

The

Spirit of

North Weald

The North Weald Airfield History Series | Booklet 1



**The beginnings of the Airfield
in World War 1**

Home Defence

The roster of North Weald's World War 1 fighter squadrons...

19 Reserve Aeroplane Squadron / 39 (Home Defence) Squadron

19 Reserve Aeroplane Squadron was tasked with home defence duties around London in February 1916. In April it was renumbered to form 39 (Home Defence) Squadron, which was based at Hounslow, with subsidiary fields at Hainault Farm and Suttons Farm. In August 1916 A Flight relocated to North Weald, joined by the other two in 1917.

On 31 March/1 April, a BE2c flown by Lieutenant Alfred Brandon from Hainault Farm intercepted Zeppelin L15, which had been damaged by anti-aircraft fire and was losing height. He attacked it with 50 Ranken darts. It came down in the sea off Margate and all but one of the crew were rescued.

B Flight of 39 Squadron at Suttons Farm was commanded by Captain Arthur Harris for several months. He had engaged in combat with Zeppelin LZ97 on 24/25 April flying from Hounslow and using the newly-issued incendiary ammunition, but suffered repeatedly from jammed guns. After service in France, he commanded 50 Squadron at Bekebourne in Kent and 44 Squadron at Hainault Farm from June 1919.

Later, two more Home Defence Squadrons arrived and 39 Squadron departed for France in November 1918.

75 (Home Defence) Squadron

75 Squadron had originally been formed at Goldington (Bedford) in October 1916 and then based at Thrapston, Therfield, Yelling and Little Staughton. It moved east to Elmswell (Bury St Edmunds), a 6th Brigade Station in

September 1917, where it used landing grounds at Upwood and Stutton. From there, the HQ plus A Flight equipped with FE2bs and BE12s came to North Weald in June 1918.

The Squadron received Avro 504Ks in July and Sopwith Pups in October. Post-war it was re-equipped with more potent Sopwith Camels and Snipes, the other two Flights arriving here in May 1919. It was subsequently disbanded at North Weald on 13 June.

The Squadron reformed in World War 2 flying bombers with mainly New Zealand crews. It flew more sorties than any other RAF heavy bomber unit, suffered more casualties than any other squadron, and dropped the second-largest weight of bombs with its Wellingtons, Stirlings and Lancasters.

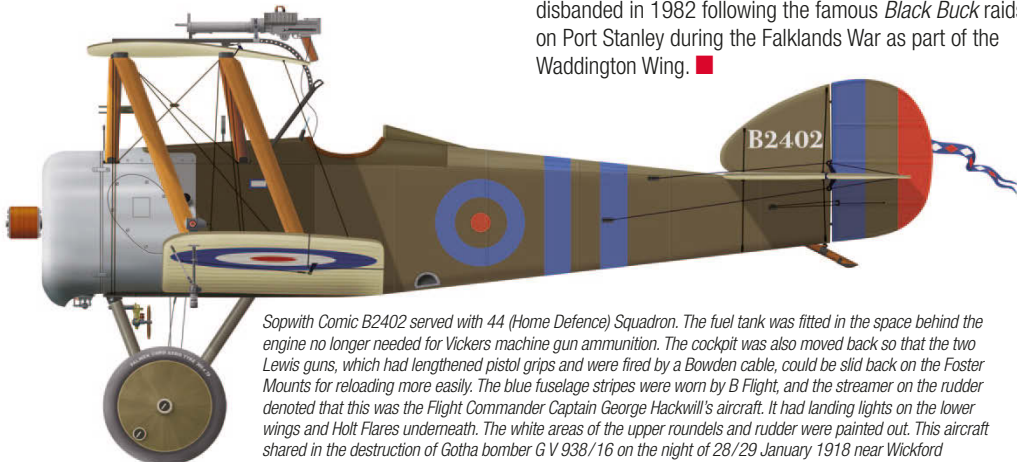
During October 1946, in gratitude for this and the sacrifices made by its New Zealand aircrew, the RAF transferred the squadron number, badge and colours to the Royal New Zealand Air Force. This was a unique gesture. The Squadron was finally disbanded in December 2001.

44 (Home Defence) Squadron

North Weald was also the home of 44 Squadron, which arrived from nearby Hainault Farm in July 1919, having been formed there two years previously from C Flight of 39 Squadron. It was partially equipped with a nightfighter version of the Sopwith Camel known as the Sopwith Comic with Lewis guns mounted on the upper wing to stop the pilot from being blinded by muzzle flashes. The Squadron was disbanded at the Airfield in December 1919.

Its final First World War CO at North Weald was Major Arthur Harris, who became AOC-in-C of RAF Bomber Command in February 1942 with the rank of Air Chief Marshal.

No. 44 Squadron was reformed in 1937 as a bomber unit with 5 Group, receiving Lancasters in 1941. Post-war it was equipped with Canberras and Vulcans. It was disbanded in 1982 following the famous *Black Buck* raids on Port Stanley during the Falklands War as part of the Waddington Wing. ■



Sopwith Comic B2402 served with 44 (Home Defence) Squadron. The fuel tank was fitted in the space behind the engine no longer needed for Vickers machine gun ammunition. The cockpit was also moved back so that the two Lewis guns, which had lengthened pistol grips and were fired by a Bowden cable, could be slid back on the Foster Mounts for reloading more easily. The blue fuselage stripes were worn by B Flight, and the streamer on the rudder denoted that this was the Flight Commander Captain George Hackwill's aircraft. It had landing lights on the lower wings and Holt Flares underneath. The white areas of the upper roundels and rudder were painted out. This aircraft shared in the destruction of Gotha bomber G V 938/16 on the night of 28/29 January 1918 near Wickford

The first phase

A Home Defence Flight Station (Night) 1st Class category...

North Weald opened in August 1916 as a Night Landing Ground for 39 (Home Defence) Squadron, part of 49th Wing, South East Area. Covering 136 acres it had maximum landing dimensions of 900 x 850 yards, with the Epping-Ongar branch of the London North Eastern railway line and large woods to the south, and Epping Forest to the west. The clay surface was wet in winter and at first there were only basic facilities.

The site was subsequently designated a Home Defence Flight Station (Night) in the 1st Class category for A Flight of 39 Squadron. Works in support of its new role then started, with 18 buildings taking up 15 acres on the southern boundary and a further 27 constructed in the regimental site to the south side of the Epping Road. There were two wooden double aircraft sheds.

The planned completion date for all the buildings was 1 December 1918. Until the messes were finished on the regimental site all personnel were fed at the King's Head in the village. During September 1917 B and C Flights of 39 Squadron also moved in from Hainault Farm and Suttons Farm. The whole Squadron remained at North Weald until the end of October 1918 when it went to France. ■



World War 1 propaganda poster of the destruction of a Zeppelin airship

Local memories

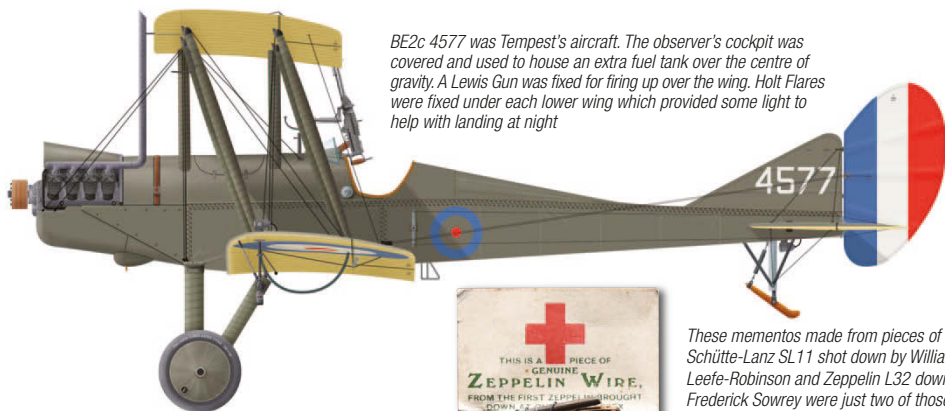
The Fyfield Night Landing Ground is commemorated ...

The First World War Night Landing Ground at Fyfield was used occasionally by 39 (Home Defence) Squadron from North Weald. This was commemorated on Friday 7 June 2019 by the unveiling of a special plaque on the village hall as part of the village's Summer Barbecue evening.

The Night Landing Ground was situated to the south west of Fyfield and used as a satellite for the main airfield from 1917 to 1919. It had no permanent buildings and was quite small, consisting of just 25 acres, with a flying area of 370 x 350 yards.

The plaque was unveiled by F/Lt John Hawkins and the ceremony supported by the band and colour of 2317 (Harlow) Squadron and the colour of 414 (Epping & North Weald) Squadron of the Air Cadets. ■





BE2c 4577 was Tempest's aircraft. The observer's cockpit was covered and used to house an extra fuel tank over the centre of gravity. A Lewis Gun was fixed for firing up over the wing. Holt Flares were fixed under each lower wing which provided some light to help with landing at night



These mementos made from pieces of Schütte-Lanz SL11 shot down by William Leefe-Robinson and Zeppelin L32 downed by Frederick Sowrey were just two of those created for the public to celebrate the first successes against the airship menace



Zeppelin killers

No. 39 (Home Defence) Squadron was the first unit based at North Weald in 1916...

The Squadron was created from 19 Reserve Aeroplane Squadron in April 1916 to combat airship raids. It had flights at Hounslow (moving later to North Weald), Hainault Farm and Sutton's Farm, initially equipped with BE2c aircraft. To improve performance no observer was carried, and the gun was repositioned for the pilot to fire over the upper wing.

Pilots from Sutton's Farm had the first successful combats. Lieutenant William Leefe Robinson in BE2c 2693 shot down the German Army Schütte-Lanz airship SL11, commanded by *Hauptmann* Wilhelm Schramm, on the night of 2/3 September 1916. He was awarded the Victoria Cross for his exploit.

Three weeks later during the night of 22/23 September, 2nd Lieutenant Frederick Sowrey flew BE2c 4112 from Sutton's Farm and shot down the German Navy Zeppelin L32, commanded by *Oberleutnant zur See* Werner Petersen. He was awarded the Distinguished Service Order (DSO).

North Weald's turn came on the night of 1/2 October. 2nd Lieutenant Wulstan Tempest was dining with his fiancée in Epping High Street when the alarm was given. Returning to the Airfield on his motorcycle he took off in BE2c 4577 and later shot down Zeppelin L31, commanded by *Kapitänleutnant* Heinrich Mathy, which was caught by the Barnet searchlight. The Zeppelin flagship crashed at Oakmere Park, Potters Bar, killing all twenty crew. Tempest was also awarded the DSO.

Excerpt from Tempest's Combat Report

"As I drew up to the Zeppelin, to my relief I found that I was quite free from Anti-Aircraft fire, for the nearest shells were

bursting some three miles away. the Zeppelin was nearly 12,700 feet high and climbing rapidly. I therefore started to dive at her, for though I felt I had a slight advantage in speed, she was climbing like a rocket and leaving me standing.

I accordingly gave a tremendous pump at my petrol tank and dived straight at her, firing a burst into her as I came. I let her have another burst as I passed under her and then banking my machine over, sat on her tail, and flying along underneath, pumped lead into her for all I was worth. I could see tracer bullets flying from her in all directions, but I was too close under them for them to concentrate on me.

As I was firing I noticed her go red inside, like an enormous Chinese lantern, then a flame shot out of the front part of her, and I realised she was on fire. She then shot up about 200 feet, paused, and then came roaring straight down on me before I had time to get out of the way. I nose-dived for all I was worth with the Zepp tearing after me, and I expected any minute to be engulfed in flames.

I put my machine into a spin, and just managed to corkscrew out of the way in time as she shot passed me, roaring like a furnace. I righted my machine and watched her hit the ground in a shower of sparks. I then proceeded to fire off dozens of green Very lights, in the exuberance of my feelings.

I glanced at my watch and I saw it was about 12.10 am. I then commenced to feel very sick, giddy and exhausted, and had considerable difficulty in finding my way to the ground through the fog; in landing I crashed and cut my head on my machine gun." ■

700 rounds to bring down a Gotha!

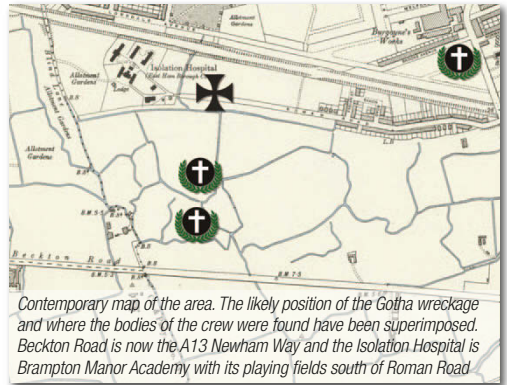
39 Squadron's only bomber kill on the night of 19-20 May 1918...

The largest air raid on Britain during World War 1 was carried out by Gothas and Staaken Giants on the night of 19/20 May 1918. Bristol Fighter A6/C4636 from 39 Squadron at North Weald, named *Devil-in-the-Dusk*, was on patrol and intercepted Gotha G.V/978 over Hainault at 10,000 feet just after midnight. The aircraft was flown by 19-year old Lieutenant Anthony Arkell with Air Mechanic Albert Stagg as his observer/gunner. This was Arkell's eleventh home defence sortie, and Stagg's fifth. After 15 minutes of firing, they were down to 1,500 feet over East Ham.

Arkell described the combat in a letter to his father: "I divided down under it, as it was hazy, and then saw against the starlight the shape of a Gotha. What I thought were lights were the exhausts of the engines. I could see the two engines, and the long planes quite clearly. I soon caught it up. I was much faster and could climb better than it. After a little manoeuvring I got under its tail, about 150 yards behind. The observer Stagg fired 20 rounds, very scattered, and then stopped. I zoomed up level with its tail firing my front guns. Directly we started firing it fired back. And when we weren't firing I could hear pop-pop-pop quite plainly. Stagg fired another drum of about 100 rounds; but, as his shooting was not very good, I decided the sooner we finished off the Hun the better, so got as close as I could underneath him. He was three times as big as we were. We were firing at point blank range, Stagg and I firing in turn. In the end Stagg fired the actual shot that set his right-hand petrol tank alight."

After firing around 700 rounds at the Gotha it was now on fire and the crew jumped to their deaths. They were *Leutnant* Paul Sapkowick, the observer, *Vizfeldwebel* Hans Tiedke, the pilot and *Gefreiter* Wilhelm Schulte, the rear gunner. The aircraft spun and came down in a bean field between Roman Road and Beckton Road, East Ham.

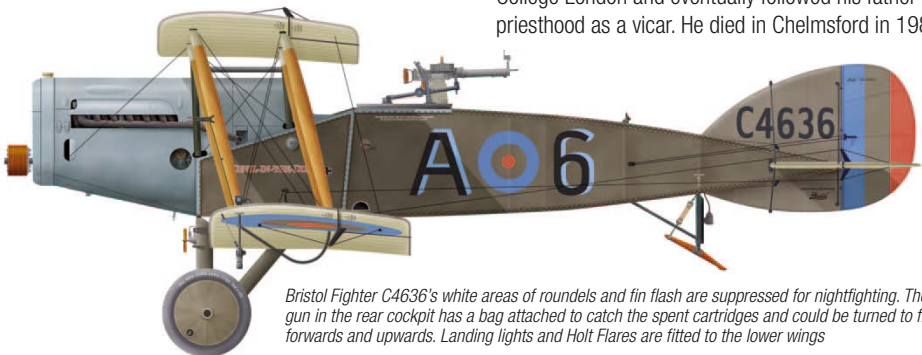
Reproduced with the permission of the National Library of Scotland

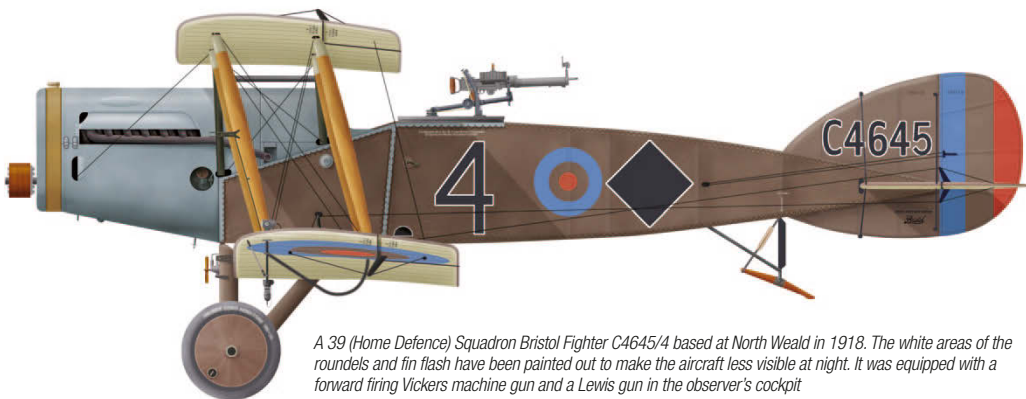


For this exploit Arkell received the Military Cross and Stagg the Military Medal. Arkell visited the site on the following day and gave this description to his father: "It had eight wheels, all more or less intact. The planes were a dark blue camouflage. I brought back a small bit of canvas, a bit of charred wood and one German cartridge case as small souvenirs ... I also got a three-ply box that contained the belt of ammunition for the Hun machine gun, slightly charred ... I couldn't help feeling sorry for the poor fellows. For after all they were only acting under orders, and it must take very brave men to come all that way at night over the sea and hostile country."

The combat occurred over the Whitsun weekend, so on the Bank Holiday Monday it attracted a large crowd of Londoners wanting to see the scene of the crash from on top of the adjacent sewer outfall embankment to the north.

After the war Arkell served as a District Commissioner and then an archaeologist in the Sudan. On returning to the UK he became a Reader in Egyptian Archaeology at University College London and eventually followed his father into the priesthood as a vicar. He died in Chelmsford in 1980. ■





A 39 (Home Defence) Squadron Bristol Fighter C4645/4 based at North Weald in 1918. The white areas of the roundels and fin flash have been painted out to make the aircraft less visible at night. It was equipped with a forward firing Vickers machine gun and a Lewis gun in the observer's cockpit

London's air defences in World War 1

A surprisingly sophisticated system evolved to fight the air raids...

At the start of World War 1 home air defences were initially placed under the control of the Admiralty. The system was formed primarily to protect London using a network of reporting posts including railway stations, lightships and lighthouses, naval shore installations, army camps and police stations. Initially these spotting stations were not issued with any equipment with which to take bearings. Nor were they operating and reporting off a set of standard maps. There were only 12 anti-aircraft guns around London.

Patrolling fighters had no radios and so headed for any searchlight and anti-aircraft gun activity they could see from the air. As an aid, large white arrows were provided at searchlight units pointing in the direction of the enemy.

The propaganda success of the German Zeppelin airship and Gotha bomber raids and the resulting public outcry gave rise to the London Air Defence Area. This was set up on 31 July 1917 and managed by the Army.

