 Squadron at RAF Gütersloh received its new Standard in a ceremony on 3 June.

Ten Buccaneers detached on exercise to Key West, Florida, carry out live firings of Martel anti-shipping missiles.

Jaguars from No 41 Squadron operate from Bardufoss, Norway, in the NATO Exercise Cold Winter.

Flt Sgt Pam Newall awarded the "California in England Trophy" by the British Gliding Association for the longest distance flown in Britain by a woman glider pilot — 242 mls (390 km) in a flight from Bicester.

Airbridge to Falklands milestone reached — 50,000 hours on the route to and from the islands.

Buccaneers flown to RAF Stanley on long-range deployment exercise.

April

12: The new Bomber Command Museum at Hendon is opened by HRH The Queen Mother.

RAF Marham celebrates the 25th anniversary of the first Valiant air-to-air refuelling operations.

Master pilot George Lapka, last of the many thousands of Poles who came to Britain in 1940 to join the RAF, retired as an air traffic controller at RAF Cosford.

May

3: Five Chinooks flown to RAF Gütersloh, Germany, and mark the return to RAFG of No 18 Squadron, Chinooks bring with them new mobility for the British Army of the Rhine.

16: 40th anniversary of the Moehne Dam raid marked by No 617 Squadron reunion and reformation as a Tornado squadron at RAF Marham.

Tornadoes from the Tactical Weapons Conversion Unit flown across the Atlantic for low-level exercises in Canada and for participation in major US air shows.

Red Arrows make spectacular North American Tour. Led by Sqn Ldr John Blackwell.

June

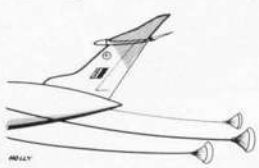
14: First BAe 146 CC Mk 1 handed over at Hatfield prior to its two-year evaluation in the transport rôle, by No 146 Evaluation Flight at RAF Brize Norton.

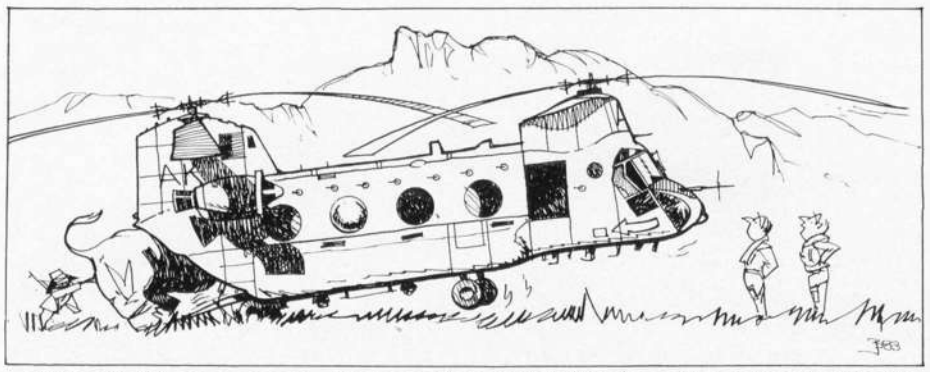
July

5: First Lockheed TriStar trooping flight from Brize Norton. Passengers were troops en route to Edmonton, Canada, as a part of Exercise *Pond Jump West*. Later in the month first Germany-Canada trooping flight by TriStar as part of Exercise *Medicine Man*.

25: First VC10 K Mk 2 tanker handed over to RAF by British Aerospace, and decision announced to reform No 101 Squadron at RAF Brize Norton in 1984 to operate the VC10 tankers.

28: Decision announced of the selection of the British ALARM missile for RAF as the new generation defence suppression weapon. End of long sales battle to supply anti-radar missiles aboard wide range of existing and future front-line aircraft.





"Lifting Gurkhas is no sweat — it's the ruddy pets they bring home that cause a problem!"

(Above) In September, Bristow Helicopters began operating three Sikorsky S-61Ns in the Falklands, under contract to the MoD.

August

29: Maiden flight of Anglo-American advanced Harrier production model AV-8B. RAF version to be known as the Harrier GR Mk 5.

September

1: Tornado Operational Evaluation Unit set up at Boscombe Down with four Tornado GR Mk 1s, under Strike Command direction, to conduct tactical and weapons trials.

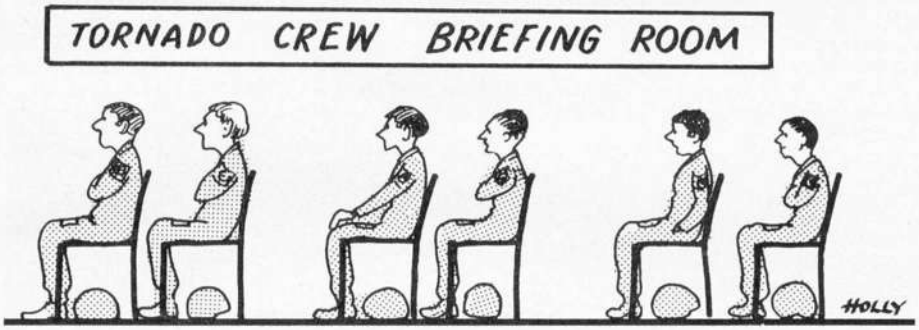
7: Chinooks from RAF Odiham fly to Beirut to support British Army peace-keeping Force. Extra long-range fuel tanks and self-defence equipment fitted and aircraft flown out using RAF Akrotiri as the forward base.

11: Six Buccaneers from Nos 12 and 208 Squadrons fly low over Beirut as a show of strength.

19-21: The Prime Minister visits British Forces in Germany including the RAF at Wildenrath, Bruggen and Gütersloh and briefings at Joint Headquarters, Rheindahlen.

27: First ship arrives in the Falklands with building materials and construction equipment for new airport.

31: First Tornado aircraft arrives in RAF Germany. Operating alongside Buccaneers until sufficient numbers are available to



(Above) Jaguar GR Mk 1s operating in RAF Germany have been progressively modified at Bruggen to permit the carriage of additional wing-mounted stores, with a consequent significant advance in their operational capability. This Jaguar of No 20 Squadron shows three of the new items — laser-guided bombs, PHIMAT chaff dispenser and AN/ALQ-101-10 ECM pod. The Tracor AN/ALE 40 flare dispenser can also now be carried. (Below left) The BAe 146 entered service with the RAF during June.

replace the latter, the Tornadoes carry No XV Squadron colours.

No 27 Squadron at RAF Marham completes re-equipment with Tornado GR Mk 1 to become third UK-based operational Tornado squadron.

Introduction of Marconi Sting Ray "thinking" torpedo; new weapon to be carried by Nimrods.

Three Sikorsky S-61N helicopters enter service in the Falklands, flown by Bristow Helicopters to supplement military fleet, freeing more Chinooks for Army support and heavy lifting tasks in conjunction with new airport construction.

Air Training Corps gliding activities are boosted with the delivery of high-performance sailplanes, comprising 10 Vanguards (Schleicher ASK 21s) and five Valiants (ASW 19Bs) plus two Schempp Hirth Janus Cs.

October

15: Minister of State for the Armed Forces, Mr John Stanley, arrives at RAF Stanley at

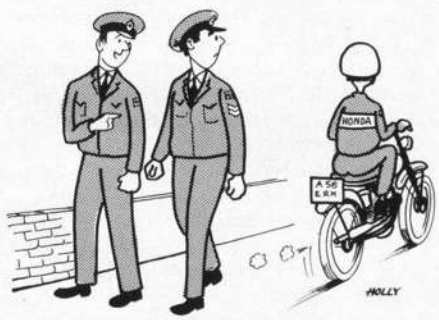
(Above) When this Lockheed TriStar entered service with the RAF, for long-range transport pending conversion to tanker configuration, it was flown for a time by British Airways crews in a mixture of civil and military markings. (Below) The Red Arrows met their USAF counterparts, the F-16 equipped Thunderbirds, during a North American tour in May. (Photo, David Smart.)

the start of a week-long tour of British Forces on the islands.

November

18-19: Nimrod MR Mk 2 made history by flying non-stop from the Falklands to its home base of Kinloss, Scotland, captained by Flt Lt Al Bone. It was refuelled in the air several times *en route*.

29: Air Vice-Marshal Kenneth Hayr, AOC No 11 Group, presented the first ever Fighter Controller brevets (to Flt Lt Hamish Montgomerie and Flt Sgt Roger Steggal from No 8 Squadron) at RAF Lossiemouth.

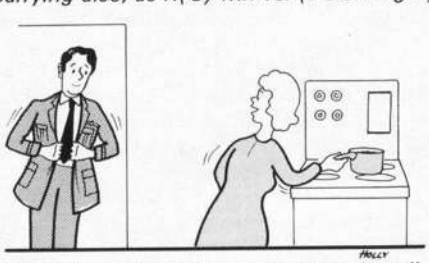


"There he goes again — Laurence of Arabia, on his Brough Superior!"

December

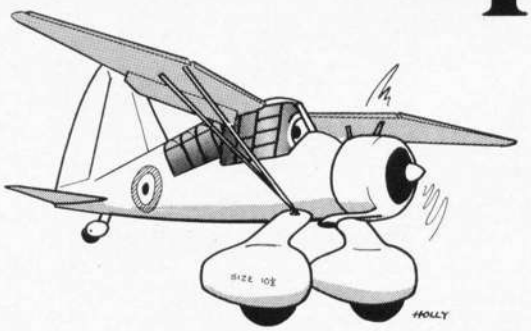
6: Two RAF Policemen, based in Germany, Flt Lt John Foster and Sergeant Jim Bryden, handed over a £28,760 cheque at the Westminster Children's hospital. The money was raised over a year by units in RAF Germany and was sufficient for at least five life-saving bone-marrow transplant operations for children.

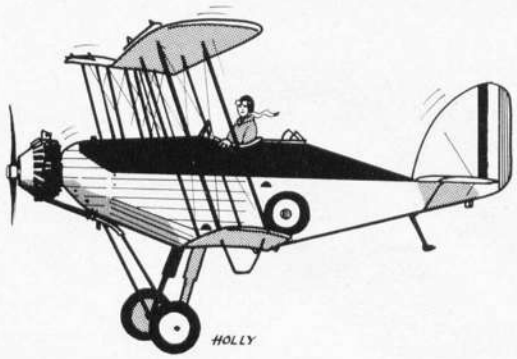
(Above left) TriStar ZD948, here seen demonstrating at the Abingdon Open Day in September, is one of six purchased by the RAF from British Airways. All are to be converted, by Marshall of Cambridge, to K Mk 1 tankers, but two will subsequently be specially equipped for cargo carrying also, as K(C) Mk 1s. (Below right) The first Nimrod MR Mk 2 to demonstrate a non-stop flight from the Falklands to the UK in November, taxying at RAF Stanley.



"Won't be long — just going into re-heat."

Of Wapiti and Lysander...





and such great names as these

By Harald Penrose, OBE, CEng

HOPES were high among the small crowd of keen workmen and staff gathered one bright Sunday morning early in 1927 to watch the first flight of a somewhat hybrid, open-cockpit, two-seat Westland biplane — but it was unimaginable that it would lead to contracts totalling over 700 machines of this basic type and keep the firm profitably employed until the mid-1930s. In fact this 46·5-ft (14,02-m) span biplane had been something of a side-line in the drawing office where the major effort was on a potentially more rewarding, big high-wing bomber, known as the Witch, to a requirement which was eventually cancelled after the prototype flew.

Westland had long been the parent firm for the reconnaissance D.H.9A which, in conjunction with the de Havillands in 1917, had been derived from the D.H.9 and was used by the RAF in greater numbers than any contemporary machine; but its capacity was limited and the water-cooled American Liberty Vee engine out-dated. The Air Ministry therefore issued Specification 12/26 for a replacement, based on long experience of the D.H.9A's policing service in the Middle East. Seven other firms decided to compete, but Westland had the advantage of practical knowledge of improvements needed for limited revision of the de Havilland design, with deeper, more capacious fuselage mounting standard 9A wings and tail, powered by a 420 hp Bristol radial engine, and the rubber cord "bunjy" undercarriage replaced by a stronger one employing oleo legs for better springing. The need to meet desert equipment conditions required quickly detachable cowling, and Zip-fasteners were pioneered for the fabric cover of the fuselage, enabling instant access to the interior — and similar ingenuity was used for stowage of equipment such as spare wheel, tail skid, tool kits, engine covers, pickets, drinking water and rations.

However, the first flight revealed an unexpected problem: the standard rudder proved ineffective, though ample for a 9A. The time-honoured sequence began of adding plywood strips to the trailing edge, and the rudder grew to formidable size before it was judged satisfactory and redesigned conventionally with new outline of fin. These distinctive vertical surfaces became an instant recognition feature of the new machine, which soon was named the Wapiti — a large North American stag.

I had first joined the Westland Aircraft Works, as it was then known, in 1925 on a six-months "sandwich" attachment for practical experience as an aeronautical student of London University, and in the following year was accepted by the firm's inventive

The prototype Westland Wapiti is here seen in the pre-flight shed at Yeovil, after being weighed. The original rudder, based on that of the D.H.9A, proved unacceptable when flight testing began — see page 48.

Captain Hill, MA, as a member of his staff on the design of the tailless, swept-wing Pterodactyl; but I also had the rôle of flight observer to Major Laurence Openshaw, MA, our test pilot, and already had accompanied him in the old Westland Limousine, Woodpigeon, Mk I Widgeon and the new Widgeon III two-seat parasol monoplane, production D.H.9As, the prototype Yeovil bomber, current twin-engined COW-gun Westbury Fighter, and latterly the Wapiti.

Some months after that last flight, I was given unpaid leave to take an *ab initio* pilot's course in the Reserve of Air Force Officers at Filton, where Bristol's famous test pilot, Captain Cyril Uwins, was the CFI. Until meeting him, I had little idea of the co-relation of prototype flying with aerodynamics, although I had, as a student, spent an instructive six months in 1924 as junior assistant in the Handley Page wind tunnel. Most test pilots in those days knew very little of the science of aeroplane design, but were instinctive judges as to whether an aeroplane handled with conventional pleasant response, or was dangerous. Uwins, for the first time, gave prototype testing an accurate basis by describing the simple manoeuvres of yaw, sideslip and pitch, which would establish the degree of control deficiencies and instabilities. Meanwhile mine was the simpler task of learning to fly straight and level and make precise turns.

Sadly, before I departed for Filton, Openshaw had been killed in a mid-air collision during a race. On my return to Westland, three months later, having achieved the dizzy heights of flying a Bristol Fighter, I was made manager of the Civil Aircraft department, but continued as official observer with the new pilot, Flt Lt Louis Paget, a tall and colourful character who flew with airy nonchalance anything presented to him.

"Flies like a piece of newspaper," was a typical report. "Steers like a donkey cart," was another. Presently the design staff began to understand his idiom, and new prototypes were gradually tamed.

To my pleasurable satisfaction, soon after my return to Yeovil he gave me a few minutes dual in one of the production Widgeon III light aeroplanes, then sent me solo. Many another flight followed, giving ample opportunity to try out the Uwins' tenets of flight testing. Soon I was permitted to demonstrate the Widgeon at air displays, and was able to try a number of other light aeroplanes on these occasions, enabling me to recognise their differing flight characteristics. Eventually Paget allowed me to pilot the prototype three-engined W.IV mini-airliner and then a Wapiti, nonchalantly standing behind me because neither had dual controls, and thereafter let me fly solo. Meanwhile, I was his observer during testing of the big Witch bomber and two-seat side-by-side Pterodactyl. Both had their special moment of expectant disaster, although flights chiefly were related to performance work. There was also an interesting phase of wing-tip slot experimentation for the Wapiti, which became the first RAF production aeroplane to have this safety device, of which I had earlier experience with models in the Handley Page wind tunnel.

Probably I was allowed to participate in these many enthralling flight test experiences because in those days of financial stringency and deteriorating world economy, it saved Westland the cost of a special test crew as there was no problem in deserting my paid job of works management for an hour or two! There was also the advantage

that the University years had at least given me an ability to undertake performance calculations and plot such things as rates of climb, or the phugoid curves of what Paget termed "pitch and toss" in exploring longitudinal stability.

Wapiti in South America

Under increasing pressure of Wapiti production testing, a second pilot was presently employed, but I was permitted to do much of the Wessex demonstrating, and now and again put in a few hours on one or other of the experimental Wapitis which were the vehicles for 100 hour development tests of Bristol radial engines, or such novelties as brake systems and cockpit heating. Steadily my flying hours mounted. It seemed an absolute gift of fortune to be given all this free flying! But they were not idle hours. I explored the Wapiti's characteristics under every condition of all-up weight and centre of gravity from screaming dives to stalled flight and even cumbersome aerobatics. Nevertheless, towards the end of 1930 I was astounded to be nominated as demonstration pilot for a Wapiti in both land and marine guise at the *Exposición Británica* in South America, scheduled for the following spring. Though used to yachts, and with brief experience of Wapiti seaplanes as passenger, I had never piloted one, so an hour's flying with a twin-float Avro 504 at Hamble was arranged, with Paget as my instructor. Together we made two take-offs and landings, then he said "Off you go", and I spent the next 40 minutes happily flying solo — but there was no opportunity of trying the special Wapiti as a seaplane because the metal floats would not be ready until the last moment when the aeroplane was crated for sea-freight to Buenos Aires. However, this machine, powered with an Armstrong Siddeley Panther radial, proved entirely satisfactory when tried for the first time as a seaplane on the mud-stained River Plate, and I flew it coastwise both to Uruguay and South Argentine, though as a landplane there had been engine problems necessitating forced landings which revealed the dangers of touch-down in long pampas grass which wound round the axle, bringing us to an abrupt tail-high stop within an ace of turning over.

Four months later, after a three-week sea voyage home, I was enjoying a few days unexpected leave when urgently asked to return to the works because my good friend Louis Paget had spun into the ground while demonstrating a Widgeon to a party of schoolboys, and was severely injured. The other pilot had left while I was in the Argentine.

"We'd like you to carry on with the test flying for the time being," benignly said our greatly respected managing director R A Bruce, MSc, who had pioneered the company and was chief engineer. "The Air Ministry has given approval, and your insurance has been extended to cover the experimental aircraft." These were the Westland P.V.3 torpedo biplane, the low-wing Interception Fighter, similar COW-gun single-seater, and a new three-seat cabin Pterodactyl, none of which I had flown.

My first flight with the latter was startling. After a number of uncontrollable hops during initial acceleration, it leapt into the air in undulating flight, emphasised by neutral stability and sensitive longitudinal control, inadequate tip-rudders, and the way in which yaw induced roll. "If this is test flying, then it's not for me!" I thought — but within 10 minutes had this tricky, tailless aeroplane reasonably weighed up, and months of development flying followed in due course. There were no problems with the others, for the P.V.3 handled much like a Wapiti, and the two fighters proved to be delightful machines but ultimately received no production contracts because the RAF was firmly entrenched against monoplanes.

Chief test pilot

After a few weeks, I was commanded to an audience with Mr Bruce. "Paget has resigned," he said. "You will be our chief test pilot. Your pay of £400 will remain the same, but we will give you a bonus of £2 for every production machine you test, and £1 an hour for all development work on Wapitis. There will be an augmented bonus for the first flight of each new prototype."

I accepted with astonished delight. Only later did I discover that the firm was paid a generous £100 for each obligatory 30 minute test flight for the RAF to cover the cost of fuel and oil, ground crew, and pilot. All that was required was a climb to the modest engine-rated altitude and then a level run at maximum rpm to check engine functioning and ensure satisfactory rigging to give lateral trim. Nevertheless, flying absolutely level with the lightly loaded, mechanically and electronically unaided machines of those days required concentration, and even the test pilots of the official Aircraft and Armament Test Establishment at Martlesham would record varying top speeds for any given aeroplane — largely, I think, because they were unaware of the effect of thermals which they would subconsciously counteract by putting the nose down to sustain a steady indicated height on their altimeter. That had become apparent after flying a Wapiti in still air at the minimum speed at which height could be sustained with throttled engine, then making a beat at the same speed and power along a hillside facing a strong wind and finding that the machine lifted in the up-current. Though this is now an example of the obvious, that was before the days when sailplane techniques became known in England and led me to make speed runs in skies uninfluenced by thermal effects of ground or clouds.

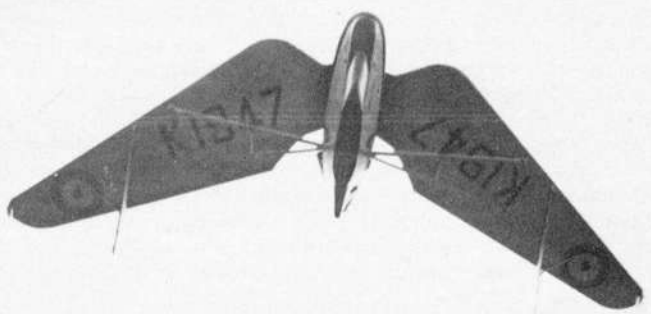
The good old, draughty, oil spattering Wapiti was great fun, and its somewhat heavy controls, coupled with safety at the stall, made it very popular with RAF pilots for patrols over the impossible forced-landing mountain terrains of the Middle East and India — though one of their barrack room ballads expressed justifiable criticism insofar that:

"The Risalpur Wapiti
Goes hoppity, hoppity,
Hoppity, hoppity, hop."

