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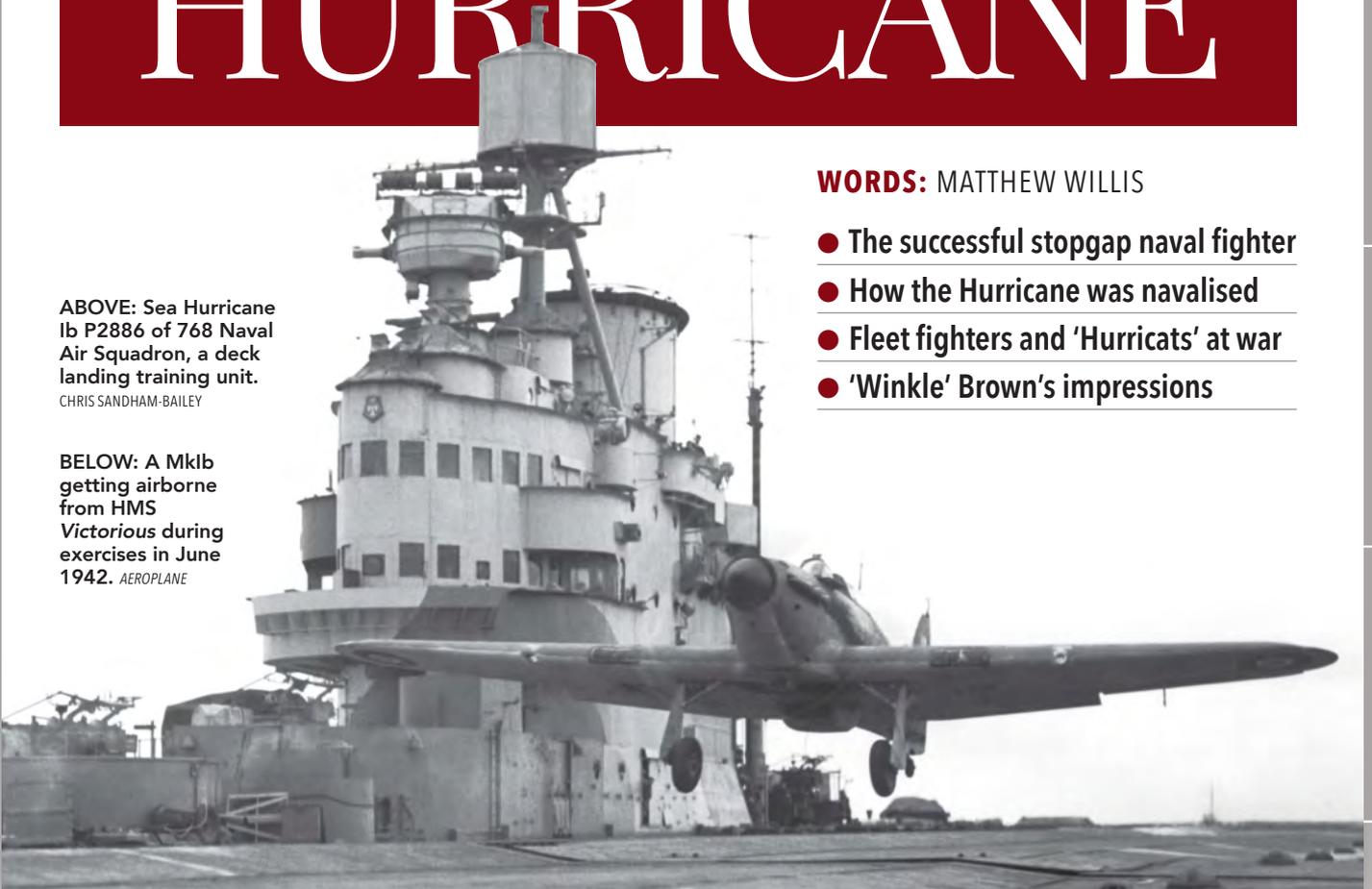
HAWKER SEA HURRICANE

WORDS: MATTHEW WILLIS

- The successful stopgap naval fighter
- How the Hurricane was navalised
- Fleet fighters and 'Hurricats' at war
- 'Winkle' Brown's impressions

ABOVE: Sea Hurricane Ib P2886 of 768 Naval Air Squadron, a deck landing training unit.
CHRIS SANDHAM-BAILEY

BELOW: A MkIb getting airborne from HMS Victorious during exercises in June 1942. AEROPLANE





LEFT: On the catapult mounted aboard the SS *Empire Darwin* and bound for North Africa is Sea Hurricane I V6733 from the Merchant Ship Fighter Unit.

Successful stopgap

The Hawker Sea Hurricane was unsuitable in many ways for the role it was shoehorned into, and at times it seemed that no-one wanted the Hurricane to go to sea. During the first years of the war the RAF was unwilling to allow the Royal Navy to have any Hurricanes, and many in the navy were sceptical as to their value. When the type eventually became a naval fighter, however, it made an immediate impression, appearing just in time to play a pivotal role in crucial strategic maritime battlegrounds.

The lack of serious interest in a naval Hurricane in the 1930s was connected with developing Royal Navy doctrine and myths about the inevitably inferior performance of carrier-based aircraft. In the

second half of the decade, the Admiralty seemingly became convinced that it would be impossible for carrier-based aircraft to be competitive with land-based machinery and had begun to develop requirements that would be hard to meet with high-performance types. These included the ability to escort strikes, carry out reconnaissance, and patrol at some distance from the parent carrier, which in the 1930s meant a two-seat aircraft fitted with wireless telegraphy (WT) apparatus and fuel for more than four hours' endurance.

In June 1938, three months before the Blackburn Skua and Roc two-seat fighters were due to enter service, the Air Ministry recommended that the aircraft be cancelled. At around this time, the Admiralty was made an offer of a supply of Hurricanes, which was hastily withdrawn in the rush to re-equip after the Sudetenland crisis.

The First Lord of the Admiralty, Winston Churchill, suggested in January 1940 that the Fleet Air Arm (FAA) should take over the air defence of naval bases. While the FAA was still adamant that

“The commander-in-chief of the Home Fleet wrote to the Admiralty, “the sooner we get some efficient aircraft the better” ”

it needed two-seat aircraft to perform the main fleet fighter role, it was agreed that a small number of Hurricanes or Spitfires could fulfil shore-based duty while also being available for embarkation aboard carriers when required. The chief difficulty involved in this was accommodating the aircraft in aircraft carriers' hangars — the lifts provided on newer carriers could not take types without folding wings, and the navy rejected the use of deck parks as a solution. The minutes reveal that Hawker was, “already working on designs for modified wings for this purpose and they hoped to be able to report on the possibilities very shortly.”

On 20 May 1940, however, with British forces under pressure in Norway and France, the Admiralty was informed that absolute priority in production resources was to be given to RAF types, meaning that the FAA could expect no replacement of its obsolete Skuas and Gloster Sea Gladiators for the foreseeable future.

An event that caused the Royal Navy to re-evaluate the Hurricane as a possible naval fighter, and change the policy of the service in favour of high-performance single-seaters, came with the collapse of the Norwegian campaign. Rather than leave their valuable aircraft in Norway, the Hurricane pilots of No 46 Squadron attempted to land their machines on an aircraft carrier, despite the lack of arresting gear. They succeeded, on 7 June, in flying their Hurricanes on to HMS *Glorious*. The commander-in-chief of the Home Fleet wrote to the Admiralty that, “our FAA aircraft are hopelessly outclassed by everything that flies and the sooner we get some efficient aircraft the better. We have made a ‘false God’ of the business of flying



ABOVE: A flight of non-hook-equipped Hurricanes from 759/760 Squadrons at Yeovilton. The aircraft coded 'N' is Mk I V6541; behind it is CCF-built MkX AE977, the aircraft today airworthy with the Biggin Hill Heritage Hangar. VIA MATTHEW WILLIS

on and off a carrier but now that [...] 10 Hurricanes have been flown onto a carrier, the matter should be reconsidered."

Meanwhile, the risk to Britain's vital supply convoys was increasing with the fall of France and Norway, and the entry of Italy into the war. Long-range patrol aircraft could pinpoint convoys and direct submarines towards them as well as attacking directly. In their first few months of operation, Luftwaffe Focke-Wulf Fw 200 Condor maritime patrol bombers sank no fewer than 90,000 tons of Allied shipping.

The Admiralty responded with plans for fighters to accompany convoys on ships, "as long-range shore-based fighters could clearly never provide the whole protection required". FAA fighters were fitted with catapult spools as a matter of course, to enable them to use accelerators mounted on aircraft carriers. This meant, however, that the

only fighters immediately available were the Skua and the just-introduced Fairey Fulmar, which had inadequate performance. Many cruisers were fitted with catapults, and the catapult training ship HMS

Pegasus (the former seaplane carrier *Ark Royal*) was available.

An approach was therefore made to Hawker by the Directorate of Research and Development in October 1940



ABOVE: The first 'shipboard' Hurricanes were the MkIs of No 46 Squadron, RAF. Pictured here being hoisted aboard HMS *Glorious* at Greenock docks in early May 1940, bound for Norway, the aircraft were flown off the carrier to the airfield at Skånland on 26 May. They returned to *Glorious* on 7 June, thus notching up the first Hurricane take-offs from and landings on an aircraft carrier.

with a view to creating a modified naval Hurricane variant. The manufacturer responded that it could do so in the space of mere weeks. As noted above, Hawker had been considering naval modifications to the Hurricane since at least late 1939 as it was working on a folding-wing design. The favoured aircraft for this project were the Miles M20 and the Grumman Martlet, but the Admiralty noted in December that, "the Air Ministry are already investigating whether the Hurricane can be similarly adapted."

