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FOREWORD

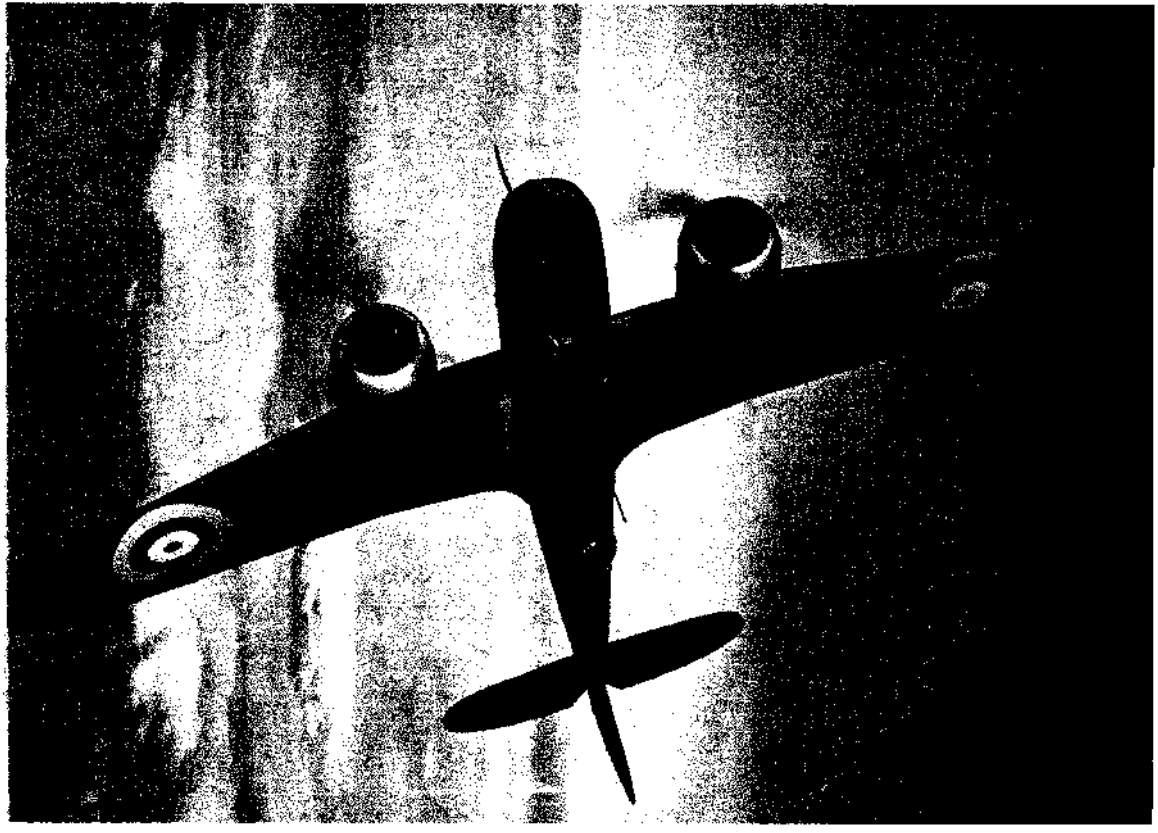
By

AIR MARSHAL SIR PHILIP JOUBERT

K.C.B., G.M.O., 13.S.O.

This book is a very carefully prepared and excellently illustrated digest of the Royal Air Force and its many activities. It is sufficiently technical to be interesting to the mechanically minded without being obscure to those who are not.

I feel 1 can compliment the publishers most sincerely on an excellent production.



THE ROYAL AIR FORCE AT WAR

By

The Stuff of "The Aeroplane"

Book designed
by
WILLIAM BUCHAN

Foreword by
AIR MARSHAL SIR PHILIP JOUBERT,
K.C.B., C.M.C., D.S.O.

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JOHN MURRAY & THE PILOT PRESS

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INTRODUCTION

Circumstances have conspired to thrust upon the Royal Air Force responsibilities far beyond those planned for it in the days of peace. Britain had counted upon the help of France, upon the use of a battlefield for her Army, upon continental aerodromes for her Air Force, and upon a strong fleet to work with her own. All these vanished with the enemy's first major onslaught, and Britain was left to fight alone. Her Army was thereby partly immobilised, her Navy's work was doubled, and the enemy had ranged himself along the whole length of Europe's coasts from Norway to the Atlantic seaboard of France. Of her fighting Services she could make immediate and effective use only of the Royal Air Force for attacks on the enemy and for defence against his air attacks on her.

How well the Royal Air Force met its unexpected burdens and averted the worst consequences of the calamities that had befallen her is told in this book. The repulse of the German *Luftwaffe* by an Air Force half its size will rank for ever with Trafalgar and Waterloo in the long and glorious history of England. Many more battles will be fought between the *Luftwaffe* and the Royal Air Force before final victory is ours; but the furious battle above the fields of Kent in the early autumn of 1940 may well prove to have been the turning point of the war in Britain's favour.

Of the outcome we need have no doubt. Britain has astonished the world by her fortitude under bombardment, by her military and industrial strength, and above all by the quality of her Royal Air Force.

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THE ROLE OF THE R.A.F.

A second generation of pilots now fights for Britain. The first fought more than twenty years ago and founded the tradition that inspires and permeates the Royal Air Force to-day. None who helped to make it will deny how worthily that tradition is being upheld.

Britain had to wait many anxious months before she was given proof that her airmen and their machines had the qualities essential to success. Events took an unpredicted course. No clash of " aerial armadas " quickly followed the declaration of war on Germany by France and Britain on September 3rd, 1939. Infrequent skirmishes, an occasional sortie, attacks on ships, the sinking of a few submarines, an armed reconnaissance now and again, and a rare combat between bomber and fighter and between fighters were all that filled the first nine months of hostilities for us. Germany was not ready for war with the big countries in the West. Nor, in fact, were the big countries ready for war with Germany, and neither side showed eagerness to take the initiative.

No one disputed the *Luftwaffe's* superiority over the Royal Air Force in numbers. Even the aeroplanes of the French Armee de l'Air added to those of the R.A.F. failed to make good the deficit. A trickle of machines from the United States was helping to swell the Allies' resources, but this, combined with the output of French and British factories, did nothing to reduce the gap when related to the *Luftwaffe's* first-line strength and the output of its vast aircraft industry.

The German Air Force was known to be a formidable fighting machine. It had been made to serve German politics as well as the German Army, and the mere threat of its use had made territorial conquests easy for the Third Reich. Squadrons of the Luftwaffe had taken part in the Givil War in Spain. Some of its experimental fighters and bombers had been tested in that war, and the experience gained with them there had been embodied in the machines built for the *Luftwaffe's* newest squadrons. The Air Forces of Britain and France, on the other hand, were equipped with aeroplanes designed only according to the estimated needs of a modern war.

World records, including two Absolute Speed Records, had been won by German aeroplanes. Some of the most interesting commercial aeroplanes operating on European, trans-Atlantic and South American air routes were designed, built and flown by Germans. Some of the most interesting experiments in the military uses of aeroplanes were conducted by the German Army, and some of the more advanced theories on air warfare came from German authors.

When the Nazi Party came to power, one of its first acts was to elude the clause of the Versailles Treaty which deprived Germany of a military air force,

and to start the building of the *Luftwaffe* on the foundations cunningly preserved by former German Governments despite the Allies' ban. The Air Force chiefs had no long-established customs and precedents to overcome and they designed the new Service with the deliberate intention of making it the spearhead of Germany's military operations. A prodigious amount of labour and money was expended in the task and, too late, other nations began to realise that the shadow of the *Luftwaffe* was darkening their own lands.

As an instrument with which to back a threat the *Luftwaffe* fulfilled the Nazi plan. It had brought Austria and Czechoslovakia into the Third Reich without resort to bombing. As a weapon of war it again fulfilled the Nazi plan when it overwhelmed the Polish Air Force and blasted the way for the invading armies. The conquest of Poland was completed with machine-like precision. It has since been described as the most perfectly planned and executed military operation of this century and one that could hardly be repeated. Its success was made possible largely by the use to which air power was put.

Further proof of the role given the *iMftwaffe* by the German High Command came when German troops occupied Denmark and Norway on April 9th, 1940. Thousands of soldiers were transported by air to the key points marked for capture in those countries. The troop transports proved as effective in Denmark and Norway as the dive bombers had in Poland, and the *Luftwaffe* scored its second success in war.

The next offensive came with the attack on the Low Countries. In this parachute troops provided the novelty. Once again textbook theory accorded with tested practice. The parachute troops completed their work in the manner planned and in the time scheduled, and virtually disarmed the defenders at the frontiers almost before their presence behind the lines had been reported.

All these campaigns were waged with a vigour and ruthlessness that spared neither the attacking force nor the attacked. In Norway the need for rapid occupation of the key points caused the transport pilots to land with more haste than judgment, and many crashed, killing themselves and their passengers. In the invasion of Holland hundreds of parachute troops were shot dead as they descended. The transports that followed were often landed away from aerodromes, and at one point scores were seen by British reconnaissance aeroplanes lying with their undercarriages wiped off. So great were the *Luftwaffe's* resources that the total loss of two or three hundred aeroplanes in a single operation could apparently be contemplated and suffered without a qualm.

This, then, was the air power which the Royal Air Force ultimately found itself facing. Thoughtful people could have been forgiven for believing the task too great. The R.A.F. was barely beginning to find its strength, and had been compelled to rearrange its operational plans by the calamities in Holland, Belgium and France. The *Luftwaffe* could order aeroplanes into battle by the thousand; the R.A.F. could oppose them only in hundreds. A fight between David and Goliath became imminent.

THE BATTLE OF BRITAIN

A test bigger than that of Dunkirk was to come. France, Holland and Belgium had succumbed and the enemy was left free to direct the full strength of his Air Force against his remaining opponent across the Channel. For the first time the *Luftwaffe* had to act alone. The army which it served was obliged to stay behind until the *Luftwaffe's* bombers had cleared away the obstacles to invasion. Success had cast the *Luftwaffe* for a role it had never played before—the role of an independent air force. Previously it had been the servant of the tanks and troops on the ground.

After a pause the test came. Wave after wave of bombers and fighters swept over the coasts in a carefully planned attempt to paralyse that corner of England nearest the Continent and open the way for invasion. Methodically, they sought to destroy every form of defence and every means of communication. They adopted the formula that had proved successful in Poland, and bombed the aerodromes of the fighter squadrons, working gradually from the coastal areas towards London as the offensive developed.

To-day, the story of the first Battle of Britain can only be told in figures. Historians to come will unfold for posterity the inner story of that struggle of which only the outline is known now. But even that is a glorious story. Outnumbered, R.A.F. fighter pilots fought back, day after day, with hardly a moment's rest. Facing a thousand dangers, the ground crews kept the fighters filled with oil, fuel and ammunition, and kept them in fighting trim. Overriding all was the brilliant strategical and tactical direction of the Fighter Command.

The Battle of Britain opened on August 8th, 1940. That day the *Luftwaffe* lost 38 fighters and 24 bombers, a total of 62 machines. Such losses seemed to disturb the German High Command and brought their brief but violent offensive to a sudden halt. For two days operations were suspended. But they were resumed on August 11th with such vigour and on such a scale that in seven days the formidable total of 495 German fighters and bombers had been destroyed. For the next seven days the scale of attack was smaller, and the losses were only 243. In the week after, the losses rose to 297; in the first week of September they amounted to 347. Raids on a fluctuating scale followed in the second week of September, but a toll of 182 was taken. Then came the memorable September 15th. Formations of ever-growing strength were hurled at the defences. In endless relays they crossed the coasts, only to be met at every point by fierce anti-aircraft gunfire and squadrons of fighters. When the final count was completed, it revealed that the *Luftwaffe,* in one day, had lost 187 fighters and bombers in raids on Great Britain. The R.A.F. had lost only 26 fighters—a seven-to-one victory!

That was the beginning of the end of the first Battle of Britain. Day raiding

ceased to be an enterprise for bombers in formation, and was entrusted to fighters carrying bombs small, fast machines with but little weight behind their punches. After that, the night bomber took over the offensive.

The *Luftwaffe* made one more desperate and forlorn attempt to break down Britain's defences by day. It was made on September 27th, but, probably to the *Luftwaffe's* surprise, our fighters were more numerous and more active than ever. The venture cost the German Air Force another 133 fighters and bombers, and established beyond doubt the ascendancy of the Royal Air Force over the German Air Force in battle. Only when the weather gives them the security of clouds dare the *Luftwaffe"s* bombers visit Britain by day now.

The invasion to which the bombing had been a prelude did not come. The materials with which it was to be made were smashed and broken by R.A.F. bombers in the ports and harbours of Holland, Belgium and Northern France. For the the same time, it recei

Fighter pilots studying their patrol area 011 a map

THE R.A.F.'s FIGHTERS

When the Battle of Britain was over, hundreds of wrecked German aeroplanes were collected from the fields of Kent, Sussex and Essex and piled up in great dumps of twisted, bent, chipped and charred swastika-covered metal. Those heaps were both the graveyards of Nazi aspirations and the vindication of a daring experiment in fighter armament.

When the air forces of other countries began to put shell-firing cannon as well as machine-guns into their fighters, the Royal Air Force merely added to the number of its machine-guns. From two, it rose to four; from four to eight. When war broke out in September 1939 a fighter with twelve machine-guns was being built.

The eight-gun scheme had its critics. They protested that the larger cannon would out-range the machine-gun; that the explosive missiles it fired would tear through protective armour. In theory they were right, and the fact that cannon are now going into British fighters proves that they were right. But a miscalculation on the part of Germany's air chiefs exposed the *Luftwaffe's* fighters and bombers to the " lethal concentration " of the British armament scheme. The Germans relied for safety on speed rather than on armour and armaments, and neglected to give their fighters and bombers the protection enjoyed by their opponents. Nor did they give them speed enough. When battle was joined, the converging fire of the eight machine-guns swept through the thin metal skin of the wings and fuselage of German bombers and fighters, killing the crew, damaging the motors, puncturing the petrol tanks and snapping wing spars and fuselage girders. On more than one occasion, the rear gunner's cockpit on a bomber was cut away as though by a massive mechanical tin-opener.

The attempt to trust in speed rather than in armour cost the enemy at least 3,000 aeroplanes, and made two British eight-gun fighters—the Hawker Hurricane and the Supermarine Spitfire —world-famous.

Of the two, the Hurricane had a bigger share in the " Battle of Britain " than the Spitfire. The Hurricane was an older design and had been in production over a longer period. It was, in fact, the first eight-gun fighter to go into service with the Royal Air Force; it was also the first monoplane fighter, and set an entirely new fashion and a new technique in aeroplane design and in fighting tactics.

A clean, unbraced monoplane replaced the braced and strutted wings of the old biplanes. The wheels retracted into the centre-section and added more miles an hour to the speed. There were flaps to steepen the angle of glide for landing and later a controllable-pitch airscrew further improved it by giving the advantages of a gear-box. The original airscrew could not vary its pitch and was, as it were, a compromise between top gear and bottom gear and therefore inefficient, as are all fixed-pitch airscrews.

Fighter speeds took on a new meaning. From the 250 miles an hour of the

HURRICANES *ON* PATROL

(In circle) Hawker Hurricane fighters on patrol above a bank of cumulus clouds

(Below) Hurrices where. with Gloster Gladiators they routed the ItalianAir though seriously outnumbered

Fury and the Gladiator biplanes which immediately preceded it, the Hurricane reached 335 miles an hour. Such a speed was undreamed of a few years earlier, and the prophets predicted that " dog-fights" in the air would be a thing of the past. Twisting and turning at such a rate, they said, would set up forces which the human body could not withstand. They were wrong, as events proved, but the modern dog-fight needs a much bigger arena than did the dog-fight of 1918.