This was because the oleo leg had marginal rebound damping, although adequate for a normal three-pointer. To touch down semi-stalled, tail-high, always resulted in a bounce and a succession of hops which were quite safe because of the open slots, but looked untidy.

Wapiti variants

For those days the Wapiti had a relatively long service life in a series of versions since adoption in 1928 as the RAF's standard "General-purpose" (GP) aircraft. Wapiti Mk I, structured with front fuselage of square-section duralumin tubes and a conventional wooden girder rear portion, had 9A wings and tail of wood except for the metal-framed rudder. Mk IA, for the Royal Australian Air Force, had a geared Jupiter VIII radial instead of the direct drive Jupiter VI of the original version and was given increased stagger to compensate for the weightier engine. Mk IB, for the South African Government, was similar, but had a split-axle undercarriage; later, the South Africans substituted an Armstrong-Siddeley Panther. Mk II complied with the Air Ministry's new requirement of all-metal construction, so the rear fuselage was constructed in similar manner to the front and the wings were of thin-gauge steel with built-up flanged and "crinkly" box spars, U-section steel ribs, and built-up steel and duralumin interplane struts. For the first few years these units were supplied complete, except for fabric cover, from the patentees, the Steel Wing



Unexpectedly nominated to take charge of test-flying Westland prototypes at Yeovil, Harald Penrose found himself responsible for such diverse types as the Pterodactyl IV (above) and the Interceptor to Specification F20/27 (below), which proved too radical to be accepted by the RAF in its day.

Co, Ltd, a subsidiary of Gloster Aircraft Ltd, but eventually were built at Westland. Centre section, ailerons, and tail surfaces were of Westland design in duralumin. Powered like the Mk I with a Jupiter VI, the Wapiti II's maximum speed was 133 mph (214 km/h) at 5,000 ft (1 525 m). The service ceiling of 22,700 ft (6 920 m) was rarely attempted by pilots because it necessitated use of oxygen equipment. Extended operational requirements led to the Mk IIA with more powerful Jupiter VIIIF, resulting in a speed of 142 mph (229 km/h) and range of 500 miles (805 km) which could be extended to 620 miles (998 km) with an auxiliary tank beneath the fuselage. Alternatively, there was provision for bombs up to 580 lb (263 kg). This was the machine so extensively used by the RAF overseas, both as a GP and to lesser extent for Army Co-operation duties. The first Wapitis to serve in India were those of Nos 11 and 39 Squadrons, which arrived in October 1928, and by January 1932 the establishment had increased to eight squadrons. In April 1933, the newly formed Indian Air Force commenced with a Flight of four Wapitis, which increased to full Squadron strength and several detached Flights by September 1939 as their only type of military aircraft.

Mk III became the type reference of the South African machines fitted with Panther engines, and Mk IV was a demonstrator for the Central Chinese Government and featured a 2 ft (61 cm) longer fuselage and Armstrong Siddeley Jaguar VI engine. Orders followed from the Kwangsi Government. That had led to the similarly long fuselaged Mk V which I demonstrated in South America, featuring a Siskin-type strengthened undercarriage which had the oleo legs at the front and pioneered wheel brakes and tailwheel. Mk VI was a trainer version of the standard machine, but powered with a 550 hp Jupiter IXF engine, and 16 were built. Meanwhile, the Mk V had led to Mk VII, initially designated P.V.6 and later named Wallace, derived from a proposal I made as the result of South American experience in order to make the machine look slicker with rounded fuselage, spatted split-axle undercarriage, and latest Bristol engine featuring a Townend ring — although originally I drew it with a pointed nose and Rolls-Royce engine. In April 1933, this prototype and the obsolete P.V.3 were the first to fly over Everest. By then the Wallace had replaced the standard Wapiti as Westland's main production which lasted until the advent of the Hawker Hector in 1937. However, it was briefly preceded by a 550 hp Panther Mk VIII Wapiti which had a divided undercarriage.

Memorable moments

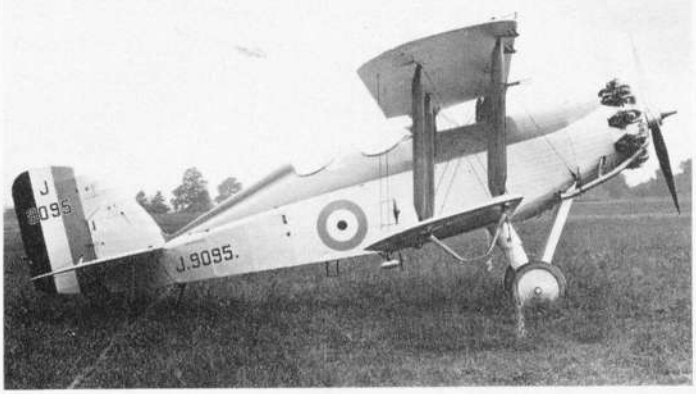
Even testing the Wapiti had its moments. On one early occasion the propeller burst, with resulting collapse of the engine mounting which left the Jupiter dangling. As a result, there was considerable research on propellers, including metal prototypes. The latter were considerably heavier and required tail ballast to trim the machine, and that provoked near-disaster with one of them, because spinning tests were called for. Nobody realised that the new weight distribution altered the longitudinal inertia. Wapitis had often been spun for the customary six turns. With an experimental machine one first tries recovery after fewer turns — but when on the next spin with this particular Wapiti I applied full rudder recovery at the sixth, she just went on and on. At the 11th turn I unbuckled the seat belt and held on to the cockpit combing. If the spin continued for two more whirls, I would try to get out and parachute — there were no ejector seats until many a year later. At the 14th turn I managed to stand, clutching the hand grips in the centre section — but before I could hurl myself overboard the wings went level at the beginning of the 15th turn, and with only 1,000 ft (305 m) left for recovery, I slipped back into the cockpit and flattened out — saved by the change of airflow when I stood up in the cockpit.

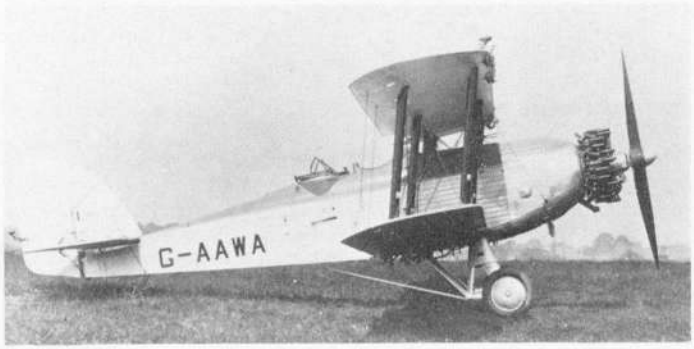
Altered airflow over the nose of a new version of the tri-motor Wessex with raised flight-deck and roof resulted in a first flight with a rudder so heavy that I could not move it, and was only able to turn by differential use of the engines. Other aircraft also had their problems. The next Pterodactyl, a powerful two-seater fighter, discouragingly shed its port top wing when initially taxied. The 60-ft (18,3-m) span, high-wing P.V.7 bomber went one better by losing its port wing in a dive, and I was lucky to escape by parachute. Subsequently our attractive F.7/30 biplane fighter twice caught fire in the air. Even Autogiro flying provided perils because in an increasing dive the longitudinal control rapidly diminished due to rotor blade flexure, subsequently tragically confirmed when an RAF C.30 at Felixstowe failed to recover and plunged into the sea.

Enter Lysander

After the Wapiti and its Wallace derivative, the next Westland machine to go into production was the Lysander, built to Specification A39/34 for Army Co-operation work, and later

Flight testing of the Wapiti by the author led to the adoption of an enlarged fin and rudder, shown (above right) on a production Wapiti IIA of No 601 Squadron. One of the interim phases of development is shown (below right) on the prototype J8495. The Wapiti J9095 (below left) with Jupiter VI engine, was specially adapted (under the author's direction) for use by HRH the Prince of Wales (later King Edward VIII).





While the RAF standardised on the Wapiti IIA, numerous other variants were developed by Westland for export or special rôles. Above left is the long-fuselage Panther-engined demonstrator for South America while, above right, is the Jaguar-engined Mk IV with split axle undercarriage for China. The four-bladed metal Leitner-Watts propeller on Wapiti J9728 gave the author problems because of its inertia.

universally known as "the Lizzie". In the intervening years, high altitude investigation, oxygen equipment, cabin enclosures, engine cooling, fuel economy, starting systems, propellers, brakes, gun turrets, and many other facets had been the subject of increasing test flying coupled with allied development of their particular hardware and techniques. Basic acceptance requirements for every new type of aircraft had been expanded into a section of the official design handbook AP 970, specifying tests in detail for aeroplane behaviour and reliability of ancillary systems, all of which must be satisfactorily completed before submission of a prototype to the Ministry's acceptance testing establishment. That usually meant many months of development flying.

There were also major changes at Westland. Bruce retired in 1935, and the chairman's 26-year-old son W E W "Teddy" Petter, BA, amid much disquiet, had been made technical director, although most of the design staff and many at the Air Ministry felt he was too inexperienced. Nevertheless his Lysander design was a triumph. Paramount was the requirement that the pilot should have maximum view in every direction: accordingly, a high-wing monoplane, with pilot in front of the leading edge, had been devised after extensive discussion between the Westland team and Army Co-operation pilots based at Old Sarum. Key to the requisite slow landing speed were automatically operated full-span slots with slotted landing flap linked to the inner pair. In order to get the longitudinal balance right in relation to the pilot's lateral view, the inboard leading edge was tapered inward like the original Widgeon, resulting in a characteristic plan form of lozenge shape that was instantly recognisable. Though the front fuselage followed Wapiti design the rear was welded framework. Everywhere ingenious use was made of extrusions and alloy forgings. Particularly remarkable was the massive inverted U-shaped hollow extrusion that formed the cantilever undercarriage to which the Vee lift struts were attached at the top, and internally sprung Dowty wheels avoided the complication of oleo legs. The undercarriage also mounted a fixed Browning gun each side, served as the attachment for stub wings carrying 12 small bombs, and had landing lights in the big wheel fairing. Pilot and crew enclosures were derived from the ill-fated P.V.7. The rear cockpit could be armed with either single or — later — twin guns, and had the usual provision for radio, camera, parachute flares and oxygen; a retractable message hook was carried under the fuselage. Power plant was a fully cowled, 890 hp Bristol Mercury XII radial.

Even though temporarily fitted with a fixed pitch wooden propeller, the Lysander revealed, on its first flight, a very short take-off. But there was a problem with landing because the tailplane was not adjustable and more than half the elevator angle was required to hold the machine at the right speed on the approach, leaving no power for flattening out — although a three-pointer landing was made by using the engine to enhance the airstream. A wide strip was therefore added to the elevator trailing edge to increase the chord, but this made little difference and on the next flight I found that at higher speeds the machine was longitudinally unstable, making a slowly diverging oscillation when the controls were left free; and in a dive it pitched steeper and steeper. Though increasing the tailplane span presently resulted in acceptable stability, the landing difficulty remained, and ultimately a major modification was required to make the tailplane incidence adjustable through a big angle. That introduced another danger. If a landing was aborted with the tail at maximum negative incidence, the Lysander reared steeply up, despite holding the stick fully forward with all one's strength, and this was only ameliorated by using half power while struggling with the many turns of the trimming wheel to set the tail neutral. I therefore turned the machine down, but the management in hot argument declared this would imperil production by another six months, and that a warning notice in the cockpit should suffice. Strings were pulled, and to my incredulous surprise the proposal was accepted by the Air Ministry and Martlesham pilots. Inevitably, in the years to come, fatal accidents resulted.

The Lysander also could develop a rocking-horse characteristic which worried new pilots. As the machine slowed for the landing approach, the tip slots would gently begin to open at 90 mph (145 km/h), but the inner slats delayed until about 80 mph (129 km/h) because of the force required to pull down the interconnected flap —

Photographs of the prototype Westland Lysander, for the flight development of which Penrose was responsible. In its first form, above, the tailplane was not adjustable, leading to some handling problems on the approach; after a period of intensive investigation, the tailplane was made variable through a large angle, as shown below.

(Above) A pre-war photograph of a Lysander, in its Mk II version with Perseus engine, serving with No 13 Squadron after the adoption, at the time of the Munich Crisis, of squadron code letters. (Below) One of the several Lysander variants was this long-range variation of the Mk III, used to ferry agents beyond enemy lines.

whereupon the nose dropped, thus increasing the speed and closing the slat, causing the trim to change, and up would go the nose, the speed reduced and the process repeated. A pilot approaching at this critical speed could therefore find himself in trouble because of what seemed the uncontrollable oscillations of the machine. Nevertheless, nothing could feel safer than making an approach at a speed below that at which the inner slats had substantially opened. In fact it was possible to set the engine at predetermined speed, giving a rate of descent of some 6 ft/sec (1,83 m/sec), and stall down parachute fashion until the tailwheel touched the ground, and then cut the engine. This certainly was useful in World War II when the Lysanders on SOE missions landed by night in small, unlit fields of occupied France. Nearly 1,000 passengers were carried during such operations in Europe and the Far East.

Lysander versions

Like the Wapiti, the Lysander was built in several variants. The Mk I series was powered with the 890 hp Bristol Mercury XII, but although the prototype had top speed of 240 mph (386 km/h) the effect of "productionising" was to increase drag because of panel air leaks and jigging discrepancies, so maximum speed dropped to 229 mph (369 km/h). Even the Mk II, powered by a 905 hp Perseus XII was a mere one mph faster, and the Mk III and IIIA, with 870 hp Mercury 30, achieved only 212 mph (341 km/h) but were also 400 lb (181 kg) heavier than the Mk I. In all, 1,449 Lysanders were built in Britain, of which a number were converted for target and glider towing, or adapted for Air/Sea Rescue, carrying two Lindholme dinghy sets and smoke floats.

Testing the production Lysanders followed much the same programme as the Wapitis, except that there was no problem with re-rigging as lateral trim was readily adjusted with aileron tabs, but setting the slat opening speeds by altering the venting between trailing edge and wing took considerably longer than the cruder spring-loaded "plaster" slats of the Wapitis.

There were, of course, a number of development and experimental Lysanders, of which the first of the black painted spy droppers was so secret that even the technical department was unaware of its purpose and had merely been told to modify the fuel installation by adding a long, cylindrical Handley-Page drop-tank beneath the fuselage and to mount a fixed ladder to the rear cockpit. Only when I called in at Newmarket Race Course for a liaison visit to No 138 Squadron did I discover its clandestine intention for use by the Special Operations Executive (SOE). Presently this Squadron and No 161 were based at heavily guarded Tempsford, Bedfordshire, where Gp Capt (later Air Vice-Marshal Sir Edward) Fielden was Station Commander.

Among experimental aircraft there was a fascinating Lysander with castoring mainwheels, which enabled landings to be made in a strong side-wind, the machine running crab-wise but directionally straight; but though that would enable singly orientated runways or roads to be used, the scheme was considered too complex for aircraft with retractable undercarriages — yet it could still be valuable in eliminating the need for multi-directional airports. Earlier, we had experimented with a special Dowty caterpillar track-belt under-carriage for use on muddy fields or soft sand; this Lysander was taxied at speeds up to 70 mph (113 km/h) but the Air Ministry abandoned the project before flight tests could be made.

There were also Lysanders with a variety of armament. Thus, in expectation of extensive German landings on the South Coast, a successful trial installation was made of a drum-fed 20-mm gun attached at the bottom of each undercarriage leg so that invasion barges and troops could be raked from low level. Another Lysander was revised during 1940 to afford a ventral gun position, and because of its profile was affectionately referred to as the "Pregnant Perch", but crashed in avoiding high tension cables during a forced landing after engine failure, and further work abandoned. An experimental installation of a Boulton & Paul four-gun turret was made on one Lysander, but by then its new rôles rendered heavy defence unnecessary, although a further variation with a package of Browning guns was intended as a potential night fighter, and another was fitted with very effective dive-brakes under each outboard wing, which in practice proved unnecessary.

Of considerable interest were two Lysanders for aerodynamic research. The first was modified by Blackburn Aircraft Ltd to take a Stieger monospar-structured, high lift, 38-ft (11,6-m) wing, which had full-span flaps and slots, with spoilers at each wingtip instead of ailerons for lateral control. However, it was less pleasant to fly than a Lysander with standard wing, nor did it land quite as slowly, so I seemed to detect a gleam of satisfaction in the eyes of our own designers!

The other was a unique conversion of our faithful hack Lysander, the prototype K6127, to a tandem wing arrangement by truncating the fuselage and fitting a close-coupled, tapered rear wing which had tip fins and rudders. Wind tunnel tests had shown that this arrangement could be flown with the centre of gravity much farther aft, enabling a heavy four-gun turret to be mounted in the tail. Odd though the machine looked, it handled parfectly except for slight diminution in rudder power, and in my experience was the only prototype ever built that required no modification. However it was too late for aggressive use in the war. In any case, we were by then intent on Whirlwinds, Spitfires and Seafires, and on developing the first pressure-cabin high altitude fighter. Nevertheless, compared to these, it was the pleasure of flying the Wapitis and Lysanders in the peaceful skies between the wars that lingers in memory. □

Two extreme modifications of the Lysander with the testing of which the author was concerned — (above) with the Stieger monospar wing fitted by Blackburn Aircraft, and (below) with Delanne tandem wing layout and a tail turret.

Birth of the Jet Fighter

BILL GUNSTON MARKS A 40TH ANNIVERSARY OF SOME SIGNIFICANCE

IT IS NOW 40 years since Allied aircrew began to encounter the Messerschmitt Me 262 over Germany. In almost every respect, this was the most advanced and most formidable fighter to appear during World War II. Yet it was by no means the only wartime jet. Britain and the USA had flown prototype jet fighters in the mid-war years, and the Gloster Meteor entered RAF service at about the same time that the Me 262 reached the *Luftwaffe*. There was also the radical tailless rocket interceptor, the Me 163, but this was a totally different concept and its story is not dealt with here.

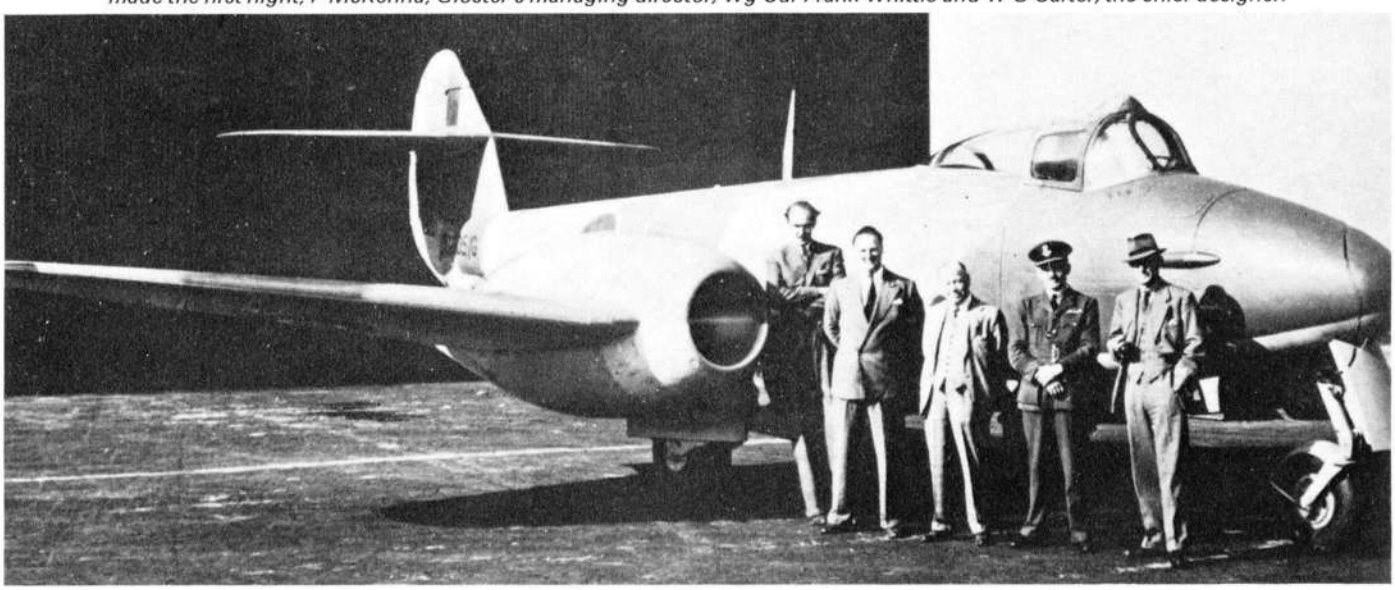
There is a common belief that Germany was the true pioneer of jet propulsion. For example, in a recent book on *The German Jets in Combat* the authors state unequivocally "... it was not until the latter part of the 1930s that serious work began, initially in Germany, to develop gas turbines . . . to power aircraft". In fact, the towering genius of Frank Whittle antedated any work on the subject in Germany, and even after almost a decade of near-total frustration he still managed to run his first turbojet on 12 April 1937. Von Ohain in Germany ran his first test model in September 1937, and then it was not an aero engine, but a demonstration rig burning hydrogen.