The Navy was not prepared to release catapult-equipped cruisers for convoy duties, and it would take years to obtain enough conventional hydraulic catapults to fit on auxiliary cruisers or merchantmen. An alternative was to develop rocket take-off gear for a Hurricane to be able to launch from a 150ft 'take-off platform'. A further suggestion was the so-called

DEVELOPMENT HAWKER SEA HURRICANE



ABOVE: Sea Hurricane I Z4936 — originally built by Gloster — of the Merchant Ship Fighter Unit being readied for a launch from the training catapult located at Speke, Liverpool, with some of the firing rockets for the launch cradle leaning against the rear of the catapult assembly. 'KE' was the squadron code allocated to the RAF-controlled MSFU.

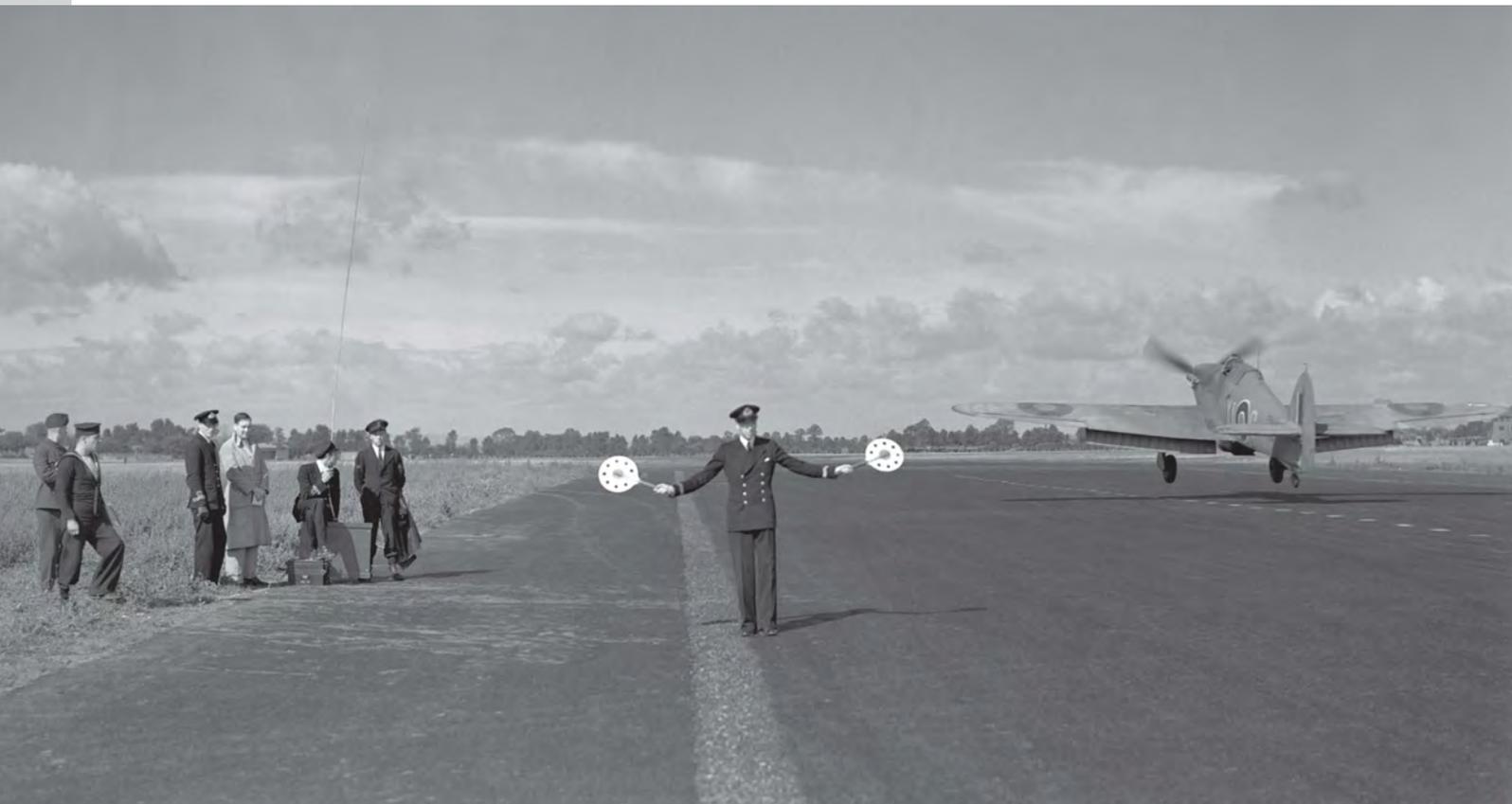
'Woolworth' option of fitting simple catapults to merchant ships and auxiliary cruisers. The Admiralty considered it unlikely that a simple type of catapult that could be manufactured quickly would be available for years. It reckoned without the Royal Aircraft Establishment's Catapult Section at Farnborough, which developed the 'P' (pyrotechnic or projectile, depending on the document) catapult in just a matter of weeks at the end of 1940.

The RAE created custom trolleys for the Hurricane and Fulmar to be powered by a battery of 18 rocket motors developed for use as projectiles, and tested them in January 1941. That May, the first of a projected 50 Catapult Armed Merchantmen (CAM ships) were fitted with the P-catapult, though in the end conversions stopped after 36 had been conducted.

Furthermore, in early 1941 three Royal Navy auxiliary ships, dubbed Fighter Catapult Ships, were fitted

with conventional catapults taken from cruisers under construction, being ready in April. The first aircraft to be used were FAA Fulmars, but these quickly proved to have insufficient performance to tackle German aircraft, particularly the fast Junkers Ju 88, so Hurricanes were employed exclusively thereafter.

The Hurricane variant produced for catapult use on convoy protection duties was designated as the Mk1a. It had the bare minimum of adaptations from the standard Mk1, the main changes to the machine consisting of the addition of the catapult spools, instruments recalibrated to naval measurements, and naval radios. Even so, there were around 80 separate modifications to be carried out. The aircraft were all received from RAF stocks. In the meantime, Hawker pursued a parallel programme of more extensive navalisation of the Hurricane for use as a conventional carrier fighter.



ABOVE: The Fleet Air Arm used standard ex-RAF Hurricanes for training purposes. This is Mk1 P2859 conducting deck landing practice with the Naval Fighter School at Yeovilton in 1943. *AEROPLANE*

Navalising a legendary fighter



The Sea Hurricane was the most basic possible adaptation of the existing aircraft for marine use. In structure and armament it was the same as the land-based aircraft, as the vast majority of Sea Hurricanes were conversions of existing airframes. A small number of Sea Hurricane Ibs from Canadian Car and Foundry were built as, or based on, brand-new aircraft, while a batch of 60 MkIIc versions was reportedly built as Sea Hurricanes by Hawker. The rest were converted.

The first conversions to be initiated were from MkI aircraft and designated as the MkIa, specifically for use on catapult-equipped ships. The conversions took the form of fitting catapult spools and navalising certain equipment, such as the radio and instruments. These aircraft were powered by a Merlin III driving a Rotol propeller, which gave a better rate of climb.

The first conventional carrier fighter Sea Hurricane was the

MkIb, similar to the MkIa but with an A-frame arrestor hook stressed for a 10,500lb aircraft, reinforcement of the lower longeron, carried recessed in a redesigned lower fuselage fairing, and a break in the ventral fin to fit the hook. The

MkIb was generally fitted with a de Havilland propeller, which was heavier than the Rotol and helped restore the Hurricane's centre of gravity after the fitting of the hook.

A proposal to fit the cannon-armed wing of the

ABOVE: A good view of the Sea Hurricane Ib configuration — especially the A-frame arrestor hook — is provided by 768 Squadron's P2886, making a training approach to HMS Argus in August 1943. *AEROPLANE*



The prototype MkIIc with its four 20mm cannon. *AEROPLANE*



ABOVE: Wrens — members of the Women's Royal Naval Service — serving as armourers at HMS Heron, RNAS Yeovilton, refitting the wing-mounted .303in Browning machine guns of a Sea Hurricane. VIA MATTHEW WILLIS

Hurricane IIc on to Sea Hurricane Is resulted in at least one prototype, and up to 100 production aircraft were ordered, though it is likely that few if any other than the prototype V6741 were actually delivered.

Designations of Sea Hurricanes are notoriously difficult to pin down. The initial suffixes 'a' and 'b' did not refer to the aircraft's wing armament configuration, as on RAF Hurricanes, but the configuration of catapult spools and arrestor hook. The MkIc description, however, applied to a MkI airframe with the MkIIc wing.

Later Sea Hurricanes were similar modifications of MkII

and Canadian MkXII variants. The MkII-based aircraft were powered by a Merlin XX, while MkXII-based machines would have originally been fitted with a Packard Merlin 29, both types driving a Rotol propeller. Catapult spools were deleted on MkII/XII Sea Hurricanes.

