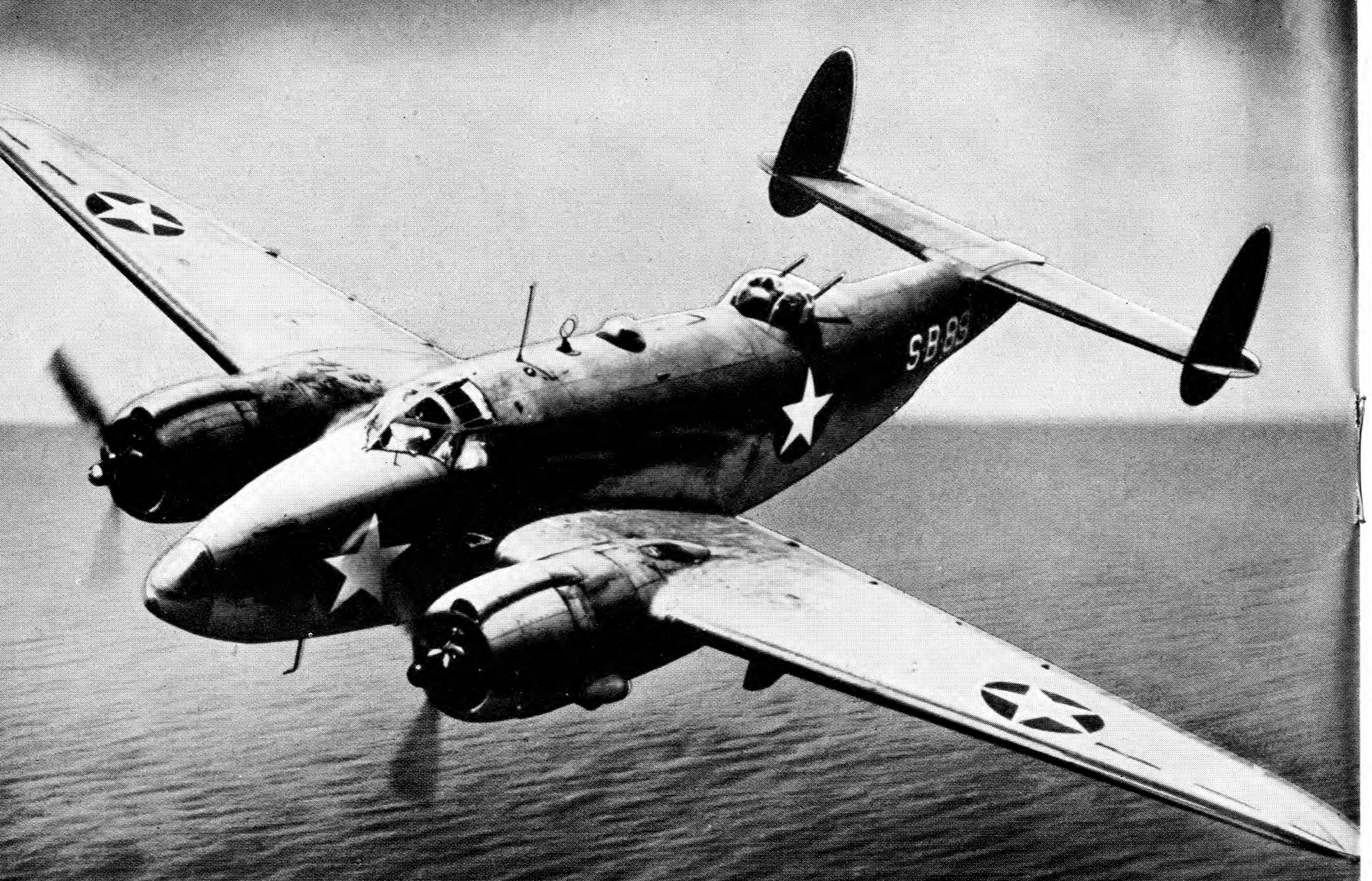
AIR TRAINING CORPS GAZETTE

VOL. III No. 9
SEPTEMBER, 1943
Price 6d.



Over America's Pacific Coast. A U.S. Navy Ventura (top), and a Flying Fortress.

AIR TRAINING CORPS GAZETTE

VOL. III NO. 9 SEPTEMBER 1943

Edited by Leonard Taylor

Published for the Air League of the British Empire, 1A Pall Mall East, S.W.1 (Telephone Abbey 5041), by the Rolls House Publishing Co., Ltd., Rolls House Breams Buildings, London, E.C.4.

All Out

IN our histories we read with pride of many occasions when we have been saved by the skill and courage of our forces on sea and land and by the stubborn grit and determination of our peoples; in this war we have seen again what can be achieved with such qualities by nations allied to overthrow tyrants.

But we of the Flying Services may still feel a special pride in the victory of the Battle of Britain, which we celebrate this month. It was the first occasion of its kind. The enemy staged in great strength a real invasion from the air as a preliminary to invasion by his troops: his plans were defeated by a small body of personnel of our Services.

None of us would belittle the teamwork of the A.A. Command, of the Royal Observer Corps and of the civil population, which contributed much to this victory: we may pay tribute to the British aircraft industry, which kept going during the years when orders were small, and developed, often from their own resources, types of machines which enabled us to survive: but the main laurels must go to the aircrews who in their heroism ignored odds against them, triumphed over dangers, and refused to be defeated by fatigue. They were at times nearly all in, but they won by going all out.

To win the Battle of Europe we must go all out, and I am certain that in this great effort the units of the Air Training Corps will play their full part; they will continue to do their magnificent work with still greater determination to fit themselves for the work that they may yet have to do.

It is difficult to picture the flying Services of to-morrow without the mass of well-trained and high-spirited young men who have gone forward and are going forward from the Air Training Corps. They will take their places behind the hardened veterans of the past and will show that they, too, are as worthy of our praise and of our thanks as were their forerunners of the Battle of Britain.

With the turn of the tide of war there is a danger that our easygoing people may relax their efforts: I hope they will not. At least we of the Air Training Corps must take our pattern from the fighting Services and go all out for the finish.

AIR COMMODORE,
INSPECTOR, AIR TRAINING CORPS

BATTLE OF BRITAIN

by Captain W. E. Johns

"AT once I was convinced that this machine, though a somewhat expensive one, might be very useful in war to enable one to discover the position of the enemy, his manoeuvres and his marches; and to announce these by signals to one's own army. I believe that at sea it is equally possible to make use of this machine . . . which time will perfect for us."

Thus wrote Gerond de Vilette in *The Journal de Paris,* following the first ascent in a Montgolfier balloon in which he was a passenger. The date was October 19th, 1783.

Gifted as this gentleman must have been with truly prophetic foresight (wider vision than was possessed by certain alleged military experts of much more recent times), it is unlikely that he foresaw that within a few generations the air would be the field for one of the most decisive battles in history, a battle upon which hung not only the fate of the British Empire, but—a tremendous but incontestable fact—the life, or way of life, of every person on earth. For it is not the number of casualties in a battle that determines its historical importance, nor even the number of troops involved: it is upon its *effect* that a battle must be judged.

Considered from this aspect the conflict that will for ever be known as the Battle of Britain must rank with such impacts between human forces as Marathon and Tours. At Marathon, in the year 490 B.C., a small Greek army saved Europe from Oriental domination, for which reason the faces of Europeans today are white, not yellow. At Tours, A.D. 732, Charles Martel stemmed the tide of a seemingly invincible Saracen army. Had that battle been lost, our skins to-day might well have been brown. Had Britain lost the battle that raged in the skies so short a while ago—but perhaps it is better not to think about that. These were not battles of frontiers, but collisions that set the course of human destiny. Let us not forget that.

The Battle of Prejudice

The year 1914 saw the introduction into warfare of a new weapon—the aeroplane. It was, in fact, more than a weapon. It was a factor, a factor of unbounded possibilities—as we are just beginning to realise. At the time only one thing was clear. The aeroplane had come to stay. The rest was in the air—in every sense of the word. During the war that followed, lessons were learned—not many, but we might call it an instructive prelude. Some longsighted men saw dimly the part that the aeroplane would play in future wars, but few guessed what the world knows to-day. Those who saw most clearly, and were in a position of authority, were at once faced with a difficult task. They had to plan for the future, to decide on a programme for air defence, and, what was even harder, break down a barrier of political, industrial and military prejudice before they could even start to put the plan into execution. Let us put it on record here: the preliminary skirmishes of the Battle of Britain were fought by a small band of men at the Air Ministry against the diehards who had their headquarters within the mighty bastions of Westminster. These men, many of whom had stood the shock of bullets, now came under the fire of missiles even more deadly—criticism, ridicule, and the like. To them the country owes much, for had they given up in the early stages there would have been neither the machines nor "the few" to fly them when, in 1939, the vital issue was joined.

Almost all of these men had fought in the air in the war of 1914-18. They, and those who served under them, had created something, something which they cherished. It was tradition . . . *esprit de corps*—call it what you will. It takes a war to forge tradition in its most enduring form, but thereafter, properly used, it can be a weapon of great power. But it has to be kept in good order, otherwise it perishes.

The Battle of Training

To keep it in good order after the last war was not easy. Newcomers to the Service—and there were many as the old hands dropped out—were inclined to look askance at those who talked (overmuch, perhaps) about hot lead rather than camera guns. Names like Ball, Mannock and McCudden lost their significance. Looking back at the years that followed the last war I have an idea that the youngsters thought we old stagers made too much of these doughty warriors. Perhaps we did. But then we knew how hard it was to do what they had done. Well, those same youngsters, veterans now, know all about it. They in their turn will talk of something *they* forged in the fire, when Old Man Death was sweating at the bellows.

The days went on. More and more of the old stagers dropped out, but we watched the new stuff, men and material, with critical eyes, for there is no greater truism than "Once an airman, always an airman." We had ample opportunity for watching—R.A.F. Displays, Empire Air Days, and the like, which the authorities so nicely called "the culmination of the year's training"

Speaking for the old hands, I don't think any of us had much doubt as to what the result would be when the big clash came. The boys were there—but were there enough of them? As British air correspondent of German and Italian newspapers I sometimes got an inside glimpse of what our enemies were doing, and I own freely that there were times when I was worried. But, after all, I was only a spectator.

The Battle of Equipment

What anxious days they must have been for the Higher Command! Remember, everything was new, untried—new tactics, new aircraft, weapons, instruments, armament. The selection of all these things had demanded major decisions by the Air Council. Were they right—or were they wrong? That was the burning question that only time could answer, for the only real test of war is war. Courage and skill are not enough in air combat if the equipment is wrong in principle. What a load of responsibility on the shoulders of those who had to make the decisions! Bomber or fighter? Precision bomber or dive bomber? Cannon or machine-guns? And so on. No matter what the Air Ministry chose it could rely on a spate of criticism from those who might be, or more often were not, qualified to judge.

When the Battle of Britain was joined, years of thought, of study, of training, of experiment, took the air for the crucial test. For the first time it was clear to all how much depended on what those responsible had provided. The hearts of those who flew the fighters were staunch enough—no one doubted that; but had they been given the *means* to defeat the enemy? Would the equipment, even if it were right, stand up to the gruelling test about to be imposed on it, strains inconceivable in times of peace? Had the training of the pilots been right, or was there some flaw as yet unrevealed? What was going to be the psychological effect of the parachute, adopted by the Air Ministry in the face of some fierce opposition? There were a hundred questions, the answers to which we know now, but did not know then.

