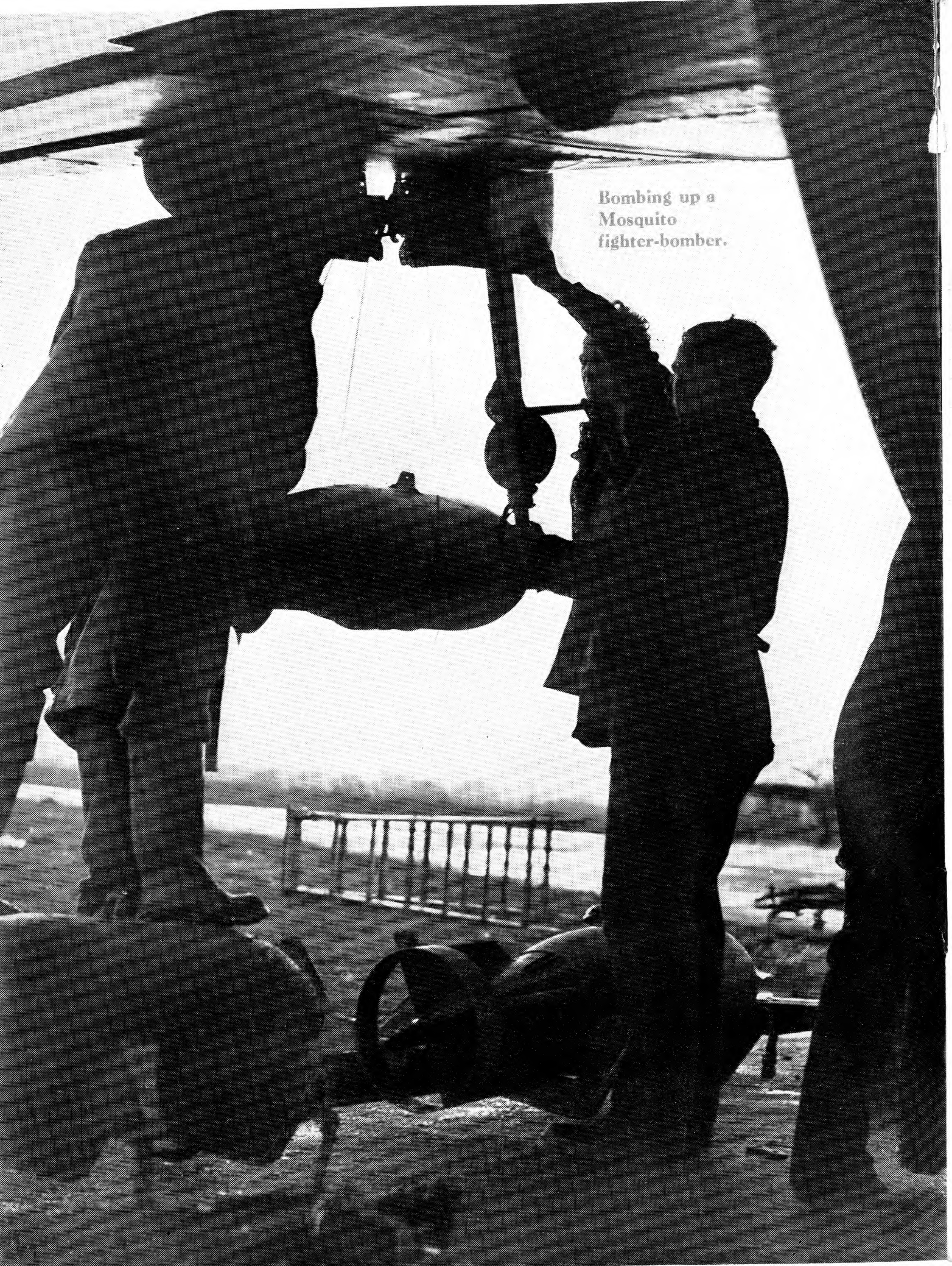
Stinson L-5 Sentinels are used for transporting wounded to hospital.

AIR TRAINING CORPS GAZETTE

Vol. IV No. 5 MAY 1944 6d.

Stinson L-5 Sentinels co-operating with tanks.



Bombing up a Mosquito fighter-bomber.

AIR TRAINING CORPS GAZETTE

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VOL. IV NO. 5 *Edited by Leonard Taylor* **MAY 1944**

Co-operation

"The North-West African campaign . . . is the finest example of the co-operation of the troops of three different countries—and of the combination under one supreme commander of the Sea, Land and Air forces which has yet been seen."—*Mr. Churchill to U.S. Congress.*

IN my last message I spoke of the great opportunities which annual training brings to members of the Corps of getting to know at first hand something of the work not only of the Royal Air Force, but of the Fleet Air Arm also.

This latter aspect of our training, that is getting to know the work of the other fellows—the Navy and the Army—is extremely important. The value of combined operations is one of the greatest things the war has taught us; and in the coming developments the full fruits of combined operations will undoubtedly be seen.

Air Marshal Sir Leslie Gossage, K.C.B., C.V.O., D.S.O., M.C

This year each of the three Services is operating a combined Cadet training camp at which sea, army and air cadets will work and train together. These combined camps, based on the Blackpool model, successfully initiated by the Air Training Corps, will afford the means of laying the foundation of knowledge of the work of all three Services; a knowledge which will prove invaluable to every one of you who will be called upon to take part in battle with your comrades of the Army or Navy. Those who were at Blackpool last year will find many improvements this year; and at the Royal Naval and Army camps similar facilities will also be found.

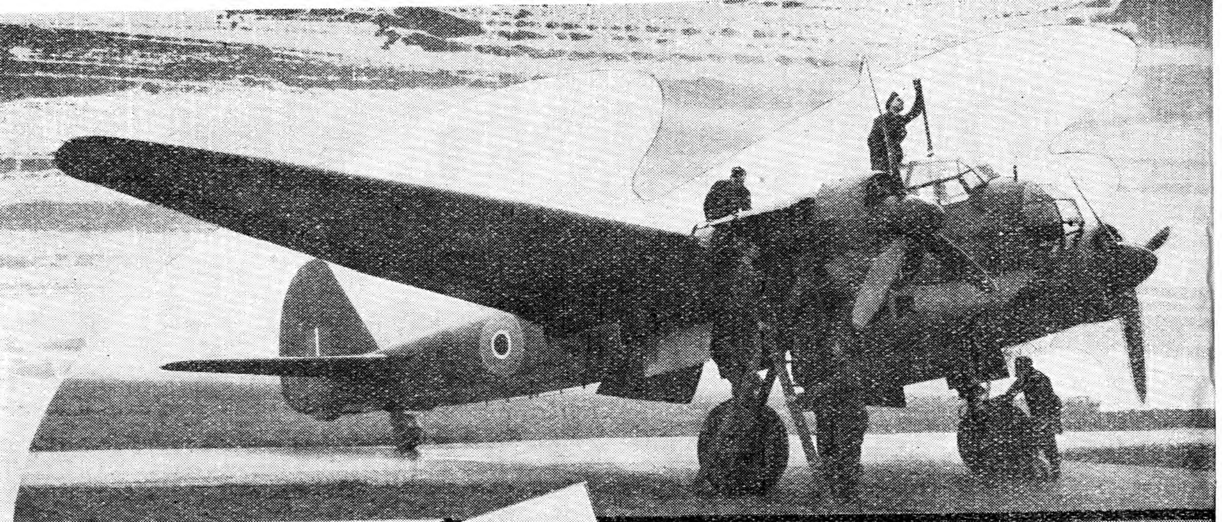
During the summer and autumn we are also running a number of special courses at Royal Air Force Stations, where officers and instructors can rub up their knowledge of Service matters and improve their technique of training. On the efficiency of the officers and instructors in the Squadrons the whole efficiency of the Corps must primarily depend. And I hope that everyone who can do so will take full advantage of these special courses.

E. L. Gossage, Air Marshal,
Chief Commandant and Director-General, Air Training Corps.

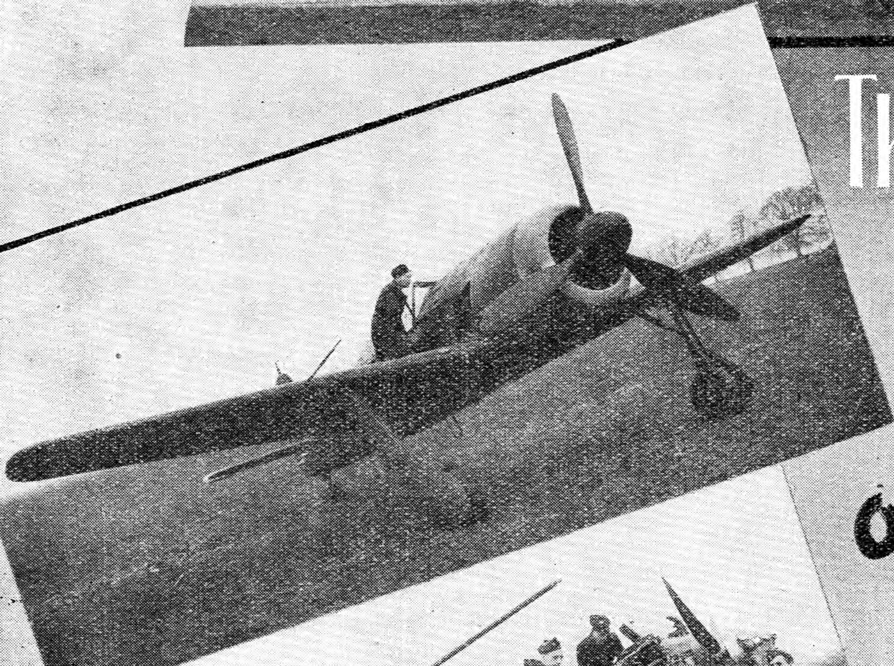
You will see nearly all your colleagues and friends at the
A.T.C. BOXING CHAMPIONSHIPS
ROYAL ALBERT HALL, LONDON
Monday, 8th May, at 7 p.m.
***Tickets** obtainable from the Royal Albert Hall*

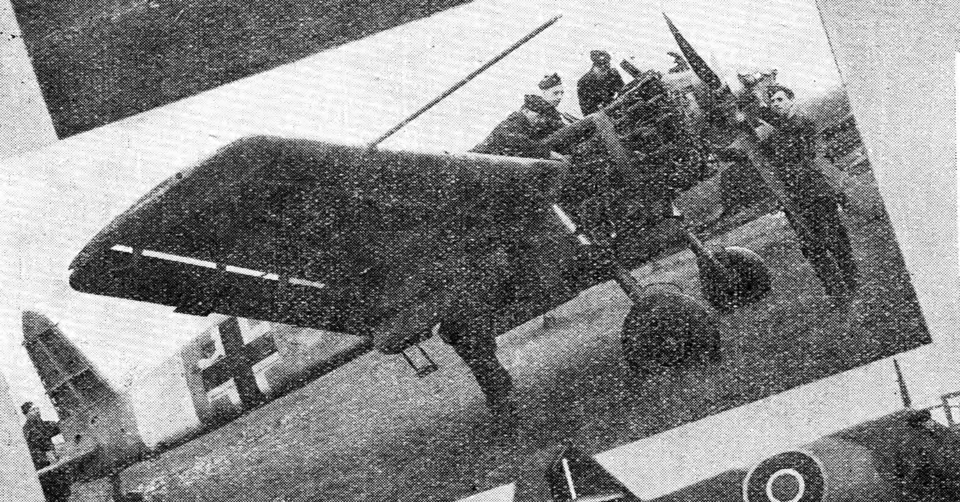
Correspondence with the Dominions

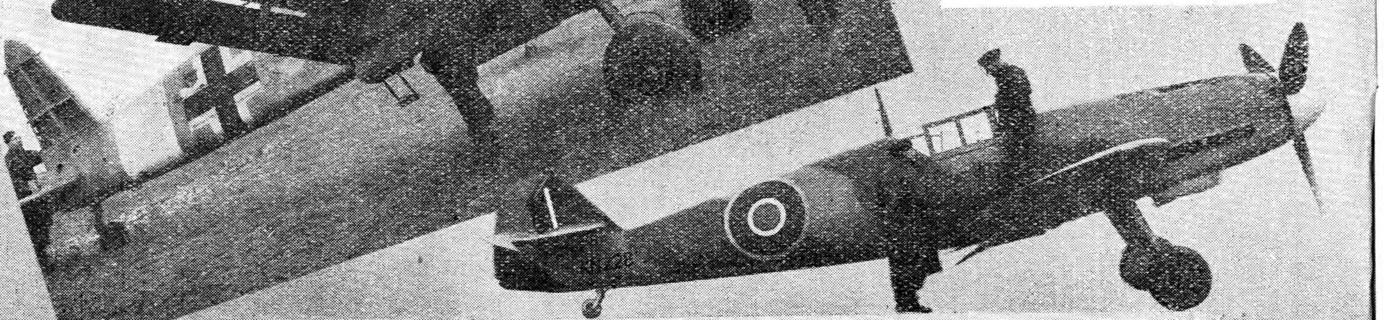
The addresses of certain A.T.C. squadrons have been given to cadet units in Canada and New Zealand. Squadrons receiving letters from them will no doubt be interested to organise correspondence.



