PER MARE PROBARE

Flight

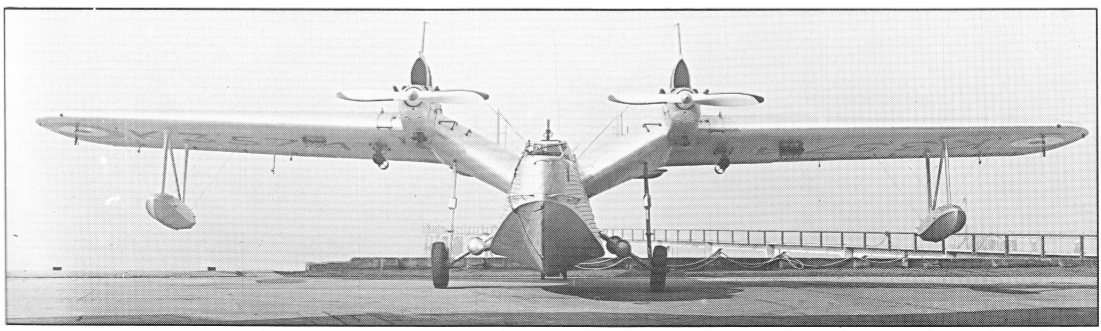
In Part Nine of their series on aeroplanes tested by the Marine Aircraft Experimental Establishment at Felixstowe in Suffolk, ALEC LUMSDEN and TERRY HEFFERNAN describe the curiously-named Short Knuckleduster flying-boat of 1933

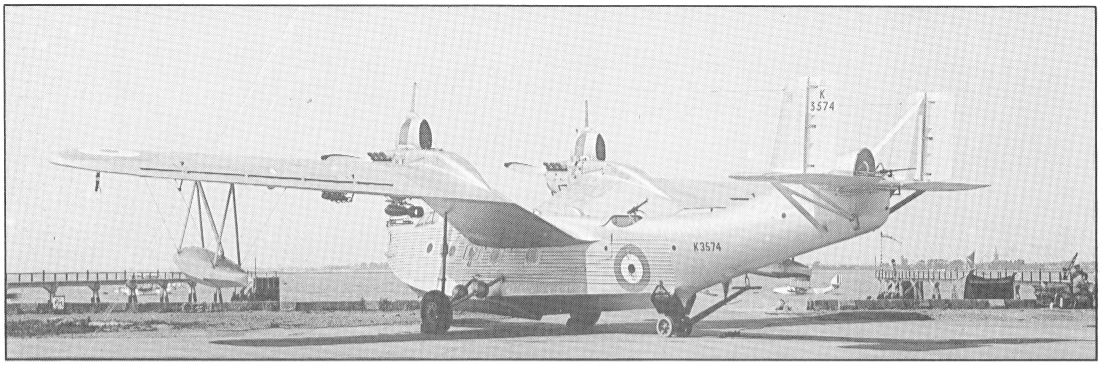
Probably the best-known British builder of boat seaplanes, or flying-boats as they came to be known, was Short Brothers of Rochester, Kent. This may well be because of the justly famed Sunderland which made such a distinguished name for itself during the Second World War as a submarine hunter. The Sunderland's forebears were a distinguished line of Short biplane flying-boats dating back even before the Cromarty of 1919 and used extensively for oversea patrols by the Royal Air Force until the arrival of the monoplane Sunderland. In *Wings of peace* in February's *Aeroplane*, John Stroud recorded how the broadly parallel line of big commercial flying-boat biplanes built by Shorts was used by Imperial Airways. As has so often happened, these commercially operated 'boats were a direct line of development from designs originally conceived for Air Ministry contracts.