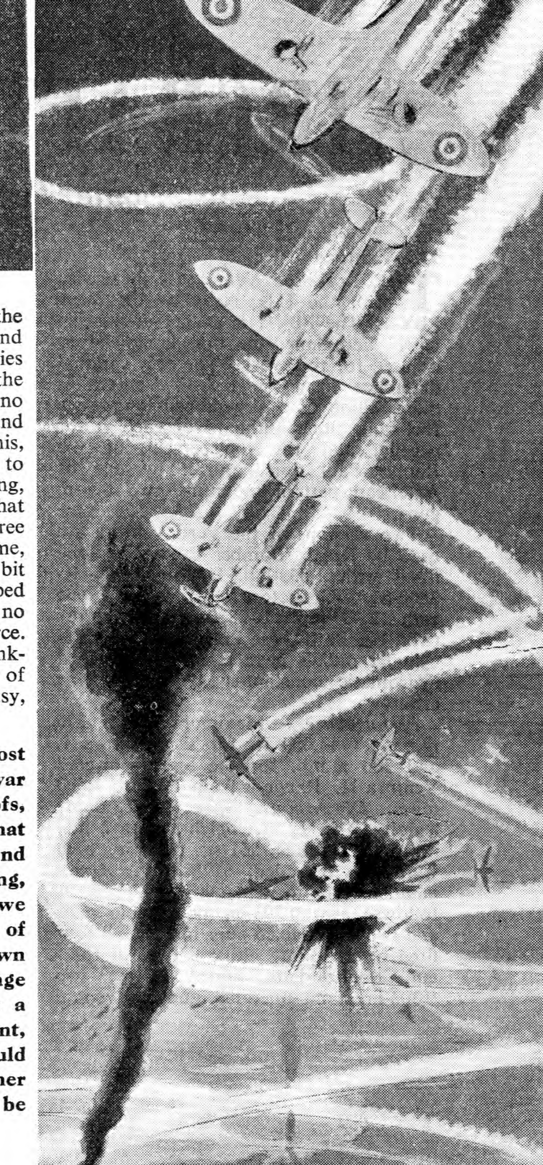
The Battle of Nerves

It is easy to look back and say everything was all right; but it was not so easy before the event. If the physical strain of the battle was great on the pilots (and I suspect that only they know how great it was), the mental strain on those who launched them into the air must have been as wearing. If the weapon broke in their hands there would be no time to make a new one. It would be the end—the end of everything.

We need not dwell here on the story of the battle, which was like no other battle, because it was watched by the people, the civil population who, at the time, may or may not have realised that those little white lines across the blue were the writing on the wall for one of two creeds—Freedom or Fetters. The Royal Air Force won a battle that was entirely its own, a battle in which ten thousand ships and ten million bayonets could not have struck a blow, even though we had them. The whole civilised world watched, and waited for the outcome.

On August 8th, 1940, the long-prepared Luftwaffe took the air. Make no mistake, it was a formidable armada of high-performance aircraft, for the most part led by pilots of considerable air and combat experience. Britain's defending fighters rose to meet them, to all appearances precisely as they had taken off in the years before the war at Hendon, to meet an imaginary foe. But this time there were bullets in the guns; and the smoke that very soon trailed across the dome of heaven was burning oil and petrol—not stannic chloride. The bodies that hurtled down through space as the enemy aircraft began to fall were no longer sand and sacking, but flesh and blood. No make-believe spectacle this, to delight a holiday crowd, although, to be sure, the crowd was there, watching, regardless of warnings to the effect that what went up must come down. For three months the battle raged, and in that time, in daylight hours, 2,375 enemy aircraft bit deep into the soil that they had hoped to conquer. With them fell, to rise no more, 375 pilots of the Royal Air Force. This was the price of victory. And thinking of it we can read again the words of the great historian, Sir Edward Creasy, written nearly a hundred years ago:

"Even those who mourn the most deeply over the sacrifices to the war must rejoice at the proud proofs, which it has given to the world, that the English heart is still staunch and true, and the English arm as strong, as in the days of old. So far as we may have suffered from any faults of system, the remedy is in our own hands. But sterling manly courage among all classes of our army is a national quality, which, if deficient, no administrative ingenuity could supply. While it is present, no other requisite for victory need long be wanting."



Drawing by Lunt Roberts

AIRCRAFT MODIFICATIONS

Some Technical Details by Roy Cross

The Ventura

THE Lockheed Ventura is in service with the U.S. Navy as the Vega PBV-1. The PBV-1 is an anti-submarine patrol aeroplane, the first landplane to be used for this work. The only external difference from the R.A.F. Ventura is the addition of a streamlined long-range fuel tank slung outboard of each motor nacelle, and the replacement of the Boulton-Paul dorsal turret by one of American pattern mounting two 0.5-in. guns.

Two versions of the Vega Ventura are used by R.A.F. Bomber Command—one fitted with 1,850-h.p. Double Wasp R-2800-S1A4-G motors (Mk. I), and one with 2,000-h.p. R-2800-2SB-G motors (Mk. II). Both these Pratt & Whitney 18-cylinder radials have Hamilton Standard hydromatic constant-speed paddle-blade airscrews.

Performance. — Maximum speed, 275 m.p.h. at 14,000 ft. for the Ventura I, and 300 m.p.h. for the higher-powered Ventura II. Range is from 1,000 to 1,500 miles. *Dimensions.*—Span, 65 ft. 6 in; length, 52 ft. 7½ in.; height, 14 ft. 2 in.; normal wing area, 551 sq. ft.; wing area with flaps extended, 619 sq. ft. *Armament.*—Eight to ten guns arranged as follows: two 0.303-in. depressible guns and two 0.5-in. fixed guns in nose, all four fired by the pilot; either a two- or four-gun Boulton-Paul dorsal turret; two 0.303-in. hand operated guns in ventral position. *Weights.*—Loaded, 26,000 lb.; disposable load, 6,800 lb., including 2,500 lb. of bombs. *Makers' Designation.*—Lockheed-Vega 37.

The Mustang Dive-bomber

The A-36, the U.S. Army's dive-bomber version of the North American P-51, has hydraulically operated dive brakes above and below each wing, and although no details have been released, it is possible that they are of the "opening book-leaf," split trailing-edge type, as installed in the Douglas Dauntless. Racks for bombs are fitted under each wing, eliminating the need for displacement gear. Thus the Americans follow British fighter-bomber practice, and, indeed, the A-36 should make an extremely formidable addition to this class.

Armament consists of two 0.5-in. synchronised guns in the nose, and 0.5-in. guns, probably two, in each wing. Long-range fuel tanks may be suspended from the wing racks as an alternative to the bomb load. The weight of racks, dive brakes, etc., increases the all-up weight by about 200 lb. over that of the normal fighter version.

Recent reports from the Sicilian front indicate that the A-36 is now in action with a bomb load of two 500-pounders, and with either the Allison V-1710-39-F3R or the Packard-built Rolls-Royce Merlin motor. Loaded weight of the Allison-powered A-36 is approximately 8,910 lb., including bomb load, and the speed is given as 353 m.p.h. at 13,000 ft.

The Whitley VII

A reconnaissance version of the Whitley, the Mk. VII, is operated by Coastal Command crews on long-range over-sea patrols. Rolls-Royce Merlin motors of 1,130 h.p. give the Whitley VII a maximum speed of 195 m.p.h. at 6,500 ft. with a loaded weight of 28,000 lb. Maximum permissible service load is 8,395 lb., and dimensions are: Span, 84 ft.; length, 69 ft. 3½ in.; height, 12 ft. 9 in.; wing area, 1,232 sq. ft.

The Spitfire V-B

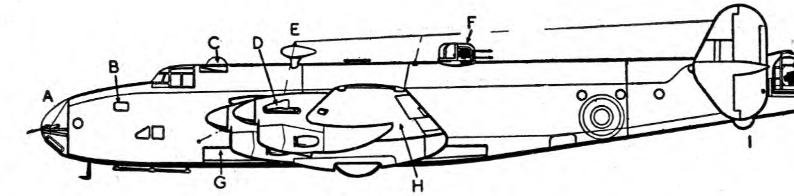
The Supermarine Spitfire V-B, which is flying in most theatres of war, including Russia, approaches in general versatility the famous Hurricane II. A clipped-wing version, co-operating with R.A.F. Mustangs of the Tactical Air Force, is engaged on intruder patrols over the Occupied Countries, and in close support work with the Army. The span is reduced from 36 ft. 10 in. to 32 ft. 2 in., with a resultant increase in speed and manœuvrability near the ground. Thus it achieves a near return in appearance to the now defunct Mk. III (Merlin 20).

Production of the Mk. III was discontinued after the first three had been built, because the climbing qualities and ceiling were impaired. As a specialised low-altitude fighter, the "clipped" V-B can ignore these disadvantages and reap the full benefit of the greater speed due to the removal of the drag of the tips. The lower aspect ratio also improves power of manœuvre low down.

A few details of the ordinary V-B with pointed wings have been officially released. They are as follows: Span, 36 ft. 10 in.; wing area, 242 sq. ft.; speed, (*a*) 369 m.p.h. at 19,500 ft. with the Merlin 45 of 1,150 b.h.p. at 17,000 ft., and (*b*) 365 m.p.h. at 22,000 ft. with the Merlin 46, which develops 1,110 b.h.p. at 19,000 ft.; tare weight, 5,067 lb.; loaded weight, 6,236 lb. Armament consists of four 0.303-in. Browning machine-guns and two 20-mm. British Hispano cannon, while two 250-lb. bombs may be carried, one under each wing. Tankage, normally for 84 gallons, may be increased by installing a flush-fitting, streamlined long-range tank between the oil-cooler intake and the radiator on the under-surface.

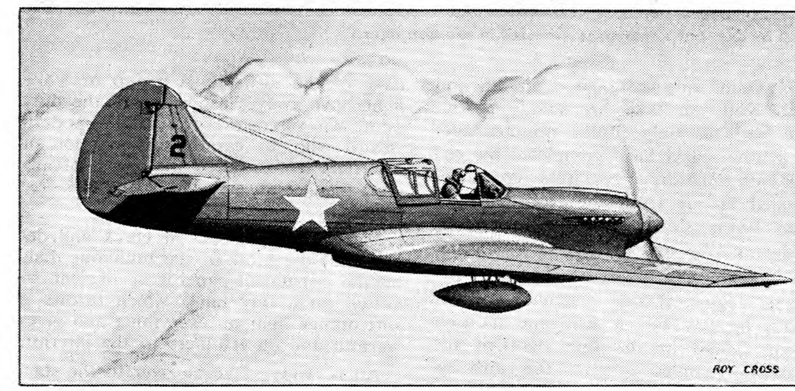
A tropical version, with a Vokes air-filter fitted, is extensively used on the Eastern fronts.

Mustangs ready for action.



THE HALIFAX

A, new transparent nose with Vickers "K" gun position; B, forward-view blister removed; C, lowered astral dome; D, Rolls-Royce Merlin 22 motor with modified cowling and flame dampers; E, wireless mast removed, aerial now attached to D.F. loop; F, B.P. four-gun turret; G, larger bomb doors to accommodate the biggest bombs; H, fuel jettison pipes now discarded; I, semi-retractable tail wheel fitted.



A U.S. Curtiss P-40E (1,150-h.p. Allison V-1710-F3R motor) with the new modified tail unit. The fin is now faired into the fuselage, resulting in greater fin area, and considerably changing the general aspect of the rear fuselage. Machines with either tail unit are in service with both the U.S. Army and the R.A.F.

The Halifax

Recent development of the Handley Page Halifax has resulted in a substantial increase in all-round performance, especially in the rate of climb. The new model, the Mk. II, series I-A, has a completely new transparent nose, affording an excellent view and a good deal more space to the navigator and bomb aimer. In addition, the Merlin 20s of the Halifax II have been replaced by Merlin 22s of 1,280 h.p., and a new type of radiator is fitted, with attendant changes in cowling design. Armament, also, has been improved. It consists of a 0.303-in. Vickers 'K' gun in the nose, operated by the navigator, a Boulton-Paul Defiant-type four-gun turret in the dorsal position, and a Boulton-Paul turret mounting four 0.303-in. Browning guns in the tail. Other modifications are well illustrated in the drawing on this page.

Internally, the engine nacelles, the fuselage at the rear bulkhead, and the elevator spar gap have all been sealed off; the bomb doors are now sealed when tightly closed, to prevent the formation of performance-eating eddies and back-draughts.

All these changes are reported to have boosted general performance considerably, both cruising speed and top speed having been increased. In fact, the Halifax has been so improved as to become almost a new aircraft.

The earlier Halifax IIs are fitted with Merlin 20 motors, which give 1,220 h.p. at 11,250 ft.

Officially quoted speed is 254 m.p.h. at 12,750 ft. Weights: empty, 35,800 lb.; loaded, 51,500 lb. Bomb load is 13,000 lb. and fuel capacity is 1,886 gallons.

The Cessna C-78

Often seen flying over Great Britain are Cessna C-78 personnel transports of the U.S. Army Air Corps. This development of the original civil T-50 Twin is powered by two Jacobs L-4MB motors, and may also be used as a light cargo or communications aeroplane. Two more versions are in service as advanced, or wireless, trainers—the A.T-8 (R.C.A.F. Crane), with Lycoming motors of 280 h.p., and the AT-17, the Bobcat, with Jacobs L-4MB motors. No data has been released on the C-78 transport, but since it is identical with the T-50T, figures for the civil machine should apply equally well to either. Here is a brief specification of the aircraft fitted with two 245-h.p. seven-cylinder Jacobs L-4MB radials:

Dimensions.—Span, 41 ft. 11 in.; length, 32 ft. 9in.; height, 9 ft. 11 in.; total wing area, 295 sq. ft. *Accommodation.*—Five seats. *Performance.*—Maximum speed, 195 m.p.h. at sea-level; cruising speed, 191 m.p.h. at 7,500 ft.; stalling speed, 55 m.p.h.; climb at sea-level, 1,525 ft. per min.; service ceiling, 22,000 ft. *Weights.*—Empty, 3,600 lb.; loaded, 5,100 lb.; wing loading, 17.3 lb. per sq. ft.