Britain, perhaps, does not fully appreciate the debt she owes to the Hurricane. Apart from bearing the brunt of the first Battle of Britain, it has served the R.A.F. well in Libya, where, with the Gladiator, it established complete mastery over the *Regia Aeronautica* from the day it first arrived, and helped to make easier the great victories scored by the Army of the Nile in its triumphant march Westward from Egypt which began in December 1940. In Malta, too, and in Albania it upheld the splendid reputation it had made in England and Africa.

The Hurricane can trace its ancestry back to the famous Sopwith Camel and other Sopwith fighters of the war of 1914-1918. Now, a descendant of the Hurricane itself, the Hawker Typhoon, is coming into service with the Royal Air Force. The struggle for air supremacy in war demands that older types must ultimately give way to new and better designs and though the name of the Hurricane and the name of its designer, Sydney Gamm, will eventually pass into history, countless R.A.F. fighter pilots will long cherish the memory of Britain's first eight-gun fighter.

Mitchell's Masterpiece

The Spitfire descends in direct line from the Supermarine racing seaplanes designed by the late R. J. Mitchell for the Schneider Trophy Contests of 1925, 1927 and 1929. The task of turning a racing seaplane into a first-class fighter demanded more than the mere exchange of an undercarriage with floats for an undercarriage with wheels, but so great was the genius of Mr. Mitchell that in the Spitfire he preserved all the fine qualities of the Trophy winners and gave the Royal Air Force an outstanding fighter.

In harmony of line, few aeroplanes can approach the Spitfire. Its wing is gracefully curved, sweeping outwards almost to a point at the tips and flowing smoothly into the fuselage at its roots without the suggestion of a harsh line anywhere.

As a short-range interceptor, the Spitfire was denied the opportunities of travel that came the way of the more robust Hurricane, and for many months it was limited to actions on the Home Front. Later, it undertook offensive " sweeps " over the Channel and parts of Northern France, in which it acted not only as escort, with Hurricanes, to the bombers of the party, but also went ahead and cleared the skies of enemy aeroplanes that might molest the bombers.

When it first went into service, the Spitfire was the fastest fighter in the world. It had a top speed of 362 miles an hour, a speed that was later increased to

367 m.p.h., then even higher by increasing the power of the Merlin motor It had an initial climb of 2,300 ft. in one minute, and is known to be capable of flying to a height of between 30,000 and 35,000 ft. (nearly seven miles). It was originally designed to carry only four machine-guns, but space was found for four more to meet the Air Ministry's insistence on the eight-gun plan.

Both the Hurricane and the Spitfire have their guns -they are Brownings— in the wings, firing through the leading edge just dear of the are of the airscrew. No interrupter gear is needed to regulate the flow of bullets past the airscrew binder, and each gun is thus able to fire at its maximum speed of 1,200 rounds a minute, a total of 9,6oo lounds a minute. The guns are normally filed in short bursts measured in seconds, but each second's fire uses 160 rounds of ammunition when all eight guns are in action. The guns are so aligned that the bullets meet at a point some 250 yards ahead of the machinc.

Cannon have replaced the machine-guns in some of the Spitfires and in some of the Hurricanes. The change became necessary because the Germans eventually fitted their bombers and fighters with armom, against winch the 303 bullets of the machine-guns were not so effective. No official disclosure has been made about the type of cannon adopted by the Royal Air Force, but the early successes scored by machines carrying it prove it to be an efficient gun capable of breaking up the biggest bombers in the *Luftwaffe* in a few rounds. One pilot filed his cannon for two seconds and saw his opponent disappear in a cloud of small pieces. He said afterwards: " It was like having a dustbin emptied in your face.'"

The Night Fighters

When the Hmricane and Spitfire proved themselves masters of the *Luftwaffe* by day, the German Air Force elected to bomb mainly at night. Although ill-equipped and ill-trained for the task they set a new problem for Britain, just as the R.A.F.'s bombing of enemy territories had set one for the Germans. Its solution has still to be found, but both the R.A.F. and the *Luftwaffc* are seeking it with the aid of night fighters as well as other devices and weapons. The Germans are adapting some of their standaid fighters for night fighting; the R.A.F. has set aside one fighter specifically for this work. This is the Boulton Paul Defiant, an " unoithodox " two-seat fighter with all its armament of four guns concentrated in a single electrically-driven gun turret aft of the pilot's cockpit. The pilot has no guns under his control.

The Defiant made a spectacular debut in daylight over Dunkirk when, on May 29th, 1940, a squadron of 12 shot down no less than 38 German aeroplanes without loss to themselves. But the enemy were quick to discover where the Defiant kept its sting and afterwards it had less success as a day fighter. As a night fighter it shaped well in its early trials. The frequency of its successes suggests that, after many experiments, the night bomber will soon find its path increasingly beset with dangers, and that, as more squadrons of night fighters

(Above) **The Bristol Beaufighter long-range day-and-night fighter**
(*Below)* The Supermarine Spitfire single-seat fighter in its war paint without its roundels on the wing tips

come into service, the hazards set for the night raider by the night fighter may ultimately prove formidable.

In general outline the Defiant is not unlike the Hurricane. It has the same motor (the 1,030 h.p. Rolls-Royce Merlin III) but is easily distinguished by the gun turret. It was designed primarily for the destruction of bombers rather than fighters, but any fighter that makes the mistake of attacking from above and behind—as many did over Dunkirk—meets a destructive volley of fire from its four Browning machine-guns. No details of its performance have been officially disclosed, but it is not as fast as the Hurricane and Spitfire, which are also used occasionally for night fighting.

Another fighter that has unexpectedly won a reputation of some distinction in this war is the Gloster Gladiator, the biplane that preceded the Hurricane. When it was the R.A.F.'s newest "multi-gun" fighter (it had four guns) it earned praise from all who flew it. In control, climb and manoeuvre it had no rival.

When the war broke out the Gladiator was on the point of retirement as a first-line fighter, but *Luftwaffe* bombers raiding naval bases in Scotland in the more leisurely days of the war encountered them on more than one occasion—to their surprise and discomfiture. The Gladiator was also the hero of a gallant attempt to set up an air base in Norway after the Nazis' air-borne troops had invaded the country and taken over the established aerodromes. A squadron was flown off the deck of an aircraft carrier, H.M.S. *Glorious*, and landed on a frozen lake in the North of Norway. They were soon found and bombed by the *Luftwaffe*, but though their " heels were fettered their fists were free," and they accounted for many of their attackers during their brief sojourn in Norway.

Its greatest triumphs were scored against the *Regia Aeronautka*—the Italian Air Force—in Libya and Albania. Here, it was matched against aeroplanes of its own type and era, and its remarkable powers of manoeuvre proved it superior even to the Italian C.R.42 biplane fighter, which was at one time rated the most manoeuvrable aeroplane in existence. Gladiators formed the equipment of squadrons of the Royal Australian Air Force and shot down scores of enemy machines during offensive patrols and in attacks on aerodromes and landing grounds.

One other fighter merits mention. That is the Blenheim, better known, perhaps, as a bomber. For some time, the Blenheim in its fighter version was Britain's only long-range fighter. It also undertook night fighter's work and has shot down several enemy raiders during the hours of darkness. In this role it was handicapped by its lack of speed and several times had to pursue its quarry for an hour or more before it could get within range. The outstanding event in the fighter Blenheim's record was, perhaps, the daring daylight raid made by a squadron on the German seaplane station at Borkum on November 28th, 1939. The Blenheims flew in cloud to within a few miles of their target, then dropped down to deliver a heavy machine-gun attack on seaplanes, workshops, ground defences and hangars. Not one was lost.

On May 12th, in the course of these operations, the first Victoria Crosses to be awarded to the R.A.F. in this War were won by Flying Officer Garland and Sergeant Gray of No. 12 Squadron, equipped with Fairey Battles. Their orders were to destroy the bridges across the Albert Canal near Maastricht, which had not been blown up by the Dutch. The defence by German fighters and anti-aircraft guns was terrific. Of five Battles which reached the target only one returned. But the bridges were down and the advance temporarily held up.

The Germans pressed on around Sedan and on May 16th the Headquarters of the A.A.S.F. was moved back to Troyes. The Battles continued their harassing operations and the casualties continued to be heavy. From May 20th the attacks were switched over to darkness and the casualties reduced.

The French had begun to crumple by this time and the Battles did not get the ground support which they were entitled to expect. Hence on June 15th the bomber squadrons of the A.A.S.F. were ordered to return to England,

In some five weeks of intense activity between May 10th and June 15th the Battles made a total of 528 raids by day and 468 by night, ranging all the way from the Channel ports to Verdun and from the Loire to the Rhine. In this total of 996 sorties the Battles lost 105 aeroplanes, 100 of which were by day. They dropped more than 300 tons of bombs on the enemy.

This phase of the War showed very clearly the losses which must be suffered in daylight attacks by low-flying bombers—a lesson the Germans were to learn still more thoroughly over England.

Meanwhile the bombers based in England had been doing great work as well. Whitleys, Wellingtons, Hampdens, Hudsons and Beauforts flew out day after day and night after night in an attempt to stem the German advance by raining bombs on troops, on railways, on ammunition dumps, on aerodromes and on bridges.

On May 15th objectives in Germany were attacked for the first time and the pressure has been maintained ever since. These first night attacks on Germany were against railway junctions and industrial plants east of the Rhine. Each night afterwards bombers went out from England and ranged over Germany until on August 25th the first raid was made on Berlin.

Meanwhile the British Army had been forced back to the sea. From May 30th to June 4th the Bomber Command was concentrated against the German Army investing Dunkirk while the British troops were evacuated.

Taking the Offensive

Italy entered the War on June 10th, doubtless believing that all that remained to be done was to collect the trophies and the booty. British bombers were sent to Marseilles straight away to prove this supposition wrong by attacks on Turin. One or two raids were made and then the French stepped in and forbade any more bombing. Apparently they were terrified lest the overrated *Regia Aeronautica* should visit some awful vengeance on them. So, for the next few weeks

the British raids on Northern Italy were made by Merlin Whitleys flying from Guernsey. The Whitleys climbed over the Alps with their heavy bomb loads and glided down to take the Italians completely by surprise.

On June 17th France capitulated. The Bomber Command gave the enemy some indication of British determination by intensified attacks on his industrial effort; its aeroplanes flying henceforth from England. Handley Page Hampdcns flew all the way to the Baltic with mines which they laid in the principal harbours to the discomfiture of the enemy shipping.

So the offensive progressed as our strength increased and crews gained more experience of operating over enemy territory. Berlin was repeatedly attacked, not because it is the capital of Germany but because it is the centre of a vast network of railways running to all parts of Europe and because it is surrounded by important industrial factories. The only diversion which was allowed to turn the bombers from their purpose over Germany was the urgent situation caused by the preparations of the enemy to invade Great Britain and the concentration of barges in the Cihannel ports. In fact, on September 15th and 16th, while the Fighter Command and anti-aircraft guns shot down 187 enemy aeroplanes over Great Britain, the Bomber Command frustrated an attempt at invasion by intense bombing attacks.

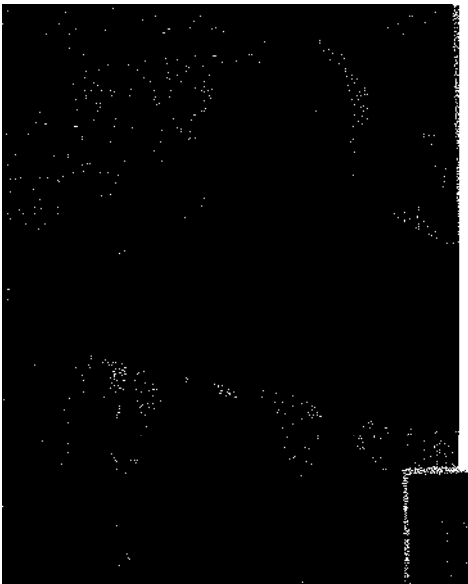
So the Winter progressed as a bombing match between the *Luftwaffe* and the R.A.F. Nearly all the British raids were at night and bomber losses were remarkably low. On October 27th the Skoda works was attacked and seriously damaged, on November 8th Munich was attacked and Hitler narrowly escaped being caught in his beer cellar. On November 10th Dresden and Danzig came in for a hammering. On December 20th Berlin suffered the biggest attack it had ever had.

Thus 1940 ended with the Bomber Command intensifying the scale of its attacks every month. Yet only 321 bombers were lost in all the operations between July 14th and the end of the year.

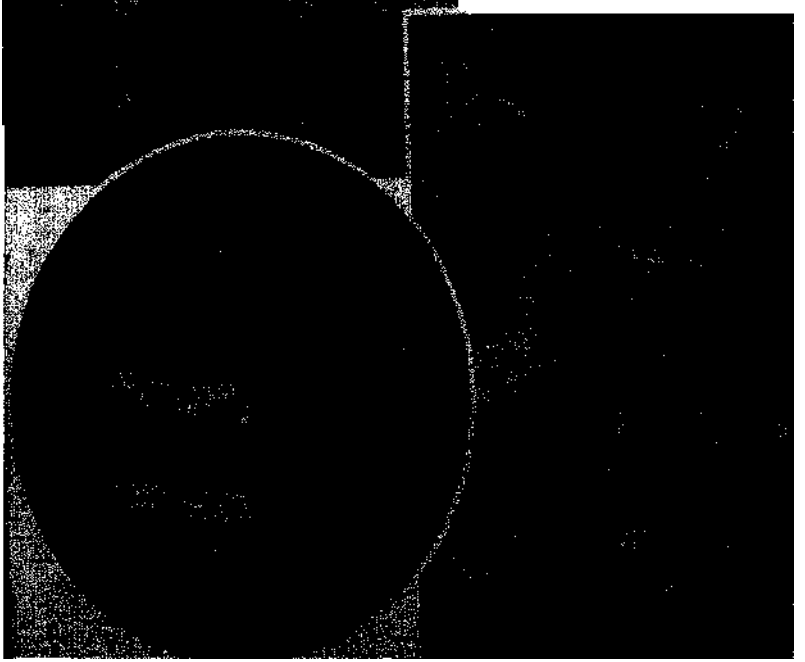
Bad weather hampered operations from England during the first part of the New Year. In the Mediterranean the operations were intensified.

When Italy invaded Greece many valuable new bases for our bombers were presented to the R.A.F. The opportunity was not wasted. Vickers-Armstrongs Wellingtons were flown out to the Middle East by way of Naples—where they left high-explosive mementos in passing—to Malta where they refuelled. Then operating from Greek bases they helped greatly in throwing back the Italians into Albania and in chasing the Italians out of Eastern Libya. Their numbers were reinforced by American types. The Martin Maryland, for instance, proved itself so much faster than any of the Italian single-seat fighters that it was able to take photographs of important objectives utterly undisturbed, with the fastest Italian fighters trailing mournfully behind.

The Blenheims, too, in the Middle East have proved themselves superior to anything the Italians could send against them. The elderly Vickers Wellesley



Bombs being **loaded into the starboard bom**b racks of a Handley Page Hampden



(Below) A bomb aimer in a Fairey Battle, his bomb sight and release button

(At Ieft) A pair of bombs o*n route* for their targets

bombers, of the type which still holds the World's Distance Record of 7,159 miles, have distinguished themselves over Italian East Africa.

Machine Types

At home four chief types of bomber have borne the brunt of the work. They are: (i) the Armstrong Whitworth Whitley; (ii) the Bristol Blenheim; (iii) the Handley Page Hampden; (iv) the Vickers-Armstrongs Wellington.