The Spoils of War







German aircraft collected by the R.A.F. (Top to bottom) Ju 88, Fw 190, Henschel 129, Me 109G. Bottom picture (foreground to back), Henschel 129, Fw 190, Me 109G, Me 110, Ju 88.

FIGHTER School

by 'STRINGBAG'

The Americans have recently announced a fleet of more than 80 aircraft carriers. While the British have made no parallel statement, it is reasonable to believe that the Fleet Air Arm today constitutes a tremendous striking force. Commensurate with this, the Battle of the Pacific, with its inevitable clash of sea-air power, looms bigger on the horizon. Here is an account of a vital aspect of sea-air war—the air tactics which are employed by naval fighter pilots.

A FLEET AIR ARM pilot dressed in Service trousers and pullover, but without jacket or cap, recently crept through the barbed wire of an aerodrome and successfully "stole" a Spitfire, in which he arrived back at his home aerodrome. He was at a naval fighter school, where pupils learn to keep their wits about them on the ground as well as in the air. They had been dropped ten miles away by lorry, after they had made a journey blindfold. Without maps, compasses or money, and forbidden to speak English, they were ordered to report back to their aerodrome at the earliest moment. In opposition to them were the police, Home Guard, Observer Corps and local Army authorities, all with instructions to arrest the naval pilots.

I mention this incident as introduction to the Navy's principal fighter school by way of suggesting that the toughest 50 hours of flying which the pupil fighter pilots have to do are not unaccompanied by ground exercises which breed the necessary qualities of alertness and initiative. It is just these qualities which will make them great fighters, and this "cross-country" test is yet another indication of how they are likely to turn out.

Duty recently took me to this school, where I made a note of just what was going on at the moment I arrived.

At 10.00 the sky up to 20,000 feet—far above the cloud layer—was speckled with Seafires. Take C flight as an example of a single unit and its duties. C flight's leader is a pupil, but tucked in beside him is his instructor, who has just returned from "holiday" with the R.A.F., with whom he has been doing some fighter sweeps, "just for fun." Two other Seafires, both flown by pupils, are also in the formation. Fifteen thousand feet below, in the radio control room, a voice crackles over the wireless:

"Hello, Tiger—this is Red leader. "I am orbiting base at fifteen thousand";

and back comes Control:

"Hello, Red leader—this is Tiger. Steer one one zero, speed two hundred and twenty."

The words are still echoing in the ether when the four aircraft swing off on to the new course, leaving behind them a filmy trail of vapour. The pilot in No. 2 aircraft nods. He is pleased. The course is accurate.

"Hello, Red leader—Tiger calling. Bogey ahead ten miles, height twelve thousand. Over."

And then half-way across England, in a temperature of minus 25 degrees (C), a pupil thinks extremely hard. Meanwhile, No. 2, who rides by his wing-tip, is watching and listening. The pupil's vital moment, when an interception will be made, is imminent. As he listens he can hear the click of the switch as the pilot close beside him flicks over his switch to transmit.

"Tally-ho, tally-ho—Red section. Number three and four to attack from port. Number two follow me."

The little block of Seafires split, and the instructor murmurs to himself—"Good boy, he's assessed the situation well."

The aircraft scream down to 13,000 feet, turn in and press home a quarter attack on a bomber, breaking away at 50 yards. That order to split the formation had been a good one, for it enabled the bomber to be "jumped" and attacked from both sides. In fact, the pace is a little hot as the camera guns record the attack, and back over the wireless comes the bomber pilot's voice:

"Tell those fellows to lay off a bit—they're coming too damn close."

And then Tiger comes up again:

"Hallo, Red leader—this is Tiger. You must break away at one hundred and fifty yards . . . one hundred and fifty yards."

The pupil grins, swings his section around in a sensational climbing turn, and comes in again, steadying as he estimates the target's line of flight and tries to anticipate its evasive action.

Bouncing

It has been a good interception, and after one further attack the pupil calls off his section and re-forms. He is so pleased with himself that he allows his section to be "bounced" on the way home. (It is a rule here that any fighter pilot may bounce another if he is flying at over 4,000 feet. It keeps everyone awake—always.) The bouncer on this occasion comes out of the sun at about 250 knots—a Wildcat flown by another pupil. The first warning comes too late from No. 3, who sees the Wildcat only as he comes into range. Instantly his transmitter switch is flicked over—"Break port, break port"—and as though every member of Red section has received a high-voltage shock, they swing into a diving turn to the left, coming near to blacking themselves out. But a camera gun has already got No. 4 on its film, and a second later the instructor in No. 2 is breaking radio silence: "That was your fault and mine, Red one—keep a better lookout."

As a result of this attack, which develops into a dogfight, No. 4 finds himself alone in the bottom of a great valley of cloud. He weaves through the canyons, and climbs up the slopes of great cumulus as he looks for a hole through which to descend. Finding none, he switches over his transmitter and calls Tiger for a homing. In another 15 seconds Tiger's voice is coming back clear and unflurried: "Steer nought five zero—nought five zero." And then a little later Red 4 gets his last instruction to come down to 2,000 feet, where he conveniently finds the aerodrome immediately below him—as he knew he would.

Shooting the Instructor

That is C flight—a very small unit of a great fighter school. At the same time, and while this has been happening, the ground personnel have been listening to the rising whine of a Merlin supercharger far overhead. The aircraft is so high that they cannot see it, although Control could tell you that it belongs to a pupil who is doing his damnedest to carry out a very difficult order—an order to shoot down his instructor. Every pupil fighter pilot will go through the same drill, and the recording angel in the shape of a camera-gun will show to a hairsbreadth exactly where his tactics went wrong. There are few pupils who succeed in shooting down their instructors.

At a more earthy level B flight is carrying out dummy decklandings. Although it is not long since the Navy's test pilots were carrying out the first experimental carrier landings with Seafires, the pupils of B flight, with a mere 200 hours of air experience, would be ready to do the same thing in another few weeks, and, what is more, do it safely on the small deck of an escort carrier.

But one pilot from B flight is missing. He is somewhere over the neighbouring county at 5,000 feet, with his undercarriage and flaps down as he practises flying at 70 knots. He has had difficulty in mastering this slow-flying technique, and is getting it "tied up" at a safe height before he comes down to join the other five on the dummy deck. Down here each of the other pupils is snapping back his throttle to the Control Officer's signals. They have learnt that it is not so much their business to land their aircraft, but that of the "batsman," who demands obedience to his signals. Blue 2 is obviously having a little difficulty, and a second officer on the runway calls him on the portable radio in order to pass over the batsman's advice:

"Hello, Blue two," he says; "try to come in a little slower and make a rather smaller circuit. Acknowledge";

and without a fraction of delay the pilot of Blue 2, who has just bounced back into the air after a bad landing, comes back over the R/T:

"Hello, Control—this is Blue 2. Wilco—out."

This radio conversation is short and sweet, and, moreover, always correct in procedure. Radio control is regarded as important as flying control.

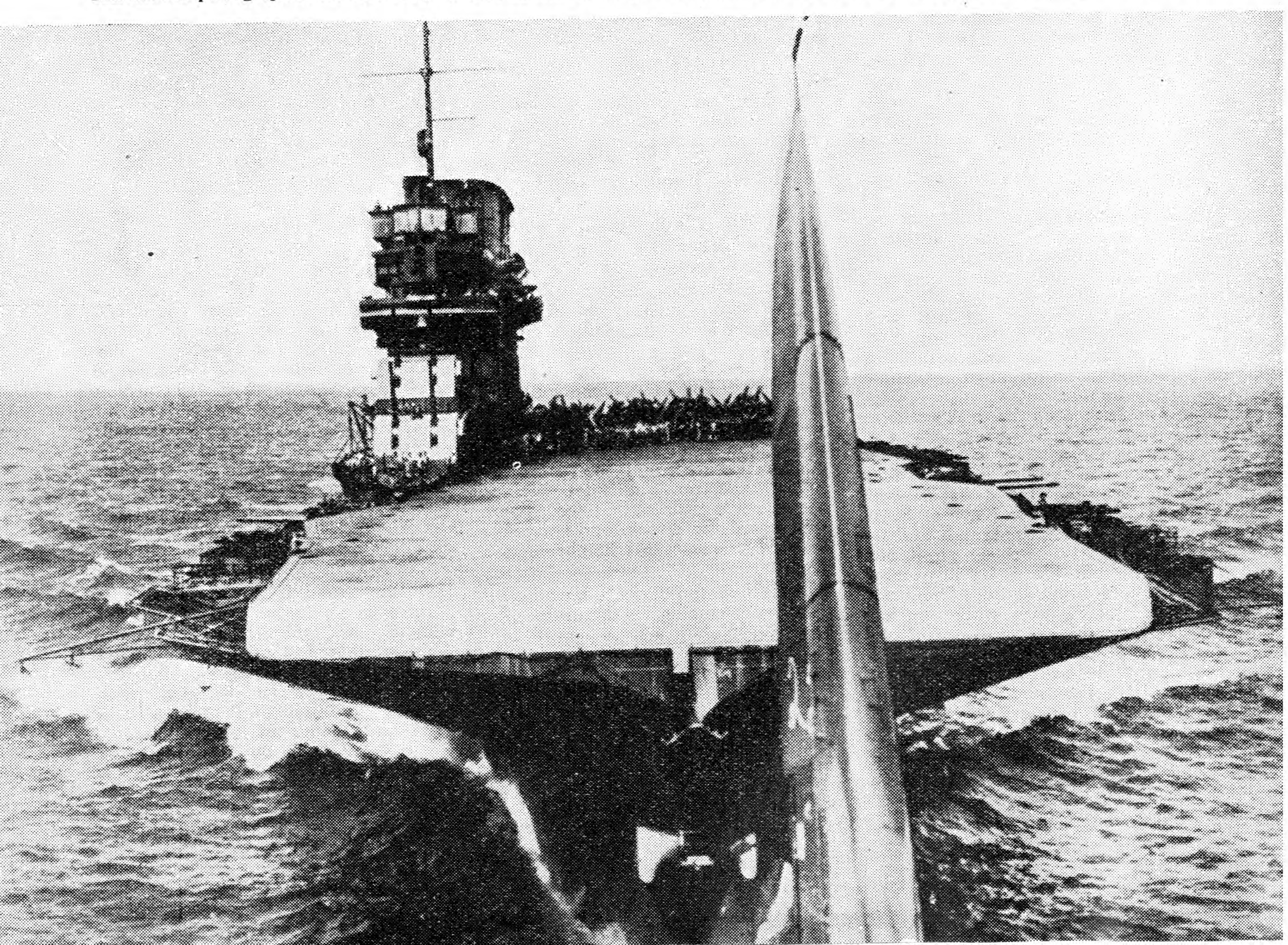
As the aircraft circuit the dummy deck they back each other up so closely that they fly in each other's slipstream—a horrible feeling until you get used to it, but is a practice which will mean a lot on operations at sea. By following each other at the shortest intervals they will ensure that their carrier is never out of place with the rest of the fleet for more than a few minutes, a point of vital importance when the ship may be caught by either bomber or submarine.