Overall, up to 800 Hurricanes and Sea Hurricanes were delivered to the Fleet Air

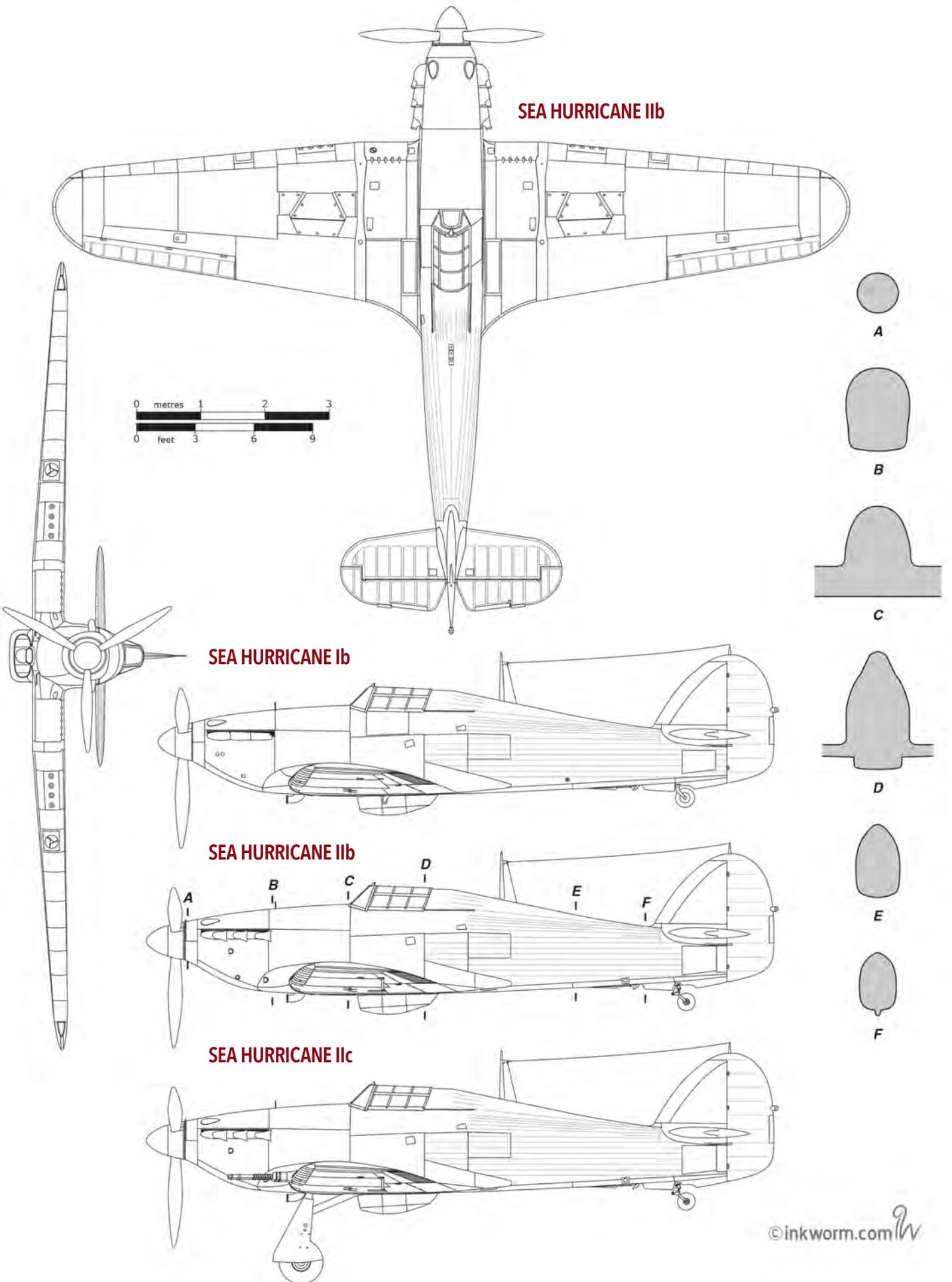
Arm, around 400 of them MkIs — no precise statistics on Sea Hurricane conversions exist. General Aircraft handled UK

conversions from 1941-42; in 1943 that work switched to Hawker's Langley factory. The last Sea Hurricane delivered was MkIIc NF717 during August 1943.

“Overall, up to 800 Hurricanes and Sea Hurricanes were delivered to the Fleet Air Arm”

SPECIFICATIONS: SEA HURRICANE Ib (MkII/XII)

POWERPLANT:	One Rolls Royce Merlin III, 1,030hp (Merlin XX, 1,280hp/Merlin 29, 1,300hp)
DIMENSIONS:	Length: 31ft 5in (32ft 0in) Wingspan: 40ft 0in Height: 13ft 1in
WEIGHTS:	Empty: 5,440lb (5,880lb) Loaded: 7,100lb (8,100lb) Maximum: 7,550lb
PERFORMANCE:	Maximum speed: 308mph at 18,000ft and +6.25 boost/ 315mph at 7,500ft and +16 boost (342mph at 22,000ft) Cruising speed: 208mph at 20,000ft (292mph at 20,000ft) Range: 500 miles normal, 1,030 miles with auxiliary tanks (460 miles normal, 908 miles with auxiliary tanks) Service ceiling: 32,700ft (35,900ft)
ARMAMENT:	Eight 0.303in machine guns with 333 rounds per gun, two 250lb bombs (MkIIb: twelve 0.303in machine guns with 333 rounds per gun; MkIIc: four 20mm Hispano cannon with 100 rounds per gun, two 250lb or 500lb bombs)



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HAWKER SEA HURRICANE II

- | | | | |
|---|---|---|--|
| 1 Fabric-covered rudder construction | 41 Tailplane control cables | 77 Fabric-covered starboard aileron | 118 Reflector gunsight |
| 2 Tail navigation light | 42 Fuselage access panel | 78 Aileron control gear | 119 Bulletproof windscreen |
| 3 Rudder tab | 43 Ventral stringers | 79 Wingtip construction | 120 Canopy hand-grip |
| 4 Elevator tab | 44 Trailing-edge wing root fillet | 80 Starboard navigation light | 121 Rear-view mirror |
| 5 Fabric-covered elevator construction | 45 Downward identification light | 81 Intermediate wing spars | 122 Port outer split trailing-edge flap |
| 6 Elevator horn balance | 46 Radio racks | 82 Aluminium wing ribs | 123 Fabric-covered port aileron |
| 7 Tailplane construction | 47 Radio equipment (R3002 and R3108) | 83 Front spar | 124 Pitot tube |
| 8 Rudder horn control | 48 Parachute flare launch tube | 84 Leading-edge nose ribs | 125 Aileron control gear |
| 9 Elevator hinge control | 49 Sliding canopy track | 85 Starboard landing lamp | 126 Port wingtip |
| 10 Sternpost | 50 Canopy rear fairing construction | 86 Wing stringer construction | 127 Port navigation light |
| 11 Tail fin construction | 51 Turn-over crash pylon struts | 87 Ammunition feed drums | 128 Aluminium alloy wing skin panels |
| 12 Fabric covering | 52 Radio equipment (TR1196 and R1304) | 88 Ammunition boxes (total 364 rounds) | 129 Port landing lamp |
| 13 Rear aerial mast | 53 Radio equipment (TR1143 and TR1133) | 89 Main undercarriage swivelling joint | 130 Port cannon barrels |
| 14 Rudder balance weight | 54 Battery | 90 Hispano 20mm cannon | 131 Hispano 20mm cannon |
| 15 Aerial cable | 55 Oxygen bottle | 91 Starboard wing cannon bays | 132 Port wing cannon bays |
| 16 Tail fin aluminium leading edge | 56 Hydraulic system equipment | 92 Cannon barrel front mounting | 133 Outboard ammunition box |
| 17 Port tailplane | 57 Dinghy stowage | 93 Main undercarriage door fairing | 134 Ammunition feed drums |
| 18 Control cable pulleys | 58 Seat back armour plate | 94 Oleo-pneumatic shock absorber leg strut | 135 Fuel filler cap |
| 19 Port access panel to tailplane controls | 59 Head armour | 95 Starboard mainwheel | 136 Fuselage (reserve) fuel tank (28 Imperial gallons) |
| 20 Ventral fin | 60 Rearward-sliding canopy cover | 96 Cannon barrel fairings | 137 Exhaust anti-glare shield |
| 21 Tailwheel | 61 Canopy framework | 97 Recoil springs | 138 Oil filter |
| 22 Dowty shock absorber tailwheel strut | 62 Safety harness | 98 Cannon muzzles | 139 Engine compartment fireproof bulkhead |
| 23 Fin framework | 63 Pilot's seat | 99 Landing gear pivot point | 140 Pneumatic system air bottle |
| 24 Fin/tailplane root fillet | 64 Seat adjustment lever | 100 Camera aperture | 141 Front wing spar centre section |
| 25 Fuselage fabric covering | 65 Fuselage/wing spar attachment joint | 101 Cine camera | 142 Engine bearer support strut |
| 26 Lifting bar socket | 66 Ventral oil and coolant radiator | 102 Front spar outer panel joint | 143 Port mainwheel |
| 27 Arrestor hook latches | 67 Position of flap hydraulic jack (fitted on port side only) | 103 Position of nine-imp gallon (41-litre) leading-edge oil tank (port side only) | 144 Carburettor air intake |
| 28 Dorsal stringers | 68 Gun heater air duct | 104 Landing gear hydraulic retraction jack | 145 Supercharger |
| 29 Fuselage diagonal wire bracing | 69 Inboard flap housing | 105 Retraction linkage | 146 Engine control rods |
| 30 Upper longeron | 70 Trailing-edge ribs | 106 Fuel filler cap | 147 Coolant filler flap |
| 31 Aluminium alloy fuselage frames | 71 Outer wing panel rear spar joint | 107 Port wing main fuel tank (34.5 Imp gal) | 148 Coolant system header tank |
| 32 Bolted joint fuselage tubular construction | 72 Breech-block access covers | 108 Main undercarriage wheel well | 149 Magneto |
| 33 Deck arrestor hook | 73 Cannon breech-blocks | 109 Centre-section strut framework | 150 Engine bearer struts |
| 34 Arrestor hook pivot point | 74 Outboard flap housing | 110 Cockpit floor level | 151 Rear engine mounting |
| 35 Bottom longeron | 75 Rear spar | 111 Pilot's foot boards | 152 Hand-turning crank fitting |
| 36 Arrestor hook damper | 76 Aluminium aileron construction | 112 De-icing fluid tank | 153 Lower engine cowlings |
| 37 Wooden dorsal fairing formers | | 113 Rudder pedals | 154 'Fishtail' exhaust pipes |
| 38 Aerial mast | | 114 Instrument panel | 155 Rolls-Royce Merlin XX engine |
| 39 Upper identification light | | 115 Control column | 156 Coolant pipes |
| 40 Upward-firing recognition flare launcher | | 116 Elevator trim tab control wheel | 157 Upper engine cowlings |



This somewhat tatty Hurricane I, P3090, flew with 759 Squadron, which operated as part of the Fleet Fighter School from 1940-43, and later with 760 Squadron's Fighter Pool. *AEROPLANE*

Fleet fighters and 'Hurricats'

After years of delay in accepting that a naval Hurricane was possible and desirable, it took only months for the aircraft to enter service. Hurricanes were delivered to the Fleet Air Arm from January 1941, though initially these were strictly land-based aircraft with modifications restricted to equipment such as the radio and instruments.