The Whitley is a big mid-wing monoplane powered with two 1,150 h.p. Rolls-Royce Merlin motors which give it a top speed of 245 m.p.h. The armament consists of a power-operated turret in the nose which mounts one Vickers gun and a second turret in the tail with four Browning guns and a total rate of fire of 4,800 rounds per minute.

The Wellington IA, the type most used at present, is another big mid-wing monoplane, powered with two Bristol Pegasus radial air-cooled motors of 1,000 h.p. each. They give the Wellington a top speed of 250 m.p.h. Its range is 2,000 miles cruising at 180 m.p.h. and carrying 2,500 lb. of bombs. Like the Whitley, the Wellington has two power-operated gun turrets. Each mount two guns. Both the Whitley and the Wellington were previously equipped with a retractable "dustbin" turret under the fuselage but this has now been removed to provide more carrying capacity for bombs.

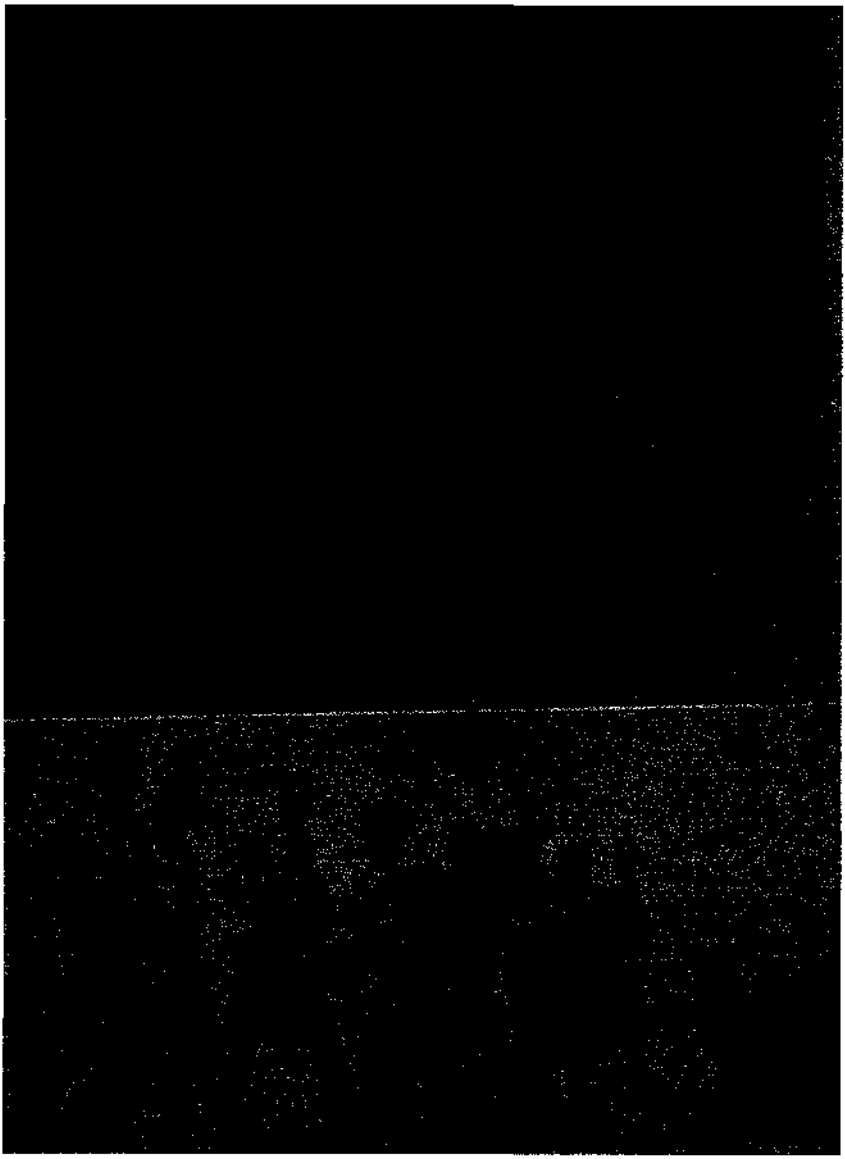
The Bristol Blenheim is in a lighter category than either the Whitley or the Wellington. It is also somewhat faster. The two 920 h.p. Bristol Mercury XV motors give the Blenheim IV a top speed of 295 m.p.h. and it has a range of 1,900 miles cruising at 220 m.p.h. The latest version of the Blenheim has a "blister" gun turret attached under the nose to fire backwards to protect the tail. It is sighted by the navigator by means of a series of mirrors. A normal type of gun turret is fitted on top of the fuselage behind the wings.

Blenheims were used when the R.A.F. began to resume the offensive on the daylight "sweeps" over enemy-occupied territory. Earlier they did most of the photographic reconnaissance work over the Siegfried Line and, fitted with a tray of four machine-guns under the fuselage, were the first two-motor long-range fighters to be used by the R.A.F.

The Handley Page Hampden has distinguished itself in many long-range night raids on Germany and in the mining of the Baltic. The Hampden is powered with the same 1,000 h.p. Bristol Pegasus XVIII motors as the Wellington IA. They give it a top speed of 265 m.p.h. Unlike the Whitley or the Wellington the crew of the Hampden are all grouped together in the deep narrow fuselage. There is no tail turret but instead gun positions on top of and below the fuselage with a wide field of fire in the rearward plane.

Aeronautical design is always progressing and new and improved designs are already on the way. The latest version of the Wellington is fitted with Rolls-Royce Merlin motors. This Wellington II has a top speed some 20 m.p.h. faster than that of the Wellington IA and can carry an equal load of bombs.

(Above) **Vertical photograph taken by an R.A.F. aeroplane on reconnaissance of an Italian aerodrome in the Western Desert. Bombs can be seen bursting on hangars**
(Below) **Bomber crews, suitably garbed, walking out to their aeroplanes before a raid over the African desert**

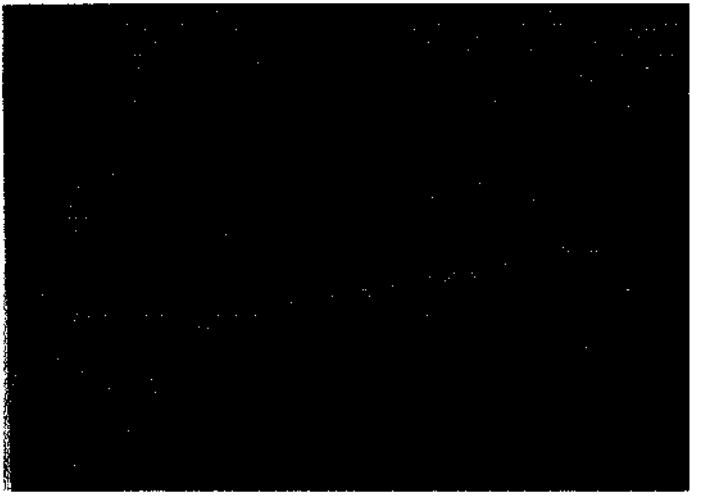


In the new Short Stirling four-motor bomber we have the most powerful weapon of offence ever designed. Details of its performance and equipment cannot be given but it will certainly enable the Bomber Command to strike farther and with more weight. To the Stirling are now added still newer bombers of great offensive power—the Avro Manchester and the Handley Page Halifax.

Apart from the bombers made in England a steady flow of American-built bombers is now being flown across the Atlantic to join the squadrons of the R.A.F. The Douglas Boston, the Martin Maryland, the Martin Baltimore, the Boeing B-17C,the Douglas Digby, the Vouglit Sikorsky Chesapeake and the Consolidated Liberator are some of the types which arc now reaching this country to intensify the offensive against Germany.

If two types may be singled out from the rest, the Douglas Boston and the Consolidated Liberator should make great names for themselves on this side of the Atlantic. The Boston is a medium bomber in the same category as the Bristol Blenheim. It has a top speed of more than 320 m.p.h. and can carry a useful load. One of its most interesting features is its tricycle undercarriage which should make it particularly easy to land.

This tricycle undercarriage is also a feature of the Consolidated Liberator, a big four-motor bomber which has a top speed of about 335 m.p.h. and a range of more than 3,000 miles. This performance has been gained by the use of the " Davis wing," a wing built on a patented form so that the drag is reduced by approximately one-third. This has been made possible by the peculiarly thin section rendered possible in its turn by advanced methods of construction. The Liberator is probably about the best aeroplane which America is sending us at present. Results of its first bombing raids arc being looked forward to with keen anticipation.



Italian aeroplanes on a desert aerodrome in Africa wrecked by R.A.F. bomb and machine-gun attacks

BEAUFORTS' DOZEN **Thirteen torpedoes on their trolleys ready for a squadron of Bristol Beaufort torpedo bombers of the Coastal Command. Beauforts have sunk many thousands of tons of enemy shipping, ehiefly off the Norwegian and Dutch coasts, in torpedo attacks**

THE COASTAL COMMAND

Many people arc surprised when they discover that the Coastal Command has fighters and bombers as well as reconnaissance machines on its strength. This Command, indeed, is a miniature Air Force on its own. It has something of everything from Sunderland flying-boats to Spitfire fighters. In its possession of the flying-boats it is unique. No other Command makes use of them. The Fleet Air Arm has some float seaplanes and some Walrus amphibians, which are small flying-boats with retractable wheels, but all the flying-boats proper belong to the Coastal Command. Since flying-boats cannot yet be provided with floating bases, that is only right, for the Coastal Command has charge of all the land-based aircraft which are responsible for reconnaissance over the sea.

At first sight there is no obvious explanation of the possession of fighters and bombers by this Command. They indicate the dual or triple purpose of this Command. It began purely as a reconnaissance Command. Now it has added to its duties those of protecting shipping from air attack as well as from sea attack and it has also undertaken the offensive tasks of bombing the enemy's coastal bases and of sinking those of his merchant ships which slink along the Dutch, Belgian and French coasts, using torpedoes for that work. Thus the Sunderlands, Lcrwicks, Stranracrs, Londons and Hudsons go out on reconnaissance and anti-submarine patrols; the Blenheims and Spitfires attack any enemy aeroplanes which seek to interfere with the convoys; the Wellingtons and Whitleys go bombing ; and the Beauforts do the torpedo raids and occupy their spare time in laying mines.

The reason for this is easy to see if the development of the war situation is examined. Up to the time in April 1940 when the Germans entered Denmark

and Norway the work of the Command was concerned almost entirely with the protection of convoys from submarines and with reconnaissances intended to warn the Navy of any significant movement by German warships. During that early period there was always a chance that Germany might try to get some of her naval vessels out through the North Sea to engage in commerce raiding on the high seas. The general reconnaissance aeroplanes—chiefly the Ansons and the Hudsons — made comprehensive sweeps daily over the North Sea to make sure that no hostile surface vessel slipped through unannounced. They watched also for such submarine movements as could be detected, but the submarines did most of their cruising on the surface during the hours of darkness and kept well below the surface by day. The submarines could not be stopped on their way in and out. They had to be dealt with in the wider seas whenever they attempted to attack convoys.

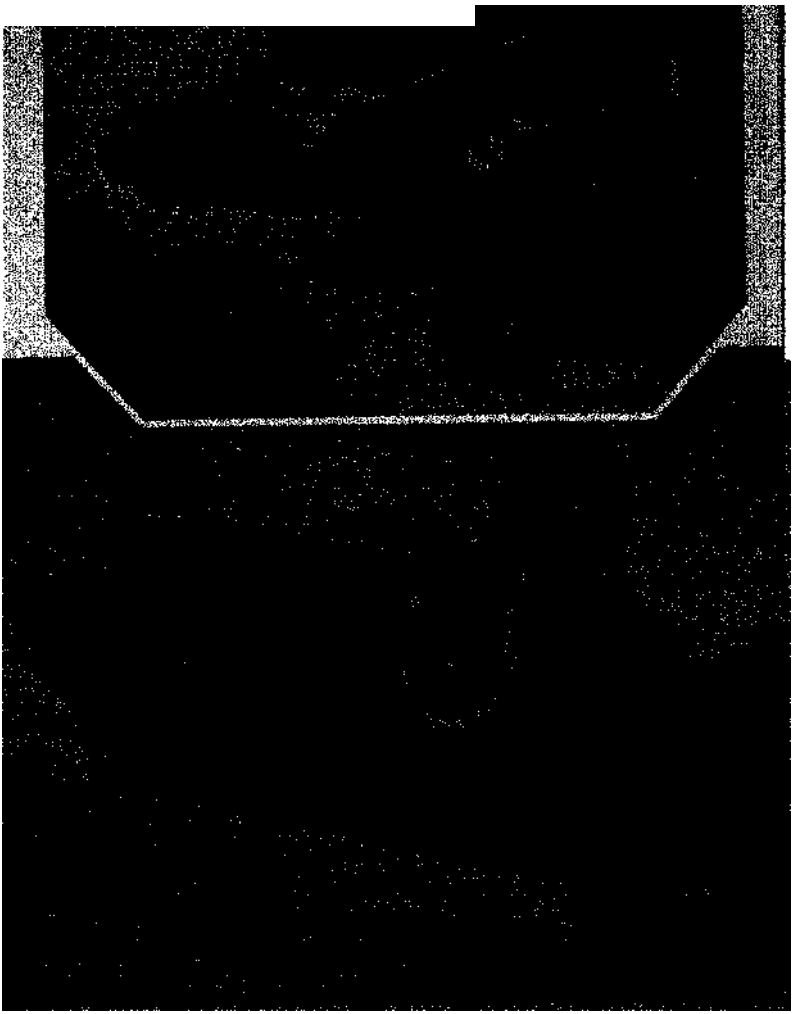
Convoy

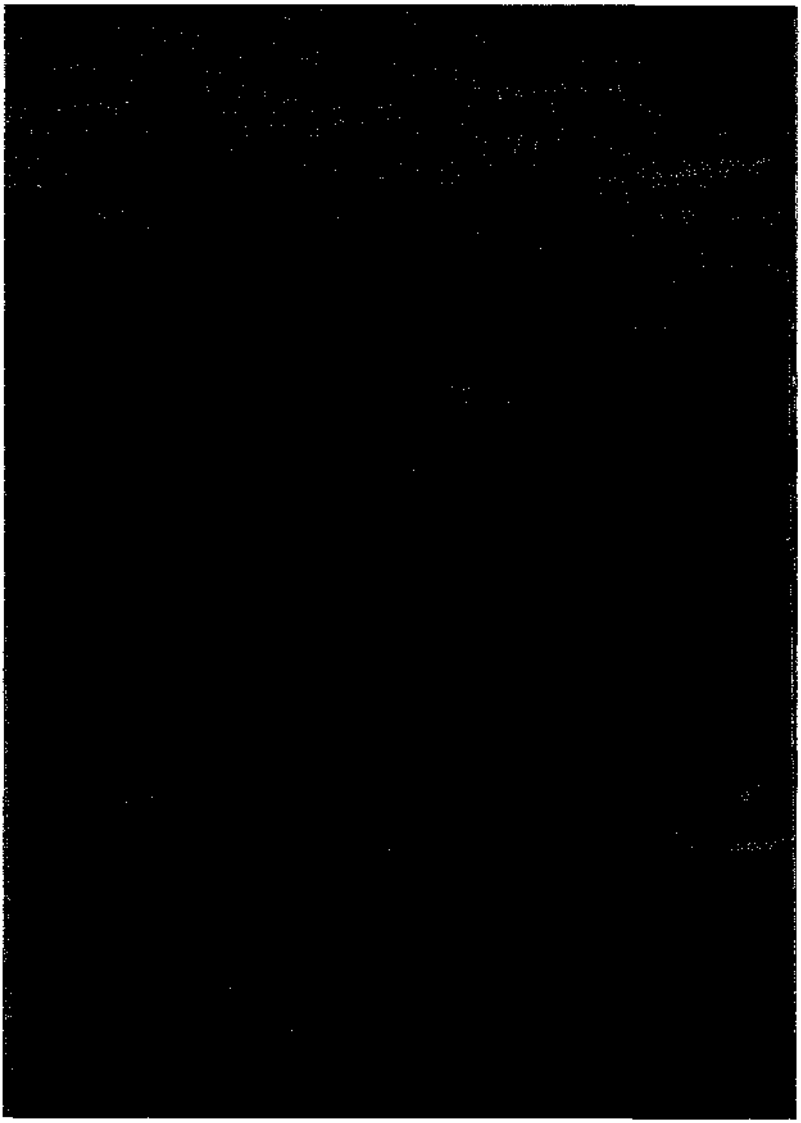
During that period the convoys were approaching British ports mostly by way of the South of Ireland and the English Channel, and the flying-boats were able to concentrate their activities in these Western approaches. They often met the convoys 400 miles West of the English coast and kept watch for several hours until the time came for them to turn for home so that they might alight before dark. Nearer the coast in certain areas there were ships of another class to be watched over. These were the smaller ships of the coastal trade which had to be shepherded past the more open parts of the sea where submarines might be expected to make incursions. This was arduous and monotonous work but it was fairly straightforward. When the Germans seized the Norwegian coasts in April an additional responsibility was thrown on to the Command. The Navy now had to take a big hand in the work of protecting troop ships and supply ships operating between Great Britain and Norway and the reconnaissance craft had to make sure that the umts of the Fleet were not taken by surprise. This would have been less difficult had not the Germans made full use of the air bases which the seizure of Norway gave them. From that time the British reconnaissance machines had to do their work constantly in the face of fighter opposition from the shore and without the help of their own fighters, unable, because of the distances, to come to their aid.