There is another vital exercise going on inside the cloud layer some 20 miles from the aerodrome. Two aircraft seem to be locked together and to be flying as a single unit with only one pilot. But in actual fact a pupil with his head screwed round to one side is watching the wing-tip of the second machine, only a few feet away, like a cat watches a mouse. He knows that the slightest error will either result in the two aircraft touching, or in losing sight of each other in the darkness of the cloud, where the visibility is a bare ten yards. In that second machine an instructor glances quickly from his instruments to his pupil, seeing that he is still there and keeping formation. He is helping all he can by maintaining an exact speed of 180 knots and a steady line of flight. In a day or two he will be climbing and turning and descending, and the pupil will stick with him a foot or two away like a leech, and now fully confident of flying through the thickest stuff without breaking formation. In these winter days the accretion of ice on the wings may terminate such an exercise as this. Today both windscreens are heavily frosted.

High above these two aircraft there's yet another fighter section acting as a bomber escort. They are enjoying the perfect sunlight of the upper air as well as looking out for the inevitable attack by "enemy" fighters which are in the offing.

So it goes on, day after day, week after week. Interceptions and scrambles, bomber escorts, carrier take-offs, night flying and deck-landing practices, and, lastly, the hard, exasperating business of learning to shoot straight. So scientific has this subject become—a development of the last three years—that the air-firing side has become an exact science which must be approached like a problem in mathematics. No longer does the pilot guess the range and deflection. He **knows it.**

This unusual photograph of the U.S. Navy aircraft carrier 'Saratoga' was made from one of her fighters just after leaving the flight deck.



School for Aces

by 'STRINGBAG'

AT a south-west aerodrome the Navy has a school of advanced air combat. Only the best and most experienced pilots go there—operational pilots who have done at least 700 hours' previous flying. It is an ace fighter pilot's course which turns good men into brilliant. At the end of it the hitting power of each individual is about ten times greater—which is to say that he will put ten times as many bullets or cannon shells into the enemy as may be expected from a standard pilot.

I recently had the opportunity of joining in the school's programme and seeing for myself the standard which the modern fighter pilot can reach. I also made the startling discovery that the ordinary pilot's idea of accurate flying—never mind accurate shooting—is usually inadequate. This was a point which was specially demonstrated by two types of attack, known as the upward and the downward "twizzles." While they were not merely sensational in themselves, they were a final test of accuracy in manœuvre upon which markmanship depends. The man who can bring home a camera record correct for line of flight, angle off, and range for an up-and-down "twizzle" can class himself as "hot."

Upward Twizzles

These attacks were demonstrated in a dual Master, for as an ordinary Service pilot I was, frankly, not good enough to show results without putting in many hours of hard practice. It is only after 50 hours of this specialised training that the ordinary pilot can do good twizzles.

We climbed up through 3,000 feet of cloud, with the wing of the target Seafire tucked in beside our own, finally breaking into brilliant winter sunshine, with the ice accretion rapidly clearing from our windscreens.

At 10,000 feet we commenced the upward-twizzle attack. Half a mile away and 2,000 feet below, the Seafire held a parallel course, a shapely outline against the great cloud layer through which we had passed. The attack was carried out by first making a stall-turn towards the enemy, and going into a steepening dive in which the speed mounted to almost the safety limits of the aircraft. For 4,000 feet we whistled downwards, and then pulling out, rushed almost vertically back towards the blue sky, against which the enemy now stood out 2,000 feet above. You feel the tremendous pressure as you pull out, and maybe a "judder" as the aircraft approaches a high-speed stall. But in a fraction of a second, perhaps after the first signs of black-out, the aircraft is shooting upwards at an angle of 70 degrees, its speed devouring 2,000 feet of vertical space almost incredibly quickly.

The eggshell-blue underside of the Seafire leaps towards you, and it is now that the attack commences. On the way up an aileron turn slowly brings you over the vertical on to your back—the only possible way of keeping your sight correctly aligned on the target. Your finger does not press the fire-button until the range has closed to 250 yards and you are already beginning the first part of a barrel-roll. The two-second burst, which is given as the barrel-roll develops, should hold the enemy in the gunsight as steadily as though you were flying straight and level — and, in fact, the subsequent analysis of this particular attack showed a picture of a Seafire sitting stationary on the edge of the sight-ring, like a butterfly pinned to a board. After two seconds—sufficient to destroy anything with our modern armament—the breakaway is completed by continuing the roll, finally leaving your own aircraft once again the right way up and on the beam of the enemy.

I was lucky in having this evolution demonstrated by a pilot who is probably the best shot in the Navy. He did tremendous execution in the Battle of Britain when he was on loan to the R.A.F., and today, with a genius for instruction, brings up to his own standard each of the pupils who comes to him.

"The upward twizzle," he says, "is not so much a standard form of attack as an exercise which will enable the fighter pilot to shoot accurately, whatever the position of his own aircraft."

Down Twizzle

This attack was followed by the down twizzle, entailing a vertical dive from some 2,000 feet immediately above the enemy. First a stall-turn, and then an aileron turn, developing into the curve of pursuit, which placed the Seafire for two vital seconds within the ring of the gunsight. And, lastly, a sensational breakaway as the stick goes forward and you flick past the tail of the enemy, dead astern of him. The object of the attack is once again to practice accurate shooting from the most uncomfortable angles.

But all this is very advanced, and comes hours after the preliminary vital exercises—exercises which answer the question: What must you be able to do to be a good fighter pilot? I should like, therefore, to go back for a moment to give a picture of this air combat course as a whole.

Fire at 250 Yards

First of all, you learn something about your ammunition and what it does when it leaves the muzzle of your guns or cannon—that the .303 bullet, for instance, drops only four inches in the first hundred yards of its flight, two and a half feet after three hundred, and 16 feet after seven hundred yards. You will learn in this connection that about four times as many shots must be fired at 400 yards to get the same number of hits as at 200 yards, and that the destructive energy of your bullets per square foot is, at the longer range, only about one-tenth that of the shorter.

Then you are introduced to your camera-guns and to the darkened projection room where the films are assessed. The assessing makes you realise that you are being presented with a dead accurate picture of the enemy at whom you have fired, together with the exact place where your bullets went. You then go into the air with the knowledge that when you come down again with the combat film you will be able to see where you went wrong and will be told how to correct it. You will probably find, for instance, that you have little habits like many "game" shots. I found in my own case, for instance, that the bullets were usually passing about ten feet above the enemy and 15 feet to the right—a habit which in combat would have disappointing results.

The first exercise is one for the estimation of range without deflection. It is to ensure that the pilot can hold a steady attack from astern at exactly 250 yards, and that he gets an unforgettable picture of the size of an enemy in his sight at such a distance. After this exercise no pilot must *ever* take a shot out of range.

In the old days—and by this I mean only a year or two ago—scores of fighter pilots opened up at 400 yards or at even a greater distance. The chances of a kill were something like ten times as small. As against this, the burst at 250 yards is as near to making a certain kill as matters.

Deflection

Once estimation of range has become automatic the pilots make their first approach to deflection shooting, and this is where the accuracy of the ordinary pilot's flying is dramatically revealed. The target Seafire makes steady circuits at 200 m.p.h., while the attacking aircraft flies inside him and pulls his gunsight through the enemy's fuselage, and on along his line of flight as far as the outer ring of his sight. Then he reverses the process until the bead is once again back on the enemy's tail. During this process the range must be constant at 250 yards.

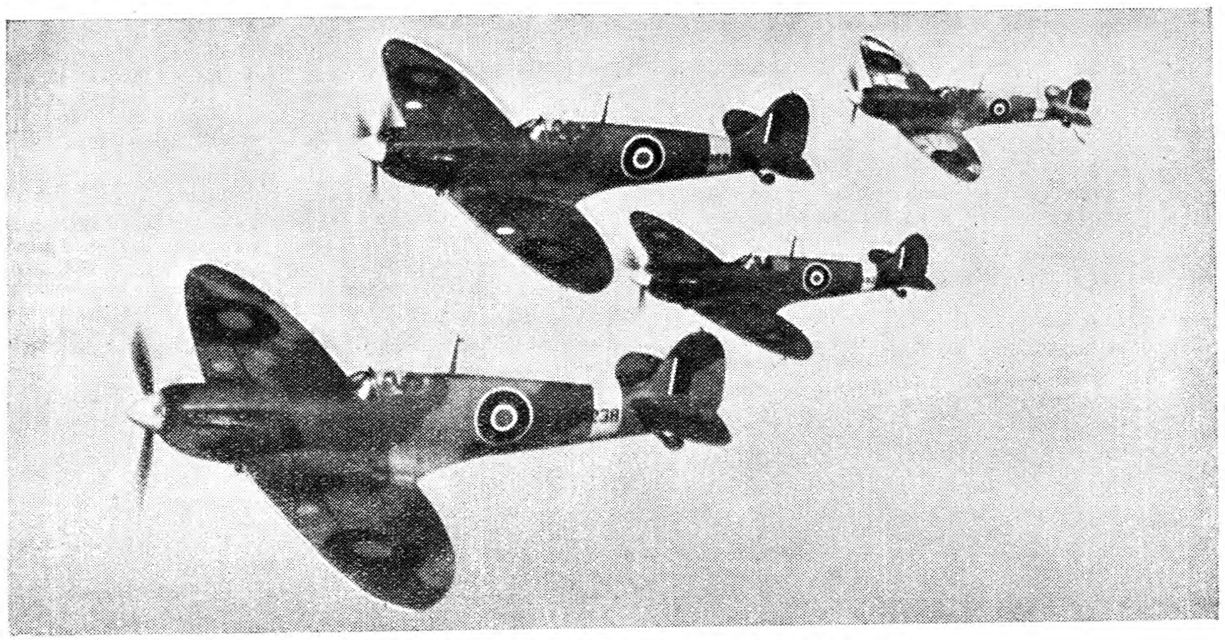
This sounds elementary, and if you draw out the course on a piece of paper you will see that it only demands a turn which is first tightened and then released. But the number of experienced pilots who can execute the manœuvre of increasing and decreasing a rate of turn without slipping to one side, or allowing their nose to rise or drop, is few. The morning following the practice, in a converted yards is the objective. Every new angle demands that the pilot should place his target in a new position inside the ring of his sight. Each angle has its own place, and very soon one knows instincitvely what it is. Every single shot is measured up by Wren assessors to within a quarter of a degree.

Quarter attacks, head-on attacks and then more and more advanced exercises in which the target takes evasive action follow, finishing with upward and downward twizzles, which I have already described.

Pheasants and Mes

And at the end of it the fighter pilot discovers that what he has learnt has an extraordinary affinity to the art of the first-class game shot. Whether you special job is not to learn so much to shoot as how to avoid being shot. The two sides of the course eventually join — the ace fighters and the ace torpedo bombers.

So the very latest tactics of fighting come up against the latest tactics in evasive action. On the whole, the honours turn out to be about even. A mathematical genius has worked out exactly what the torpedo bomber must do to prevent the fighter—however well it is flown—bringing his sights to bear. The mathematics, which have been translated into simple flying terms —involve two important lessons. The first is an exact appreciation of the range of the overtaking fighter, and the second — put into effect at the moment the critical range is reached— is a sensational corkscrew line of flight,



Spitfires being flown by Naval pilots at a Naval air training station.

barn with shutters across the windows and an iron stove glowing almost red-hot, a company of fighter pilots saw their own work on the ciné screen with mixtures of horror and surprise. But the voice of the chief instructor breaks in with some reassuring phrases that accuracy is only a matter of further practice.