The prototype carrier-capable Sea Hurricane was available for testing in March 1941. This was Canadian-built Mkl P5187, which had supposedly been written off in November 1940. Assuming this was the same aircraft, it was probably converted to Sea Hurricane standard while under repair. In May that year, further conversions began and the first front-line squadron, 880 Naval Air Squadron, received its first non-carrier-capable Hurricanes for training. By October 1941, some 120 aircraft had been converted.

It should have been possible to form the first Sea Hurricane fleet fighter squadron rather earlier, but for a shortage of pilots caused by the fact that

many were still on loan to the RAF. When 880 embarked on the carrier HMS *Furious* for operations in July, it was only possible to send a flight of four aircraft, which was dubbed 880A Squadron.

With the German invasion of the Soviet Union in June 1941, the war cabinet wished to make a gesture of support, and a simultaneous raid on the northern Norwegian ports of Petsamo and Kirkenes was planned for 31 July 1941. The missions would be conducted from HMS *Furious* and HMS

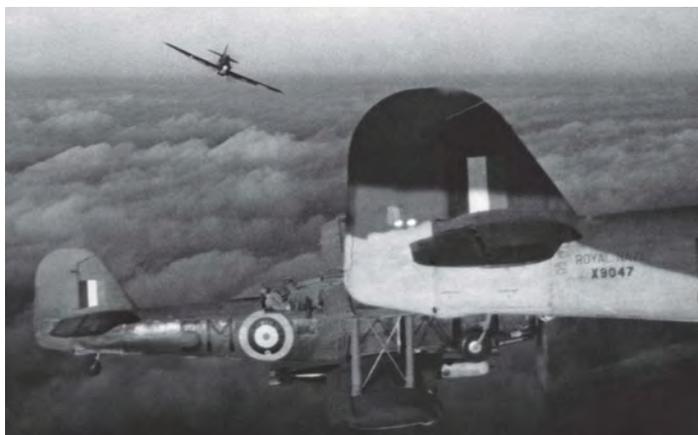
Victorious with Fairey Albacores bombing shore installations and torpedoing ships in the harbour, escorted by Fairey Fulmars. The Sea Hurricanes of 880A Squadron were responsible for air defence of the fleet.

The raids themselves were largely unsuccessful, with little achieved in the way of damage to the targets and heavy losses in the attacking squadrons. The Sea Hurricanes chalked up their first victory after the operation, when a Dornier Do 18 flying boat

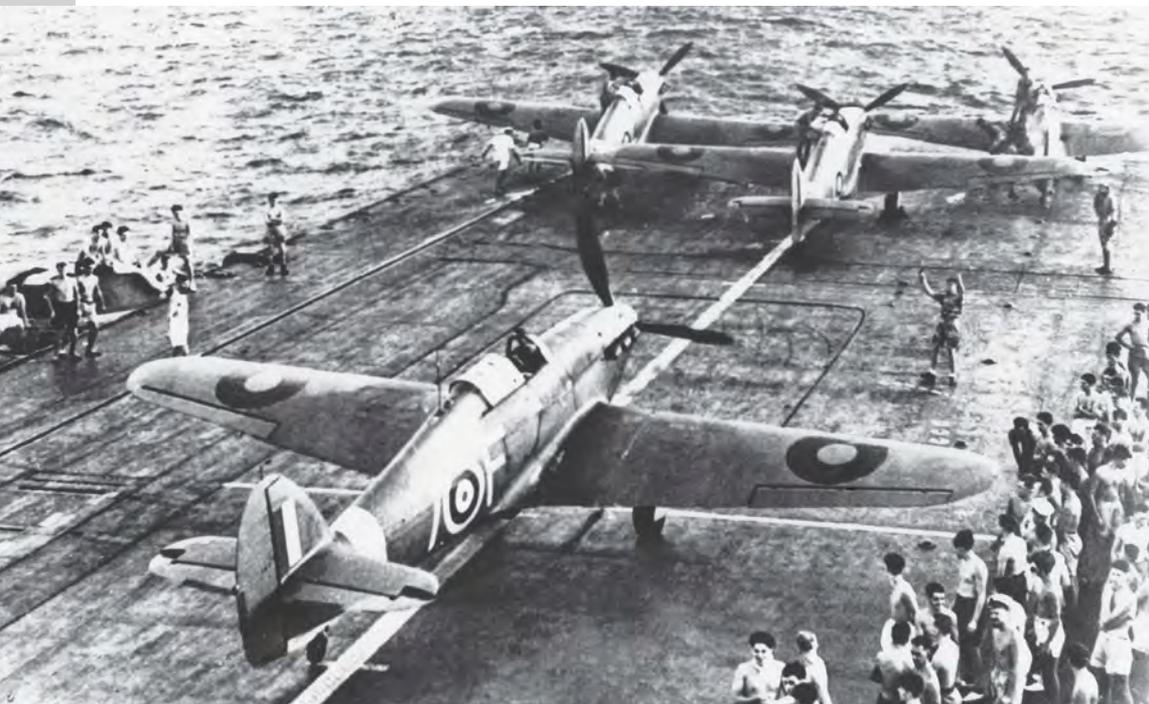
located the task force, and two fighters from 880A duly shot it down. The CO, Lt Cdr Judd, was credited with the kill.

The squadron recombined and embarked on HMS *Indomitable* later in 1941. It took part in Operation 'Ironclad', the capture of Diego Suarez on Madagascar to deny its use to the Japanese, during May 1942.

Although Sea Hurricanes were now available to the FAA, the service found significant problems with the availability of the spares, equipment and knowledge to operate the fighters, and the tired state of the aircraft received from the RAF. In July, three Sea Hurricanes brought to the Mediterranean by HMS *Furious* were flown by Ark Royal's pilots and took part in trial landings and take-offs from the carrier. Ark's commanding officer was unimpressed, reporting to Admiral Somerville, in command of Force H, that two of the aircraft had gone unserviceable. He noted that no technical publications, spares or tools had been provided, that the



ABOVE: A Sea Hurricane from HMS *Indomitable* making a mock attack on a pair of Fairey Albacores. VIA MATTHEW WILLIS



ABOVE: 880 and 800 Squadrons provided the Sea Hurricanes aboard HMS *Indomitable* for Operation 'Pedestal', the August 1942 Malta convoy protection effort. VIA MATTHEW WILLIS

mechanics had no experience with the type, and that consequently great difficulty was experienced in keeping them running. Somerville was equally frustrated and explained to the Admiralty that he intended not to embark any Sea Hurricanes on *Ark Royal*.

The condition of the Hurricanes initially supplied to the FAA from RAF stocks was extremely poor, especially considering how important they were to their new operator. Many were from the first batches of deliveries to the RAF, after long and sometimes hard lives, and some had sustained serious damage more than once. "All these old aircraft suffer from a multitude of minor defects and the Stations have had to expend many weeks' work in rendering them fit for allotment to a Squadron", wrote the Vice Admiral, Naval Air Stations to the Admiralty in September 1941, adding, "it is most likely that they will continue to suffer from minor defects during their remaining life". The vice admiral was further concerned with the effect on morale such "cast-offs" would have on the squadrons they were issued to.

That month, Prime Minister Winston Churchill expressed surprise that the FAA's fighter squadrons were equipped with the Sea Hurricane I rather than the newer and more powerful MkII. He wrote to the Chiefs of Staff Committee in September 1941, following a visit to HMS *Indomitable*, noting that he was, "astonished to learn that the handful of Hurricanes to be allotted to this vital war unit were only of the lower type

Hurricane Ones. I trust it may be arranged that only the finest aeroplanes that can do the work go into all aircraft-carriers... The aircraft-carriers should have supreme priority in the quality and character of suitable types."

This was a dramatic U-turn from Churchill's position as expressed in January 1940, but gave impetus to the FAA receiving newer Hurricanes. In the meantime, though, it had

“ Churchill wrote, "I trust that it may be arranged that only the finest aeroplanes that can do the work go into all aircraft carriers" ”



ABOVE: Canadian-built MkII JS327 of 804 Squadron from HMS *Dasher* ran out of fuel during the first day of Operation 'Torch', November 1942's Allied landings in North Africa, and force-landed near the beach at St Leu (now Bethioua), Algeria. The US-style white star was applied over the roundels of British aircraft engaged in 'Torch' as an identification measure for Allied forces; note also the overpainted fin flash.

to soldier on with older machines.