Command and control

The main Control Centre was housed in Horse Guards, Central London and equipped with an air raid plotting table designed by Major P Fooks. This was divided into lettered squares – *Ack*, *Emma*, *Jay* and *York*. These squares were again split into a further four squares numbered 1, 2, 3 and 4. Ten plotters stood around the map table moving symbols as they received information through telephone headsets from the 26 Sub-Control Centres. Discs were used to represent single enemy aircraft, rectangles for enemy formations and aircraft shaped counters for British fighters.

To avoid out-of-date information, the clock was divided into four quarter-hour periods. The first five minutes were coloured

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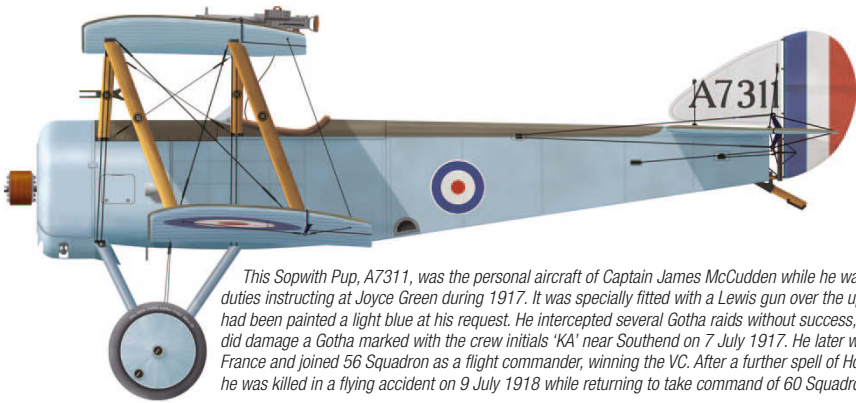
green, the next red and the third yellow. The map table symbols were similarly coloured and only two five-minute periods remained displayed on the plot at any one time. It was the forerunner of the plotting tables used in World War 2.

This was the world's first integrated air defence system of reporting, combined with tethered balloon aprons, sound locators, searchlights, gun sites and aircraft patrol lines. By November 1918, it comprised 286 guns, 387 searchlights and eight Home Defence squadrons with about 200 fighters and was commanded by Brigadier Edward Ashmore.

Radio communication now assisted in directing fighters towards their targets, with special tracking aircraft being used to report at two-minute intervals in a simple code the number of hostile aircraft, their positions and bearing of flight. Radio direction finding developed by Marconi at Chelmsford also gave warning of Zeppelin and Gotha raids.

Observation posts

The Home Defence forces also used ground observers for early warning. The London Metropolitan Observation



This Sopwith Pup, A7311, was the personal aircraft of Captain James McCudden while he was on Home duties instructing at Joyce Green during 1917. It was specially fitted with a Lewis gun over the upper wing and had been painted a light blue at his request. He intercepted several Gotha raids without success, although he did damage a Gotha marked with the crew initials 'KA' near Southend on 7 July 1917. He later went back to France and joined 56 Squadron as a flight commander, winning the VC. After a further spell of Home instruction he was killed in a flying accident on 9 July 1918 while returning to take command of 60 Squadron

Service was established with some 200 outposts. These were staffed by special constables who used instruments to measure the bearing of the approaching aircraft both horizontally and vertically, then passing the details using a standard format based on common maps and a grid system.

The Observation Posts reported to 26 Sub-Control Centres, which assessed and filtered the reports. This allowed bearings from two or more posts to be used to provide a cross-cut giving a more accurate position, direction and altitude of a raid. A sighting report could get through to the main Control Centre in London in around three minutes, but sometimes took ten. Gun batteries could then be made ready, aircraft launched and warnings given to the public.

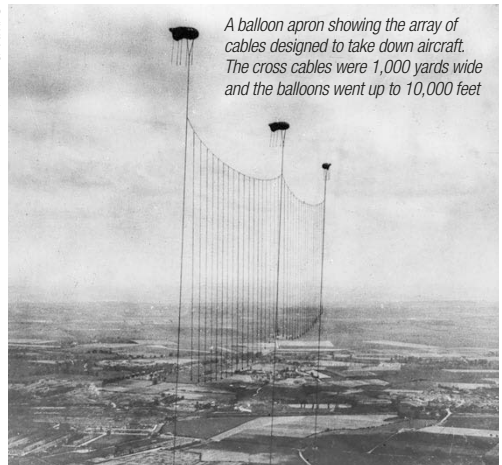
The posts were often placed on high points. At Claybury Hospital near Woodford Bridge one was on top of the asylum's 170-foot high water tower, which was almost 400 feet above sea-level and gave a view to the Thames. The Hainault Observation Post used a local land owner's tower and employed 34 officers and men to keep watch.

Pairs of posts were used by anti-aircraft gun sites to report on the accuracy of the shellfire so that aim could be adjusted accordingly. Special rockets could be fired to draw the attention of the patrolling fighters and large white arrows were placed on the ground to indicate directions of raids.

Lightships at sea were also able to report on raids, giving numbers and the general direction of the aircraft as an early warning of an attack. The *Kentish Knock* lightship around 30 miles off the coast between Clacton and Margate was well placed for frequent sightings.

There were eight other ships in the approaches to the Thames Estuary as well, including the *Tongue* and *Swin Middle*, which each reported the first Gotha raid of 25 May 1917. Coastguard Stations could also report on raids crossing the shoreline.

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A balloon apron showing the array of cables designed to take down aircraft. The cross cables were 1,000 yards wide and the balloons went up to 10,000 feet

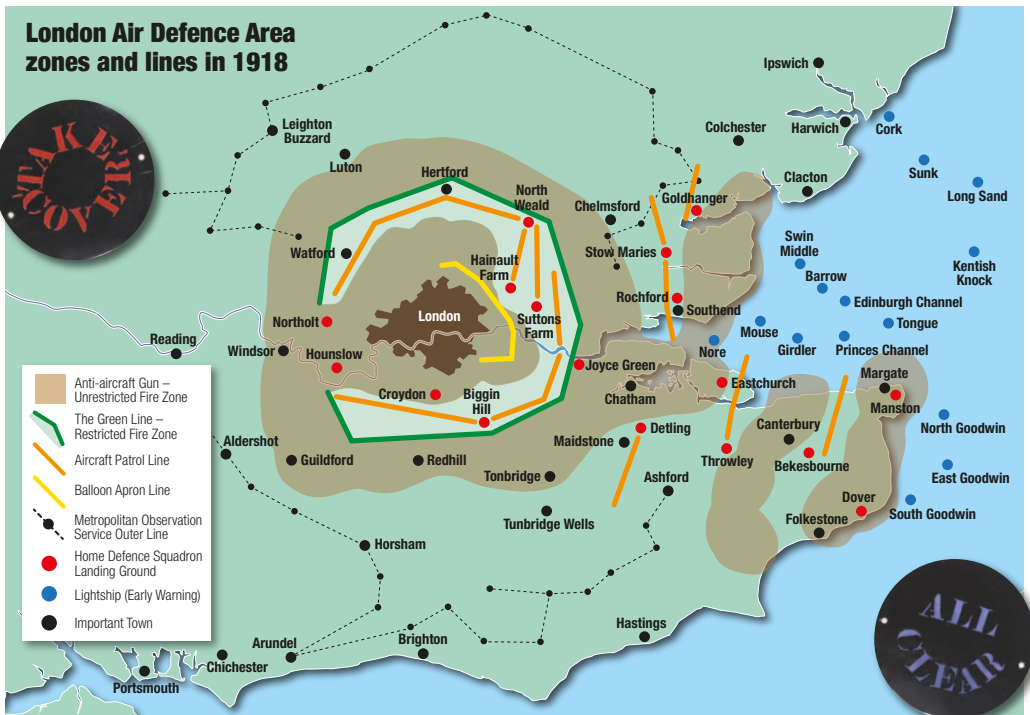
Balloon Aprons

Caquot Barrage balloons were made of rubberized cotton impregnated with a special sealing dope and filled with hydrogen. They were organised into ten Aprons, each of three balloons set 500 yards apart and linked by cables. Every 25 yards 1,000-foot steel wires hung down from the cables. The balloons would be tethered at 7,000-10,000 feet and forced air raids to fly more predictably so the guns knew where to aim and correctly set their fuses.

These were part of 7 Balloon Wing and deployed from Edmonton to Lewisham: No. 1 Balloon Apron at Barking (Creekmouth), No. 2 at Chadwell Heath, No. 3 at Barking, No. 4 at Barkingside, No. 5 and Wing HQ at Chingford, No. 6 at Edmonton, No. 7 at Snarebrook and No. 8 at Manor Park. Two further Aprons protected the Woolwich Arsenal and south of the Thames at Shooters Hill and Bexleyheath.

The aprons made navigation difficult and prevented the bombers from operating in low cloud. Staaken Giant, R.12,

London Air Defence Area zones and lines in 1918



Paul Markers © WMA FE02 8855 and 8859

hit and ripped away two steel apron cables at Chingford on 28 January 1918 following a combat over North Weald with Bristol Fighter C4638 crewed by 2nd Lieutenant J Goodyear and Airman 1st Class W Merchant, who was wounded in the arm. It went on to bomb London. Another Staaken, R.25, was forced back by the Manor Park Apron on 29/30 January 1918 after losing an engine in combat.

Anti-aircraft guns

By September 1916, in response to the Zeppelin raids on London, anti-aircraft guns were put in place, forming a layered defence. Some guns were mounted on buildings or in special emplacements with shelter for the gunners provided by temporary huts. The guns were organised into five districts: Central London, West London, Epping, Redhill and Chatham, Thames & Thanet along with two Mobile Brigades covering the north and south.

The Royal Gunpowder and Small Arms Factories at Waltham Abbey and Enfield were defended by fixed sites as well as mobile guns of several different calibres. Some guns were mounted in pairs and emplaced in the grounds of large houses such as Temple House, Monkshams Hall, Newmans and Warlies Park.

The 3-inch Quick Fire (QF) gun was developed, the first specifically for the anti-aircraft role. It was very effective



and continued in service until the 1940s. At an elevation of 45° it had a range of almost 11,000 yards with a rate of fire of 25 rounds per minute and an effective ceiling of 23,000 feet and able to hit the Zeppelin airships and Gotha bombers which operated up to 16,000 feet. Barr & Stroud coincident rangefinders helped to direct the fire.

13- and 18-pounder QF field guns were also adapted for high-angle anti-aircraft use and some were mounted on lorries. These were originally based with the RNAS Depot at the Talbot Works in Ladbroke Grove and were later moved to Kenwood House Stables on Hampstead Heath as a mobile response to raids. They were organised in pairs of guns along with searchlights and support vehicles.



The layers of defences deployed to the east of London by 1918

Altogether a total 10 airships and 22 aircraft were brought down by the air defences. Shellfire did also cause damage on the ground by falling pieces of shrapnel and shells which did not explode, resulting in a number of fatalities. The shellfire during the raid of 29/30 September 1917 damaged 31 properties belonging to the Portman Estate between Marylebone and Paddington Stations, for example. Often the cost of the shells fired was more than the destruction wrought by the bombs. Each shell cost around £2.

Pre-set gun barrages

The guns were organised in a series of defensive lines on the likely approaches for raids. Groups of guns could then be combined to create a curtain barrage firing along the path of a passing bomber or Zeppelin. Elevations, bearings and fuse settings for particular curtain barrages were all pre-set to save time.

These were given names, so that gun positions would know which direction a barrage was to be fired. Three near Waltham Abbey were called *Hannibal*, *Brutus* and *Caesar*. Two near Woolwich were *Robin Hood* and *Ace of Spades*. Between Tottenham and Romford were the less warlike *Cosy Corner* and *Jigsaw*. There were around 100 named curtain barrage lines across London.

Curtain barrages were later superseded by polygon barrages, which could surround a bomber more accurately as experience was gained by the gun layers and directors. Gun and searchlight positions had gridded plotting tables which could be lit from underneath at night to track the progress of raids and prepare the defensive response.

The Green Line

A defensive ring was formed at a 25 mile range from Hyde Park. It extended as far as Ware in the North and Oxted in

the South and was known as the *Green Line*. Inside this area fighters were able to operate safely, and beyond it any aircraft could be considered as hostile by the gunners. North Weald, Hainault Farm and Suttons Farm Landing Grounds were inside the *Green Line*. Other air patrol zones were established further to the East and South, centred on the clusters of landing grounds used by Home Defence (HD) squadrons, such as those at Stow Maries, Rochford and Goldhanger in Essex or Throwley, Detling and Bekesbourne in Kent.

Own Copyright



A British Mark 1 Sound Locator showing the layout of horizontal and vertical horns

Searchlights

At night, it was hard to see the aircraft and direct gunfire onto them. Searchlights helped the gunners, but it was difficult to ensure that they were trained on the attackers fast enough. They were powered by electric filament lamps or by acetylene gas and so were not very bright.

Searchlights were set up in posts right across the eastern approaches to London and along the Thames, often with several at one location. They were manned by Territorial Force companies of the London Electrical Engineers.

North Weald and Joyce Green were both Landing Grounds equipped with their own searchlights. Other adjacent sites could also be under the control of the HD squadrons' HQs.

Two 120cm searchlights mounted on top of converted trams with generators inside were placed in position every evening outside Barkingside and Chadwell Heath Police Stations. Another such tram was used at Barnet, which illuminated the Zeppelin L31 allowing Wulstan Tempest from North Weald to shoot it down over Potters Bar in October 1916. Five more were based around south and west London including at Croydon and Purley.

Sound locators

Sound locators were placed in the battery positions to follow attacking aircraft. The operator listened to a pair of horns separated horizontally and swung them around to

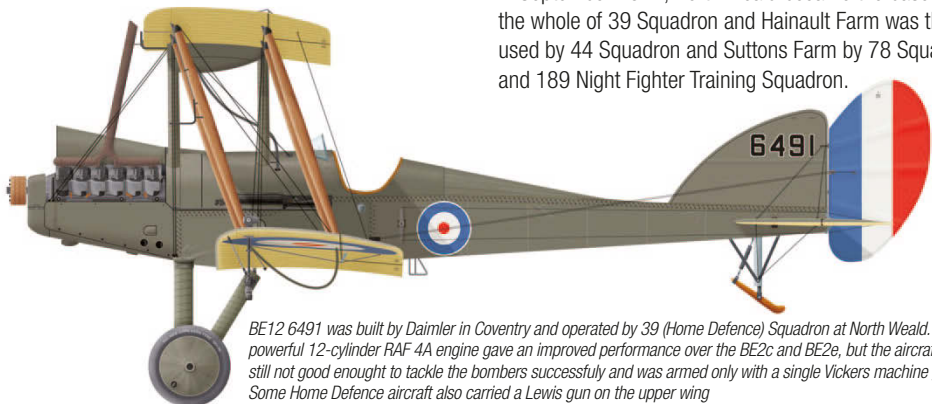
determine the bearing of the target; then he used horns separated vertically to determine the elevation of the target. The elevation and the bearing were then passed to the searchlight operators and the gunners. Blind operators were often used because of their superior hearing skills.

Acoustic detection was also used by the Observation Service to provide early warning of air attack. Large sound mirrors were cut into cliffs in Kent to provide early warning of air attacks and a network of smaller concrete versions were also built by the Royal Engineers, such as those at Binbury Manor near Detling, Biggin Hill and Warden Point on Sheppey.

Airfields and Landing Grounds

There were several local airfields operated by the Royal Flying Corps (RFC) and Royal Naval Air Service (RNAS). These included the RFC Landing Grounds at North Weald, Suttons Farm and Hainault Farm each originally housing a Flight of eight aircraft from 39 Squadron. There were also smaller night reserve strips at Fyfield, Sheering Hall Farm north east of Harlow and Shingle Hall near Sawbridgeworth, where a 39 Squadron Bristol Fighter failed to get airborne and went through the eastern boundary hedge one morning.

In September 1917, North Weald became the base for the whole of 39 Squadron and Hainault Farm was then used by 44 Squadron and Suttons Farm by 78 Squadron and 189 Night Fighter Training Squadron.



BE12 6491 was built by Daimler in Coventry and operated by 39 (Home Defence) Squadron at North Weald. Its more powerful 12-cylinder RAF 4A engine gave an improved performance over the BE2c and BE2e, but the aircraft was still not good enough to tackle the bombers successfully and was armed only with a single Vickers machine gun. Some Home Defence aircraft also carried a Lewis gun on the upper wing



Gotha G.V/904 Erika was flown by Leutnant Claus Petersen and was named after his wife. It has the additional front Stossfahrgerstell wheels to stop it nosing over on landing (which had caused many accidents). The square-edged Balkenkreuz has replaced the original cross on the printed lozenge camouflage scheme of the fuselage and also on the rudder. This Gotha was shot down over Germany in July 1918 by friendly fire while on a training mission

Three Flights of 37 Squadron flew from Stow Maries, Rochford and Goldhanger further to the east.

The RNAS operated fields at Fairlop, which was only about 400 yards from Hainault Farm, and Chingford. This was a flying school and later used by the RFC as well. The clay soil made the site very boggy in wet weather.

Flares helped aircraft to return again and were set up in an 'L' shape in the wind direction. These included *Money Flares* made from asbestos packed in a wire cage and soaked in paraffin. Small searchlights manufactured by *Arthur Lyons & Co* were used to aid landings as well.

Three airships and a Gotha were shot down by 39 Squadron, while 44 Squadron brought down their first Gotha which eventually crashed in the sea off Dover in December 1917 and caught a second one over Wickford in January 1918. North Weald and Suttons Farm (Hornchurch) both became permanent RAF stations after the war.

The blackout and air raid precautions

In July 1917, an official warning system was put in place. If raids occurred during the daytime, policemen patrolled the streets, blowing whistles or ringing bells to get people to take cover. They could also carry billboards bearing the notice '*Air raid – take cover*'. Impending night raids were signalled by firing maroons.

The '*All clear*' was often sounded by Boy Scout buglers who were driven around in police cars. One scout Scout, Alfred Page (13), was killed at Romberg Road in Tooting during a Gotha raid on 31 October 1917 along with his father. A woman and two other children were injured.

Local authorities had the power to decide what to do about lighting restrictions under the *Defence of the Realm Act* introduced in September 1914. Special Constables were used to enforce the blackout, although some householders complained that this increased the burglary rate as well. Even church bells and clocks were stopped from chiming at night because it was thought that in

still weather the sound could help to guide Zeppelins!