Where the Germans beat the British hollow was in recognising the importance of the turbojet early and in launching major jet aircraft programmes. In Britain, there was nobody in a position of authority able to foresee the importance of the jet engine, or to instruct firms in the airframe industry even to think about it. In Germany, however, Prof Ernst Heinkel and his bitter enemy Prof Willy Messerschmitt were engaged in the design of jet fighters by 1938. In Britain, the chief fighter designers not only had no jet programmes during the war at all, but had to be dragged into the jet era with reluctance in mid-1944 when many jet fighters were already flying. It is instructive to examine the situations and policies at Hawker, Supermarine, Bristol and Fairey in 1938-44 to see why absolutely nothing was done to parallel the German work.

The Gloster company only got into the act because it was part of the Hawker Siddeley Group, with a factory full of Hurricanes and Typhoons designed at Kingston, and an excellent design staff under W G Carter almost unemployed from early 1939. As for engines, Whittle had grown tired of trying to excite a glimmer of interest from any of the main British manufacturers, whom he had canvassed from early 1934 onwards. He finally managed to get a little financial backing from investment bankers O T Falk & Partners, and, in March 1936, he had formed a company called Power Jets to employ a small staff and turn his idea into reality. But he still could have done little had not the BTH company had such faith in his scheme that it provided draughtsmen, laboratories and skilled engineers, all for next to nothing, and then actually built his first engine, the U, or W.1U.

Whittle had nobody to turn to. His centrifugal compressor's airflow, his combustion chamber's heat release and his turbine's operating conditions were far beyond anything previously attempted anywhere. Moreover, the very idea of a gas turbine propelling an aircraft by its own jet was his own invention. The government's own gas turbine experts, Griffith and Constant, had, since the 1920s, toiled at Farnborough with axial-flow compressor engines intended to drive propellers. The axial promised eventually to be more efficient than the centrifugal, but it was heavy, expensive and desperately difficult to perfect. Sadly, both scorned the simple centrifugal compressor, and were instrumental in cooling any interest which

(Heading photo) The first jet fighter to reach operational status in substantial numbers was the Messerschmitt Me 262, although its deployment was principally as a fighter-bomber. Illustrated are Me 262A-1a fighters of the Kommando Nowotny being prepared for a mission. (Below) The first flight of a Gloster F.9/40 (prototype of the Meteor) took place on 5 March 1943. This prototype, DG205/G, flew with Rover W2B engines on 12 June 1943 and is here seen with, left to right, Gloster test pilot John Crosby Warren, Michael Gaunt, who made the first flight, F McKenna, Gloster's managing director; Wg Cdr Frank Whittle and W G Carter, the chief designer.



The first Me 262 to fly on jet power alone was the Me 262 V3, seen (above) on its first take-off on 18 July 1942 and (below) landing back at Leipheim, with unburned fuel igniting in the hot jet pipes and spilling onto the runway.

might have been shown in Whittle by the Air Ministry.

Nevertheless, when the young RAF officer actually managed to run an engine, the Department of Scientific Research under H T Tizard decided to inject a little money. The original engine was several times rebuilt until it was described as "a running heap of scrap", but it provided the vital basis for the next engine, the W.1. In August 1939, the Air Ministry at last changed its view about Whittle's work from somewhat "ivory tower" long-term research to being the basis of a near-term practical engine. It placed an order for the W.1 as a flight engine, and a month later, just after the outbreak of war, contracted with Gloster for an aircraft in which to fly it, covered by Specification E.28/39.

The W.1X experimental engine ran at the end of 1940, and in October 1941 was to be sent to the US General Electric Company to get American jet programmes started. The W.1 flight engine, rated at 860 lb (390 kg) thrust, ran in April 1941, and a few days later actually left the ground in a test hop of the E.28/39 at Brockworth. Its official first flight came on 15 May 1941 at Cranwell. Subsequently the two little Gloster aircraft did a vast amount of useful work, despite their rudimentary design which, among other things, deprived the pilot of pressurisation or even any kind of heating.

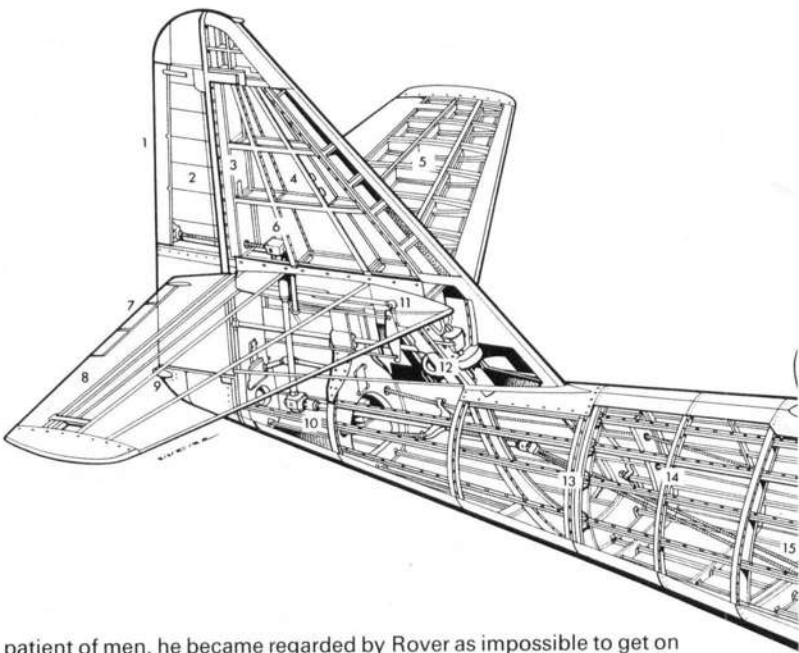
In late 1939, Whittle had begun the design of a more ambitious turbojet of roughly twice the thrust, the W.2, and early in 1940, the Air Ministry (later the Ministry of Aircraft Production, MAP) came round to the welcome view that it might be possible to develop a jet fighter for use in the war. Accordingly, many things happened almost at once. Power Jets was given a contract for the W.2, but was informed it would become a pure R&D organisation, feeding new jet designs to other companies who would build the engines in quantity. Direct contracts were to be placed with BTH, Rover and Vauxhall for W.2 production; and Gloster was awarded a contract for the design of a twin-engined interceptor, around which Specification F.9/40 was later written.

Birth of the Meteor

In fact, Carter had already begun such a project, later to be identified by the Gloster design office designation G.41. At first it was called the Rampage, then Thunderbolt, and in 1942 (because of the subsequent emergence of the Republic P-47) the name was changed to Meteor. Its features included two engines centred on the very broad low-mounted wings, well outboard of the fuselage, with the main units of the tricycle landing gear folding away between the tubby nacelles and the wing roots; a very slim fuselage with a pressurised cockpit in the nose flanked by six 20-mm Hispano cannon, and an unusual tail with the horizontal surface mounted high above any disturbance from the jets. All flight controls were manual, although — unlike that of the E.28/39 — the engines were to drive a full range of pumps and generators. Perhaps wisely, Carter's aerodynamicists hardly concerned themselves at all with the fact that the turbojet made possible a new realm of virtually unlimited airspeed, and not only was the Meteor a wholly conventional aircraft, apart from its engines, but the term "Mach number" is not mentioned in any of the design documents.

Design of the Meteor went ahead normally, and as MAP had placed an order in October 1940 for production of 80 Meteors and 160 W.2 engines a month, the way seemed set for an impressive programme. Had it gone to plan, the Meteor would have been, by more than a year, the first jet fighter in service in the world. But, on the engine side, the picture went from bad to worse. We have to cut a very long and involved story short, but the germ of the trouble lay in the fact that the production firms were not supposed to alter the Power Jets drawings, except by agreement to facilitate easy manufacture, while the W.2 turned out to have fundamental problems which, among other things, made the compressor surge and limited thrust to a mere 1,000 lb (454 kg). Vauxhall and BTH pulled out, and Rover toiled away at Bankfield Shed, Barnoldswick, on the north Yorkshire border with Lancashire, trying to produce an engine whose production drawings never appeared.

Eventually, Rover began tinkering with the design, and this made Whittle progressively more incensed. Though actually the most

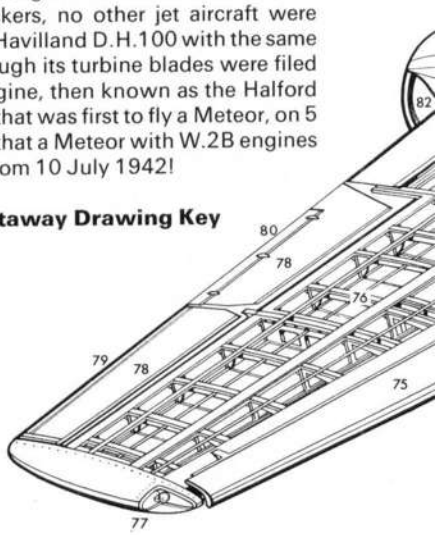


patient of men, he became regarded by Rover as impossible to get on with, and relations deteriorated steadily through 1940, 1941 and 1942, until, by November 1942, practically nothing was being done and Rover's boss, S B Wilkes, was hardly on speaking terms with Whittle, who had never been invited to Barnoldswick. As jets were highly secret, nothing got into the papers, but with the benefit of hindsight it is outrageous that three vital years should have been almost wasted in what could have been the first jet programme in the world.

Equally amazingly, while other jet engines had been ordered from de Havilland and Metropolitan-Vickers, no other jet aircraft were ordered except prototypes of the de Havilland D.H.100 with the same company's engine. In fact, even though its turbine blades were filed by hand, it was the de Havilland engine, then known as the Halford H.1 and later to become the Goblin, that was first to fly a Meteor, on 5 March 1943. This is despite the fact that a Meteor with W.2B engines had gone through its taxying trials from 10 July 1942!

Messerschmitt Me 262A-1a Cutaway Drawing Key

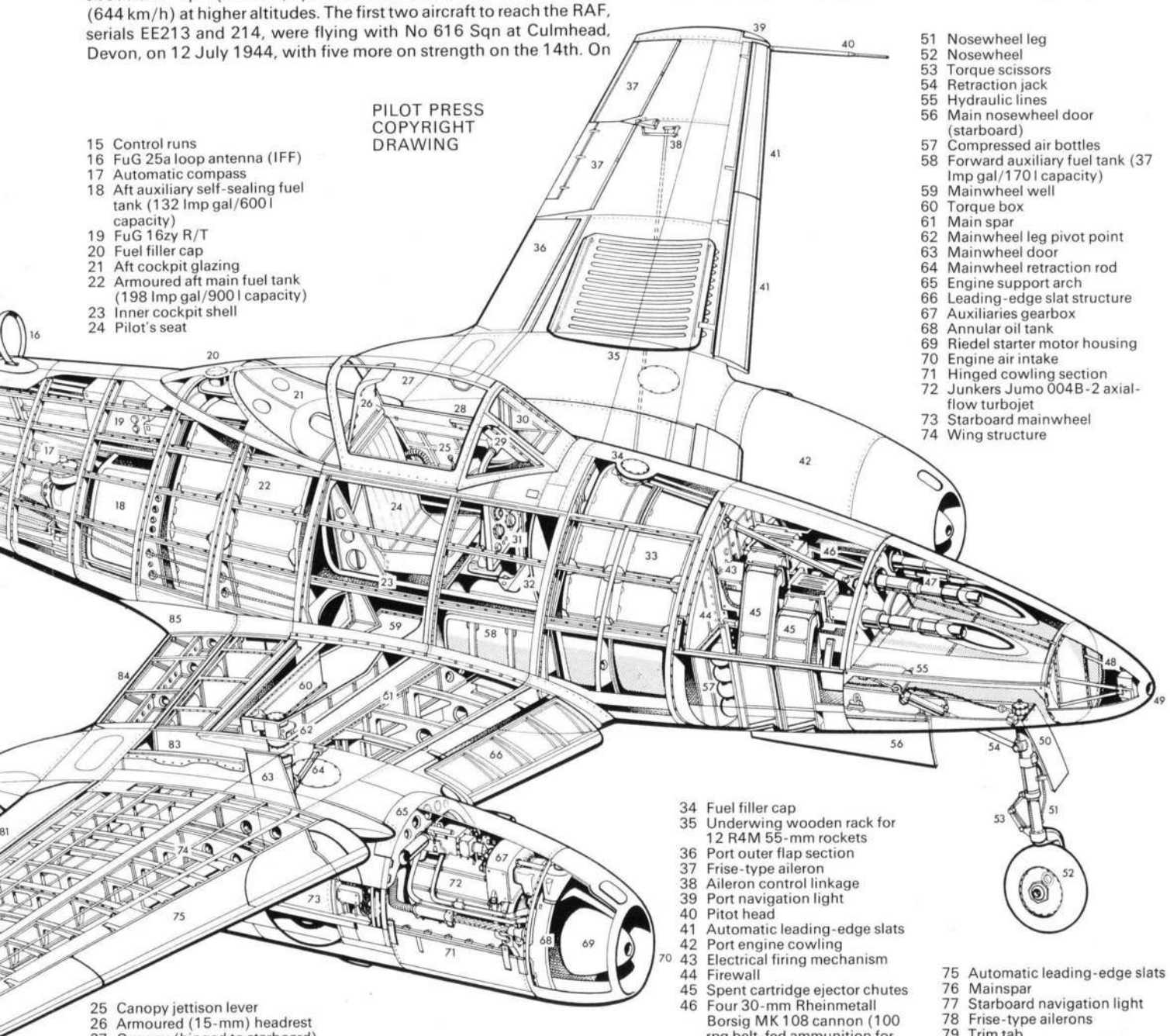
1 Flettner-type geared trim tab
2 Mass-balanced rudder
3 Rudder post
4 Tail fin structure
5 Tailplane structure
6 Rudder tab mechanism
7 Flettner-type servo tab
8 Starboard elevator
9 Rear navigation light
10 Rudder linkage
11 Elevator linkage
12 Tailplane adjustment mechanism
13 Fuselage break point
14 Fuselage construction



What finally broke the log-jam was the personal intervention of E W (later Lord) Hives, of Rolls-Royce. He had been kept up to date on the jet scene by S G (later Sir Stanley) Hooker, one of his brilliant team. In November 1942, Hives told Hooker "We are going to dine with Wilkes at the *Swan and Royal* in Clitheroe; be ready at four o'clock". The meeting that evening, costing five shillings a head (the wartime limit), was one of the most important in history. Hives simply said to Wilkes "Give us this jet job, and you can have the tank-engine factory at Nottingham". On the very next day, Hives and Hooker were at Barnoldswick, which was henceforth to be used for development only, and the whole situation changed. Hooker bulldozed through rapid development of the W.2B/23, which became the Rolls-Royce Welland, and two of these engines at last flew a Meteor on 12 June 1943. Pilot-production Wellands reached Gloster in May 1944, and the main run followed from a small new factory built at Newcastle-under-Lyme.

Rated at 1,600 lb (726 kg), the Welland I was a reliable and tractable engine, although the Meteor I was no great performer. Because of its size, rather than its modest weight, it reached only about 390 mph (628 km/h) at sea level and a little over 400 mph (644 km/h) at higher altitudes. The first two aircraft to reach the RAF, serials EE213 and 214, were flying with No 616 Sqn at Culmhead, Devon, on 12 July 1944, with five more on strength on the 14th. On

A Messerschmitt Me 262A-1a, probably in service with the Kommando Nowotny, receives attention from its ground crew. Serviceability was a major problem for all the early jet fighters.



15 Control runs
16 FuG 25a loop antenna (IFF)
17 Automatic compass
18 Aft auxiliary self-sealing fuel tank (132 Imp gal/600 l capacity)
19 FuG 16zy R/T
20 Fuel filler cap
21 Aft cockpit glazing
22 Armoured aft main fuel tank (198 Imp gal/900 l capacity)
23 Inner cockpit shell
24 Pilot's seat

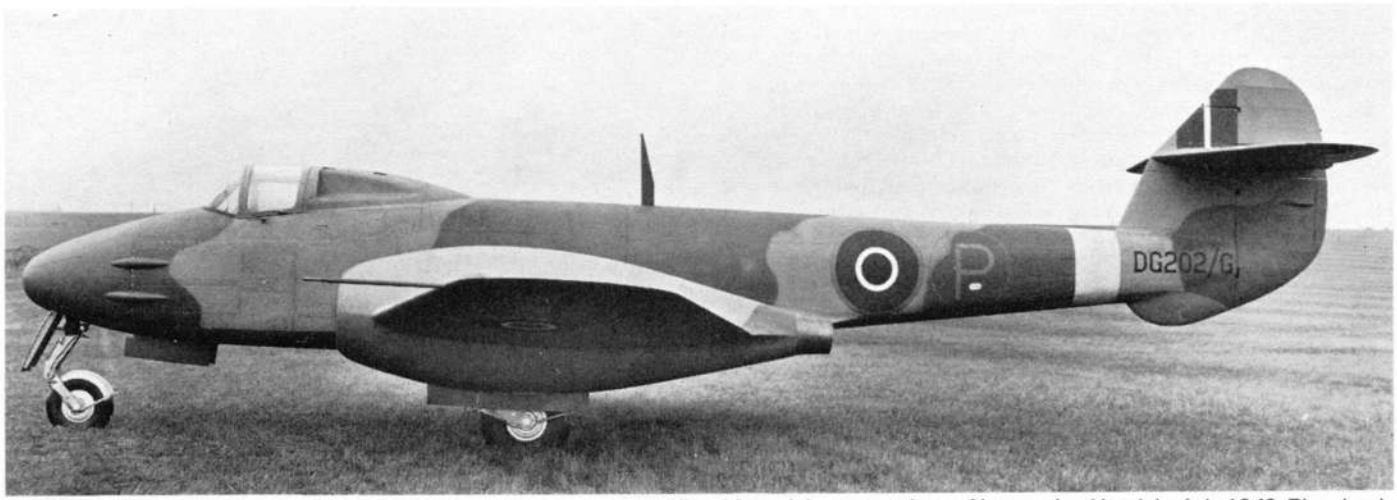
25 Canopy jettison lever
26 Armoured (15-mm) headrest
27 Canopy (hinged to starboard)
28 Canopy lock
29 Bar-mounted Revi 16B sight (for both cannon and R4M missiles)
30 Armourglass windscreen (90-mm)

31 Instrument panel
32 Rudder pedal
33 Armoured forward main fuel tank (198 Imp gal/900 l capacity)

34 Fuel filler cap
35 Underwing wooden rack for 12 R4M 55-mm rockets
36 Port outer flap section
37 Frise-type aileron
38 Aileron control linkage
39 Port navigation light
40 Pitot head
41 Automatic leading-edge slats
42 Port engine cowling
43 Electrical firing mechanism
44 Firewall
45 Spent cartridge ejector chutes
46 Four 30-mm Rheinmetall Borsig MK 108 cannon (100 rpg belt-fed ammunition for upper pair and 80 rpg for lower pair)
47 Cannon muzzles
48 Combat camera
49 Camera aperture
50 Nosewheel fairing

51 Nosewheel leg
52 Nosewheel
53 Torque scissors
54 Retraction jack
55 Hydraulic lines
56 Main nosewheel door (starboard)
57 Compressed air bottles
58 Forward auxiliary fuel tank (37 Imp gal/170 l capacity)
59 Mainwheel well
60 Torque box
61 Main spar
62 Mainwheel leg pivot point
63 Mainwheel door
64 Mainwheel retraction rod
65 Engine support arch
66 Leading-edge slat structure
67 Auxiliaries gearbox
68 Annular oil tank
69 Riedel starter motor housing
70 Engine air intake
71 Hinged cowling section
72 Junkers Jumo 004B-2 axial-flow turbojet
73 Starboard mainwheel
74 Wing structure

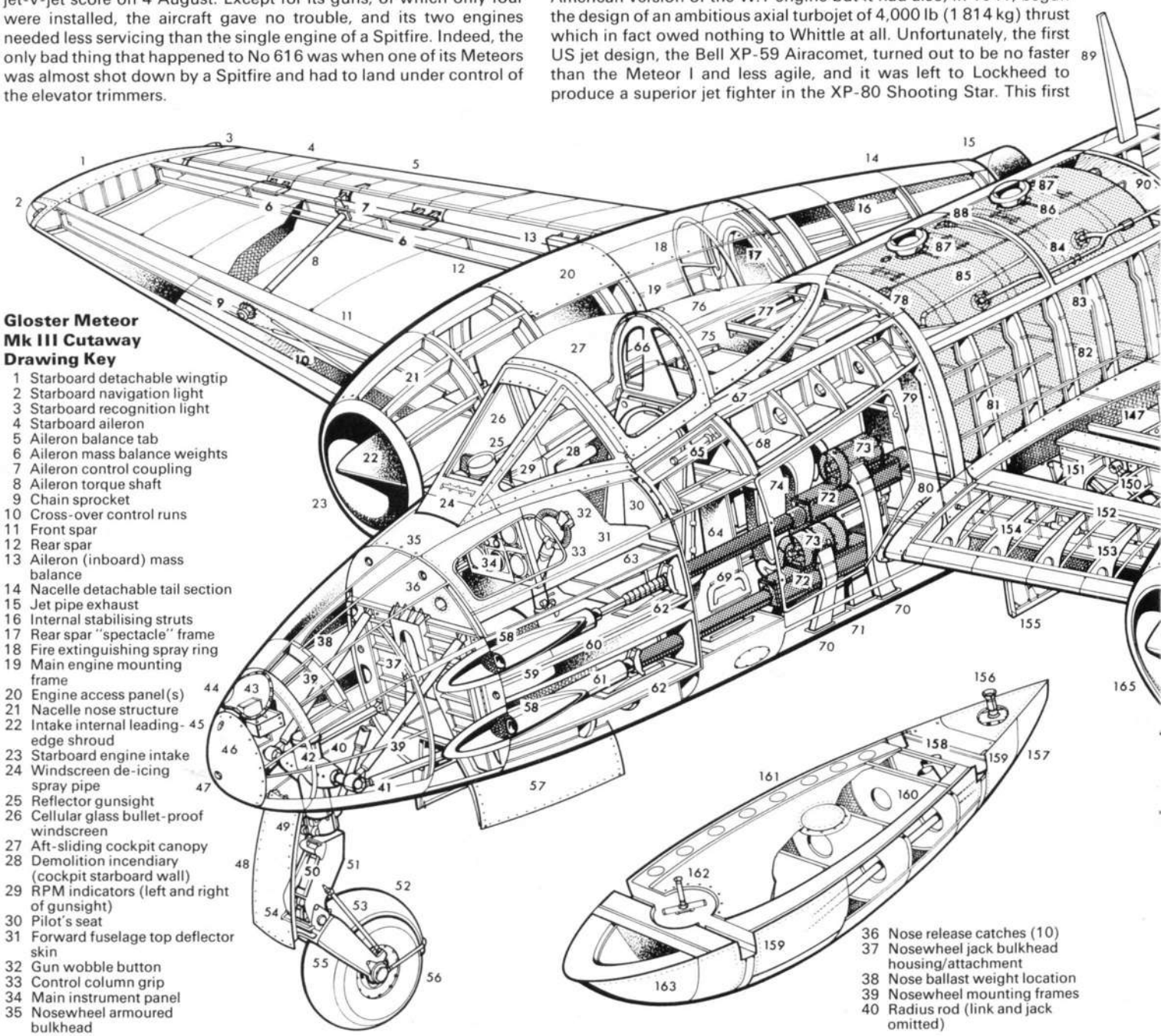
75 Automatic leading-edge slats
76 Mainspar
77 Starboard navigation light
78 Frise-type ailerons
79 Trim tab
80 Flettner-type geared tab
81 Starboard outer flap section
82 Engine exhaust orifice
83 Engine support bearer
84 Starboard inner flap structure
85 Faired wing root



The first of the eight Gloster F.9/40s, DG 202/G, was not the first to fly, although it was taxying at Newmarket Heath in July 1942. The classic lines of the Meteor were apparent right from the start.