The Cessna C-78.

Russian Types

The LAGG-3 (1,200-h.p. M-105P motor) is a committee-designed fighter, fighter-bomber and bomber escort. Its general lines follow closely those of the earlier YAK-1, which has the M-105 motor of 1,100 h.p. Armament of the LAGG-3 comprises one 20-mm. cannon firing through the airscrew hub, and two nose machine-guns. Light bombs are carried under each wing, and with these the top speed is 328 m.p.h. Without bombs, speed is increased to 347 m.p.h. for a loaded weight of roughly 7,000 lb.

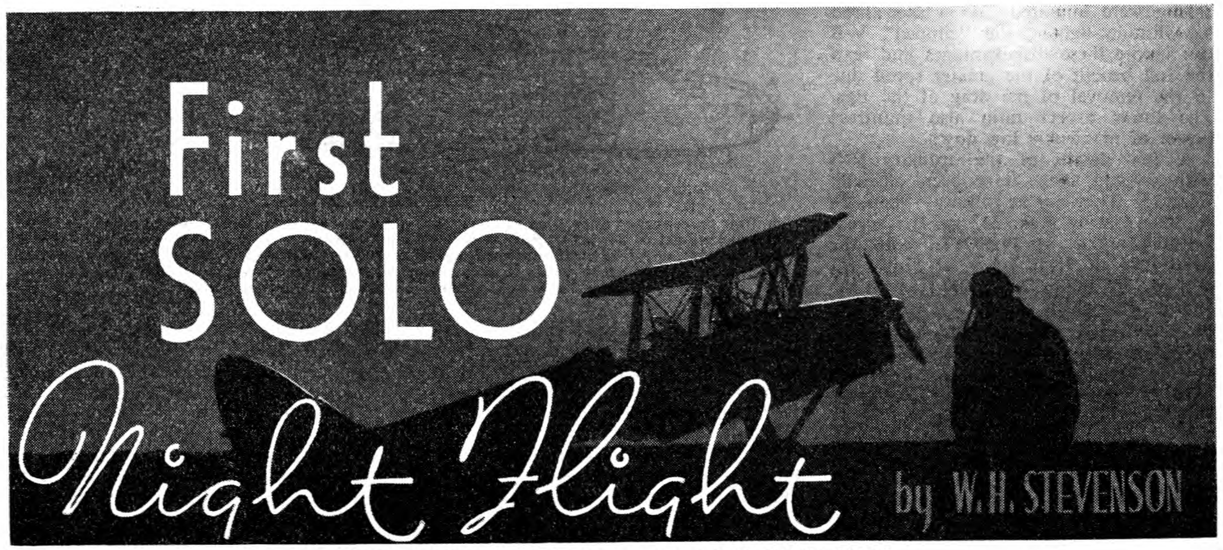
The PE-2, used for medium-height precision bombing, dive-bombing and reconnaissance by the Red Air Force, has been modified to include a turret in its armament instead of the manual gun position at the rear of the cabin, and in its new form is known as the PE-3.

Best known of all Soviet warplanes to the general public is the Iliuchin IL-2 Stormovik. A two-seat version is now in service, the IL-3, with the 1,300 h.p. AM-38 motor and a more formidable armament consisting of three cannon and five machine-guns. Top speed is well over 250 m.p.h.

Assisting the IL-2s in their low-level attacks are numerous Hurricane II-B twelve-gun fighter-bombers equipped with rocket-bomb rails beneath the wings. The original II-Bs left by the R.A.F. wing in Russia have since been supplemented by large numbers of Hurricanes sent via the northern convoy route. Spitfires and Kittyhawks are also serving the Russians, the Spitfires (V-Bs) being supplied through Iraq.

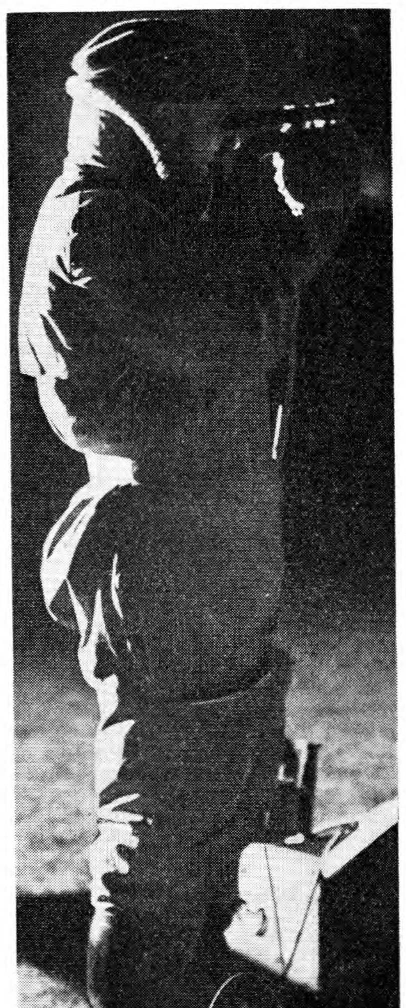
First SOLO Night Flight

by W. H. STEVENSON



"A Tiger Moth by day, but a fearsome monster in the dim light."

"O.K. to land." The Control Officer gives the green light.



"DO me one more good circuit, and you can take her solo," my instructor said only fifteen minutes ago. And now that I have completed the circuit with only one or two mild reproaches levelled at me from the front cockpit, here he is slowly unstrapping himself and preparing to leave me to face those pitch-black skies alone.

The engine of our machine, a Tiger Moth by day but a fearsome monster when viewed in the dim light of the present, rumbles quietly, the airscrew flattening the long grass so that it ripples like water in the ghostly green glow of our starboard navigation light. Outside this little pool of comforting brightness nothing is distinguishable bar variously coloured lights dotted in an irregular pattern about the airfield. Shorn of his normal vision, the pilot must interpret the meaning of each of those lamps if he is to project himself into the air safely and in the approved manner.

My instructor having freed himself from the machine, waddles towards me and shouts something in my ear. He seems confident. He tells me to taxi back to the duty pilot's position after I have landed and take him over to the marshalling-post. I promise to oblige if ever I reach ground again intact.

Off

Now he waves me away, and opening the throttle gently, for taxying at night is a tricky business, I roll forward to a position near one end of the flarepath from which I shall be able to see the duty pilot's signal telling me to get cracking.

Even above the broken beat of my engine I can hear the steady hum of the generator, its presence indicated by a large red lamp. Near it stands the "Christmas-tree," a triangle of lights guiding aircraft to the downwind boundary of the airfield. A group of white lights give away the position of the duty pilot, who stands ever-watchful, a modern wizard who, by careful manipulation of his Aldis lamps, keeps the circuit of aircraft going with an orderly and risk-free swing.

I make a rapid cockpit check and decide that the glow of the luminous dials on the instrument panel is insufficient, so switch on a tiny lamp which throws a soft orange light on everything and gives warmth and cheerfulness to the interior.

All is ready. I reach over to the starboard side of the cockpit and flash the Morse letter of my aircraft on the downward recognition-light key. Dit-dah, pause, pause, pause; dit-dah, pause, pause, pause; dit-dah. . . .

A green ray of light blinds me for a second. Having slipped across the grass it has found my machine and now holds me long enough to make its presence felt, informing me that my request to use the flarepath has been granted. I switch on my downward recognition light to steady and peep over the side to check that it is really on. Then carefully avoiding the tiny red glim-lamps which mark bad ground, I taxi to the bottom of the flarepath.

Up

I turn so that "Tiggy's" nose points to the last of the sparkling chain of lights. No ground is visible—only that string of shaded lamps with which I must keep parallel on taking off. I set my compass grid-ring with the lubber-line showing direction of take-off, and open to full throttle. Blue streaks splutter from the exhaust like a gas-jet, the machine quivers and gathers speed. The bulky form of the duty pilot, silhouetted against a light, slides past. Aiming for the end light of the flarepath, I steady the aircraft, keeping her straight by use of rudder and the bottom needle of the all-important turn-and-bank indicator. I keep the control column steady so that the take-off is made from three points, instead of pushing it forward as normally.

I should have said the take-off is supposed to be made from three points. But this time we bounce—oh! how we bounce—until I can almost hear my instructor saying in a pained tone: "For the love of Allah take her up or keep her down, laddie," and I feel certain we must be leaving the ground not only on two wheels and a tail-skid, but two wing-tips and a nose as well.

Alone in the Dark

Quite suddenly the chain of lights drops away, rather disconcertingly after the initial struggle to become airborne. I switch off the downward recognition light and continue climbing, checking with the aid of two tiny lamps below that I am not deviating from course. At 500 feet I push the nose down to gain a little extra speed and make a gentle half-rate climbing turn to the left on to the reciprocal of my original course.

Reducing throttle and settling down to cruising speed, I take up the attitude misnamed "straight and level flight." Ignoring the rolling, pitching and yawing movements through which "Tiggy" is going, one might call my passage through the air reasonably straight. My height, at any rate, remains at 1,000 feet.

If I have done everything correctly up till now I should be flying downwind and parallel to the flarepath. Trimming the machine, I glance over the side, and sure enough there are the twinkling lights below and to port. Another aircraft is just taking off, a triangle of three lights zipping along a pearl chain and throwing off blue sparks.

Two-thirds of the way along this leg a probing beam of light creeps through the slight ground mist and bathes me in eerie green light, replying to the signal I have been flashing for permission to land. I acknowledge it by switching the downward recognition light on to steady again. As the green pencil vanishes, I realise how detached I am from earth at this moment, and snatch a few seconds to glance around the sky, now patched with silver where the clouds have broken apart to reveal the moon. Up here all is cold and friendless, yet the place holds a fascination for me and a fleeting thought suggests "Keep going. Don't land yet."

Down

But this is surely madness which would grip me. Slightly annoyed at the way I have let my attention wander, even though for seconds only, I return to the job in hand. The flarepath is far enough behind for me to begin my turn across wind. A rate-one turn through 90 degrees does the trick, and I level out to see the flarepath, very much foreshortened, slip towards the leading edge of the port wing. I ease back the throttle and speed drops to a little over sixty.

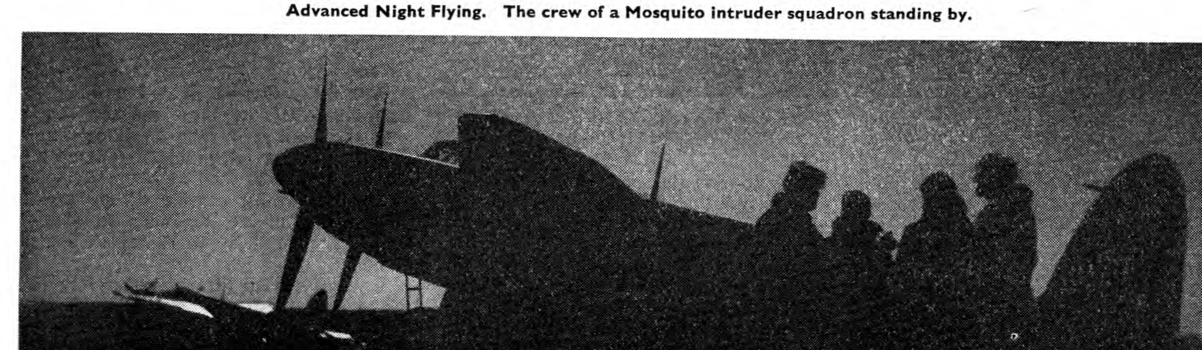
If I make my turn into wind now all will be set for a nice powered approach and landing. As I commence the turn I am still too high. I throttle back further and sink more rapidly. I know that if I can hold it I shall be making the correct approach.