Street lights in Central London were turned off from September 1917 and the distinctively shaped lake in St James's Park, which served as a landmark for bomber crews, was also drained and became a hutted camp. ■

North Weald Airfield Museum



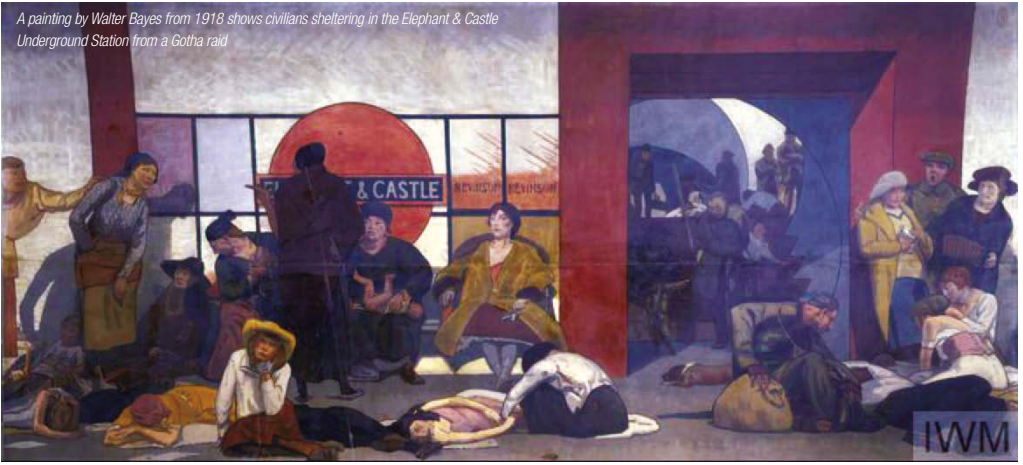
The special gifts from a Maharaja

Aircraft presented to 39 Squadron by an Indian prince...

In both World Wars, money was raised by donations from individuals and organisations to purchase aircraft for presentation to squadrons. These were usually painted with inscriptions noting the fact. By 1917, sufficient funds had been collected for 437 such aircraft, costing from £1,500 for a BE2c to £3,500 for a Short Floatplane.

39 Squadron received a BE2e, 'Rewa Fiji', inscribed 'PRESENTED BY THE NATIVES OF REWA PROVINCE, COLONY OF FIJI. FOR THE USE OF THE ROYAL FLYING CORPS, 1917' and then two Bristol Fighters in early 1918. B1252 was marked 'PRESENTED BY MAHARAJA BAHADUR SIR RAMESWAR SINGH OF DARBHANGA No.2 THE LORD CHELMSFORD' on both sides of the fuselage. The other aeroplane was B1330, which was inscribed as 'No.5'. ■

A painting by Walter Bayes from 1918 shows civilians sheltering in the Elephant & Castle Underground Station from a Gotha raid



The first Blitz

London's prolonged ordeal from bombing raids in World War 1 ...

The British mainland came under attack in various ways throughout World War 1. On 16 December 1914 Scarborough, Whitby and Hartlepool were bombarded by battlecruisers from the German High Seas Fleet, causing much damage and consternation from the public unused to such 'frightfulness'. Dover was first struck by an air raid on 21 December.

The Zeppelins begin their campaign

Several towns were bombed by Army airships in early 1915 including Southend, Ipswich, Dover and Ramsgate. London received its first raid on 30 May by LZ38. In total around 120 bombs were dropped from Stoke Newington south to Stepney and then back northwards to Leytonstone.

On 17-18 August the first German Navy Zeppelin, L10, reached London, dropping its bombs on Walthamstow and Leytonstone. Ten people were killed, 48 injured and property damage was estimated at £30,750.

Another successful Army airship raid took place on 7-8 September. The first, SL 2, hit houses on the Isle of Dogs, Deptford, Greenwich and Woolwich and the second, LZ 74, bombed Bermondsey, Rotherhithe and New Cross.

A Navy raid by L13 the following night also had a significant effect: a 300-kilogram (660 lb) bomb, the largest yet carried, exploded on Bartholomew Close near Smithfield Market, destroying several houses and killing two men. More bombs hit textile warehouses north of St Paul's Cathedral, starting a fire which, despite the efforts of 22 fire engines, caused

over £500,000 of damage. The Zeppelin then turned east and dropped its remaining bombs on Liverpool Street Station. It was commanded by *Kapitänleutnant* Heinrich Mathy, who became the leading Zeppelin proponent.

This was followed on 13 October by a five Zeppelin raid which struck central London including Charing Cross, the Lyceum Theatre, Exeter and Wellington Streets, as well as Guildford, Folkestone, Tonbridge, Croydon and Hertford because the airships found it hard to navigate. There were a total of twenty raids in 1915, in which 37 tons of bombs were dropped, killing 181 people and injuring 455.

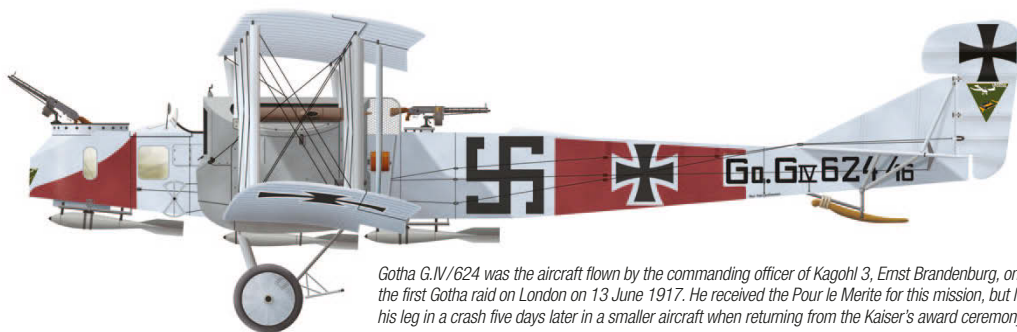
Improved Zeppelins were introduced in 1916, which could fly higher, but the British defences were also improving. A total of 23 raids dropped 125 tons of bombs, killing 293 and injuring 691 people across the country.

The first raid at the end of January was aimed at Liverpool, but bad weather scattered the airships, which bombed Tipton, Wednesbury and Walsall in the Midlands instead. On 5-6 March a raid aimed at Rosyth in Scotland hit Leith as well as Hull further down the east coast.

As the weather continued to give Londoners a respite the North East and Midlands had further scattered raids, which caused damage and casualties.

The London raids resumed in August when thirteen Navy Zeppelins were launched on 24-25th. Heinrich Mathy's new R-class L 31 dropped 36 bombs on West Ferry Road, Deptford Dry Dock, the station at Norway Street and houses in Greenwich, Eltham and Plumstead.

The biggest raid to date was launched on 2-3 September, with twelve German Navy airships and four from the German Army taking part, including the newly-commissioned SL11. This was the only one to reach the capital and was shot down by Lieutenant William Leefe-Robinson of 39 (Home



Gotha G.IV/624 was the aircraft flown by the commanding officer of Kagohl 3, Ernst Brandenburg, on the first Gotha raid on London on 13 June 1917. He received the Pour le Merite for this mission, but lost his leg in a crash five days later in a smaller aircraft when returning from the Kaiser's award ceremony



Plaque commemorating Constable Alfred Smith who saved factory workers in Central Street, Hoxton, during the raid on 13 June 1917 – this is part of the Memorial to Heroic Self-Sacrifice at Postman's Park near St Paul's Cathedral

Defence) Squadron flying from Suttons Farm. This loss meant that it was also the last Army airship raid on Britain.

More successes followed for 39 Squadron when 2nd Lieutenant Frederick Sowrey shot down L32 on 23-24 September. This was part of a twelve-ship Navy raid. A second airship, L33, was hit by anti-aircraft fire while over London and came down at Little Wigborough in Essex and was burned by its crew. Mathy's L31 managed to drop bombs on Streatham, Brixton and Leyton.

Mathy's demise along with his crew in L31 occurred on 1 October when they were shot down by 2nd Lieutenant Wulstan Tempest flying his BE2c from North Weald. They were part of a raid by eleven Navy Zeppelins on London and the Midlands, and the only crew to reach the capital.

A raid on 27-28 November hit the Midlands and Tyneside and a further pair of Zeppelins were shot down. Although sporadic Zeppelin raids continued, effective defence by nightfighters ended their campaign of strategic bombing.

The Gothas take up the baton

Aircraft would now take over the bombing role and the first raid on London by a single-engine LVG C.IV on the following day managed to drop six tiny 10 kg bombs which fell between Victoria Station and Brompton Road.

The main aerial effort now devolved to the twin engine Gotha G.IV and G.V bombers. *Kampfgeschwader der*

Obersten Heeresleitung (Kagohl 3), was posted to Belgium with the new G.IV aircraft in March 1917 to carry out Operation *Turkenkreuz* (Turkish Cross) to bomb London.

The first raid of 25 aircraft set out on 25 May but turned back because of bad weather. They bombed Folkestone and Shorncliffe instead, killing 94 and injuring 197. A second raid on 5 June ended up hitting Sheerness.

The first Gotha raid to reach London took place on 13 June. This killed 162 and injured 432. Among the dead were 18 children, killed by a bomb falling on the Upper North Street School in Poplar.

The next Gotha raid of 22 aircraft was on 7 July and came in over Epping Forest. It resulted in 57 deaths and 193 injuries. One bomber was shot down and three damaged for the loss of two British Home Defence fighters.

On 22 August fifteen Gothas set out to attack Dover and Margate. This time three bombers were shot down. The Gothas now abandoned day bombing for the night skies, which brought a whole lot of other problems instead.

The first night raid by just five Gothas was on 3 September against Chatham, killing 152, including many naval cadets. More bombers returned the next night against London, with five reaching the intended target. One was lost to anti-aircraft fire but nightfighters were also active.

On 24 September sixteen Gothas set off, of these thirteen reached England, most bombing Dover and other targets in Kent. Only five got as far as London. The next night fifteen bombers set out, with only three reaching London. One failed to return.

On 28 September 25 Gothas and two Staaken R.VIs of *Riesenflugzeug-Abteilung 501* tried a further raid but most turned back because of the weather, with three Gothas lost and six damaged due to accidents. The following night seven Gothas and three Staakens tried again, this time, killing 40 and injuring 87 for the loss of one aircraft.

Now many Londoners were seeking shelter in Underground stations every night as the raids continued. On 30 September

eleven Gothas headed for London and on 1 October eighteen more sortied, with eleven reaching England.

In response the RFC and RNAS bombed the German bases and they had to relocate. This gave a respite and the next small abortive raid of just three aircraft was on 29 October, with a large raid returning on the next night. This involved 22 Gothas carrying a new type of incendiary device. Most were unable to reach London, but some suburbs were hit causing minimal damage because the bombs proved to be unreliable. Five Gothas were lost in landing accidents.

Bad weather prevented further raids for over a month, the next one setting out on 5 December. This time 22 Gothas and two Staakens attacked causing £100,000 of damage and light casualties. Two Gothas were taken down by anti-aircraft fire and two others crash landed in Britain with their crews surviving. In another raid on 18 December six Gothas and a single Staaken caused £225,000 of damage, the greatest since the Zeppelin raid on London of September 1915, and a Gotha was shot down by a 44 Squadron Camel.

On 28 January 1918 thirteen Gothas and two Staakens departed, with six of the Gothas returning prematurely due to the weather. Nightfighters flew over 100 sorties that night and another Gotha was destroyed by a Sopwith Camel and Sopwith Comic from 44 Squadron near Wickford, the second destroyed by fighters at night.

On the ground, 67 people were killed and 166 injured. Some of the casualties were caused from stampedes when people queuing for shelters panicked resulting in 14 dead and 14 injured. Another 11 were injured by shrapnel from anti-aircraft fire. A 300 kg (660 lb) bomb struck the Odhams printing works in Long Acre where there was a public shelter for 600 in the basement, killing 38 and injuring 85 when presses crashed down through the floor.



The next night four Staakens from *Rfa 501* set out again, with three reaching London, causing minimal damage.

The *Abteilung* tried again on 16 February, when four aircraft attacked the capital. One aimed a 1,000 kg (2,200 lb) bomb at Victoria Station, but it fell half a mile away on the Royal Hospital, Chelsea.

Another of these Staakens returned again on the 17th, this time hitting St Pancras Station with a 1,000 kg bomb, killing 21 and injuring 32. A further raid on 7 March reached England with five of these giant aircraft. One was one carrying another 1,000 kg bomb, which fell on Warrington Crescent near Paddington Station. A notable casualty was Lena Ford, who had written the lyrics of the wartime song *Keep the Home Fires Burning*.

On 12 March five Zeppelins once again tried to attack the industrial towns of the North of England, but headwinds drove them off course and they bombed Hull instead. On the next night only one of three airships managed to reach England and bombed Hartlepool. The penultimate Zeppelin raid took place on 12 April, but the bombing of the Midlands was scattered and little damage done.

The last and largest bomber raid of the war took place on the night of 19 May 1918, when 38 Gothas and three Staakens attacked London. Six Gothas were shot down by anti-aircraft fire and fighters.

Lieutenant Anthony Arkell with Air Mechanic Albert Stagg as his observer/gunner from 39 Squadron at North Weald was on patrol in Bristol Fighter C4636/A6 and caught Gotha G.V/978 over Hainault at 10,000 feet just after midnight. They eventually brought it down in flames over East Ham.

A seventh Gotha was forced down after being engaged by a Bristol fighter of 141 Squadron from Biggin Hill.

Counting the cost

The last Zeppelin raid on Britain took place on 5 August, when four Zeppelins bombed the Midlands and North of England. L70 was shot down and the crew killed including Peter Strasser, commander of the Naval Airship Service.

The Gothas had been mostly used to support the land offensives since March, but a project, *Der Feuerplan* (The Fire Plan), was proposed using all the remaining heavy bombers to fly in waves over London and Paris and drop loads of the new Elektron B-1E incendiary bombs causing large fires which would force the allies to sue for peace.

Originally scheduled for August and then September, the situation for the German ground forces was such that the raids were shelved, because the Germans themselves were on the brink of surrender and did not want to exacerbate their predicament further at that stage of the war.

The Zeppelin raids killed 557 people and injured 1,358 more across Britain, causing £1.5 million of damage (at 1914-18 values). The later bomber raids on London resulted in 486 deaths and 1,432 injuries. Elsewhere in the South-East another 351 died and 559 were wounded by similar attacks. £1.4 million damage was done, mostly in the London area and production interrupted at the Woolwich Arsenal. ■

A lucky escape

The Zeppelin raid which narrowly missed North Weald in 1915...

A German Army Zeppelin LZ77, which was commanded by *Hauptmann* Alfred Horn, left its base in Belgium on the evening of 11 September 1915 for another raid against England. The airship had also been over Essex four days previously and fortunately caused little damage.

The Zeppelin was sighted passing the *Kentish Knock Lightship* at 20:35 and crossed the Essex coast at around 3,500 feet just south of the Tillingham Coast Guard Station, which opened fire on it along with a similar post at Holiwell Point. This caused the airship to climb to 5,000 feet as it passed Southminster, where a Pom-Pom also fired at it without effect.

It dropped a fuel tank near Latchingdon and proceeded south-westwards. At 23:37 the raid was reported and Great Eastern Railway trains into and out of London were stopped to prevent their lights from giving the Zeppelin any assistance. Production was also temporarily halted for two hours at the Royal Arsenal in Woolwich and one hour at the Royal Gunpowder Factory in Waltham Abbey.

The night was getting misty, but Horn continued to navigate towards London. He passed over Ongar and North Weald where he noticed something out of the ordinary and dropped parachute flares.

These illuminated a large tented camp of the 61st (2nd South Midland) Division between Wintry Park Farm and Hayles Farm just to the north of Epping. The Zeppelin then circled back over North Weald and Wintry Wood and dropped eight high explosive bombs and 52 incendiaries.

Fortunately the HE bombs failed to explode because the safety pins had not been removed. Four had landed within the lines of the 2/III (South Midland) Field Artillery Brigade. Only one incendiary did any damage, burning out the mess

The ill-fated German Army Zeppelin LZ77



A Caudron G3 can be seen in the Grahame-White Hangar at the RAF Museum, Hendon

tent of the 183rd (2nd Gloucester and Worcester) Brigade.

The airship then turned for home, passing Bury St Edmunds at 01:00 and coasted out near Caister at 02:05. The London defences were stood down at 02:50 after no further threat had materialised.

The fog had also affected the Home Defence aircraft, which were then the responsibility of the Royal Navy. Two Caudron G3s finally took off from RNAS Widford near Chelmsford when the Zeppelin was already approaching Norwich on the way back to the east. These were of French design, although 233 were built in the UK. They were armed with a single gun fired by the observer in the front seat.

An RFC BE2c had also flown from a new landing ground at Writtle where it had arrived only two days earlier, as part of the Government's response to the raids caused by the public outcry. Although it would take another year before a Zeppelin was shot down by a nightfighter – a 39 Squadron BE2c flown by William Leefe-Robinson from Suttons Farm. By then North Weald had also become operational as an RFC Landing Ground.

Zeppelin LZ77 was later to be hit and brought down in flames by anti-aircraft guns on 22 February 1916 while attacking the Révigny marshalling yards in support of the Verdun offensive. *Hauptmann* Horn and his crew were all killed.

The 61st (2nd South Midland) Division was the first 2nd Line Territorial formation sent to France in May 1916 and suffered heavy losses at the Battle of Fromelles in July. ■

Built-in mobility

Keeping RFC squadrons supplied in World War 1 ...

The Royal Flying Corps (RFC) was formed in April 1912 from the earlier Air Battalion of the Royal Engineers. Its original establishment strength was 36 aeroplanes and 12 manned balloons. It had a Military Wing and a Naval Wing, which separated in 1914 to become the Royal Naval Air Service. By the time it went to war in August 1914 the RFC consisted of one balloon squadron and four aeroplane squadrons of twelve machines each. By 1918 it had over 150 squadrons.

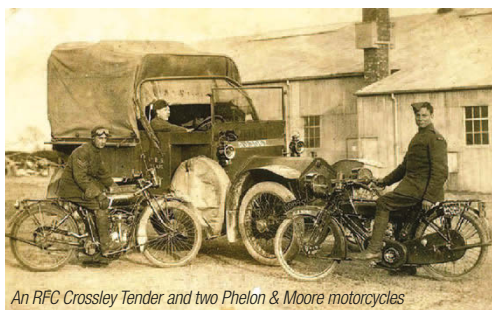
From the outset, the RFC was designed to be fully mobile and was equipped with more motor transport than other parts of the Army, which gave it great flexibility. The basic vehicles were Crossley light tenders and Leyland 3-ton lorries, which were often fitted with specialist bodywork, such as workshops or as observation balloon vehicles. One of these workshops is on display at the IWM Duxford. Many Phelon & Moore motorcycles were used as well. The vehicles were all maintained by the squadrons.

In 1914 squadrons had a staff car for the CO, 26 lorries and tenders, six motorcycles and two trailers. Later this establishment increased to 45 vehicles, which serviced the needs of each squadron's ground crew numbering around 145 men. By the end of the war there was roughly one vehicle for every ten personnel and three vehicles for every aircraft. These represented about 10% of all the motor transport used by the British Expeditionary Force in France, in support of 1.1% of the total manpower!