Sea Hurricanes finally joined Force H in early 1942, when HMS *Eagle* took *Ark Royal's* place (the newer carrier having been sunk in November 1941). Initially *Eagle* could only carry two Sea Hurricanes of the 813 Squadron Fighter Flight, but these provided what air defence they could during operations to supply Spitfires to Malta in May 1942. When 824 Squadron's *Swordfish* disembarked at Malta ahead of the Operation 'Harpoon' convoy in June 1942, however, the 12 Sea Hurricanes of 801 Squadron replaced them, making 14 defending the convoy, along with six Fulmars of 807 on *Argus*. This was 801's first major carrier operation since it had re-formed as a Sea Hurricane unit in August 1941, having been largely devoted to defence of the Scapa Flow base in that time, although its aircraft had shot down an Fw 200 while operating from *Eagle*, covering an outbound Singapore convoy in December 1941. 'Harpoon' was an attempt to escort six merchantmen to Malta, while concurrently another convoy would approach from Alexandria, Operation 'Vigorous'. Only the old carriers *Eagle* and *Argus* were available to provide air cover as the newer armoured carriers were all occupied in the Atlantic and Indian Ocean.

The air defence of 'Harpoon' was compromised by light winds directly from aft, meaning that to fly off aeroplanes the carriers had to leave the screen and steam fast in the opposite direction to the convoy. Despite this, *Eagle* managed to maintain a section of Sea Hurricanes airborne from 08.45hrs until nightfall on 13 June, the first day after departure from Gibraltar. They damaged a Ju 88 and shot down a CANT Z1007.

The following day opened with more air combat: *Eagle's* Sea Hurricanes damaged a Ju 88 and shot down a Breda Ba 88 early in the morning. Shortly after 10 o'clock it was



ABOVE: 880A Squadron's charges aboard *Indomitable* off Freetown in late July 1942, when the carrier was heading for Malta following Operation 'Ironclad'. Also visible are Albacores and Martlets. *AEROPLANE*

clear that enemy forces were massing for a concerted attack. *Eagle's* Sea Hurricanes shot down a bomber at around 10.20, and thereafter the convoy was under attack for two hours. The Sea Hurricanes downed two torpedo bombers and a high-altitude bomber, plus two fighters.

The attacks commenced again at 18.15 with 10 minutes of dive and high-level bombing. The fighters managed to break up the attacks and forced some aircraft to jettison their bombs, while those that did get through all missed. Further raids came in after eight o'clock in the evening, including a force of torpedo bombers with a 20-strong fighter escort that prevented the carrier fighters from disrupting the bombers, though all of the enemy aircraft missed the targets.

At the end of the day, the convoy now being within the range of fighters from Malta, the carriers turned back for Gibraltar. While 'Harpoon' had been under the protection of the FAA, only one of the merchant ships had been hit.

The immediate pressure on Malta was relieved slightly, but the Admiralty knew that another convoy would be needed soon. The resulting Operation 'Pedestal' would be a single convoy from the west, made up of 14 fast merchant ships with the strongest escort of any convoy in the war to that point. It included four fleet carriers, which were able to accommodate more Sea Hurricanes by carrying them

on outriggers projecting from the flight deck. HMS *Victorious* embarked six Sea Hurricanes of 885 Squadron in addition to her Fulmars; *Indomitable* had the 12 Sea Hurricanes of 880 Squadron and 10 from 800 Squadron, which had replaced its Fulmars with the single-seaters in June, alongside some Martlets; *Eagle* still carried the 12 Sea Hurricanes of 801 Squadron and four 813 Squadron aircraft; while *Furious*, whose job was to fly off more Spitfires, had six Sea Hurricanes of 804 Squadron for self-defence. Before the convoy entered the Mediterranean, exercises were carried out with the carriers, which provided the Navy with

some valuable lessons in fighter control.

The convoy passed through the Straits of Gibraltar in two groups on the night of 9-10 August. The first enemy aircraft were sighted on the morning of the 11th, and two sections of 880 Squadron were launched to intercept. One shadower was damaged and another shot down at 08.30. *Furious* flew off her Spitfires between 12.15 and 15.15, but during that phase *Eagle* was torpedoed by a U-boat and sank with the loss of all but four of her Sea Hurricanes, which were airborne on patrol at the time. *Furious* collected *Eagle's* survivors and returned to Gibraltar that afternoon, leaving the convoy under the protection of *Indomitable* and *Victorious*.

The first air attacks arrived at dusk, in the form of six groups of Ju 88s. Fifteen Sea Hurricanes and four Fulmars ➤

“While convoy 'Harpoon' had been under the protection of the FAA, only one of the merchant ships had been hit”

IN SERVICE HAWKER SEA HURRICANE

launched to bolster the defences. One Ju 88 was attacked out of the sun by *Indomitable's* Sea Hurricanes and was seen diving into the sea, though one of the fighters was hit by defensive fire and had to ditch. It was too dark for the Sea Hurricanes and recovery became confused in the failing light, several aircraft landing on the wrong carrier. The maintainers were kept at full stretch repairing damage to the surviving fighters — one Hurricane had to have its entire tail unit replaced.

The attacks resumed the following morning, 30 more Ju 88s making dive-bombing attacks, but again they failed to do any damage and two were shot down. The first hit to one of the merchant ships was achieved by a raid of Italian

CANT Z1007s at 12.14, a bomb striking MV *Deucalion*, but the vessel was able to continue. Half an hour later, 35 torpedo bombers attacked, but while there were multiple close calls, no ships were hit. The Sea Hurricanes were once again in the thick of the defence with 800 and 885 Squadrons tangling with bombers at 18,000ft. Lt Cdr Bill Bruen, a veteran of 800 Squadron, became an ace when he claimed his fifth kill, a Ju 88.

The Axis efforts to overwhelm the convoy's defences increased into the

afternoon of Wednesday 12 August, the Admiralty narrative of the convoy noting, "German and Italian fighters present in large numbers. Fleet fighters heavily engaged". Aircraft and pilots were wearing out fast. A formation of bombers finally broke through the cordon and hit *Indomitable*, whose fighters in the air had to land on *Victorious*. Another Sea Hurricane pilot, Lt Cdr Rupert Brabner MP, made ace status after shooting down two Italian torpedo bombers, but the co-ordinated attacks between torpedo and high-level bombers stretched the

“The Admiralty was determined to undertake the North African landings under the cover of the most modern and powerfully armed fighters”

fighter force, which was outnumbered and couldn't be everywhere at once. A section of Hurricanes from 880 Squadron, pursuing a

torpedo bombers, was bounced by Messerschmitt Bf 110s and two were shot down, including the squadron commander, Lt Cdr Judd. The senior pilot, Lt Cork, a veteran of the Battle of Britain, assumed command. Cork would shoot down six aircraft in the 'Pedestal' defence.

The carrier force turned back when the convoy was under the fighter umbrella of Malta. While the Fleet Air Arm had been responsible for the defence of the convoy against air attack, only one merchant ship had been hit and none sunk. "Fleet fighters



ABOVE: On 10 October 1944, MkIIc NF722 overshot on landing aboard HMS *Ravager*, or missed a wire, and ran into NF728, severely chewing its tail. Both aircraft belonged to Inskip, Lancashire-based 760 Squadron. AEROPLANE

intercepted all bombing attacks on Force 'F', reported the Admiralty narrative, a remarkable achievement considering how few in number they were. Vice Admiral Syfret stated, "during daylight hours our fighters, though greatly outnumbered, continued their magnificent work both in reporting approaching raids and in shooting down enemy aircraft". The fleet fighters claimed 39 aircraft destroyed and five probably destroyed, the lion's share by Sea Hurricanes. With more heavily armed fighters, the totals would have doubtless been higher.

Upon the temporary relief of Malta afforded first by 'Pedestal' and then the withdrawal of many German squadrons to the Eastern Front, the Allied commanders' attention turned to the invasion of North Africa, Operation 'Torch'.

The shortcomings of the Hurricane I's armament having been underlined by 'Pedestal', the Admiralty was determined to undertake the North African landings under the cover of the most modern and powerfully armed fighters. This required dramatically bringing forward agreed deliveries of Hurricanes. Vice Admiral Lyster, who had been in

BELOW: Sea Hurricane IIc NF691 of 835 Squadron, the last unit to fly the type operationally — it did so from HMS *Nairana* in 1944. CHRIS SANDHAM-BAILEY





charge of the 'Pedestal' air operations, demanded 60 hooked Hurricane IIcs by 15 September and a further 15 Hurricanes without hooks for training by 1 September, in addition to Supermarine Seafires.

Hawker's Langley factory was working at full stretch to deliver hooked Hurricanes, but as well as the greater performance of the MkII the Admiralty wanted the hitting power of the four-cannon 'C' wing, and acquired 30 sets of wings thus equipped. Hawker was not prepared to take back the .303in-armed machines it had already converted to Sea Hurricanes, so the RAF maintenance unit at Henlow carried out this work, and was also able to modify 24 of the 30 aircraft to carry long-range fuel tanks. This would allow them to make ferry flights to operate on shore if required.

Unlike the Seafires, the Hurricanes were all modified with hooks in good time, which allowed for plenty of deck landing training. Nevertheless, the availability of stores remained a difficult issue, and it was noted that the FAA was only starting to receive Hurricane I spares in quantity as the MkII was replacing it.

Squadrons on leave, including those that had been given leave after taking part in

'Pedestal', were recalled early in September. This hit morale somewhat for units that had just been through the hardest-fought operation of the FAA's war so far, but given the short time available to work up it was inevitable. Nevertheless, while considerable problems were experienced with Martlets and Seafires in training, the Sea Hurricane II — despite being new to the Navy — presented no problems. Five squadrons were re-equipped with the newer type: 800, 802, 883, 804 and 891, all of which would be operating from modified escort carriers.