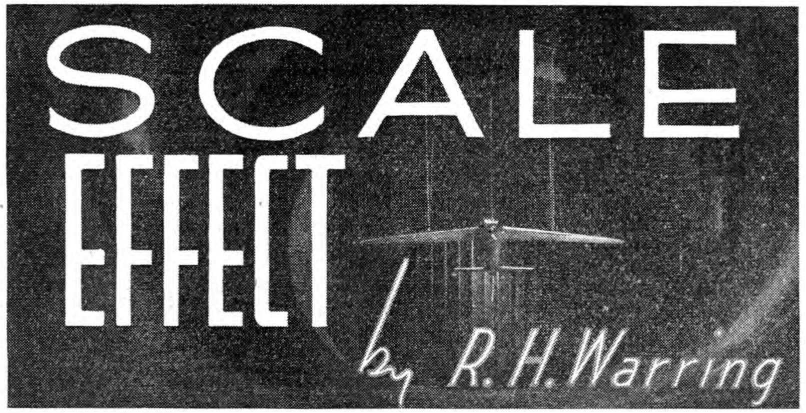
The flarepath rises slowly to meet me. The airfield lights are closer now, and I begin bringing the stick back very gradually. The indicator shoots past, followed by the flarepath lights, which file past one by one. I sense the nearness of the ground but resist the temptation to attempt a three-point landing, which seldom comes off. Every nerve in my body is tensed, waiting for the jar of wheels on ground. A tiny shock and we are no longer in the air; it looks as though this is going to be a nice wheel landing. I have cut the throttle, but nevertheless an involuntary back pressure on the stick puts the aircraft into the air again. "Ballooning" in the darkness is a nasty sensation, and I curse the way in which I have spoiled the landing. I touch down again with a series of thuds, slithering along the flarepath, the tail bouncing into the air. Reaching the end of the lights I turn off into the blackness beyond, stopping awhile to accustom myself to the fact that I'm back on Mother Earth, still safe and sound.

As I move away to pick up my instructor I notice that it is nearly 3 a.m., and realise that I'm feeling very very tired. Twenty minutes later, still wrapped in flying-kit, I'm dead to the world, stretched out in the luxury of an over-stuffed armchair in the crew-room. First solo night-flight is over, and even in sleep a deep sense of satisfaction cheers me.

The Real Thing. A Fleet Air Arm pilot climbs into his Albacore in Malta.

Advanced Night Flying. The crew of a Mosquito intruder squadron standing by.





Seldom will the average man come across the term Reynolds Number, yet in aeronautics, as in any other subject, it is good to know just a little more than is actually required for the job. In this way one gains confidence, in being able to understand and intelligently discuss any unexpected angle of technical conversation. Terms such as "Reynolds Number" and "scale effect" are more familiar to the designer and the research worker than to aircrews, and a full explanation is quite involved. This article attempts to give only a semi-technical explanation of the two terms and how they are employed.

SCALE effect means just what it says, namely, the effect of the scale, or size, of an aircraft upon its performance. One might expect at first sight that aeroplanes which are geometrically similar, such as a scale model and a full-size machine, should behave in exactly the same manner at their respective scale speeds. Actually they do not, as anyone who has built and flown model aircraft will know. In other words, a one-tenth full-size model tested in a wind tunnel at a scale speed of, say, 20 m.p.h., corresponding to 200 m.p.h. on the actual machine, will not give results in simple proportion to the geometric scale. Neither are these differences determinable by pure mathematics.

Thus we introduce a further scale, an *aerodynamic* scale, in fact.

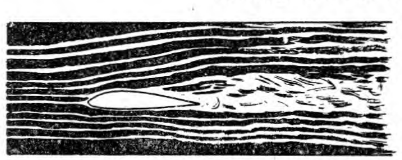
It is not possible in aerodynamics, as it is in geometry, to change from one aerodynamic scale to another with any great degree of accuracy unless the calculations are based on numerous practical experiments at different (aerodynamic) scales. This difference is due to scale effect, and is one of the chief problems met with in wind-tunnel testing.

Like every other scale, aerodynamic scale must have units of measurement, and this measure is called the Reynolds Number, named after the famous English physicist Professor Osborne Reynolds. The exact meaning of the Reynolds Number will be explained later.

Let us take a simple analogy. The edge of a sharp razor blade may be pressed into the palm of the hand without cutting if the pressure is evenly and slowly applied, but a quick slash will cut deeply. So it is with air, which resists all attempts to displace it. The relative effect of the air on a body passing through it depends upon the speed at which it is attacked and the size of the body. At low speeds it resists separation and is sluggish; at higher speeds the rapid "attack" readily separates it.

Hence at low speeds and small scale one could expect less efficiency, which is borne out in practice. As with the razor blade, one cannot, however, expect increasing efficiency with increasing speed and scale without limit. At extremely high speeds compressibility effects come into force which give adverse results, but that is beyond the scope of this article.

Drawings based on Wind Tunnel observations



Early separation of airflow at small angle of attack at low Reynolds Number.

Same section at same attitude at higher Reynolds Number.

A simple relationship exists between aerodynamic scale, velocity and geometric scale (provided that the air remains "standard"). For aerodynamically similar properties the product of the velocity and some fixed dimensions of the machine or model must be the same. This dimension is nearly aways taken as the average chord of the wing, or for body tests the length of the body (sometimes the cube root of the volume) and is measured in feet (or metric units). The velocity is measured in feet per second (or, again, metric units).

Our one-tenth scale model, then, must fly at *ten times* the velocity of the full-size machine, i.e. $10 \times 200 = 2{,}000$ m.p.h., to have the same aerodynamic properties. Such speeds are impossible or impracticable, and even if they were not, compressibility effects would introduce a further error.

Thus in order to obtain results from a wind tunnel at or approaching the Reynolds Number of the full-size machine, either the wind speed must be very high or the tunnel large enough to accommodate a very large model. There are tunnels where the full-size machine itself may be tested, but the smaller tunnels are more common. Scale effect in these cases must be estimated in working out results, based on specific test data obtained on test-pieces at varying Reynolds Numbers, previous corrections being checked against actual flight tests carried out by the full-size machine.

There is another way of partly getting around this difficulty. The full mathematical expression for the Reynolds Number is:

$$\text{Reynolds Number (R.N.)} = \frac{\rho V l}{\mu}$$

$$\text{or R.N.} = \frac{Vl}{\nu}$$

where ν, called the kinematic viscosity of air $= 1.59 \times 10^{-4}$ ft.^{2}/sec.

Now, instead of keeping the product Vl constant, the air itself may be compressed and thus its density increased. From the first equation it will be seen that increasing the density has the effect of increasing the Reynolds Number.

Several such wind tunnels have been built in which the working airstream has a density of from four to five times greater than that of standard air. In this way the geometric scale (i.e. l) may be kept within reasonable proportions, or the working velocity kept reasonably low, or both. Or, working with a relatively large scale model and as high an airspeed as is practicable, results at a Reynolds Number near to that of actual flight are possible.

The effect of Reynolds Number on aerodynamic forces may be summarised briefly as under.

Effect on Lift

With decreasing Reynolds Number i.e. decreasing Vl, the most marked characteristic is an early stall. A model wing operating at a Reynolds Number of about 60,000 will stall at approximately 10 degrees, whilst a wing of the same section at full-size Reynolds Numbers will not stall until 16 or 17 degrees angle of attack.

A set of typical lift curves is given in Fig. 1, but these only strictly apply to the section concerned. Different sections behave differently, but generally the early

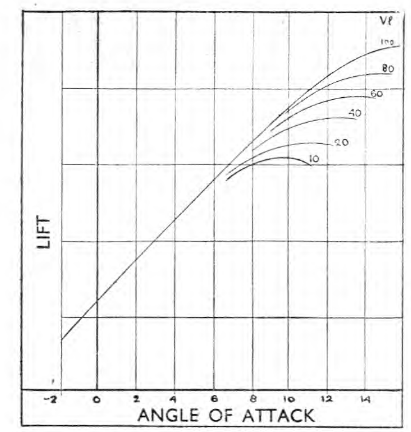


Fig. 1. Scale effect on lift.

stall is most marked on thicker sections.

In all cases there appears to be an upper limit. Thus with increasing Reynolds Number the maximum lift increases up to a certain value and remains at this for further increases in R.N.

Effect on Drag

Another graph, Fig. 2, shows simply the effect of R.N. on drag. With increasing Reynolds Number the drag decreases, up to a limit, when it remains appreciably constant. These limits are generally taken as representing figures for full-scale R.N.

Unfortunately for the research worker, such generalisations do not apply to all aerofoils and body shapes. Some sections behave very erratically, whilst others closely follow certain general rules. Hence the importance of wind-tunnel tests carried out at R.N.s as near to that of full-scale flight conditions as possible is clearly shown.

The terms Vl and Reynolds Number are closely related, as shown in the formula, and since all results are corrected to standard air it is more convenient to employ Vl for quick calculation, since this involves only simple multiplications. To change Vl into the corresponding Reynolds Number, simply multiply by 6,300, i.e.

$$\text{Reynolds Number} = 6{,}300 \times Vl.$$

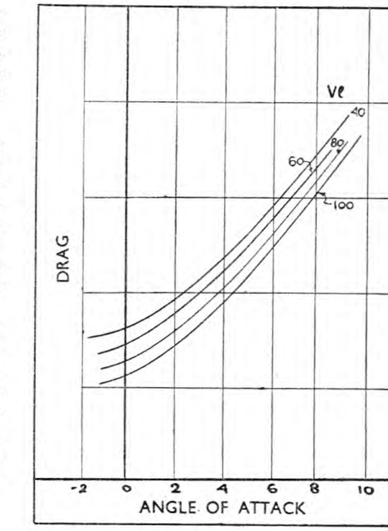


Fig. 2. Scale effect on drag.

Some typical working Reynolds Numbers are as follow:

Model wing	50,000
Light-plane (full-size) wing .	5,000,000
Small wind-tunnel test-piece	2,000,000
Large wind-tunnel test-piece	30,000,000
Variable-density wind tunnel	200,000-10,000,000
Spitfire wing	22,000,000
Transport aeroplane . . .	20,000,000
Airship (based on length) .	500,000,000

This large wind tunnel is used by a group of aircraft manufacturers in Southern California.

WHAT IS NAVAL AIRMANSHIP?

by Captain NORMAN MACMILLAN, M.C., A.F.C.

THERE are several distinct varieties of naval airmanship.. These can be divided into (1) the Fleet Air Arm—in aircraft carriers, capital ships and cruisers equipped to carry aircraft, and even to submarines, which may be fitted with a hangar for a seaplane, and in the larger types which might have a catapult; (2) Coastal Command; (3) the Merchant Ship Catapult Unit; (4) Bomber and Fighter Commands when employed on naval tasks; and (5) Fleet Air Arm units when stationed on shore—as in the case of the Swordfish squadron which attacked the Scharnhorst and Gneisenau when they passed through the English Channel on February 12th, 1942, and that of the Fleet Air Arm aircraft which co-operated in the Western Desert with the British Eighth Army.

In the broad sense, these sub-divisions are all examples of naval airmanship, but from the more specialised point of view naval airmanship must be regarded as airmanship which has for its specific object the furtherance of the duties of one's own ships; it is the air co-operation which enables one's own ships to carry out their tasks that comprises true naval airmanship, rather than that form of less immediate assistance which prevents the enemy ships from fulfilling their tasks.

Interdependence

The duties of the three combatant Services are so interwoven as to make it impossible to draw a distinct line of cleavage, and thus say that on the one side there is naval airmanship and on the other there is not. Attacks upon the Mediterranean ports by R.A.F. and F.A.A. aircraft are of combined naval, military and air value. They reduce the enemy's sea power, interfere with his supplies, and hamper his war effort. The attacks made by the R.A.F. upon the *Scharnhorst, Gneisenau* and *Prinz Eugen* when they lay in Brest and during their passage through the English Channel fell into a different category, for those attacks were directly naval in character; but, it must be remembered, they also had a wearing effect upon enemy industry which had to be employed in repairing damage instead of using men and materials to make new weapons.

The Distinction

For these reasons it is necessary to try to define what we mean by naval airmanship. Obviously it is not simply the duty of attacking targets of a naval character, for that is frequently the task of the R.A.F. Nor is it to be defined solely by operation of aircraft from ships, for, as we have seen, F.A.A. units have gone into action from bases on shore.

The term "airmanship" is foreign to the R.A.F. It is the naval counterpart of seamanship. That leads directly to a definition of naval airmanship as the air operations of sailors. The distinction is less one of task than one of Service. The Royal Air Force is dedicated to the service of the air, even when it is protecting convoys, bombing ships, sinking coastal vessels with cannon-fire. What is the essential difference between bombing a factory or a ship? Or in shooting-up a locomotive on a railway track or a motor-vessel in the tidal lanes? The R.A.F. must be ubiquitous, and its training must be fitted to its manifold tasks. Naval airmanship serves the sea. It is a specialist branch of the Royal Navy. It has to be accommodated to maritime conditions. Naval airmanship is an extension of sea power into the air above ships, the opposite of the extension of sea power under the sea by means of the submarine.