Although the Sunderland was the first monoplane flying-boat to serve the Royal Air Force in an operational capacity, it was not the first to appear in Service colours. For example, the little-known Beardmore/Rohrbach Inverness and Blackburn Sydney monoplanes were tested by pilots at the Marine Aircraft Experimental Establishment at Felixstowe, Suffolk in 1927 and 1930. Meanwhile, the flying-boat scene continued to be dominated by massive and majestic biplanes with two, three, four and even six engines (with a click of the heels in the direction of Friedrichshafen in recognition of Dornier's vast 12-engined Do X monoplane 'boats—see *Wings of peace*, October *Aeroplane*). It was not until 3yr later that another and somewhat revolutionary monoplane appeared from the erecting shop at Shorts at Rochester.

Mounting the engines on any seaplane for operation in open water creates peculiar problems. Protection of the engines and propellers is essential, both being

Heading photograph, *the Short R.24/31 on the company slipway at Rochester in February 1934.* **Below,** *K3574 photographed during trials by the MAEE at Felixstowe.* Flight *described the Knuckleduster thus: "a craft to make one open one's eyes, and perhaps rub them".*



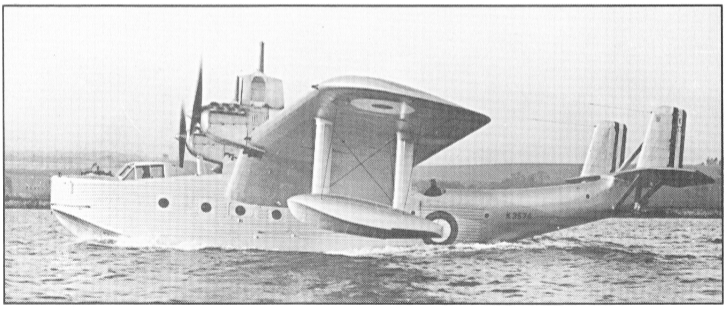


vulnerable to the impact of salt water. A seaplane taking off or alighting at 60–70kt in a swell of up to 6ft throws a lot of fairly solid water about, particularly if there is a strong breeze. On a flying-boat, the wing has to be mounted on top of or just above the hull to keep it above the spray.

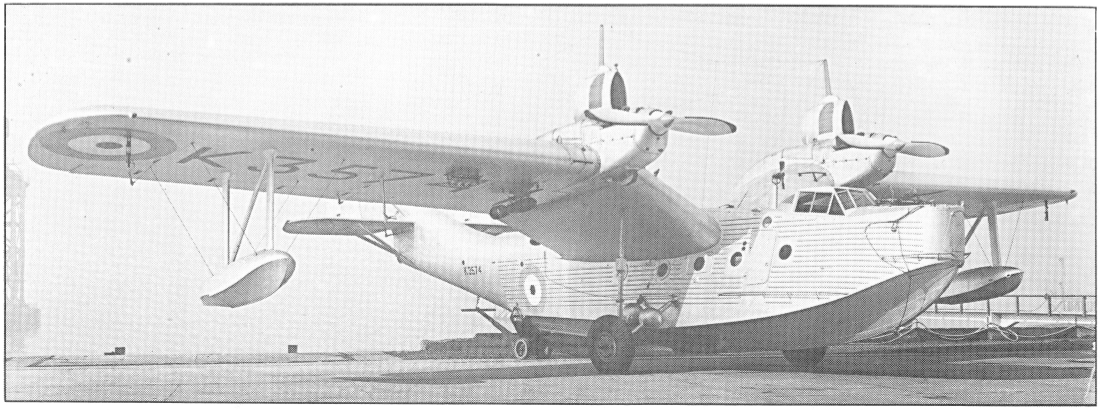
In the case of the older and more traditional type of biplane 'boat with a shallow hull, the wing layout enabled the engines to be mounted either between them, as in the Short and Blackburn 'boats, or on the upper wing, as in Supermarine and later Saro aircraft. Henry Knowler at Saunders-Roe achieved this in his small early monoplane 'boats like the Cutty Sark and Cloud by mounting the engines well above the wing on struts or pylons.