A natural reaction to this situation was to attack the bases from which the German aeroplanes and naval vessels worked. The reconnaissance machines which had hitherto stuck strictly to their allotted task now assumed the part of bombers. The Hudsons which had spent nearly nine months on sweeping the North Sea were suddenly switched over to bombing duties and they did much good work in attacking aerodromes and harbours in Norway.

Air opposition to British reconnaissance work was diminished in weight and intensity during the Norwegian campaign by the damage done to those bases. The work was hard and continuous. It was all done a long way from home, and

The Lockheed Hudson, developed from a famous American civil air transport, is extensively used by the Coastal Command for reconnaissance and for attacks on enemy surface and underwater vessels





while it was being done the reconnaissance work in those northerly parts of the North Sea was still most thoroughly carried out. So the Command added bombing to its less spectacular work and that phase of its duty has expanded ever since.

But fresh demands were about to be made on it. The fall of France in June 1940 presented the enemy with a host of new bases so much closer to British shipping routes that he was able to remodel and intensify his scheme of attacks on British convoys.

By this change in his fortunes he was able not only to send out submarines from many new ports anywhere between Norway and the Spanish frontier, but he found himself in a favourable position for sending out bombers to intercept British convoys as they approached the Irish coast and to harass the ships with bombs from the air as well as with torpedoes from under the sea. He fitted out a number of Focke-Wulf Kuriers for long-range bomber work and arranged for them to go searching the seas to the west of Ireland for the ships as they drew in on converging courses towards the home ports.

Counter Attack

The ships now had to be protected against bombers besides submarines and that meant fighters to supplement the work of the reconnaissance craft. The submarines now had additional bases and that meant still more bombing to make those bases unfit for use and to limit the number of bases from which the submarines might set out. So the Blenheims came in as long-range fighters.

There is a further sideline of the Command's work. Its Bcauforts have done a great deal of mine-laying outside certain German ports and in certain coastal traffic lanes used by German shipping. When the Beau forts are not mine-laying they are often occupied in the direct destruction of enemy ships which hug the coasts of Holland and Belgium in an attempt to take supplies to the occupied ports without braving the dangers of the open sea. Attacking ships in coastal waters is a ticklish business because it means that the aeroplanes must occasionally come under fire from land batteries. Nevertheless in the course of three months during 1940 the Beauforts, serving mostly as torpedo-bombers, sank 50,000 tons of enemy shipping in that way. In the same way the bombers have done good work against the submarine bases. In December 1940, a month in which the weather was sometimes far from good, fully 100 tons of bombs were dropped by Coastal Command aircraft on the bases at Lorient, Bordeaux and Brest.

These arc the newest aspects of the Command work. The reconnaissance and protecting work has been going on much longer, and the scale on which this is done may be gauged from the fact that the monthly average of reconnaissance flights up to the end of 1940 represented some 32,000 hours, whereas the convoy work from the beginning of the war to the end of 1940 had meant 16,500 separate flights for the protection of 4,700 convoys. In the last six months of 1940 no fewer than 53,000 hours were flown on these duties. During that part of the War

A Short Sunderland flying boat on patrol over a British convoy. These huge flying boats watch for submarine and enemy surface raiders, but have also shot down many German bombers in defence of their charges

which carried us up to the end of 1940 the reconnaissance craft had sighted submarines on 260 occasions and had been able to attack 166.

On these tasks the Sunderlands are often out for 12 hours on end and the landplane types, including the Hudsons, may remain out for eight hours. The work is linked closely with that of the Navy and the contact between the two services must necessarily be intimate. It endures throughout the twenty-four hours.

Naval Co-operation

That is not to say that Coastal Command aircraft on reconnaissance or anti-submarine patrol are working all the time in association with naval vessels. That would be a duplication rather than co-operation. And it is co-operation at which the two Services aim. Occasionally, as on convoy patrol, they do work together—the destroyers or cruisers standing by the ships while the aeroplanes range over the seas around them watching for the first sight of enemy craft in the sea or in the air—but that is not the sense in which contact between the Services assumes its main importance.

The vital point is that there shall be unanimity in control. In other words there must be close association between the Admiralty and the headquarters of the Coastal Command so that information is exchanged and each Service knows what the other is doing towards securing the common end of safety for the ships and frustration of all enemy attempts to violate our shores.

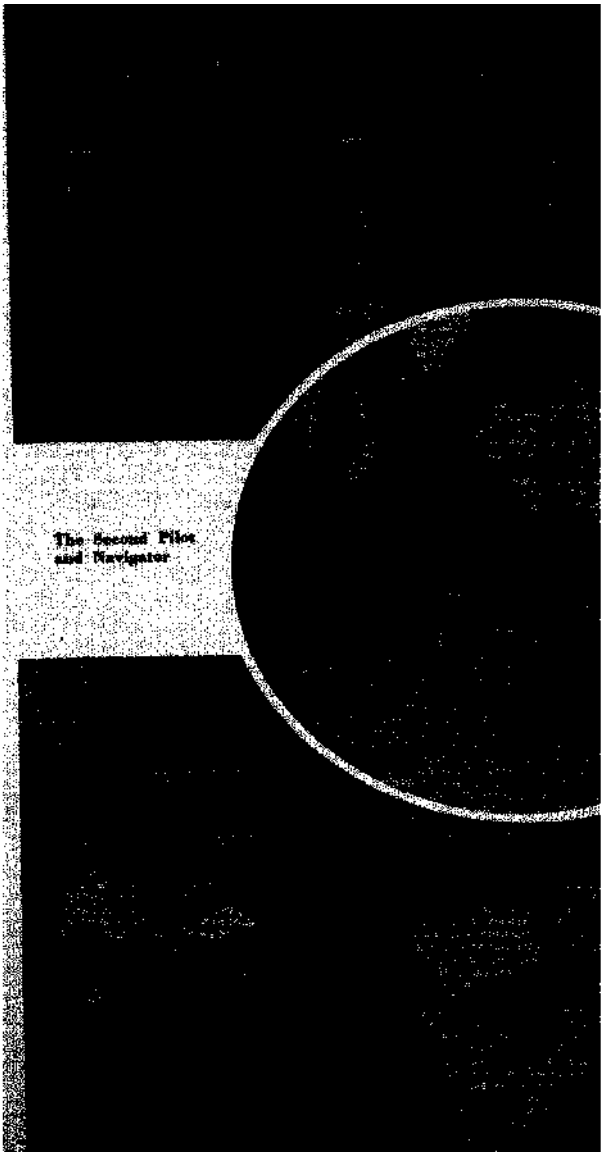
The chiefs of the Admiralty and of the Coastal Command are able to deal directly with each other at any time and in order to make sure that questions of detail shall not cause uncertainty or misunderstanding, there is an Air Force liaison "officer at the Admiralty and a Naval liaison officer at the Coastal Command headquarters. As a background to these means of consultation and explanation there is a free exchange of operational information throughout the twenty-four hours.

The safeguard is carried a step farther down the ladder. In the areas covered by the principal Naval Commands in Great Britain there are combined headquarters shared not only by the Navy and the Air Force but also by the Army. This means that the general instructions are known by all the Services and the daily operations which are based on them are ordered with the full knowledge particularly of the Naval Officer commanding the area. Through these headquarters all the information given to and received from Commands, Groups and Stations are communicated simultaneously to the other Service. Here the Group Commanders of the Coastal Command are stationed and the geographical limits of those Groups are deliberately made to coincide with the areas covered by the Chief Naval Commands. The Navy knows everything that the Coastal Command is doing and vice versa. If a submarine is sighted by a warship the particulars of date, time and position are communicated immediately to the Air Force. If a reconnaissance aeroplane sights a submarine

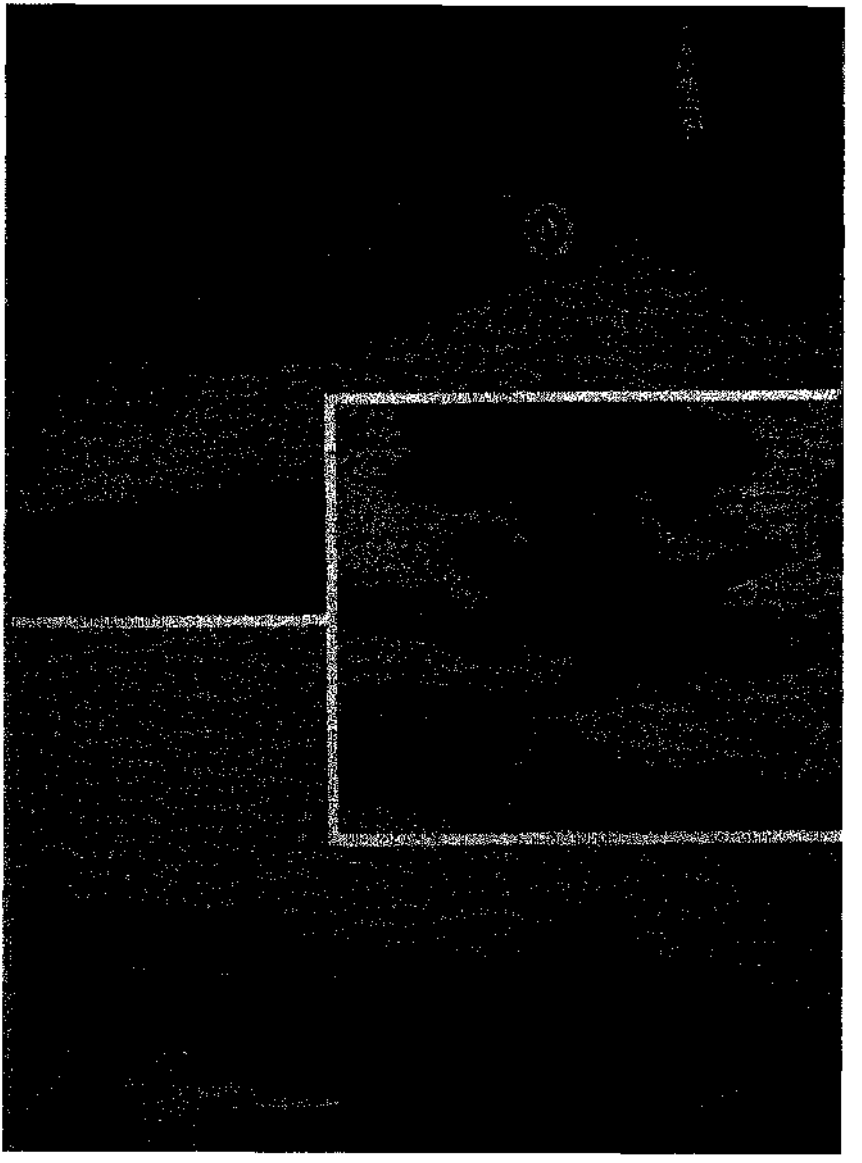
The Short " Sunderland " long-range reconnaiHsnnce flying-boat has four Bristol"Pegasu8XXII'" engines, each of 1,010 h.p. With the four engines developing a total of 3,360 h.p. at 6,250 ft. it attains a maximum speed of 210 m.p.h. and has a range of approximately 2,000 miles

Port and starboard gunners

INSIDE A FLYINC-BOAT



Members of the crew take a real while on a twelve-hour escort patrol over the Atlantic



the corresponding particulars are handed over at once to the Naval officers and to the Admiralty.

Thus in Norwegian waters during the campaign there, the Swordfish and Skuas of the Fleet Air Arm supplemented the work of the Sunderlands and the Hudsons. There were occasions later, on which Fleet aircraft took a hand in dealing with submarine bases. Strictly, the naval aeroplanes are intended to work only in Fleet actions. They are all ship-borne and it is really no part of their business to attack targets which can be reached by shore-based aeroplanes unless those targets are such as to demand special Naval knowledge and experience.

The nearer seas are the particular sphere of operation of the Coastal Command, but the scope of its activities is widening and will continue to widen as the range of aeroplanes increases. Thus the long-range work of the Focke-Wulf Kuriers is leading the fighters of the Coastal Command farther and farther out to sea. The point at which they would normally hand over to the machines from the aircraft carriers is gradually moving farther from the shore. All the sjeps which are being taken to meet this changed situation cannot yet be disclosed, but an indication of the trend of things is to be found in the fact that the Blenheim in its latest form has a range of 1,900 miles and a top speed of 295 m.p.h.

Up to the present, long range rather than high performance has been demanded in Coastal Command types. The Sunderland, for instance, has a top speed of only 210 m.p.h. but its range at a cruising speed of 178 m.p.h. is 2,880 miles. The Hudson has a maximum speed of 248 m.p.h. and a range of 1,700 miles at a cruising speed of 170 m.p.h. Following the Blenheim is the Beaufort, particulars of which arc not yet released, but its top speed is known to be something more than 300 m.p.h. The Hudson will soon be followed by the Ventura, a military version of the Lockheed Lodestar which has a top speed of 276 m.p.h. and a range of 1,480 miles.

Some of the American flying-boats are beginning to find their places in the Coastal Command. Among them is the Consolidated Model 31 which has a top speed of 285 m.p.h. and an unusually long range. In the fight for British sea communications, the Coastal Command is thus well equipped to help the Navy in the waters where opposition from sea or air craft is likely to be heaviest.

A TALL " TAIL "

A mcehunic examines the tail of *a* Sunderland flying boat **with** the aid of a ladder

(Top) The Blackburn Bolha, a general reconnaissance aeroplane, now used for training

(cetere) A Bristol Beaufort silhonetted against the evening sky as it returns to base from patrol

(Bettom) The Saunders-Roe Lerwick, another long-range flying boat used for convoy protection by the Coaslal Command

RECONNAISSANCE

Not least of the aeroplane's military duties is that of reconnaissance. Army, Navy and Air Force commanders are always in need of up-to-date information about the enemy's plans, and aeroplanes are now extensively used to supply it. They seek their clues from the enemy's preparations on the ground, the movement of troops and ships, and the activity of his industries, roads, railways and aerodromes.