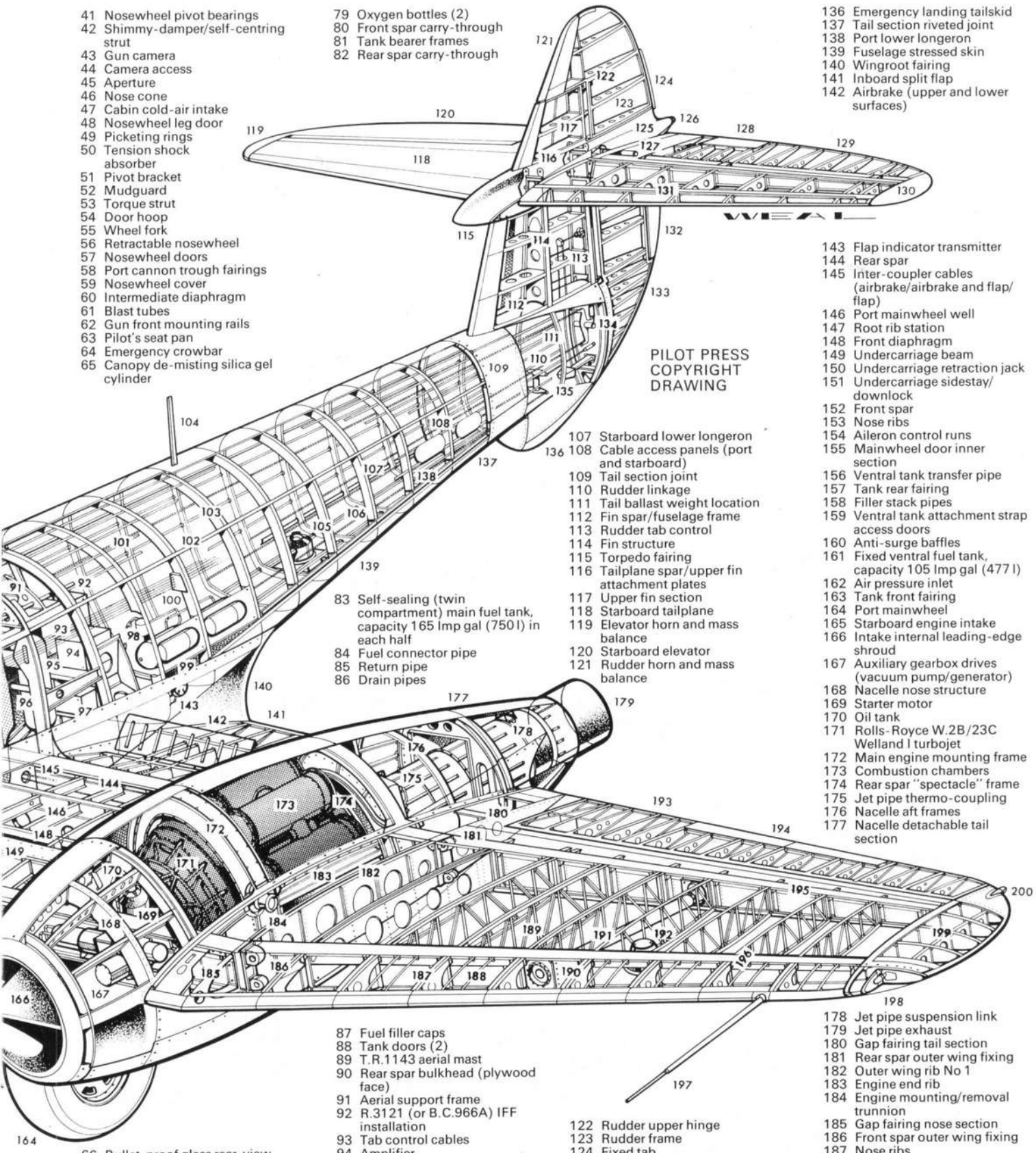
25 July the squadron had gone to Manston to operate against flying bombs, and (after a week curing gun-firing circuit faults) opened its jet-v-jet score on 4 August. Except for its guns, of which only four were installed, the aircraft gave no trouble, and its two engines needed less servicing than the single engine of a Spitfire. Indeed, the only bad thing that happened to No 616 was when one of its Meteors was almost shot down by a Spitfire and had to land under control of the elevator trimmers.

In the USA, the General Electric Company had not only worked three shifts producing — by intergovernmental agreement — an American version of the W.1 engine but it had also, in 1941, begun the design of an ambitious axial turbojet of 4,000 lb (1 814 kg) thrust which in fact owed nothing to Whittle at all. Unfortunately, the first US jet design, the Bell XP-59 Airacomet, turned out to be no faster than the Meteor I and less agile, and it was left to Lockheed to produce a superior jet fighter in the XP-80 Shooting Star. This first



Gloster Meteor Mk III Cutaway Drawing Key

1 Starboard detachable wingtip
2 Starboard navigation light
3 Starboard recognition light
4 Starboard aileron
5 Aileron balance tab
6 Aileron mass balance weights
7 Aileron control coupling
8 Aileron torque shaft
9 Chain sprocket
10 Cross-over control runs
11 Front spar
12 Rear spar
13 Aileron (inboard) mass balance
14 Nacelle detachable tail section
15 Jet pipe exhaust
16 Internal stabilising struts
17 Rear spar "spectacle" frame
18 Fire extinguishing spray ring
19 Main engine mounting frame
20 Engine access panel(s)
21 Nacelle nose structure
22 Intake internal leading-edge shroud
23 Starboard engine intake
24 Windscreen de-icing spray pipe
25 Reflector gunsight
26 Cellular glass bullet-proof windscreen
27 Aft-sliding cockpit canopy
28 Demolition incendiary (cockpit starboard wall)
29 RPM indicators (left and right of gunsight)
30 Pilot's seat
31 Forward fuselage top deflector skin
32 Gun wobble button
33 Control column grip
34 Main instrument panel
35 Nosewheel armoured bulkhead
36 Nose release catches (10)
37 Nosewheel jack bulkhead housing/attachment
38 Nose ballast weight location
39 Nosewheel mounting frames
40 Radius rod (link and jack omitted)



41 Nosewheel pivot bearings
42 Shimmy-damper/self-centring strut
43 Gun camera
44 Camera access
45 Aperture
46 Nose cone
47 Cabin cold-air intake
48 Nosewheel leg door
49 Picketing rings
50 Tension shock absorber
51 Pivot bracket
52 Mudguard
53 Torque strut
54 Door hoop
55 Wheel fork
56 Retractable nosewheel
57 Nosewheel doors
58 Port cannon trough fairings
59 Nosewheel cover
60 Intermediate diaphragm
61 Blast tubes
62 Gun front mounting rails
63 Pilot's seat pan
64 Emergency crowbar
65 Canopy de-misting silica gel cylinder

66 Bullet-proof glass rear-view cut-outs
67 Canopy track
68 Seat bulkhead
69 Entry step
70 Link ejection chutes
71 Case ejection chutes
72 20-mm Hispano Mk III cannon
73 Belt feed mechanism
74 Ammunition feed necks
75 Ammunition tanks
76 Aft glazing (magazine bay top door)
77 Loading ramp
78 Front spar bulkhead

79 Oxygen bottles (2)
80 Front spar carry-through
81 Tank bearer frames
82 Rear spar carry-through

83 Self-sealing (twin compartment) main fuel tank, capacity 165 Imp gal (750 l) in each half
84 Fuel connector pipe
85 Return pipe
86 Drain pipes

87 Fuel filler caps
88 Tank doors (2)
89 T.R.1143 aerial mast
90 Rear spar bulkhead (plywood face)
91 Aerial support frame
92 R.3121 (or B.C.966A) IFF installation
93 Tab control cables
94 Amplifier
95 Fire extinguisher bottles (2)
96 Elevator torque shaft
97 T.R.1143 transmitter/receiver radio installation
98 Pneumatic system filter
99 Pneumatic system (compressed) air cylinders
100 Tab cable fairlead
101 Elevator control cable
102 Top longeron
103 Fuselage frame
104 IFF aerial
105 DR compass master unit
106 Rudder cables

107 Starboard lower longeron
108 Cable access panels (port and starboard)
109 Tail section joint
110 Rudder linkage
111 Tail ballast weight location
112 Fin spar/fuselage frame
113 Rudder tab control
114 Fin structure
115 Torpedo fairing
116 Tailplane spar/upper fin attachment plates
117 Upper fin section
118 Starboard tailplane
119 Elevator horn and mass balance
120 Starboard elevator
121 Rudder horn and mass balance

122 Rudder upper hinge
123 Rudder frame
124 Fixed tab
125 Rear fairing
126 Tail navigation light
127 Elevator torque shaft
128 Elevator trim tab
129 Elevator frame
130 Elevator horn and mass balance
131 Tailplane structure
132 Rudder combined balance/trim tab
133 Rudder lower section
134 Elevator push-rod linkage
135 Rudder internal lower mass balance weight

136 Emergency landing tailskid
137 Tail section riveted joint
138 Port lower longeron
139 Fuselage stressed skin
140 Wingroot fairing
141 Inboard split flap
142 Airbrake (upper and lower surfaces)

143 Flap indicator transmitter
144 Rear spar
145 Inter-coupler cables (airbrake/airbrake and flap/flap)
146 Port mainwheel well
147 Root rib station
148 Front diaphragm
149 Undercarriage beam
150 Undercarriage retraction jack
151 Undercarriage sidestay/downlock
152 Front spar
153 Nose ribs
154 Aileron control runs
155 Mainwheel door inner section
156 Ventral tank transfer pipe
157 Tank rear fairing
158 Filler stack pipes
159 Ventral tank attachment strap access doors
160 Anti-surge baffles
161 Fixed ventral fuel tank, capacity 105 Imp gal (477 l)
162 Air pressure inlet
163 Tank front fairing
164 Port mainwheel
165 Starboard engine intake
166 Intake internal leading-edge shroud
167 Auxiliary gearbox drives (vacuum pump/generator)
168 Nacelle nose structure
169 Starter motor
170 Oil tank
171 Rolls-Royce W.2B/23C Welland I turbojet
172 Main engine mounting frame
173 Combustion chambers
174 Rear spar "spectacle" frame
175 Jet pipe thermo-coupling
176 Nacelle aft frames
177 Nacelle detachable tail section

178 Jet pipe suspension link
179 Jet pipe exhaust
180 Gap fairing tail section
181 Rear spar outer wing fixing
182 Outer wing rib No 1
183 Engine end rib
184 Engine mounting/removal trunnion
185 Gap fairing nose section
186 Front spar outer wing fixing
187 Nose ribs
188 Intermediate riblets
189 Wing ribs
190 Aileron drive chain sprocket
191 Aileron torque shaft
192 Retractable landing lamp
193 Port aileron
194 Aileron balance tab
195 Rear spar
196 Front spar
197 Pitot head
198 Port navigation light
199 Outer wing rib No 10/wingtip attachment
200 Port recognition light

flew on 9 January 1944 — because de Havilland was generous enough to ship to the USA the H.1 engine that had already been fitted to the second D.H.100 Vampire — but the XP-80 missed the war.

The German jets

In Germany, the big difference was that the RLM (air ministry) marshalled the industry into thinking about jets as early as February 1938, and while Heinkel, Messerschmitt and others began studying jet fighters and reconnaissance aircraft, Heinkel, Bramo (BMW), Junkers, Daimler-Benz and even Porsche worked on turbojets. Paradoxically, the pioneer effort by Heinkel was destined to wither. It had been started by Hans von Ohain at Göttingen in 1935, whose professor introduced him to Heinkel. The latter took on young von Ohain as head of a new engine department, which, in complete secrecy, conducted many tests and finally built a rather indifferent flight engine, the HeS 3B of 1,100 lb (500 kg) thrust, which flew the world's first jet aircraft, the He 178, on 27 August 1939. By this time a Heinkel design team under Robert Lüsser was working on a fighter, the He 280, with two more powerful HeS 8A engines, but although this had many good features and was certainly the first jet fighter in the world to fly, on 2 April 1941, the programme petered out.

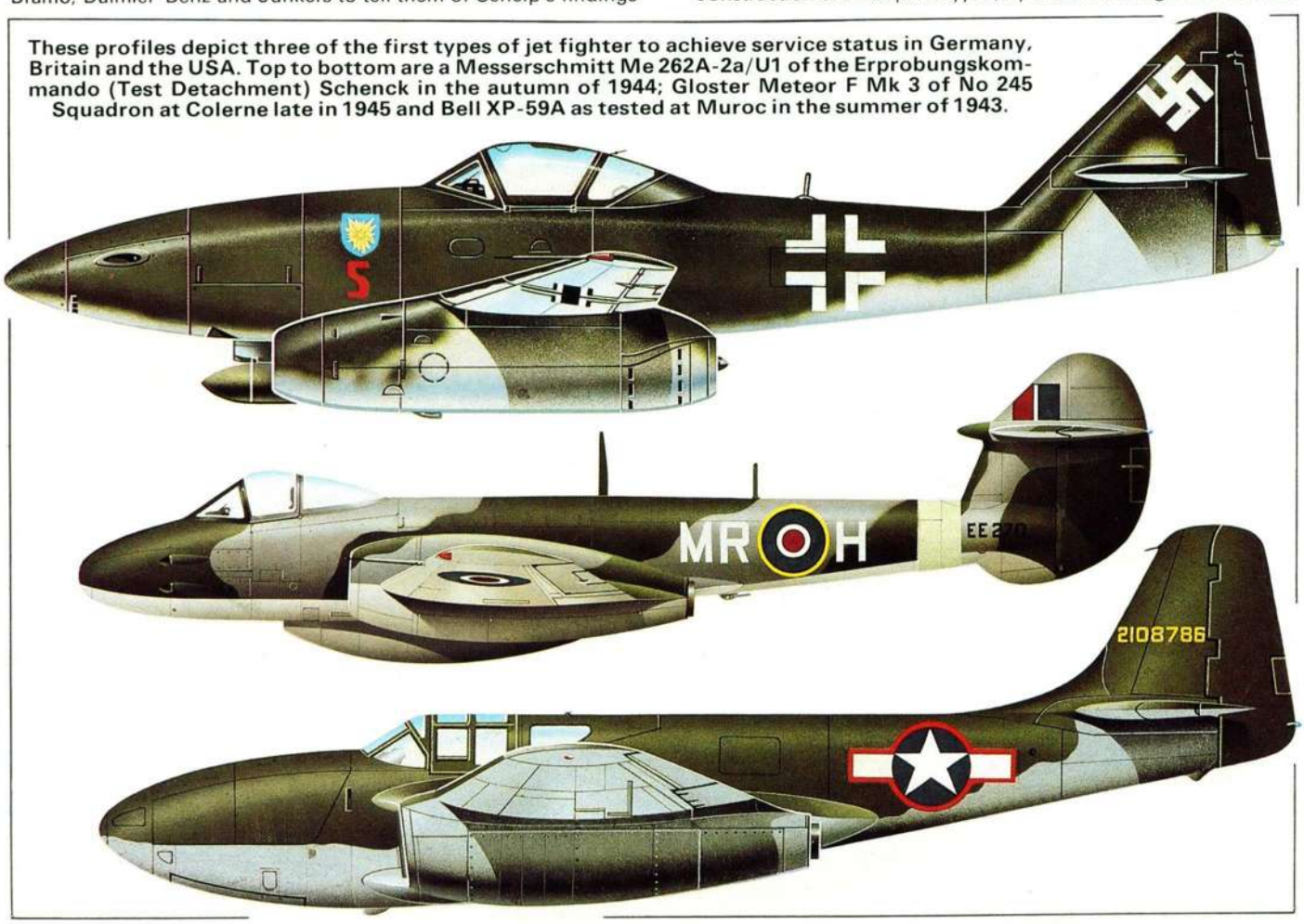
It has often been suggested that the He 280 was killed through political machinations and jealousies, of which there were plenty in wartime Germany. In fact, the HeS 8A needed to be replaced by the very advanced Heinkel 109-011 engine or one of the rival axial engines, and in any case, the He 280 was deficient in range and inferior to the Messerschmitt Me 262 aerodynamically.

This left the initial field — discounting the specialised Me 163 rocket interceptor — to the Me 262. What triggered this, and many other programmes, was the August 1938 meeting between Hans Mauch, RLM head of rockets, and a young engineer named Helmut Schelp. Schelp was head of jet propulsion in the RLM research division, and had not only established Mach 0·82 as the immediate barrier to speed posed by compressibility problems but had made many calculations on how this speed might be attained, finding the best propulsion system to be the turbojet. Mauch had already found out about Heinkel's jet work and he immediately visited BMW, Bramo, Daimler-Benz and Junkers to tell them of Schelp's findings and press them to get into jet propulsion. Nallinger, head of DB, refused point-blank; Bramo and BMW soon merged, and eventually this left two first-generation axial turbojet projects, the BMW 003 and Junkers Jumo 004. The latter was bigger and more powerful, but BMW's problems enabled the 004 to overtake the 003 in timing.

The RLM also pressured airframe companies to follow Heinkel in designing a jet fighter, and, in late August 1938, Messerschmitt AG, which had been formed a month earlier by name-change from the BFW company, was given a study contract. Prof Messerschmitt assigned Woldemar Voigt to head the work, and by October the project number P 1065 had been assigned. Various twin-engined schemes were studied, followed by contrasting singles, but all were noted by their objective of satisfactory flight characteristics up to Schelp's limit of Mach 0·82. By spring 1939, Voigt's team was back to twins, and after many configuration changes the decision was taken to hang the BMW P 3302 (later the 003) engines in plain underwing nacelles. The wing was made exceptionally thin, and this made it difficult to retract the large main units of the tailwheel landing gear. Eventually the unique answer was forthcoming in allowing the wheels to project right up above the inboard section of each wing and making the fuselage of almost triangular cross-section so that the lower part was wide enough to cover the wheels. This unusual shape also gave a very good pilot view, which was further improved by adopting a canopy raised above the humpbacked top of the fuselage.

The initial specification was passed to the RLM on 7 June 1939, and outlined a very neat and light machine powered by two BMW engines of 1,323 lb (600 kg) thrust each. Estimated cruising speed was a remarkable 559 mph (900 km/h). Indeed, later in 1939, it was decided that the design was overpowered, and the momentous decision was taken to double the internal fuel capacity and fit the devastating armament of four or even six 30-mm guns. The last major change prior to first flight stemmed from BMW's admission that the 003 engine would be much heavier than forecast, and the decision to sweep back the outer wing panels. This feature, adopted purely to preserve centre of gravity location, was later often misconstrued as yet another advanced innovatory feature concerned with postponing compressibility problems.