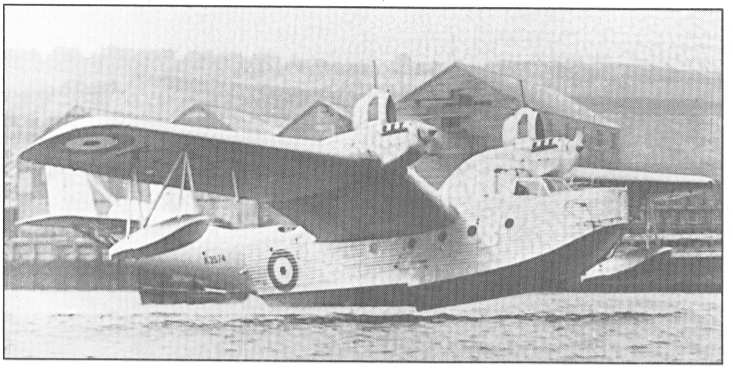
Other than by designing a deep hull and mounting the wings shoulder-fashion (to which the Sunderland subsequently owed its characteristic shape), the only other practical solution lay in the gull-wing. It was this to which Shorts turned in their submission for a twin-engined general-purpose flying-boat to Air Ministry Specification R.24/31. This called for an aircraft capable of long-range patrols and of flying on one engine, a crew of five being specified. The Short Rangoon, a military version of the three-engined Calcutta, was introduced into RAF service in 1931 and this specification was for a 'boat intended eventually to replace them. There were two other contenders for this competition, from Supermarine and Saro, the others being very conventional biplanes and powered by Bristol Pegasus radial engines. The submission by Short Brothers was as dramatic in appearance as it was unusual.

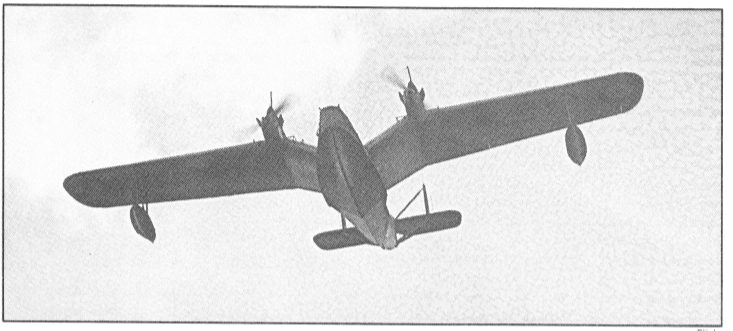
A variation of the shoulder-wing solution, the gull-shaped cantilever layout, with a 30° dihedral inner wing, enabled Shorts to adapt a fairly conventional hull, of moderate depth, to raise the twin engines to a height which would carry them and their wooden propellers reasonably clear of spray. The engines, Rolls-Royce Goshawk VIIIs developed from the well-proven Kestrel but with a new and revolutionary steam or evaporative cooling system, were mounted with their steam condensers on what might have been described as the "elbow". Perversely and with a mixing of metaphors, the flying-boat—which at first sight was a rather graceful design for its day—had the unlovely name of "Knuckleduster" inflicted on it, albeit unofficially for it never had an official name. Upon closer inspection, the Short R.24/31 was rather



Three views of the Knuckleduster showing different wing float mountings: **Top,** *the intermediate inverted-vee struts with sprung diagonal;* **right,** *the original wide single struts with wire cross-bracing; and* **below,** *the final single strut mounting retaining the sprung diagonal.*







Flight

Left, *the Knuckleduster landing on the Medway at Rochester. K3574 ended its days as an instructional airframe at RAF Cosford with No 2 School of Technical Training.*

heavy in its proportions, particularly regarding the hull and wing centre section. Nevertheless, its clean lines made it somewhat faster than any potential competitor. Its hull was built in similar fashion to that adopted by Saunders-Roe for their A.14 hull for the Supermarine Southampton N251.