The central naval task group at Oran included HMS *Biter* and *Dasher*, and the eastern task group at Algiers featured *Avenger*, all with 15 Sea Hurricanes. On 7 November, *Dasher* flew off six Hurricanes of 804 Squadron to escort Fairey Albacores from HMS *Furious* to La Senia. Unfortunately, on returning, the Sea Hurricanes were unable to locate the carrier and had to force-land on the shore. The following day, Sub Lt Goodfellow was able to acquire petrol to return to the carrier, but the other aircraft were all lost.

After that, *Dasher* maintained a CAP with 891 Squadron, which also undertook some beach patrol and close support missions, while 800 from *Biter* provided close air support and top cover to American troops, during which the squadron claimed five Dewoitine D520s destroyed. Sub Lt Godfrey of 891 was set upon by two D520s over La Senia and shot down. He was captured, escaped, recaptured and finally escaped for good, being reunited with Allied forces on 12 September.

'Torch' was the last major operation in which Sea Hurricanes operated with the fleet. Thereafter, their role was increasingly taken by Seafires and American-built fighters, but the Hurricane IIc would remain potent for some time to come, operating from escort carriers in convoy protection.

CONVOY ESCORT

Catapult trials of Sea Hurricanes took place at RAE Farnborough in late 1940, and by the end of March 1941 some 60 Merlin III-powered MkIs were allocated for convoy protection duties. These aircraft were 'one-shot' machines, intended to be launched from a naval Fighter Catapult Ship or a Catapult Armed Merchantman (CAM) ship. The pilot, after launching, would be required to fly to land if possible, or to bale out ahead of the convoy in the hope of being recovered. The Hurricane's ditching characteristics were very poor — Hawker estimated that the aircraft would float for less than two seconds.

The FAA unit 804 Squadron at Sydenham, Belfast, was given the task of flying from Fighter Catapult Ships. On 9 May, HMS *Maplin* sailed with Sea Hurricanes aboard. Shortly after the naval operation commenced, the Merchant Ship Fighter Unit (MSFU), an RAF outfit, formed at Speke. It was to be manned by RAF volunteer pilots and maintenance crew, supplemented by FAA pilots in an emergency, and RN fighter direction officers. SS *Michael E* was the first CAM ship ready to operate, and a Hurricane Ia was loaded for a maiden voyage on 28 May, with an FAA pilot due to a lack of RAF pilots. By the

beginning of July, 25 Sea Hurricane Ia variants had been delivered to the MSFU, and there had been 16 CAM ship sailings but no launches.

That month, HMS *Maplin* began its second voyage, a convoy to Halifax. On 18 July, an Fw 200 of I./KG 40 was spotted approaching, and Lt R. W. H. Everett launched his Sea Hurricane to make a head-on attack when the Condor was shot down by anti-aircraft fire. The ship's next voyage was on the Gibraltar run, again with Everett and two sub lieutenants as the duty pilots. On 2 August, Everett launched to intercept a Condor, and shot it down after a tailchase. He managed to ditch, after trying twice and failing to bale out, and was recovered by HMS *Wanderer*, later being awarded the DSO for the achievement.

By September 1941, 39 pilots had trained for the MSFU and there had been 37 CAM ship sailings on Atlantic convoys, but still no launches. The Gibraltar route, however, was starting to suffer badly at the hands of Condors and only had FCSs to cover it. On 2 September Sub Lt Walker launched from *Maplin* to attack a Condor, which jettisoned its bombs and withdrew after taking damage from the Sea Hurricane. Later that month, six CAM ships were put on the Gibraltar route. ➤



ABOVE: The 'one use only', catapult-equipped Sea Hurricanes launched from CAM ships, as here, were nicknamed 'Hurricats'.

BAE SYSTEMS

IN SERVICE HAWKER SEA HURRICANE

The first operational CAM ship launch finally came on 1 November 1941. Plt Off Varley, flying from *Empire Foam*, disrupted a Condor's bomb run and drove it to escape into cloud.

From the beginning of 1942, most of the Condors were withdrawn from North Atlantic patrols so the CAM ships were transferred to the Gibraltar route and Russian convoys. Fg Off Kendal aboard *Empire Morn* made the first CAM ship launch on the latter run on 25 May 1942, shooting down one of two Ju 88s attacking convoy PQ16. Unfortunately his parachute failed to open properly and Kendal died of his injuries. Plt Off Al Hay later flew off *Empire Laurence* to intercept torpedo-carrying Heinkel He 111s, damaging one and disrupting the attack so that no hits were scored, before baling out successfully.

The MSFU was at its peak from May-July 1942 with 29 CAM ships in operation on three different routes. However, they were rapidly eclipsed. Eight were removed in July when the vessels were withdrawn from North Atlantic convoys, and by the end of that summer only 13 remained. Russian convoys were scaled back that August to support Operation 'Pedestal' but CAM ships continued to cover the Gibraltar convoys through the Bay of Biscay. This was followed by the largest Russian convoy to date, PQ18, on 2 September 1942, escorted not only by the CAM ship *Empire*



ABOVE: A 'Hurricat' on its launcher, ready to go. The flaps would be pre-selected in the take-off position.

Morn but by the newly received American-built escort carrier HMS *Avenger* with 12 Sea Hurricane IIs of 882 and 802 Squadrons.

Many lessons were learned on this convoy. The first time an enemy aircraft was spotted, on 12 September — a Blohm und Voss Bv 138 flying boat — several Sea Hurricanes were launched but the shadower evaded them in cloud and mist, largely wasting the fighters' energy. A diversionary bombing raid by a few Ju 88s successfully pulled the Hurricanes away from a large-scale torpedo attack, which scored eight hits on the convoy's ships. The Sea Hurricanes did at least manage to shoot down several He 111 torpedo bombers that attacked in the evening.

Avenger's captain subsequently resisted the temptation to scramble the fighters whenever an enemy aircraft appeared, deciding that it was preferable to hold them back to tackle concerted

attacks such as the torpedo strike on the 12th. Sure enough, another large, low-level attack materialised on 14 September, and *Avenger* quickly launched nine Sea Hurricanes, which made a head-on attack and broke up the formation. This time, the fighters were in the right place when another attack developed from astern the convoy. A determined effort opened up a breach in the diamond of Ju 88s, and, in the words of one pilot, "the formation broke up and there was a lovely scrap all over the sky". The Sea Hurricanes were engaged all day, and none were lost to enemy fire, though three were shot down by 'friendly fire'. All three pilots were recovered.

The following day looked to be a repeat of the 14th, but few of the German bombers ventured below cloud, and most attempted to bomb 'blind' from high altitude. On the 16th, *Avenger* withdrew but *Empire Morn* launched her

Sea Hurricane in response to a developing attack the next day. Fg Off Burr shot down a Heinkel before heading for Murmansk, where he landed safely.

CAM ship operations were briefly extended to Algiers convoys in November 1942, but the following March they were withdrawn from Russian convoys. The MSFU disbanded in July 1943, but some CAM ships were still in operation, with two returning from Gibraltar. The Condors were now generally attacking in formation at high altitude. On 28 July one made a rare individual attack at low level, and was shot down by Fg Off Stewart flying off *Empire Darwin*. On the same day Fg Off Flynn launched from *Empire Tide* against another Condor at low level and shot it down. Both men were safely recovered after the last MSFU action. Eight operational launches resulted in six kills and, more importantly, many raids were broken up and disrupted. Only one pilot was lost, and that was unfortunately due to a faulty parachute.

Sea Hurricanes continued to fly from escort carriers throughout 1943 until finally being replaced fully by newer types in October 1944. The last squadron to use the type in anger was 835 Squadron, a composite unit with a Sea Hurricane 'fighter flight' alongside anti-submarine Swordfish, flying from HMS *Nairana*. Its Hurricanes wore a distinctive, mainly white colour scheme, which helped camouflage them against abundant clouds experienced on the North Atlantic and Arctic runs. For 10 months of 1944, the squadron's Sea Hurricane IIs flew in appalling conditions, tackling shadowers and bombers, and providing cover for the Swordfish when attacking submarines.

The Sea Hurricane, initially unwanted and hurriedly adapted, took to its role with aplomb, performing feats in the Battle of the Atlantic and the Mediterranean theatre that were arguably as significant as its land-based counterpart's success in the Battle of Britain.

THE FINAL HURRICANE KILL

On 26 September 1944, 835 Squadron chalked up the last combat kill for the venerable Hurricane. "Some distance out on the convoy's starboard bow, we saw a Ju 290 which must have just descended to sea level to escape convoy detection", wrote Lt Burgham. "We were at 2,000 or 3,000 feet and decided to separate so that we could attack him from opposite sides. He soon saw us and turned away, putting Richardson in a position to attack first. As he committed himself to a diving attack the Ju took the

usual evasive action by turning towards him, making it difficult for him to get a bead on it. This meant that the 290 was turning away from me and put me in an excellent position to attack. As I approached it I could see Charles Richardson closing in astern in a very tight turn, when his wing tip hit a wave and he exploded in a ball of oily flame. As the Ju began a turn towards me, I came within range, opened fire and began to see pieces falling from the aircraft which climbed a little, then nosed over into the sea, where it exploded."

FAA pilots' impressions

The Sea Hurricane was popular with pilots for its handling and aerobatic qualities. Though its deck landing characteristics were not as good as aircraft such as the Martlet, Fleet Air Arm pilots generally adapted easily and the aircraft did not suffer the high accident rate of types such as the Seafire.