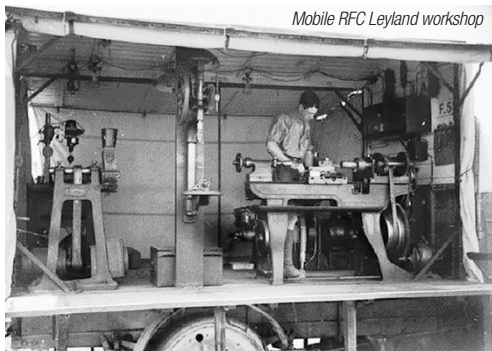
On the Western Front squadrons tended to move every couple of months, including their personnel, temporary workshops, darkrooms for developing aerial photographs and canvas hangars. A move would take 48-hours to complete on average and might be up to 70 miles. Each Flight had a Sergeant and around 35 mechanics on its strength to maintain the engines, airframe, instruments, cameras, radios and ordnance.

An engine fitter from 60 Squadron recalled how four lorries were parked in a square which was covered with a large tarpaulin to provide a temporary workshop utilising the 110-volt generators in the vehicles to power lathes and grinders. Every Flight carried two spare engines and at least four had to be serviceable at any time in each squadron of three flights.

Aviation spirit was transported in 2-gallon and 4-gallon cans. Oil, pyrotechnics, engines and other aircraft spares including



An RFC Crossley Tender and two Phelon & Moore motorcycles



Mobile RFC Leyland workshop

sets of wings had to be regularly collected from the Army Aircraft Parks. Machine gun ammunition was supplied separately to the squadrons by the Army Ordnance Services until 1917 when the RFC took over the task. Bombs were delivered by special RFC Air Ammunition Columns each made up of six Leyland 3-tonners.

Accessible crashed aircraft were also routinely salvaged, with as many as 95% being recovered for repair or reduction to serviceable spare parts and scrap for recycling. Working parties could quickly dismantle aircraft, which were easily transported using the squadron trailers. Sometimes they were repaired on the spot by fitting a new propeller or radiator.

In the UK, permanent establishments were equipped with wooden aircraft sheds or canvas Bessonneau hangars and hutted offices, workshops and accommodation, but still required motor transport to support squadron operations. North Weald was no exception, but would have used mobile workshops and temporary canvas hangars when the landing ground was first set up in the summer of 1916 until more permanent structures were put in place. Many supplies would have been delivered by rail, and then collected from the LNER station, as in later years.

One of the North Weald wooden Aircraft Sheds survived as a garage in Moreton until 2010, when the site was redeveloped for housing. Although it was offered to us, we did not have the means to relocate it back to the Airfield. ■

Projecting airpower

The German strategic airborne strike forces during World War 1 ...

The threat from Germany in the air over Britain mainly centred around airships in the first part of World War 1. Small aircraft carried out nuisance bombing raids, but it was not until 1917 that a major effort to raid Britain with larger bombers began. This continued until the end of the war, keeping many British aircraft on Home Defence duties.

Zeppelin airships

Count Ferdinand von Zeppelin's interest in airships began in 1874, when he set out a design for a rigid envelope containing several gas bags of hydrogen. His first prototype flew from Friedrichshafen on Lake Constance in 1900.

Other airships followed and generated a huge amount of public interest. Zeppelin built 21 airships before World War 1. Some were used by the world's first airline – *Deutsche Luftschiffahrts-Aktiengesellschaft* – founded in 1909.

Both the German Army and Navy operated Zeppelins. The Navy ones were used extensively for fleet reconnaissance as well as bombing raids over Britain and France, the Army used theirs mostly for bombing across mainland Europe.

The pre-war M-class designs were enlarged, to produce the 536 feet-long duralumin P-class, with gas capacity raised from 794,500 cu ft to 1,126,000 cu ft. A fully enclosed gondola and an extra engine added 2,000 feet to the maximum ceiling and around 6 mph to the top speed. A total of twenty-two were constructed.

In July 1916 the R-class of super Zeppelin was introduced. This was now 644 ft 8 in long and had a gas volume of 1,949,600 cu ft. These could carry loads of up to four tons of bombs and reach speeds of 64 mph. They were powered by six 240 hp Maybach engines.

In 1917, following losses to British air defences, new designs were able to fly higher at up to 20,000 feet by reducing the weight of the structure, halving the bomb load, removing the defensive armament and having only five engines.

84 Zeppelins were built during the war; over 60 were lost to enemy action and accidents. 51 raids had been made on England in which 5,806 bombs were dropped, killing 557 people and injuring 1,358. The damage caused was around £1.5 million. The airships were vulnerable to ground fire, but the use of explosive and incendiary bullets by fighter aircraft beginning in 1916 proved to be the ultimate downfall of these hydrogen-filled giants.

Zeppelin L31 was shot down over Potters Bar by a BE2c from North Weald



Schütte-Lanz airships

The Schütte-Lanz company designed airships at Mannheim which were constructed from wood and plywood composites that had a theoretical superiority as the structural material for airships up to a certain size. However, moisture tended to degrade the glued joints, which meant that the main users of the type were the German Army.

Their streamlined shape gave a better performance than equivalent Zeppelins. Design innovations that were copied in subsequent airships included the cruciform tail plane, with a single pair of rudders and elevators. The engines were mounted in aerodynamic gondolas or cars and machine guns were carried for defence in each of them. Twenty airships were delivered by the end of the war.

The Type-E *SL11* was the first airship to be shot down over Britain on 3 September 1916. This was by Lieutenant William Leeffe-Robinson of 39 (Home Defence) Squadron from Sutton's Farm – an exploit for which he won the Victoria Cross. As a result the Army stopped its raids on Britain.

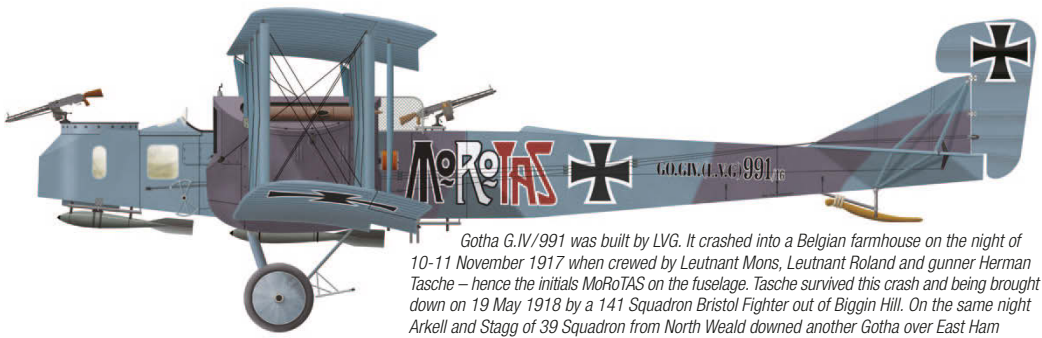
The Type-E airship had a length of 571 feet and a gas capacity of 1,370,000 cu ft. It cruised at 53.7 mph and had a payload of 46,000 lb. It was powered by four Maybach 6-cylinder in-line engines with a total of 960 hp.

Gotha G.IV and G.V bombers

When the Zeppelins began to suffer unacceptable levels of casualties for the damage they were causing, massed Gotha bombers began to be used for raids over Britain instead.

In November 1916, 35 Gotha G.IV bombers were ordered from the *Gothaer Waggonfabrik*, the order later being increased to 50. This was the first large bomber to be used on the Western Front and against Britain. A further 80 aircraft were also ordered from the *Siemens-Schuckert Werke* and 100 from *Luft-Verkehrs-Gesellschaft (LVG)*.

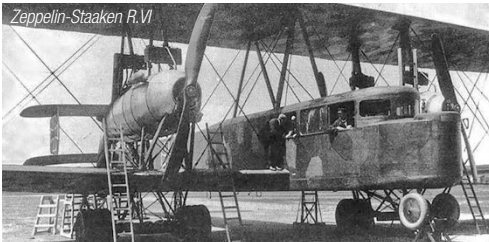
The Gotha had a crew of three – pilot, observer/bomb aimer and dorsal gunner. It was powered by two Mercedes D-IVa engines of 260 hp giving it a maximum speed of 83 mph, a range of 506 miles and a service ceiling of 16,400 feet. It was armed with two or three Parabellum machine guns and normally carried six 50 kg bombs on racks fitted beneath the



Gotha G.IV/991 was built by LVG. It crashed into a Belgian farmhouse on the night of 10-11 November 1917 when crewed by Leutnant Mons, Leutnant Roland and gunner Herman Tasche – hence the initials MoRoTAS on the fuselage. Tasche survived this crash and being brought down on 19 May 1918 by a 141 Squadron Bristol Fighter out of Biggin Hill. On the same night Arkell and Stagg of 39 Squadron from North Weald downed another Gotha over East Ham

wings, fuselage and nose or four external 50 kg bombs and eight 12.5 kg bombs in two internal racks on daylight raids, with a heavier load of five 50 kg and two 100 kg bombs used at night. These were aimed with a Goerz bombsight incorporating a three-foot Zeiss vertical telescope.

The Gothas served with *Kampfgeschwader der Obersten Heeresleitung (Kagohl 3)*, which was based in Belgium for raids against Britain and France. The first daylight raid against London was on 13 June 1917, causing 162 deaths and 432 injuries. However, the improved British air defences later forced *Kagohl 3* to abandon daylight raids. Night raids provided a measure of protection but made navigation and landing more difficult and hazardous. The Germans lost a total of 60 Gothas – over half in accidents, often on landing.



Zeppelin-Staaken R.VI and R.XIV bombers

The R.VI was a four-engine strategic bomber and one of the earliest closed-cockpit military aircraft, known as a *Riesenflugzeug* (Large Aircraft) or *Gigant*. The production was spread across several manufacturers: Schütte-Lanz, Aviatik and Albatros. The aircraft carried a crew of seven – commander, a first and second pilot, a radio operator and fuel attendant in the cockpit, plus a mechanic in each engine nacelle and was armed with four Parabellum machine guns. It carried a bomb load of 4,409 lb and was powered by four Mercedes or Maybach engines giving it a speed of 84 mph, a range of 500 miles and a service ceiling of 14,190 feet.

Two units, *Riesenflugzeug-Abteilung (Rfa)* 500 and 501, operated the type on the Eastern Front, then in Belgium. *Rfa 501* flew 11 raids on Britain between 28 September

1917 and 20 May 1918 using the R.VI and R.XIV which dropped nearly 60,000 lb of bombs in 30 sorties. Small numbers of aircraft flew individually on moonlit nights, receiving directional bearings by radio after take-off, then using the River Thames for navigation. Missions on the 340-mile round trip lasted seven hours. Raids scored direct hits on the Royal Hospital Chelsea with the first 2,200 lb bomb dropped on England as well as St Pancras Station. None of the 13 which saw active service were lost in combat over Britain but three crashed returning to base in the dark.



Goldschmidt incendiary bomb

This incendiary device weighed around 10 kg and was packed with benzol, tar and thermite. The outside of the casing was covered with tarred rope. It was used in early Zeppelin raids and had a long streamer attached to the handle.



Carbonit bombs

Produced by *Sprengstoff A G Carbonit-Schlebusch*, this type of bomb was used throughout the war. It had a bulbous shape and a tail fuse which was activated by a small propeller. There were various sizes (4.5kg, 10kg, 20kg, and 50kg), generally containing a TNT explosive charge.



Goerz-PuW bombs

Prufanstalt und Wertf der Fliegertruppe developed a series of streamlined bombs in 1917 which were made by Goerz with steel casings and fins. These rotated the bomb and aided accuracy. They ranged in size from 12.5 kg to 1,000 kg, but were not very reliable. While around 90% of the 12.5 kg bombs performed correctly, up to 30% of the 50 kg bombs failed to explode and a further 10% went off prematurely! ■

An urgent spur for inventiveness

The development of weapons technology during World War 1

Aviation developed considerably during World War 1, with more powerful engines enabling greater payloads of weapons to be carried. At the start of the war aircraft fought using rifles and pistols to try and shoot each other down. Machine guns were then fitted which had to fire outside the arc of the propeller and often mounted on the upper wing. Zeppelin raids provided additional challenges of finding ways to bring down these huge airships. Several novel weapons were invented, which had mixed success.

The Ranken Dart

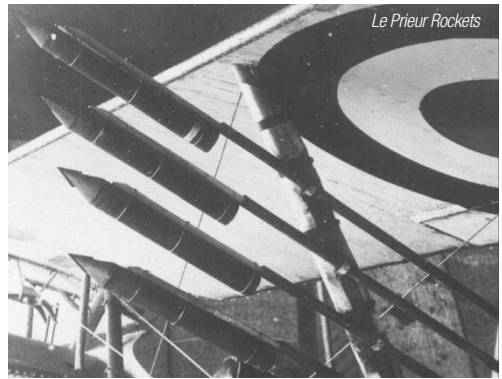
The **Ranken Dart** was a tinplate tube 13 inches long, with a cast iron pointed nose at one end, and a plug and three spring-loaded metal arms at the other, designed to attack Zeppelins from above. The arms were kept closed by means of a cap when the dart was in its dropping tube. It was invented by Commander Francis Ranken of the Royal Navy in 1915 and weighed 1 lb.

When the Dart was released, its three arms would open, pulling up an igniter rod inside the body and detonating the high explosive, black powder and phosphorus payload when it pierced and entered the Zeppelin's fabric envelope (rather like drawing a match head across a rough surface causes it to ignite).

Zeppelin L15 was attacked using these Darts over the Thames Estuary on 31 March / 1 April 1916 by Lieutenant Alfred Brandon in a 39 Squadron BE2c from Hainault Farm. Already damaged by anti-aircraft gunfire, L15 came down in the sea near Margate. The Darts became obsolete when effective incendiary ammunition was introduced, so had a short service life of less than a year.

Le Prieur Rocket

The **Le Prieur Rocket** was a cardboard tube filled with 200 grams of black powder with a wooden conical head attached (by doped paper or linen tape) and had a triangular knife



blade inserted in a slot across its apex forming a spear point. A square-section wooden stick (usually pine) was taped to it with about 10 feet extending back from the base of the rocket tube. This fitted into a launch tube attached to the aircraft inter-plane struts. Up to four could be carried on each side.

It was invented by the French Lieutenant Yves Le Prieur and first used on the Verdun Front in 1916. It was mainly fired against smaller artillery observation balloons, but was also adapted by Home Defence squadrons for launching against Zeppelins. With a range of only 150 yards they were not really very practical in this role and never hit any airships although widely used for a short while. Again, incendiary ammunition proved to be the effective weapon of choice.

Incendiary & explosive ammunition

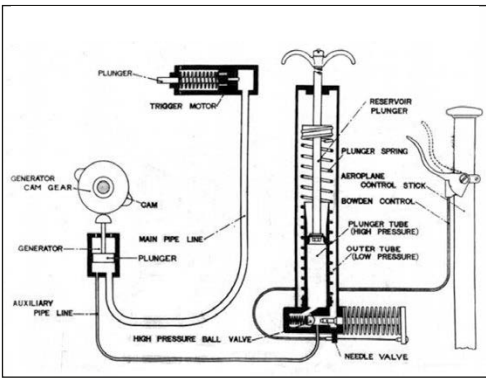
Even before the conflict began, the War Office was aware of the risks posed by Zeppelins and had considered the use of explosive or incendiary bullets to ignite the hydrogen employed. They believed that the standard 0.303-inch round would carry too small a charge and so looked at the 0.45-inch Martini-Henry cartridge instead.

The Martini-Henry carbine itself was an obsolete single shot weapon, but was used extensively at the beginning of the war in the air. The **Flaming Bullet** was developed as an incendiary for use against Zeppelins. The bullet consisted of a heavy brass envelope, filled with an incendiary mixture which was a mixture of 20 parts potassium perchloride and 7 parts aluminium. On top of this were 20 grains of an igniting mixture of barium thermite and copper. It scored a number of observed hits on the airships without success as the rate of fire of the carbine was insufficient.

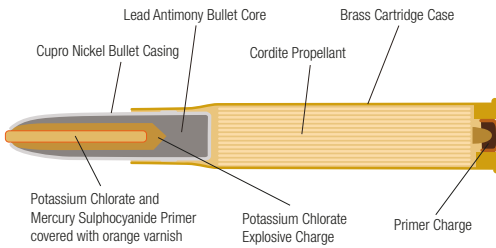
Once automatic weapons were in regular use, several types of 0.303-inch incendiary and explosive ammunition were developed for use against airships and balloons. Different types were designed to create tears in the gas bags so that air could be introduced to create an explosive mixture with the hydrogen, which was then ignited by an incendiary



The Ranken Dart had pop-out vanes which detonated the explosive charge when the point penetrated the airship's fabric. Each dart weighed 1lb



Brock Explosive Bullet



bullet. The drum magazines or ammunition belts carried different combinations of rounds in sequence to blow open the fabric and then ignite the gas. The rounds were also used to bring down artillery observation balloons.

It was unsafe to fire the early explosive/incendiary ammunition from a Vickers machine gun because the bullet left in the hot chamber after firing a burst could 'cook off' from the heat. In this instance, the Lewis Gun's open-bolt firing was an advantage, as well as the Foster mounting on the upper wing, which meant the gun could fire upwards and the muzzle flash did not blind the pilot.

The use of such rounds was technically illegal because explosive/incendiary bullets were banned as inhumane by international agreement, but both sides fired them against balloons and airships.

Brock – This was an explosive bullet developed by Commander Frederick Brock RN in 1915. The bullet was designed to explode between the outer covering and gas cells of an airship and contained the powerful oxidiser potassium chlorate which was very sensitive. It was used by the RFC until 1917 and the RNAS throughout the war.

Pomeroy – First developed by New Zealand engineer John Pomeroy in 1902, this explosive bullet was quickly adopted to combat Zeppelin raids. Filled with nitro-glycerine the bullet ignited the hydrogen gas which escaped from the tear in the Zeppelin gas bag created by the bullet's passage.

Buckingham – The Buckingham bullet was a true incendiary/tracer bullet based on a phosphorus/aluminium mixture, invented by James Buckingham in 1914. The bullet contained an incendiary filling which percolated out through a small hole, the seal of which melted when the gun was fired, the phosphorus then igniting on contact with the air.

Sparklet – Aerators, a company best known for their *Sparklet* soda siphons, produced a tracer round which was solid bronze bored at the rear to accept about 18 grains of a 17/2 mix of barium peroxide and magnesium.

Machine gun synchronisation gear

The problem early military aircraft had was finding a way of firing forwards through the arc of the propeller. Metal plates were tried which were attached to the roots of the blades to deflect bullets, but seriously affected performance.

Various mechanical means were invented to harness gearing from the engine or a mechanical linkage driven by a cam on the engine crankshaft to trigger the machine gun to fire between the blades as they revolved. The longer the distance from the gun to the propeller over which the linkages had to operate, the more problems there were with backlash, wear, heating and cooling. This could lead to the bullets striking the blades and sometimes shooting them off.

The Sopwith-Kauper system used gearing and was one of the better systems, but still suffered from breakdown and wear. The mechanical systems were also difficult to fit to rotary engines which required linkages fitted at awkward angles which could cause rods to deform, leading to failures.