Chris Barnes, in his informative book *Shorts Aircraft since 1900* (Putnam, 1967) records that, bearing the serial K3574, the R.24/31 was first flown by Shorts' test pilot John Parker, with two crew on November 30, 1933. The take-off at 13,560lb was very quick, with no tendency to porpoise, but the pilot landed immediately because of flexing in the fins. Stiffening of the fin and tailplane mountings delayed further flights for about a month. The initial flights showed that the Knuckleduster taxied cleanly, turning easily on the water, and was stable in flight up to 137kt. It alighted smoothly at 57kt but would not fly straight and level against a dead engine with full rudder trim. An 18 per cent increase in the area of the rudders improved matters but the asymmetric foot load was still too heavy.

Testing continued until the beginning of February 1934, when a sudden unexpected climb occurred in flight which could only be controlled by closure of the throttles. The cause was found to be the collapse of the tail gunner's cockpit fairing. The following day, when the Knuckleduster was on its first full-load climb at 17,760lb, the port engine overheated at 7,000ft. Following these incidents both engines were changed, the fins were toed-in one extra degree and the rudder balance was increased. On March 23 a full-load

Above, *the Knuckleduster photographed at the RAF Pageant at Hendon in July 1935. It appeared in formation with several other experimental flying-boats.*

climb to 15,000ft was made in 35min and, on the 26th, diving tests were made from 6,000ft at over 200 m.p.h. This was the first time that a military flying-boat had completed full diving trials by a contractor before delivery to Felixstowe.

Back in the works, modifications were made to the tail, including the fitting of a movable cupola over the tail gunner's position. On May 26 a satisfactory test flight was made from rough water and, early in June with new wooden propellers fitted, a true airspeed of 152 m.p.h. was recorded. On the following flight, the starboard engine backfired and was stopped, John Parker having to alight at high speed downwind but without much porpoising. A number of valve springs were found to have broken, possibly due to the engines having exceeded briefly their design r.p.m. limits on the diving trials. The springs having been replaced, the Knuckleduster was found to be capable of turning easily with either of the engines throttled back.

Near the end of the month, the aircraft was flown by an MAEE crew to Felixstowe for service trials. There, unfortunately, it suffered a collision while taxying (with what, seems not to have been recorded) and the bows and wing floats were damaged. It returned to Rochester on October 1, the opportunity being taken to replace the wing float mountings. These had originally been single pairs of tie-braced streamlined struts on each wing, but had been replaced in May by two pairs of narrow struts, wire-braced on each float, in inverted vee configuration. Each assembly had a sprung diagonal to absorb longitudinal shocks. The new float mountings reverted to the broad, streamlined struts but retained the sprung diagonal shock-absorbers, the lateral wire-bracing also being retained.

Satisfactory test flights were made on March 4, 1935 and the Knuckleduster, together with the Supermarine and Saro R.24/31 prototypes, went to Mount Batten, Plymouth. There they joined 209 Squadron, deputising for the unit's Blackburn Perths which were unserviceable. All three stayed there until October, when they returned to Felixstowe. It was not until that month that, ultimately, the MAEE report on the Knuckleduster was finally issued, although interim inter-departmental reports had passed to and fro between the establishment and Short Bros.

Each mainplane had a single spar the full depth of the wing section, built up in the form of a rectangular braced box structure, with four stainless steel tubular booms for torsional stiffness, to avoid the risk of aileron reversal. The ribs were of duralumin tubes, plate-braced, and the whole was fabric covered apart from metal-covered leading and trailing edges. The MAEE had to make various detail modifications and these included strengthening the undersurface near the engines and at the tips. Tightening of the aileron controls, which were cable and chain-operated, required the spars of the Frise-type ailerons to be stiffened so as to eliminate vibration.