Sea Power

The purpose of naval airmanship, then, is to maintain sea power. The object of sea power is broadly to maintain to oneself the freedom of the seas and to deny it to the enemy. It is therefore a form of power exerted primarily to give to the stronger maritime nation the advantage of surface-water communications, which provide both the cheapest form of transport and the greatest bulk-transport system.

To an island people like the British, sea communications are essential to survival, either in peace or war. The Americans are not in quite the same position, for they have far more land upon which to support their population. Nevertheless, the Americas form a great continental island, separated from every other continent by water, and, as things are to-day, war can be kept from them or be fought by them only if they and we together possess the control of the seas to deny passage to the enemy and ensure passage of men and materials from America.

Germany made her great bid for surface sea power in the war of 1914-1918. It failed. This time Germany did not divide her energies by making a bid for surface sea power. Instead, she concentrated on the submarine in an effort to destroy that British and American control of the seas which she could not wrest from us by surface challenge.

The Royal Navy, the Fleet Air Arm and the R.A.F., together with Dominion and American units, broke the Italian surface sea-power challenge in the Mediterranean Sea before the invasion of Sicily started. Fleet Air Arm aircraft from the carrier *Illustrious* attacked the Italian Fleet lying in harbour at Taranto on the night of November 11th, 1940, and severely damaged and partially sank two battleships, two cruisers and two fleet auxiliaries.

The United States Navy, together with the Royal Australian, New Zealand and Dutch Navies and the combined Air Forces, are steadily breaking the sea power of the Japanese in the Pacific Ocean, a power in that largest of all oceans never fully challenged before. They wield a tremendous threat from the air above the ships. For example, in the sea battle of Midway Island, which secured the Hawaiian Islands from Japanese attack, the Americans sank four enemy aircraft carriers, two heavy cruisers, three destroyers and a transport, although the fighting ships never came into contact. All these ships were sunk by aircraft.

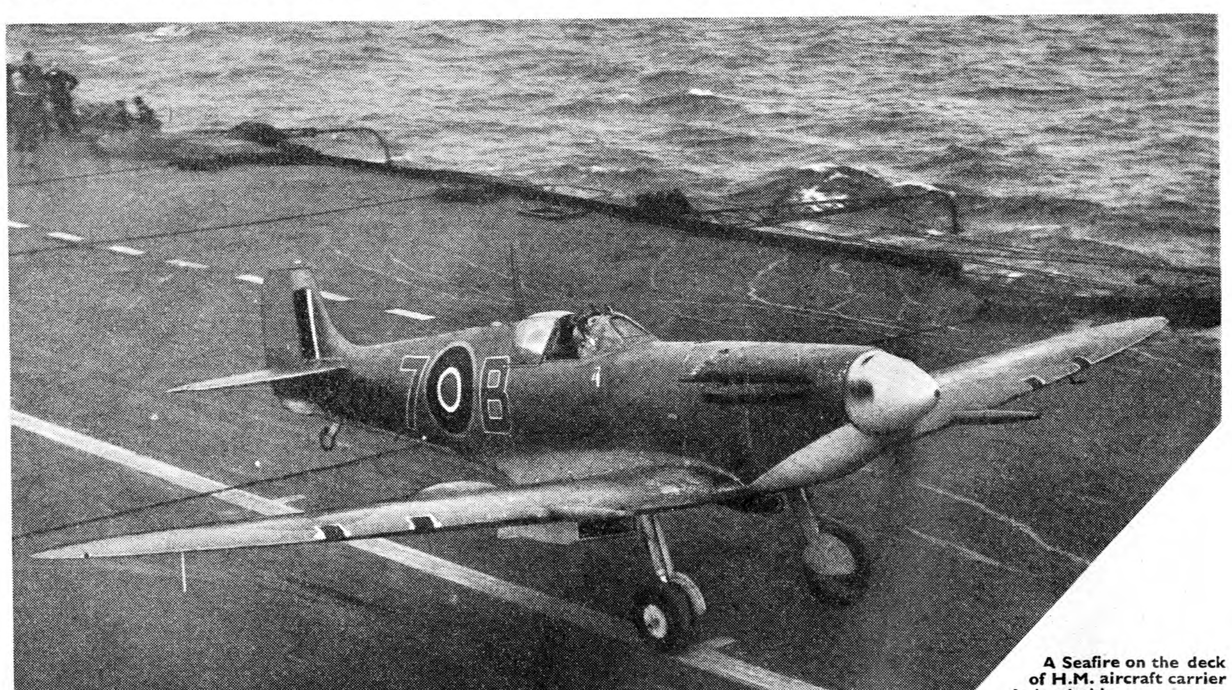
We ourselves lost the *Prince of Wales* and *Repulse* to Japanese bomber and air torpedo attack off the Malayan coast.

The Sea Tradition

Naval airmanship is, however, not all devoted to the attack on large surface ships. Such targets are the exception rather than the rule in the air as on the surface of the sea.

Naval airmanship extends the vision of the sailor far beyond the horizon visible from his ship's lookout. It provides him with intelligence of the movements of the enemy in the air, on the water and under the water. It has to protect the surface ship from air attack and aid in its protection from submarine attack. It has to destroy the enemies of the surface ship wherever they may be found, on the high seas, in harbour, in the air and under the surface.

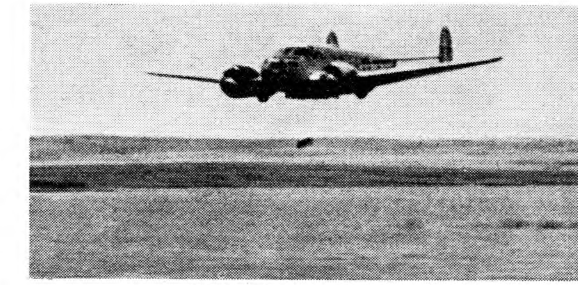
Men have sailed in companies in ships for centuries, living apart from their fellows on shore. They have developed their own traditions; their idiom and their ways of thought have been trimmed to the ships they served. Naval airmanship is tied to their ways of thought and to their words of speech, because it serves the same ships as the sailors. To the sailor naval airmanship is a screen to protect the ship and a weapon to extend its power. Those who have the sea in their blood will find the modern answer to the ancient urge in naval airmanship amid the gallant company of aircrews whose air service is dedicated to the service of the sea.



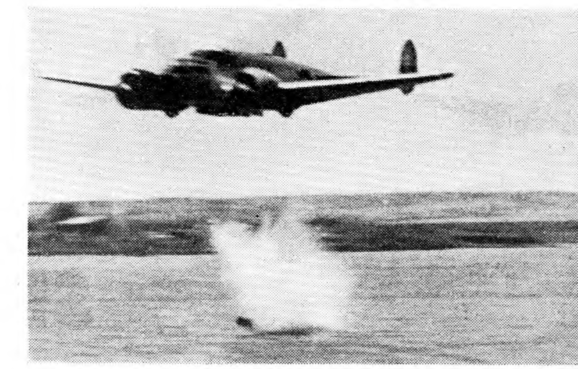
A Seafire on the deck of H.M. aircraft carrier Indomitable.

SKIP BOMBING

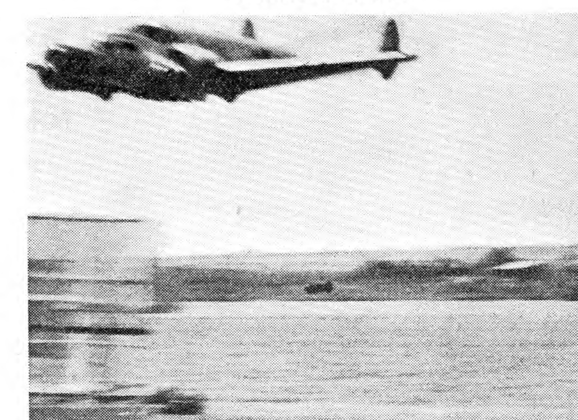
Skip bombing is like the game you play at the seaside, skimming a pebble along the surface of the water. On striking the water the bomb skips in the direction in which the aircraft is flying. It can be done on land as well as on water.



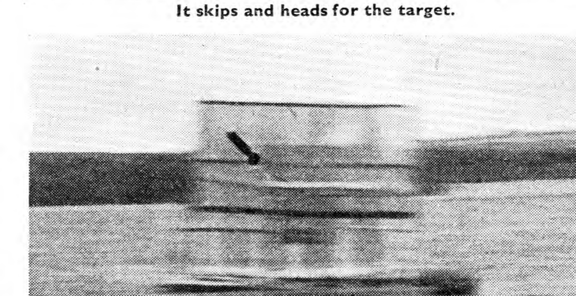
The bomb leaves the aircraft.



It strikes the water.



It skips and heads for the target.



A direct hit right through the target.

A SPOT OF SPOTTING

FOR KEY SEE PAGE 22

WHAT CAN YOU TELL BY TAILS?

Tails are of interest to the student of aerodynamics as well as the spotter. They give clues to the size, shape and speed of the aircraft for they comprise the main balancing and control surfaces and must therefore be designed and modified to the needs of the main structure. If you cannot name some of these try estimating the size and speed of the aircraft to which they belong, and see how right you are by referring to the key on page 22.

AIR CHIEF MARSHAL LORD DOWDING

by C. G. GREY

AIR CHIEF MARSHAL Baron Dowding of Bentley Priory, G.C.B., G.C.V.O., C.M.G., A.D.C., one of the most famous of the senior officers, now retired, of the R.A.F., is best known as the Air Officer Commanding-in-Chief, Fighter Command, R.A.F., during the Battle of Britain. He had built up Fighter Command since its creation by the Air Council in 1936, and his headquarters then were at Bentley Priory, hence the choice of that historic if unedifying edifice as the territorial designation of his peerage.

Hugh Caswall Tremenheere Dowding was born at Moffat, Dumfries, on April 24th, 1882, but, because "by Tre, Pol and Pen you may know the Cornish men," one may assume that he is of Celtic descent.

Like the present Chief of the Air Staff, he went to Winchester. Thence he went to the Royal Military Academy, otherwise "The Shop," at Woolwich, where they teach real engineering.

He was gazetted to the Royal Artillery in 1900, and served in India and the Colonies before learning to fly at his own expense in 1913 at the Vickers School at Brooklands. His pilot's certificate is No. 711. During that time he passed through the Army Staff College at Camberley.

He joined the Royal Flying Corps Reserve in April 1914 as a Captain R.G.A., and was seconded as a flying officer in August 1915.

He was employed as a General Staff Officer, 3rd Class, or G.S.O.3, from December 12th, 1914, graded as flight commander, and was promoted temporary major and graded as squadron commander in March 1915. He became a substantive major in the Royal Artillery in December 1915.

In July 1915 Major Dowding was commanding No. 16 Squadron, R.F.C., in France. In February 1916 he was promoted to lieutenant-colonel, graded as wing commander, and given command of No. 7 Wing in Home Establishment. But in June 1916 he was out in France again, commanding No. 9 Wing.

Lt.-Col. Dowding came home again in December 1916 and was appointed temporary colonel in January 1917, when he took over No. 7 Group. In June 1917 he was appointed temporary brigadier-general and brigade commander, R.A.F. In April 1918 he was promoted to substantive colonel (temp. brig.-gen.) for administrative duties at home in North-Eastern Area.

On January 1st, 1919, he was created a Companion of the Order of St. Michael and St. George for war services.

In August 1919 he was re-seconded from the R.G.A. to the R.A.F. for two years, resigned from the R.G.A. and was given a permanent commission in the R.A.F. as group captain—all in one day. A month later he was graded air commodore while commanding an Area.

On January 1st, 1922 he was promoted to air commodore as Chief Staff Officer to the A.O.C. Inland Area. And in the New Year's honours of 1923 he was gazetted a Companion of the Bath.

Air Commodore Dowding went to Iraq as C.S.O. to the A.O.C. in September 1924, and came back on appointment as Director of Training, in the Department of the Air Member for Personnel, in May 1926. On January 1st, 1929, he was promoted air vice-marshal, and gave up the post of Director of Training to take over temporarily the command of Palestine and Trans-Jordan. He came back in December 1929 to take command of Fighting Area, Air Defences of Great Britain—that was his first command specifically of fighters.

On September 1st, 1930, Air Vice-Marshal Dowding was appointed to the Air Council as Air Member for Supply and Research, and to him is due largely the remarkable progress which was made, with our fighters and bombers in particular, between then and 1936, when our panic expansion scheme began.