Capt Eric 'Winkle' Brown was with 802 Squadron during its work-up before embarking on HMS *Avenger*, and undertook some of the first landings of a Sea Hurricane Ib on an escort carrier.

"Aerobatics in the Sea Hurricane were certainly pleasant and easy to execute", he wrote in *Wings of the Navy*, "adding up to a very manoeuvrable fighter with fairly good harmony of control throughout the speed range."

For deck landings, Brown felt the Sea Hurricane was inferior to the Martlet, and "the inadequate view forward simply had to be accepted. Its harsh stalling characteristics were anything but suited for

deck landing and the undercarriage had a lot of bounce in it which could prove embarrassing on occasions. At least it was more robust than the Seafire that was to succeed it and could withstand quite a lot more deck landing punishment."

Cdr R. 'Mike' Crosley described his first flight in a Sea Hurricane in *They Gave Me A Seafire*:

“Eric Brown called the Sea Hurricane, “a very manoeuvrable fighter with fairly good harmony of control throughout the speed range””

“My first take-off in a Hurricane was like a first ride in a high-powered speed-boat, noisy, shaky and out of control and,

with the same colossal acceleration which almost dragged my hand off the throttle and jerked my head back against the headrest, it was so unexpected. The aircraft took charge. It shook with power as the 900 horses, only a few feet in front, wrenched round the propeller and dug it into the air. It was frightening too, for the whole thing leapt into the sky well before I was ready for it, and having used only a quarter of the runway.”

A

SEA HURRICANE SURVIVORS

Just one Sea Hurricane survives in naval configuration: this is, of course, the Shuttleworth Collection's MkIb Z7015/G-BKTH. A Canadian Car and Foundry-built example first flown on 18 January 1941, it was shipped to Britain and converted for FAA use by General Aircraft Ltd.



The Shuttleworth Collection's Sea Hurricane Ib Z7015.

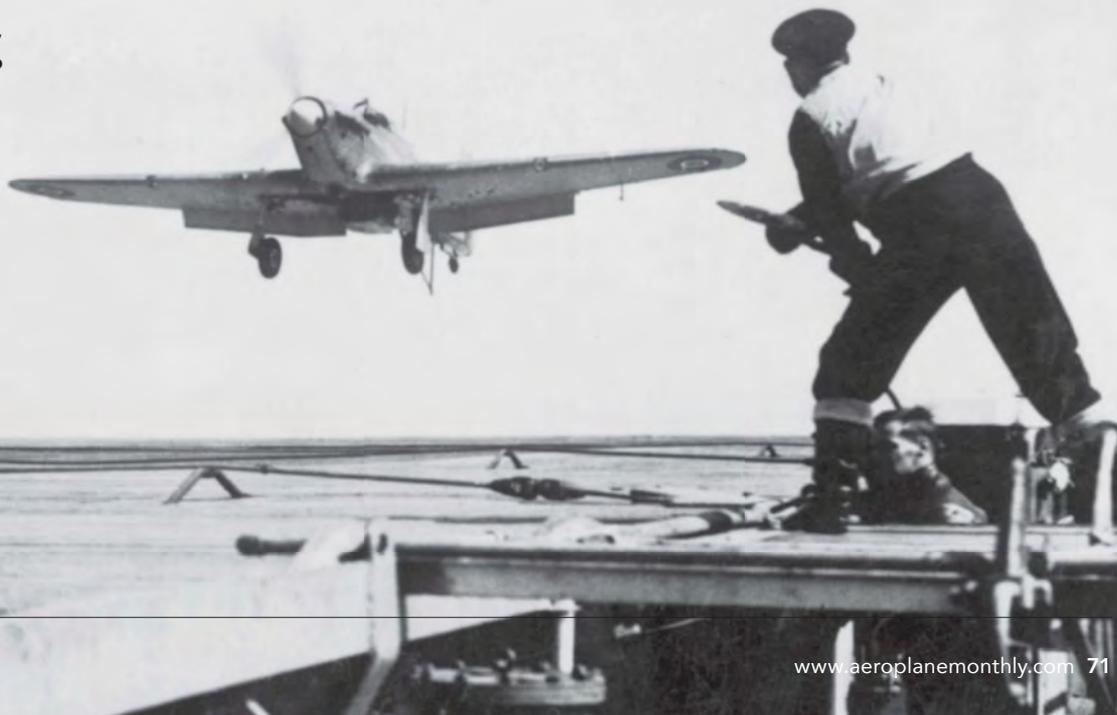
BEN DUNNELL

Z7015 was delivered that July to RNAS Yeovilton, entering service with 880 Squadron and being despatched with that unit to RNAS Hatston in the Orkneys. 880 embarked on HMS *Indomitable* during October 1941, but Z7015 was unserviceable and missed out. Following a period of repair, the aircraft returned to Yeovilton on the strength of 759 Squadron (the Naval Fighter School) in December 1942. By the following autumn it had been retired to Loughborough College as an instructional airframe. Later acquired by Shuttleworth, Z7015 spent many years as Old Warden Aerodrome's 'gate guard'. A joint Shuttleworth/Imperial War Museum restoration was carried out at Duxford from 1986, culminating in a maiden flight on 16 September 1995. It wears the markings of 880 Squadron.

As described in the preceding feature, the Flying Heritage and Combat Armor Museum's MkXII BW881 was once a Sea Hurricane, but has been restored to non-navalised configuration. MkX AE977 of the Biggin Hill Heritage Hangar, meanwhile, served with the Fleet Air Arm but was never converted into a Sea Hurricane.

Ben Dunnell

BELOW: The 'batman' stands by as a Sea Hurricane gets ready to land on HMS *Avenger* in June 1942. AEROPLANE



BRIEFING FILE

Under the skin of aviation technology and tactics

One of the disputes that peaked in which piston engine configuration

Radial Pratt & Whitney Twin Wasp as example

Cylinders

Arranged around a crankshaft. Adding extra banks increases power. In this case, there are two banks of seven, totalling 14

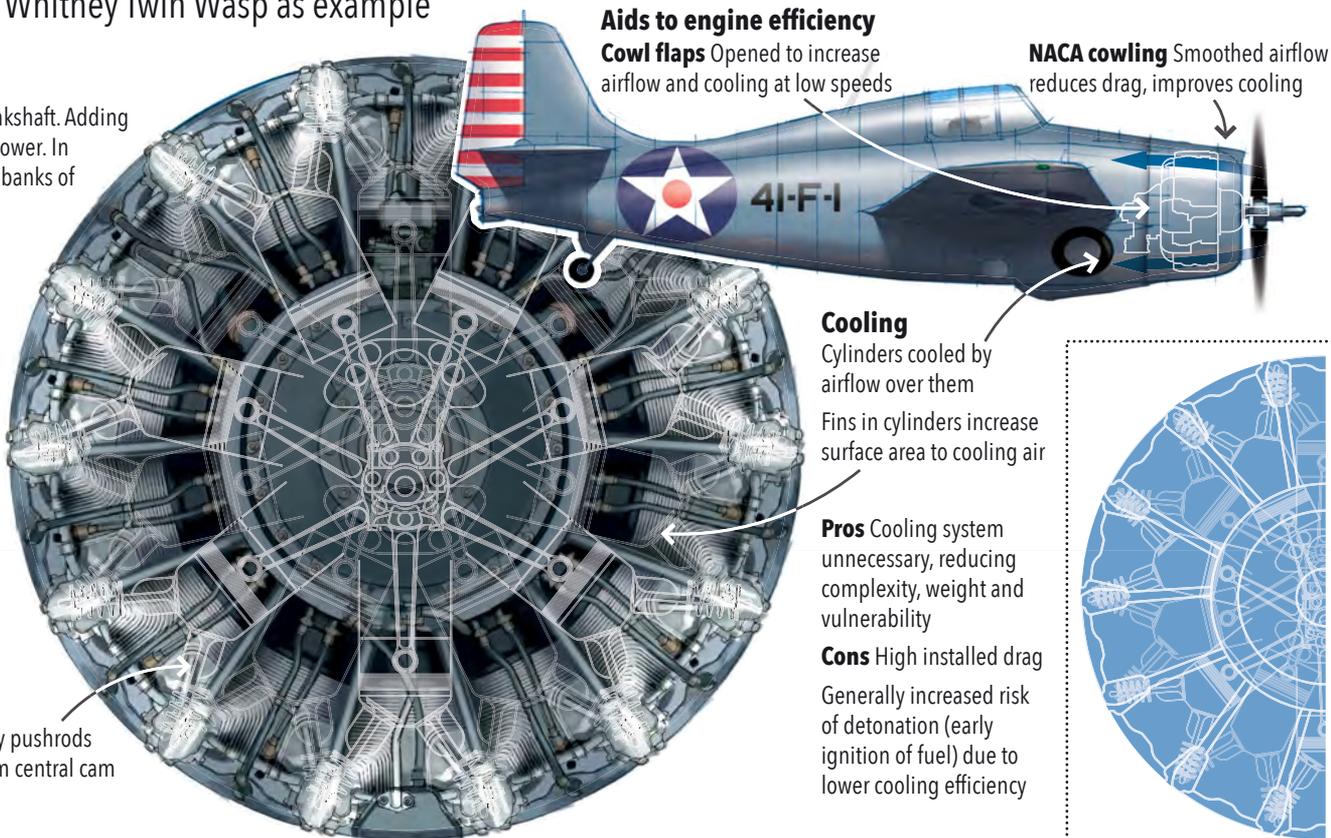
Pros Short crankshaft reduces torsional vibration.