The Maxim/Vickers machine guns were better suited to be adapted for synchronised firing because they used a closed bolt. The Hotchkiss and Lewis guns fired from an open bolt, which caused too long a delay in the firing sequence to be used successfully by mechanical gearing.

The most successful was a hydraulic system invented by the Romanian George Constantinesco. The liquid in the pipes did not move, but merely transmitted the sonic pulses at very high speed to trigger the gun. This gear had several advantages over all mechanical gears: the rate of fire was greatly improved, the synchronization was much more accurate, and it could easily be adapted to any type of engine and airframe, instead of needing a specially-designed impulse generator for each type of engine and special linkages for each type of aircraft.

It was introduced in early 1917, but took several more months to be developed for use with two machine guns firing through the propeller arc on aircraft such as the Sopwith Camel. It subsequently became standard issue and continued in use until World War 2 in RAF fighters up to the Gloster Gladiator. Over 50,00 units were built. ■

The BE2 family

The type of aircraft first used at RFC North Weald in 1916...

The Royal Aircraft Factory Blériot Experimental (BE) series of tractor biplanes were first designed in 1912 by Geoffrey de Havilland under the direction of Mervyn O'Gorman. Around 3,500 BE2s were eventually built, mostly by private contractors using drawing supplied by the Royal Aircraft Factory. A BE2a was the first Royal Flying Corps (RFC) aircraft to reach France at the outbreak of war in 1914.

The first example of the BE2c flew in May 1914, and was fitted with ailerons in place of the original wing warping. The two bay wings were of a new design too, improving handling of the aircraft, along with a larger tailplane and fin to help with directional stability. It was powered by a modified version of the Renault engine called the RAF 1A, a V8 which developed 90 hp.

The BE2c performed many roles during World War 1 including reconnaissance, artillery spotting and bombing. It was designed to be very stable and carried the observer in the front cockpit. This proved to be a problem in combat as there was no clear field of fire for the Lewis gun because of the struts and rigging wires, at a time when an interrupter gear for firing through the propeller had not yet been developed. Outclassed by the new German scouts and unable to defend itself effectively, it suffered heavy combat casualties on the Western Front, although it did have a low accident rate.

In 1916 the BE2c began to be replaced by the BE2e. This featured one bay wings with a shorter lower span, a redesigned tailplane and a curved shape fin. The type

North Weald Airfield Museum



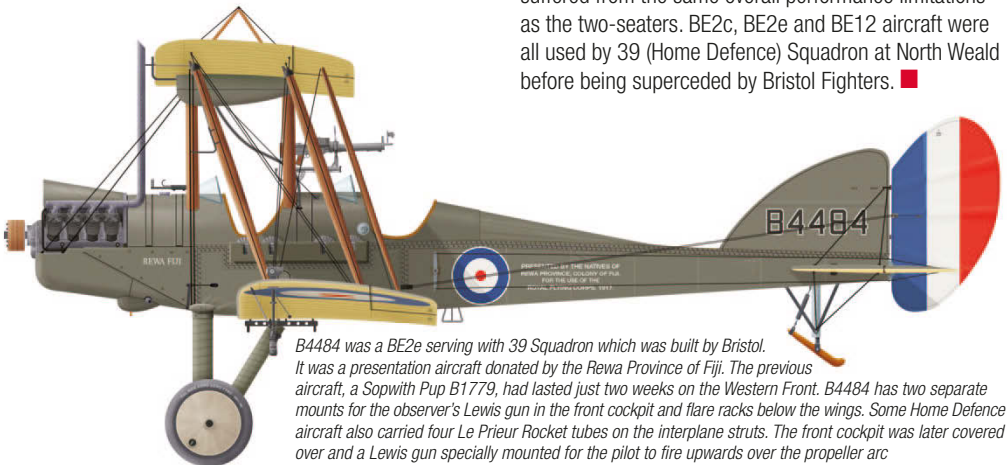
A BE2e with shorter span lower wings outside the Twin Shed hangars at North Weald. An ammunition pannier is visible next to the rear cockpit

was superseded by the RE8, with the pilot in the front cockpit and an observer/gunner in the rear one.

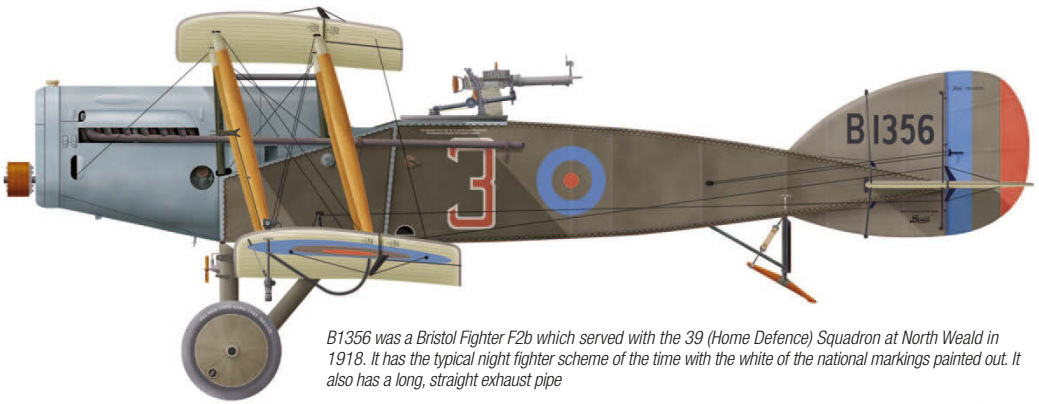
BE2s were also used by Home Defence squadrons as night fighters. By fitting a fuel tank in the observer's cockpit over the centre of gravity they proved to be successful against Zeppelins, though outperformed by the later Gotha bombers because of their lack of speed and poor rate of climb.

A number of weapons, such as Le Prieur Rockets and explosive Ranken Darts were tried without success. The standard armament settled on was a single Lewis gun fixed to fire up over the wing. The ammunition was the newly-developed Brock, Pomeroy and Buckingham incendiary and explosive bullets designed to blow open the fabric and ignite the hydrogen gas used by the airships. The inherent stability of the design helped when the pilot reloaded the gun in flight. Spare magazines were carried in a pannier attached to the outside of the fuselage.

BE2s served with 72 RFC squadrons as well as the RNAS and several other air forces. The BE12 was a single-seat development of the type, and was used for long-range reconnaissance and as a Home Defence fighter, and was armed with a synchronised Vickers machine gun, but suffered from the same overall performance limitations as the two-seaters. BE2c, BE2e and BE12 aircraft were all used by 39 (Home Defence) Squadron at North Weald before being superseded by Bristol Fighters. ■



B4484 was a BE2e serving with 39 Squadron which was built by Bristol. It was a presentation aircraft donated by the Rewa Province of Fiji. The previous aircraft, a Sopwith Pup B1779, had lasted just two weeks on the Western Front. B4484 has two separate mounts for the observer's Lewis gun in the front cockpit and flare racks below the wings. Some Home Defence aircraft also carried four Le Prieur Rocket tubes on the interplane struts. The front cockpit was later covered over and a Lewis gun specially mounted for the pilot to fire upwards over the propeller arc



B1356 was a Bristol Fighter F2b which served with the 39 (Home Defence) Squadron at North Weald in 1918. It has the typical night fighter scheme of the time with the white of the national markings painted out. It also has a long, straight exhaust pipe

Bristol Fighter F2B

The potent two-seater that could be handled like a scout...

The Bristol Fighter was originally designed as a replacement for the BE2c and BE12 and the first version the – F2A – flew in September 1916. It was powered by the new Rolls Royce Falcon Vee-12 engine and armed with a forward-firing Vickers machine gun with a Lewis gun mounted on a Scarff ring in the rear cockpit.

The type was quickly superseded by the F2B, which became the standard production model and most were powered by the 275 hp Falcon III. This engine was always in short supply and other engines were tried including the Sunbeam Arab, which was not reliable and the Hispano Suiza 8, which was also unable to meet demand and needed instead for the SE5a.

Early operational experience with 48 Squadron was not successful with many being shot down because the pilots were not used to manoeuvring a two-seater as aggressively as a single-seat scout due to concerns about structural strength. The CO of 48 Squadron at the time was William Leefe-Robinson who won a VC with 39 (Home Defence) Squadron for shooting down the first Zeppelin. He was one of those shot down but survived and was captured.

Once pilots realised that the aircraft was strongly built they were able to hold their own and quickly gained success in combat. The forward-firing gun was used as the main weapon, with the Lewis gun guarding the tail from surprise attack. The aircraft had a top speed of 123 mph.

They were also used for fighter reconnaissance and as nightfighters. 39 Squadron at North Weald were re-equipped with they type in November 1917 and had their

North Weald Airfield Museum



39 Squadron Bristol Fighter, B1356, with F/Lt Burns and Lt Stoneham

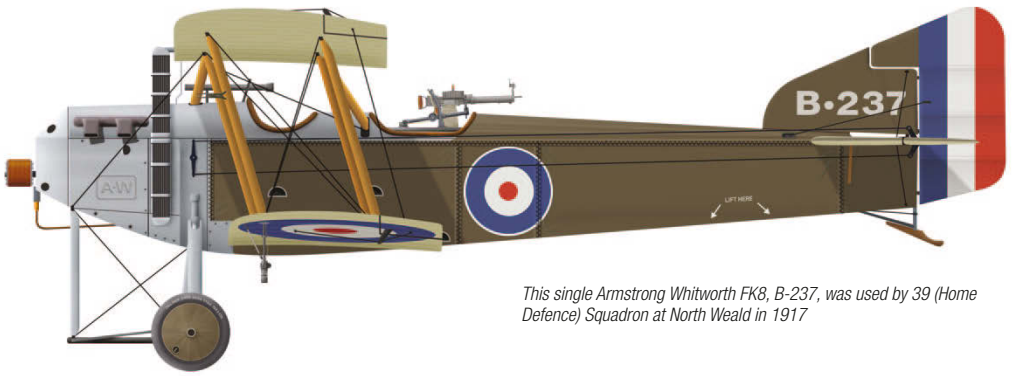


A Bristol Fighter can be seen flying as part of the Shuttleworth Collection at Old Warden

only success against the Gotha bomber raids in May 1918. Some of the aircraft were fitted with radios as trackers for the raids, transmitting information about the location, height and bearing of the raids every two minutes.

After the war Bristol Fighters continued to be used as the standard army co-operation aircraft with the RAF, seeing distinguished service in the Middle East and India where they were specially fitted with tropical radiators and desert equipment. The type was finally retired from service in 1932.

They were also used by the air forces of New Zealand, Australia, Afghanistan (3), Canada, Ireland, Greece, Mexico, Norway (5), Peru, Poland (106), Spain and Sweden. The Polish aircraft fought in the Polish-Soviet war of 1920 and continued in service until 1932. ■



This single Armstrong Whitworth FK8, B-237, was used by 39 (Home Defence) Squadron at North Weald in 1917

Wood and fabric

World War 1 era aircraft which operated from North Weald...

Armstrong Whitworth FK8

The Armstrong Whitworth FK8 was a two-seat general purpose biplane, which first flew in May 1916. It was intended to replace the BE2c and was powered by a 160 hp Beardmore six-cylinder inline engine giving it a top speed of 95 mph.

It was armed with a forward firing Vickers machine gun with a Lewis gun mounted in the rear cockpit. It could also carry bombs under the wings. The FK8 was used for reconnaissance, artillery spotting, ground-attack, contact-patrol and day and night bombing.

A total of 1,650 were built, but they were quickly withdrawn at the end of the war with the final examples being retired in 1919 while serving in Greece. At North Weald, 39 (Home Defence) Squadron used a single example, B-237, as a nightfighter during June and July of 1917.

Avro 504K

The Avro 504 first flew in September 1913 and finally left RAF service in 1933. The production run was 8,970, and continued for almost 20 years, making it the most-produced aircraft of any kind that served in the First World War.

The type carried out the first bombing raid on Germany in 1914 when several hit the Zeppelin works at Friedrichshafen. It soon became obsolete as a front-line aircraft and was then used for training, which it carried out with great success for the rest of its career. Some were also converted into single-seat nightfighters armed with a single Lewis gun mounted on the upper wing. 75 Squadron, which arrived at North Weald during 1918, used Avro 504Ks in this role.

Wikipedia Commons



An original Avro 504K is still flying at Old Warden in nightfighter configuration. 75 (Home Defence) Squadron used similar versions of this aircraft

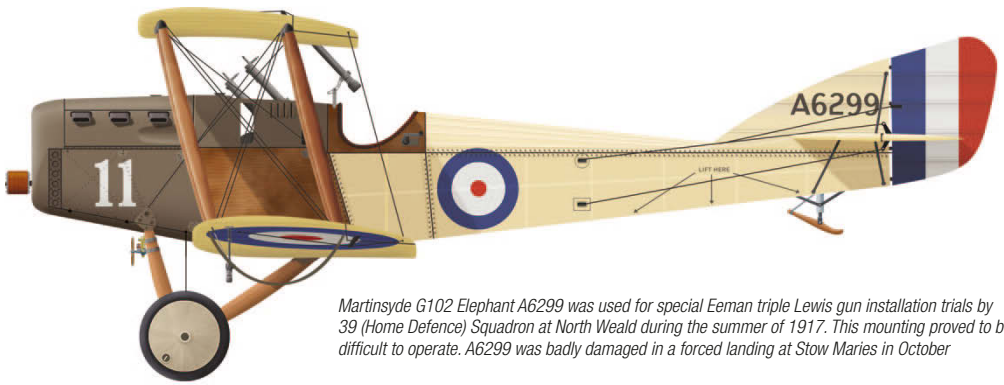
The aircraft was powered by a range of rotary engines and a universal mounting was developed to accommodate this. It later had a Lynx radial engine fitted in its final version, the Avro 504N. The Avro 504 was widely exported and many were used for pleasure flights in the 1920s by civilian operators operating war surplus aircraft.

Martinsyde G102 Elephant

This single-seat machine with two-bay wings was fitted with a 160 hp Beardmore engine, which gave a maximum speed of 108 mph. Designed as a long-range escort fighter, it was used as a day bomber because of its lack of manoeuvrability and low rate of climb. Just 171 were built and only 27 Squadron was fully equipped with the type.

It was known as the Elephant because it needed a large wing area for a single-seater to achieve its endurance and usually carried a single Lewis gun on the upper wing. A second could be fixed to fire rearwards behind the pilot's left shoulder, although this was very difficult to aim effectively!

39 Squadron used a single example, A6299, on detachment starting in June 1917 for evaluation purposes from the Aeroplane Experimental Unit based at Martlesham Heath. This Elephant was fitted with the Eeman gun mounting that consisted of three Lewis guns firing upwards at 47° in a triangle arrangement through slots cut in the centre section. In practice the guns were almost impossible to reload.



Martinsyde G102 Elephant A6299 was used for special Eeman triple Lewis gun installation trials by 39 (Home Defence) Squadron at North Weald during the summer of 1917. This mounting proved to be difficult to operate. A6299 was badly damaged in a forced landing at Stow Maries in October

The mount was designed for attacking the underside of Gotha bombers, but when they were fitted with a downward firing gun its operational role was rendered problematic and so was it used for anti-Zeppelin duties instead. On 19 October Captain L Eeman flew a patrol with A6299 and had to make a forced landing at Stow Maries, damaging its undercarriage.

Martinsyde F3 and F4 Buzzard

The Martinsyde F3 was a 1917 development of a short span G102 Elephant, the RG, with single bay wings and powered by a 275 hp Rolls Royce Falcon III engine. It had excellent manoeuvrability, was easy to fly and quite fast for the period with a top speed of 129 mph. It was armed with two synchronised Vickers machine guns. Only seven were constructed and two of the pre-production aircraft, B1491 and B1492, served with 39 Squadron in June 1918 for operational evaluation for home defence purposes.

An improved version, the F4 Buzzard, was then built. The cockpit was moved further aft for a better view and the lower wing chord reduced to improve the handling even more. Because of the shortage of Falcon engines, which were chiefly to be used in the Bristol Fighter F2b, the 300 hp

Hispano Suiza 8 engine was substituted. This gave a remarkable top speed of 145 mph. The run of F3s then under construction were converted to this standard.

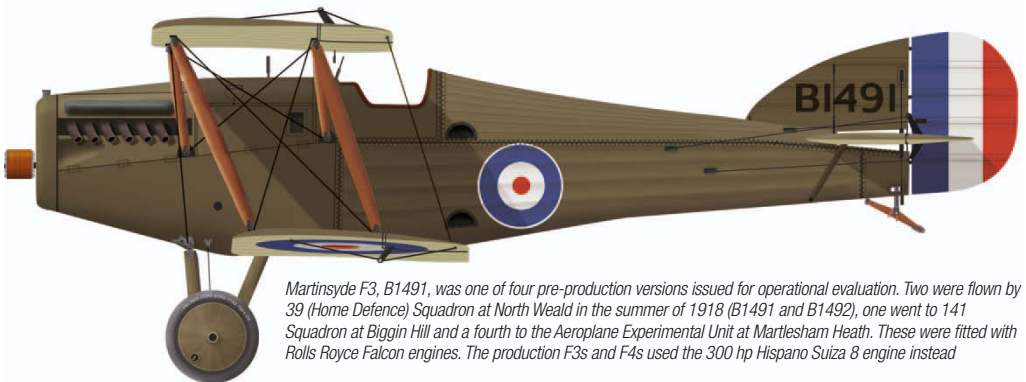
This engine was also in short supply and so more delays occurred. The type had been pencilled in to replace the SE5a in service and 1,450 were ordered, but the end of the war saw most of these cancelled. Fewer than 400 were eventually produced and only 57 entered RAF service, the Sopwith Snipe being the preferred fighter post-war because it was cheaper, although of much poorer performance.

The type was operated by twelve other air forces including Spain (30), Portugal (4), Finland (15) and the Soviet Union (100). The Spanish examples were still flying at the start of the Civil War in 1936. A Finnish example survives.

When Martinsyde went bankrupt in 1922 the Aircraft Disposal Company bought up the remaining stock. These were sold over the course of several years and some were fitted with different engines.

Royal Aircraft Factory FE2b

The FE2b was a two-seat pusher biplane used for reconnaissance and bombing missions, especially at



Martinsyde F3, B1491, was one of four pre-production versions issued for operational evaluation. Two were flown by 39 (Home Defence) Squadron at North Weald in the summer of 1918 (B1491 and B1492), one went to 141 Squadron at Biggin Hill and a fourth to the Aeroplane Experimental Unit at Martlesham Heath. These were fitted with Rolls Royce Falcon engines. The production F3s and F4s used the 300 hp Hispano Suiza 8 engine instead



75 (Home Defence) Squadron operated the FE2b in the nightfighter role

night. It carried two Lewis guns operated by the observer in the front cockpit, one of which could fire rearwards over the top wing, although in this position the observer was rather exposed!