The Knuckleduster's hull had two steps, the forward one being of V-form in plan and the after one being straight. The forebody was sharply tapering upward in cross-section, with straight tumble-home sides, but the rear body was a monocoque of oval section. Ahead of the rear step, the main portion of the hull consisted of very strong framing which was not altogether satisfactory because too much reliance had been put on it and too little on the skin plating. Substantial plating was considered desirable by the MAEE, so as to withstand normal wear and tear afloat and, at Felixstowe, considerable areas were found to be in need of replacement. As in the Saro A.14, the skin of the forebody was fluted longitudinally. The planing bottom plating was of nearly flat Alclad sheet. All loads on the forebody were taken by longitudinal, vertical and diagonal members, the centre portion consisting of box section frames. Some longitudinal box members continued aft through the rear monocoque to the tailplane spar frames. An inspection aperture was made in the keel, the main fore-and-aft member, for access to the tail actuating gear. The chines were also made of substantial box section. In the cabin, extra portholes were cut in the navigator's compartment and head paddings were added to the frames. A step and handgrip were also fitted to make entry easier and a foot

rail added to the starboard side, incorporating a cleat for a dinghy painter. The wing floats were satisfactory.

The tail unit was strut-braced, the rear spar of the tailplane having the mounting support of the rear gunner's ring at its centre. The empennage assembly was similar in design to the wings. The screw gear for tail trim actuation was mounted on the rear spar. To correct a tendency to swing to starboard, the fin setting was altered slightly.

The engines were secured directly to the spar and their installation was good, as were the cowlings and maintenance platforms, although the latter needed some reinforcement and modification. The original Goshawk fitted over-revved by 50 r.p.m. but, with different propellers, Mark VIII Special engines were quite satisfactory.

The pilot's controls to the engines were modified to reduce lost motion in the system. Those to the elevators and rudder were operated by tie rods and chains and those to the ailerons were operated by flexible cables. Flying controls incorporated limit stops and could be positively locked and checked. The pilot was provided with a rudder bias gear.

The pilot's accommodation was good, as also was the "dashboard" arrangement. Stops had to be added to prevent the seat being lowered to where it fouled the throttle controls. The "coupé" was satisfactory but rear windows were added to improve the view aft. The navigator's space beside the pilot was satisfactory but the table too fragile and not rigid; the standard compass was awkwardly placed below the pilot's seat. An auxiliary removable control conversion and seat could be provided but "cannot normally be carried" (no explanation was offered, but presumably there would not be room for the navigator to work as well). The wireless operator's seat was cramped but adequate and the accumulator (battery) trays were too shallow.

Although the engineer's accommodation and workbench were satisfactory, the fuel gauges which he had to monitor gave persistent trouble and were considered unsuitable for their location in the wings. The armament, had this been called for, comprised a gunner's Scarff ring and Lewis gun in the bow position, a midships gun ring which could be slid to either side and a rear gunner's position above the elevators.

The bombsight and mooring gear were mounted in the forward gunner's position. The domestic accommodation comprised two folding bunks for pilot and navigator and two fixed and one folding bunk for the rest of the crew aft of the rear spar hull frames. There was a small galley area, ice box, wash basin and lavatory just ahead of the mid gunner's position.

As regards operating equipment, the water tank was detachable for cleaning. The anchor, cable and operating facilities were suitable. Beaching arrangements were acceptable although the beaching chassis top fitting was somewhat inaccessible and the four screwed slinging points on the hull top could become damaged and difficult to engage. Engine covers were difficult to secure due to the overhang. No auxiliary power unit was fitted. A collapsible dinghy together with its foot pump inflator and oars were stowed aft, mounted on the side frames.

The cooling system, though not unique, was novel. Steam condensers were mounted in low-drag ducted fairings, which had a positively gothic look, above and aft of each engine with a short radio mast on top. Errors in installation at first gave trouble, but this was corrected. The oil cooling system was considered inadequate for tropical conditions. The two main fuel tanks were mounted in the sloping inner wings. Fuel cocks were controlled by the engineer and feed was by engine-driven pumps to gravity tanks or direct to the engines. The gravity head only just provided the minimum flow to the carburettors and therefore these tanks were used only for starting up and emergencies. Refuelling could be carried out only by means of a Zwicky pump mounted on top of the hull.

