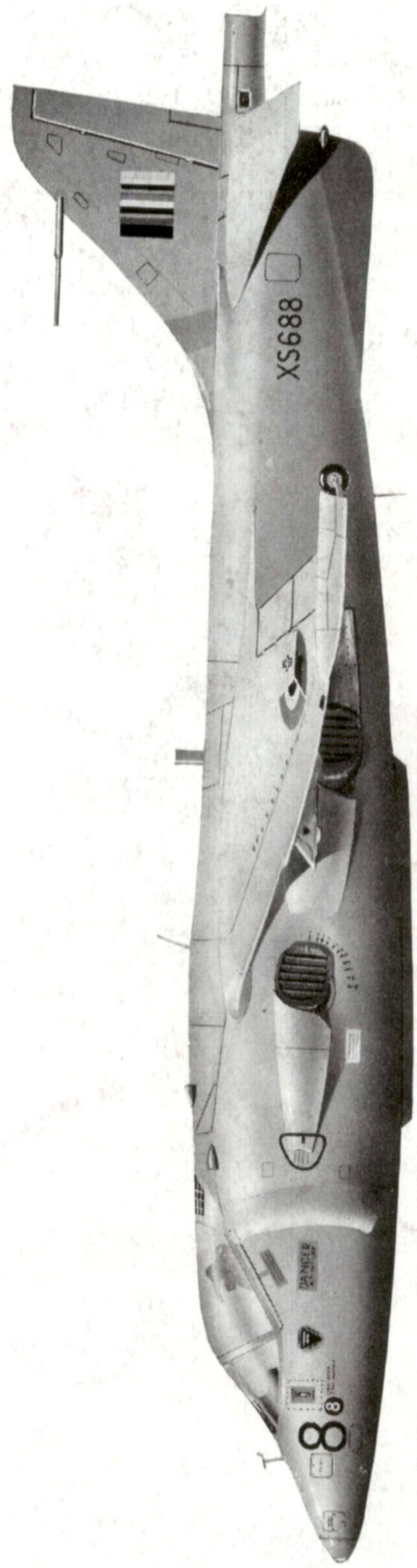
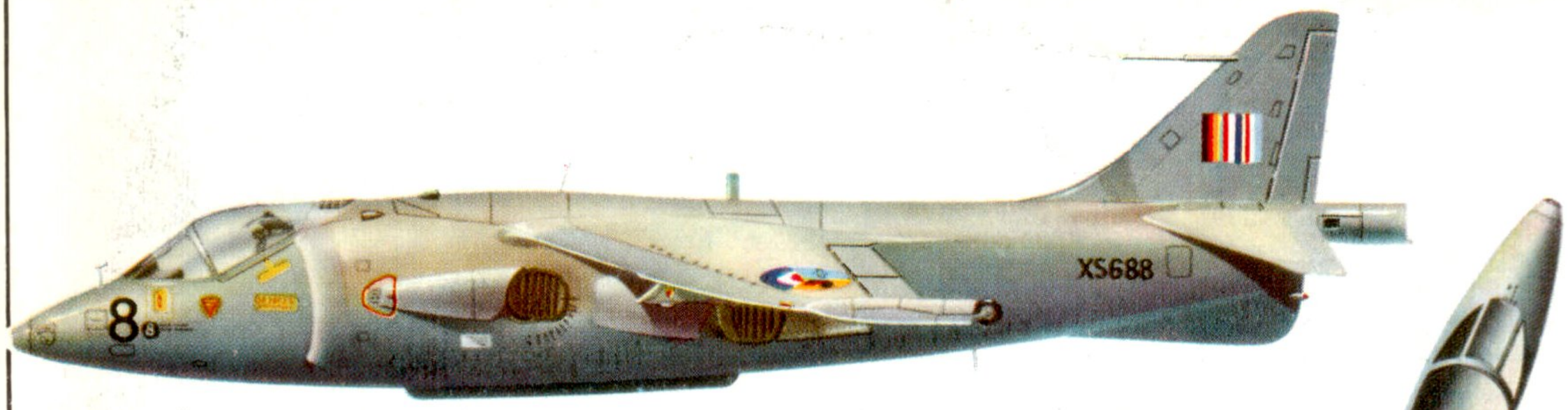
PROFILE PUBLICATIONS

The Hawker P.1127 and Kestrel

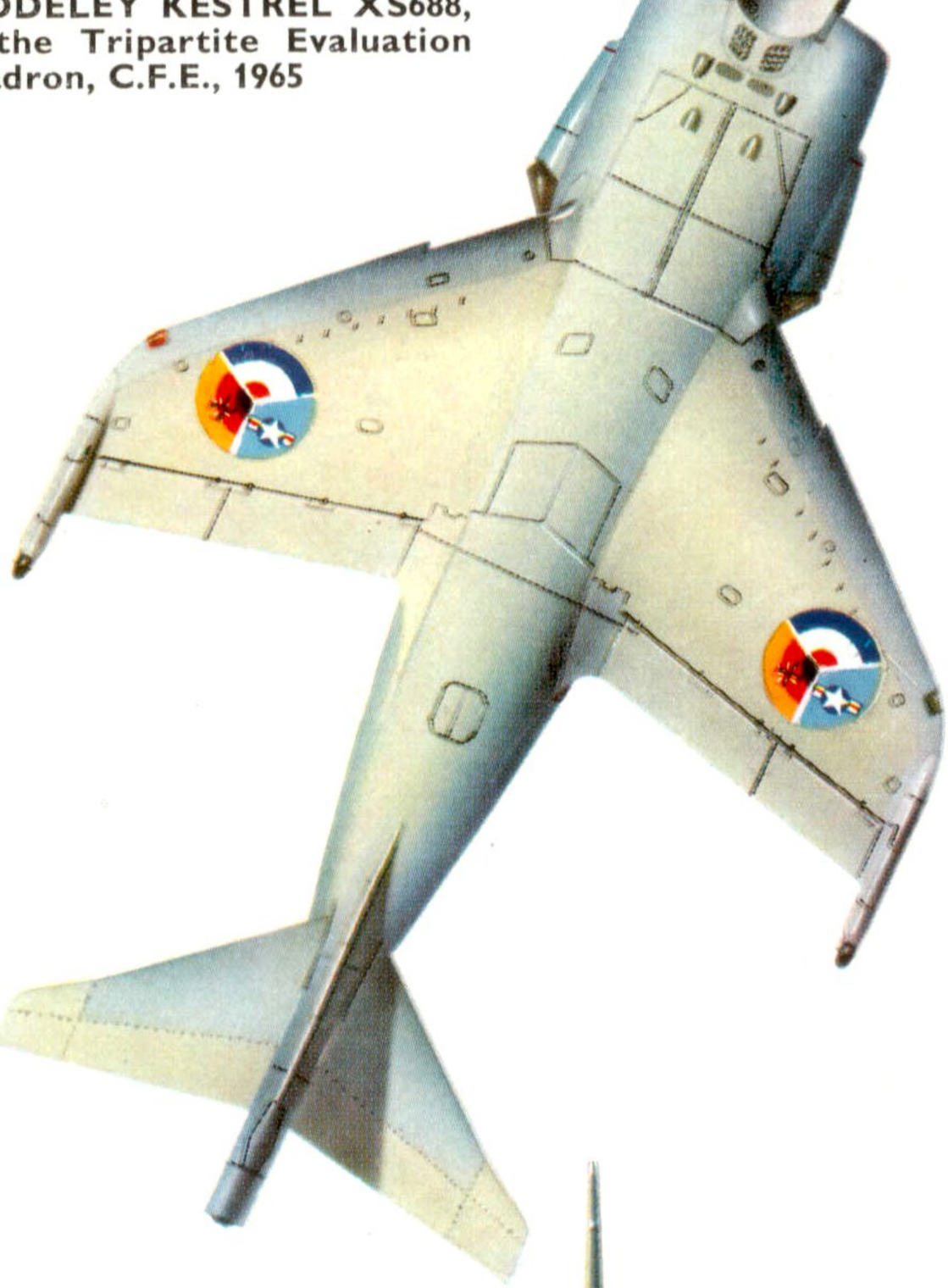
NUMBER 198



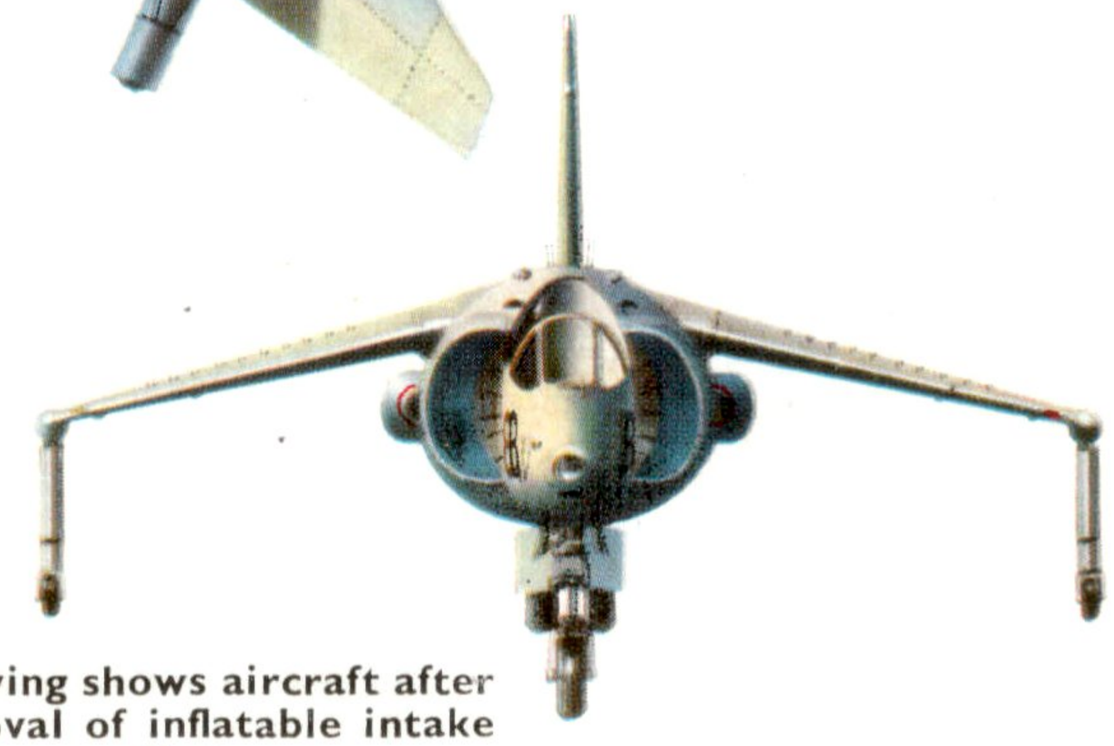


HAWKER SIDDELEY KESTREL XS688, as flown by the Tripartite Evaluation Squadron, C.F.E., 1965