Surplus aircraft were also used by Home Defence squadrons as nightfighters and 75 Squadron were equipped with a few of them. However, they were not very successful because of their low speed and poor ceiling. The FE2b was powered by a 160 hp Beardmore engine, giving it a top speed of 91 mph.

Royal Aircraft Factory SE5

This single-seat fighter was designed by the Royal Aircraft Factory to counter a range of new German machines which were decimating the Royal Flying Corps in 1917. The SE5 and its later development the SE5a helped to regain air superiority along with the Sopwith Camel.

In many ways it was the better aircraft with more benign handling characteristics, but was beset by a shortage of suitable engines based on the Hispano Suiza design, which also suffered from initial reliability problems. This had an impact on production and squadron service, although 21 squadrons eventually operated the type.

It was armed with a fixed Vickers machine gun and a Lewis gun on a Foster mount on the upper wing, which could be tilted back to fire upwards and for reloading. With a top speed of 138 mph it was one of the fastest fighters in service and had superior performance to the Camel at altitude.

Two SE5s, including A8941, were operated by 39 Squadron in July 1917 as part of early evaluation trials against the Gotha raids. They were certainly more capable than the BE2s and BE12s the Squadron normally flew. It was subsequently re-equipped with Bristol Fighters in September 1917, which also had success against these raids.

Nick Carney-Harris



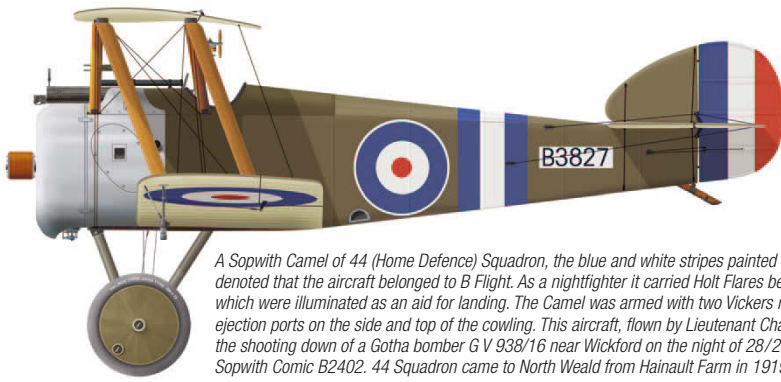
Sopwith Pup B1807 originally served as a nightfighter with a Gnome Monosoupape engine

Sopwith Pup

The Sopwith Scout, later known as the Pup, first flew in 1916 and incorporated the newly-developed interrupter gear for its single Vickers machine gun, which could now fire through the propeller arc. Some were also fitted with a Lewis gun on the upper wing. The Pup served with the Royal Naval Air Service as well as the Royal Flying Corps and was very manoeuvrable and relatively easy to fly compared to other types.



SE5a A8941 was one of two evaluated by 39 (Home Defence) Squadron during July 1917 and flown by Captain J Mackay. It was powered by a geared 200 hp Hispano Suiza 8B engine with a high thrust line rather than the direct-drive Wolseley Viper derivative, which had a propeller on the centreline. It was also fitted with a short exhaust pipe. The aircraft later served with the Central Flying School carrying the code B.I. 56 Squadron was the first to be equipped with the SE5 in March 1917 and was briefly used for home defence duties before departing to France



A Sopwith Camel of 44 (Home Defence) Squadron, the blue and white stripes painted on the fuselage denoted that the aircraft belonged to B Flight. As a nightfighter it carried Holt Flares beneath the wings which were illuminated as an aid for landing. The Camel was armed with two Vickers machine guns with ejection ports on the side and top of the cowling. This aircraft, flown by Lieutenant Charles Banks, shared in the shooting down of a Gotha bomber G V 938/16 near Wickford on the night of 28/29 January 1918 with Sopwith Comic B2402. 44 Squadron came to North Weald from Hainault Farm in 1919

Cross & Cockade via Nick Carey-Harris



Sopwith Pup B1807 as it probably looked while with 39 (Home Defence) Squadron at North Weald. It now had an 80 hp Le Rhône engine

The Pup later equipped several Home Defence fighter squadrons as well as nightfighter training squadrons and these were fitted with a Gnome 100 hp Monosoupape engine which gave an improved rate of climb and a top speed of 111 mph. 39 Squadron had an unarmed example, B1807, as a hack. This had been re-engined with an 80 hp Le Rhône rotary. 75 Squadron also had some Pups on its strength as fighters at North Weald in October 1918.

Sopwith Camel

The Sopwith Camel was a development of the Pup with a larger engine and better performance. It was also harder to fly because of the fierce gyroscopic effects of the 130 hp Clerget rotary engine, which caused many accidents. Its top speed was 113 mph. There were also centre of gravity problems when the fuel tank behind the cockpit was full, which made it fly tail heavy.

It was armed with two Vickers machine guns and shot down 1,294 aircraft – more than any other type. The Camel was used by several Home Defence squadrons as a day and night fighter against the Gotha bomber attacks. Both 44 Squadron and 75 Squadron used Camels. The Camel was an unofficial name given to the aircraft because the metal shroud over the gun breaches, which

protected them from freezing, was said to resemble a camel's hump!

A separate development called the Comic had two Lewis guns on the upper wing as the muzzle flashes from the Vickers guns tended to dazzle the pilot at night. This configuration also allowed the use of new, more effective incendiary ammunition that was considered unsafe to fire from synchronised Vickers guns. The cockpit was moved back to allow easier reloading of these guns and the fuel moved forward. 44 Squadron used the Comic as well as Camels.

Sopwith Snipe

The Snipe was the final development of the Sopwith rotary-powered single-seat fighters and the prototype first flew in November 1917. It remained in RAF service during the 1920s and was finally retired in 1926. Although a large production run was planned, the end of the war saw just under 500 actually produced.

It was powered by a 230 hp Bentley rotary engine, giving a top speed of 121 mph. It was stronger and easier to fly than the Camel, had a better view from the cockpit and carried the standard armament of two Vickers machine guns.

The Snipe was one of the types used by 75 Squadron at the end of the war, replacing its Camels. ■

RAF Systems



Aero engines at RAF North Weald

Some of the different types of engines that powered service aircraft at the Airfield ...

Royal Aircraft Factory RAF 1A and 4A

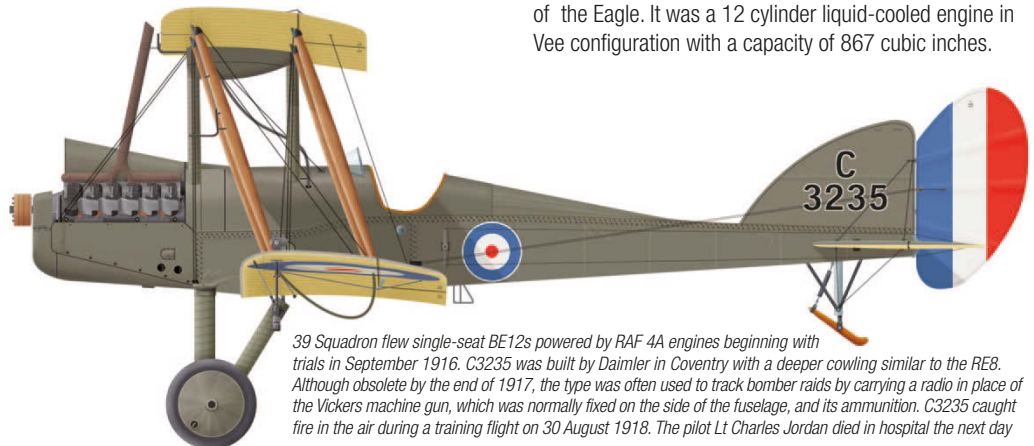
The RAF 1A engine was based on a Renault design. It had eight cylinders in vee configuration, with a total capacity of 540 cubic inches. It was air cooled and produced 92 hp at 1,600 rpm. A reduction gear at the front of the crankcase drove a four-bladed propeller at one half engine speed.

The engine was produced for the Royal Aircraft Factory's BE2 series of aircraft as well as several other types. It was subsequently manufactured under licence by six different British companies including Daimler, Rolls-Royce and Wolseley Motors.

The RAF 4A was a twelve cylinder development of this engine, which produced 150 hp and was produced by Daimler and Siddeley-Deasy. It powered the BE12s used by 39 Squadron as well as other aircraft.

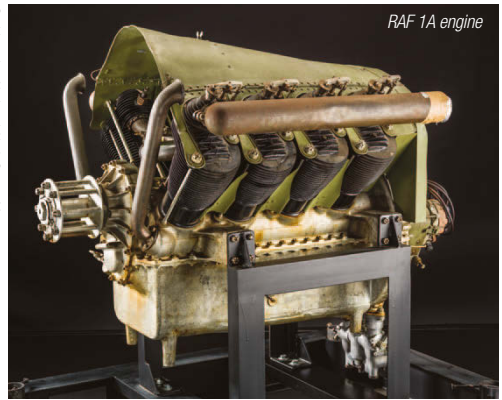
Beardmore Inline Engines

The Beardmore was a six-cylinder inline water-cooled engine first produced in 1914. The original version generated 120 hp and was a licence-built version of the Austro Daimler powerplant. The engine featured cast iron cylinders and mild steel concave pistons. The engine was used on several aircraft types including the Armstrong Whitworth FK8 and Royal Aircraft Factory FE2.



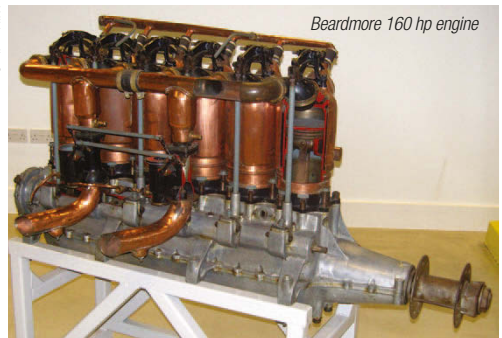
39 Squadron flew single-seat BE12s powered by RAF 4A engines beginning with trials in September 1916. C3235 was built by Daimler in Coventry with a deeper cowling similar to the RE8. Although obsolete by the end of 1917, the type was often used to track bomber raids by carrying a radio in place of the Vickers machine gun, which was normally fixed on the side of the fuselage, and its ammunition. C3235 caught fire in the air during a training flight on 30 August 1918. The pilot Lt Charles Jordan died in hospital the next day

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RAF 1A engine

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Beardmore 160 hp engine

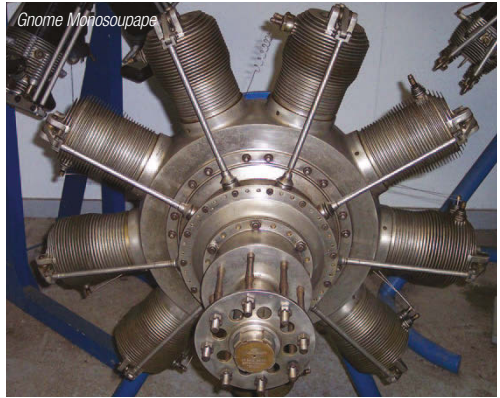
A more powerful development with an output of 160 hp was also produced from 1916. This was made by the Beardmore subsidiary Arrol-Johnston and Crossley Motors. The engine was used by the Martinsyde G102 Elephant along with other types.

Rolls Royce Falcon

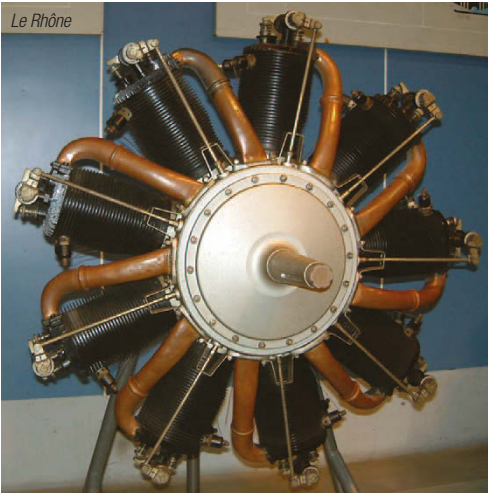
The Falcon was developed in 1915, as a smaller version of the Eagle. It was a 12 cylinder liquid-cooled engine in Vee configuration with a capacity of 867 cubic inches.



RR Falcon III engine



Gnome Monosoupape



Le Rhône

The Falcon III developed 295 hp and was manufactured in the largest numbers.

The Falcon powered many aircraft types, the principal one being the Bristol Fighter F2b. The engine continued in production until 1927.

Gnome Lambda and Monosoupape

The Monosoupape was a rotary engine first produced in 1913 by the Société des Moteurs Gnome and was made in both seven and nine-cylinder configurations. Versions were built by allies and the Germans also used it under licence as the *Oberusel*.

Gnome originally used a system of inlet valves embedded in the top of each piston, which popped open without springs or pushrods on the downstroke to allow the fuel/air mixture to enter the cylinder from the crankcase and an exhaust valve mounted on the cylinder head. This set up was used in

the Gnome Omega and Lambda engines, but was difficult to service, as the whole cylinder had to be dismantled.

As a result, the single valve engine (*Monosoupape*) was introduced. This had ports in the side of the cylinder for introducing the mixture when the piston dropped far enough.

The spark plug was situated on the rear of the cylinder and an internal-tooth ring gear mounted on the engine drove a stationary magneto mounted on the firewall. The output terminal was in close contact with the spark plug terminals as they rotated, so no distributor and high voltage wiring was needed.

The seven-cylinder version had an output of 80 hp, which the nine-cylinder models produced from 100 to 180 hp. The engines had no carburettor or throttle and so were not very fuel efficient, although they did have a petrol regulating lever, which gave a little control over fuel flow. Castor oil was used as a lubricant in a total loss system. The engines also had to be finely balanced, which made them expensive to produce.

The engines were installed in Avro 504s, Sopwith Pups and Sopwith Camels, as well as many other aircraft types. The Home Defence Pups used the 110 hp version.

Le Rhône Rotaries

The Société des Moteurs Le Rhône produced a range of rotaries which had conventional cam-operated inlet valves in the cylinder head fed by copper induction pipes. The engines also used a single centrally-pivoting rocker arm which moved the exhaust valve and the intake valve.

The engines ranged in output from 80 to 130 hp, with seven- to nine-cylinders, so were not the most powerful models available. But they were regarded as dependable and saw wide use, including the Avro 504, Sopwith Pups and Camels and the Nieuport family of Scouts.

A German version was used in the Fokker DR1 Triplane, but a shortage of castor oil meant that a substitute mineral oil was used for lubrication. This oil was prone to dissolve in petrol, whereas castor oil did not, which led to many engine failures.

Gnome and Le Rhône subsequently merged in January 1915 but continued to produce the separate ranges throughout the war, 100,000 engines being made in their factories and under licence.

Clerget Rotaries

The Clerget rotary engine family had normal intake and exhaust valves unlike the Gnome, and the connecting rod arrangement was much simpler. The engines were produced in seven-, nine- and eleven-cylinder versions, with a corresponding power output of 80, 130 and 200 hp respectively. They had aluminium pistons with connecting rods of tubular section. The inlet and exhaust valves were mechanically operated with separate cams, tappets and rocker arms.

The brass piston rings were a source of failure and had to be replaced every few hours. Nevertheless, the Clergets were regarded as reliable engines but were expensive to produce and maintain. They also featured a throttle unlike other contemporary rotary engines.

The engines were used extensively in Sopwith Camels as well as the earlier Vickers Gunbus. The 130 hp version used by the Camels cost £907 per unit.

Bentley BR1

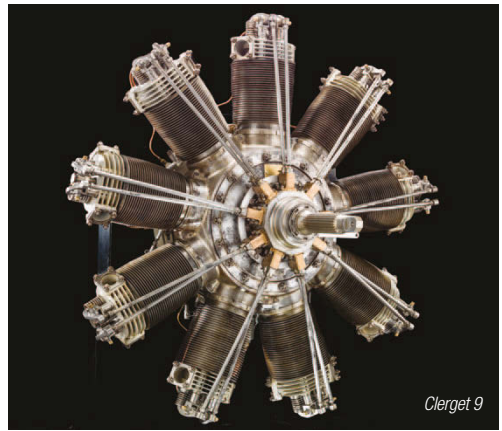
The Bentley BR1 nine-cylinder rotary engine was developed from the Clerget to address its faults and make an engine cheaper to produce and maintain. It was fitted with aluminium cylinders and cast-iron liners along with aluminium pistons. Dual ignition was fitted and the piston stroke increased to 6.7 inches which allowed power output to be increased to 150 hp. The engine was also more reliable and the unit cost was reduced to £605 each – a significant saving! Demand for the engines, which powered the Sopwith Camel and Sopwith Snipe always outstripped the production capacity.

Hispano Suiza 8 Family

The Hispano Suiza 8 was a vee-eight water-cooled engine first designed in 1914. In its original form, the 8A, it produced 140 hp, increasing to 200 hp in the 8B. Further developments during the war boosted this to 330 hp in the 8F version with higher compression pistons.

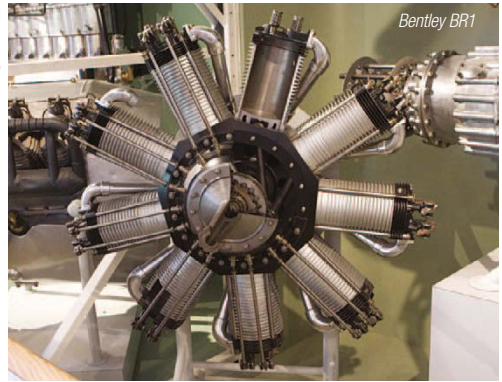
The crankshaft was machined from a solid piece of steel. The cylinder blocks were cast aluminium in one piece and

Smithsonian National Air & Space Museum



Clerget 9

Wikipedia Commons



Bentley BR1

Wikipedia Commons



Hispano Suiza 8

the inlet and exhaust ports were incorporated in the blocks. It also featured dual spark plugs and dual magnetos.

The engine powered many aircraft types including the French Spad fighter family and Sopwith Dolphins. The type was also produced under licence by the Wolsley company in several versions. The best-known was the Wolsley Viper, which powered the SE5a. ■

Typical six-bay Bessonneau Hangar



Under cover

Hangar types from World War 1...

During World War 1, the Royal Flying Corps found itself constantly on the move and needed an easily transportable means of protecting their comparatively fragile aircraft from the elements, especially during the winter months.

The Bessonneau Hangar

The Bessonneau Hangar (*French for shed*) was a portable timber and canvas aircraft hangar, first designed in 1908 and manufactured by the French rope and canvas manufacturer *Établissements Bessonneau*. It was made as a kit of parts that could be easily erected within 48-hours, dismantled, transported and re-erected at another location as required.