During that period I had a slight discussion with him over a matter of research, because I had criticised in print a principle which, I still think, puts civilian technical people in a false position. And the respect which I had always had for him was permanently increased by the way in which he dressed me down and stuck up for his minor officials. Although they were only civilians and bureaucrats, he was as loyal in supporting them as if they had been serving officers.

In January 1935 Air Marshal Sir Hugh Dowding, who had been promoted to Air Marshal in January 1933 and to K.C.B. in June 1933, became Air Member for Research and Development, but soon after, in July 1936, he was made Air Officer C.-in-C. Fighter Command.

There he built up the organisation which won the Battle of Britain. He selected the officers who commanded the Groups—Air Vice-Marshal Keith Park, of No. 11 Group, Essex to Hampshire, which took the main load of fighting; Air Vice-Marshal Sir Quintin Brand, No. 10 Group to the West; and Air Vice-Marshal Trafford Leigh-Mallory, No. 12 Group to the North. He approved the eight-gun fighters which won the mechanical side of the battle. For four years he studied and put into use new tactics and new ways of training for them. And he well deserved his promotion to Knight Grand Cross of the Order of the Bath, which he was given in September 1940, as soon as might be after the battle was won and we were saved from invasion.

Shortly after the Battle of Britain he retired, but was sent on a mission to the U.S.A. to tell the chiefs of their Army Air Corps something of our experiences in the Battle. I gather from friends in the States that he did it highly effectively. But he is not given to what is now known as "shooting a line," so he had not a good press over there.

In 1941 he was asked to review the "establishments" of the R.A.F.—not a general march-past, you understand, but a sort of inquisition into waste of man- and woman-power to see whether we could in the field of human endeavour owe still more to still fewer.

Ever since Captain Dowding, R.G.A., joined the R.F.C. in 1914 he has been known as "Stuffy." A nickname is generally a compliment and always a recognition of personality in the Services. His grew because of his manner of delivering the concise and comprehensive remarks, maxims, epigrams, or aphorisms which are his very own line of humour.

I think that the first aphorisms popularly attributed to him in the early days of the last war was: "The life of a military aviator seems to consist of hours of idleness punctuated by moments of intense fear"—which is not so true now as it was then, but still applies. And the R.F.C. in those days had a whole stock of Stuffyisms, most of which he would probably disown.

Between wars, while he was in Iraq, an old Kurdish sportsman named Sheikh Mahmoud was continually in rebellion, and the R.A.F. were kept constantly in training chasing him and bombing his fortified villages. Sheikh Mahmoud got bored with being chased and came in and surrendered to the R.A.F. The story goes that when the news reached the Air Ministry Air Marshal Dowding went into the office of the C.A.S. and said: "Oh, Salmond, I have just come in to offer you my sympathy in the loss of your Director of Training in Iraq." If the story is not true it ought to be, for it is in quite the right style.

On August 12th, 1939, less than a month before the outbreak of war, Air Chief Marshal Sir Hugh Dowding broadcast from the B.B.C. a short summary of some exercises which had just ended. He said that he would like to leave his listeners with a feeling of quiet confidence in our defence organisation, while not neglecting wise precautions to minimise such attacks as did get through.

He ended his address by saying: "It only remains for us to see that our technical equipment keeps ahead of that of our potential enemies. What we have been doing is to work towards the hundred per cent which is our goal. I am satisfied with our progress, and I confidently believe that serious air attacks on these islands would be brought to a standstill in a short time."

How right he was. He built up the Fighter Command and he commanded it in its supreme moment of glory. What more could a man wish?

American Technical Terms

BY P. W. BLANDFORD

THE Americans seem to favour "ship" where we would use "aircraft," while "airplane" is their equivalent of our "aeroplane" (which in this country has now been dropped in favour of "aircraft"). Their "gasoline" or "gas" for "petrol," and "kerosene" for "paraffin," are well-known. Other general terms which explain themselves are "disassemble" as the opposite of "assemble," "oilpan" for "sump," "tag" for "label," and "ground" for the electrical "earth."

Undergrounded

Not so obvious is "undergrounded" as applied to an ignition switch. When an ignition switch is off, it is earthed or grounded, and "undergrounded" is the name given to the opposite position, when it is on. The external battery which we use for engine starting and refer to as a "trolley battery" is called a "cart battery." An American electrical socket is referred to as a "receptacle."

Popoff

An hydraulic jack may be called an "actuating strut" or an "hydraulic cylinder," while a safety valve has the very descriptive title of "popoff." A non-return valve is a "check valve." The fork joint used in flexible couplings is called a "clevis." The word "paulin" without its context appears strange, but when read in a sentence will be seen to be a shortening of "tarpaulin," in this case engine and cockpit covers. The American insignia of a star in a circle, the equivalent of our roundel, is called a "cocarde."

Slushing Compound

Most names given to engine parts are very similar to ours. A "blade connecting rod" is a plain connecting rod. A "cotter pin" we more commonly call a "split pin." The wrist pin on a radial engine is called a "knuckle pin." Our "gudgeon pin" is a "piston pin." The fluid used to inhibit an engine which is to be stored is known as "slushing compound." Fuel and oil cocks are often called "valves," although "cock" is also used. The inlet and exhaust manifolds may be "stacks."

Boost pressure is referred to as "manifold pressure." Where our boost gauges are calibrated in lbs./sq. in. above or below atmospheric pressure, American gauges show equivalent barometric pressures in inches of mercury. As the normal atmospheric pressure is about 30 inches of mercury, this is the equivalent of a boost pressure of 0 lbs./sq. in. To convert a boost pressure reading in its American form to the British equivalent, subtract 30 and divide by 2.

Short-Measure Gallons

An American gallon is not the equivalent of a British or "Imperial" gallon. The proportion is about 5:6, or, correct to four places of decimals—1 Imp. gal. =1.2009 U.S. gals., and 1 U.S. gal.= .8327 Imp. gals.

The parts of an aircraft are generally named the same as ours. The parts of a wing are called "outboard" and "centre panels" instead of "outer or main plane" and "centre section." The tail unit complete is called the "empennage," a term which has been used in this country, but is not now favoured. In the U.S.A. the tail plane and fin are called "horizontal" and "vertical stabilizers" respectively.

THE VITAL LINK

by REX RANSLEY

"The crowds gathered round."

THE Link Trainer, invention of a young American, Edward Link, is to-day speeding the flying training of thousands of young airmen of the United Nations.

The Trainer can even reproduce exactly the effects of stalls, air-pockets and iced-up wings. By using the Link Trainer in the early stages of a pupil's tuition the period of actual flying training can be greatly reduced.

Link started his experiments in 1927, when he was 23. His workshop was a corner of his father's busy organ factory. He had had no engineering training, but as a boy, prowling about the factory, he was perpetually tinkering with bellows and compressed-air gadgets. His first Link model he built for his own amusement, using odd scraps of junk, discarded piping and an antiquated bellows. Then the startling possibilities of his idea occurred to him. He went to work seriously.

There were long months of wasted experiment and constant disappointment. As quickly as one problem of mechanical design was overcome a new one developed. But eventually his first orthodox model was completed and passed its tests. It was a queer-looking contraption, very different from the imposing Link Trainer of to-day. But despite its ungainly appearance it was a unique achievement, the first successful attempt to ease the difficulties of training flyers by a working model.

Eagerly Link opened a small factory and began commercial production. Then came bad luck. The great financial depression that struck the United States in 1930 wiped out thousands of business enterprises Link, with no capital to weather the storm, suffered with the rest.

He was broke. But he had courage and initiative. He loaded his Trainer on to a lorry and drove to a fairground. The crowds gathered round interestedly.

"Link Flights! Twenty-five cents a time!" shouted the enterprising inventor. He was almost bowled over in the rush. His brainwave was a money-maker. Takings poured in, swelling to a flood that, by 1934, enabled him to begin commercial production once again, provided with plenty of capital.

This time he set to work to popularise his device not as a fairground sideshow, but as a serious and valuable contribution to aeronautical progress and a means of quickly training pilots for the swift-spreading network of civil airlines.

Like many inventors before him, Link encountered scepticism and refusals. He countered with facts and demonstrations.

"My Trainer can cut flying-training time by half," he said bluntly: and proceeded to prove it. His brother George, a Link enthusiast, got his "wings" as a solo flyer after only 42 minutes of dual instruction.

At last came official recognition. The Link Trainer was adopted by the U.S. Bureau of Air Commerce. The U.S. Army became interested. Soon enquiries came in from foreign governments, busy expanding their air forces as war clouds began to gather.

To-day the business that began in a corner of a workshop is a gigantic enterprise employing thousands of skilled workers. A single order for £1,000,000 worth of Link equipment is almost commonplace. Trainers are manufactured at two huge up-to-date factories, one in Canada, the other in the U.S.

The early models, costing about £1,250, were of fairly simple design. But gradually, often at the request of Service experts, aviation schools and foreign air forces, new refinements were incorporated, delicate radio equipment installed and new devices introduced. There are now several different models ranging in price from £1,250 to £2,500.

To-day the Link can not only teach a pupil to fly: it can also give him practical training in landing on a radio beam, the system used for guiding a plane to a safe touchdown in darkness or fog and to prevent collisions in landings and take-offs.

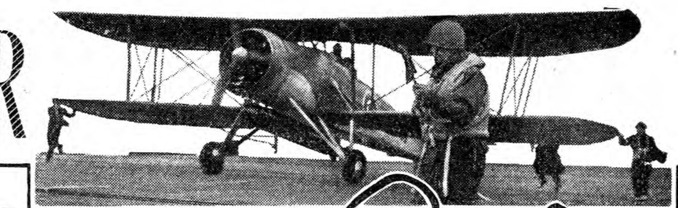
Another device is a recording meter carrying a spool of paper on which is automatically traced the course of the "plane" during a Link "flight," a valuable visual aid which can be studied and analysed by the pupil.

More vital than ever to-day, as the United Nations train thousands of young aviators for the final onslaught against the enemy, the Link Trainer is being used in the air forces of Britain, the United States, Russia and China.

Nor will its value lessen with victory. For in the tremendous post-war boom that may be expected in civil aviation the Link Trainer will be an indispensable aid to busy flying-schools.

An American instructor explains to an R.A.F. cadet the controls of a Link Trainer.

A NAVAL OFFICER says — *There's something about a Swordfish*



PERHAPS once in the lifetime of every designer will come an inspiration which will result in an exceptionally good aircraft. It may be born of a pipe-dream or be merely the product of hard work blessed by the goddess of good luck. But whatever the origin, every pilot who lays his hands upon it will instantly know that it is exceptional.

Such an aircraft is the Fairey Swordfish. Coupled with the name "Fairey" must go the word "Bristol," for without Bristol's Pegasus engine the Swordfish might be something less than great.

It is strange that a pilot should write in such terms of an aircraft which by the standards of modern design is ten years out of date. How extraordinary, you may say, that a biplane with a maximum speed of only 150 miles an hour continues to be a success in the year 1943. There must be something about it. Well, there is.

Right at the beginning, before you start thinking of hurling the 1,500 lb. of bombs from its wings, or the massive torpedo from its belly, you know that you have got a friend. When you are fighting your way through the darkness towards a lurching flight deck, or are alone a hundred miles out over an empty waste, a friend is something worth having.

The first time I ever saw a Swordfish was at a deck-landing practice for a course of new pupils. They were staggering through the air towards the dummy deck held up only by what I thought must be a miracle. They looked to be completely stalled fifty feet up. Their wings swayed, first to one side and then the other. Nothing, it seemed, could prevent an immediate spin, and disaster. It was only when I sat in the cockpit myself, made the same run towards the deck at a staggeringly slow speed, and I felt the firm and instant response to the controls, that I knew at last that I was flying the product of a designer's genius. Think what such qualities mean on a dark night when the carrier's deck below is pitching the height of a house.