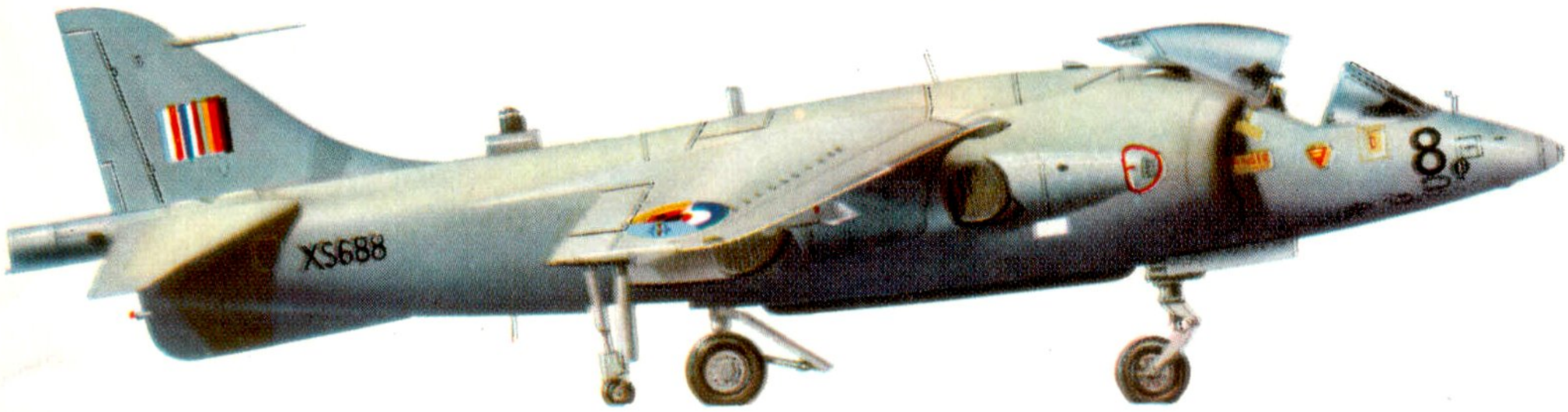
Inscription reads:
CREW CHIEF:
T/Sgt. MASSEY, C.



Tripartite wing insignia



Drawing shows aircraft after removal of inflatable intake lips.



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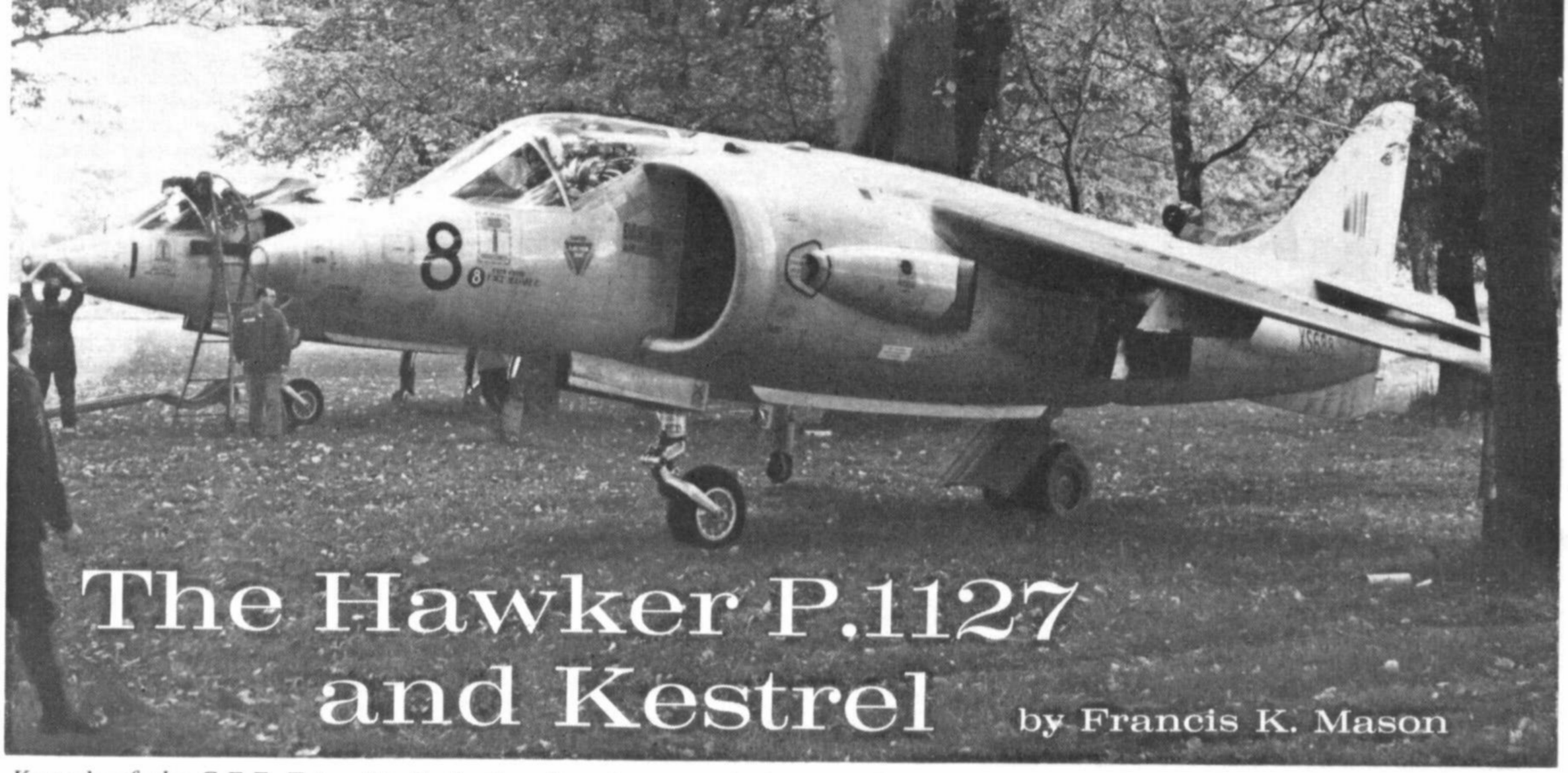


The Hawker P.1127 and Kestrel

by Francis K. Mason

Kestrels of the C.F.E. Tripartite Evaluation Squadron seen during one of several dispersed-site operations. Aircraft No. 8 is the subject of one of the general arrangement drawings in this Profile. *(Except where stated, all photographs are by courtesy of Hawker Siddeley Aviation Ltd.)*

It has been said—perhaps with more sentiment than truth—that private enterprise has sired greater technical advance in the air than has nationally-sponsored demand. Be that as it may, the concept and early development of the Hawker P.1127 must be recognised as probably the last commercially-initiated major military project to emerge from Britain's post-War aircraft industry. Moreover, critics of the late Sir Sydney Camm—there *were* some—averred that his design team possessed the ability to perfect the ideas of others while lacking original thought. As if to silence this critique for posterity, Sir Sydney's ultimate design was as original as it was brilliant. No one, however, would attribute the design to Camm himself but to the design team he had fostered for nigh on forty years, yet he was the leader who held firm to and propounded the particular thesis of the P.1127, and while so many "better" philosophies seemed to win the day, his design won the final battle.

* * *

After the Korean War had ended, a number of aircraft manufacturers in America and Europe turned their attentions to the problems of vertical take-off by combat aircraft, the dream of eliminating vulnerable runways by launching aircraft vertically rather than horizontally. One suspects that, with the War then past, the aircraft projects (the tail-sitters, the flat-risers and the bedsteads of the then-current vernacular) were as much orientated towards commercial as military exploitation. Certainly by 1957 the balance of future support had been tilted towards airliner application, so that at the Anglo-American Aeronautical Conference at Folkestone few of the delegates envisaged realistic high performance military aircraft possessing VTOL characteristics.

It was however at about this time, early in 1957, that Dr. Stanley Hooker of the Bristol Engine Company informed Camm that his company was pursuing a project combining the Orpheus and Olympus engines to provide a ducted fan jet with rotatable "cold" jets on either side of the compressor. The "hot" jet remained a conventional central tailpipe. (A similar project had been initiated by M. Wibault in France using a hypothetical engine some time previously).

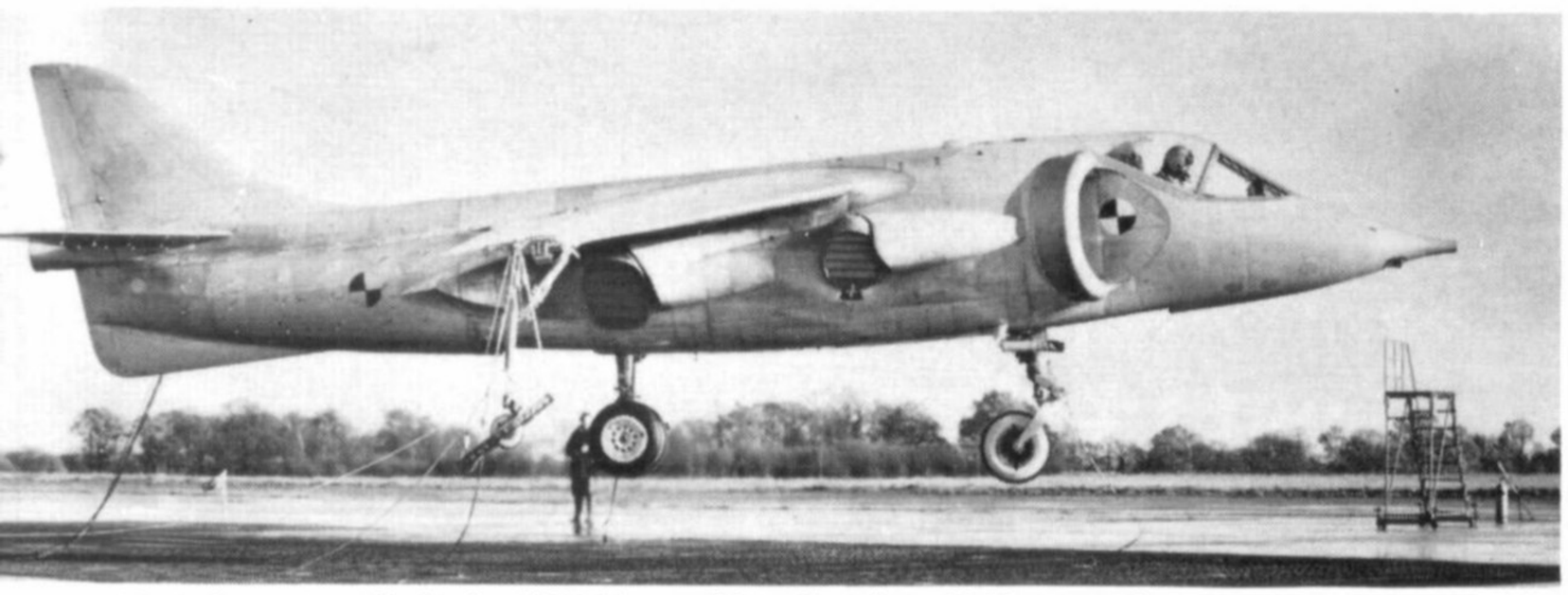
It fell to Ralph S. Hooper, a senior Project Engineer at Hawker, to scheme up an initial layout (the P.1127) around this Bristol engine project—and this designer remained prominent in the development of the P.1127 for ten years after. In July the design was altered to incorporate a bifurcated tailpipe (as patented by Hawker in the Sea Hawk) featuring rotatable nozzles at the "hot" end. The aircraft was thus able to dispense with the tailwheel undercarriage and assume the more conventional nosewheel ground stance.