Construction of three prototypes, by this time designated Me 262,



These profiles depict three of the first types of jet fighter to achieve service status in Germany, Britain and the USA. Top to bottom are a Messerschmitt Me 262A-2a/U1 of the Erprobungskommando (Test Detachment) Schenck in the autumn of 1944; Gloster Meteor F Mk 3 of No 245 Squadron at Colerne late in 1945 and Bell XP-59A as tested at Muroc in the summer of 1943.

(Above and below right) The RAF's first jet fighter squadron was No 616, which began to receive Meteor F Mk 1s at Culmhead on 12 July 1944. Less than a month later it claimed its first "kill" when a V-1 Flying Bomb was tipped out of control by the wingtip of one of the squadron's Meteors after the latter's guns jammed. With Meteor IIIs, the squadron was operational in Europe by January 1945.

began at Augsburg in August 1940. By the end of the year BMW was still in deep trouble with the engine, but an alternative had appeared in the form of the rather larger Jumo 004. Nevertheless, it was becoming increasingly evident that neither turbojet would be ready for flight until long after completion of the Me 262 V1, the first prototype. Prof Messerschmitt suggested starting flight testing at modest speeds with a piston engine in the nose, which could readily be installed with the centre of gravity in roughly the correct location, and accordingly the Me 262 V1 made its first flight, in the hands of Fritz Wendel, on 18 April 1941, powered by a 730 hp Jumo 210Ga piston engine. This unique beginning to a jet flight development programme ensured that low-speed handling could be sorted out while waiting for the definitive engines.

Indeed, even when the first two BMW 003s arrived in November 1941, the decision was taken to retain the piston engine in the nose. This probably saved the V1 aircraft when, on the first jet take-off on 25 March 1942, both turbojets failed soon after becoming airborne. For BMW it was a case of "back to the drawing board", and, in fact, the company was to make no further contribution to the Me 262, although its 003A Orkan turbojet did power several other important *Luftwaffe* machines late in the war.

Junkers had an even larger and heavier engine in the 004, but at least it worked. Fitting two into the Me 262 V2 called for no change in wing sweep, but to preserve directional stability the vertical tail was made taller. (In fact the added portion was ineffective, and snaking at high speed was never eradicated, just as in the case of the early British Meteors.) Flight testing was transferred to Leipheim, home of the Gigant gliders, and there, on 18 July 1942, Wendel began taxi trials. This time there was no propeller slipstream, and Wendel found the elevators ineffective. He could not get the tail up, and almost ran out of runway. On the next attempt he touched the brakes as unstick speed was neared; the aircraft nosed over, the elevators began to bite and the Me 262 climbed away on a first flight that Wendel described as "sheer pleasure".

It was clear that, at speeds over about 186 mph (300 km/h) the Me 262 was a pilot's dream. Almost the only immediate modification was to prevent flow breakaway at the wing root by making the profile thicker, and to preserve the low thickness/chord ratio the leading edge of the inboard wing was extended forward at the same "sweep angle" as the outer panels. The powerful leading edge slats were also extended inboard of the engines.

Subsequent flight development proved that the Me 262, dubbed *Schwalbe* (Swallow), was a superb aircraft subject to certain limitations. Some of the problems, such as getting the tail up on take-off and avoiding scorching the grass and tarmac, were solved by switching to a tricycle landing gear. Junkers replaced the 004A engine by the productionised 004B, which was easier to make, used fewer strategic materials, was lighter, and, by late 1943, was giving more thrust, at 1,980 lb (898 kg). *Luftwaffe* General of Fighters Adolf

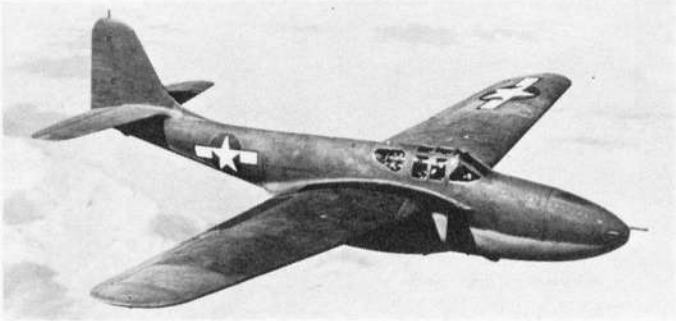
(Below) A line-up of Me 262A-1a fighters, thought to be serving, when this photograph was taken, at Giebelstadt with I/KG(J)54. A field modification has deprived the example in the foreground of two of its customary four MK 108 cannon.

Galland wanted maximum effort on the Me 262, at the expense of stopping all other fighters except the Fw 190, but Erhard Milch said that Hitler urged caution with so new an aircraft. Indeed, on 2 November 1943, Goering told Messerschmitt that Hitler's only concern was whether the Me 262 could carry bombs. Curiously, instead of simply telling the truth, Messerschmitt replied that such capability had been considered from the start, and that bomb racks could be fitted "in two or three weeks".

This fixation of the Führer on using the Me 262 as a *blitz-bomber* has often been put forward as a cause of serious programme delay. In fact, although it cost a lot of trouble and argument, and, by October 1944, did lead to deployment of the Me 262A-2a *Sturmvogel* (Stormbird) with racks for 1,102 lb (500 kg) of bombs, usually with fixed armament reduced to two guns, there was no way that the Me 262 in any form could have been put into service sooner than it was. The pacing item continued to be the engine, which even at the end of the war had a total life of only 25 hours and a time between overhauls of 10 hours!

In the event, 16 pre-production Me 262A-0 fighters, which had been lying at Lechfeld waiting for engines, were accepted by the

Too late to see service in World War II, the Bell P-59 Airacomet was America's first jet fighter, shown above and below left. Its development allowed the USAAF to gain early jet experience that was used to good effect when the more efficient Lockheed P-80 Shooting Star followed the P-59 into production.



Luftwaffe between 18 and 29 April 1944, and at the end of that month *EKdo* 262 was formed at Lechfeld under *Hptmn* Werner Thierfelder. This special test unit strove to gain experience and write the Me 262A-1a fighter version operating manual. On 27 May, a furious Hitler ordered that the Me 262 was not to be regarded as a fighter, but was to enter service exclusively as a *blitz-bomber*. His previous order had been almost ignored — as was this one — but, in parallel with fighter production, Messerschmitt did have to hurry through the Me 262A-2a bomber model which entered service with KG 51, *Kommando* Schenk, in late August 1944. Meanwhile, *EKdo* 262 had opened its score against Allied aircraft in late June with destruction of an F-5 Lightning, followed in July by a second and also a Mosquito, all caught on solitary high-altitude reconnaissance missions.

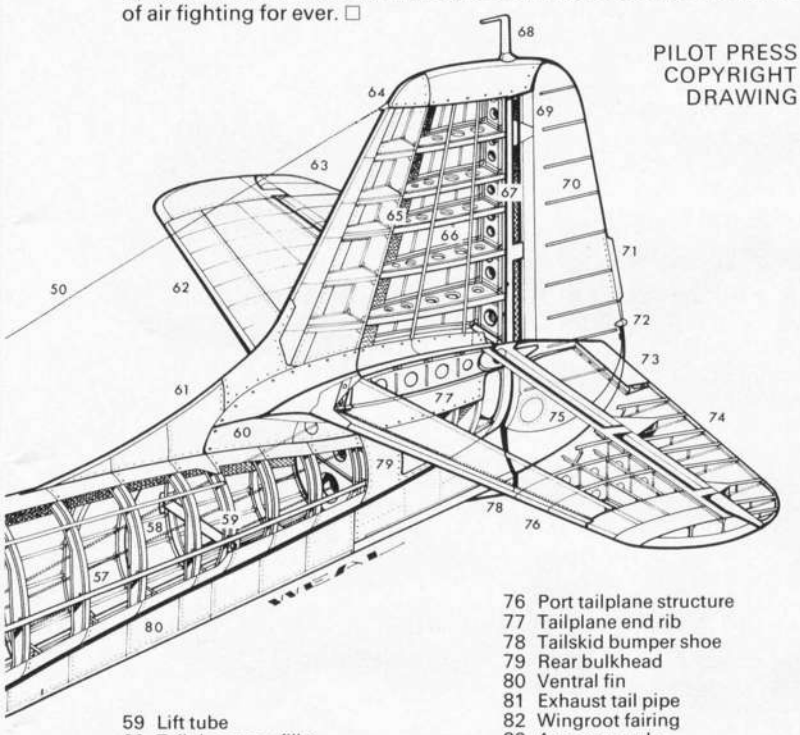
Subsequently there were many Me 262 variations, notably including the Me 262B series of two-seat night fighters, early examples of which saw brief action over Berlin. By the end of the war, 1,433 of the Messerschmitt twins had been completed, although

Bell P-59A Airacomet Cutaway Drawing Key

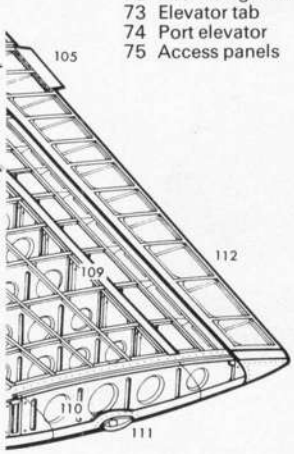
1 Three 0·50-in (12,7-mm) machine gun barrels
2 37-mm cannon muzzle
3 Nose landing lamp
4 Nosewheel oleo-pneumatic shock-strut
5 Forward lift tube access plate
6 Torque link
7 Towing link
8 Retractable nosewheel
9 Cantilever strut
10 Nosewheel door
11 Retracting link
12 Nose gear access plate
13 Gun camera
14 Ammunition magazines
15 Removable panels
16 Forward bulkhead
17 External power supply
18 Rudder pedal assembly
19 Control column
20 External canopy release
21 Throttle switch
22 Pilot's seat
23 Removable panel
24 Gunsight
25 Bullet-resistant windshield
26 Hinged canopy
27 Self-sealing fuel cells
28 False (forward) spar
29 Butted skin joint
30 Forward spar
31 Wing skinning
32 Starboard navigation light
33 Aileron
34 Aileron tab
35 Wing ribs
36 Access panels
37 Flaps
38 IFF antenna spike
39 Rear spar
40 Starboard mainwheel well
41 Aerial lead-in
42 Receiver-dynamotor unit
43 Transmitter
44 Antenna relay
45 Modulator
46 Receiver-transmitter
47 Air scoop
48 Removable hatch (radio compartment)
49 Bulkhead
50 Aerial
51 Dorsal recognition light
52 Command set antenna
53 Access panel
54 Main circumferential frame
55 Aluminium alloy skinning
56 Longitudinal stringers
57 Longeron
58 Control cables

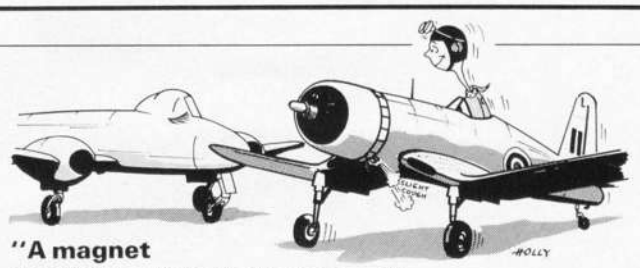
only a small proportion of these saw combat duty. With their overwhelming performance advantage and devastating firepower, they could not fail to destroy many Allied aircraft, but for various reasons they failed to score even a 1-for-1 ratio when losses due to accidents are included. The best estimate appears to be about 150 Allied aircraft shot down for the loss of not less than 98 Me 262s in combat, plus another 240 in accidents.

Why were there so many accidents? Mainly because the engines were grossly temperamental, and would never have been accepted by any Allied air force. On occasions the "onion" centrebody, which the pilot could move in and out of the jet nozzle, came adrift and acted as a thrust-reverser; few pilots ever brought the aircraft back once this happened. Not least, the single-engine safety speed was never less than 180 mph (290 km/h), and for the bomber version 186 mph (300 km/h), and a lot could happen while working up to this speed on take-off. Thus, the Me 262 was a two-sided coin; dangerous to its pilots as well as its enemies. In any case, because its engines took so long to reach even a marginally acceptable standard of handling and reliability, the aircraft arrived on the scene too late to influence the war — but the work on jet engines that was under way by 1945 in Germany, Britain and the USA was to change the nature of air fighting for ever. □



59 Lift tube
60 Tailplane root fillet
61 Dorsal fairing
62 Starboard tailplane
63 Starboard elevator
64 Aerial attachment
65 Fin spar
66 Fin structure
67 Rudder post
68 Pitot head
69 Rudder upper hinge
70 Rudder
71 Rudder fixed tab
72 Rear navigation light
73 Elevator tab
74 Port elevator
75 Access panels
76 Port tailplane structure
77 Tailplane end rib
78 Tailskid bumper shoe
79 Rear bulkhead
80 Ventral fin
81 Exhaust tail pipe
82 Wingroot fairing
83 Access panels
84 Non-slip walkway (port and starboard)
85 Centre-section wingroot rib
86 General Electric turbojet
87 Forward spar/fuselage attachment
88 Engine accessories
89 Engine air intake
90 Engine access removable panels
91 Auxiliary drop tank
92 Fuel filler cap
93 Self-sealing fuel cells
94 Port mainwheel
95 Wheel fork
96 Retracting link
97 Mainwheel oleo-pneumatic shock-strut
98 Underwing shackle-type bomb (stores) rack
99 Reinforced rib
100 Mainwheel pivot
101 Filler
102 Worm and gear assembly
103 Steel forging wing spar attachment
104 Flaps
105 Aileron tab
106 Lateral stringers
107 Forward spar
108 Wing ribs
109 Rear spar
110 End rib
111 Port navigation light
112 Port aileron





"A magnet for distinguished aviators . . ."

THE "media" did not exist in 1944; we had newspapers and the wireless instead. On 6 January, the 6 o'clock news informed us of the existence of "Jet Propulsion", and that the new engine was already being flown on test in the Gloster "Gyrone" — immediately dubbed "Squirt" by the reporters. By July 1944, the first jet fighters were entering service with the RAF — the Meteors of No 616 Squadron at Manston.

Personal recollections are of close encounters with the Meteors at Church Broughton in Derbyshire, where Rolls-Royce in conjunction with Power Jets was setting up a base to continue development flying under the wing of the Ministry of Aircraft Production. Initially, they had four-and-a-half Meteors and two Wellington Mk IIs each with a jet-unit mounted in the tail. One of the Meteors was being fitted with turboprop engines.

These exotic aircraft became a magnet for distinguished aviators from all over the country, who told the most terrible fibs imaginable about lack of fuel, deteriorating weather, rough engines — or anything that might provide an excuse for a "precautionary" landing and a few hours at Church Broughton. They came in Seafires and Spitfires, in Corsairs and Mustangs, Lincolns and Fortresses; one even arrived in a Barracuda — trembling, no doubt. Another arrived in an ancient Defiant, "out of consideration for his civilian observer who needed to find a public convenience." Battle of Britain pilot Johnnie Johnson turned up in an Anson, of all things. It was a beautiful August day, but he said he thought there just *might* be some fog on the high ground farther north. He got more than he bargained for — a puncture in the Annie's wheel! □

CHARLES HALL

Prelude to Overlord

This year sees the 40th anniversary of D-Day, the Allied invasion of Normandy, on 6 June 1944. In this article we examine the parts played by the Allied air forces, and, in particular, by the Royal Air Force, during the eight tense months preceding D-Day, in the count-down to Operation *Overlord*.

NEVER was an amphibious landing more meticulously and thoroughly prepared and planned than Operation *Overlord*, which, ultimately executed by all three arms of the British and American services, presented the hazardous task of placing an Allied army on a hostile shore with the minimum of loss. What was to take place following the landings, in the difficult bocage country of northern France, was to be inevitably in the hands of the men on the ground, the generals, the corps commanders, the gunners, the tank men and the infantry. For it is they, and not so much the men of the air and naval forces, who reap victory.

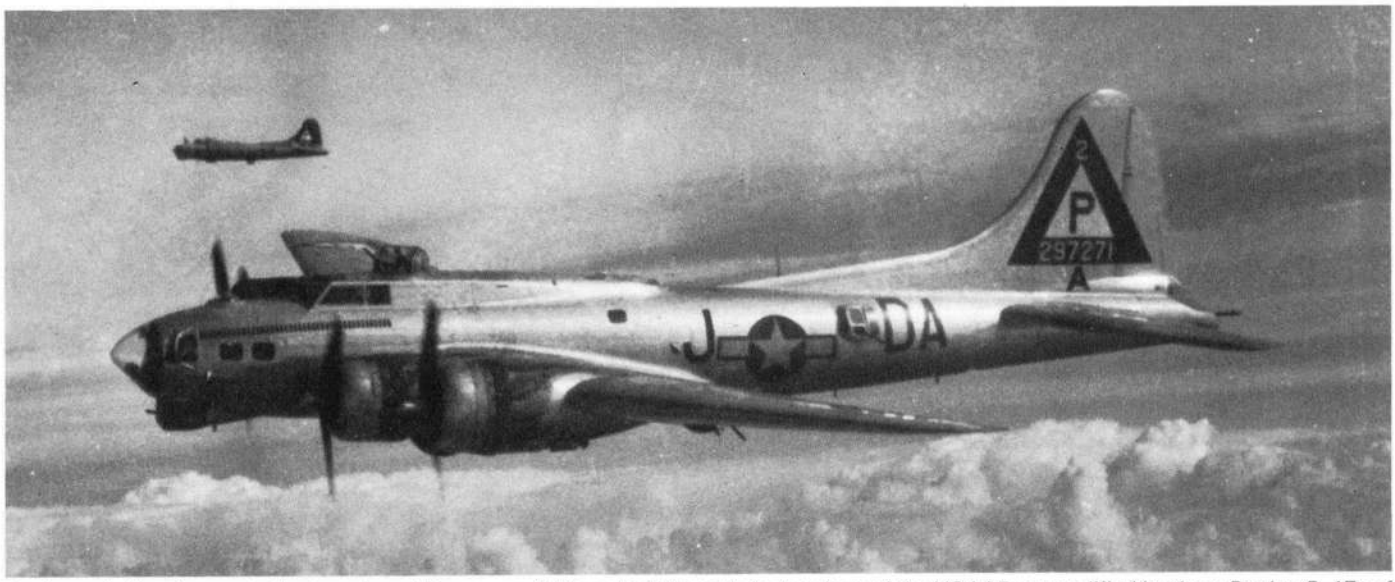
It was at Casablanca, during the conference between Churchill, Roosevelt and the Combined Chiefs of Staff in January 1943, that a British officer, Lieut-Gen F E Morgan, was given the task of planning the logistical and tactical aspects of a major sea and airborne landing on the shores of northern France, whence the Allies were to conduct their final and supreme offensive of the war against Nazi Germany. Under his grandiose title of Chief of Staff to the Supreme Allied Commander (Designate), or COSSAC, Morgan commenced work on this project with a small staff in March 1943. At the Trident Conference in May 1943, the Allied CCS tentatively scheduled the date of 1 May 1944 as D-Day for Operation *Overlord*, as the mission was now code-named: the plans of *Overlord* were revealed by Morgan to the CCS at Quebec in the following August. These took the form of a now standard format wherein control of the sea-lanes

(Below) This Supermarine Spitfire F Mk XIV was flown by the CO of No 610 Squadron, Sqn Ldr R A Newbury, operating from Lympne against V-1s in mid-1944.

(Above) Hawker Tempest V Srs 1 of No 486 Squadron, RNZAF, in full D-Day markings.

(Below) No 157 Squadron used Mosquito NF Mk XIXs such as this for intruder missions over *Luftwaffe* night fighter airfields in the weeks after D-Day.

(Below) Beaufighter TF Mk X of No 455 Sqn, RAAF, operating as part of the Strike Wings provided by Coastal Command.



In the period leading up to the invasion of Europe on D-Day, daylight raids by bombers of the USAAF, exemplified by these Boeing B-17s of the 8th AF, played a significant rôle. RAF Bomber Command kept up the pressure by night.

and the skies preceded seaborne assault landings, and key objectives were secured by air landings.

When Morgan came to Quebec he could draw on the experience of the landings in North-west Africa (Operation *Torch*: 8 November 1942), where air and ground opposition from Vichy forces had been minimal, and the more recently conducted assault of Sicily (*Husky*: 10 July 1943). The invasion of Sicily had been made under an umbrella of total Allied air superiority, which had been gained in the course of two months of hard fighting against the *Regia Aeronautica* and the *Luftflotte* 2 of the *Luftwaffe*. In a round of operations starting in May, the B-17s and B-24s of the US 9th and 12th Air Forces, the Wellingtons of No 205 (Bomber) Group, and the Bostons and Baltimores of Tactical Bomber Force had attacked airfields, depots and installations in Sardinia, Sicily and southern Italy to inflict a high rate of attrition upon the *Luftwaffe*.