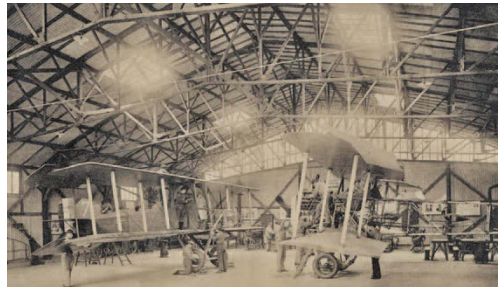
The principal material of the framework was wood, joined by wooden plates, steel brackets, and steel bolts. Vertical stanchions supported the roof trusses, with extensive ties and beams. The framework was covered with canvas, which was tied to the framework with ropes. To support the whole structure ropes were used as tie downs attached to steel pickets driven into the ground.

The hangar was made up of six, nine or twelve bays. It was already in service with the French forces in 1914 and the Royal Flying Corps quickly adopted the type as well, generally using the six-bay version.

The Bessonneau Hangars were also used in the UK for temporary protection for aircraft pending construction of permanent hangars. They continued to be used until the 1990s and were known as Type H Aircraft Hangars.

Aeroplane Sheds

Wooden Aeroplane Sheds were constructed for use on permanent sites such as the Home Defence Flight Station at North Weald. They were of a single or double frontage



Interior structure of a Bessonneau Hangar



One of North Weald's Aeroplane Sheds was moved to Moreton after World War 1 and used as a garage for many years. It is now sadly gone

design and had sliding canvas doors at each end for easy access. North Weald was equipped with two Home Defence Pattern Double Sheds measuring 210 feet x 65 feet as well as an adjacent Bessonneau Hangar.

There were also workshops and repair sheds, including a dope shop, blacksmith's shop and machine gun store.

This type of shed was superseded elsewhere by the 1917 GS Shed with a Belfast Truss roof structure, which originated from the Ulster flax industry as a way of creating a very economical wide span roof.

North Weald's two Aeroplane Sheds were demolished in 1922 and replaced by two larger Type A Hangars when the site was redeveloped and extended as a two squadron fighter station for the RAF. ■

The Cliffe cordite factory

Pilots flying over the Thames towards Rochester from North Weald may have noticed a series of buildings and earthwork structures next to the south bank of the River Thames. These are the remains of Curtiss & Harvey's cordite factory at Cliffe, which dates from 1898.

Cordite was invented in 1889 and patented the following year as one of the new generation of 'smokeless' propellants. It was made from a mixture of nitroglycerine, guncotton and mineral jelly in the ratio 58:37:5, and extruded into long strands, rather like spaghetti – hence the name 'Cordite', which were used in bundles inside shell cases.

By 1902 full-scale production was going ahead and in 1908 the factory was described as "one of the largest in the Kingdom." With the outbreak of war the demand for explosives expanded even more and in 1916 the site was taken over as HM Cordite Factory and an extension built on land adjacent to the site, which is now all owned by the Port of London Authority. The facilities closed in 1921 and are now derelict with no public access.

During the war, an anti-aircraft site was also set up with one 3-inch and one 6-pounder gun to protect the works.

Despite the precautions and earthworks to minimise the effects of blast, there were a number of serious incidents at Cliffe. A particularly large explosion of a covered bogie

truck in the nitroglycerine washing and filtering house on 26 July 1911 killed three and injured three. It severely damaged many buildings across the site and shook windows out of their frames at Cliffe Fort downstream.

Between 1904 and 1921 a total of 21 workers were killed and a further 38 suffered injuries. There were also 20 incidents, which did not result in death or injury.

The Silvertown explosion in 1917

The Brunner Mond chemical factory was built in 1893 on the North Woolwich Road next to the Thames in Silvertown, at a site close to what is now London City Airport, to make soda crystals and caustic soda. Production ceased in 1912, which left part of the factory idle.

Because of the acute shell shortage, which became manifest early in World War 1, the War Office then decided to use the factory's surplus capacity to purify TNT (trinitrotoluene), the high explosive filling for shells.

This was regarded by Brunner Mond as more dangerous than manufacturing TNT itself, and not sensible in the midst of a heavily built-up area. Nevertheless, production of TNT began in September 1915 at the rate of ten tonnes a day.

On Friday 19 January 1917, a fire broke out in the melt-pot room, and efforts to put it out were under way when approximately 50 tonnes of TNT ignited at 18:52 pm.



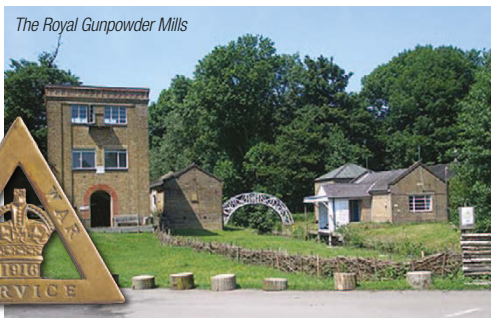
The **explosive** history of World War 1

The insatiable demand for more and more shells created huge risks...

The remains of the Cliffe cordite factory can clearly be seen from the air with the earthworks and reinforced concrete buildings set apart to minimise the effect of accidental explosions



The Silvertown works in ruins after the explosion



The Royal Gunpowder Mills

The TNT plant, railway goods wagons and many nearby buildings, including the Silvertown Fire Station were destroyed by the explosion. The blast was heard as far away as Sandringham in Norfolk and a gasholder over the river on the Greenwich Peninsula was hit, creating a fireball from the detonation of 7,100,000 cubic feet of gas.

Fortunately most of the workforce had finished for the day. Even so, 73 people were killed or later died of their wounds and 400 were injured. Up to 900 nearby properties were destroyed or damaged so badly that they could not be repaired and another 70,000 suffered to a lesser extent. The reconstruction work later employed 1,700 men and £3m was paid out in aid to those affected.

Andrea Angel, the chief chemist who was attending to the initial fire, was posthumously awarded the Edward Medal (First Class) along with George Wenbourne. Police Constable Edward Greenoff was posthumously awarded the King's Police Medal.

According to the *Police Review*: "PC Greenoff got many people out of the burning building and prevented a stampede. Regardless of his own personal danger he devoted himself to duty. In this he was heroically occupied when the terrible explosion occurred." He was struck on the head and died in hospital a few days later, leaving a wife and eight year-old daughter.

He is commemorated with a plaque on the Memorial to Heroic Self-Sacrifice in Postman's Park at St Martins Le Grand in the City. There is also a memorial to all the victims in a small park on the former factory site.

At Rainham in Essex on 14 September 1916 an explosion caused by a watchman's illicit cigarette destroyed HM Explosives Factory next to the Thames, which had been taken over for purifying TNT in November 1914. The blast killed seven and injured 69 and damaged nearby buildings including the Three Crowns Inn. In the summer of 1918 another chemical works nearby began making lethal gases for weapons as HM Chemical Warfare Factory.

A similar explosion at Uplees, Faversham, in Kent killed

115 on Sunday 2 April 1916 when fifteen tonnes of TNT and 150 tonnes of ammonium nitrate detonated in a fire. Later, the National Shell Filling Factory at Chilwell in Nottinghamshire was devastated by an explosion of eight tonnes of TNT on 1 July 1918, killing 137 and injuring 250.

The Royal Gunpowder Mills, Waltham Abbey

Situated to the west of the District, the Royal Gunpowder Mills started life in the Middle Ages as fulling mill for cloth originally set up by the monks of Waltham Abbey. In the 17th century, during the Civil and Dutch Wars, more gunpowder was needed and mills were set up at Stratford and along the Lee valley. The mill was then converted for grinding the ingredients and the river used for transporting them.

Production was gradually expanded and in 1735 the facilities were described by Thomas Fuller, a local historian, as "the largest and compleatest works in Great Britain." In the 1860s, Colonel George Rains called them the "best existing steam-powered mills in any country."

In order to ensure a constant supply of gunpowder, the Crown purchased the Mills in 1787 for £10,000 from the owner John Walton. Production was expanded to meet the increased demands of the Napoleonic Wars.

Guncotton was developed at Waltham Abbey and patented in 1865, followed by Cordite in 1890. To meet the huge demands of World War 1, staff numbers increased by around 3,000 to a total of 6,230. These workers were largely female and recruited from the surrounding area.

In the 1920s and 30s development work was carried out on TNT production and the new explosive RDX. After the outbreak of World War 2, staff helped to set up other facilities elsewhere and production ceased at the Mills in 1943.

It became a research establishment for propellants and high explosives in 1947 including the increasingly important field of solid and liquid rocket propellants and rocket motors. The research centre finally closed in 1991.

It is now a museum and heritage site. You can find out more at www.royalgunpowdermills.com ■

The armaments workshop of the world

London's war production from 1914-18 spans every area of industry...

World War 1 caught all of its participants unprepared for the long battle of attrition and national production that it became once the front lines were deadlocked in a trench system that stretched from the Belgian coast to the Swiss frontier by the end of 1914.

Britain, with its small professional army, had a lot of catching up to do. The hundreds of thousands of Kitchener volunteers and later conscriptees needed to be provided with uniforms, boots, a rifle and other equipment, as well as fed and housed. The relentless need for guns, shells and small arms ammunition had to be met as the war ground on.

Expansion gets underway

London was already provided with a core of Government facilities on which to build – the Woolwich Royal Arsenal complex of ordnance factories which produced heavy guns, ammunition, small arms, gun carriages, limbers and other stores, the Royal Small Arms Factory at Enfield, whose production rose from 1,000 Lee Enfield rifles a week in 1914 to 6,500 by 1916, and the Royal Gunpowder Factory at Waltham Abbey, where cordite propellant tonnage rose from 70 tons a week to 250 tons by 1917. All these sites expanded and their output grew.

Other factories were converted to war production and nationalised, where necessary. Some remained under private ownership. All were collected into specific groups allowing for planning to direct their work. This followed on from the 'shell crisis' scandal of 1915 which led to the Ministry of Munitions being set up under David Lloyd George.

There was also a need for a large influx of labour and many of the new workforce were women. The existing unions resisted this, regarding it as a 'dilution' which undermined skilled trades. Inevitably it took time for production to get up to speed and efficiency, and many of the shells were defective and failed to explode – a deadly harvest still being recovered from the battlefields today.

Transport was a key to managing production and the rail network was already far more dense than it is now. Rivers and canals were also used to move raw materials and finished goods – the Thames as far west as Kingston, the River Lee and the Regent's Canal from Limehouse through Mile End, Camden Lock and Paddington Basin were all useful highways for the war effort.

The armaments industry roughly split into two halves with explosives, shells and guns mostly being produced on a line down the Lee Valley and along the Thames Estuary to

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Female munitions workers at the Royal Arsenal, Woolwich

the east. Aviation-related factories were generally located to the west in an arc from Hendon to Brooklands.

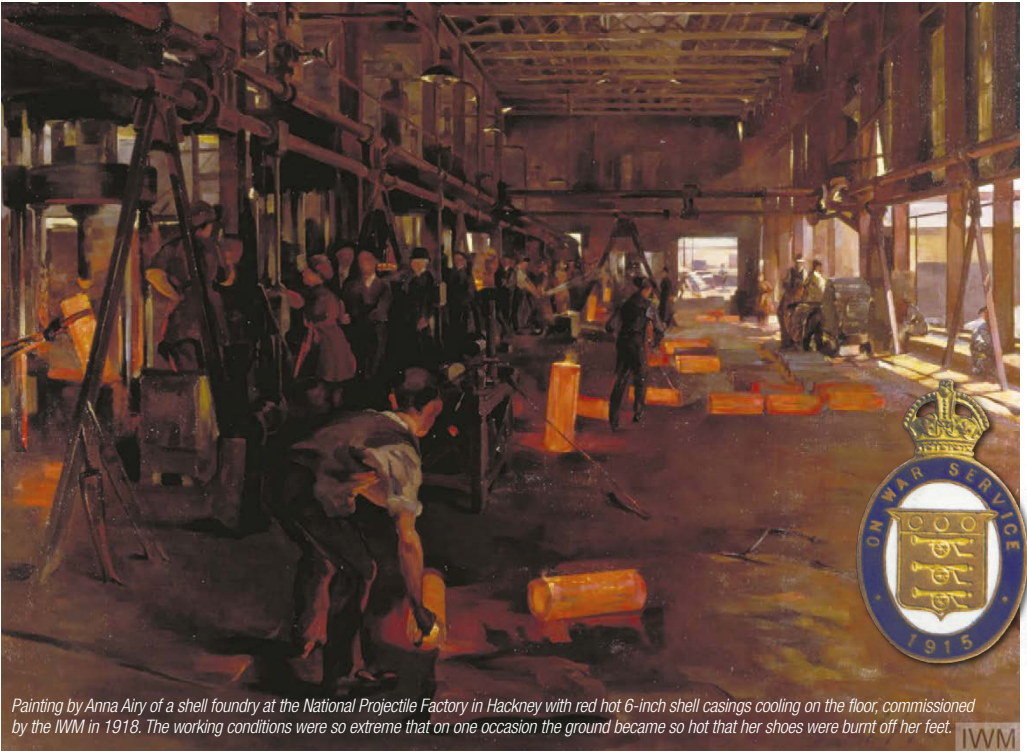
A range of factories producing arms

Shell production relied heavily on the north of England and the Midlands where steel production and metal working was centred. But there was a National Projectile Factory at Ponders End making heavy shells of up to 12-inch calibre, another on the Hackney Marshes (Dick, Kerr & Co) for 6-inch shells, and a third (Klinger) at Willesden making components, whose proprietor was interned as an alien.

The shells still had to be filled with explosives, complex fuses manufactured and all the elements put together, however. This was done in a series of National Filling Factories, and several of these were ranged around London at Abbey Wood, Southwark, Perivale and Hayes.

Trench Warfare Filling Factories catered for hand grenades, mortar bombs, flares, incendiary and smoke munitions. These were situated at Erith, Fulham and Watford. A glass factory owned by Baird & Tatlock at Walthamstow was converted to produce chemical weapons including tear gas shells and grenades and later filled Livens Projector drums and shells with lethal agents. A similar establishment was the Chemical Shell Assembling Station at Greenford. A facility making lethal arsenic-based gases was set up on the Thames at Rainham in the summer of 1918.

Small arms ammunition was manufactured by Eley at Edmonton and designated a Government Cartridge Factory making 6,000,000 rounds a week. There were similar works at Blackheath and within the Woolwich Arsenal complex. Nobel had a factory making aircraft incendiary ammunition in Waltham Abbey. The engineering conglomerate Vickers had a cluster of factories in south east London and Kent



Painting by Anna Airy of a shell foundry at the National Projectile Factory in Hackney with red hot 6-inch shell casings cooling on the floor, commissioned by the IWM in 1918. The working conditions were so extreme that on one occasion the ground became so hot that her shoes were burnt off her feet.

around the Nordenfeldt works at Erith, the Maxim works at Crayford and others in the Dartford area. These made machine guns, ammunition and other armaments, employing 14,000. Vickers also built housing estates for its workers.

Explosives for shell fillings and propellents like cordite were of course in great demand and output from the Royal Gunpowder Factory at Waltham Abbey was augmented. Brunner Mond had converted part of their chemical works at Silvertown to make TNT and another site at Rainham was used to refine TNT from 1914. Both later suffered catastrophic explosions causing loss of life and damage.

Another TNT facility at the Phoenix Chemical Works in Hackney Wick was later closed because it was too close to residential areas, but kept in reserve in case of urgent need. Other explosives factories were based on the Crayford Marshes, as well as at Watford and Colnbrook. Cordite was also manufactured at the Cliffe complex on the Thames Estuary in Kent and at Kynochstown near Fobbing.

Aircraft manufacture

The aircraft industry was in its infancy during 1914 with a limited productive capacity. Some companies were able to build their own airframes such as Shorts, Sopwith and

Vickers. Others made the Royal Aircraft Factory-designed BE2, FE2, RE8 and SE5 or similar types under licence.

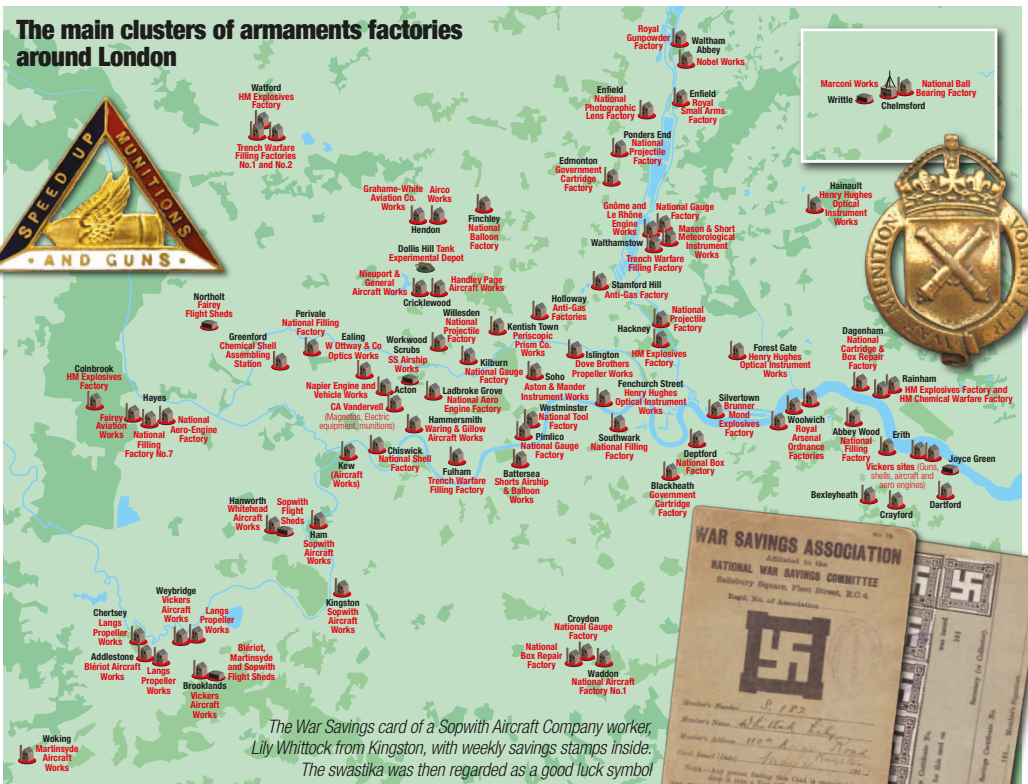
The Aircraft Production Company later set up a factory at Hendon, which it shared with the RNAS and the Grahame-White Aviation Company. Handley Page made heavy bombers in its works at Cricklewood and used a nearby aerodrome with the Nieuport & General Aircraft Company, which built Nieuports and then Sopwith Camels.

Around Kew and at Hanworth the Whitehead Aviation Company made BE2s and Sopwith Pups under licence. The Hanworth site was an aerodrome also used by the nearby Sopwith works at Ham and Kingston, along with Brooklands where they had more assembly sheds. This latter aerodrome was shared by the Blériot Company at Addlestone and Martinsyde at Woking with sheds alongside the Vickers works. All were making the Royal Aircraft Factory's SE5 fighters. Vickers had a factory at Weybridge as well.