It is necessary here to observe that preparations were at this time underway in NATO to choose a light tactical support fighter, for, though the Fiat G-91 would shortly enter service, its replacement would be necessary inside seven years. As much on account of this requirement as in frustration from the 1957 Defence White Paper, Hawker determined to suit the P.1127 to the NATO performance and load requirements. Whatever wisdom lay in this line of action, there was never a shortage of British Air Staff Officers and politicians to decry and denigrate the Hawker efforts. "After all", they cried, "we've enough on our plate to get GOR339 (the TSR-2) developed". So Hawker, having abandoned its own P.1121 project at final assembly stage, went ahead alone.

Alone, that is, with Bristols. But even Bristols were having financial difficulties for, as there appeared to be no civil application for the new engine, the British Treasury would lend no support. It rested therefore upon NATO interest, and through this, on American financial aid. This was ultimately forthcoming through the offices of the MWDP (Mutual Weapons Development Programme), and it is worth remembering this fact when considering the survival of the whole project in the light of the abandoning of others.

Design development of the P.1127 thus continued throughout 1958 almost entirely supported by Company funds. Numerous visits were paid to NATO headquarters to learn of European tactical demands, and the Hawker design staff was often left to arbitrate between demands for supersonic performance with

Roll-out picture of the first prototype P.1127, XP831, *taken on 17th August 1960. The cockpit canopy is still protected by masking material and various minor panels are not fitted.* (Neg. No. EXP255/60)



First hovering flight by XP831 *on 21st October 1960 over the gridded platform. The aircraft is tethered at the nosewheel and at each wingtip, and the other cables carry instrumentation data and radio telephone. Note the large intake lips, rear fuselage and tailplane tufting and omission of tail parachute, wheel doors and nose boom. Only the noise was indescribable!*

light loads on the one hand, and a simpler, multi-purpose subsonic aircraft on the other. In the face of tremendously sophisticated aeroplanes (the F-104G was about to enter service), Camm at Hawkers steadfastly believed that his aeroplane must portray simplicity. Quoth he, "Sophistication means complication, then in turn escallation, cancellation and finally ruination."

The P.1127 in 1958 had crystallised—on paper—as being powered ultimately by a Bristol B.E.52 lift/thrust engine giving about 13,000 lb. thrust; the aircraft, fully equipped, would weigh slightly less than this figure so that true vertical take-off would be bestowed under all normal field conditions. So as to maintain high tactical flexibility, no fixed armament would be designed into the airframe, reliance being placed on carriage of underwing stores.

Hawker also initiated an interesting series of blowing trials using models through which cold and hot air was directed on to ground boards to simulate the ground effect on lift-off. These trials were of vital importance as little was known of the adverse effects that might influence the aircraft's ability to take-off. Experiments were also conducted with wingtip control jets, for it should be remembered that without forward speed the aircraft would possess no airflow over the ailerons, tailplane and rudder. A most ingenious control response simulator was developed by the Project Office by linking a simple set of flying controls to a computer, this work being undertaken under the direction of R. Balmer.

So quickly did Hawkers' basic research prove the validity of the project that by the end of 1958, senior technical advisers at NATO were even suggesting that the re-equipment of member countries should "leap-frog" the next generation of support fighters and that development of the P.1127 should be accelerated. It is possible that this interest, combined with the fact that TSR-2 had during 1958 reached approval stage with the British Treasury, was the reason for increased support by the British Air Staff—with the result that Hawker learned in January 1959 that the Ministry of Supply was considering a contract for two prototype P.1127s. It was even rumoured that an Air Ministry Specification was about to be drafted around the project.

It was at about this stage that further efforts were made to learn whether American finance could be acquired, but Hawker was advised that almost all available MWDP funds were earmarked for development of the Vickers Swallow swing-wing project. However, considerable "off the cuff" free-flight model work *was* undertaken for the project's overall benefit by NASA at Langley Field (both in a free-flight tunnel and "round the pole").

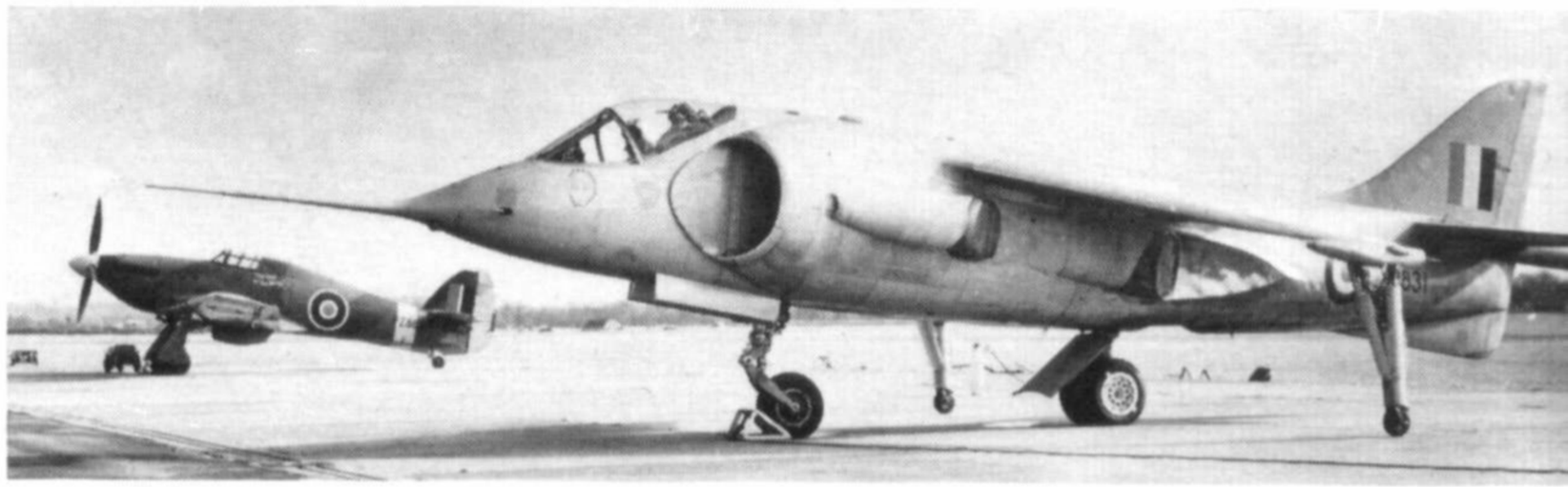
By the time, in April 1959, that Hawker was formally asked to go ahead with the manufacture of two prototypes, the Company had already virtually formed its design and two months previously had passed all manufacturing design work to the Experimental Design Office in Kingston. From that time on scarcely a day passed that some important mission was not visiting Kingston as evidence of mounting interest in the project.

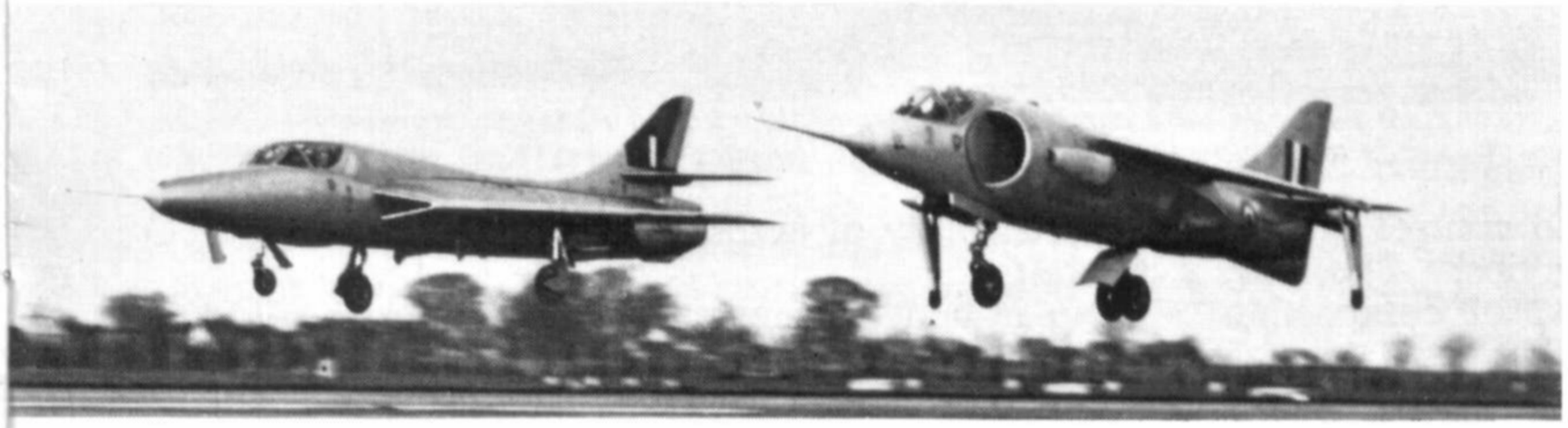
Still the way ahead was far from straightforward. A design philosophy that had been nurtured through the appearance in 1956 of the multi-engined Short SC.1 VTO test vehicle and which, supported by Rolls-Royce mechanically and politically, had achieved a fair degree of sympathy from Air Staff, commercial aviation and foreign circles, was now proposed as being the most realistic approach to a tactical air-superiority, supersonic strike aircraft. Those who felt that there would be little justification in

Preparations being made for engine running prior to the first flight. In the cockpit is Bill Bedford, beside him Frank Cross, head of the Experimental Design Office. The large sheet metal shrouds were designed to allow both horizontal and vertical nozzle positions during engine running. (Neg. No. EXP256/60)

Right: *During the original translational flights by* XP831, *the last Hurricane* PZ865-G-AMAU (*owned by Hawker*) *was used as chase 'plane, possessing as it did a controllable speed range from 70-250 knots.* (Neg. No. EXP32/61)

Below: *A two-seat Hunter T.7 was used as chase 'plane during the first conventional flights by* XP831 *at the R.A.E., Bedford.*
(Photo: Bristol Siddeley Engines, Neg. No. E46897)





pursuing a subsonic combat aircraft now demonstrated the traditional fickleness that has characterised British military air planning since the Second World War. It was this situation of political incoherence among defence planners, resulting in impotence in the Civil Service, that undoubtedly delayed the issue of a Contract to Hawker Aircraft Ltd.