Now comes the time for learning what is meant by "deflection." It is based on the ring-sight of the fighter's guns and the appreciation that at 200 miles an hour the enemy advances 293 feet a second. At this speed it is impossible to make a good attack from directly on the beam, and modern tactics at today's high speeds demand an angle to the enemy of not more than thirty degrees. Once again every shot is recorded on the film, and once again a steady burst at exactly 250 are shooting at pheasants or Messerschmitts, success depends on three things—the correct estimation of range, the correct estimation of the target's line of flight, and finally the correct estimation of the deflection which must be allowed when you fire. This affinity has a practical side, for clay-pigeon shooting is a daily exercise, using standard 12-bore shotguns. I have seen a pupil go round the clay-pigeon range, taking six shots from each of six stands, and securing 34 hits out of a maximum of 36. His performance with the two cannons and the four machine-guns of his Seafire was on a par with this.

Avoiding being Shot

Parallel with the fighter pilots are an equal number of torpedo bomber pilots each with his own aircraft. Their rather like a barrel-roll without actually turning over on to your back. Its secret lies in changing two things at the same time and at the right moment—the line of flight and the angle off. From the fighter pilot's point of view, he *must* judge the bomber's line of flight correctly, and on this he *must* lay off the right deflection. If both components are changing, it is only a flukey shot which will obtain a kill.

A nice tribute to such evasive tactics was recently paid by an American Liberator pilot who had visited the naval school and had shown great interest in its evasive tactics. The following day he returned from a Bay of Biscay patrol to say "thank you." He had put them into operation against six Ju 88s, shot three of them down, and returned without a mark!

Single-Seater EMERGENCY DINGHY

THE R.A.F. has always been provided with first-class safety equipment to enable aircrews to meet any contingency which might arise during flight, but it was not until this war really began that emergency dinghy gear was regarded as an essential part of equipment, and even then, in the early days, it was not imagined that the severest fighting in the air would take place over the sea. It is for this reason that the dinghy is now looked upon as just as important an item of equipment as the parachute, and in fact it is probable that many aircrews are flying now who would have been prisoners in enemy hands had they not had full confidence in taking to their emergency dinghy in the North Sea rather than jumping by parachute over enemy territory before they reached the sea, which they knew they could not cross with their shot-up aircraft.

The average man is very apt to imagine anyone but himself in a certain predicament, so great pains are taken to instruct aircrews in the correct method of operating a dinghy in an emergency. It is, of course, difficult to simulate the real conditions which occur when an aircraft makes a forced landing in the sea, but aircrews who have had to use a dinghy in an emergency are often thankful for the apparently boring practices which they previously had to make, time and again. The success of emergency dinghies depends to a large extent on the knowledge of the user, and, in multi-seat dinghies, one member of the crew may prove to be the weak link in what would otherwise have been a completely successful "ditching."

The K Type

The single-seater dinghy, or K type, as it is generally called, is designed for use either in single-seater fighters or in larger aircraft where it is not practicable to have one large dinghy for all the crew. In the latter case each member of the crew has a K type of his own. This dinghy is the only type which is actually attached to the user when in the aircraft; the reason for this arrangement is so that the wearer may abandon the aircraft in mid-air, come down by parachute and land in the sea complete with his dinghy, since small aircraft such as single-seat fighters are rather difficult to land on the water, and, moreover, they do not usually float as long as a bomber. If the pilot of a fighter landed his aircraft on water he would have to be strapped in to prevent himself from being thrown forward when he touched the water, and he might not have sufficient time to free himself from the harness before his aircraft sank.

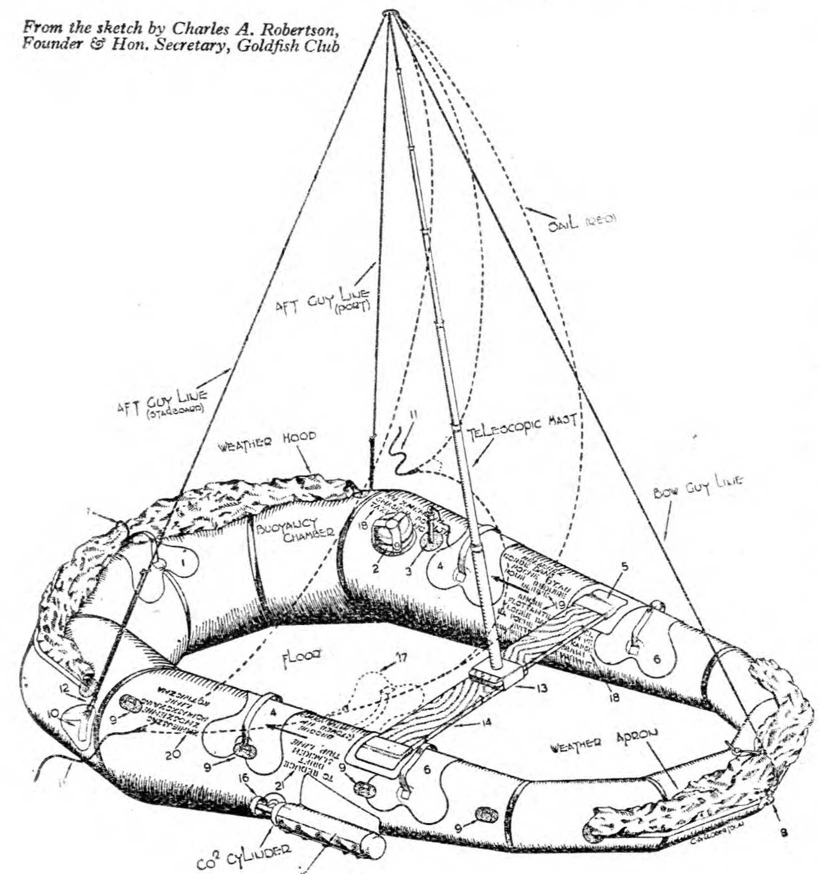
There are several different arrangements for the K-type dinghy, but perhaps the most usual is the seat type. This one is used when the pilot is equipped with the kind of parachute pack which hangs down behind him and upon which he actually sits in the aircraft. The dinghy, which folds up into a pack roughly about the same shape as the parachute pack, but not so thick, clips on to the latter, and is positioned between the parachute pack and the wearer, so that, when in the aircraft, he is sitting on a cushion consisting of the parachute and the dinghy both folded away in their respective packs. There is a piece of webbing which attaches the wearer to the folded dinghy in the pack, and the webbing is connected by a quick-release attachment to some part of the pilot's clothing or equipment.

First Stage

When, in an emergency, the pilot has to jump from his aircraft over the sea, he opens his parachute in the normal way as soon as he has fallen clear of the aircraft and floats down to the sea. On touching the water he operates his parachute harness quick-release unit, which immediately frees him from the parachute and harness and leaves him with his dinghy pack in the water beside him. It does not take long to get the dinghy working, but the pilot may be wearing boots

CONTINUED ON PAGE 8

From the sketch by Charles A. Robertson, Founder & Hon. Secretary, Goldfish Club



Single-Seater EMERGENCY DINGHY

CONTINUED FROM PAGE 7

and heavy clothing, and he will blow up his "Mae West" as soon as he gets in the water; this will keep him safely afloat while he gets the dinghy pack open.

The pack is easily opened by pulling on the handles provided at each side of it. A cylinder of compressed carbon dioxide is at once exposed which will inflate the dinghy as soon as the former and the folded dinghy are pulled out of the pack and the valve on the cylinder slowly opened. If it were opened too quickly the sudden rush of gas might burst the dinghy. The pilot then climbs into the dinghy in such a way that he does not upset it, and sits himself down in comparative comfort, still attached to the dinghy by the piece of webbing, so that if he should happen to fall overboard the dinghy will not float away. The rest of the dinghy pack is attached to the dinghy by a piece of cord, and when this is hauled in the pilot will find a lot of useful articles packed away. Amongst them may be emergency rations, distress signals, a drogue to prevent the wind blowing the dinghy too fast across the water, and leak stoppers for plugging any holes which may have appeared in the fabric of the dinghy. Stowed in the dinghy itself there will be topping-up bellows and a baler. There are obviously few situations which could arise for which the pilot could not find a remedy amongst his equipment. Some of the K-type dinghies have got waterproof aprons with which the pilot can completely cover himself except for his head and arms, which stick out of holes in the apron; others have a mast and sail, and in skilful hands these little dinghies have been known to make voyages which many seamen would never risk in a boat four times its size.

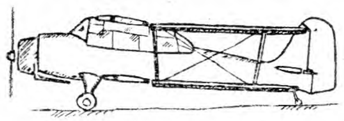
It Needs Practice

Having read this brief description of the working of the K-type dinghy, it may appear that the whole thing is delightfully simple, and that providing the pilot keeps his wits about him and does the right thing at the right time he cannot go wrong. But what must be remembered is that the whole thing happens in an extremely short space of time; the pilot may have just been in contact with the enemy, there may be a big sea running, it may be a bitter January day; and unless the pilot knows subconsciously what to do and when to do it—which knowledge he can gain only through practice of his dinghy drill—his chances of a successful ditching are greatly decreased.

Back to the Fold

by **Philip Banbury**

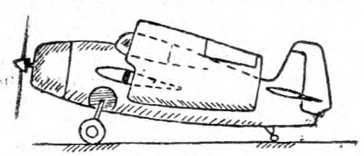
WINGS that would fold were standard up to 1940 on many aircraft for private use and civilian training and on all shipborne aircraft. Since then the only aeroplanes built with folding wings have been those in the latter category, though the Seafire, Sea Hurricane and Zero fighters and the big twin-motor Mitchell bombers have been used with fixed wings. The problem presents certain difficulties



Biplane.

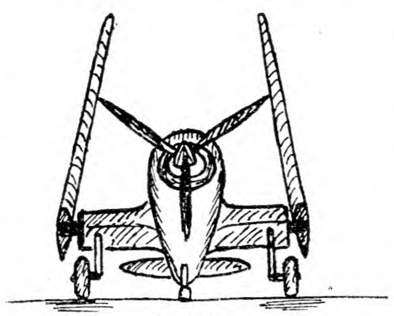
other than those connected with the mere mechanical accomplishment of the folding, which may partially or completely nullify the obviously great advantages.

The sketches show the methods in common use. The method employed on biplanes is simple from the manufacturing point of view, and the fold-



Method A.

ing is easily carried out even on a large machine. It was used also for folding the outer wing panels of the



Method B.

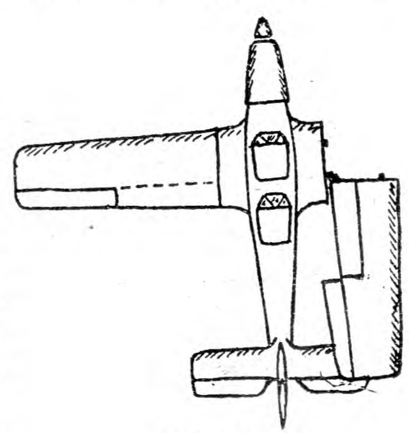
de Havilland twin-motor Dragon transport.

Monoplane (method A) is the scheme used on most British carrier-borne monoplanes and on some private-owner types. The wing illustrated hinges, leading edge downwards, the top surface being outwards; a variant is trailing edge downwards and undersurface of wing outwards. On a two-spar wing the hinge may be on either spar or on a jury spar between them. Whichever variant is used there is no need for hinged flaps on the trailing edge, as in method C.

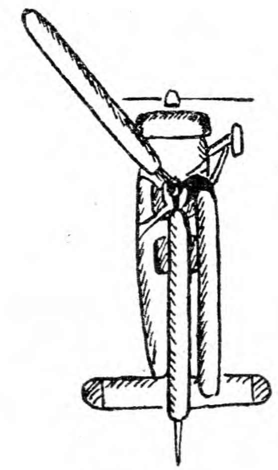
Monoplane (method B) may be loosely labelled the American method, since it is usual on U.S. shipborne aircraft. Once again hinged trailing-edge flaps are unnecessary. This is the simplest method of all, though it does not permit quite such a reduction in dimensions as does method A, since the smaller the span the greater the height.