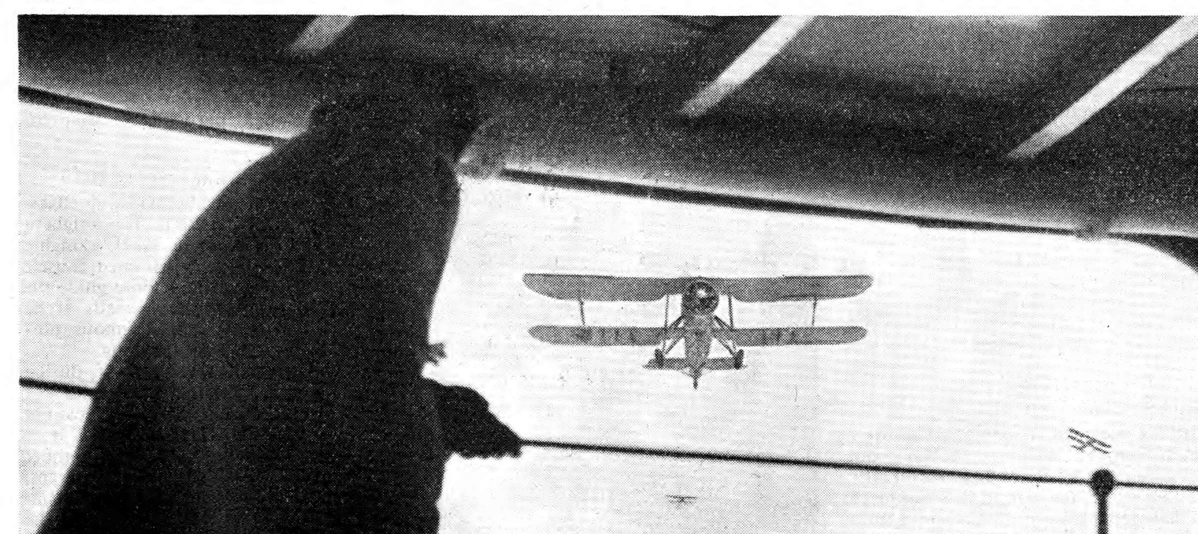
That first flight was a revelation in more than one direction. I had taken off without being aware of it—it flew itself off. In experimenting with violent, and still more violent, turns, I found that it was easier to fly than even a Tiger Moth. I could fly the rate-of-turn indicator off the dial, and, what is more, fly so badly that I knew that most other aircraft would have stalled and spun long before. The old Swordfish just did nothing—its 690-horsepower engine growled away cheerfully as much as to say: "Really, old man; isn't it time you grew up?"

From the operational point of view the pilot has got something else as well. He is probably introduced to it one fine morning when he sees a squadron of Swordfish peeling off into an almost vertical dive. Nothing in that, of course. But when he sees that the dive is held to within a few feet of the water he will be frankly horrified. "This isn't flying," he will say; "it's suicide." Then he goes and does it himself. He finds out two things—that his Swordfish will manœuvre in a vertical plane as easily as it will straight and level, and that to bring it out of the dive does not require a strong-man act on the stick, helped maybe by a few desperately hurried turns on the trimming-wheel. A gentle pressure on the control column pulls it out as quickly and as safely as it went in.

The second time he dives he will notice —even though he comes down from 10,000 feet—that his A.S.I. never rises much beyond 200 knots.

Translate this into terms of a night torpedo attack when the moon is glinting on a glassy sea and the enemy is a faint silhouette on the moon's track, and the pilot is relieved of half his worries—that of getting the aircraft out of the dive in time. He can concentrate on hitting his target, jabbing the rudder bar or man-handling the control column in the sure knowledge that he's virtually safe from a high-speed stall.

That is why Swordfish have gone out and come back safely on nights so rough that the chief cook hadn't the heart to put the ship's cat out. That is why, for night operations when high speed is not vital for getting away, Swordfish are still the greatest torpedo bombers in the world —in the eyes of the pilots who fly them.



FITNESS FOR FLYING

by **A Medical Officer**

THE specialised fitness-training of the airman must be aimed at developing his powers of resistance to the effects of high altitudes, sudden changes of direction and speed, and other abnormal conditions peculiar to flying. It should begin, therefore, with an understanding of the manner in which the human body adapts itself to unusual conditions of living and working. Its power of adaptability is vast, as long as the transition is effected gradually; in aviation much of the difficulty arises from the fact that changes from high to low pressure, or from heat to cold, occur with rapidity.

The muscles of the arm and forearm may develop considerable strength through exercise, yet fracture of an arm bone has occurred from the sudden contraction of a powerful muscle while a cricket-ball was being thrown. The trained ballet-dancer can stop abruptly in the middle of a whirling dance, and remain motionless and erect, yet the novice, after even a few turns, will be seized with vertigo and stagger or fall. Persons who have lived for years close to a busy railway line cease to notice the noise of the traffic, and may even be unable to sleep if they move to the quiet of the countryside. These are but a few examples of the way in which Nature adapts herself to environment or to occupational needs.

Some of the effects produced by flying are physical and mechanical, and some, like the railway-line instance in the examples mentioned above, are largely psychological.

Air Sickness

The psychological, or mental, element is present in air sickness, as is shown by the fact that those whose minds are diverted by some occupation while flying are less likely to be sick. The main cause of the air sickness, as in the case of the novice attempting the whirling dance, is sudden and unaccustomed strain on the centre of equilibrium in the internal ear; it is not the speed, but the sudden changes in speed and in direction, as in turning, which give rise to the disturbance. The constant noise and vibration, by inducing fatigue of the nervous system, are contributory factors.

Prevention of this condition is, therefore, achieved largely by maintaining a healthy nervous system, and by the practice of such sports as ski-ing or ice- and roller-skating. A light meal, with little fluid, and with additional carbohydrate in the form of glucose to combat the sensation of cold, will lessen the tendency to vomit.

Altitude Sickness

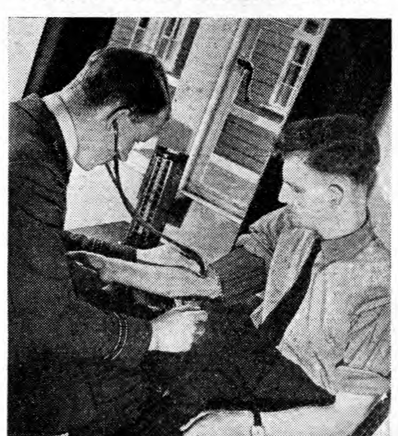
Altitude sickness, a condition entirely distinct from air sickness, results from rapid ascent to levels of low barometric pressure. Here the effects are produced by a lessened pressure of oxygen, with a consequent lessening of the amount carried by the blood to the tissues. They are comparable to the effects which would occur in a man who had been working under pressure in a caisson, as in bridge-building in a river, if he were brought to the surface without the pressure being gradually decreased.

In more gradual ascents, as in mountaineering, Nature acclimatises the person to the change by producing an increase in the red-blood cells to carry the oxygen, but in rapid ascents an increase in the supply of oxygen has to be provided by artificial means.

A point to be remembered by the pilot is that the decreased atmospheric pressure results in an expansion of gases in the body cavities. This may have little effect on the nasal and other bony sinuses, and the cavity of the middle ear, as long as the passages which connect them with the outer air are unobstructed. If these are blocked, as when the Eustachian tube which leads from the middle ear to the back of the mouth is blocked by catarrh, such symptoms as deafness and giddiness are increased. Cleanliness of the mouth and throat, and the avoidance of dental sepsis, tend to prevent this condition.

Expansion of gases in the stomach and intestine may be more painful and dangerous. Such gases arise largely from the fermentation of starchy foods, such as potatoes, or of fresh bread, especially if the food has been hastily swallowed, instead of being thoroughly masticated in contact with the saliva, with sufficient interval after swallowing to allow of digestion. Constipation not only increases the tendency to gas formation, but causes the bloodstream to absorb poisonous material which induces lethargy and headache and interferes with the working of the brain.

A medical officer makes a blood pressure test before a man enters a pressure chamber to test his fitness for high flying.



Vision

Flying not only requires a high degree of visual acuity, but also calls for the use of eye functions which may have been used little, or not at all, in other occupations. Ability to read distant lettering or numerals, or to read small print without symptoms of eyestrain, is not, therefore, any criterion of visual efficiency from the standpoint of the airman.

Many persons may possess night-blindness or defective colour-vision without being aware of the fact. In a recent examination of a group of men over twenty-five years of age several were found to have comparatively little sight in one eye. Yet some of these had been driving motor-vehicles.

Colour-blindness is a defect for which many theories have been advanced. It is an unalterable condition, although some experimental work has been carried out in an endeavour to train the eye by means of colour-filters.

Night-blindness is now regarded as a deficiency disease, a result of insufficiency of vitamin A, with an improvement has been obtained by a diet rich in this component. Vitamin A is present in butter and milk from pasture-fed cows, and to a great extent in cod-liver oil and halibut-liver oil.

Persons in whom both eyes do not work together may be able to read or to see objects at a distance, but they do not possess stereoscopic vision, by means of which the airman is able accurately to estimate depths and distances. Such unequal working of the eyes obtains in cases of squint, but may also occur in persons who present no obvious signs. Exercises may be prescribed to rectify the condition after a thorough examination of the muscle-balance and visual power of the eyes.

Eyestrain may be caused by reading in bad or badly placed light; the eyes may also be affected by the glare of sun or snow, and by the excessive use of inhaled tobacco smoke, particularly that of cigarettes.

Fitness for Fortitude

Such examples as the harmful effects of either too little light or too bright a light, and the instance in which a highly developed and suddenly strained muscle caused a fractured bone, should guide the cadet in his recreation, especially if he be inclined towards such strenuous pursuits as cycle-racing or sprinting.

The athlete who brings himself, during a season, to the zenith of efficiency for certain types of competitive sport cannot remain indefinitely at that pitch. It is well, therefore, for the cadet to remember that he is training not for a single event, but for a career in which he must maintain continuous bodily fitness without the production of fatigue or strain.

Exactor Controls

by P. W. BLANDFORD

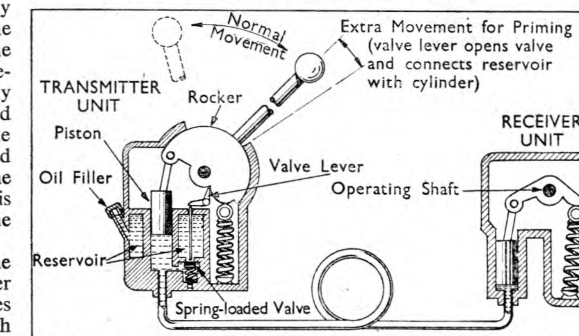
IN the Pilots' Notes for some aircraft we find an instruction to "prime" certain controls when preparing to start the engines. This indicates that these controls are operated by Exactor remote-control systems.

Of course, the levers in the cockpit of any aircraft are not connected directly to the mechanisms they operate. The movement of the throttle lever, for instance, has to be transmitted perhaps several yards to the throttle on the carburettor. The movement has to be instantaneous; there must be no backlash and the control must stay put in exactly the right position.

There are many methods of providing this remote control. Cables, chains and rods are often employed. There are complications in the installation of mechanical control systems where obstacles have to be passed. The more bends and joints there are the greater is the risk of inaccuracy. With an hydraulic system the power can be carried from the operating lever to the mechanism along any route and around any obstacles by a single small-diameter pipe.

The Exactor system, which is used for throttle, mixture and propeller controls on aircraft, and for engine controls on R.A.F. launches, has a transmitter and a receiver unit joined by a pipe.

The construction of the transmitter and receiver unit is very similar, each containing a rocker arm connected at one end to a piston in a cylinder and at the other to a spring. The two cylinders are connected by the pipe. The operating lever is connected to the rocker arm of the transmitter. Any movement of the lever operates the piston, and its movement is immediately exactly reproduced by the piston in the receiver unit and transmitted to the mechanism which is connected to the rocker arm.



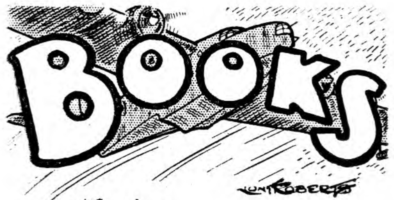
EXACTOR CONTROLS. Diagrammatic Sections of Units.

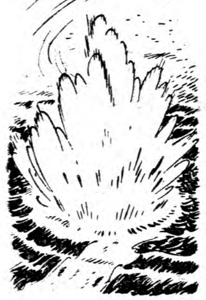
The fluid in the system is kept under pressure at all times by the springs which act on the pistons in the two units. By an arrangement of cams these springs are arranged to exactly balance each other in all positions, so that there is no risk of the pistons moving after the control lever is released.