Collecting this information is a hazardous undertaking. The enemy resents the presence of the spying aeroplane and is at great pains to conceal, by camouflage and other devices, as much as possible from its sight, to prevent it from reaching centres of activity, and to prevent its return should it catch a glimpse of the things it is searching for.

Air crews can observe and record a great deal, but their descriptions, however vivid and accurate, can seldom convey the detail of the photograph. Hence, most aeroplanes on reconnaissance carry a camera—sometimes two—and the crew reports combine with the photograph to make the complete picture the commanders require.

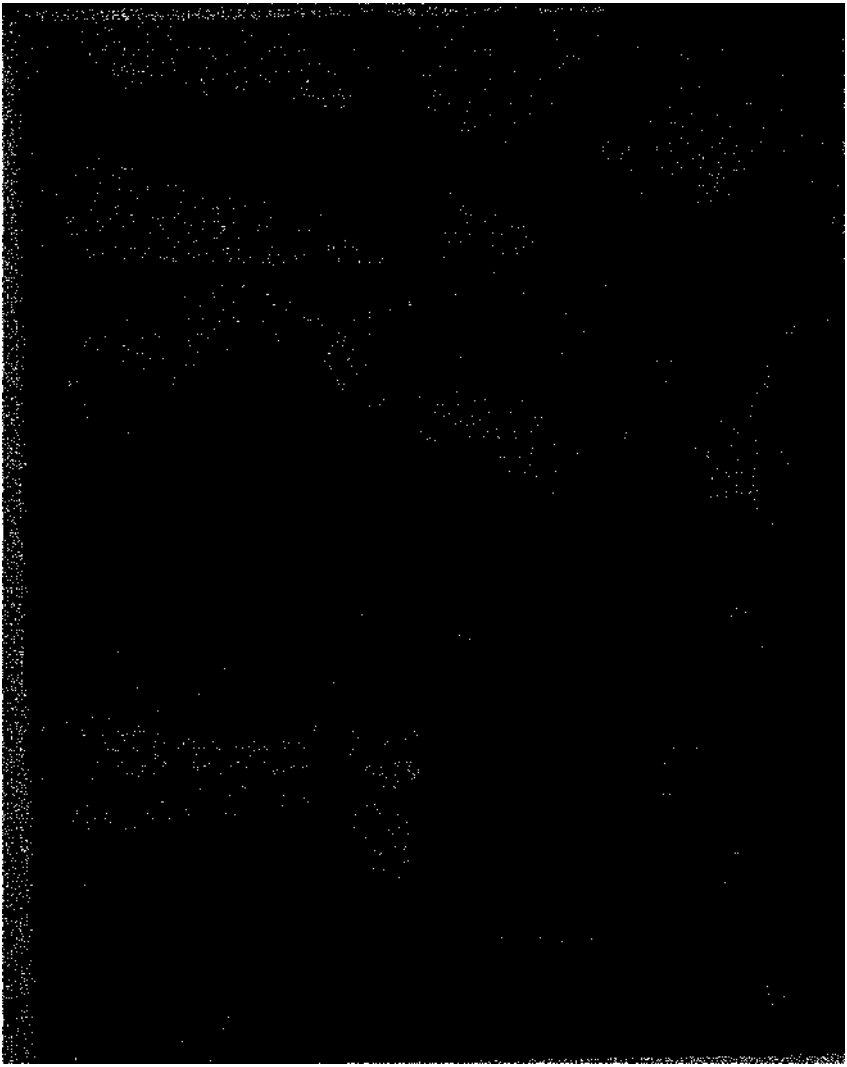
Most frequently used is the fixed camera which is installed in the underside of the aeroplane's fuselage and takes vertical pictures of the ground below. Supplementing it, when necessary, is the hand camera which can also take vertical shots, but is more often used for the taking of obliques. The type used will often depend upon the subject to be photographed or the nature of the information sought.

The fixed vertical camera has a magazine which carries as many as 125 negatives on a single film. Re-loading can be done in the air in a few moments, and the task of photographing a given area, or a single object, can proceed as rapidly or slowly as the conditions demand or circumstances allow. Sometimes, several visits must be paid before all the photographs are secured; on other occasions, a large area covering many square miles can be photographed in a single run, provided that the air is clear and cloudless and the enemy has relaxed his vigilance for a moment.

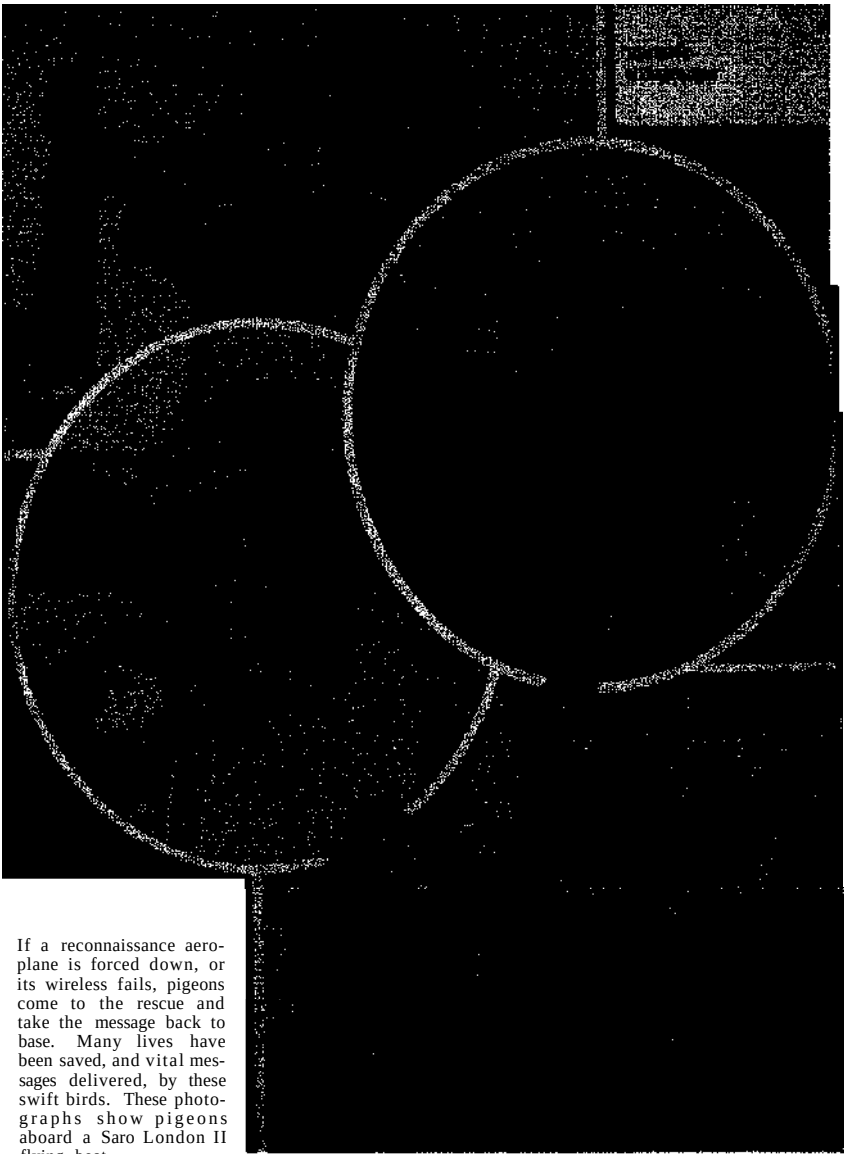
Shutter speed and lens setting are determined and adjusted before take-off. So great is the " latitude " of modern films that small mistakes in these adjustments seldom spoil the photographs taken. The actual taking, with the fixed vertical type, is automatic, and the pilot, beyond flying straight and level while the camera is in action, has no more to do than switch on the electric driving motor at the beginning of a scries of pictures and switch it off again at the end. The hand-operated camera works on the same principle as the ordinary camera used by amateur photographers—and resembles it in all but size and weight. It needs two strong hands to hold it steady.

In pre-war days, the Royal Air Force planned to take its pictures at heights between 8,000 and 10,000 feet, and trained its pilots and crews accordingly.

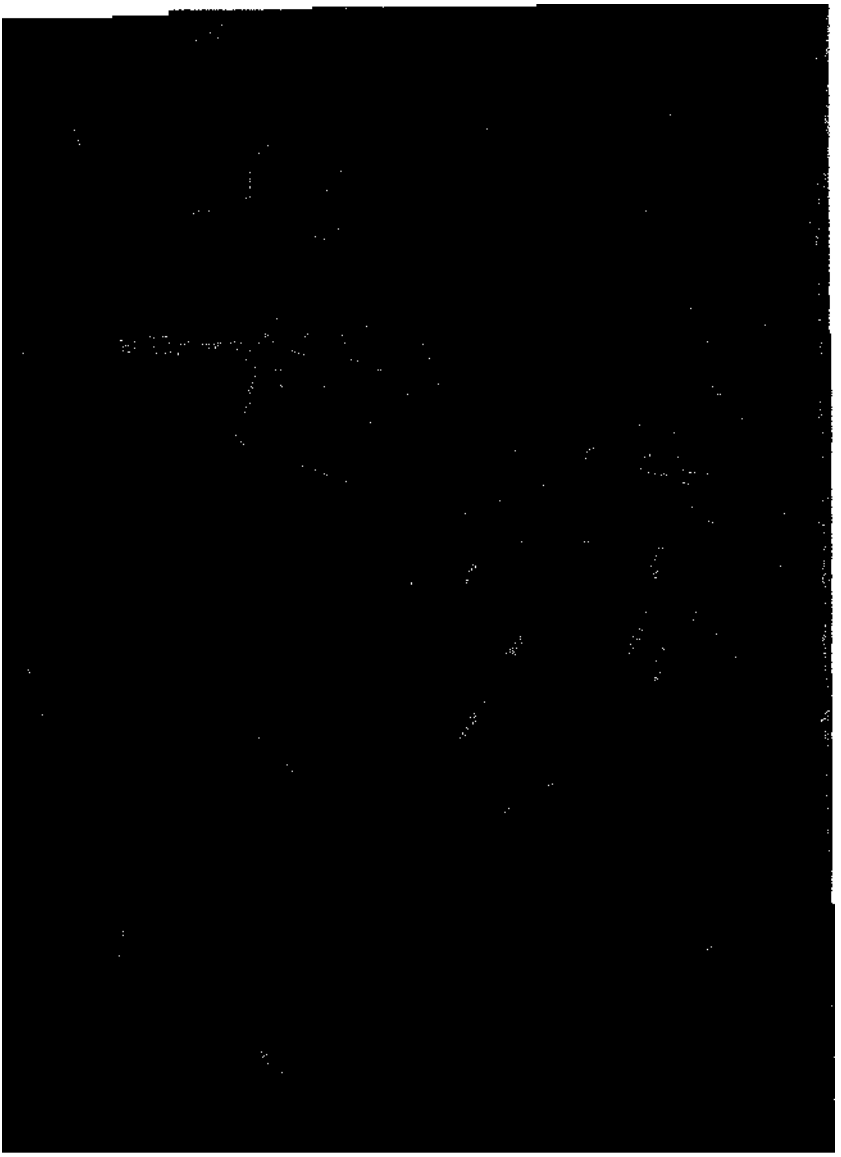
The Avro Anson reconnaissance landplane and some of its crew. The **Anson** is **also** used for **the** training of **bomber and** reconnaissance crews



PHOTOGRAPHIC RECONNAISSANCE "Thumbs up" signs exchanged between pilot and observer of a Blenheim at the end of a photographic flight augur well for the Intelligence Officer who is waiting to discover what seerets the camera has brought back. The exposed films are handed to a messenger who runs with them to the developing tent. A little later, prints are being examined by an officer skilled in the art of reading the story photographs tell.



If a reconnaissance aeroplane is forced down, or its wireless fails, pigeons come to the rescue and take the message back to base. Many lives have been saved, and vital messages delivered, by these swift birds. These photographs show pigeons aboard a Saro London II flying boat.



When peace-time training gave way to the more serious business of probing the enemy's secrets, tactics had to be changed quickly. The photographic aeroplane too often ran foul of enemy fighters and the anti-aircraft defences, and came back badly damaged—and sometimes not at all.

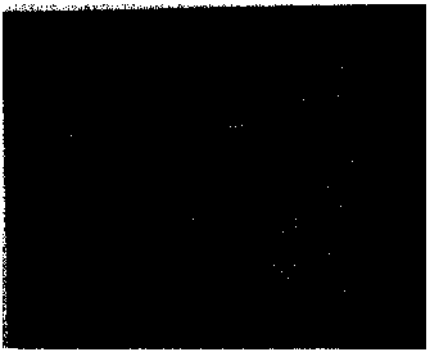
The aeroplanes were forced to fly higher—much higher—and there instantly arose new problems that for a time defied solution. Lenses were " fogged " by condensation, the mechanism ceased to function, parts were broken. These troubles originated largely from the intense cold at the great heights to which the photographic aeroplane had been driven, but after much thought and experiment, the correct answers were found and to-day R.A.F. reconnaissance machines bring back clear and sharp photographs of a quality and a wealth of detail that would have been regarded as impossible from such heights before the War.

Little of value would be drawn from many of these photographs had not the R.A.F. trained to a high degree of skill a staff of interpreters whose task it is to extract from each print every item of information contained in it. These interpreters will often study a single detail for an hour or more if it is likely to yield a vital secret or prove a link in a chain of evidence. From a set of photographs taken over Kiel Harbour last year, these interpreters were able to name every warship shown, or its class, to note bomb damage from an R.A.F. raid, to identify every building, and to draw a series of conclusions—particularly about the German Navy -which subsequent events proved to be correct in every fact.

Most photographic reconnaissance is done by day. Recently, however, promising progress has been made with air photography at night. The R.A.F. had been developing this branch of its work for some years, and had reached the stage at which difficulty was found in distinguishing between a picture taken at night and one taken by day. More rapid strides might have been made had the flash bomb which provides the illumination been less noisy. It bursts with the sound of a high explosive bomb, and out of consideration for the sleeping population of England, the R.A.F. confined its peace-time experiments to infrequent trials over Salisbun Plain.

More recently, much much sucess has been achieved with night air cinematography by the R.A.F. The method of illuminating the object to be filmed is a secret, but if the results of the first attempts are a guide, the R.A.F. will soon be bringing back "animated" pictorial proof of the destination and effect of every bomb it drops on enemy targets by night.

German destroyers photographed by an R.A.F. reconnaissance aeroplane in the Heligoland Bight



AN EPIC RECORDED

Photographs taken next day by fast Bristol Blenheim and Martin Maryland bombers of the R.A.F. from Africa confirmd the success of the night attack by the Fleet Air Arm on ships in Turunto Harhonr on November Hth, 1910. Powerful units of the Italian vaw were seriousls damaged, and some of them are shown in this preture still burning. Patches of oil cover the water

Link Trainer at a Flying Training School

R.A.F. Radio Operators under training

Instruction in airframe details for a group of R.A.F. flight mechanics under training

AIR TRAINING

No air force in the World set itself a higher standard *of* training in peace time than did the Royal Air Force. Not only was skill demanded from the pilot in the manipulation of joystick and rudder bar, but also a deep and exact knowledge of navigation, the theory of flight, the structure of an aeroplane, the working of an aero motor; of air gunnery, radio, air photography and instruments; and of fighter tactics, bombing methods and a hundred and one other things which the modern pilot must know if he is to get the best from his machine and himself.