Method C is the way it was done on light single-motor civil aeroplanes, both high and low wing. The wing hinged on the rear spar after a flap (shown folded in the starboard wing and dotted in the port wing) has been lifted. The aerodynamic flaps were usually fitted in the lower surface of the folding flap, and after being disconnected were lifted up with it. This method of folding was used with variations on Percival, de Havilland and Miles civil aeroplanes.

There are other methods, of which the most notable was that evolved by Mr. Baynes for the little twin-motor private-owner aeroplane he designed. In this machine the whole wing, which was in one piece and mounted on the top of the fuselage, complete with



Method C.



Gyroplane.

motors and airscrews, revolved on a turntable until it was fore and aft along the top of the fuselage. Brilliant though it is, the scheme rather binds the designer in the positioning of his wing, motor nacelles and undercarriage as well as restricting him to two-bladed airscrews.

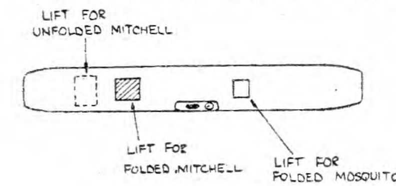
The sketch of a gyroplane with the rotors folded back shows that the advantages of rotating wings are not confined to vertical landing and take-off.

There are operational difficulties in folding the wings of modern aircraft, particularly warplanes. General to both military and civil aircraft are difficulties in disconnecting the de-icing equipment in the outer wing panels, whether of the pulsating, liquid or exhaust-heating systems. In military aircraft there are many snags. Firstly, the modern practice of mounting the armament outside the airscrew disc tends to locate it in the folding panels of the wing. Similarly, the methods of undercarriage retraction generally in use make it necessary for bombs and long-range tanks to be mounted under the outer wing panels.

The Fairey Aviation Company has recently taken out patents relating to the methods of bombing up with wings folded as shown in monoplane (method A). In this case the lower surface of the wing must be outwards, a point worth noting. Putting bombs and long-range tanks on the folded wings of monoplane B bristles with difficulties. Gun servicing is not easy. The arming of monoplane C is easier if the auxiliary flaps are made to fold down instead of up as in civil practice; however, the strain on the wing-folding hinge may be prohibitive.

Folding the wings on a twin-motor aircraft as big as the Mitchell would be a difficult undertaking, because of the weight of the panel to be folded and its height above the deck. The carrying of aircraft of this size on the flight deck for long periods can be justified only when desperate measures are called for, but as there will be a demand for twin-motor bombers and torpedo carriers of this size in the immediate future, the problem must be solved. The best solution seems to be folding by electrical or hydraulic means controlled from the cockpit. Simplicity of mechanism suggests method B as the only system of folding suitable for power operation.

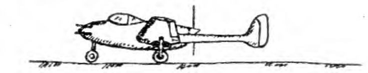
The folding *downwards* of ten feet of the outer section of each wing of a



Flight Deck.

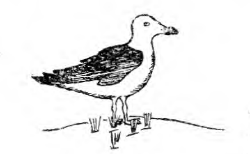
Mitchell reduces the span from 67 feet to 47 feet, or little more than that of a Sea Hurricane. A Mosquito treated in the same way would be reduced to 38 feet. The sketch of a carrier's flight deck with a lift big enough to take a Mitchell folded in this way shows that even a small reduction is worth doing. The dotted rectangle would be needed for the taking of an unfolded Mitchell below. Also shown is a lift for a folded Mosquito.

Regarding the future development of the single-motor warplane, study of wing folding and armament servicing requirements, together with the need for maximum manœuvrability and the desirability of adopting the tricycle undercarriage indicate that research might be directed once again towards the pusher type, on the lines of the drawing.



We may see an increase in the use of folding wings on warplanes not primarily intended for shipborne operation as the result of an extended use of underground hangars and factories.

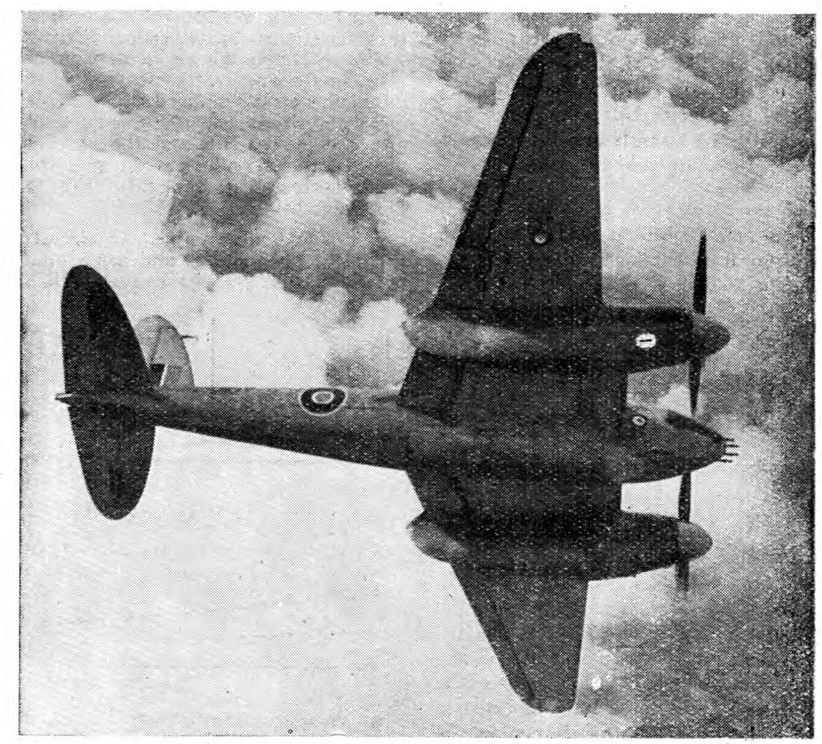
Jet propulsion, by clearing the nose of engine and airscrew, allows the location there of all guns, while bombs and long-range tanks can be mounted centrally under the fuselage. Wing folding will be greatly simplified by this.



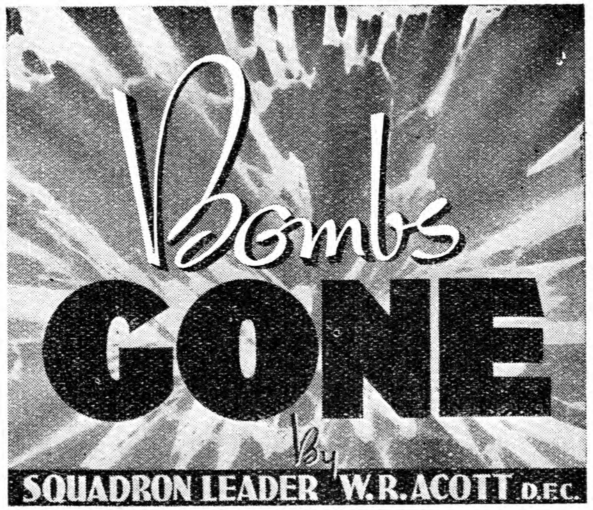
Perfection.

The final sketch shows a natural aircraft, designed quite a long time ago, with its variable camber, variable incidence, flapped and slotted wings folded snugly back on the fuselage; this is monoplane method P—P for perfection.

The Mosquito.



There is a general impression that aircraft ascend instantly when heavy bombs are released, and this has been stated many times by writers. But from my own experience and that of those who have released 8,000-lb. bombs I can assure you that this is not so. If the crew were not aware that they were over the target, and the bombs were released in fairly rough air, such as now obtains in highly concentrated raids, only the pilot would be aware of this fact, and he only because the aircraft would be flying at a lighter wing loading, and would consequently be more responsive to the controls and have a better climb

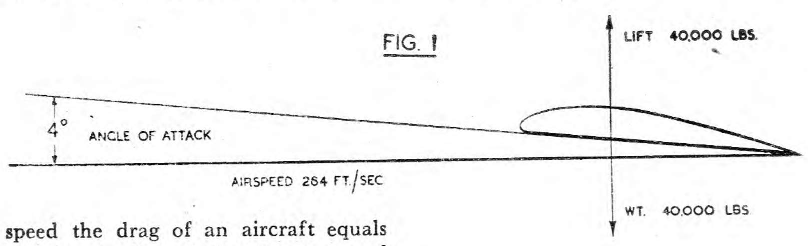


WHY is it necessary for the bomb-aimer to cry "Bombs gone"? Are not the members of the crew aware of the great change in weight by an upward movement like a swiftly ascending lift? A submarine, its tanks blown, shoots to the surface. Buoyancy is restored when its weight is made less by blowing out the water in the buoyancy tanks. Does the release of a 4,000-lb. bomb have the same effect on an aircraft?

Though there is a change in height when an aircraft releases its bombs, the change is hardly noticeable. The aircraft does not shoot upwards like an ascending lift. An aircraft is supported by the airflow beneath and above the wing. Lift varies with the speed of the aircraft and the angle at which the wing meets the air.

Balance

For an object to be in uniform motion it is necessary that all forces should be balanced. At a steady airspeed the drag of an aircraft equals the thrust. Should the thrust exceed the drag there will be an increase in speed. Similarly in level flight, the weight is exactly equalled by the lift. If lift is greater than weight the aircraft gains height. Yet when the forces are unbalanced by the release of a heavy bomb the change in the attitude of the aircraft is hardly noticeable. Why is this so?



Changing the Angle of Attack

A change of weight changes the angle of attack; the lifting power of the mainplane is increased or reduced by an amount corresponding to the change of weight. Fig. 1 shows the wing at a normal angle of attack in level flight, usually about four degrees. The angle between the main airstream and the wing is four degrees.

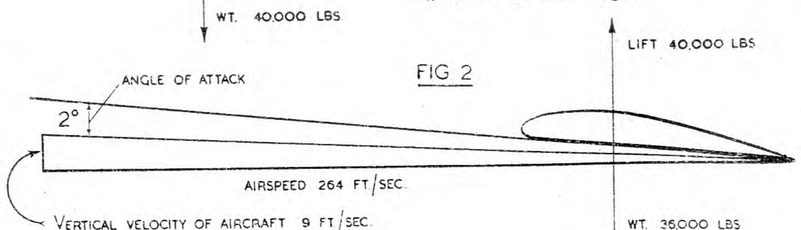
Remove some part of the weight and the forces are unbalanced, there being an excess lifting force which causes the aircraft to rise vertically. The instant that the aircraft has a vertical velocity while still maintaining a horizontal attitude the angle at which the wing meets the air is changed. The angle of attack is reduced. A lower angle of attack gives less lift, and the upward velocity is just sufficient to give the right decrease in total lift. Fig. 2 illustrates this.

Let us take an example. An aircraft weighs 40,000 pounds and has a total wing area of 1,450 square feet. When the airspeed is 180 m.p.h. at an angle of attack of four degrees the aircraft is in level flight. Releasing a 4,000-pound bomb reduces the weight to 36,000. The angle of attack necessary to support 36,000 pounds is two degrees. The aircraft rises with a velocity which causes the relative airstream to meet the wing at the new angle of attack. To do this a velocity of only approximately nine feet per second is necessary.

A vertical velocity of nine feet per second is so small as to pass unnoticed. In normal flying ascending and descending air currents produce velocities far in excess of this figure, and these are taken as a matter of course. In a flak concentration the aircraft is buffeted and shocked. It is not strange then that the vertical velocity resulting from the release of a heavy bomb is not apparent to the crew.

Conditions vary, of course. The rate of ascent of the aircraft after release of the bombs varies according to the percentage weight the bombs make of the total weight. I have considered an average case.

The question of the engine power available at lighter load involves the problem of flying to maximum range. Briefly, one may say the pilot may retain his engine-power output and increase his airspeed, and so shorten the flight, or he may reduce his engine power to fly at his best lift/drag ratio to obtain maximum air miles per gallon. His choice will depend on the distance of the target.



RIVETS and Riveting

by R. H. WARRING

RIVETS are of vital importance in present-day aircraft construction methods. A study of the various types of rivets and their application is useful and interesting.