Lang, Garnett & Co. produced propellers in premises at Addlestone, Weybridge and Chertsey. Dove Brothers had another such workshop in Islington. Fairey Aviation was based at Hayes but used the airfield at RFC Northolt.

Vickers also built aircraft at Crayford with subsidiaries in Erith, Bexleyheath and Dartford, sharing Joyce Green

The main clusters of armaments factories around London



The War Savings card of a Sopwith Aircraft Company worker, Lily Whittock from Kingston, with weekly savings stamps inside. The swastika was then regarded as a good luck symbol

landing ground with the RFC. Shorts produced their seaplanes at a new factory in Rochester as well as Eastchurch. The National Aircraft Factory No.1 was set up at Waddon near Croydon, also using the RFC's airfield there. This became the Aircraft Disposal Company's base after the war. Waring & Gillow used its furniture factory in Hammersmith to make aircraft components such as wings.

Aero engines were always in short supply and caused production bottlenecks throughout the war. Many had to be imported from France. The Vickers factory at Crayford made Bentley rotary engines under licence, Napiers had an engine works at Acton and two National Aero-Engine Factories were set up at Hayes and Ladbroke Grove, the latter in the Talbot works for repairing Rolls Royce engines. Another engine facility was built on Blackhorse Lane in Walthamstow by Peter Hooker Ltd to house the British Gnôme & Le Rhône Engine Company making rotaries.

A National Balloon Factory was established in the Bohemia Picture Palace at Finchley and Naval 'Submarine Scout' blimps were built on Wormwood Scrubs, where pilots were trained as well. Shorts also had a works at Battersea next to the gas works, which had been set up before the war.

Technology develops

Radios played an increasingly important role as the war progressed and they could be made small enough to be carried in aircraft. The Marconi works at Chelmsford was a major source of production and used the small landing ground at Writtle for testing.

As well as its radios, Marconi direction finding equipment tracked the progress of Zeppelins and Gotha bombers raiding Britain and helped to give some early warning. Chelmsford was also home of the Hoffmann works which was designated as a National Ball Bearing Factory.

Gauges, instruments and tools were in great demand too. National Factories were again set up in Walthamstow, Westminster, Pimlico, Kilburn and Croydon. There was a National Photographic Lens Factory in Enfield and the Periscopic Prism Company had a facility in Kentish Town making sighting telescopes and optics. Henry Hughes opened a factory at Hainault in 1917 to produce aircraft compasses and optical instruments to supplement existing facilities at Fenchurch Street and Forest Gate.

Gas warfare brought a whole new dimension to the war.



Painting by Anna Airy of the production line for DH9 bombers at the Airco factory in Hendon during 1918 and an Airco worker's war service badge

© IWM (Art.IWM ART 1937)

Two mills in Holloway were converted to making gasmasks as Anti-Gas Factories and an LCC depot in Stamford Hill made granules which were incorporated into mask filters.

The huge amount of material being consumed meant much could be used again. Boxes were a suitable source and National Box Factories were set up to repair or make new boxes in Croydon (grenade boxes) and Deptford. A National Cartridge & Box Repair Factory at Dagenham also refurbished field gun cartridges as well as boxes.

The human side of the equation

The influx of so many women into factories led to changes in working practices. Examples can be seen at the Royal Gunpowder Factory (RGPF) and Royal Small Arms Factory (RSAF), which were transferred from the War Office to the Ministry of Munitions in August 1915.

Special buses were chartered to bring local people to work at the RGPF. New facilities at Waltham Abbey included a women's hospital, complete with operating room, constructed in late 1916 and a hostel. By 1918 almost half the workforce of 6,230 was female. Air raid shelters were also built.

On 2 February 1916, four pubs in the vicinity of the RSAF

came under state ownership – the Greyhound, Royal Small Arms Hotel, Ordnance Arms and Swan & Pike. The reason was that the men were used to going to the pubs for their meal breaks and if too much was then drunk productivity would suffer as a result.

They were now only open for four and a half hours around factory meal times and the sale of spirits was banned. But they were refurbished with bigger dining rooms providing cheap and well-cooked food. The Royal Small Arms Hotel could seat 600 and was regularly feeding up to 3,000 a day.

The new canteen inside the factory was also feeding 500 women at a sitting, giving them better sustenance than the cold food they had previously brought from home for their mid-shift breaks as they were reluctant to use the local pubs. There were nearly 1,500 working on site by 1918.

In some factories the workers were handling toxic chemicals. The yellow skin caused by picric acid led to the name of 'canaries' for ammunition workers. Over 100 women died from toxic jaundice due to exposure to TNT. Better protective clothing and handling methods were later introduced. On the other hand no eye protection was provided against swarf for those operating lathes and other machinery. ■

A true survivor!

Sopwith Pup B1807 is being rebuilt to fly for the first time since 1921...

Volunteers are currently restoring a Sopwith Pup which once completed, will be the only original flying Sopwith Pup. B1807 was built as a Home Defence night fighter in 1917, by the Standard Motor Company in Coventry.

Originally issued to 112 (Home Defence) Squadron at Throwley in Kent, the aircraft flew on an anti-Gotha patrol on 12 August 1917, piloted by 2nd Lieutenant J G Goodyear. On 22 August 1917 the aircraft was flown by 2nd Lieutenant N E Chandler on another anti-Gotha patrol. There appears to be no record of any combat on either flight.

The Pup was then re-issued to 36 Home Defence Squadron which is believed to have been based at Cramlington, just north of Newcastle. There are no dates for this period. At some stage in its fighting career the squadron code 'A7' was applied to the fuselage. The Pup was later transferred to 198 (Night) Training Squadron, based at Rochford (now Southend Airport).

Finally, on 18 September 1918 the aircraft went to 39 Squadron at North Weald Bassett in the Southern Area, where it remained until after armistice, probably used as a squadron hack by an officer transferred from Rochford.

During its military career, the original Gnome 100hp Monosoupape rotary engine was replaced with the standard fitment of an 80hp Le Rhône engine. It still retained the distinctive $\frac{3}{4}$ cowling complete with cooling louvres.

On 16 August 1919 the aircraft was registered on the Civil Register as G-EAVX by the Aircraft Disposal Company, at Waddon to A R M Rickards. F/O (later Wg/Cdr) Rickards DSO, of Fairford (Cirencester) was an RAF pilot forced down by bad weather at Waddon, Croydon (later to become London Airport of Imperial Airways fame), whilst on a cross country flight with his friend and Commanding Officer, a Norwegian called Trygve Gran, who had served with 39 Squadron at North Weald in 1916 under an assumed name (Teddy Grant).

At this time Waddon was one of the airfields used by the newly formed Aircraft Disposals Company which was founded by Frederick Handley Page.

Both Rickards and Gran bought a Pup each during this forced visit, whilst looking around the serried rows of aircraft waiting for disposal. Gran intimated later in his writings that the type was familiar and known to be an easy-to-handle aircraft. They were both serving officers based at No. 2 Navigation School, RAF Andover. Rickards' Pup was intended to be flown around Europe by its owner on various trips, most notably Norway.

In Gran's book *My Life between Heaven and Earth* he wrote that bad weather and engine problems forced them both down in Kent the week before Christmas in 1920 on a

Nick Carey-Harris



flight to Norway via Holland. A decision was then made to use the prevailing wind and fly to Newcastle, to embark aboard the steamship *Jupiter* instead.

'VX re-appeared at the Royal Aero Club's 1921 Hendon Aerial Derby on 16 July, which was a two-lap air race around London, each lap of about 100 miles (*see Page 32 overleaf*). The Pup was flown on this occasion by Dring Forestier-Walker, who tipped the aircraft onto its nose while landing after feeling unwell at the end of the first lap. A Pathe News film clip of the aftermath can be seen at: <https://www.youtube.com/watch?v=qXMHUwOZUHI>

The aircraft was taken to the Graham-White hangars on the airfield, where it remained for what is believed to be two years during that time the wings were sold to P T Capon, who was an engineer and journalist as well as the Chief Engineer for Cierva (UK).

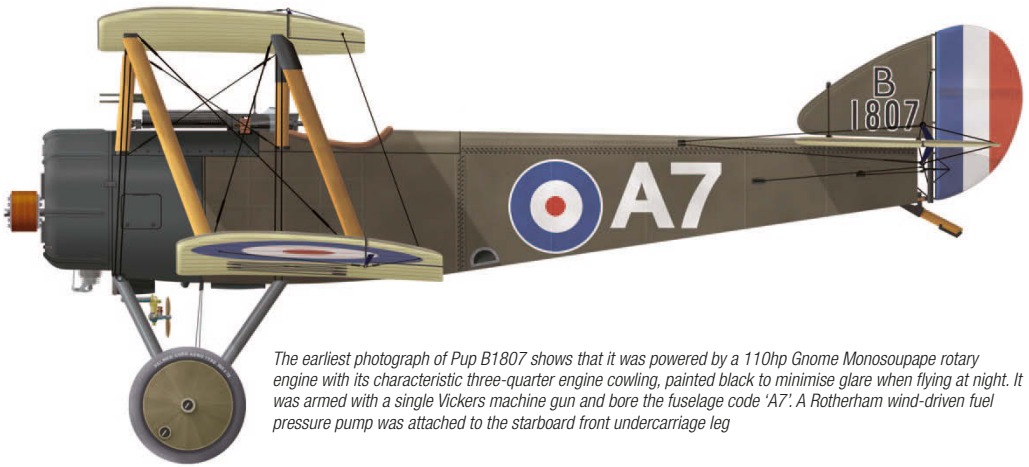
After this, G-EAVX was supposedly disposed of by being set fire to, along with two limousines! However, Capon told Kelvyn Baker that the aircraft which was burnt had a Monosoupape engine in it, clearly it wasn't B1807!

The remains were bought by Kelvyn Baker in 1972, who had been told that the fuselage of two aircraft were in a barn on a farm in Somerset, the property of which was being disposed of by auction. He was led to believe that the bits and pieces were parts of a de Havilland Puss Moth.

The aircraft were in a sorry state having been stored with their tails exposed to the elements. One fuselage was fairly quickly identified as a Bristol Fighter, but the other defied identification. There were other parts, including the wings which belonged to the 'Brisfit', undercarriage, wheels and parts of engines etc, which Kelvyn bought.

Intrigued by the unidentified fuselage, Kelvyn started rebuilding it almost immediately, although the aircraft was moved to several different workshops, where Kelvyn and his friends managed to almost complete the fuselage. It was during this rebuild that Wally Berry from the Shuttleworth Collection paid Kelvyn a visit and identified the fuselage as a Sopwith Pup.

Now he had an aircraft type and the manufacturer's plate found with the aircraft, Kelvyn contacted the Civil Aviation Authority. Their records confirmed that the Pup was B1807 / G-EAVX, intriguingly stating that Kelvyn's restoration will be



The earliest photograph of Pup B1807 shows that it was powered by a 110hp Gnome Monosoupape rotary engine with its characteristic three-quarter engine cowling, painted black to minimise glare when flying at night. It was armed with a single Vickers machine gun and bore the fuselage code 'A7'. A Rotherham wind-driven fuel pressure pump was attached to the starboard front undercarriage leg

rebuild number 2. There are no records of the first rebuild, although it is possible that rebuild 1 was when the Pup took on its civilian guise when Rickards owned it.

Since then the Popular Flying Association (now LAA) has inspected the work throughout the build, so the fuselage is ostensibly airworthy. Due to workshop ownership changes, the aircraft had to be placed in storage in 1985, and was subsequently moved to Kelvyn's garage. A chance meeting with Nick Carey-Harris put Kelvyn in touch with the Royal Naval Historic Flight Director, John Beattie. On seeing the aircraft John immediately offered space in a hangar at RNAS Yeovilton for the rebuild to continue.

The aircraft moved to RNAS Yeovilton on 30 March 2007, where it was hoped that work would recommence on the aircraft. However, financial issues and changes in the team of volunteers meant that very little work was done.

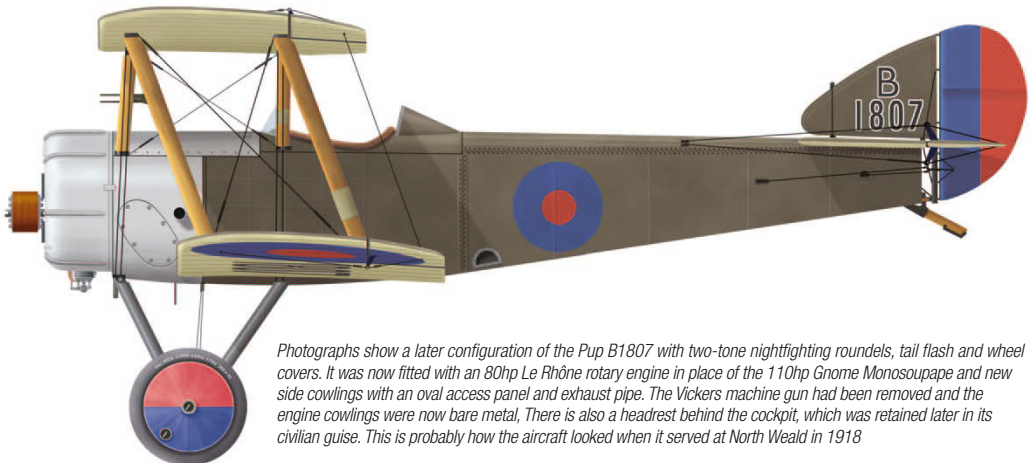
In late 2010 the Pup was moved to a private airfield, owned by a North Somerset businessman, Derek Paget, then again to a large garage near Kelvyn's home. The Pup moved

once more to another airfield in Somerset, which boasts workshop facilities and expertise to assist the team!

Even after all these years, the Pup still has the original illuminated night-flying instruments, which still work. Other work includes refitting the turtle decking behind the cockpit, assembling the port side cowl fairing, and building from scratch the front fuselage lower cowl which forms part of the engine exhaust vent – a major piece of kit!

The wings are probably the biggest job to complete now, as the original wings are missing. The Sitka Spruce for the spars was obtained at great cost, and has been machined to the required shape. The now completed main spars are currently being populated with ribs, compression struts, interplane wiring and a myriad of other bits and fittings.

Progress has been painfully slow due to all the team members using their own funds to contribute to the costs of the restoration. The people currently involved in the restoration include Kelvyn Baker, Nick Harris, Jason Nuttall, and Mike Waldron. ■



Photographs show a later configuration of the Pup B1807 with two-tone nightflying roundels, tail flash and wheel covers. It was now fitted with an 80hp Le Rhône rotary engine in place of the 110hp Gnome Monosoupape and new side cowlings with an oval access panel and exhaust pipe. The Vickers machine gun had been removed and the engine cowlings were now bare metal. There is also a headrest behind the cockpit, which was retained later in its civilian guise. This is probably how the aircraft looked when it served at North Weald in 1918

The Aerial Derby

Epping played a vital part in the early air races around London...

The Aerial Derby was an air race around London originally sponsored by the *Daily Mail*. It was first held in 1912, with subsequent races in 1913 and 1914, the single lap courses ranging from 80-90 miles. It was resumed after World War 1 in 1919, and the race was then taken over by the Royal Aero Club (RAeC) in 1920 using a longer course.

The race now consisted of two laps, each of about 100 miles with the start and finish at Hendon and turning points at Brooklands, Epsom (venue for the horse racing Derby), West Thurrock, Epping (the Church Tower) and Hertford.

The RAeC provided prizes of £500 for the overall winner, with three of £250, £100 and £50 for the first three places in the handicap competition. (By way of comparison, the average house could be bought then for around £620!)

The 1921 Aerial Derby is of most interest to us as one of our surviving aircraft took part – Sopwith Pup B1807 / G-EAVX – featured on Page 38. Sadly it only managed to complete one lap before the pilot, Dring Forestier-Walker, was taken ill and had to land at Hendon, tipping the Pup onto its nose and breaking the undercarriage in the process.

The overall race and the handicap competition were won by Jimmie James in the Gloster Mars prototype G-EAXZ. A war surplus SE5a was second in the handicap competition, a Bristol Tourer (based on the Bristol Fighter F2b) came third, and a Sopwith Camel competed as well as the Pup. Ten aircraft flew the race, although only six managed to finish!

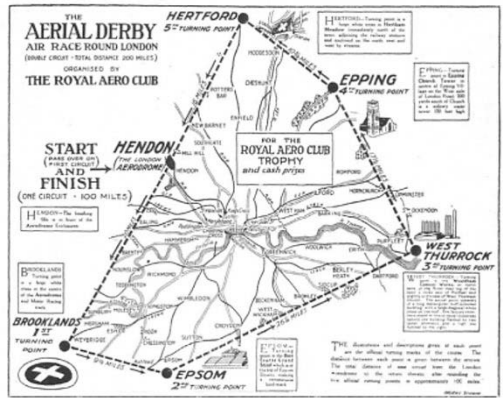
In 1922 the start and finish of the race was moved to Croydon Airport and in 1923 the Epping turning point was omitted. That year proved to be the final Aerial Derby.

The 1921 Oxford & Cambridge Varsity Air Race

The rivalry between Oxford and Cambridge Universities has traditionally found a focus in the Boat Race. After World War 1, young men either resumed courses interrupted by military service or embarked on their delayed studies. Many had been pilots, and A R Boeree, who was a student at Oriol College, Oxford, had the idea of holding a Varsity Air Race.

The Royal Aero Club agreed to hire eight SE5a aircraft for use by the two teams, with six taking part and two held as reserves. The pilots had to have a minimum of 1000 hours flying time in their logbooks. Six were selected from each university, with three of each team flying in the race. The prize fund was £400, mostly donated by Shell along with the fuel.

The race took place on the same day as the 1921 Aerial



The turning point near Chelmsford for the April 2009 North Weald Air Race



Derby, but flew three laps of a 43 mile course (Hendon – Epping – Hertford – Hendon). The aircraft were marked in the university colours – dark blue for Oxford and light blue for Cambridge. The six competitors were lined up at 2.30 pm with Oxford represented by Boeree (Oriol), Pring (New) and Hurley (Keeble) while Cambridge had Francis (Caius), Philcox (Caius) and Muir (St. Catherine's).

The two teams adopted different tactics. Oxford chose to fly low and took the lead for the first lap. Cambridge elected to go much higher. This proved to be faster and Cambridge came first, second and third, the air race being won by WS Philcox. One Oxford aircraft (Pring's) suffered a broken ignition lead and had to force land in a field near Epping. Sadly this proved to be the only Varsity Air Race.

North Weald's later success in the sport

The Airfield was for many years a centre of excellence for air racing. Skysport UK encouraged its pilots to take part, and they became a core of a wider group who enjoyed great success in the sport, including winning the prestigious King's Cup and Schneider Trophy races and the British and European Air Racing Championships. These pilots included Roger Hayes (CFI of Skysport UK), Craig Beevers, Alistair Allen, Ian Cooper, Dan Pangbourne and Roderick Morton.

Two air race meetings were also held at North Weald on 28-29 April 2007 and 25-26 April 2009. Racing has always been an exciting and challenging part of aviation! ■