In the past eighteen months that high standard of peace-time training has paid a big dividend. It proved to be the foundation of the R.A.F.'s mastery over the *Luftwaffe* in combat, and has left no doubt that the long period devoted to training was amply justified.

A new problem was created when peace changed to war. Could the high standard be insisted upon when a hundred pilots had to be trained where before only ten had been trained ? Dare quality be sacrificed to quantity ? Could the mass-production of pilots be attempted ? War itself gave the answer. The men who went out on active service found that they needed every particle of the knowledge and every degree of skill they possessed. Not a single lesson, they discovered, had been a waste of time, and they thanked the instructors who had so painstakingly taught them the mysteries of navigation and aerodynamics, the principles of the design and construction of an aeroplane, the strange ways of bullets when fired from a machine-gun moving at 300 miles an hour or more. And they silently thanked their flying instructors—those heartless taskmasters who had made them perform some simple manoeuvre over and over again until it was done perfectly—for the trouble they had taken to make them sound pilots.

The standard was kept, and as time went on and more machines were produced and more training facilities became available, it was raised. To-day the men who are passing to the Operational Squadrons of the Royal Air Force are even better trained than their predecessors.

The Four Stages

A recruit becomes a pilot in four stages. He passes first to an Initial Training Wing, next to an Elementary Flying Training School, then to a Service Flying Training School, and finally to an Operational Training Unit. When he has passed the examinations of all four training centres he reaches the goal of his ambitions—an Operational Squadron.

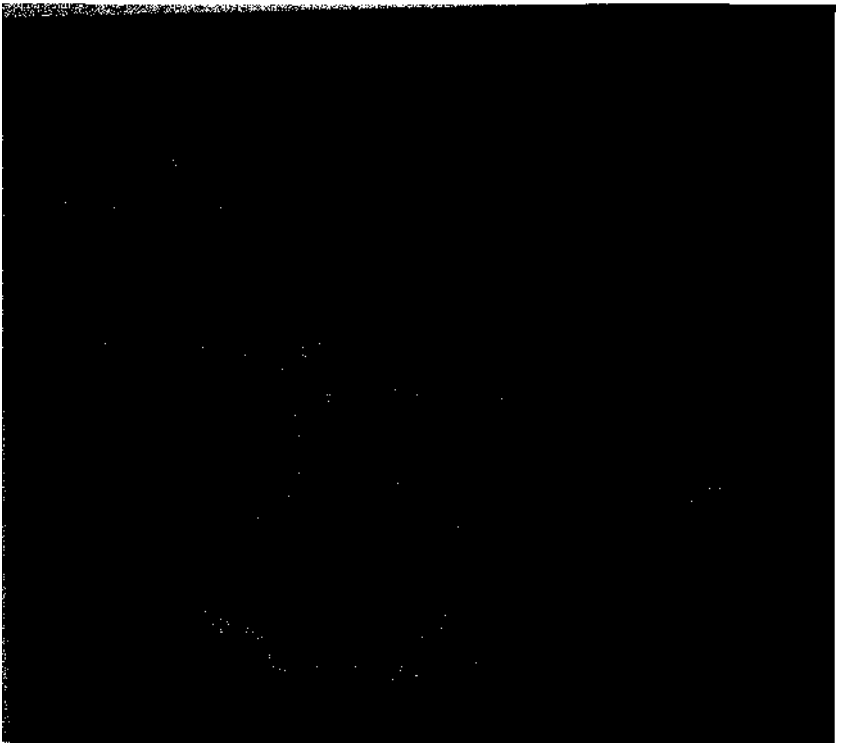
At the Initial Training Wing the pupil spends half his time in the classroom studying the theoretical side of flying, and the other half in sports and games. He must be physically fit in readiness for the intensive training he will undergo. He does not fly at the I.T.W., but is introduced to the workings of joystick and rudder bar on the Link Trainer, an ingenious imitator of the real aeroplane.

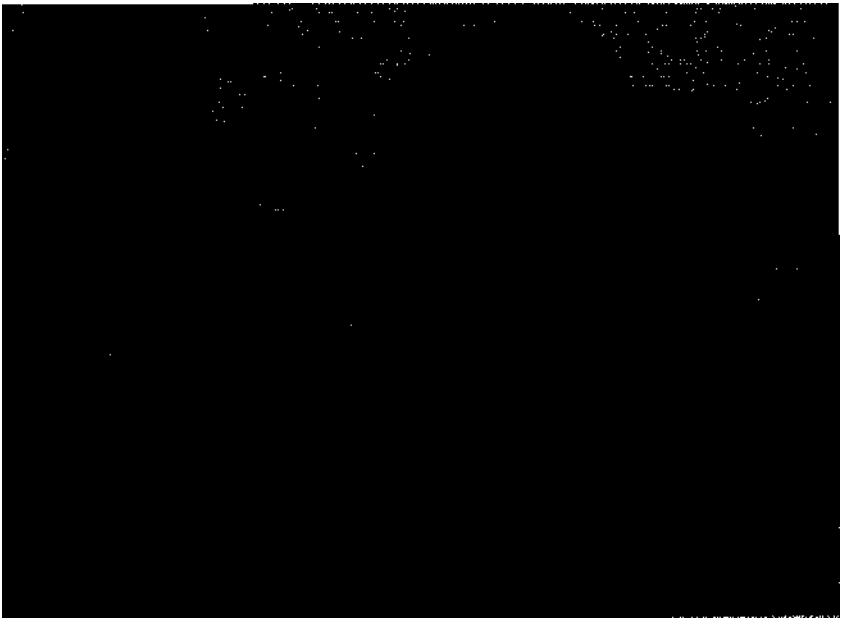
The Link has a stumpy fuselage with a stumpy tail and wings, poised on a

set of bellows which inflate and deflate themselves in response to the commands of the joystick, It also turns in answer to the movement of the rudder bar, and will take up all the attitudes and follow the manoeuvres (within prescribed limits) of an aeroplane, even to spinning, The Link's equipment includes a " crab "—so named because of its shape and crab-like gait—which records, in ink—and with relentless accuracy—the course "flown" by the' pilot,' The cockpit has all the instruments essential to navigation for, normally, flying is done by instruments alone while the pilot is enclosed by a windowless hood. At the I.T.W, the pupil merely studies the effects of the controls and usually flics with the hood open.

Examinations passed, the pupil next goes to an Elementary Flying Training School and learns to fly. Here he finds only one type of trainer. It may be the Miles Magister monoplane or the Tiger Moth biplane, Again half the day is spent in the classrooms where the pupil plunges deeper still into the subjects

Training in the use of field wireless





TAIL DEFENCE The FraBer-Nashh four-gun, power-driven turret in the tail of a Whitley boml

he had studied at the I.T.W. The other half is spent in flying. There are no short cuts, and no one is sent off alone until his instructor is assured of his readiness. Then comes the pupil's first great moment—the first solo.

Fifty hours or more will have been entered in the pupil's log-book before he has completed the course. He has learned to make forced landings, to do simple aerobatics and has ventured on short cross-country flights to put into practice some of the theoretical instruction he has had on air navigation and map reading. He will also have had more Link training and learned to " fly " complicated courses under the hood,

At the Service Flying Training School he flies an aeroplane live or six times more powerful than that on which he learned to fly. It may be the Airspeed Oxford or the Avro Anson, two popular two-motor trainers that form the standard equipment of many of the R.A.F.'s flying schools, Or it may be the single-motored Miles Master or the N.A. Harvard. While he was at the Elementary Flying Training School the pupil showed, in a score of ways, whether he was best suited for " twins" or for single-motor types, and the second type to which he progresses is not chosen by guesswork but by a careful study of his temperament.

Instruction in flying and in theoretical subjects is continued side by side at the Service Flying Training School, and there is still more Link training—difficult cross-country trips and " blind approaches " to the aerodrome by radio aids. It is here, too, that the pupil has the second great moment of his flying career—night flight. He has been well prepared for it, and needs but little dual instruction before he is sent off down the flare path alone. On a dark cloudy night he sees nothing outside his cabin but the glow of his exhausts and the six amber points of light far below that mark the flare path to which he will shortly return for the first night landing he has ever made unaided. Inside, he has the company of a panel of green, luminous dials that tell him his speed, height, attitude, direction, and a dozen other useful details.

Soon, he will take the final examinations and tests. If he passes—and the chances are in his favour—he is at last allowed to sew on to his tunic the " wings " that will henceforth distinguish him from lesser mortals who have not qualified as pilots of the Royal Air Force. That is his third great moment. The R.A.F. does not bestow its wings lightly, and no one can begrudge the young pilot the satisfaction he feels. He has the right to be proud.

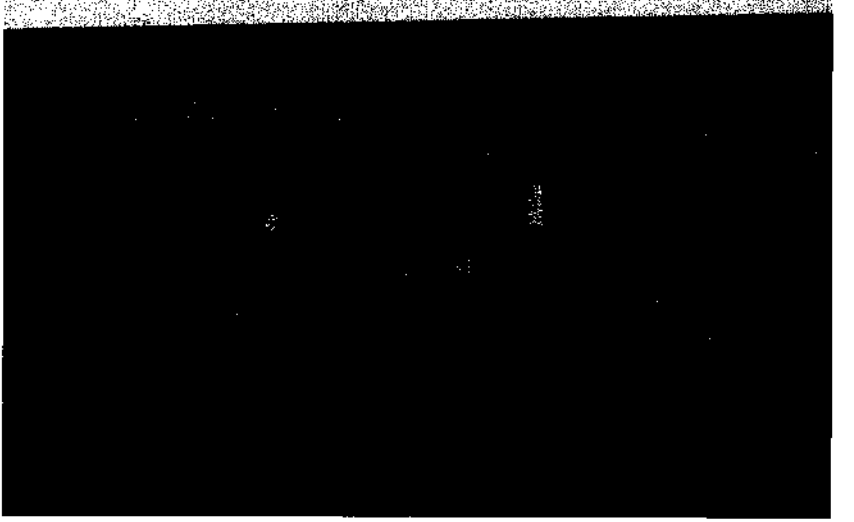
And, now, only an Operational Training Unit stands between him and an Operational Squadron. The O.T.U. is a war-time institution, and its purpose is to take the pupil to the edge of the War without exposing him to its risks. Fighter pilots are taught combat tactics and offensive operations against ground targets. Bomber pilots are teamed up with the air observers and wireless operators who may, and often do, stay together and serve as a crew in a squadron. The R.A.F., unlike the *Luftwaffe,* encourages the team system and will never wittingly break up a crew that gets on well together.

Final Stages

This last stage of bomber training is as arduous as any that preceded it. Every trick and dodge learned by " veteran " crews in the course of many flights over enemy territory is imparted to the newly-formed crews, and every section of the training is made to resemble as nearly as possible the conditions of actual warfare. In the air it is given in the type of bomber used by the squadrons to which the crew will be sent at the end of their training, and on the ground " theoretical " exercises are undertaken. Pilot, air observer and wireless operator " fly " to specified destinations inside a small cubicle equipped with the essential navigational instruments. Slides projected on a screen opposite the cubicle window indicate points on the route. Over " enemy territory," anti-aircraft gun-fire, represented by minute flashes dancing over the scene projected on the wall, breaks out, and searchlights—small electric torches—point enquiringly at the " bomber." To speed up the raid, the operations room clock can be made to slip off the minutes without reference to Greenwich Observatory or the sun; with its aid a six-hour journey can be accomplished in two.

In a darkened hangar is a large but silent bomber, jacked up in flying

(Above) A Miles Magister, a standard elementary monoplane trainer of the R.A.F.
(Below) The North American Harvard I, a standard advanced trainer of the R.A.F.



position. In it, the different members of the crew rehearse their separate duties or practise together the tasks—such as launching the collapsible lifeboat in case of a forced alighting on the sea—which require their combined services. The rear gunner spends time shooting with a tiny point of light at the projected shadow of an enemy night fighter on a screen behind the tail. The bomb aimer unloads his cargoes in whatever order he chooses; the pilot becomes adept at lowering and raising his undercarriage and flaps. The Operational Training Unit is, in effect, a finishing school. When pupils leave it they know almost everything but the actual experience of active service.

The training of gunners, wireless operators and air observers is equally thorough. This elaborate preparation is more than justified, and no matter how desperate Britain's need of air crews the standard of training will not be lowered. The modern aeroplane demands far more from the men who fly it than mere manual dexterity and courage, and any fall in the quality of training would be dangerous.

The Air Training Corps

When it formed the Air Defence Cadet Corps in 1938, Air League *of* the British Empire showed that it understood some of the problems that would face the Royal Air Force in finding personnel for its flying crews and ground staff's should war break out. The League had watched the growth of the German Air Force and had a fair idea of the leeway Britain would have to make up.

Two hundred Cadet squadrons were formed in towns all over the country. Boys between 14 and 18 flocked to join and many squadrons were over strength. None had vacancies they could not fill and only financial stringency prevented still more squadrons from being formed. The Cadets paid for their own uniforms and attended lectures and parades once or twice during the week and at week-ends. Voluntary instructors gave up their spare time to teach the boys the first principles of such subjects as radio telegraphy, aerodynamics, aero motors, aeroplane structures, meteorology, air navigation and photography. In 1939, just before war broke out, hundreds attended gliding camps and many qualified for one or other of the British Gliding Association's badges and certificates.

The War disorganised some of the squadrons; others took on new life and those near R.A.F. aerodromes were able to give their " big brothers " valuable help when help was badly needed by the R.A.F.

So useful did the Cadet Corps prove that, early in 1941, the Air Ministry decided to use it as the foundation of a new organisation for training boys for the Royal Air Force and the Fleet Air Arm. The new organisation was called the Air Training Corps, and within a month or six weeks of the scheme's introduction more than 600 squadrons had been formed, including the 200 or so of the old Air Defence Cadet Corps which were taken over by the A.T.C.

The Air Training Corps was designed to attract fads of 16 to 18, and grants on a generous scale were provided to cover the running costs of squadrons

made up of boys between these ages. Younger boys could be accepted but no grants were made in respect of them. The limited training facilities previously available were multiplied and an attempt was made to standardise training throughout the Corps.

Great importance was attached to the teaching of mathematics, and arrangements were made for selected cadets to receive additional training at universities in this subject as well as in electricity and magnetism, engineering, meteorology and navigation. Special courses were planned for cadets chosen to serve as ground crews and as wireless operators. All the necessary equipment for training was issued to squadrons free of charge.

This " pre-entry " scheme will undoubtedly lighten the task of the R.A.F. in preparing its recruits for flying and ground duties, and will make less arduous the work of the recruits in absorbing the subjects they must know to pass the many examinations they must take in the course of their R.A.F. training.

TRAINED OVERSEAS -Eager to be " up and doing," these airmen have been trained in Canada under the Empire Air Training Scheme, and have just arrived in England

ARMY CO-OPERATION

Working for the Army has always been one of the primary duties of the aeroplane. When, in the early years of this century, the authorities were at last convinced, after many demonstrations, that the flying machine—as it was then called—cpuld serve a useful military purpose, it was designed to become the "eyes'" of the Army, and between 1912 and 1914 all training and experimental flying was framed to make the aeroplane an important auxiliary to the ground forces. Its duties included the locating and reporting of the enemy, his numbers and dispositions, and supplying valuable intelligence to headquarters concerning the progress of the battle.

The aeroplane long ago outgrew the narrow limits originally prescribed for it, but the Army still needs its own aeroplanes to do the specialised work which cannot easily be undertaken for it by ordinary operational lighter and bomber squadrons. So great, indeed, is the modern army's need of air support that an Army Co-operation Command has recently been formed within the Royal Air Force. This Command will have at its disposal a number of lighter and bomber squadrons, as well as its own particular squadrons.