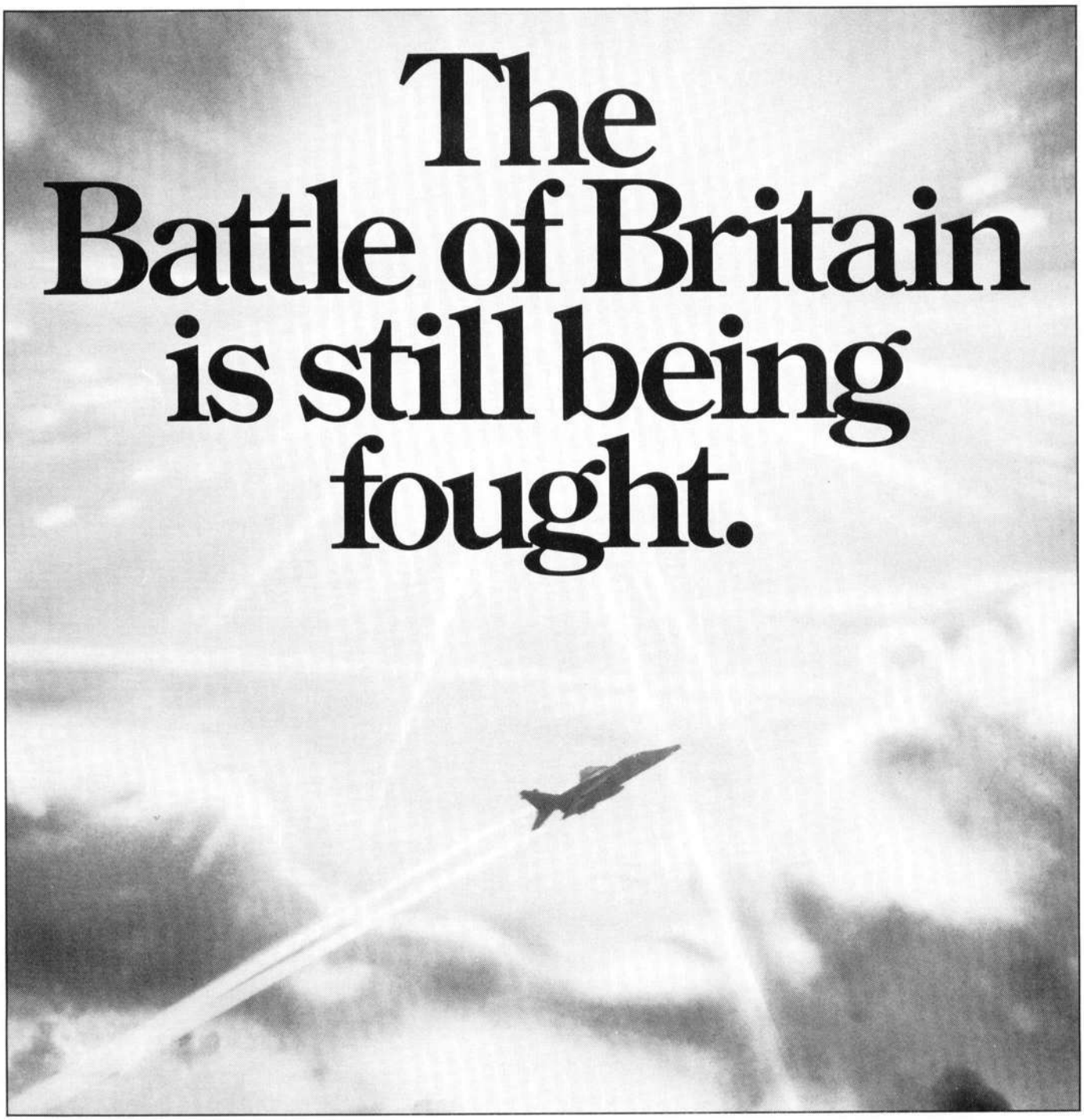
The piecemeal destruction of German bomber units on the ground had seriously affected *Luftflotte* 2's ability to interfere with the vast build-up of Allied shipping at Oran, Algiers, Bone and Philippeville on the Algerian coast prior to *Husky*, with the German fighter units also suffering heavy casualties on the occasions when they rose to defend their airfields. Despite a heavy priority vested in *Luftflotte* 2, the fact that this formation had been reduced to near impotence by 10 July 1943 was a testament of glowing proportions to Air Chief Marshal A W Tedder's counter-air campaign, and to the foresight with which it had been planned. It went without saying, therefore, that total air supremacy over the *Luftwaffe* would be an essential pre-requisite for *Overlord* in 1944.

Morgan selected Normandy as the venue of *Overlord* on the basis of fact that the German defences there were much weaker than those in the Pas-de-Calais. Three seaborne divisions and two airborne brigades were to form the forces in the initial assault, with a follow-up of another two divisions: eighteen divisions were planned to be ashore by D+14. The objective was the establishment of a lodgment in the area Caen-Carentan, to be followed by an advance to the north-west, via the Cotentin peninsula, to secure the port of Cherbourg. Initially, too much reliance was placed on using this port to inject fresh divisions into Normandy, for recent experience was to point to German efficiency in the destruction of port facilities prior to a withdrawal. Therefore, ports and disembarkation quays of a pre-fabricated nature would have to be towed across the Channel, and constructed at points off the Normandy coast.

The provision of mobile unloading facilities was but one in a multitude of problems facing Morgan and his planning staff in the months to come. Some conception of the logistical and administrative feats that were to be encountered could be gauged by the size of the forces available for *Overlord* and Operation *Neptune* (the cross-Channel phase) in the first week of June 1944. Fifty thousand men would form the assault forces with another 2,000,000 men in 39 divisions to be shipped to France as reinforcements. The naval armadas consisted of 138 major warships for escort and support duties, 221 smaller ships of destroyer category or below, over 1,000 minesweepers and auxiliaries, 4,000 LSTs, LCIs and assorted landing craft, 805 merchant ships, 59 blockships and some 300 miscellaneous vessels.

The command of all forces engaged in *Overlord* was to be vested in General Dwight D Eisenhower, USA, as Supreme Allied Commander (Europe), assisted by his deputy, Air Chief Marshal A W Tedder, and Lt-Gen Walter Bedell Smith as his chief of staff. The Allied Naval Expeditionary Force was to be under Admiral Sir Bertram Ramsay RN. General Bernard L Montgomery was to be the GOC Allied 21st Army Group in the forthcoming battle, to which the 1st US Army (Lt-Gen Omar N Bradley) and the 2nd British Army (Lt-Gen M C Dempsey) were to be subordinated: these appointments took place

Strong fighter escorts were provided for the 8th AF bomber formations, leading to frequent combat with Luftwaffe *fighters, which suffered heavy attrition as a result. North American P-51 Mustangs and Republic P-47 Thunderbolts are seen here at a UK airfield.*



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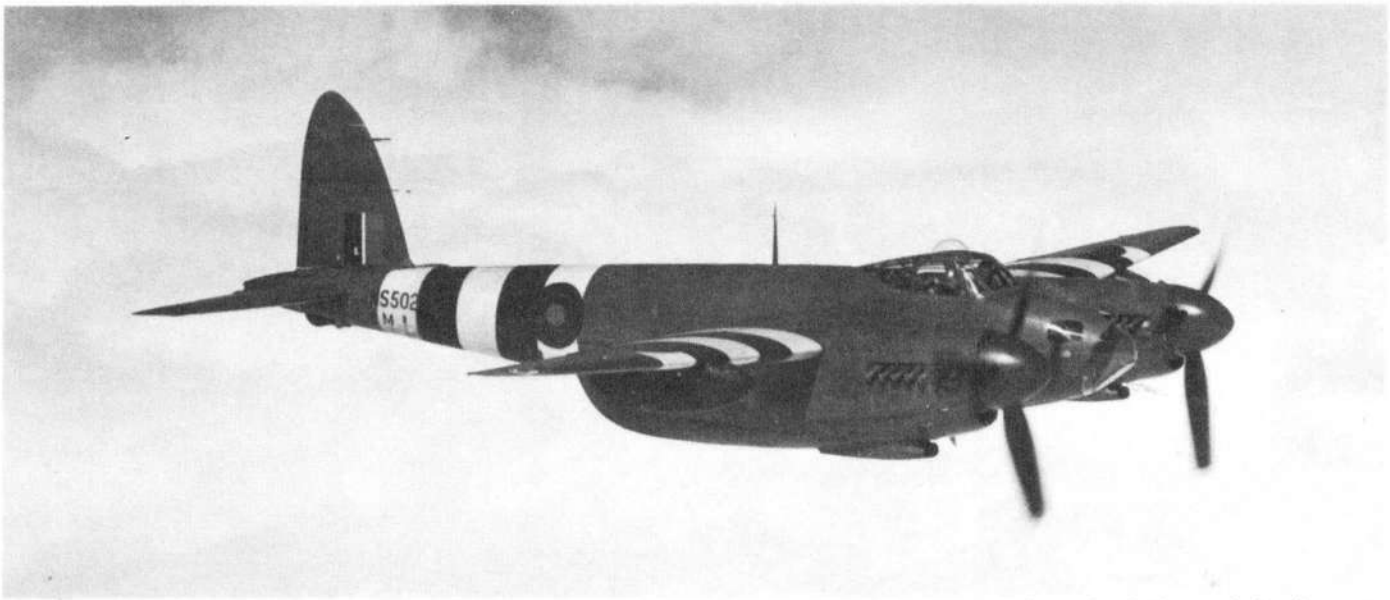


Photographic reconnaissance aircraft maintained a constant watch over the enemy, contributing vital information in the weeks leading up to, and immediately following, the invasion. This is a Mosquito PR Mk XVI, displaying the black-and-white "invasion stripes" adopted for all Allied aircraft in June 1944, to minimise the risk of mis-identification.

during the spring of 1944 as the planning was finalised. The overall responsibility for air operations prior to and during *Overlord*, with the exception of the control of the strategic bombing forces and RAF Coastal Command, was placed in the hands of the erstwhile Fighter Command leader, Air Chief Marshal Trafford L Leigh-Mallory, who assumed command of the Allied Expeditionary Air Forces (AEAF) on 15 November 1943.

Formation of the Tactical Forces

The first steps in the constitution of a tactical air force for the support of the ground forces were taken as early as mid-summer 1943. On 1 June, Air Vice-Marshal B E Embry assumed command of No 2 Group, which was then transferred from Bomber to Fighter Command. This formation was equipped with Boston III, Mitchell II and Ventura II light bombers, and was highly experienced in the conduct of daylight offensive operations. On 14 June 1943, the RAF Second Tactical Air Force was formed with Air Vice-Marshal J H D'Albiac as its commander, to which Nos 2 and 83 Groups were subordinated: a third group, No 84, was placed under 2nd TAF on 15 July. Until the time of the formation of the AEAF in November, the 2nd Tactical Air Force was maintained on a headquarters basis only, being under the orders of RAF Fighter Command: from the outset, Air Vice-Marshal Harry Broadhurst's No 83 Group was built around a force of fighters and fighter-bombers for the eventual support of the 2nd British Army, with No 84 Group (Air Vice-Marshal L O Brown) providing the similar function for the 1st Canadian Army that joined Montgomery's Group in the spring.

The air units were formed into composite Wings in much the same manner as employed by the Royal Air Force in operations overseas — for example, in North Africa under the Desert Air Force. Squadrons within the Wings were grouped under numbered airfields for initial purposes. Thus, within No 83 Group, No 15 (Fighter) Wing consisted of 122 Airfield (Wg Cdr H A C Bird-Wilson at Gravesend, with Nos 19, 65 and 122 Sqns), and 125 Airfield (Wg Cdr R D Yule at Detling, with Nos 132, 184 and 602 Sqns). The headquarters staff, and the servicing and supply echelons, were fully mobile: accommodation at forward airfields was usually under canvas, with all personnel trained in airfield perimeter defence should the need so arise. At all levels there was close liaison with the Army, with a high accent on an efficient signals and communications network. Pilots and groundcrews lived close by their aircraft, and were expected to operate under primitive conditions.

The embryonic units of what was to be the 2nd TAF were thrown straight into operations during the summer of 1943, as Fighter Command continued its maximum-effort offensive against the *Luftwaffe* fighter force stationed in Belgium and northern France.

Autumn Crisis

By the summer of 1943, the dominant theatre of the war in the air over Europe lay in the Allied strategic bombing offensive against Germany and in the weight of the commensurate defensive effort by the *Luftwaffe*. Following the failure of the last major German offensive on the Eastern Front, in the Kursk-Orel salient, and the loss of Sicily in August 1943, the *Luftwaffe* at last turned to the defence of the *Reich* as its first priority against RAF Bomber Command by night, and by day against Lt-Gen Ira C Eaker's US 8th Air Force. It was not before time. Aided by H2S, Oboe and Gee Mk II (TR.1335), Bomber Command's Lancasters and Halifaxes had commenced their 1943 offensive with a campaign of devastating nocturnal attacks on the industries in the Ruhr on the night of 5-6 March, when 442 aircraft

Seen here on a European airfield after D-Day, North American Mitchells were among the light bombers used by the RAF in the unremitting assault on Fortress Europe prior to the Allied landings.

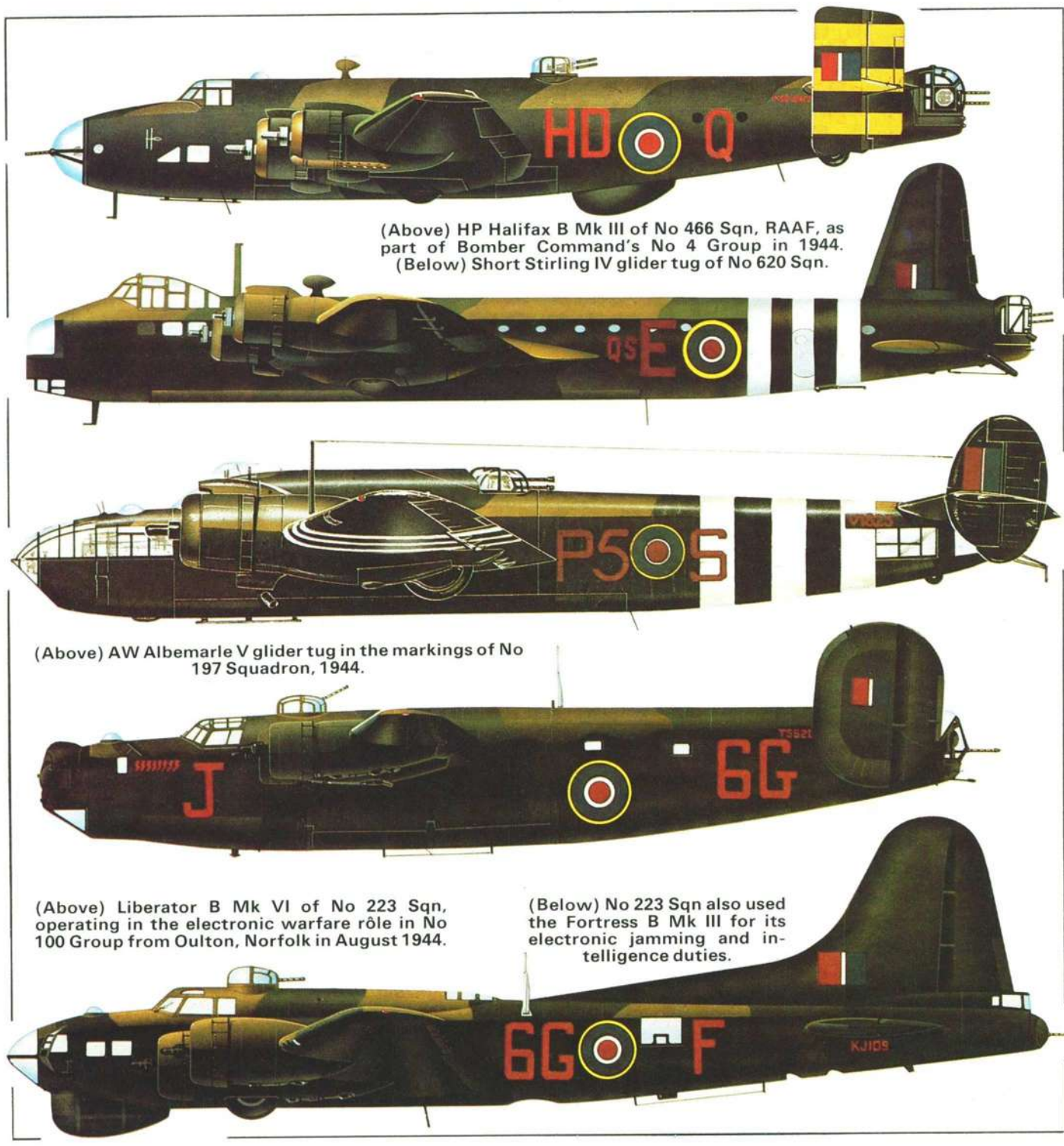
were despatched to Essen. Taking advantage of the steadily improving weather, Eaker sent 103 Boeing B-17F Fortresses of USAAF VIII Bomber Command to attack the Bremer-Vulcan Schiffbau U-boat construction yards at Vegesack, near Bremen, on 18 March: in their first major attack on an objective in the *Reich*, 97 bombed with great accuracy for the loss of only two of their number. These two raids, made by forces following totally opposed theories concerning the most efficient means of bombing, signalled the start of an escalation in the Allied offensive, as called for in the Casablanca Directive of 21 January 1943.

In March 1943, the *Luftwaffe* possessed a strength of 493 night fighters, based in Germany and on airfields in Holland and Belgium on the approaches to the Ruhr. The night fighters, mostly Messerschmitt Bf 110F-4s, Bf 110G-4s and Junkers Ju 88C-6s, were normally controlled from the ground in boxed zones which contained a number of radar stations: the FuMG 80 *(Freya)* gave early-warning capability, while control was effected via *Würzburg-Riese* (FuMG 65) GCI radar. The Germans referred to this form of GCI technique as *Himmelbett*. However, an increasing number of night fighters were being fitted with Airborne-Intercept radar (AI), known as FuG 212 *Lichtenstein* C-1.

By using new radar equipment, and profiting from a period of almost three years of constant trade with RAF Bomber Command, German night fighter crews were becoming increasingly formidable.

Their daytime counterparts were slower to get off the mark, but, on 1 April 1943, the size of the *Luftwaffe* day force was increased by the formation of *Jagdgeschwader* 11 from elements of JG 1, while a wing (III/JG 54) was positioned at Oldenburg from northern France. At the same time the new Messerschmitt Bf 109G-5 and G-6 appeared on the line, with an increased armament of one 20-mm Mauser 151 cannon and two 13-mm MG 131 machine guns: a simple modification enabled the Bf 109G-6/R6 to carry three 20-mm cannon. These, and the heavily-armed Focke-Wulf Fw 190A-5s (the newest and fastest of this series), formed a potent nucleus in the *Luftwaffe* inventory.

April 1943 also saw the emergence of a revision in the strategic



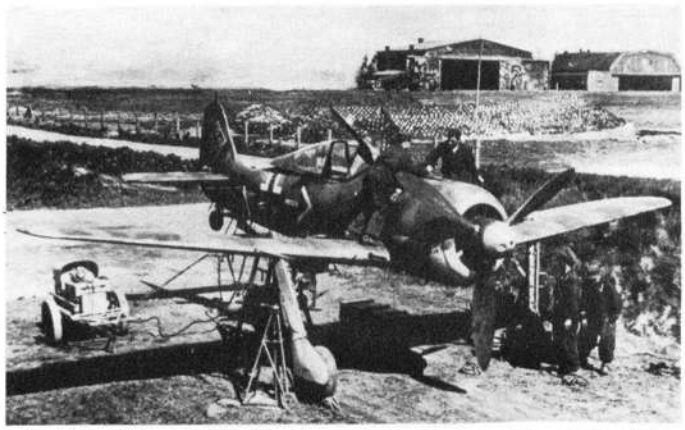
(Above) HP Halifax B Mk III of No 466 Sqn, RAAF, as part of Bomber Command's No 4 Group in 1944.
(Below) Short Stirling IV glider tug of No 620 Sqn.

(Above) AW Albemarle V glider tug in the markings of No 197 Squadron, 1944.

(Above) Liberator B Mk VI of No 223 Sqn, operating in the electronic warfare rôle in No 100 Group from Oulton, Norfolk in August 1944.

(Below) No 223 Sqn also used the Fortress B Mk III for its electronic jamming and intelligence duties.

(Above) Serving on the invasion front in 1940, these Focke Wulf Fw 190G-8 fighter-bombers of I/SKG 10 each carry a 1,100-lb (500-kg) SC 500 bomb plus drop tanks in order to strike at Allied ground targets. Note the shrubbery used as camouflage. (Below left) An Fw 190A-5 receives attention at an airfield somewhere in Germany in July 1944.



priorities of the US 8th Air Force, known commonly as the Eaker Plan. By now the U-boat priority as directed at Casablanca was becoming slightly less urgent, thanks to the balance in the Battle of the Atlantic swinging in favour of the Allied naval and air forces. Of increasing priority was the emergence of the power and efficiency of the German Fighter Arm *(Jagdwaffe)*, which if unchecked posed a direct threat to the Allied air forces' urgent quest for air supremacy over Europe. It was now the desire of Lt-Gen Ira Eaker that both RAF Bomber Command and the US 8th Air Force be brought together in a combined bomber offensive against mutually agreed objectives, with the first priority directed at the defeat of the *Jagdwaffe*: his plan called for a carefully timed programme against the *Luftwaffe* and its supporting industries in order to reduce its effective fighter strength to a total of less than 650 by 1 April 1944.