The engine installation itself gave very little trouble, with reasonably easy maintenance. The Special Goshawk VIIIs required to be thoroughly warmed up before take-off, otherwise it was impossible to open them up. The 'boat had therefore to be towed well away from any shipping in order to provide space for warming up. Ladders, platforms and a slinging derrick were provided for access to and removing the engines. The ramshorn-type exhausts gave continuous trouble, requiring replacement several times. The automatic boost control, a very early example, at first gave a lot of trouble. An RAE Mk II type gas starter was provided, as well as hand-starting handles. Fuel jettisoning gear (spring-loaded)—something of a novelty—was provided, the control levers being mounted under the pilot's cockpit roof and the discharge being through the planing bottom just aft of the main step.

The MAEE report stated that the take-off was normal and very good in calm and choppy conditions, with the tail adjustment set ¼ of the total movement up. There was no tendency to porpoise but, on opening up the engines, there appeared to be no force on the air controls until a speed of 25–35kt was attained, according to the wind. In normal flight, all controls were light and effective. Though light in operation, the rudder control required fin offset bias for cruising at 2,400 r.p.m. and over. At low speeds, the elevator was ineffective below 60kt, the ailerons were light and effective but the rudder, though light, was sluggish. No measurements of stability were made. For alighting, there were no flaps but it was made comfortably with the tail well down.

In the dive, with the centre of gravity normal, the seaplane was steady at all times and response to control movement was good. Limiting conditions were either a speed of 30 per cent above the top level speed or an engine speed of 3,600 r.p.m. In each case the airspeed was the limiting factor. For example, at full throttle and attaining a true airspeed of 165·5kt, the r.p.m. was 3,140 and 1,000ft were lost.

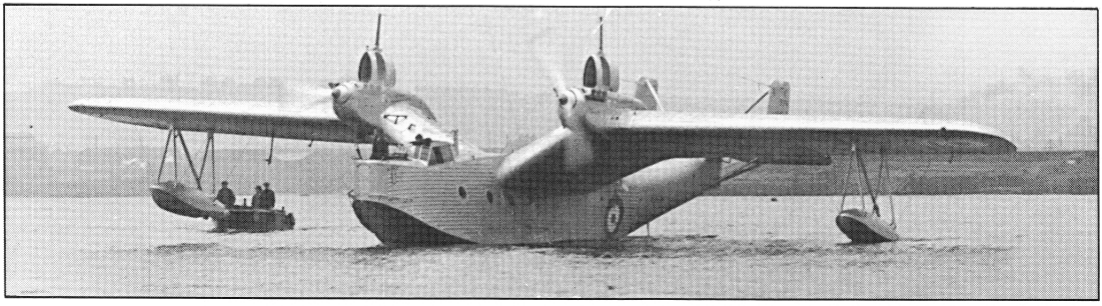
With a spare engine carried on the top

Continued on page 656

Short S.18, R.24/31 Knuckleduster data

Engines: Two Rolls-Royce Goshawk VIII, Special. 722 h.p. at 2,600 r.p.m., +3·75lb/in² boost, 3,000ft

Dimensions	
Span	90ft 0in
Length	63ft 3in
Height (on wheels)	22ft 6in
Wing area	1,147ft²
Wing section	Göttingen 436 (mod), 20·18 per cent
Tailplane section	R.A.F. 27
Weights	
Loaded (normal)	17,550lb
(overload)	18,500lb
Empty	11,720lb
Performance	
Take-off run	350yd
Climb, 3 min	2,800ft approx
Maximum speed, 5,000ft	124kt
Cruising speed, 5,000ft	85kt
Stalling speed	57·5kt
Gliding speed	75kt
Service ceiling	15,450ft
Range	460 nautical miles



The Rolls-Royce Goshawk engines of the Knuckleduster were mounted high on the wing "knuckles" so that the propellers were well clear of spray during take-off.

white space on most pages—but that is about the only criticism that can be levelled at this splendid book.

Britain's first warplanes is a fascinating compilation and, unlike many picture books, a useful work of reference for a period pocked with pitfalls for the unsuspecting researcher. Incidentally, just one of the 400 aircraft is still with us: No 304, the RFC Military Wing's second Cody Biplane, may be found in the Science Museum at South Kensington.