These Army Co-operation squadrons are equipped with aeroplanes possessing unusual qualities. They can land in and take off from small fields, can send and receive messages by radio, pick up messages from the ground without landing, and drop messages to ground forces; drop food and supplies in special containers attached to parachutes; and take photographs, observe the accuracy of artillery fire and signal corrections to the gunners; can give a good account of themselves in air combat and often take the offensive against troops on the ground.

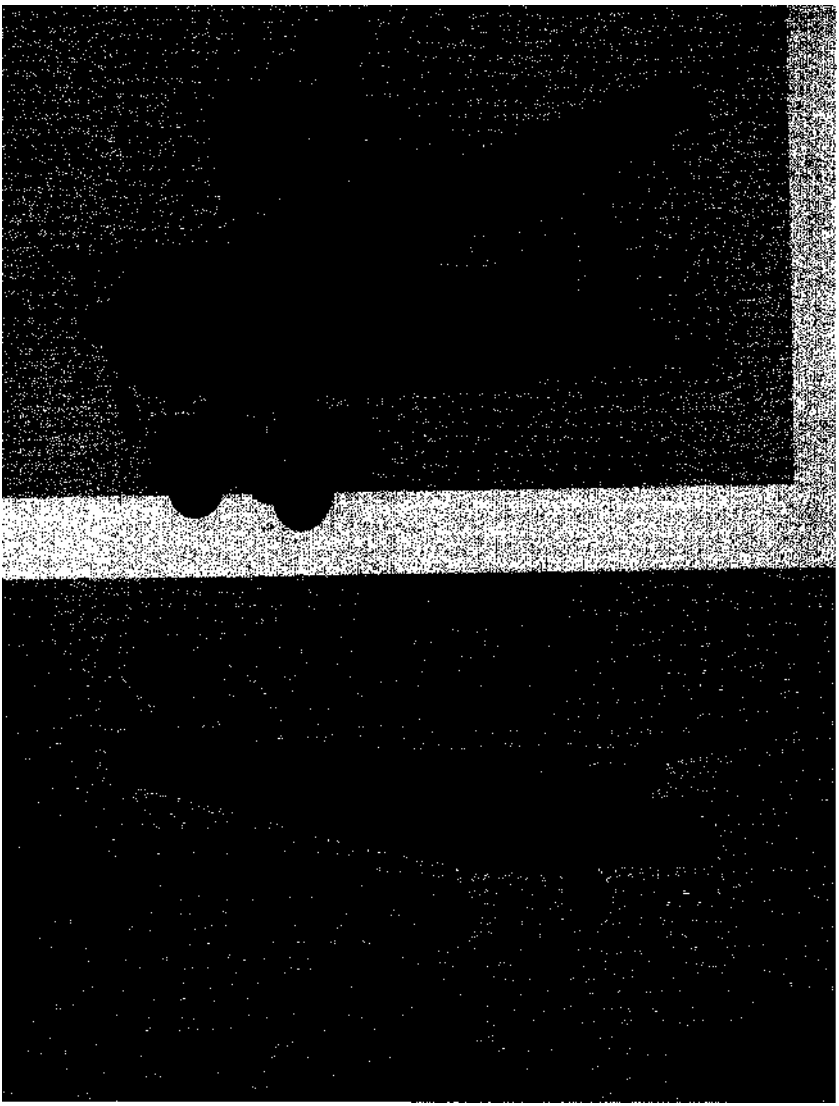
The standard R.A.F. Army Co-operation type of aeroplane is the Westland Lysander, a machine with a distinctive shape that makes it particularly easy to identify in the air. Its wings have slots the whole length of their front (or leading) edge, to give the pilot full control at low speeds, and flaps along the rear (or trailing) edge to steepen the angle of glide when a landing has to be made in a small space.

It carries two machine-guns concealed in the wheel coverings of its fixed undercarriage and two more on a swivelling mounting in the aft cockpit. The front guns are controlled by the pilot; those in the aft cockpit are fired by the observer.

One type of fighter known to be in service with the Army Co-operation Command is the American Curtiss Tomahawk. This type first saw active service in the Middle East and accounted for many enemy bombers both in the air and on the ground.

FOR SERVICE WITH THE ARMY
Westland Lysanders, the standard Army Co-operation aeroplane of the R.A.F.

FOR TRANSPORTING THE ARMY
Bristol Bombay transport, some of which flew hundreds of Imperial troops to the different theatres of war in Africa and conveyed many hundreds of senior Italian officers to prisoner-of-war camps on the return journeys



THE BALLOON BARRAGE

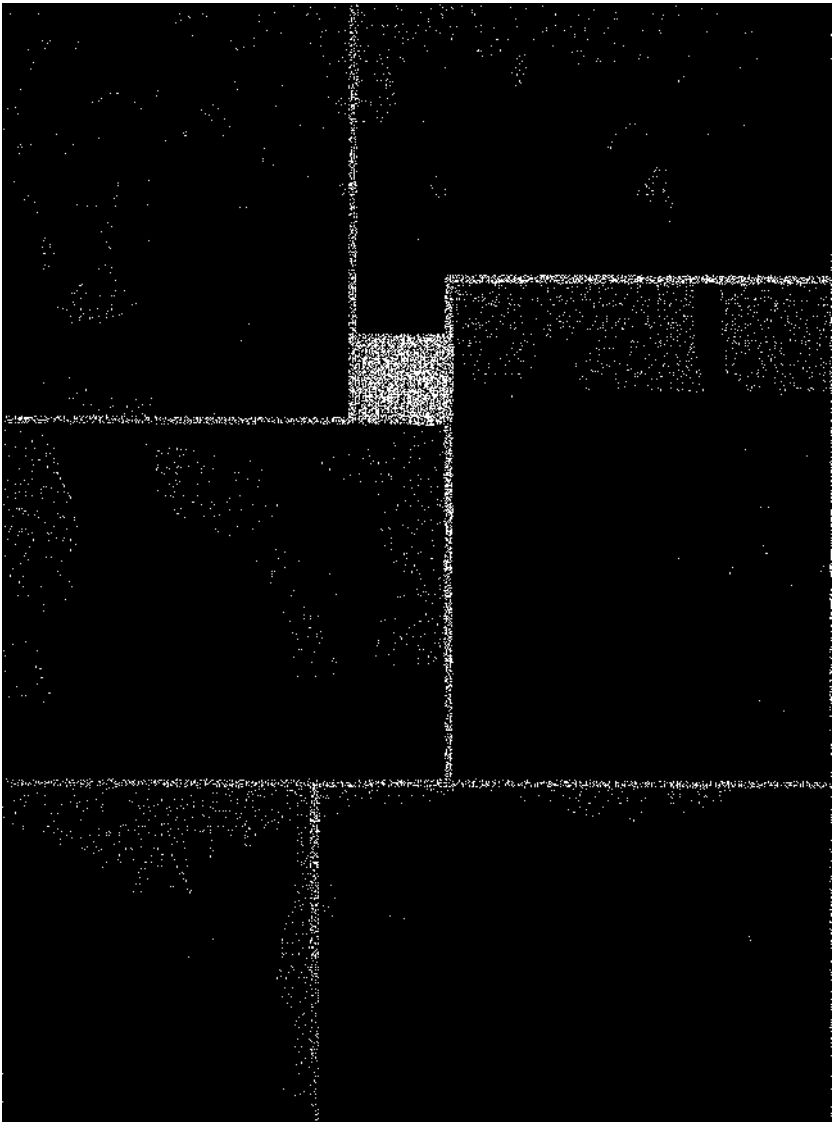
Of all the weapons of war, none looks more harmless than the fat and silvery barrage balloon as it rides motionless in the sky above a great city or, perhaps, an important factory. The balloon itself is as harmless as it looks, but connecting it with the ground is a fine wire cable. It is this cable that the raiding bomber fears, not so much the balloon.

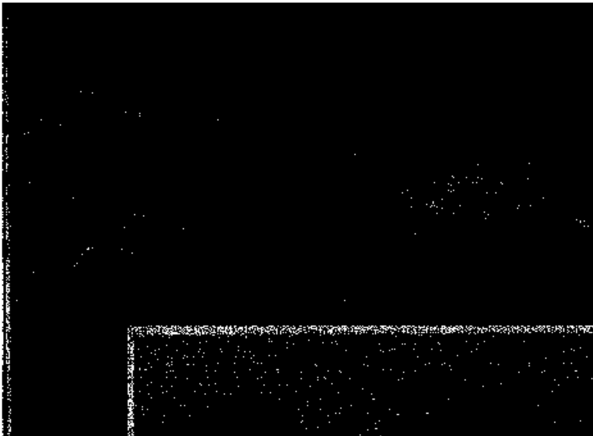
Thousands of men in the Royal Air Force serve with the Balloon Command. Their job is unlikely to bring them honour and glory, yet it exposes them to some of the greatest perils of the War. Not only are they exposed to the risks of bombs, but in certain areas enemy fighters make a practice of diving on the balloons and shooting them down.

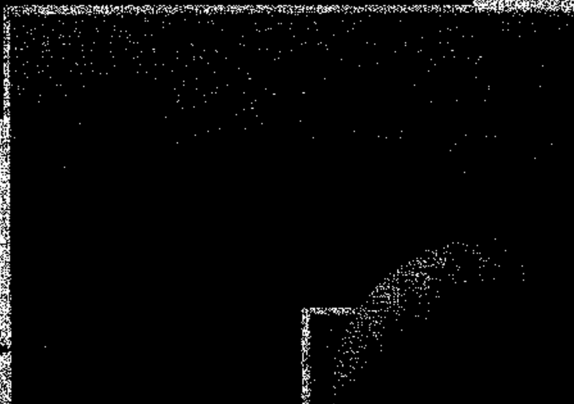
The barrage balloon is a snare only for the low-flying bomber. Its object is to force the raider to release its bombs from a height at which accurate aiming is not possible. In the past, these balloons rose to between 10,000 and 12,000 feet, but an improved balloon was introduced in Britain early in 1941 which attained greater heights without diminishing the " lethal " nature of the cable which secured it. As research solves more and more problems the barrage will doubtless rise higher still and add further troubles to harass the invading bomber.

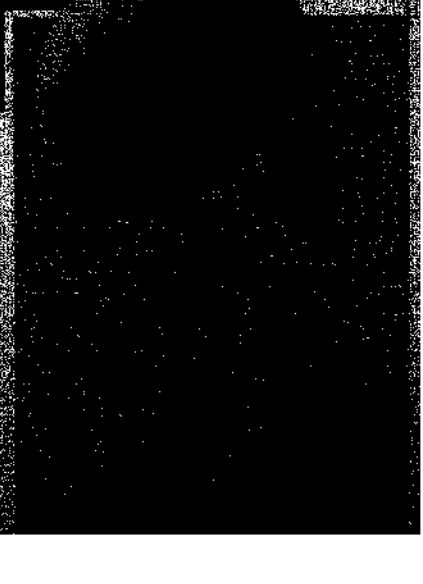
A motor-driven winch raises and lowers the balloons. Hydrogen contained under pressure in long cylinders carried on trailers is used to fill the balloons, and ten cylinders supplying the gas simultaneously to a balloon make the task of inflation a brief one. In the early types the large stabilisers at the rear of the balloon were filled with air which flowed in through small scoops. Though they look so docile when riding high in the sky on a calm day, the balloons can sometimes give a display of temper, particularly in gusty weather, that makes them difficult and sometimes dangerous to handle near the ground. Sometimes, too, a small failure in the stabilisers will cause the balloon to become unmanageable in the air.

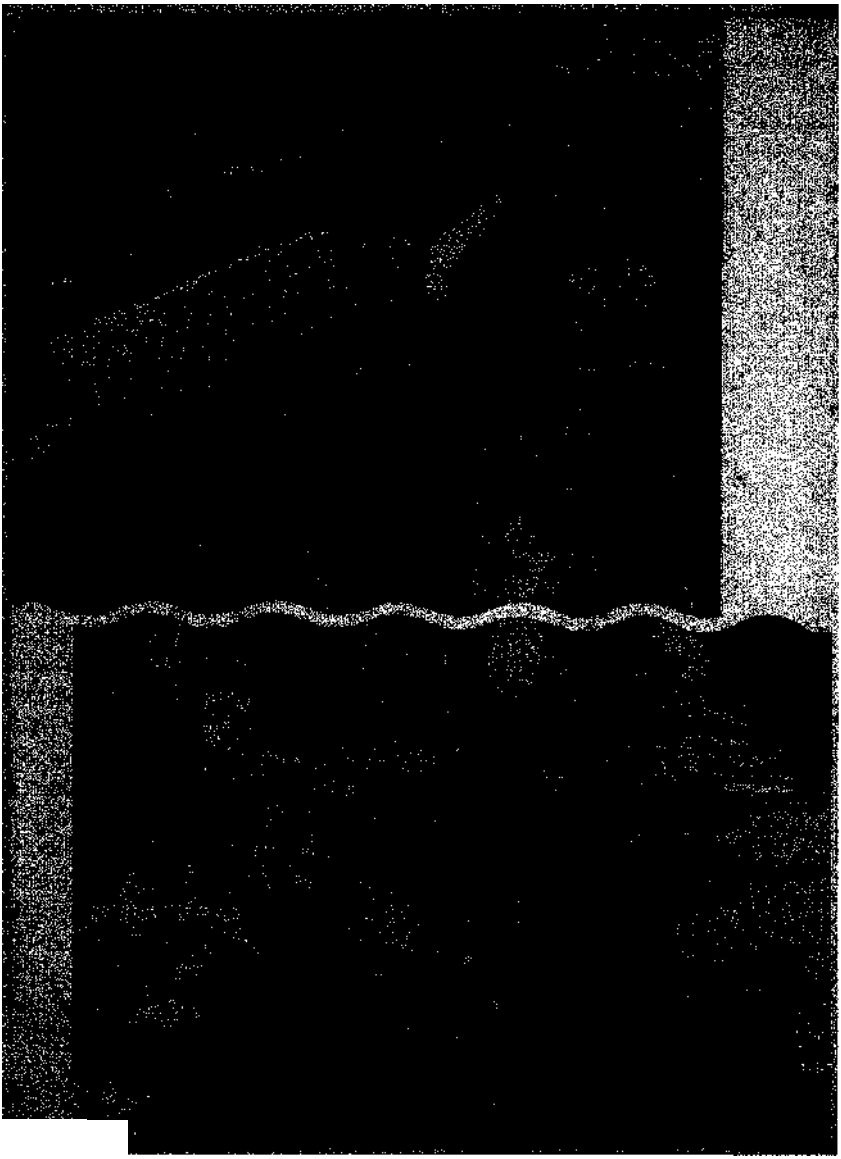
The sites from which balloons are flown vary from pleasant open spaces in the country to rubbish dumps in towns; from city squares to convoy barges. Each site is chosen with particular care, and when balloons accompany convoys they keep perfect station with the vessels in order that they may afford the greatest degree of protection from the dive-bombers that are waiting to pounce on the ships as they steam up and down the Channel. Though the work of the balloon barrage is unspectacular, the German Air Force would have done a great deal more damage to the cities of Great Britain and some of the more exposed factories in the countryside but for the obstruction it raises against low bombing.