Any possibility of a combined bombing offensive was, however, ruled out by Air Marshal A T Harris, the AOC-in-C RAF Bomber Command, who saw no reason to change his policies that had stood the test of time since his instatement in February 1942. Indeed, he had much to be proud of, having taken over responsibility for Bomber Command when its fortunes were at a low ebb: the Command would continue to conduct a campaign of devastating area attacks on German cities, wherein vital industries were located, in the hope that the will of the German people would be undermined.

The Air Staff directive of 10 June 1943 encapsulated most of Eaker's proposals, bringing the counter-air campaign against the German fighter arm to the top of the priorities list, at least, for US VIII Bomber Command: Harris' forces on the other hand were given the task of continuing area attacks in accordance with "their main aim in the general disorganisation of German industry". And so the US 8th Air Force embarked upon what became known as Operation *Pointblank*; an all-out campaign aimed at attacking the German fighters in the air and on the ground, and on the production lines in the factories.

With the exception of fighter cover by RAF Spitfire Mk VBs and Mk IXs on the first stage of the route outbound and during the withdrawal, Eaker's B-17s were unescorted on the increasing number of deep penetration raids into the *Reich*. The *Luftwaffe* reacted violently, using fighters with 20-mm cannon, lethal 21-cm Wfr.Gr 21 rocket-mortars and aerial-bombing: an early indication of what they could achieve took place during the Kiel mission on 13 June when 26 B-17s failed to return. VIII Bomber Command's deepest penetration to date was on the Chemische-Werke GmbH synthetic rubber concern at Hüls on 22 June, in which 16 B-17s were shot down with another four failing to return from a diversionary mission to Antwerp.

Throughout this time, the Fortresses continued to pay attention to U-boat bases on the Bay of Biscay coast and to the airfields in northern France. It was in this sector that a German command known as *Höhere Jafü West* maintained a force of some 250 Bf 109G-6s and Fw 190As based at Evreux, St André-de-l'Eure, Beaumont-le-Roger, Lille, Vitry-en-Artois and Cambrai, of *Jagdgeschwader* 2 and 26. These were tough and professional opponents, but their task of combating strong formations of escorted B-17s, B-26s and RAF Bostons and Venturas was becoming increasingly difficult, and the losses of JG 2 and JG 26 reached a peak in the hectic fighting of July-August 1943.

In July, VIII Bomber Command returned to targets in the *Reich* in a series of raids that became known as Blitz Week: starting on 24 July 1943, the B-17s went to Heroya (in Norway), and then to Hamburg, Hannover, Kiel, Warnemünde, Kassel and Oschersleben. Blitz Week ran concurrently with RAF Bomber Command's ferocious attacks on Hamburg (Operation *Gomorrah*) which started on the night of 24-25 July with the long-awaited use of *Window* jamming: cut to half the wavelength of German radars, aluminium foil-backed paper strips interfered with the *Würzburg* and *Lichtenstein* AIs on the 450 to 500 MHz frequency band, and at a stroke neutralised the *Himmelbett* GCI system of the night fighters and the gun-laying radars of the *Flak* arm.

Despite the impact of repeated bombing by the RAF and the USAAF, German industry made superhuman efforts to match Luftwaffe *attrition by production of new fighters, such as these Messerschmitt Bf 109G-6/R6s awaiting delivery.*

One of the German developments to counter the Allied bombing formations, and especially those of the USAAF's 8th Air Force, was the "Pulk-Zerstörer" (Formation Destroyer), a Wfr.Gr.21 mortar. The Bf 109G-6/R2s (above) carry one of these weapons beneath each wing; the Bf 110G-2/R3 of 9.Staffel of ZG26 (below right) has two beneath each wing.

Unfortunately, the short summer nights went a long way towards offsetting the value of *Window* for Bomber Command and after an initial pause the *Luftwaffe* reacted by sending up freelance Fw 190s and Bf 109Gs on *Wilde Sau* (Wild Boar) patrols which relied on visual contact, with the regular night fighters flying similar missions without the claustrophobia of the tight GCI system. In August, Bomber Command lost 275 aircraft in 7,807 sorties, with an estimated 141 shot down by night fighters. The climax of operations of the US 8th Air Force in August 1943 took place on the 17th when two task forces were sent to Messerschmitt AG at Regensburg, and the VKF ball-bearing concerns at Schweinfurt: a total of 60 B-17Fs were shot down. Following this, VIII Bomber Command co-operated with Fighter Command in Operation *Starkey*, an elaborate invasion deception plan aimed at bringing the forces of *Höhere Jafü West* to battle: the latter refused to be drawn, however, and the results of *Starkey* were meagre. Returning to Germany, VIII Bomber Command lost 45 B-17s on 6 September, in a badly executed raid on Stuttgart, before turning back to strike at objectives in France.

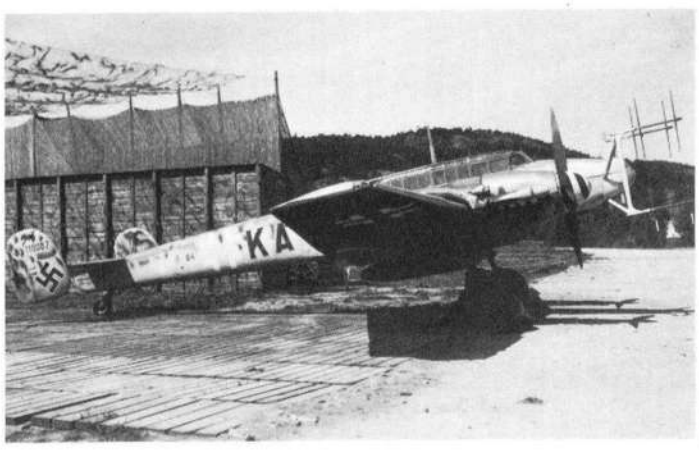
By this time, six groups of Republic P-47D Thunderbolts were on hand to provide VIII Bomber Command with limited fighter cover, with the small 75 US-gal (284 l) giving way to the 108 US-gal (409 l) auxiliary drop-tanks that enabled the P-47s to operate to a maximum radius of 375 miles (604 km) from base. On 27 September 1943, the use of the larger tanks enabled the 353rd Fighter Group to make a highly effective bounce on II/JG 11 to the south of Groningen, while the bombers ran in to make their attack on Emden using H2X radar for the first time: the P-47s claimed 21-2-6 (destroyed, probable, damaged) in total, for the loss of one of their number. It was the first occasion whereby US escort fighters had managed to interfere effectively with German interceptors over the borders of the *Reich*.

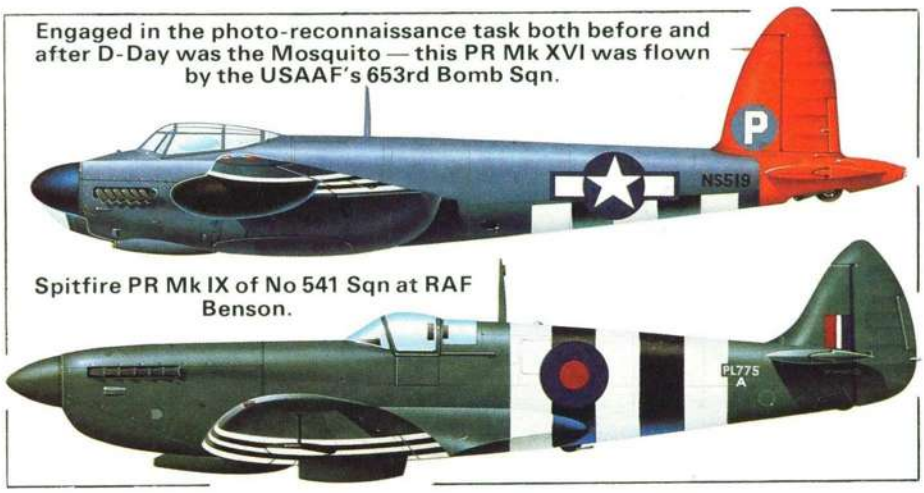
Limitations in the range of the P-47 forestalled VIII Fighter

Command's valiant attempts to stave off German fighter attacks during the series of heavy raids in October 1943. A record 370 B-17s and B-24s were sent to Emden port area and Leeuwarden airbase on 2 October to bomb through 10/10ths cloud with the aid of H2X-equipped pathfinders. Two days later, 361 US bombers sallied to the Saar area, and to Frankfurt and Wiesbaden, to encounter a heavy reaction by *I Jagdkorps* and *7.Jagddivision*: 16 bombers were lost. Thirty were shot down on 8 October, in a savagely contested attack on Bremen; 28 failed to return on the following day when 378 bombers attacked aircraft assembly plants at Anklam and Marienburg, and the port areas at Danzig and Gdynia. The raid on Münster's extensive rail facilities on 10 October cost 30 B-17s.

As if this was not enough, 60 out of 291 Fortresses despatched were nailed by *Flak* and fighters in the attack on Schweinfurt's ball-bearing concerns on 14 October 1943. It was the climax in what was an appalling month of attrition for US VIII Bomber Command: the loss of 198 bombers (MIA and Cat E) in 2,159 credit sorties represented the totally unacceptable casualty rate of 9·2 per cent of sorties. The heavy losses of October 1943 fostered a crisis of confidence in the conduct and results of *Pointblank*, and brought to an end further attempts by VIII Bomber Command to launch unescorted deep-penetration missions by day.

Bomber Command's night raids were countered, in the period leading up to D-Day, by radar-equipped night fighters such as (right) the Junkers Ju 88G-1 of 7./NJG 2 and (left) the Messerschmitt Bf 110G-4c/R3, both with Lichtenstein SN-2 radar.





Engaged in the photo-reconnaissance task both before and after D-Day was the Mosquito — this PR Mk XVI was flown by the USAAF's 653rd Bomb Sqn.

Spitfire PR Mk IX of No 541 Sqn at RAF Benson.

The situation was made immeasurably worse by the reports of Allied air intelligence that pointed to the escalating strength of the *Jagdwaffe,* which was supported by a buoyant industry. In a report of 3 November 1943, Air Commodore F F Inglis (ACAS Air Intelligence) predicted that by 1 April 1944 the *Luftwaffe* would have a total of 2,865 day and night fighters, of which 2,120 would be deployed in Germany, Austria and the western occupied territories against the Allied strategic bomber forces.

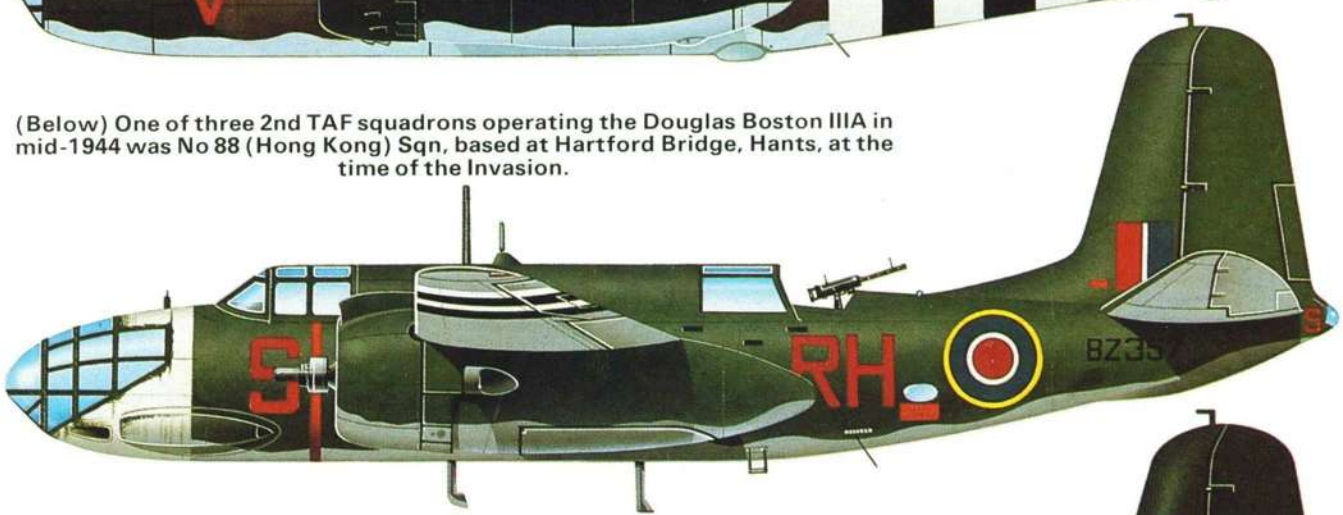
Crossbow Commitments

By November 1943, an element of grim urgency had surfaced in the Allied conduct of air operations over north-west Europe. The various operational directives had provided the target priorities which directly or indirectly were connected with the invasion of Normandy, and the attainment of air superiority over the *Luftwaffe*. Air Chief Marshal Sir Arthur Harris chose this month in which to launch an offensive of renewed dimensions primarily upon Berlin, the capital city of the *Reich*. Starting on the night of 18-19 November, his offensive, which was to result in the loss of 587 bombers in 9,319 sorties, was to last until 24-25 March 1944, before RAF Bomber Command was turned to the task of dislocating German transportation.

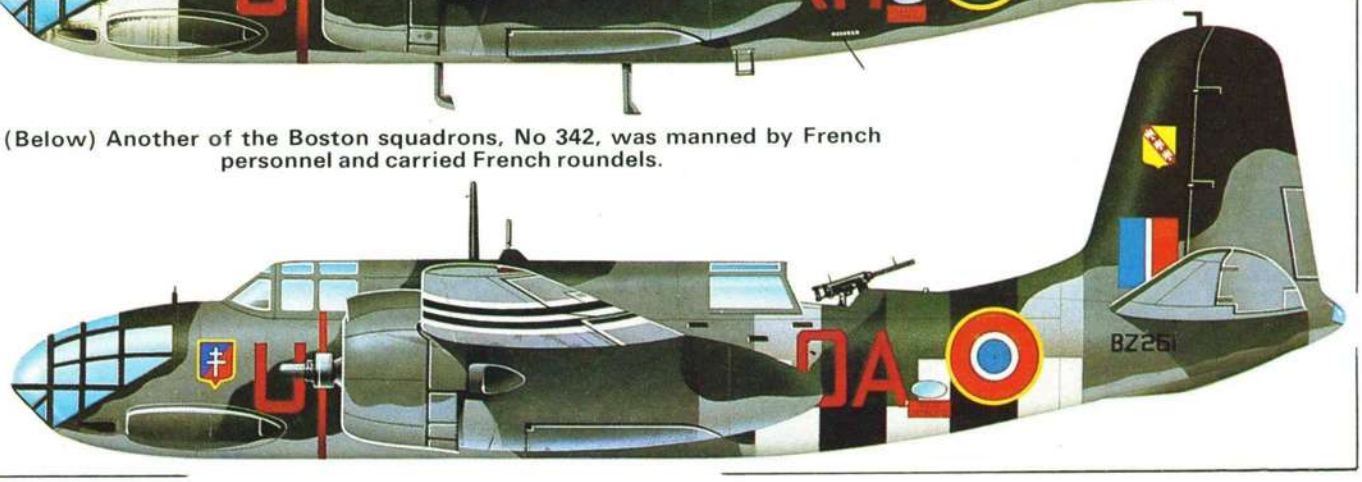
From bases in the Foggia complex, in southern Italy, the US 15th Air Force commenced attacks on targets in Austria, Romania, Hungary and southern Germany to take some of the pressure off Eaker's forces based in England. In its determination to carry out the aims of *Pointblank*, the US 8th Air Force made energetic efforts to extend the range and increase the performance of the P-47D, and to introduce the Lockheed P-38 Lightning and the superlative North American P-51B Mustang, which had a combat radius of 600 miles (965 km), on operations in the course of the next two months.

The presence of large numbers of aggressively led long-range US fighters in the skies deep within the heart of the *Reich* overturned *Luftflotte Reich*'s defensive strategy in one single catastrophic stroke during the mammoth air battles of the spring of 1944. German fighters were bounced on assembly, intercepted in vicious fighter-versus-fighter combats before the bombers could be reached, chased

(Below) A Mitchell II of No 226 Sqn, operating from Gilze Rijen in the Netherlands before the end of June 1944. Five squadrons of Mitchells operated in 2nd TAF in the build-up to D-Day.

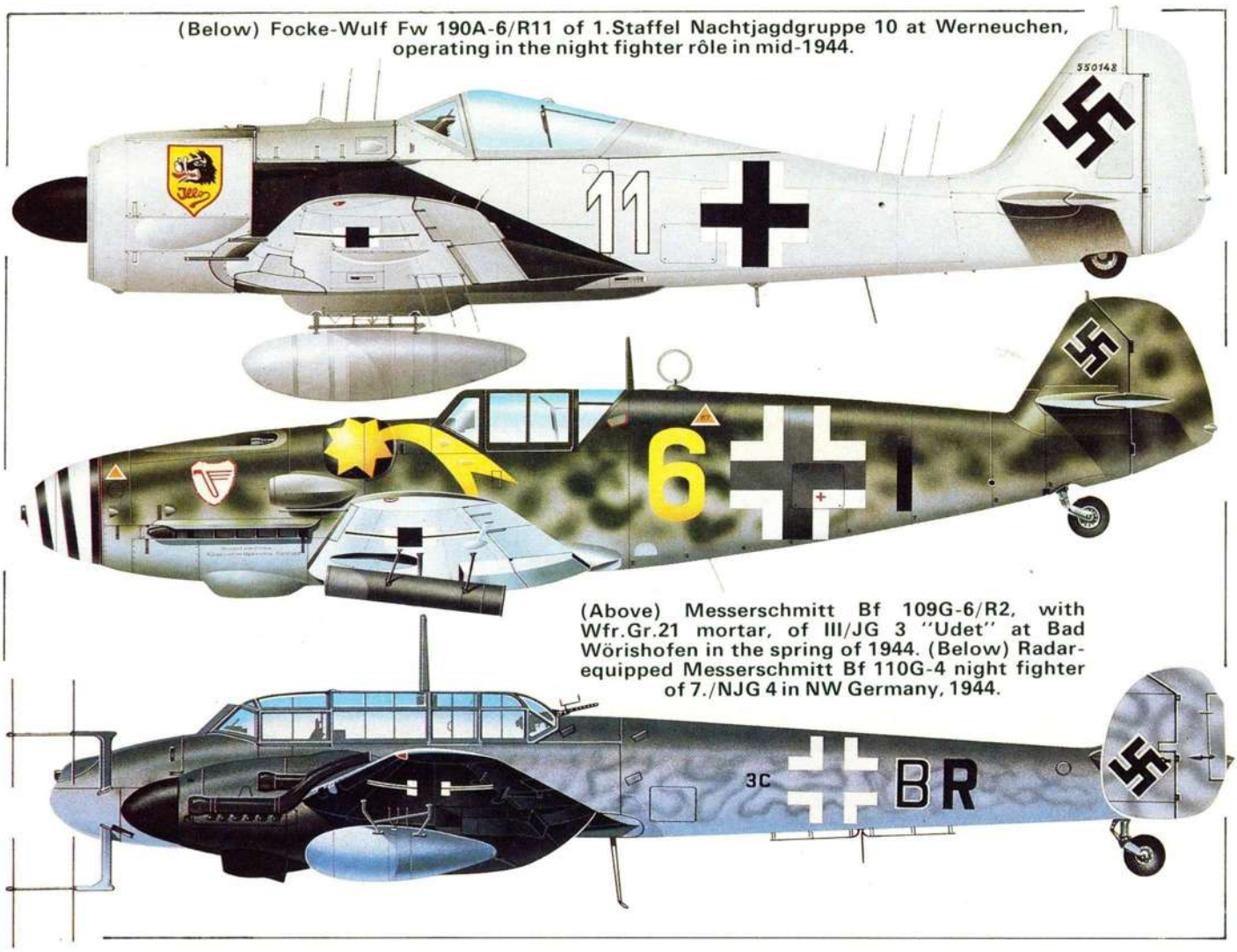


(Below) One of three 2nd TAF squadrons operating the Douglas Boston IIIA in mid-1944 was No 88 (Hong Kong) Sqn, based at Hartford Bridge, Hants, at the time of the Invasion.



(Below) Another of the Boston squadrons, No 342, was manned by French personnel and carried French roundels.

(Below) Focke-Wulf Fw 190A-6/R11 of 1.Staffel Nachtjagdgruppe 10 at Werneuchen, operating in the night fighter rôle in mid-1944.



(Above) Messerschmitt Bf 109G-6/R2, with Wfr.Gr.21 mortar, of III/JG 3 "Udet" at Bad Wörishofen in the spring of 1944. (Below) Radar-equipped Messerschmitt Bf 110G-4 night fighter of 7./NJG 4 in NW Germany, 1944.

and harried on their recovery to bases and strafed on the landing roll. In February and March 1944, during the *Big Week* and in the Berlin raids, *Luftflotte Reich* lost 969 Cat E destroyed, of which 683 Messerschmitts and Focke-Wulfs were brought down in aerial combat. Whilst there was no shortage in the supply of replacement aircraft, the accumulative effects of the air fighting over Germany were disastrous in terms of the loss of the hard core of experienced fighter personnel: units, shorn of their best pilots, were manned by freshmen with little or no combat experience.