Rivets are made in many forms and in many metals. Duralumin rivets are most widely employed, with mild-steel rivets for highly stressed areas. Other metals used are aluminium, aluminium alloy D.T.D. 303, nickel alloy D.T.D. 237, monel metal, tungum and copper. Duralumin rivets suffer from the disadvantage that they must be heat-treated or *normalised* before use to soften them, and after normalising must be used within two hours. Otherwise age-hardening sets in, and the rivet head is likely to be cracked or split during working. If not used within this time-limit they must be normalised again. This is inconvenient at times, and so other light-alloy rivets have been produced, although in general their strength is less than that of a duralumin rivet of the same size.

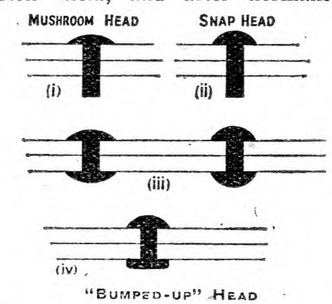


Fig. 1.

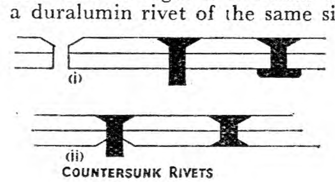


Fig. 2.

Colour Identification

These rivets may immediately be identified by their colour. Duralumin rivets are stamped with the letter "D" on the head and shank, whilst other light-alloy rivets are dyed as under:

Aluminium—black.
Aluminium alloy D.T.D. 327—violet.
Magnesium alloy MG 5—green.
Magnesium alloy MG 7—red.

Snap Head

For all straightforward riveting the mushroom-head or snap-head rivet is generally used. Fig. 1 shows the characteristics of these two rivets before and after forming. The mushroom-head rivet is shallower than the snap head, and therefore widely used on external surfaces, where they offer less drag.

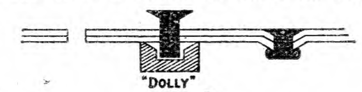


Fig. 3.

The process of riveting consists of holding the rivet in place by means of a "dolly" over the pre-formed head and beating the shank to shape; or the other way round—holding the "dolly" against the shank and forming it by hammering on the pre-formed head. Mechanical riveters are invariably employed, and both the hammer head and the "dolly" are specially shaped so that the pre-formed head is not deformed by the process and a similar head is formed on the shank. Where the "dolly" is not cupped, or the head formed on the shank by hammering with a flat surface, the finished rivet has what is termed a "bumped-up" head (Fig. 1, iv).

Flush Riveting

Now, even though the mushroom-head rivet has a shallow projecting portion, the turbulence caused by several rows of such rivets on, for example, the surface of a wing, is quite considerable, and so flush riveting is desirable on such surfaces. This is particularly important on high-speed aircraft, and is generally brought about by using countersunk rivets.

Countersunk

The two most common forms of countersunk rivets are shown in Fig. 2. The surface of the outer plating is countersunk to take the pre-formed head and the shank "bumped-up" as before. Or a double countersunk rivet may be used, when the shank is formed into another countersunk head (Fig. 2, ii).

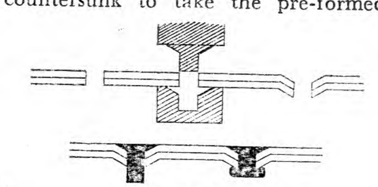


Fig. 4.

When the thickness of the plating is insufficient to allow countersinking, other methods have to be employed. (For example, the sheet covering of a wing may be, say, 25 s.w.g. steel, which is only .02 inches thick).

A Continental system of flush riveting on thin skins is shown in Fig. 3. Here the "dolly" is shaped so that during the riveting action the rivet "dimples" or cups the skin and forms its own countersink. This is directly applicable with skin thicknesses up to 25 s.w.g. (i.e. .02 in. thick). Where the skin thickness exceeds this, and up to 19 s.w.g. (.04 in. thick), the skin "dimple" is formed first with a special tool, the rivet then inserted and beaten off.

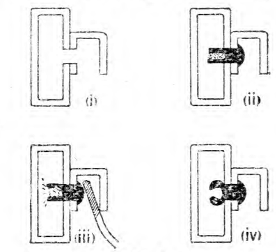


Fig. 5.

If, however, the *lower* plate is thick enough to permit of countersinking, the press countersunk method may be used (Fig. 4).

Explosive

The Heinkel explosive rivet is an example of a rivet designed for work where access to one side only is possible. This consists of an ordinary mushroom- or snap-head rivet with the shank hollowed and filled with a small explosive charge (Fig. 5). The rivet is inserted and heat applied to the head by an instrument something like an electric soldering-iron. The heat ignites the small explosive charge, which spreads the shank and clamps the work.

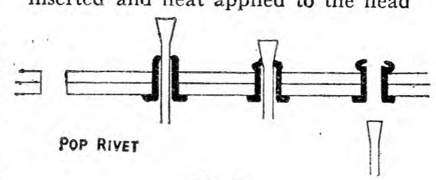


Fig. 6.

Pop

Explosive rivets have been developed in this country and America as well as in Germany, but are only used where no other method is possible. For ordinary blind riveting a pop rivet is generally employed.

These rivets are hollow, and all work on the same principle. A typical pop rivet is shown in Fig. 6. To form

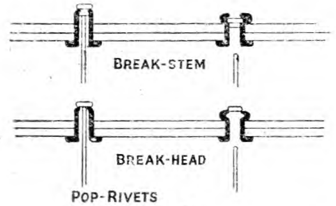


Fig. 7.

to shape the pop rivet is threaded on to a mandrel and inserted in the work. The mandrel has a specially shaped head. The stem of the mandrel is gripped by a special instrument and pulled through the rivet, thus forming the head, as shown in the figure. In some forms of pop rivet the mandrel itself is deformed during this process, and thus is used only once; in others it is made of hardened steel and can be used again and again.

Break-Mandrel

The break-mandrel pop rivet is also popular, and exists in two forms (Fig. 7). Here the action of riveting is as before, but the mandrel head is left in the rivet (break-stem), or simply broken off after the rivet is formed (break-head), and falls inside the structure.

Chobert

A further type is the Chobert rivet, with which a tapered mandrel is used with a tapered hole through the rivet. Withdrawing the mandrel forces the rivet hole to parallel sides, thus forming the head (Fig. 8). This type of rivet is applied by a Chobert rivet-gun, which looks something like a tommy-gun and consists of a mandrel over which about a hundred Chobert rivets are threaded. A rivet is fed up to the end of the mandrel, inserted in the work and the mandrel withdrawn, clenching the rivet. Another rivet is then automatically fed up to the head, the tool inserted in the next hole, and so on, until the supply of rivets is

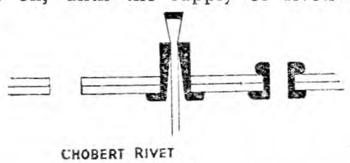


Fig. 8.

exhausted. With such a rivet-gun a production speed of about 1,200 rivets an hour is possible. Hollow rivets such as these are usually plugged with a sealing compound.

Others

There are several other types of rivets in common use, amongst them

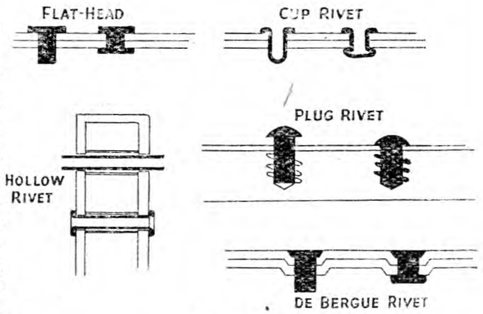


Fig. 9.

being the cup rivet, flat-head rivet (invariably of copper), plug rivet, tubular rivet, etc. Some of these are shown in Fig. 9.

The diagrams are self-explanatory, although the plug rivet may require further description. It is used to rivet sheet to solid metal. The rivet must be softer than the metal backing, and is like an ordinary countersunk type (or sometimes the snap-head type), but the blind hole in the solid metal is tapped with a screw thread. When the rivet is hammered in, it spreads out into this thread and thus firmly secures the plate. In other words, the rivet shank is forced into a screw thread mating with that in the hole by the riveting action, and forms a very strong joint.

Keeping out the Cold

W. J. Roberts discusses the problem of aircraft heating

TWO methods of heating have been extensively tried, the first system being simply to pipe exhaust gases through radiators in cockpits and cabins and rely on the hot gases for warmth. The greatest drawback to this is the danger of carbon-monoxide poisoning through damaged pipes or leaking joints. A much better method is that of putting a water jacket round the exhaust outlets and using it as a boiler.

This system is shown diagrammatically in Fig. 1. The steam and hot

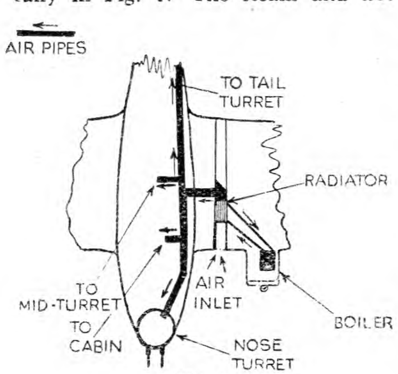


Fig. 1.

water passes round the radiator and back to the boiler; air is admitted, through a passage in the leading edge, and is heated on its way through the radiators. From the radiators the air is passed by pipes through the aircraft as required, the quantity passed being controlled by the pilot or crew. A small tank is carried to supply water to the boiler, to compensate for evaporation, and a bypass is usually arranged to discharge air direct to atmosphere when the heaters are not required.

Heating systems of this nature are quite efficient for the parts of the aircraft near to the radiators, but, as the pipes have to traverse the length of the fuselage, the effect at the midway points is much less, and at the tail end the heat has almost all been dissipated.

Electrically Heated Clothing

Electrically heated clothing has been developed which is designed to provide warmth at the right places, and is used in varying degrees by all long-distance aircrews. Some forms of heated clothing are shown at Figs. 2 and 3, and it will be seen that the heating elements are carefully planned so that they follow the lines of the arteries in the body of the wearer.

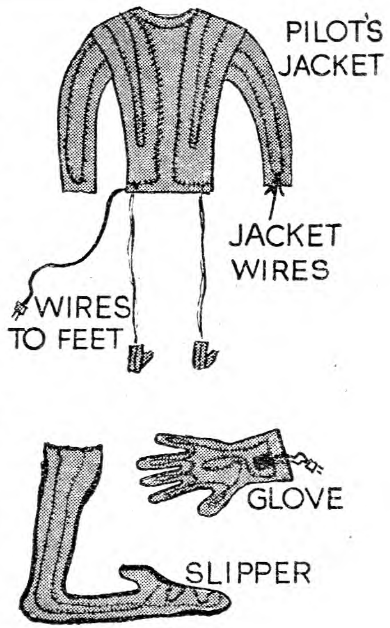


Fig. 2

The pilot and co-pilot usually occupy a heated cockpit, and consequently they normally wear only the lined jacket, socks and gloves. The gunners, owing to the exposed stations they occupy, wear full equipment of socks, gloves, helmet, and a complete overall which is lined and wired with

CONTINUED ON PAGE 28

The Beech AT-10 (above) is the first all-wood advanced trainer to be used by the U.S.A.A.F. After tuition on the AT-10 the pupil will pass on to operational types, such as the B-17G Fortress below.