● Published just too late to coincide with the 50th anniversary year of the prototype's first flight, Eric Morgan and Edward Shacklady's **Spitfire: the history** *(ISBN 0-946219-10-9; Key Publishing Ltd, PO Box 100, Stamford, Lincs PE9 1XQ; 640 pages; 12in × 9in hardback; £39·95)* is the last word on the Supermarine Spitfire in more ways than one.

This massive volume brings a whole new meaning to heavy reading: it describes every stage in the Spitfire's development, including its antecedents from the F.7/30 of 1934 and its successors up to the Seafang of 1945. In addition—and this is the breathtaking bit—it includes potted histories of more than 22,500 individual aircraft. These sections make the book look like a telephone directory in places, but its value as a reference source is indisputable.

Spitfire: the history is copiously illustrated with three-views, black-and-white photographs, *Profile*-style colour side views and, unusually, plenty of manufacturer's drawings and diagrams taken from manuals. It is sad that the photographic reproduction tends to be murky, the paper is very cheap (though better quality would inevitably have pushed the price through the roof) and the design and layout does not mirror the elegance of the subject. Overall, though, these minor faults do not detract from what is a major achievement in detailed, specialised history: it is the most informative Spitfire book ever to overstress *Aeroplane*'s editorial bookshelves.

● Of the hundreds of books sent to *Aeroplane* for review each year, an unfortunately large proportion consist merely of familiar, popular information regurgitated in a new form in order to sell as many copies as possible in the shortest possible time. Many publishers are no longer prepared to keep books in stock—they publish, sell and remainder sometimes in the space of a few months. Against this background it is very difficult to find publishers for histories which, no matter how carefully researched and readable, fall outside the normal sphere of World War Two, swastikas, preserved warbirds and modern fast jets.

One victim of this problem was Philip Jarrett's **Another Icarus: Percy Pilcher and the quest for flight** *(ISBN 0-87474-556-X; Smithsonian Institute Press; distributed in the UK by Eurospan University Press Group, 3 Henrietta St, Covent Garden, London WC2E 8LU; 238 pages; 9in × 6in hardback; £19·50).* What a shame that no British publisher took up this, the *only* full biography of the UK's foremost gliding pioneer.

Ex-*Aeroplane* assistant editor Jarrett, a respected and long-established historian, has spent more than 12yr researching Pilcher's life and the gliding experiments he carried out between 1895 and 1899. The result is an examination of how Pilcher conceived, built and tested his gliders, and how he relied much less on theory than on practical flight trials—something which taught him the vital need, overlooked by many early experimenters, to temper stability with controllability.

The high point of the book is Jarrett's absorbing reconstruction of the Hawk glider's crash on September 30, 1899 which cost Pilcher his life; by careful research he has produced what amounts to a highly detailed accident investigation report, 90yr after the accident.

As well as putting Pilcher's gliding experiments fully before the public for the first time, *Another Icarus* firmly establishes the important links between Pilcher and other pioneers including not just Otto Lilienthal in Germany, but Octave Chanute in America and Lawrence Hargrave in Australia.

Jarrett also makes an appraisal of Pilcher's planned experiments in powered flight, which were cut short by his death. Appendices to the book include details of all Pilcher's patents (not all of them were in the aviation field) and a survey of the reproduction Pilcher gliders in existence.

Percy Pilcher has received comparatively little attention from historians until now, and Jarrett shows many of the previously published facts about him to be completely wrong. "As the first Briton to die for the cause of powered flight, and only the second person in the world to do so," says Jarrett in his preface, "Pilcher deserved better." By turning a spotlight of remarkable brilliance and clarity onto him, *Another Icarus* has at last given Pilcher the recognition he deserved.