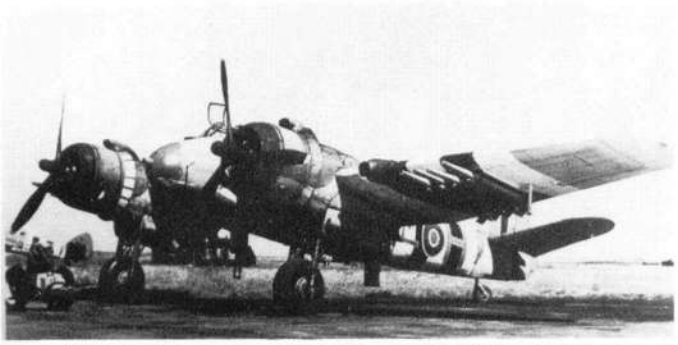
In the course of April 1944, the 8th Air Force of USSTAF achieved air superiority on all but a few isolated occasions over Germany: its fighters claimed 332 enemy aircraft destroyed in the air and 493 on the ground in 12,586 effective sorties for the loss of 148 missing in action. The loss of 361 B-17s and B-24s in 11,428 sorties, although heavy, was an acceptable percentage casualty rate. The attrition inflicted upon *Generaloberst* Hans-Jürgen Stumpff's *Luftflotte Reich* amounted to 556 Cat E, of which 433 were lost in combat, and in May 1944, when USSTAF turned to attacks on the synthetic oil refineries, the *Luftwaffe* fighter losses were to be even higher than those suffered in April. No air force could take that kind of punishment and at the same time be able to defend its own territory *and* counter a massive Allied invasion. Thus, the contribution of the US 8th Air Force in attaining air superiority over the *Luftwaffe* was of immeasurable value.

In the midst of the Allied pre-occupation of strategic bombing came the unwelcome discovery of the German V-1 weapon (FZG 76), and the construction in northern France of its associated launching sites. The campaign of bombing these sites became known as Operation *Crossbow*, started on 5 December 1943, and was primarily the responsibility of Air Chief Marshal T L Leigh-Mallory's AEAF. By November 1943, the AEAF controlled the RAF 2nd Tactical Air Force (led by Air Marshal A Coningham from January 1944), the transport Nos 38 and 46 Groups, the units of the Air Defence of Great Britain (formed from Fighter Command) and Lt-Gen Lewis H Brereton's US 9th Air Force.

On 15 November 1943, with the transfer of fighter and close-support units from the disbanded Fighter Command, the 2nd Tactical Air Force consisted of 11 squadrons of light-bombers of No 2 Group: Nos 21, 464 and 487 Sqns had been re-equipped with Mosquito FB Mk VIs; Nos 88, 107 and 342 Sqns had Boston Mk IIIAs, with the Mitchell Mk II serving with Nos 98, 180, 226, 305 and 320 Sqns. The Mosquito units were trained in low level tactics, and normally carried four 500-lb (227-kg) GP bombs in addition to their heavy armament of four 20-mm cannon and four 0·303-in (7,7-mm) machine guns. The Bostons and Mitchells flew in tight boxed formations ideally at 14,000 ft (4 260 m) which was considered to be beyond the range of German 20-mm and 37-mm *Flak*.

Broadhurst's No 83 Group consisted of 20 squadrons equipped with Spitfire Mk IXs and LF Mk IXs, Typhoon Mk IBs, Mustang Mk IAs (tactical reconnaissance), and a single squadron equipped with rocket-firing Hurricane Mk IVs, while 16 squadrons equipped Air Vice-Marshal L O Brown's No 84 Group. The Spitfire LF Mk IXs (Merlin 66), capable of 407 mph at 22,000 ft (654 km/h at 6 700 m) with +18 lb boost, were more than a match for the Fw 190A-6s and Bf 109G-6s now encountered with decreasing regularity over northern France, although the same could not be claimed for the Spitfire LF Mk VB that still formed the equipment of a number of squadrons in 2nd TAF.

For the Hawker Typhoon Mk IB the tribulations of its past were over, and the type was taking its place as a first-rate close-support fighter. In addition to its four 20-mm Hispano 404 Mk II cannon and a bomb load of up to 2,000 lb (908 kg), the Typhoon was being modified to carry eight rocket projectiles. This weapon consisted of a solid-fuel propellant, No 865 Mk I or No 878 Mk II percussion fuses, with either a 60-lb (27-kg) SAP/HE Amatol head for hard emplacements or a 25-lb (11,3-kg) AP-shot for tanks and AFVs. Initially, problems were encountered in short burn times and excessive gravity-drops which made accuracy difficult to maintain, but over the months pilots learned to use the RP with effect, and the exploits of 2nd TAF's rocket-carrying Typhoons in the Battle for



Bristol Beaufighters were among the aircraft of Coastal Command used to maintain the offensive against U-boats in the Channel; this is a TF Mk X of the Canadian No 404 Squadron.

Normandy were to become legendary.

The format of operations conducted by AEAF can be illustrated in an account of air operations over France and the Low Countries on a single day — 4 January 1944: the term *Ramrod* was the code name for a bomber attack on a specific target. The first mission was *Ramrod* 415 with Zero Hour at 08.00, in which more than 470 B-17s and B-24s were despatched to Kiel and Münster in Germany with the support of 558 US fighters operating in relays. Acting on 1st Fighter Sweep, Typhoons of Nos 198 and 609 Sqns swept the Eindhoven-Gilze Rijn sector to net six Dornier Do 217M-1 bombers of KG 2: Fg Off G J C Daix of No 609 Sqn failed to return. At 09.15 three combat wings of 9th Air Force B-26s set off on *Ramrod* 416, to attack V-1 sites (code-named *Noballs*); this was followed at 10.45 hrs by *Ramrod* 417 in which 2nd TAF Typhoons attacked sites in the Pas-de-Calais with No 184 Sqn's Hurricane Mk IVs: Fg Off K W Sim (No 245 Sqn) was shot down, but managed to bale out of his crippled Typhoon.

Ramrod 419 at 15.00 hrs (Zero) was held in two parts: two combat wings of 72 Marauders assembled over Beachy Head at Z+20 minutes with their Spitfire escort to attack *Noballs* XI/A/63 at Longuemont, A/59 at Béhen, A/60 at Bois de Coquerel, and A/37 at Gorenflos in Part I, followed by another wave against the same targets in Part II at Zero plus 45 minutes. No 122 Airfield (Nos 19, 122 and 222 Sqns: Spitfire Mk IXs) provided Escort Cover, with the Mk IXs of No 126 Airfield (Nos 401, 411 and 412 RCAF Sqns) acting on 2nd Fighter Sweep in the Evreux-Beaumont sector: in skirmishes two Fw 190s were claimed as probably destroyed.

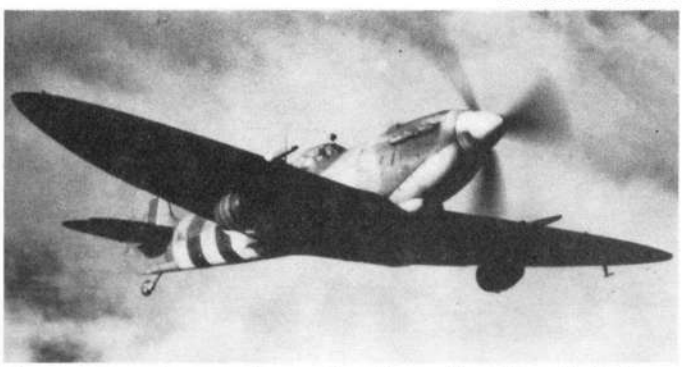
This operation ran concurrently with *Ramrod* 420 in which Typhoons dropped 36 500-lb (227-kg) GPs on *Noball* XI/A/39 at Yvrench-Bois Carré. While daylight still held, No 2 Group's bombers launched a maximum effort on V-1 sites in *Ramrod* 422 at 15.45 hrs: Part I was to *Noball* XI/A/65 (Ruisseauville) by Mosquito FB Mk VIs of Nos 21, 487 and 613 Sqns; Part II to XI/A/40 at Ligescourt by the Bostons of Nos 88, 107 and 342 Sqns; Part III to XI/A/25 at Bois Wairipel by No 320's Mitchells; Part IV was against Bois Carré by Nos 98 and 180 Sqns. When south of Abbeville, two Spitfires of No 501 Sqn were detached to take photographs of the attack, were bounced by eight Fw 190s, and one LF Mk VB was shot down. In all, the AEAF flew a record 1,104 sorties that day and lost only six aircraft.

The fighters of *II Jagdkorps* were airborne on this day, but confined their activities to combating the American heavies over Germany, and on the withdrawal route over the Ardennes and Luxembourg. Seldom was any reaction made against the AEAF as it proceeded with its pre-invasion tasks. The *Crossbow* commitment was to remain with the Allied air forces to D-Day and beyond, but the V-1 offensive, which commenced on 13 June 1944, was but a shadow of what it might have been.

Transportation Attacks

In the knowledge that the balance of *Overlord*'s success or failure would depend upon *Wehrmacht* ability to rush reinforcements to the Normandy sector in the wake of D-Day, the Allied air forces now turned part of their attention to attacks on rail communications, mainly those in Belgium and France. RAF Bomber Command received a new directive from the Air Ministry on 4 March 1944, which, in addition to ordering a continuance of attacks on industrial targets in Germany, charged the Command to open attacks on the SNCF rail network and the marshalling yards at Trappes, Aulnoye, Le

(Left) Ground crew of one of the Dutch squadrons serving with the RAF in 1944 attend to a Spitfire under difficult field conditions. As opportunities for air-to-air combat declined, the Spitfire was increasingly used for ground attack sorties — hence the underwing bomb load. (Right) The Hawker Tempest squadrons were heavily engaged during and after the landings. (Below left) Once the Allied troops were safely ashore, the provision of supplies and reinforcements took on a new importance. An unlikely but welcome innovation had Spitfires carrying barrels of beer on the wing strongpoints!



Mans, Amiens-Longeau, Courtrai and Laon. Harris' formidable force, which in March fielded on average 974 Lancasters, Halifaxes, Mosquitoes and Stirling Mk IIIs, began its campaign on transportation on the night of 6-7 March 1944.

Bad weather prevented the AEAF from starting its series of raids on rail targets until 15 March, when IX Bomber Command's B-26s went to Aulnoye on *Ramrod* 655: the important marshalling yard at Creil was visited by the B-26s two days later. Initially these attacks were made on a trials basis, not only to assess the damage, but also to ensure that civilian casualties were not grievously high. Considerable opposition to the transportation plan had been encountered, but Leigh-Mallory's staunch advocacy of its advantages won the day. On 15 April 1944, Air Chief Marshal C F Portal, the RAF Chief of the Air Staff, handed a complete list of transportation targets to the US 8th Air Force and RAF Bomber Command, both of which had been placed under Eisenhower's command for the purposes of *Overlord*. By the night of 2-3 June, when Trappes was attacked once again, RAF Bomber Command had flown more than 8,800 sorties and dropped over 42,000 tons (42 674 tonnes) of bombs on 33 primary rail centres, including those at Mantes-Gassicourt, Creil, Trappes, Juvisy, Vaires-sur-Marne, Noisy-le-Sec and Villeneuve-St Georges.

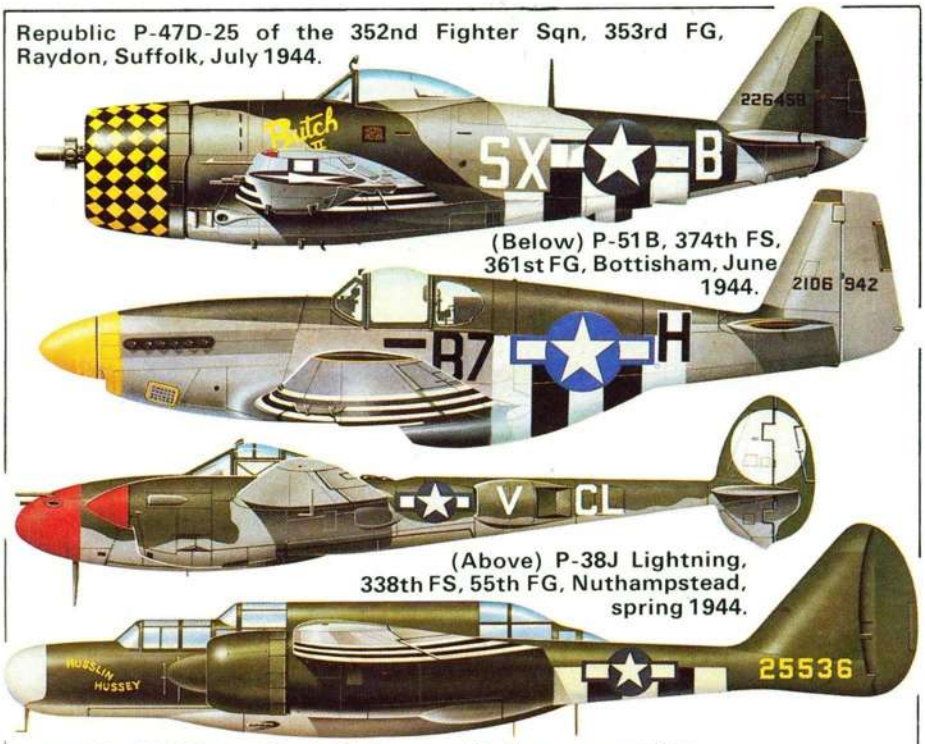
The 8th US Air Force, still embroiled in the cut-throat battles over the *Reich*, was slower off the mark, but commenced its own series of heavy transportation attacks on 11 May, when the rail centres at Epinal, Mulhouse, Belfort, Chaumont and Saarbrücken were raided. By the dawn of D-Day, 66,517 tons (67 586 tonnes) of bombs had been directed against 80 chosen rail targets, 51 of which were assessed to have been rendered to a state of permanent disrepair. Photographic reconnaissance brought back little indication of the true state of immobility to which the *Région Nord* of the SNCF had been reduced, and in the days following the invasion German reinforcements were moved by rail only with the greatest difficulty.

The crescendo in pre-invasion operations predictably took place in May 1944 by overwhelmingly powerful Allied air forces. The balance of air power in numbers alone was unprecedented, with Eisenhower having 3,467 heavy bombers, 1,645 medium, light and torpedo bombers, 5,409 fighters and 2,316 transport aircraft and gliders positioned at bases in the United Kingdom for *Overlord*. As late as 31 May, the enemy air force command in France and Belgium, *Luftflotte 3*, could dispose only the following serviceable aircraft: 16 close-reconnaissance Fw 190s and 30 long-range reconnaissance aircraft, 102 night fighters, 36 ground-attack Fw 190G-3s, 34 night bombers, 19 fighter-bombers, and 119 Fw 190A-8 and Bf 109G-6 day fighters of JG 2 and JG 26 at Creil, Cormeilles-en-Vexin, Lille-Nord, Lille-Vendeville, Denain and Cambrai-Epinoy. There was, in addition, a small force of anti-shipping Junkers Ju 88A-4s based in southern France. Over the few weeks preceding D-Day RAF Bomber Command and the US 8th Air Force kept up an increasing tempo of operations on rail transportation, while the AEAF's 2nd Tactical Air Force and US 9th Air Force blitzed V-1 sites, road and rail termini, bridges, airfields, coastal batteries and radar stations. Throughout these operations the *Luftwaffe* was seldom in evidence.

D-Day: The Landings

In so many ways, all sections and arms of the Allied air forces contributed to the creation of a favourable situation for the launching of Operation *Overlord*. Not least among these were the units of Air Chief Marshal W Sholto Douglas's RAF Coastal Command, to which Nos 15, 16, 18 and 19 Groups were subordinated with attached units of the Fleet Air Arm and the US Navy. Thirty squadrons were equipped with Liberator GR Mk IIIs and GR Mk Vs, Sunderland GR Mk IIIs, Catalina Mk IVs and Leigh-Light Wellington Mk XIIs for long-range patrol work, with Beaufighter TF Mk Xs and Mk VICs forming two powerful strike wings within Nos 16 and 19 Groups. With the lethal Type IX U-boats now equipped with the *schnorkel*

(Above) The Douglas C-47 Skytrain (Dakota in RAF parlance) proved to be the transport workhorse of Operation Overlord, carrying paratroops and supplies in enormous quantities. Much less well-known but also engaged was (below) the Curtiss C-46 Commando, of similar capability.



device, Dönitz was able to mount patrols well within the coastal reaches of Britain and in the Channel: in June, when the U-boats were sent to their anti-invasion stations BdU fielded 21 submarines at Bergen in Norway, nine at Brest and La Pallice earmarked for operations off the Isle of Wight, and 19 in reserve at bases in the Bay of Biscay. From 16 May 1944, the Norwegian U-boats made their transits into the Atlantic via the Iceland-Faröes gap: these were countered by No 18 Group from bases in Scotland, assisted by No 15 Group and two squadrons located in Iceland. Regular *Cork* patrols were made by the Liberators of No 19 Group over the Bay of Biscay and in the Western Approaches from airfields in south-west England.

The battle began in earnest on the night of 6 June, when the Biscay forces left their bases and headed north for the Channel: Sunderlands of Nos 201 and 228 Sqns sank U-995 and U-970 in the Bay on the night of the 7th, with four U-boats being sunk in the western reaches of the Channel during 8-10 June by Nos 206, 120, 224 and 248 Sqns. By 15 June, the Bergen-based submarines entered the Channel, having suffered the loss of four of their number during the northern transits to RAF Coastal Command. In all, seven U-boats were sunk in the Channel in June 1944, with another seven in July despite the use of *schnorkel*: their attacks netted 12 ships and four LSTs sunk, and one small escort vessel damaged.

With RAF Coastal Command continuing its fight against the insidious threat of the U-boat, the first week of June 1944 saw the final preparations for *Overlord* and *Neptune*. The troops were on board the ships, and the great armada was prepared to sail. A factor over which the Allies had no control, the weather, continued to give anxiety to the commanders with the forecast of low cloud, rain and high winds. At 04.50 hrs on 5 June, Eisenhower made the loneliest decision of his long career: the landings were to take place in the course of the following morning.

At Harwell airfield, at 23.03 hrs on 5 June, Squadron Leader Merrick with Air Vice-Marshal L N Hollinghurst at his side lifted off the first of six Albemarles carrying the 22nd Independent Parachute Company, the pathfinders for the air landings of the British 6th Airborne Division. In the blackness of this crowded night 264 aircraft and 98 tug-glider combinations of Nos 38 and 46 Groups headed for the drop-zones at points on the Orne and the Dives: 4,310 paratroops were dropped, and 493 men, 17 guns, 44 jeeps and 55 motorcycles were landed by Horsa and Hamilcar gliders. Seven RAF transport aircraft and 22 gliders were shot down. To the west, at St Mère-Eglise, US 9th Air Force C-47s and Waco CG-4A gliders carried the men of the 82nd and 101st Airborne Divisions. All drops and landings were completed by 04.04 of the morning of 6 June.

As the naval forces headed south across the Channel, Lancasters of Nos 138, 149, 161, 218 and 617 Sqns engaged in Operation *Taxable* for ECM jamming of the German radar stations. By 10.15 the assault forces of British 2nd Army and US 1st Army were firmly ashore on the Normandy beaches, which had been subjected to a pre-assault pounding by naval units and Bomber Command's Lancasters and Halifaxes; most of the landings took place in conditions of light opposition, only at Omaha, where the US 16th and 116th Infantry Divisions were under pressure, was there much anxiety. If anything, the events in the air on this momentous day were something of an anti-climax: up to 20.00 hrs the AEAF flew a total of 3,796 sorties, to claim only 3-0-1 for the loss of 30 to *Flak* and another 33 damaged. Of the *Luftwaffe* there was little sign.

As early as 07.40 twenty Fw 190A-8s of III/JG 2 from Cormeilles made an abortive attack on B-26s retiring from a mission over the Pointe du Hoe; twelve Bf 109Gs bounced a squadron of Typhoons south-east of Caen at 12.00 without effect; another abortive interception occurred at 12.55 once again on Typhoons in the vicinity of Caen. Evidence of increased activity was noted in the afternoon when small formations of Ju 88s, Ju 188s and Me 410s attempted to gain access to the shipping lying offshore: Spitfire Mk IXs of Nos 349 and 485 Sqns chased a *staffel* of Junkers Ju 88A-4s from Gold Beach to Caen where they shot down four and damaged three. The Mustangs and P-47Ds of US VIII Fighter Command had more fortune and experienced some opposition, including a spirited fight with II/JG 26 over Beauvais-Tillé, while the 56th Fighter Group excelled itself by claiming 15-0-4 Ju 88s. The losses of *Luftflotte* 3 on 6 June 1944 amounted to 31 aircraft destroyed in action and seven damaged in fruitless attempts to break through the Allied air umbrella. Bitter and protracted fighting on the ground was to endure until late-August 1944, but throughout this campaign the issue in the air, prepared at such cost and over three years, was never to be in doubt. □

Under the curtain

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From "Lessons from the Falklands Campaign", a White Paper presented to the House of Commons, December, 1982.

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