A fluid cannot be compressed, but it is affected by changes in temperature. In any hydraulic system, allowance has to be made to compensate for expansion and contraction caused by rise and fall in temperature. In the Exactor system this is arranged in the following way:

The transmitter unit also incorporates a small reservoir. This is connected to the cylinder by a spring-loaded valve, which is normally shut. When the control lever is moved to the normal end of its stroke, then pressed and held a little farther, the valve is opened and the whole system is connected to the reservoir. The pressure is released and any variation in volume is rectified, any deficiency being made up from the reservoir and any excess being forced out. When the lever is moved back to its normal position the valve closes and the system is sealed. This balancing of volume due to temperature changes is known as "priming," hence the instruction in Pilot's Notes.

ONE MAN AIRCREW, Cadet Charles S. Moffett, U.S. Army, has qualified as pilot, observer, flight mechanic, bomb aimer (bombardier) and air gunner. He was an expert parachute jumper before joining the army.





Reviewed by **The Editor**

The opinions expressed are those of the Editor and do not have official approval or otherwise of the Air Training Corps.

The *Aero Modeller* Plans Service

SERIES 1, 2 AND 3 (British, American and German). Published by *Aero Modeller*. 4/6 each.

These packets of plans are similar to those appearing in *Aircraft of the Fighting Powers*. They are printed on both sides of the paper to a scale of 1/12th. Series 1 contains plans of 24 British aircraft, Series 2 24 American aircraft and Series 3 24 German aircraft. All modern, accurate and detailed enough for model-making. The plans can also be bought separately at prices from 3d. to 9d.

Service Slang

(July 1943.) By F/O J. L. Hunt and Lieut. A. G. Pringle, R.A. Faber & Faber. 2/6. 72 pages. 7¼″×4¾″.

Not of much use for learning slang, but will be of interest to those who hear it occasionally without understanding it. Deals with the slang of all three Services.

The Red Air Force

(May 1943.) By John Stroud. Pilot Press. 5/-. 48 pages. 10⅝″×8¼″. 50 illustrations.

Presents detailed descriptions of many Russian aircraft and fairly good large photos of a number of them. There are no three-view drawings and silhouettes, but dimensions are given.

The Air Navigator's Stars

(1943.) By L. R. Glegg. Rolls House. 1/-. 40 pages. 7⅜″×4⅞″. Illustrated.

The author begins by assuming that the reader knows nothing about astronomy. He then proceeds to build up the subject carefully and logically until the elements of astro-navigation are reached in the final chapters. He has also something to tell us about planets and the use of the planisphere. Celestial timekeeping is usually taken as understood by most writers on this subject, but Mr. Glegg does not fall into this error, and as we read the whole night sky is presented as a timekeeper as easily read as the face of Big Ben.

Medical Aspects of Aviation

By Capt. E. Jokl, M.D. Pitmans. 10/6. 104 pages. 8½″×5⅜″. Illustrated.

"The sensory switchboard with which nature has equipped the human species, while serving well under conditions of terrestrial life, is of limited value in the air. It is the instrument board to which the pilot has to appeal as the supreme judge." The writer, an experienced flyer and medical man, discusses the failings of the human body under flying stresses and how they can best be minimised. He deals with speed and acceleration, effect of changes in altitude, noises and vibration, and with other physiological and psychological matters which affect the flyer.

Tattered Battlements

A MALTA DIARY BY A FIGHTER PILOT. Peter Davies. 7/6. 134 pages. 7¼″×4¾″. 9 illustrations.

The long-drawn-out Battle of Malta ranks with the shorter Battle of Britain as a major action of the war. The Battle of Britain saved Britain from defeat. The Battle of Malta saved the Empire and permitted the conquest of Africa and further conquests.

This account is written in rough diary form, with some later additions and amendments. The author tells vividly and well the story of the operations in which he was engaged as a Spitfire Pilot.

English for Air Training

(July 1943.) By T. C. Rising. Harrap. 1/6. 62 pages. 6¾″×4½″.

Be Proficient in English

(1943.) By A. R. Moon, M.A. Longmans. 1/-. 48 pages. 7¼″×4¾″.

English Simply Explained

(1943.) By Frank J. Wain, M.A. Pitmans. 9d. 40 pages. 7¼″×4⅞″.

Each of these booklets seeks to put an aeronautical gloss on the English of those who lack it. The first lays most emphasis on spelling, the second on construction and the third on style.

Morse Tutor

A Fairylite Patent, made by G. B. of London.

Rather like the familiar word-making games for children, this Tutor consists of small cards with Morse symbols on one side and the letters on the other and which can be made up as words and sentences. Cadets soon get beyond the stage when the game would help them, but it might interest their younger brothers and sisters.

The mobile repair unit here pictured at work has saved the U.S.A.A.F. thousands of dollars and months of labour. This crashed Fortress on which the men of the mobile repair depot are at work made a forced landing somewhere on the South Coast. A special runway was laid down by an engineer unit of the U.S. Army and the Fortress was flown back to her station.

Key to
A Spot of Spotting

(*See page* 12)

1, Curtiss Mohawk; 2, Douglas Dauntless; 3, Fairey Albacore; 4, D.H. Tiger Moth; 5, Hawker Hector; 6, Fairey Fulmar; 7, North American Mustangs; 8, Curtiss Tomahawk; 9, Supermarine Spitfire V-B; 10, Messerschmitt 109E; 11, Boeing Fortress II; 12, Consolidated Liberator; 13, General Aircraft Hotspur II; 14, Westland Whirlwind; 15, North American Mustang; 16, Hawker Hurricane II-C; 17, Miles Master I; 18, Armstrong-Whitworth Whitley V; 19, North American Mitchell; 20, Douglas Bostons III; 21, Bristol Blenheim IV; 22, SB-3; 23, Bristol Beaufort; 24, Martin Maryland; 25, Focke-Wulf 190A; 26, Macchi C.200; 27, Caproni Ca. 135; 28, Bristol Beaufort; 29, Bristol Beaufighter I; 30, MBR-2.

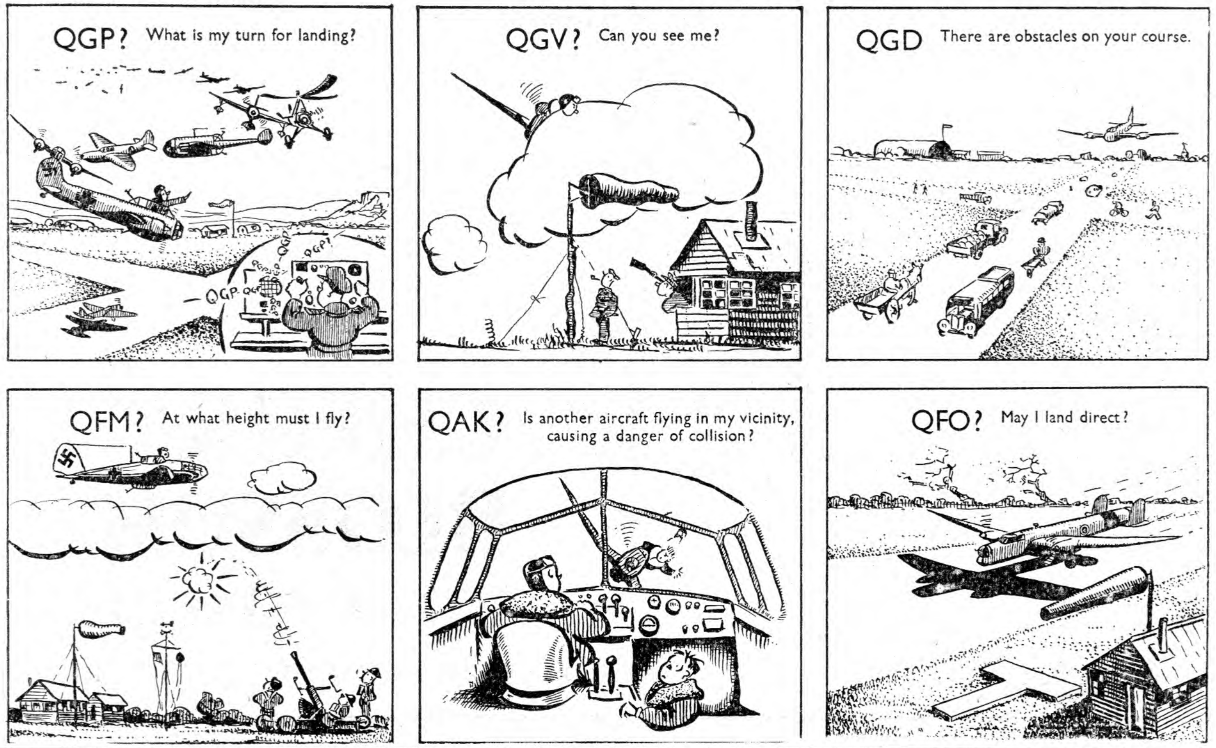
Key to
What can you tell by Tails?

(*See page* 13)

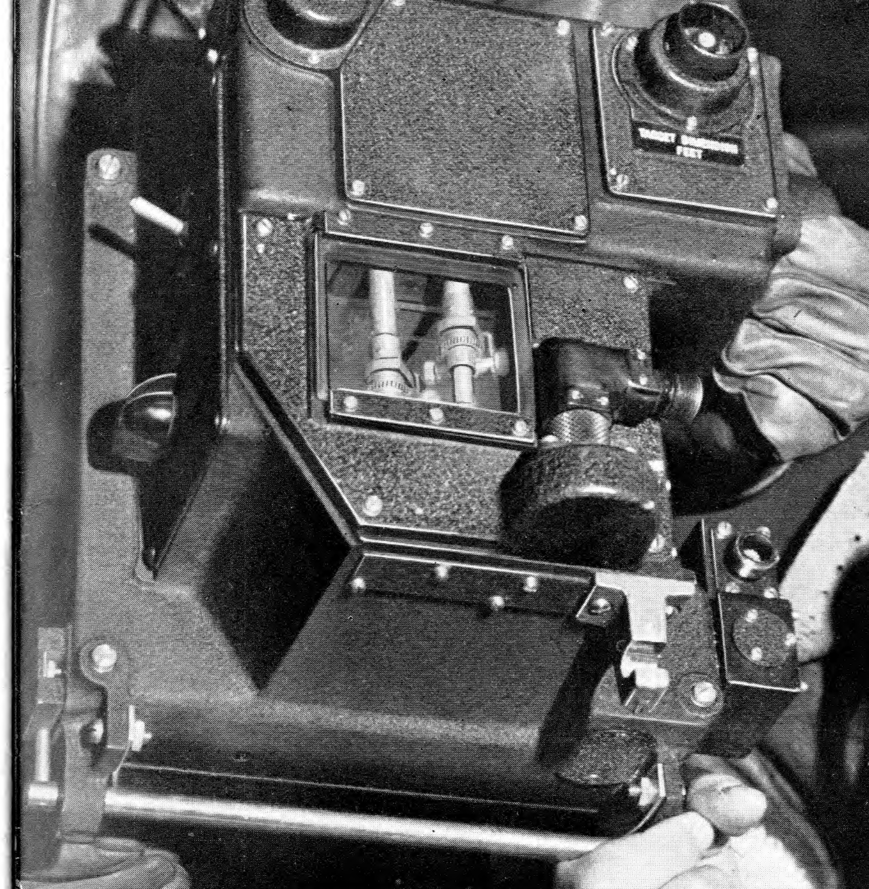
1, Short Sunderland; 2, Short Stirling; 3, Vickers-Armstrongs Wellington I-C; 4, Heinkel 111K; 5, Martin Marauder; 6, Westland Whirlwind; 7, North American Harvard II; 8, Grumman Avenger; 9, Fairey Albacore; 10, Boeing Fortress I; 11, Douglas B-19; 12, North American Mustang; 13, Republic Thunderbolt; 14, Focke-Wulf 190; 15, Supermarine Spitfire; 16, Consolidated Catalina; 17, Boeing Fortress II; 18, Westland Lysander; 19, Brewster Buffalo; 20, Messerschmitt 109F; 21, Miles Master I; 22, Grumman Martlet; 23, Boulton Paul Defiant; 24, Curtiss Commando; 25, Avro Anson; 26, Hawker Typhoon; 27, Junkers Ju. 87b.

THE Q CODE

Drawn by W. MEGORAN



Published for the Proprietors, The Air League of the British Empire, Kinnaird House, 1a Pall Mall East, London, S.W.1, by the Rolls House Publishing Co., Ltd., Rolls House, Breams Buildings, London, E.C.4, and printed by the Stanhope Press Ltd., Rochester, Kent.



The Sperry Automatic Computing Gun-sight, a device resembling an oversize movie camera. The gunner looks through a peephole at the reflected image of the approaching enemy fighter. Bracketing the image of the target are two white vertical lines, and when these "touch" the wing-tips the enemy aircraft is dead on, and the gun is fired.