HARDWARE AND HARD CASH

On 23rd June 1959 the Company authorised maximum effort and overtime on the P.1127. By then Bristols had made considerable strides in the development of the engine and, although no prototype engine yet existed, they were able to predict that by the time any production order could be placed they would be able to offer at least 15,000 pounds thrust.

By March 1960 an early bench engine had been tested suggesting that the prototype would fly with about 10,000 lb. installed thrust. Meanwhile the two senior Company test pilots, Bill Bedford and Hugh Merewether, paid a visit to Ames AFB in the U.S.A. to gain familiarity with the Bell X-14 research aircraft (during the course of one such flight a situation developed in which inadequate roll control remained to counter a wing-down state during landing, and the resulting minor accident prompted Hawker to increase the roll control power in the hover on the P.1127.).

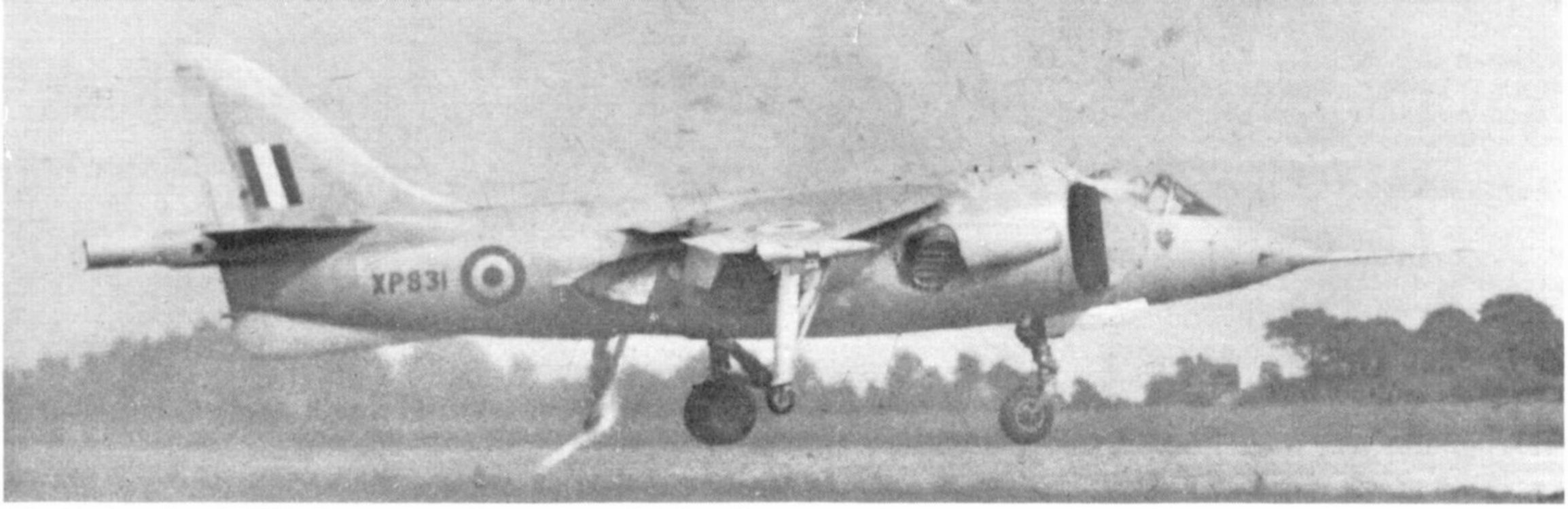
On 6th May 1960 the first engine was delivered to Hawker for installation in the prototype *XP831* . . . and on 22nd June the contract for two prototypes was signed!

It is convenient at this point to describe the P.1127 in some detail, but in so doing it should be remembered that for every ounce of additional structure or equipment weight advocated by this or that design section or Service department a compensating saving had to be found elsewhere, or greater engine thrust provided—a natural consequence of any aircraft dependent upon engine "lift" rather than wing lift.

The aircraft was a conventional structure with ground attack strength factors. The cockpit was located forward of the engine which derived its air through large "elephant-ear" intakes. The "cold" air exhausted from the large fan forward of the compressor through rotatable fibreglass nozzles, and bleed

Disembarkation by Bedford at Bedford.

Backslapping, pianissimo, after the first conventional flight at Bedford, 13th March 1961. Left foreground, Sir Sydney Camm; in flying overalls, Bill Bedford; in dark suit, foreground, George Anderson (Sales Manager); far left background, Roy Chaplain, Deputy Chief Designer, with Fred Sutton, Flight Test Manager. Tall figure in centre of photo with briefcase is Ralph Hooper, Senior Project Engineer in charge of P.1127, talking to Frank Cross (standing behind Bill Bedford). The group on the right includes Hugh Merewether (Chief Experimental Pilot who flew the chase Hunter), Nigel Money (Senior Project Engineer, Flight Liaison), and Bristol Siddeley technicians.
(Photo: de Havilland Aircraft Co. (Dennis T. Waller) Neg. No. L746)



Short take-off by XP831 *from grass. Numerous such take-offs were carried out at Dunsfold with surprisingly little surface erosion, and though a good deal of dust is thrown up this tends to be blown aft and seldom limits the pilot's vision.* (Neg. No. 1127(R)83/62)

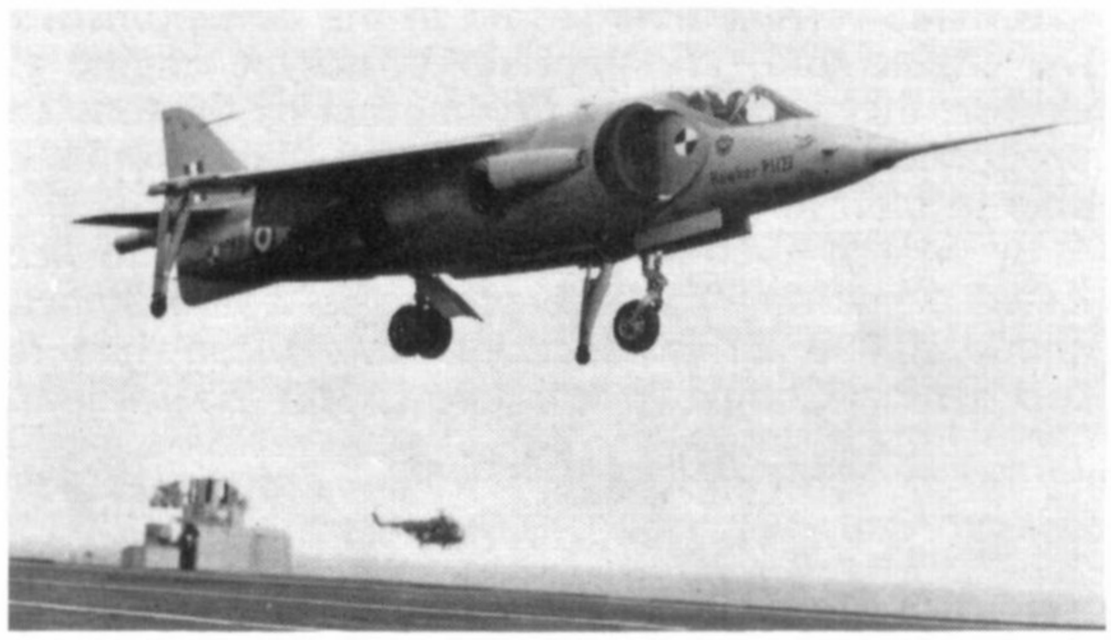
air was led from the compressor to control nozzles ("puffers") at nose, tail and wing tips. The rear, "hot" end of the engine consisted of combustion chamber and turbines exhausting burnt gases through a bifurcated exhaust trunk to two steel rotatable nozzles in either side of the fuselage. The shoulder-mounted wing was a continuous structure mounted across the top of the fuselage and included marked anhedral. Wing shapes were progressively altered from clipped delta to full-swept, with extended leading edges and sawtooths from time to time. The all-moving tailplane was a single-piece unit hinged through the rear fuselage.

Perhaps the most unusual feature—even for this aeroplane—was the undercarriage, often incorrectly referred to as a bicycle type. This was in fact a "zero-track" tricycle, the aircraft weight being taken mainly upon midship-mounted twin main-wheels and steering being by conventional nosewheel (on the prototype a Sea Hawk nose leg was adapted). Balancing on the ground was by wing-tip outriggers which were originally to be "signalled down" as soon as the mainwheel oleo was loaded so as to protect these relatively light structures from undue loads during landing. This sequencing was soon found to be unnecessary.

The flying controls were entirely conventional in the normal flight regime. However with a reduction in airspeed to the point at which normal aerodynamic stall would occur, control progressively reverted to the reaction jets at nose, tail and wing tips. This was automatically achieved as the nozzles were moved down from the rearward direction by bleeding progressively more air from the engine compressor.

It was always a bone of contention as to what reliance was to be, indeed required to be placed upon an autostabiliser, and, although this was always fitted, countless transitions were carried out with the equipment switched off. (It is not within the scope of the *Profile* to discuss here the weight, complexity and reliability of autostabilisers fitted in other VTO aircraft).