VIDEOS

● **Farnborough: the glorious years** *(produced by, and available direct from, How Video, Kirby House, Kirby Hill, Boroughbridge, N. Yorks YO5 9DS. Tape 1, 1956-57; Tape 2, 1958-59; Tape 3, 1960-61; Tape 4, 1962. All £19·95 except Tape 4 which is £15·95. Add £1 p&p per tape).* Relax and watch the Farnboroughs of the Fifties and Sixties without worrying about rain, the traffic jam outside, and the extortionate prices for refreshment. These tapes are pure nostalgia. Hunter and Sea Hawk teams, looping and rolling Victors and Vulcans (!) the original four-engined (Leonides) Handley Page Herald; Austers, Gannets, Gnats, the experimentals and one-offs; F.D.2, Bristol 188, Scorpion Canberra, SR.53, H.P.115, Fairey Rotodyne. Good old all-British bliss. Some tapes in colour, some in black and white, some with commentary, some with sound (dubbed in some cases? Surely the Gannet could only sound like that if it fell down the deck lift?). **Mike Gaines**

● **Flying the Ark; The birth and life of a frigate; Life with the Marines** and **Out of the air** *(produced by Film Archive Management and Entertainment, Phillipp House, 20 Chancellor St, London W6 9RL)* Of these four Royal Navy videos, only *Flying the Ark* is good to watch, even if the commentary is a bit over-enthusiastic; the mind-blowing business of conventional jet carrier operations comes across with all its clutter and clamour. You can almost smell the AvGas fumes.

As for the others, they bring back memories of the early days of basic training, cold, draughty classrooms and boring training films with that hysterical screech of a sound-track intro courtesy of the Service Kinema Corporation (only HM Forces would use a K).

I never thought I would spend an afternoon some 20yr later watching the RN variant in my own time. It has the same effect, though. I particularly recommend the one on underwater salvage to all insomniacs. **Mike Gaines**

PER MARE PROBARE

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deck a change of trim of 4° was necessary, but there was excessive vibration. Underwing bomb racks with a portable hoist and winch could be installed, as also could a spare torpedo, although no provision was made for launching it. The torpedo was actually mounted, for trial purposes, under the starboard wingroot close to the hull but flight tests with it were not made.

On the water, control in taxying was satisfactory but no rough weather tests had been attempted at the time the report was issued. Turning either way in a small radius, off the wind, was easy; however, in strong winds, there was a pronounced tendency to drift to leeward when coming round into wind. The wingtip floats, cleanness in running, stability, mooring and drogue operations were satisfactory, apart from the absence of a drogue signalling system.

The MAEE, summarising the Short R.24/31, considered that it did not meet the specification as regards range. Because of structural weaknesses, the maximum weight allowed was only 17,550lb and the amount of fuel which could be carried in such circumstances limited the range to 465 sea miles. Although the top speed and ceiling were up to specification requirements, the performance was regarded as disappointing for a monoplane. The flying and water-handling qualities were generally satisfactory, although the rudder was rather sluggish at low speeds. Doubts were expressed about the sturdiness of the wingtip floats but trials in rather rough seas had not revealed any weakness.

Hardly a world-beater

The Short R.24/31 did not win the competition, its two rival biplane companions jointly being successful. Unfortunately this was no surprise, bearing in mind the unsuitable choice of power unit. Repeated engine failures on take-off were no fault of the Goshawks, but rather of the fuel installation, in which fuel pipes became blocked with foreign matter. Nevertheless, the Goshawk did point to the very serious shortcomings of steam, or evaporative, cooling, which might have been very hazardous in war conditions. This system was luckily made superfluous by the discovery that the addition of a small percentage of ethylene glycol in a normal radiator system raised the boiling point of the mixture to allow the coolant to run at well over 100°C, and to take advantage of higher octane fuels and higher compression engines—a particularly valuable asset in military aircraft. The hull design also provided useful experience in formulating the lines of the Empire and Sunderland 'boats.

The Knuckleduster, which had appeared at the Hendon Air Display in June 1935 in a formation of experimental flying-boats, last appeared in public at Felixstowe on Empire Air Day in the summer of 1938. It ended its active life at Felixstowe in the autumn of that year and, shortly afterwards, was moved to Cosford where, at No 2 School of Technical Training, it became instructional airframe 1154M.