DESCENT THROUGH Cloud

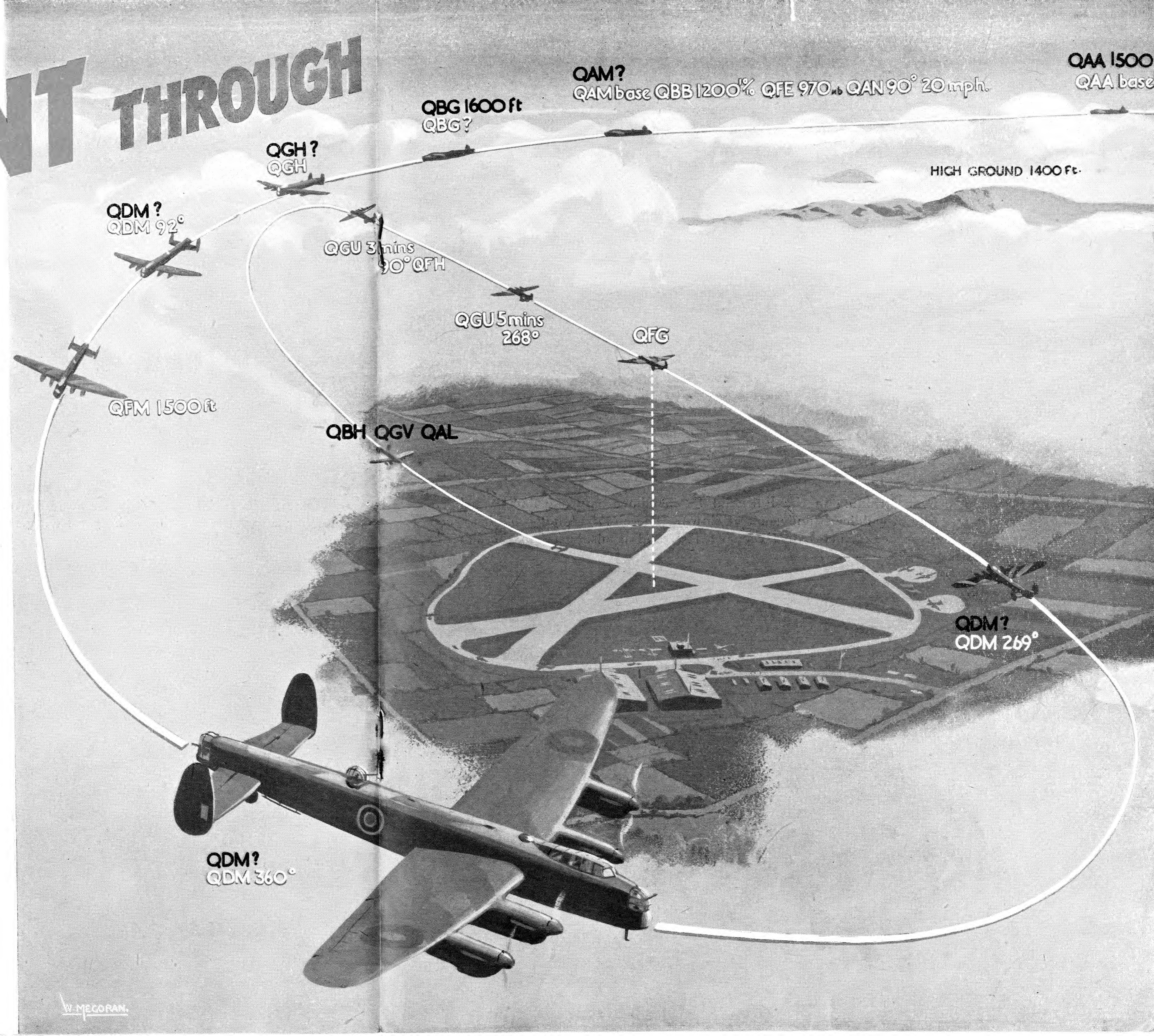
An aircraft returning to its home base frequently finds the aerodrome completely obliterated by a layer of cloud. The process of "breaking cloud" would produce some anxious moments for the pilot without suitable assistance from the ground. Definite "Q" Code procedures have therefore been evolved, and if properly carried out provide a safe and sure method of descending below the clouds without colliding with neighbouring mountains or other obstructions.

The adjoining illustration has been "opened" and shows diagrammatically what would normally happen both above and below the cloud layer.

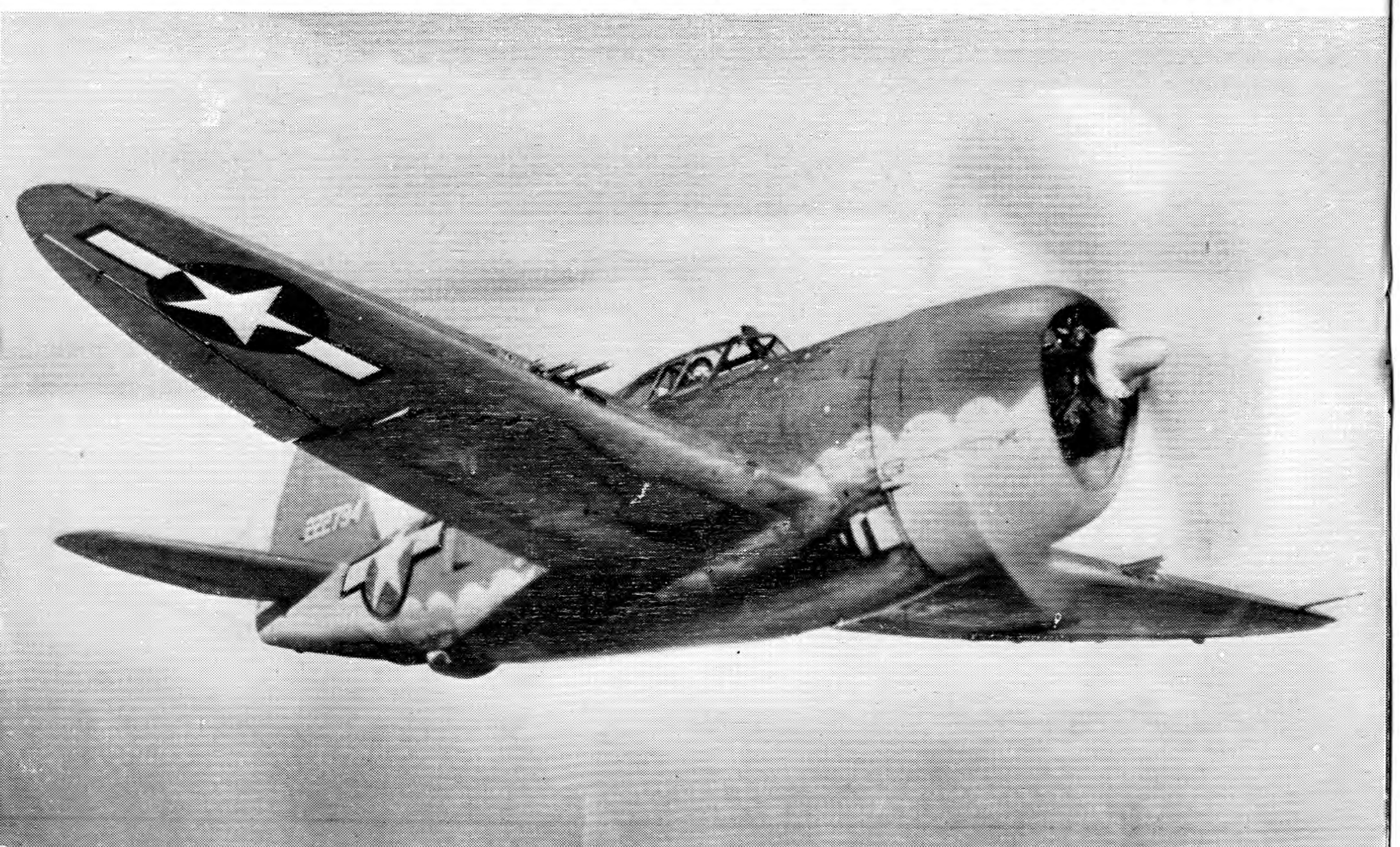
Signals from the ground to the aircraft are lettered in white, and those from the aircraft to the ground are in black.

The following may be taken as a typical procedure incorporating the more commonly used "Q" Code signals, which of course vary to meet local conditions:

A/C to Ground	Ground to A/C	
—	QAA base?	At what time do you expect to arrive at base?
QAA 1500	—	I expect to arrive at 1500 hours.
QAM?	—	Can you give me the latest "met" report?
—	QAM base	The latest met. report at base is:
—	QBB 1,200 10/10	The height of the base of the cloud is 1,200 ft. 10/10.
—	QFE 970 mb	The barometric pressure at ground level is 970 mbs.
—	QAN 90°20 mph	The surface wind is 90° at 20 m.p.h.
—	QBG?	Are you flying above the clouds?
QBG 1600 ft	—	I am flying above the clouds at a height of 1,600 ft.
QGH?	—	May I land using the procedure of "Descent through Cloud?"
—	QGH	You may land using the procedure of "Descent through Cloud."
QDM?	—	What is the magnetic course to steer to reach you?
—	QDM 92°	The magnetic course to steer to reach me is 92°.
—	QFM 1,500 ft.	Fly at 1,500 ft.
—	QFG	You are above the aerodrome.
—	QGU 5 mins 268°	Fly for 5 minutes 268° magnetic.
—	QGU 3 mins 90°	Fly for 3 minutes 90° magnetic.
—	QFH	You may descend below the clouds.
QBH	—	I am flying below the clouds.
QGV	—	I can see you.
QAL	—	I am going to land.



The pupil receiving primary training in the Fairchild PT-23 above may one day fly a high-speed fighter, such as the Republic Thunderbolt (below). The P-47 Thunderbolt has been in service in the Mediterranean since 7th December last, and is also used in the Pacific.



J. A. KYD on

Reading Aero Engine INSTRUMENTS

ENTERING the cockpit of the modern aircraft for the first time, with the knowledge that you will have to master the purpose and function of every instrument and control to be seen, before you have completed your aircrew training, gives you a feeling of helplessness similar to that experienced when for the first time you open a Latin or Greek textbook. You know that everything you want is there, but how to sort everything out and make use of it at the right time and for the right purpose is apparently not going to be so easy.

You should approach the problem with the conviction that everything has got a definite purpose and that nothing has been put there just to make things harder. Once you have got this firmly in the back of your mind and you begin your aircrew training, you will find that each stage through which you are taken introduces you to a little of that rather fearsome-looking cockpit which may one day be under your control. By the time you have reached the O.T.U. stage you will wonder how anyone could possibly think that such an array of instruments and controls are unnecessary, and you will realise that their positioning has been carefully thought out to make them easily read.

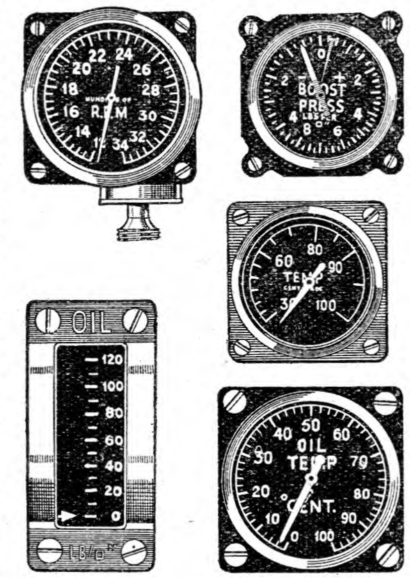
So much for the cockpit in general. Now, let us look at one group of instruments—those which show how the engine is functioning—and find what each is for and how intelligent translation of their readings is an essential part of the pilot's or flight engineer's training.

The engine instruments usually found in the present-day operational aircraft are as follows:

(1) Engine-speed indicator; (2) boost gauge; (3) oil pressure gauge; (4) oil temperature gauge; (5) coolant temperature gauge (liquid-cooled engines) or cylinder-head pyrometer (air-cooled engines).

Gone are the days when the engine-speed indicator was the main guide to the engine's health. Nowadays the engine may be badly down in power but yet the engine-speed indicator will show the full r.p.m. at full throttle in flight. This is because the constant-speed propeller corrects any tendency for the speed to drop when the engine has some small defect, and it is only when the propeller is against its limit-of-travel stop that the engine-speed indicator can be used for checking the engine performance. It has, of course, many other uses, such as synchronising the engine speeds in a multi-engined aircraft.