No in-built armament was carried in the P.1127, reliance being placed for maximum tactical flexibility upon various under-wing stores which ranged from multiple 2-inch rocket batteries, 30-mm. Aden gun pods and 1,000-pound bombs to drop tanks and Napalm tanks. The prototypes all featured a long nose instrumentation boom but on later aircraft the pitot boom was mounted on the fin as a tactical camera was installed in the nose. Another unusual feature was the ram-air turbine mounted in the top of the rear fuselage just forward of the fin; this provided power for ancillary services in the event of an engine failure and therefore was extended outside

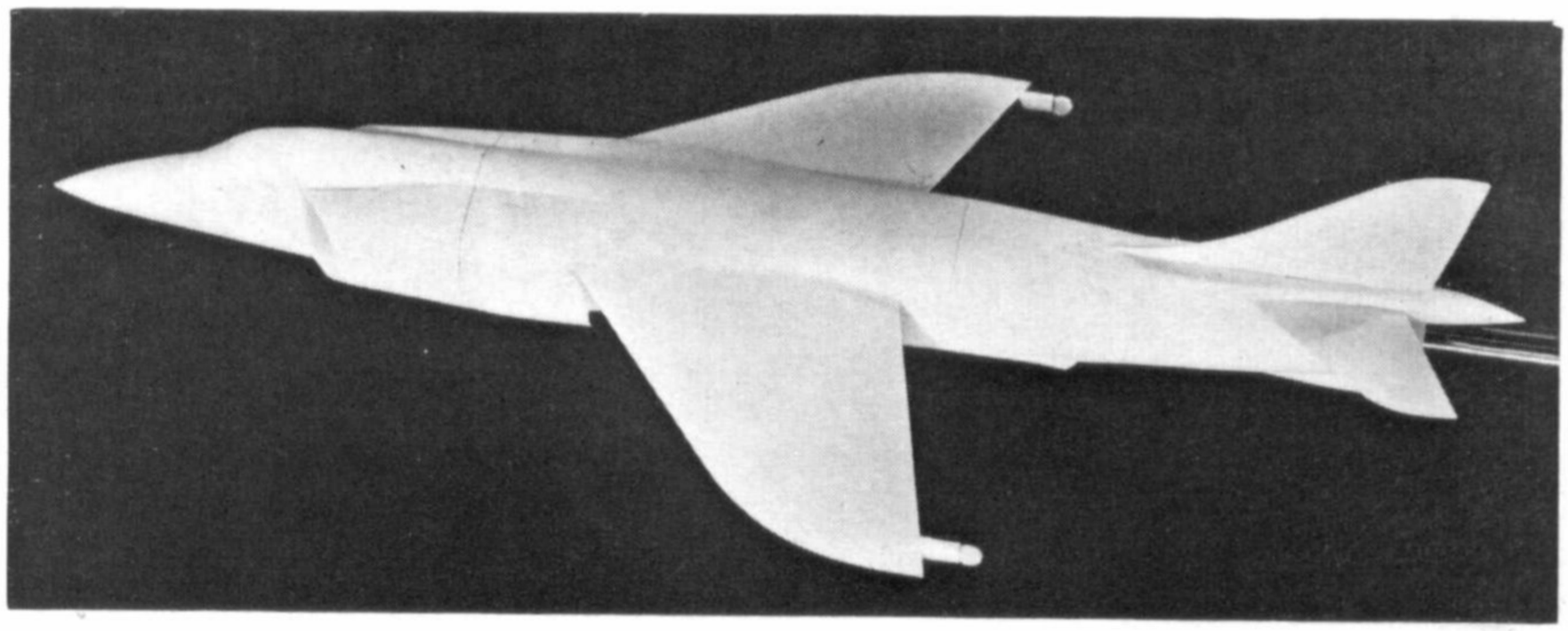


Carrier trials by XP831 *aboard H.M.S.* Ark Royal *early in 1963 were not accompanied by the usual symptoms of apprehension among the deck crew, frequently witnessed during trials with new aircraft!*

Bedford, Merewether and Simpson airborne in the three surviving prototypes (prior to the arrival of XP984). *The scorching and wrinkling of the rear fuselage skins is evidence of problems not entirely solved by enlarging of the rear nozzle "pen-nib" fairings. Note that* XP831 *has acquired the anhedral tailplane.* (Neg. No. 1127/115/63)

Penultimate prototype, XP980, *on the grid at Dunsfold in 1963. This prototype introduced the streamwise wingtip; note also the intake inflatable lips and the underfuselage strakes.* (Neg. No. 1127(R)80/63)

The aesthetic lines of the ill-fated P.1154 are shown by this wind-tunnel model. The wingtip arrangement with inset balancing wheels has since been adopted on the Harrier.



the fuselage whenever the engine was inoperative on the ground.

FIRST FLIGHTS AND MORE PROTOTYPES

Although not quite unique in this respect, the P.1127 was unusual in that it represented not only a totally new concept of a flight technique but also featured a brand new type of powerplant, the lift/thrust fan turbojet. What was perhaps even more unusual was that this engine had never previously been flown in a test bed. Nevertheless, despite any misgivings that anyone may have harboured as to the inherent dangers in the forthcoming trials, Bill Bedford certainly displayed no lack of confidence in the new aircraft for, having broken his leg in a car accident while in Germany the week before, he proceeded to conduct all the initial hovering trials with his leg encased in a large plaster cast—not the simplest expedient for control sensitivity!

XP831 was delivered to Dunsfold on 15th July 1960 and on 31st August the first engine run was carried out in the airframe using a specially-modified silencing pen. Even now there was drama for during these runs a small fire developed as the result of an oil leak and only the very prompt action of an attendant fireman, who ventured right up to the "hot" end of the running engine and inserted a foam extinguisher nozzle between the panels, prevented the possible spread of the fire.

Meanwhile, on the aerodrome a special platform had been constructed; this was in effect a large concrete-lined pit over which was placed a steel grid. Its object was to deflect the hot exhaust gases away from under the P.1127 when running with the engine nozzles vertical, thereby reducing the adverse ground effect during early hovering trials. Later, as engine power was increased, a greater margin of power would exist to enable this effect to be overcome without recourse to the grid.

On 13th October the first Pegasus flight engine was delivered to Dunsfold and run in the airframe. With a total thrust of 11,300 lb., this engine probably gave an installed thrust of slightly over 10,000 lb. And on 21st of the same month *XP831* rose off the grid to the height of 18 inches (albeit securely tethered and rigorously stripped of all extraneous weight)!

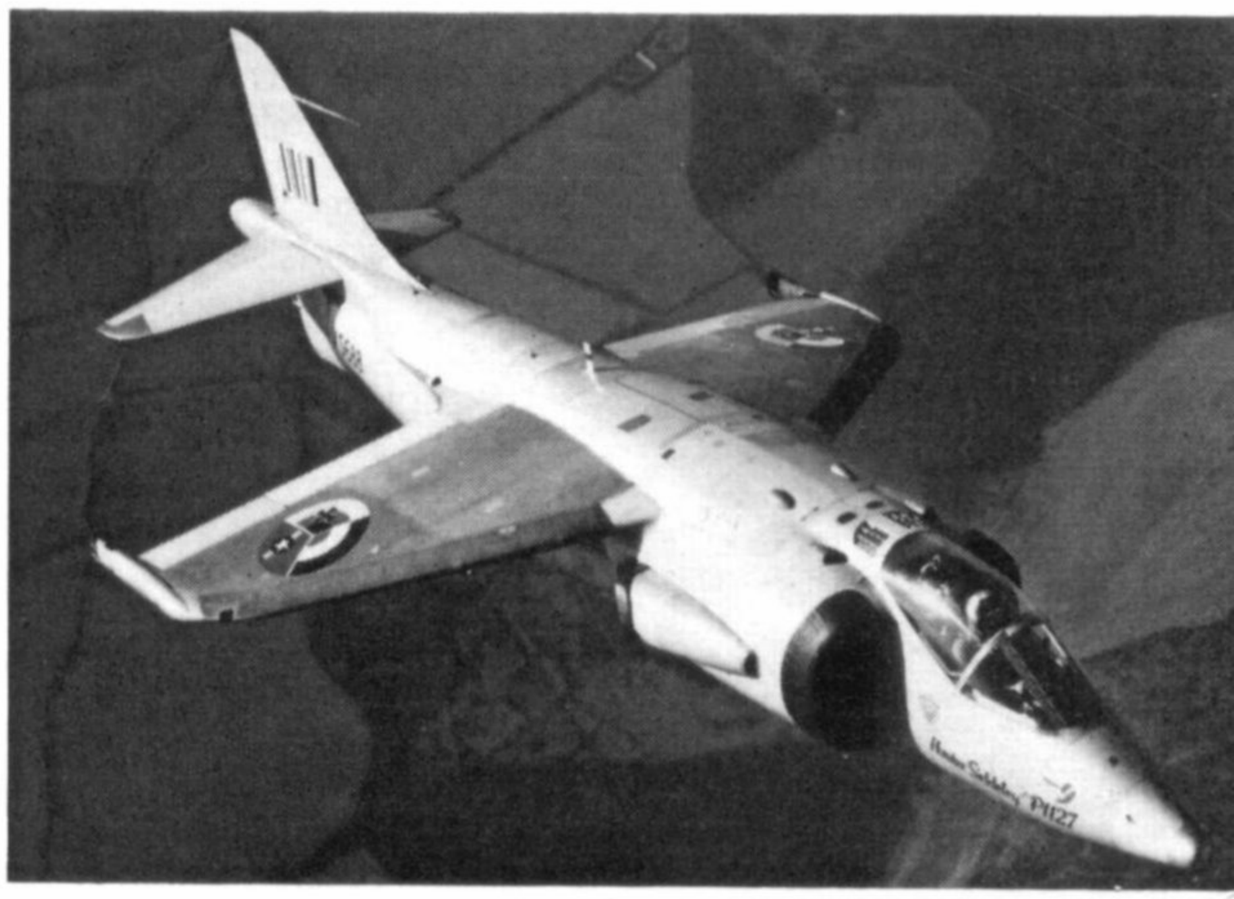
Despite stringent limitations on engine running time, which in effect prevented the Pegasus from being run for more than 2½ minutes at a time, both Bedford and Merewether continued to familiarize themselves with the hovering controls and, on 4th November, the first of countless "flights" was carried out without recourse to use of the autostabiliser, both channels being switched out. A week later conventional taxying trials were performed and speeds of up to 70 knots were reached. On 19th November *XP831* was hovered "free" over the gridded platform and on the 25th photographs were released of the aircraft to the Press.