AIRCRAFT PRODUCTION

When the last war ended Britain had the biggest aircraft industry of any country. During 1918 it was making an average of 2,668 airframes and 1,841 aero motors a month. Unfortunately for Great Britain, the Royal Air Force was reduced in size so drastically in the early post-war years that the majority of the firms that had helped to give the Allies technical and numerical superiority over the Germans in 1918 either closed down or turned to other trades and professions, and only a handful were left to fare as best they could. Such orders for military aeroplanes as were given by the Air Ministry did little more than keep the industry alive.

By sheer merit, British aeroplanes won favour in many foreign countries, and if orders for the home market were smaller than they ought to have been, a brisk trade with overseas customers sprang up to supplement them. Hence, when the deepening shadow of the German *Luftwaffe* spread itself still farther over Europe, and the British Government decided to defer no longer the air rearmament scheme it had postponed for ten years, it had for the foundations an Industry possessed of great vitality but of no great dimensions or large manufacturing capacity.

The Government's first task was to give new girth and strength to the Industry it had long neglected, and hundreds of thousands of pounds had to be spent in a matter of months in creating an organisation adequate to the task facing it. New buildings were erected alongside old; new buildings were put up on new sites; the great manufacturing resources of the motor-car trade were enlisted; more firms were given sub-contracts for aircraft work; the factories of important accessory suppliers were enlarged or duplicated or both, and under the threat of an impending war the Aircraft Industry of Great Britain rose to a high place among the country's major industries.

The programme was still incomplete when war broke out, and expansion still proceeds. In a hundred and more different factories, in scores of laboratories and foundries, thousands of men and women are toiling without pause to supply the Royal Air Force with its essential weapons. Bombers, fighters, troop carriers and Army co-operation machines must come off the assembly lines as fast as human industry can piece them together. Soon, still more factories and still more workpeople will add their precious quota to the total output. Meanwhile, a rising tide of aeroplanes flows from Canada and the United States.

No mechanical device has greater beauty of line than the modern streamlined monoplane. From nose to tail it flows in easy curves and gives the illusion that it was made in a mould, like a jelly. But if the smooth skin is stripped from wing and body the illusion is gone. A profusion of complicated structures meets the eye, dispelling any notion of a mould. In its place comes

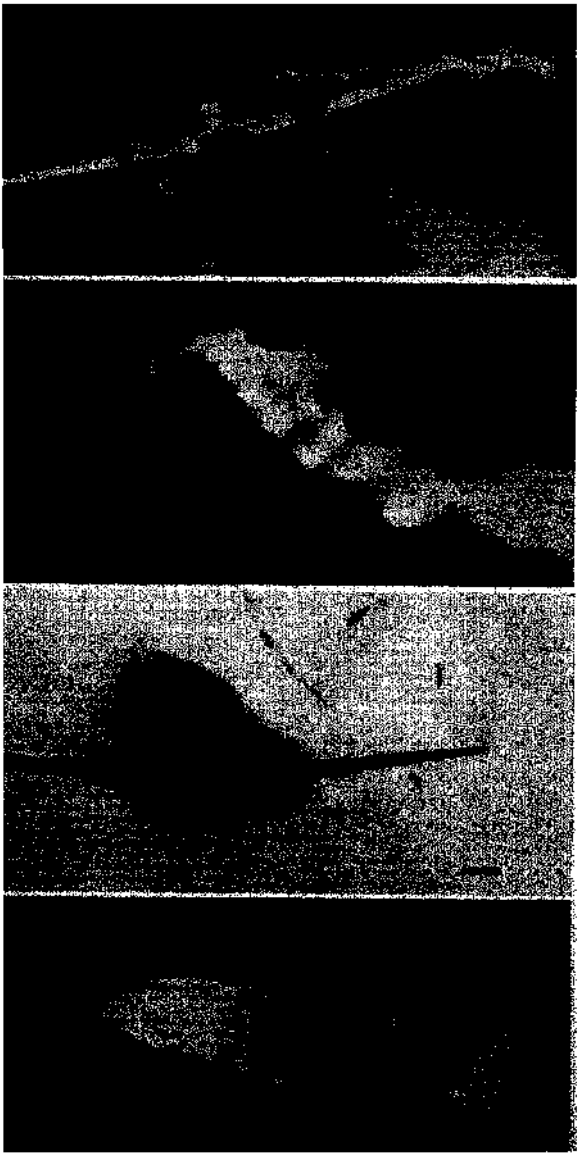
(Above) Building Vickers-Armstrongs Wellington bombers
[Below) Handley Page Hampden bombers on the assembly line

at the very moment that the expansion of the industry was creating a thousand other problems in workshop space, workpeople and supplies. They were brilliantly overcome, as events showed, and within a year or so the Royal Air Force began to take delivery of machines like the Whitley, the Wellington and Hampden, the Hurricane, Spitfire and Defiant.

No sooner is a type in production than work begins on its replacement. Almost every first-line aeroplane in service to-day has a successor already under development, but the problem is to avoid a pause in the change-over from the building of the older type to the building of the new. Sometimes a designer is able to use much of the machinery and many of the jigs used before, but when the change in type is sweeping, the entire factory may need re-tooling and re-jigging.

New types remain for a long time on the Secret List, but the Air Ministry has admitted the existence of the Hawker Tornado and Typhoon which* will ultimately replace the Hurricane. Some of our older bombers, too, are beginning to give way to newer and better types. Already, the British Aircraft Industry has given evidence that it can outstrip the aircraft industries of Germany and Italy in the quality of its newest aeroplanes, and soon it will outstrip them in quantity too.

NURSE AND PATIENT
An automatic pilot being overhauled by a girl mechanic



AERIAL COMBAT

Those photographs are official records of aerial combats. They were taken by the camera-gun fitted to Hurricanes and Spitfires. These cameras, which are loaded with 16 mm. film, are fitted in the wings alongside the guns and automatically register a record as the pilot puts his guns into action. When firing ceases, the picture ceases. Every time a picture is taken, therefore, the British fighter is actually firing at an enemy aircraft. If the records sometimes lack clarity due to cloud condensation on the lens, vibration and fumes from the exhaust of aircraft being attacked, they nevertheless provide certain evidence of the concentrated gunfire brought to bear by an eight-gun British fighter, the fire power of which is greater than that of the entire machine-gun strength of a 1914 brigade of infantry. These pictures have been enlarged from the cinematic records of several recent combats

PICTURE No. 1 shows the remarkable effect of the first bursts on a Mrssersehmitt Me 110. Both

into flames. The furling white streak marks the path of a tracer bullet

PICTURE No. 2.—The devastating etteet of mathine-gun fire f r o m our fighter airrraft is proved by this picture of a Dormer Do 17

PICTURE No.3. This is a Hemkel 1HK at the end of a combat just before it crashed in flame*. The engines, fuselage and petrol tanks are all ablaze. The film from which this picture was taken shows the enemy aircraft disintegrating in mid-air

PICTURE No. 4. The starboard engine and wing are on fire

THE FLEET AIR ARM

Most first-line acioplanes of the Fleet Air Arm are ship-bome I he majority are on board airaft camers, the remainder are with niseis ,andl battleships equipped with catapults for launching The Admiialt also conliol hall a doen on mon aeiodiomes ashore for traming and maintonamcc and lot operational squadrons All the aelodromes are known by ships' names One is H.M.S. *Daedalus;* anothei H M S. PergnmIn a radio hroadcast the Germans onee clainn d to ha\< sunk a Fleet Air Arm aerodrome

Britain's fleet of aimaft cainers,bunlt or building when the wan broke out was the higgest in the WorId Two, the Cow*ageous* and theGlonpus have been lost one by suhmarine and the other man atunk by German warships off the coast of Norway hut two new carriers, the *Foimudable* and the *Illushrous,* soon replaced them. Both the new ships have a displacement of 23,000 tons; the *Ark Royal,* Iumched in 1938 and the first of the new class, displaces 22,000 tons. Other aineraft carriers belonging to the Royal Navv molude the *Eagle, Hermes, Furous, Agus* and, newest of all, the *Vutous*

Aimalt cariters are not without then lunting uifluences when working with at fleet, but they are by no means the defenceless targets for enemy bombers they were often lated True, they must steam dead into wind whnle then aeroplanes land 01 take off I10111 then deaks, ,and this may take them in tin wrong direction, but expcnence, partoulaily m the Mediteanean, has pfoved them an essential part of any naval force likely to be assailed by the land- 01 vanierbased aeroplanes of the enemy. Only one British aircraft carrier, the Illustnous, had, at the end of eighteen months of wan, been struck by bombs and put temporanly out of

commission. The damage failed to disable the ship and she steamed under her own power first to Malta and then to Alexandria, in spite of the enemy's efforts to complete her destruction by ior .attaek

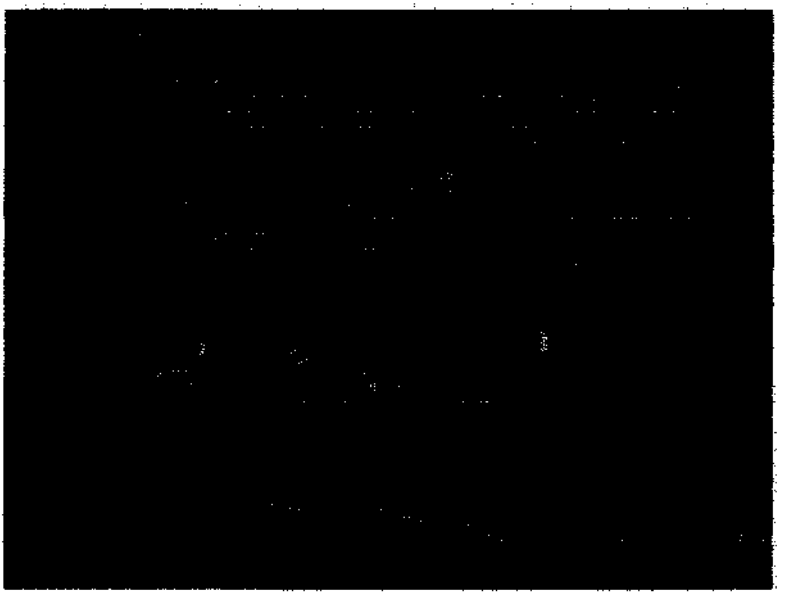
Against the temporarv retirement from active service of the *Illmtnous* had to be balanced the loss of many German bombers, shot down by her fighters, and the complete frustration of the enemy's plans to break British sea communications in the narrow waters of the Mediterranean.

Aeroplanes for service in aircraft carriers must have special qualifications. Space for stowage is restricted; wings must therefore fold. The length of the flying deck is limited; the aeroplanes must therefore become air-borne quickly. They must carry flotation gear lest by some unhappy chance they fall into the sea and sink.

With their larger wing areas, biplanes more easily met the demands of the aircraft carriers, and remained in favour long after the monoplane had established itself in other spheres. One of the most recent additions to the Fleet Air Arm was the Fairey Albacore, a large single-motor biplane classed as a torpedo-spotter-reconnaissance type. This, however, may prove to be the last biplane to go into service on carriers. Several efficient monoplanes have proved their ability to meet the limited conditions, as well as their worth in combat and bombing raids.

British types now in service with the Fleet Air Arm include the Blackburn Roc, Fairey Fulmar and Gloster Sea Gladiator fighters; the Fairey Swordfish and Albacore tor-pedo-spotter-reconnaissance bombers; the Blackburn Skua dive-bomber and, for service on cruisers and battleships with catapults, the Supermarine Walrus amphibian and the Fairey Seafox. Of American aeroplanes supplied to Britain, the Grumman Martlet has been chosen as a Fleet fighter. The Roc, Fulmar, Skua and Martlet are all monoplanes.

Normally, a sharp line divides the spheres of action of the Fleet Air Arm and the Royal Air Force, but when occasion arises the two

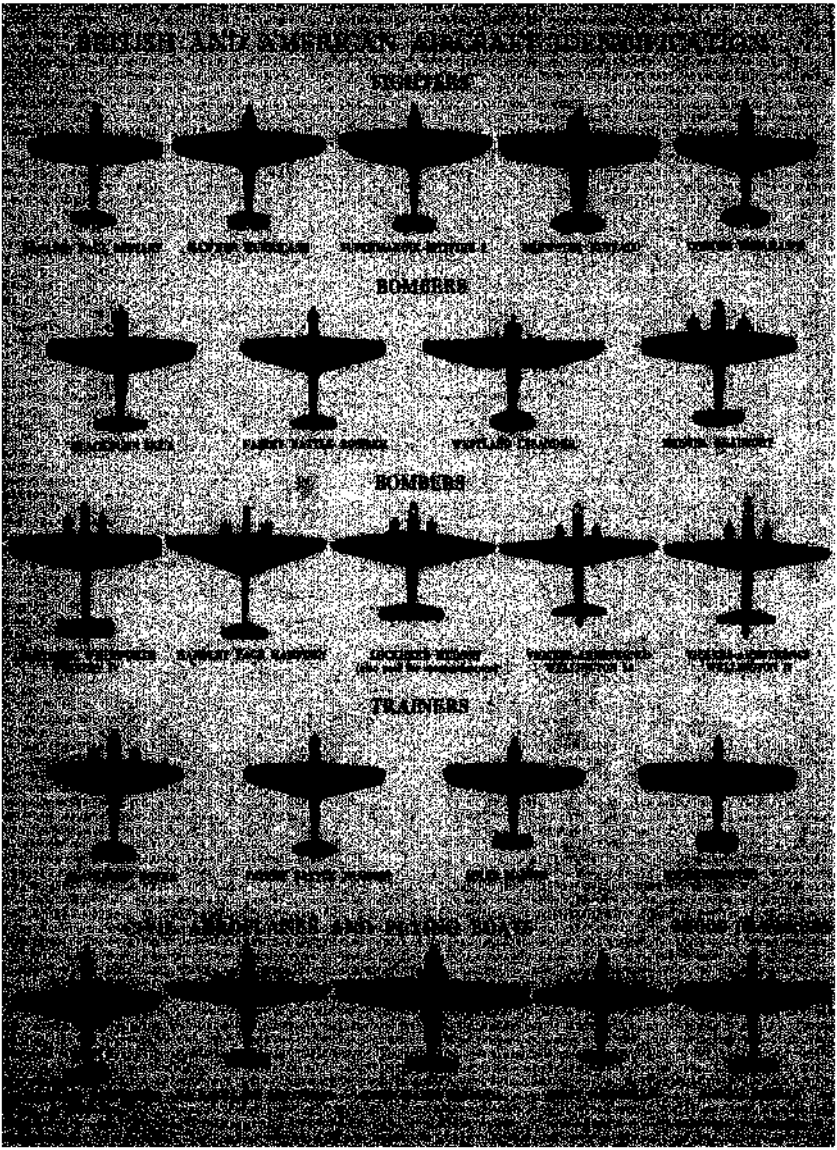


Fairey Albacores over the Coast

damage was done to this important Italian base by shells and bombs.

Swift action by the Fleet Air Arm also led to the biggest naval battle of the Mediterranean so far fought when, on March 28th, 1941, units of the Italian Navy were sighted. But for the torpedoes of the Fleet Air Arm's aeroplanes many of the enemy's ships, using their superior speed, might have escaped from the slower British warships. Impeded by air attack, the Italians were forced to fight and seven ships were known to have been sunk in the action that followed. The aeroplanes were flown off H.M.S. *Formidable.* Farther north, Blenheim bombers of the R.A.F., diverted from their land objectives, scored hits on other units of the Italian navy.

The Fleet Air Arm has already proved itself a worthy successor to the Royal Naval Air Service that won imperishable fame in the war of 1914-18, and has justified the beliefs of those who urged the Navy to arm itself in the air to the limit of its resources.


BRITISH AND AMERICAN AIRCRAFT IDENTIFICATION
FIGHTERS
BOMBERS
BOMBERS
TRAINERS