Single cylinders can be removed, easing maintenance

Cons High drag of large frontal area
One crankshaft throw has to take load of seven connecting rods

Valves

Worked by pushrods timed from central cam



Aids to engine efficiency

Cowl flaps Opened to increase airflow and cooling at low speeds

NACA cowling Smoothed airflow reduces drag, improves cooling

Cooling

Cylinders cooled by airflow over them
Fins in cylinders increase surface area to cooling air

Pros Cooling system unnecessary, reducing complexity, weight and vulnerability

Cons High installed drag
Generally increased risk of detonation (early ignition of fuel) due to lower cooling efficiency

RADIAL VERSUS

A perennial argument in aviation technology pits the simplicity, robustness and reliability of the radial piston engine — advantages offset by the large frontal area and drag — against the more streamlined in-line piston engine, which itself suffered from the extra weight and vulnerability of its liquid cooling system. Some non-fighter in-line engines were of course air-cooled, generally the lower-power types; notable examples were the Fieseler Storch's Argus As 10 inverted V8, a number of US Ranger engines and the widely used de Havilland units.

In the early period of World War Two, successful naval fighters (as illustrated by the Wildcat, above left) were often fitted with simpler and more reliable radials, while fighters required to achieve high-speed, rapid interceptions over home territory (like the Spitfire, above right) more regularly used

in-lines. As the war progressed, and engine capability and power increased, that distinction became less clear. While each had advantages, both benefited from developments in engine and airframe design, which addressed each configuration's shortcomings, while neither engine configuration entirely supplanted the other in most major roles.



Although the ducted spinner on the first Fw 190 proved a failure, in almost every other way the engine design showed what could be done with a radial in an uncompromised fighter. VIA JAMES KIGHTLY

For the benefit of a reduced frontal area, the in-line engine had to carry extra weight, primarily the cooling system. This had been a significant performance burden for aircraft such as the inter-war Schneider Trophy racers, with almost every external surface of several racers being covered with coolant radiators. By the late 1930s this was being overcome

through design and engineering improvements, while other solutions, like evaporative steam cooling, were found to be dead ends. The use of the Meredith effect, from the mid-1930s onwards, significantly countered the drag of the radiator system.

On the other hand, the frontal area of a radial engine is not, of course, a solid disc. Rather, the airflow passes between the cylinders and fins and cools them, and the use of a Townend ring and NACA-type cowlings, plus other streamlining fairings, meant that the radial engine's drag was significantly reduced, while cooling efficiency was improved. That cooling could be adjusted by the use of cowl flaps, open at lower speeds and closed for less drag at higher speeds with the ram airflow providing adequate cooling. From the Focke Wulf

World War Two was a notably powerful one: was superior – radial or in-line?

In-line Merlin V12 as example

Cooling system components

Header tank Engine-driven pump

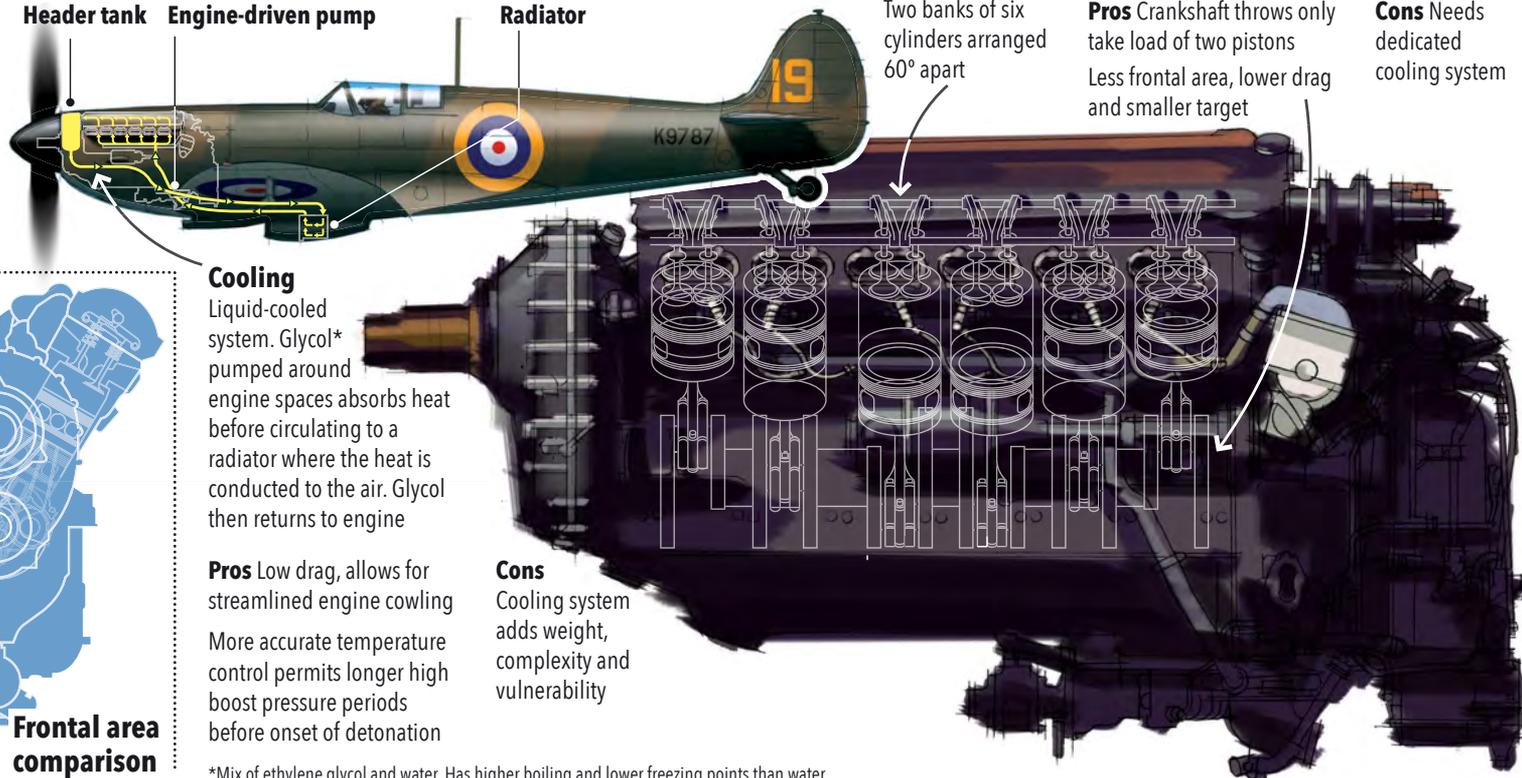
Radiator

Cylinders

Two banks of six cylinders arranged 60° apart

Pros Crankshaft throws only take load of two pistons
Less frontal area, lower drag and smaller target

Cons Needs dedicated cooling system



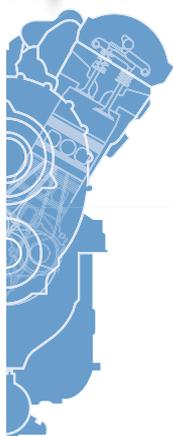
Cooling

Liquid-cooled system. Glycol* pumped around engine spaces absorbs heat before circulating to a radiator where the heat is conducted to the air. Glycol then returns to engine

Pros Low drag, allows for streamlined engine cowling
More accurate temperature control permits longer high boost pressure periods before onset of detonation

Cons Cooling system adds weight, complexity and vulnerability

*Mix of ethylene glycol and water. Has higher boiling and lower freezing points than water



Frontal area comparison

IN-LINE

WORDS: JAMES KIGHTLY ARTWORK: IAN BOTT

Fw 190 (first flown in 1939) onward, careful cowling and airframe design enabled powerful two-row fighter radials to be efficient both in terms of cooling and drag, and by the late part of the war the difference could be moot — exemplified by the in-line-powered but still ‘round-nosed’ Fw 190D.

Wars are not won by fighters alone. Many bombers were radial-powered, and radial-engined transports were even more common. The reliable longevity of the radial, first achieved in the 1920s, as well as its relative simplicity and easier servicing trumped the advantages of the in-line. The Merlin was a successful engine in British bombers, but it is often forgotten that it was not so highly regarded for transport use.

Two-row radials mostly run efficiently despite the aft row having less cooling efficiency from the heated, disturbed airflow, but



Whether with the Allison V-1710 — as here — or, later, the Packard Merlin, the P-51 Mustang’s design was a triumph of elegant and effective streamlining around the in-line configuration. LIBRARY OF CONGRESS

radials with three or more rows usually suffered from significant cooling issues on the aft cylinders. Interestingly, the huge, 3,500hp Pratt & Whitney R-4360’s 28 cylinders in four rows worked well thanks to careful airflow design, and was shown to have a similar frontal area to the liquid-cooled, less powerful, in-line H-3130.

Accounts of engines continuing to run with phenomenal damage, while important, don’t prove the superiority of either configuration without careful quantified assessment — which would need to include those engines that failed in flight on single-engine types and ‘failed to return’. Almost all radial and in-line engines also required

an oil cooler system, essentially a smaller version of the in-line’s radiator, and vulnerable to the same damage and resultant failure.



It is worth noting that the world air speed record for piston-engined aircraft has been held at various times since the 1930s by both specialised (and standard, but modified) radial and in-line engines. The latest record was set with a special Merlin and propeller configuration on highly modified racing Mustang *Voodoo*, beating the previous benchmark set by the radial-powered Bearcat *Rare Bear*.

While there were definite, clear advantages for one configuration over the other at times, the fact that both types of engine were effectively and widely used by most combatant nations though to the end of World War Two — and beyond — is the most significant point.