In the months that followed, while further hovering flights continued at Dunsfold, Hawker set about presenting the potentialities of the aircraft to technical missions from all over the world in what can only be described as an atmosphere of general apathy. Things appeared to have got out of hand at NATO where the realisation of the tactical advantages of VTOL and STOL had prompted the formulation of a new requirement, known as NBMR-3—far in advance of anything achieved by the P.1127 or likely to be in its present form. In effect this demanded an aircraft similar in performance to that of the McDonnell Phantom, but with added VTOL capacity. Numerous companies the world over set their sights on this valuable requirement, complicated by the weight of argument put forward by Rolls-Royce in support of the multiple-engine lift technique. Even Hawker, spurred by the success of its early trials, sought to extend the design, first by the P.1150 (an extended, supersonic version of the P.1127) and then by the P.1154.*

Despite the lack of tangible interest by the military in the P.1127, the Ministry of Supply had issued a contract for a further four prototypes on 2nd

* *It is not within the scope of this* Profile *to dwell upon the P.1154. This design reached the "final" of the NBMR-3 competition and was adjudged the technical winner, though politically it was not favoured, using as it did a British airframe* and *engine. Later however it became the cornerstone of British tactical planning, both by the R.A.F. and Royal Navy, only to suffer cancellation in 1965.*

First of the "Tripartite Nine", XS688, later to become aircraft No. 8 on the West Raynham squadron. Comparison between this and the following pictures discloses numerous minor modifications introduced immediately prior to the commencement of the trials, principally the deletion of the inflatable intake lips, introduction of wing sawtooth and vortex generators and increase in tailplane size. (Neg. No. 1127/114/64)



Emphasising the independence of obstacle-free airfields and runways, these pictures show Kestrels dispersed and operating among heavily wooded sites in the neighbourhood of West Raynham, Norfolk. The take-off photo illustrates one of several types of transportable operating platforms tested. Note the addition of wing pylons.

November 1960, and through these it was planned to develop the airframe towards the evolution of a realistic combat design, in particular the development of the wing shape, increase in engine power and the accommodation of operational equipment. The Company was even asked to quote on the production of 100 aircraft during January 1961!

Tests on *XP831* were slightly delayed when, on 4th February, the main oleo leg cracked during high-speed taxying runs, but at the end of the month the aircraft was delivered to the R.A.E. at Bedford in readiness for conventional flight trials. These were preceded by taxying runs up to 150 knots. The first conventional flight took place on 13th February and lasted 22 minutes, Bill Bedford reporting the aircraft to be entirely satisfactory.

Back at Dunsfold a new Pegasus, producing 12,000-lb. thrust installed, was prepared and with this engine *XP831* embarked on a new series of hover-

Presenting a unique picture with their zero-track undercarriage and curious ground stance, the Kestrels at West Raynham equipped the world's first vertical take-off jet combat squadron —albeit for evaluation purposes.
(Neg. No. K(R)113/65)

ing trials in May. Still no agreement could be reached between the Air Staff and the Ministry of Aviation (as it was now called); at a quoted price of about £500,000 each for the production aircraft, the Air Staff still felt justified in pressing for the P.1127's abandoning in favour of the TSR-2 (which it was still firmly believed would cost well under a million pounds and at the same time constitute a more effective and universally applicable strike force). Added to this, the French Mirage IIIV (VTO version of the excellent IIIA supersonic fighter) was said to be only two years behind the very-experimental P.1127.

Armed now with plenty of work to do on the coming prototypes, Hawker nevertheless contented itself with the development of the design, believing that only the successful demonstration of the aircraft would swing favour away from the multitude of paper aircraft being "flown" by its competitors.

In June *XP831* took its first major step towards a transition from hovering to horizontal flight. On the 13th it took off from the Dunsfold grid and, by moving the nozzles slightly back, flew the length of the runway at a height of 50 feet, reaching a speed of about 50 knots. The following month the second prototype, *XP836*, was completed, being prepared for conventional flight, and on the 7th was flown off the Dunsfold runway. With two aircraft flying it was now necessary, by means of the translational flight manoeuvre being demonstrated by *XP831* and by conventional slow speed flying by *XP836*, to examine the entire speed range of the aircraft from zero upwards. By 8th September 1961 the "gap" had been closed; in other words, the speed range from hovering to full wing-borne flight had now been scanned, and on 12th of the month both Bill Bedford and Hugh Merewether made complete transitions in both directions, i.e. accelerating and decelerating. These manoeuvres were followed on the 20th without using the autostabiliser. Finally, two days later, the aircraft lifted vertically off solid ground, and the grid's useful life was at an end.

FAMILIARISATION AND FAILURES

Now that Hawker, despite an almost total lack of support from the Royal Air Force and precious little from the Civil Service, could demonstrate the validity of its design concept, it was now necessary to enlist the support of the flying branch of the Ministry of Aviation. Accordingly an R.A.E. pilot, Sqdn. Ldr. Henderson (who had been engaged in flying the Rolls-Royce/Short SC.1), carried out an assessment of the P.1127, culminating in successful, un-auto-stabilised, landing transitions. His favourable reports must have contributed much to the improving attitude

by the Ministries that was now to become evident.

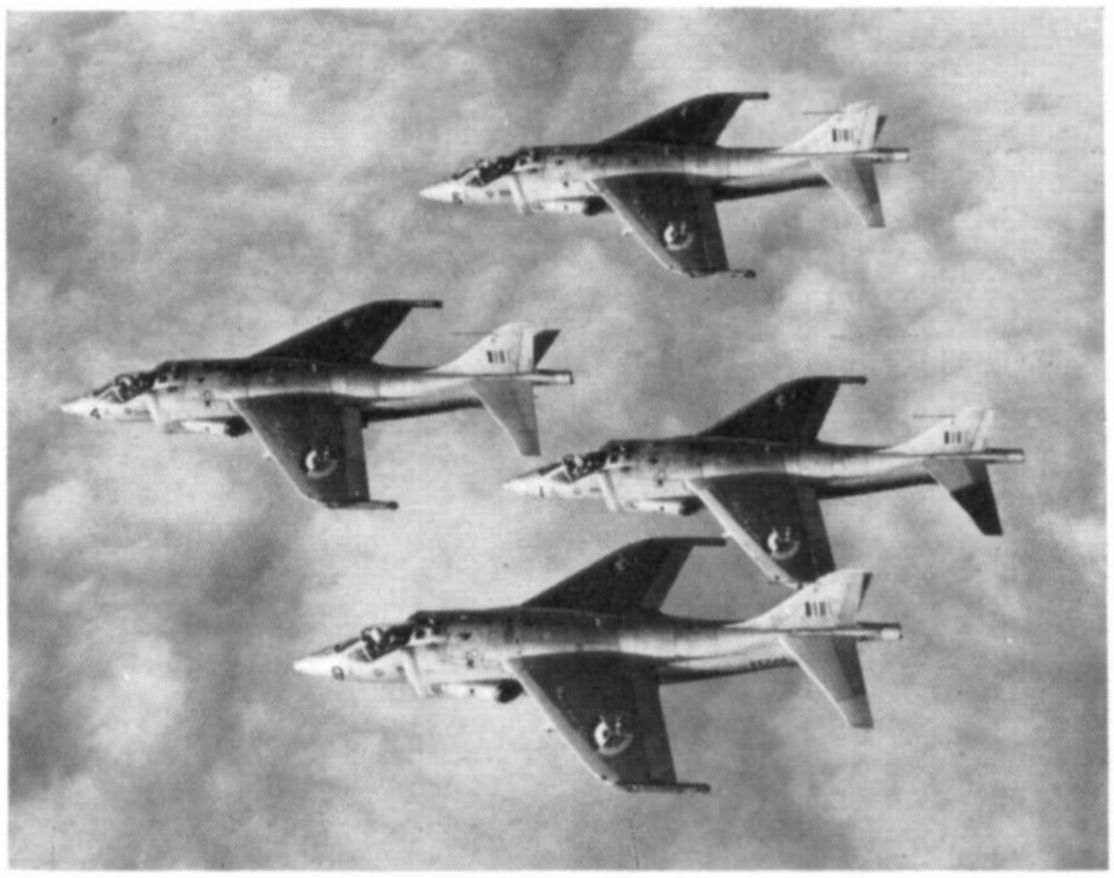
Then, on 14th December, *XP836* was lost in an accident. Bill Bedford, who was flying over Wiltshire, reported engine trouble and told Duncan Simpson (in the Hunter chase 'plane) that he would land at Yeovilton. When on the approach to a conventional landing with flaps down, however, the aircraft commenced to roll and, being unable to correct this, Bedford ejected at about 200 feet from the ground. He was unhurt but, seconds later, *XP836* hit a barn and exploded. Only four days later was the cause of the accident traced when a farmer found one of "cold" nozzles almost four miles to one side of the aircraft's flight path. Apart from the loss of the aircraft, this was a most unfortunate accident as it had already been intended to replace the fibreglass front nozzles with steel components when the failure occurred. (The pilot of the chase 'plane had failed to notice the nozzle becoming detached, flying as he was on the other side of *XP836*).

The third prototype, *XP972*, was completed and carried out its first flight on 5th April 1962 powered by a 12,500-lb. thrust Pegasus 2, and at much the same time a 13,500-lb. Pegasus 3 was installed in *XP831*.

It was now that all the campaigning by Hawker to enlist support for the project began to show results. During the first few months of 1962 the Operational Requirements branch of the Ministry of Aviation and Air Ministry decided to seek Treasury sanction for a small batch of nine production aircraft to be used by a special evaluation unit administered by the Central Fighter Establishment at West Raynham. Certain academic interest displayed by the U.S. air forces and by West Germany spurred the British Government to seek collaboration in this venture and thereby contribute towards the relatively high costs of the trials. This support was forthcoming and on 22nd May 1962 Hawker received an Instruction to Proceed with the procurement of materials for this production. As a preliminary, two NASA pilots, Messrs. Reader and Drinkwater, visited Dunsfold and carried out a complete series of handling trials on *XP831*, performing short and vertical take-offs and landings from grass and flying the aircraft throughout its performance envelope.

On 12th July the fourth prototype, *XP976*, which incorporated a local modification to the wingtip leading edge to improve transonic flight characteristics, was flown, and the production test pilots, Duncan Simpson and David Lockspeiser, commenced familiarisation flying on the P.1127. *XP972's* life was however shortlived. Early in September Merewether reported a fire warning light in the cockpit and decided to force land at Tangmere. Unfortunately the undercarriage failed to cushion the landing impact and the aircraft caught fire. Once again the pilot escaped unhurt but the aircraft was severely damaged. The cause had been the failure of an engine main bearing resulting in compressor disintegration and the blowing of a hole in the side of the compressor casing. (The airframe was returned to Kingston where it remained for some months while negotiations were conducted with a German company for its purchase for the installation of one or two vertical lift engines in addition to a Pegasus. This design concept had been favoured elsewhere for some time but, as far as is known, the project involving *XP972* remained stillborn).

While Hawker busied itself preparing for the limited

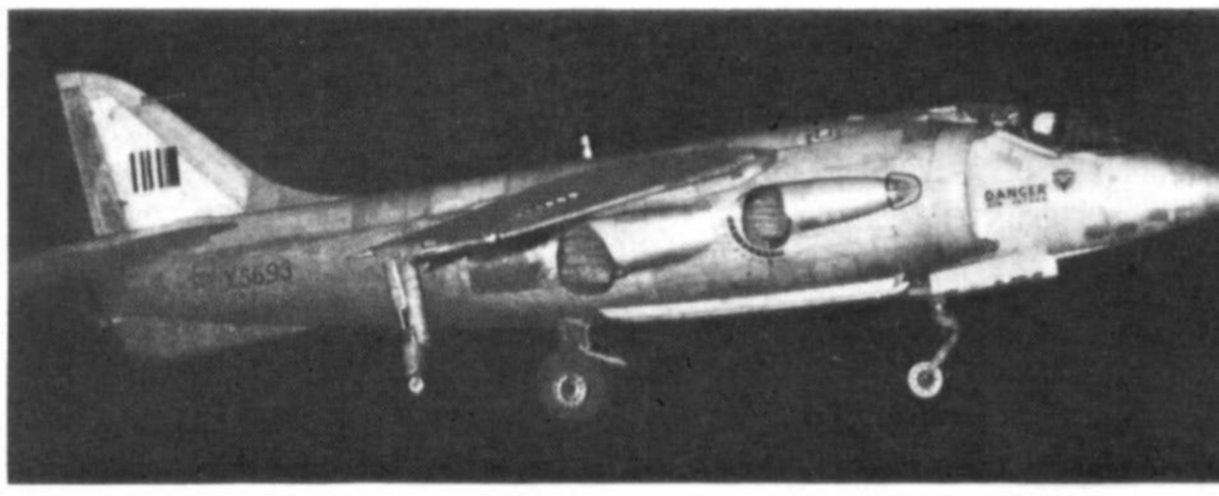


Curiously suggestive of a shoal of porpoises, four Kestrels of the West Raynham squadron in vic formation with "one in the box". The corrected wing markings (i.e. not mirrored) are evident. Also well illustrated are the extended tailplanes.
(Neg. No. 687/261)

production of the evaluation batch, the P.1127s grew in number, *XP980* and *'984* following during the autumn and winter of 1962. Each aircraft introduced a number of modifications; *XP980*, for example, appeared with a "streamwise" wingtip, taller fin and sharply anhedralled tailplane. *XP984* introduced an all-swept wing.

By now all aircraft were flying with inflatable rubber intake lips. These were bags which, inflated by compressed air, modified the engine intake lips at low forward speed, thereby improving the intake efficiency by contributing a smooth airflow round the lip. Although successful this system has evidently been abandoned following lengthening of the intake ducts and introduction of suction relief doors on later aircraft.

1963 witnessed numerous excursions into new regimes by the P.1127. Night flying was carried out and the aircraft was flown (in shallow dives) at



Above: *Night flying trials by a Kestrel at Dunsfold in 1965.*
(Neg. No. K(R)54/65)

Below: *After shipment to the United States, Kestrels (XV-6As) in American Tri-Service markings at NAS Patuxent River, Maryland.*
(Photo: U.S. Navy, dated 5-5-66, Neg. No. P-26153)

An XV-6A (Kestrel) undergoing qualification trials aboard U.S.S. Raleigh *LPD-1.*
(Photo: U.S. Navy, dated 17-5-66, Neg. No. 26545-5-66)

supersonic speed. Following interest by the Navy, Bedford flew a P.1127 on to the deck of H.M.S. *Ark Royal* at sea in the Channel—this despite the fact that he had never previously deck-landed a combat aircraft, demonstrating the radical changes foreshadowed by VTO operations from carriers, and their relative simplicity.

The 1963 Paris Air Show proved a tragedy for the P.1127, for just at a time when Hawker was anxious to demonstrate the tremendous progress achieved by the P.1127 side-by-side with the competitive multi-engine concept portrayed by the experimental French Mirage Balzac V, *XP831* crashed directly in front of the crowd and was severely damaged. Yet again a mortified and frustrated Bedford climbed unharmed from the cockpit. This time it was said that a fragment of dust had penetrated the air motors which rotated the nozzles and without adequate forward speed and lift component the aircraft descended out of control on to the ground.

INTO SERVICE AT LAST

After the Paris Air Show three prototype P.1127s remained, *XP976*, *XP980* and *XP984*. Together these aircraft underwent further trials at Dunsfold, Bedford, Farnborough and Boscombe Down. *XP984* was generally regarded as the forerunner of the evaluation versions—widely known as the Tri-partite Nine—and was powered by the Pegasus 5, provisionally rated at 15,000 pounds installed thrust.

On 7th March 1964 the first of the long-awaited evaluation aircraft, *XS688*, was flown by Bill Bedford, and was followed by the remaining eight (*XS689-XS696*). Powered by the Pegasus 5 (down-rated to 15,000 pounds thrust to conserve engine life), these aircraft dispensed with the familiar nose boom, its place being taken by a forward-facing reconnaissance camera operating behind "eye-lids". Operational equipment was carried in a bay in the rear fuselage, a Ferranti light fighter sight and UHF radio was installed as standard.

Climax of the Kestrel (as the P.1127 became known in mid-1964) development was reached with the formation of the Tripartite Evaluation Squadron at the Central Fighter Establishment, West Raynham, Norfolk, on 15th October 1964. The pilots, who came from the United States and Germany, as well as the R.A.F. (thereby qualifying the Squadron for the unique segmented roundel markings on the aircraft), were:

Wg.Cdr. D. McL. Scrimgeour, R.A.F., Commanding Officer,
Col. Gerhard F. Barkhorn, *Luftwaffe*, Deputy Commanding Officer,
Cdr. J. J. Tyson, Jr., U.S. Navy, Deputy Commanding Officer,
Sqdn. Ldr. F. A. Trowern, R.A.F.
Maj. Kohn K. Campbell, U.S.A.F.
Maj. Paul R. Curry, U.S. Army (replacing Lt.-Col. L. K. Solt),
Maj. John A. Johnston, D.F.C., U.S. Army,
Flt. Lt. R. J. A. Munro, A.F.C., R.A.F.
Flt. Lt. D. J. McL. Edmonston, R.A.F.
First Lt. V. Suhr, *Luftwaffe*,

and there were seven other Officers and 112 other ranks, also drawn from the above Services. Conversion training of these highly-experienced pilots* consisted of a week's ground school at Bristol Siddeley on the Pegasus 5 engine, and a week's ground instruction at Dunsfold prior to a three-hour flight conversion conducted by Bill Bedford.

Broadly speaking, the purposes of the evaluation trials were, in order of effort applied:

(*a*) *Suitability of V/STOL aircraft for operations in the field.* For this purpose a number of dispersed, prepared and semi-prepared sites were used to assess the ability of an aircraft to operate from them.

(*b*) *Comparison of various methods of take-off and landing.* Studies were made to determine the ease of operation with differing loads in STO and VTO techniques, and such considerations as surface erosion and artificial operating surfaces to maintain pilot visibility in dusty conditions.

(*c*) *Flight Operating Procedures and Techniques.* This was principally the establishment and confirmation of operating limitations as much for the benefit of the evaluation pilots as for future training parameters. Such normal techniques as landing patterns, overshoot procedures and fuel reserve limitations were established.

(*d*) *Jet-borne operations.* The application of jet-borne manoeuvring to the flight profile, apart from the normal take-off and landing aspect.

(*e*) *Instrument flight.* Limited simulated instrument flying assessment.

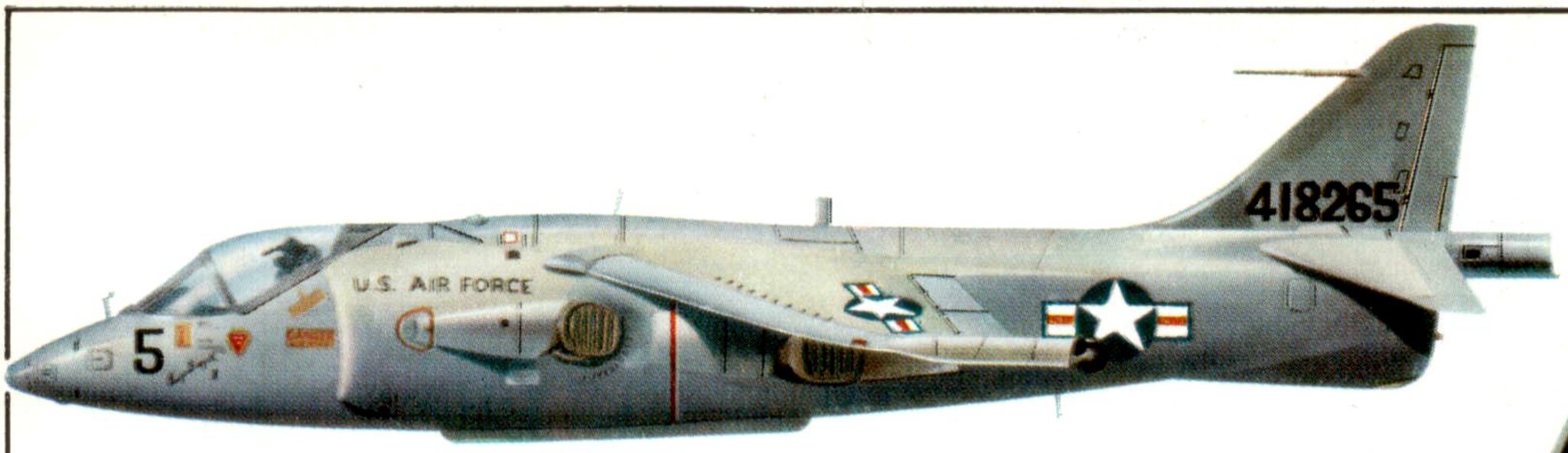
(*f*) *Night flying.* Carried out towards the end of the programme in collaboration with the Blind Landing Experimental Unit of the R.A.E. at Bedford.

Some idea of the mass of data generated during the trials may be gained from the fact that in eleven months 938 take-offs and landings were carried out—a high figure considering the serviceability complications associated with such a radical airframe/engine combination. One of the aircraft was written off in a short take-off accident involving one of the U.S. Army pilots, but this aircraft (*XS693*) was not replaced.

Following the successful completion of the Tripartite Trials and a further brief period of flying in the U.K., the eight remaining aircraft were shipped to America where deck landing and other trials were carried out under the American aircraft designation XV-6A during 1965 and 1966 with the U.S. Navy, Army and Air Force. Several aircraft were also flown from Edwards A.F.B. during 1967.

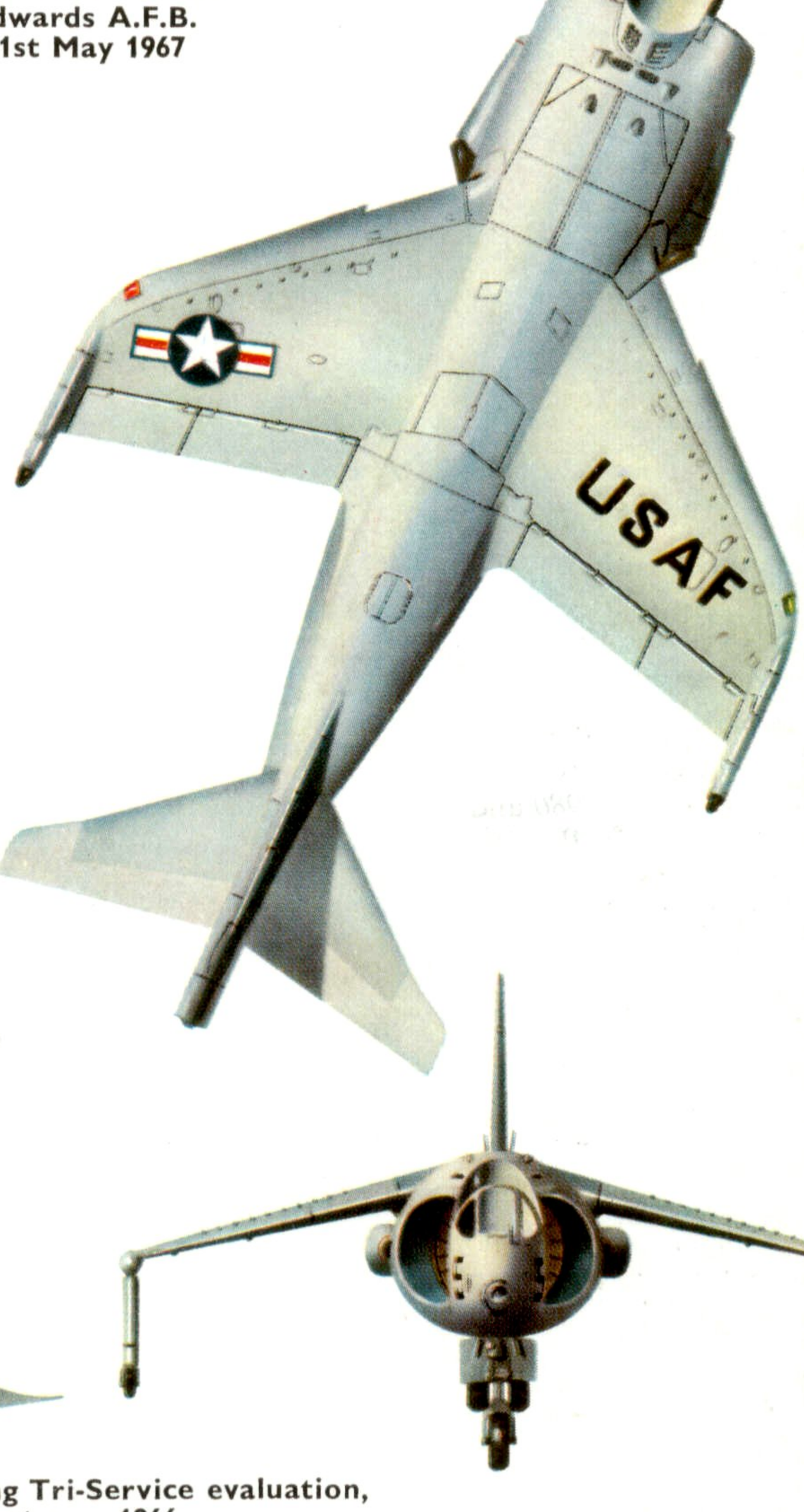
By mid-1966 however the definitive pattern of R.A.F. tactical requirements had crystallised and an initial standard of preparation had been drawn up for the proposed production aircraft to be called

* *For example Col. Barkhorn, wartime Commodore of JG 6, is one of the greatest fighter "aces" of all time, being credited with 301 confirmed victories over Allied aircraft during the Second World War.*



HAWKER XV-6A
Edwards A.F.B.
21st May 1967

Aircraft No. 5 "Cyclops"; pilot, Maj. P. R. Curry, U.S. Army



Fin marking during Tri-Service evaluation, Autumn, 1966

TED FREEMAN

One of several XV-6A Kestrels at Edwards AFB. Note deletion of Tri-Service markings and addition of U.S.A.F. insignia. (Photo: Dr. René J. Francillon, Ph.D., dated 21/5/67)

the Hawker Siddeley Harrier,† and within nine months the first six pre-production Harriers had been flown.

In retrospect it may be thought that the ten years that passed between the project stage and the first pre-production flying was an inordinate period in these days of computerised development programmes; but while progress *has* continued to be made, and real achievements gained, where are those once-much-vaunted competitors?

† *The author can claim some responsibility for this as he was asked in 1963 to suggest a suitable name that the Hawker Management could submit for official approval. He was however aware that Camm's previous Harrier (of 1928) possessed rather less auspicious take-off characteristics than the later creation!*

PRODUCTION SUMMARY

XP831
First prototype Hawker P.1127, commenced hovering trials at Dunsfold, flown by A. W. Bedford, O.B.E., 21st October 1960; first untethered hovering flight, 19th November 1960; first conventional flight, R.A.E. Bedford, 13th March 1961. Damaged in accident at Paris Air Show, 16th June 1963.

XP836
Second prototype Hawker P.1127, first flight 7th July 1961. Lost in accident at R.N.A.S. Yeovilton after loss of port cold nozzle. A. W. Bedford ejected safely at about 200 feet, 14th December 1961.

XP972, XP976, XP980 and **XP984**
Prototypes. Modifications introduced included streamwise wingtip fairings, fin-mounted pitot head, anhedral tailplane, steel cold nozzles, extended wing leading edge and intake lips with reduced rake. *XP972* first flown on 5th April 1962; *XP976* first flown on 12th July 1962. *XP972* damaged by fire following forced landing at Tangmere resulting from engine bearing failure in high-G turn; pilot, Hugh Merewether, escaped unhurt.

XS688, XS689, XS690, XS691, XS692, XS693, XS694, XS695, XS696
Nine aircraft ordered for Tripartite evaluation trials at C.F.E. West Raynham, Norfolk, during 1964-65. First flights: *XS688*, 7th March 1964; *XS689*, 28th May 1964; *XS690*, 5th August 1964; *XS691*, 5th September 1964; *XS692*, 7th November 1964; *XS693*, 25th November 1964; XS694, 10th December 1964; *XS695*, 17th February 1965; *XS696*, 5th March 1965. Aircraft officially named Kestrel F.(GA) Mk. 1, introduced fully swept wing, nose camera, taller fin, extended tailplane, and bulged

First of the pre-production batch of Hawker Siddeley Harriers, XV276. *Though not strictly the subject of this* Profile, *the Harrier represents the end product of the P.1127 design commentary. Points of interest in this photo are the reversion to nose pitot, suction relief doors in the extended engine intakes, adoption of "flip-flop" mainwheel doors, inset wingtip wheels, dorsal fin intake and wing leading edge fences.*

and slightly longer fuselage for 15,000-lb. thrust Pegasus. One aircraft written off during trials, remaining eight aircraft shipped to U.S.A. as XV-6A, underwent Tri-Service trials at NAS Patuxent River, and aboard U.S.S. *Independence*, and U.S.S. *Raleigh*. U.S. Air Force trials at Edwards A.F.B. U.S. BuAer Nos. *418261-418268*. Flown by pilots of U.S. Air Force, Army, Navy and Marine Corps.

DESCRIPTION AND SPECIFICATION

Structure. Fuselage: Conventional light-alloy structure with local titanium components adjacent to engine. Engine mounted amidships with access for removal through top of fuselage (after removal of wing). Cockpit forward of engine, lateral air intakes and engine nozzles under wing roots. Reaction control jets in nose and tail. Camera installation in nose. Wings: Shoulder-located, single-piece wing with 10° anhedral and integral fuel tanks in centre-section. Ailerons irreversibly operated by tandem hydraulic jacks. Control reaction jets in wingtip outrigger fairings. Underwing strong-points for external stores. Tail: All-swept tail surfaces with single-piece tailplane incorporating marked anhedral. Rudder interconnected with tail reaction control. Ventral underfin with ground bumper. Undercarriage: Dowty zero-track tricycle with twin mainwheels and steerable nosewheel; balancing outrigger wheels mounted at wingtips. Dunlop wheels with low-pressure tyres and Maxaret anti-skid units.
Powerplant: Single Bristol Siddeley Pegasus vectored-thrust turborfan developing over 15,000-lb. thrust, with rotatable lift/thrust nozzles exhausting through sides of fuselage amidships. Integral fuel tanks in fuselage and wings containing more than 500 gallons to which may be added fuel in underwing drop tanks.
Equipment: Martin-Baker 6HA rocket-assisted zero-zero pilot ejector seat; hydraulic system includes a ram-air turbine in top of fuselage to drive small hydraulic pump for emergency power. AC electrical system with transformer-rectifiers to provide additional DC supply. No fixed armament. Ferranti light fighter sight installed for use with underwing arsenal. Provision for CDC/Bendix homer indicator. Forward-facing reconnaissance camera.
Dimensions: Wing span: 22 ft. 11 in. *Length:* 42 ft. 6 in. *Height:* 10 ft. 9 in. *Approximate weights:* Empty: 10,000 lb. Loaded (for VTO), 15,000 lb. Overload: 17,000 lb.
Performance: Max. speed: Approx. M=0·97 at 36,000 ft.; 630 knots at sea level. Initial rate of climb: More than 20,000 ft./min.

Another Harrier from the pre-production batch, XV279. *Here displaying camouflage scheme, small nose pitot and modified dorsal excrescences, the Harrier is shown with various paired stores including rocket batteries, ferry and napalm tanks of a pattern not associated with the Hunter. The presence of a single 1,000-pound bomb confirms the ability to carry ordnance centrally under the fuselage, and the 30-mm. ammunition would be for underwing podded Aden guns.*

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