The boost gauge measures the pressure of the mixture in the induction manifold after it has passed through the supercharger. When a constant-speed propeller is fitted it is the sole means by which a rough indication can be given of what power the engine is developing. The power varies quite



considerably, for a number of reasons, for any given boost. The boost is varied by movements of the throttle, and, as the throttle lever is advanced during flight, the boost will rise, but owing to the action of the constant-speed propeller the revolutions per minute will not vary. In the old days movement of the throttle varied the engine speed and showed at once what sort of power the engine was developing. The boost gauge is now the sole indication.

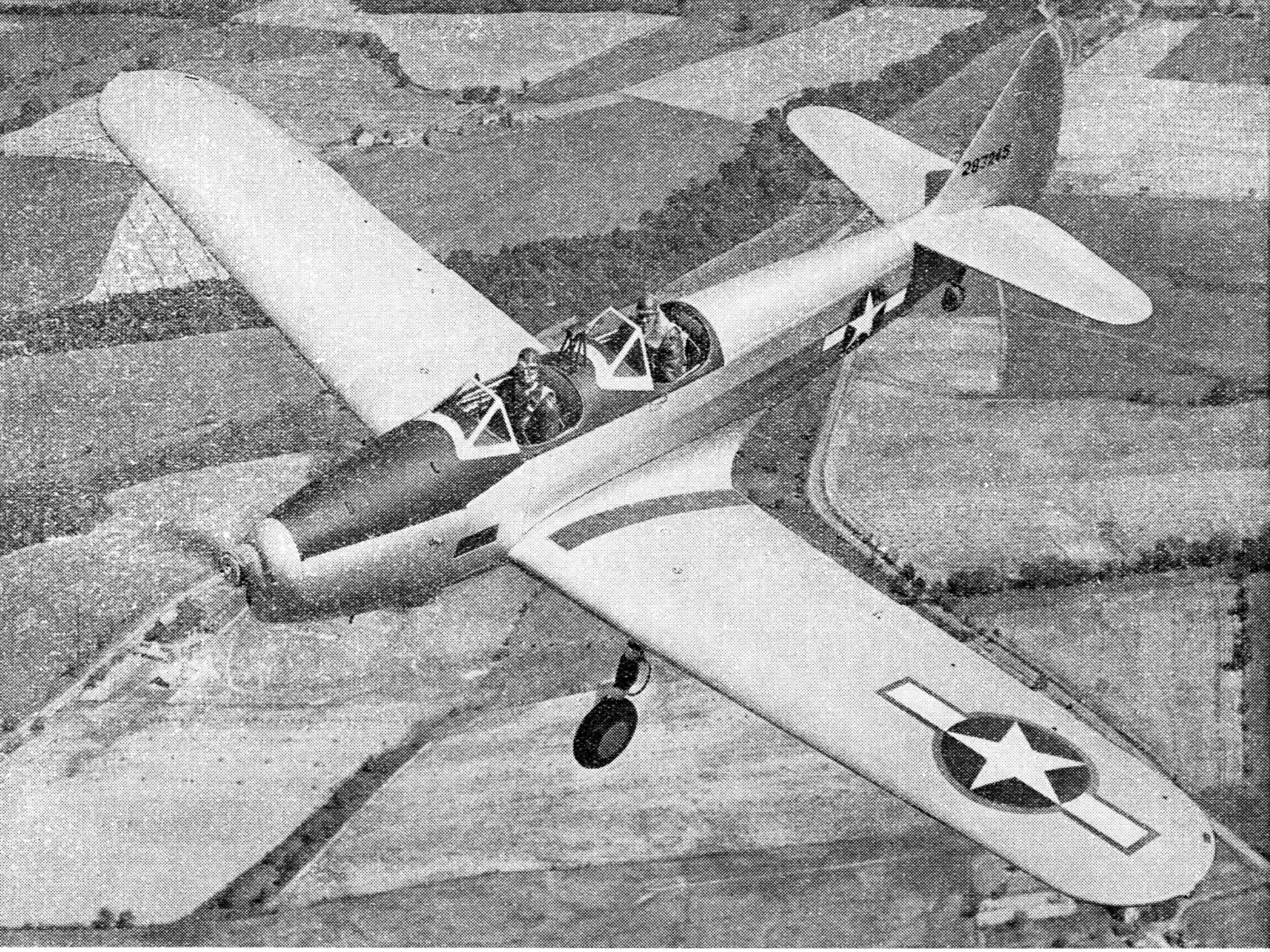
Boost gauges in British aircraft are usually calibrated in pounds per square inch, and they may read from −4 lb. per square inch up to perhaps +10 lbs. per square inch. Zero on the gauge is equivalent to normal atmospheric pressure, i.e. 14.7 lb. per square inch. So, when an engine is quoted as running at 5 lb. per square inch boost, it means that the pressure in the induction manifold is at 5 lb. per square inch above the normal atmospheric.

Lubrication of all moving parts, some with oil under pressure and some by splash, is of prime importance to the aero engine. Clearances between moving parts are small, and unless there is a film of oil between the parts to act as a flexible bearing surface excessive friction is at once caused, heat is generated and the parts fail. The oil must be under pressure to squeeze its way between all the moving parts, and if this pressure is allowed to drop too low trouble is certain to follow. The oil pressure gauge is therefore very well worth keeping an eye on, and if the pressure begins to drop below the minimum figure stipulated for running, nurse the engine.

The oil temperature gauge is useful for showing when the oil has reached a sufficiently high temperature to be thin enough to flow freely throughout the system, and so enable the engine to be run at high r.p.m. A rise in the temperature shown on the gauge above that permitted, for no apparent reason, is unlikely, although a faulty oil cooler is a possible cause.

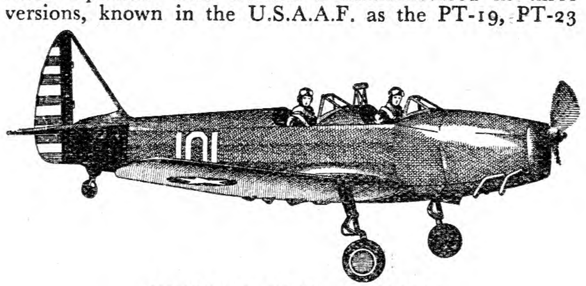
Liquid-cooled engines are provided with a thermostatic control in the system to keep the coolant temperature within the correct limits. Occasions will arise, though, when the automatic control will be unable to cope with excessive rises or falls in the coolant temperature, and the coolant temperature gauge is provided in the cockpit to warn the pilot when it is time to open or close the radiator shutters.

Cylinder-head temperatures in air-cooled radial engines have also to be kept within the prescribed limits. The pilot corrects the deviations, shown by the gauge in the cockpit, by opening or closing the cowling gills around the rear of the engine. When the cowling gills are opened to allow more air to flow through the engine, and thus reduce the temperature, the drag is increased, and so they should not be opened more than is necessary.



THE FAIRCHILD CORNELL

DURING last March it was announced from Canada that nearly 12,000 trainers were in use by the R.C.A.F. and the British Commonwealth Joint Air Training Plan in North America. Of these, many are the Fairchild Cornell primary or elementary trainers, which were introduced to succeed the Tiger Moth and Fleet biplanes. The Cornell is manufactured in three versions, known in the U.S.A.A.F. as the PT-19, PT-23



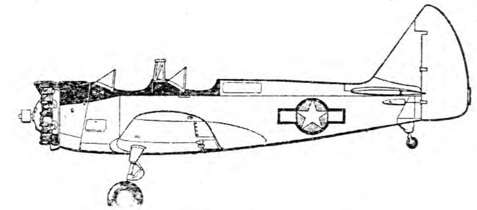
FAIRCHILD PT-19B CORNELL

Span	36 ft.	Max. speed (sea level)	121 m.p.h.
Length . . .	27 ft. 8 ins.	Stalling speed (with flaps)	52 m.p.h.
Height . . .	7 ft. 6 ins.	Climb . .	560 ft. per min.
Gross weight . .	2,632 lbs.	Service ceiling . .	13,000 ft.
Empty weight . .	1,931 lbs.	Normal range . .	475 miles

and the PT-26, the latter being the model supplied to Canada.

The Cornell was designed to meet the need for an elementary trainer of the same characteristics as those of high-performance low-wing combat aircraft, and from the start has been popular with both pupils and instructors. First deliveries were of the PT-19, developed from the Fairchild M-62 light sporting two-seater of 1940, and were allotted to the U.S. Army and the Royal Norwegian Air Force. Large repeat orders for the slightly modified PT-19B are now being fulfilled by the Fairchild Aircraft Division Factories at Hagerstown (Maryland) and Burlington (N. Carolina), and by the Aeronca Aircraft Corporation.

Robust construction is necessary in any trainer, and the welded steel tube frame of the Cornell's fuselage can take any amount of knocks. Fabric covering is used, except for a light sheet-metal covering around the tandem cockpits and the Duramold plywood aft top-decking, which can be removed in large portions to make accessible the interior of the rear fuselage. Wings and fixed tail surfaces have spruce spars and ribs, with formed plywood skin; movable surfaces are aluminium, alloy-framed and fabric-covered except for the manually operated split flaps, which are of similar construction to the wings. The landing-gear consists of two main fixed cantilever com-



FAIRCHILD PT-23 CORNELL

Span . .	35 ft. 11 $\frac{8}{16}$ ins.	Max. speed (sea level) .	131 m.p.h.
Length . .	25 ft. 10$\frac{7}{8}$ ins.	Stalling speed (with flaps)	54 m.p.h.
Height . . .	9 ft. 6 ins.	Climb . .	965 ft. per min.
Gross weight . .	2,747 lbs.	Service ceiling . .	13,250 ft.
Empty weight . .	2,046 lbs.	Normal range . .	370 miles

ponents with oleo-spring shock absorbers and expander tube brakes, and a steerable-swivel tailwheel. Hydraulic wheel-brakes and steerable tailwheel are operated from the rudder pedals, which, incidentallv, have the usual fore-and-aft movement common to American machines. Two fuel tanks, of 45 U.S. gallons total capacity, are placed one in each wing. The contents gauges, set into the upper wing surface, can be read from either cockpit.

Four detachable metal panels enclose the Ranger motor on the PT-19B. The model 6-440-C2 six-cylinder, air-cooled, inverted in-line motor fitted has a 175-h.p. output at sea-level at 2,450 r.p.m., drives a fixed-pitch wooden airscrew and is turned over by a direct hand-starter.

Both cockpits are similarly equipped, and much thought has been given to the handy location of supplementary controls and switches. Instruments in the cockpits are A.S.I., altimeter, compass, clock, revolution counter and engine gauge unit. The seats are adjustable for height.

All the Cornells have a crash pylon between the cockpits. The structure looks quite strong enough to give the occupants good protection in the event of a turnover crash landing.

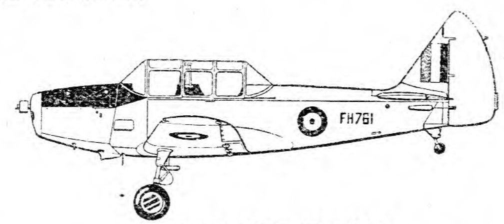
Identical to the PT-19B in construction and equipment, the PT-23 has the Continental R-670-11 seven-cylinder radial motor, giving 220 h.p. at sea-level at 2,075 r.p.m.

This aircraft is manufactured under licence by the Howard Aircraft Corporation and St. Louis Aircraft Corporation for the U.S. Army Air Force.

Canadian schools are still receiving numbers of the third Cornell type, the PT-26, which is made from Fairchild designs by Fleet Aircraft Ltd., of Toronto, to comply with R.C.A.F. specifications. Additions on the PT-26 include a transparent hood with sliding panels covering both cockpits, a blind-flying hood in the rear cockpit, a cabin heater, and speaking-tubes instead of the electrical intercockpit communication systems of the PT-19B and PT-23. The following extra instruments are fitted for blind flying, etc.: bank-and-turn indicator, rate of climb, gyro horizon and directional gyro. A landing-light in the starboard wing and full navigation lights enable the machine to be used for night flying.

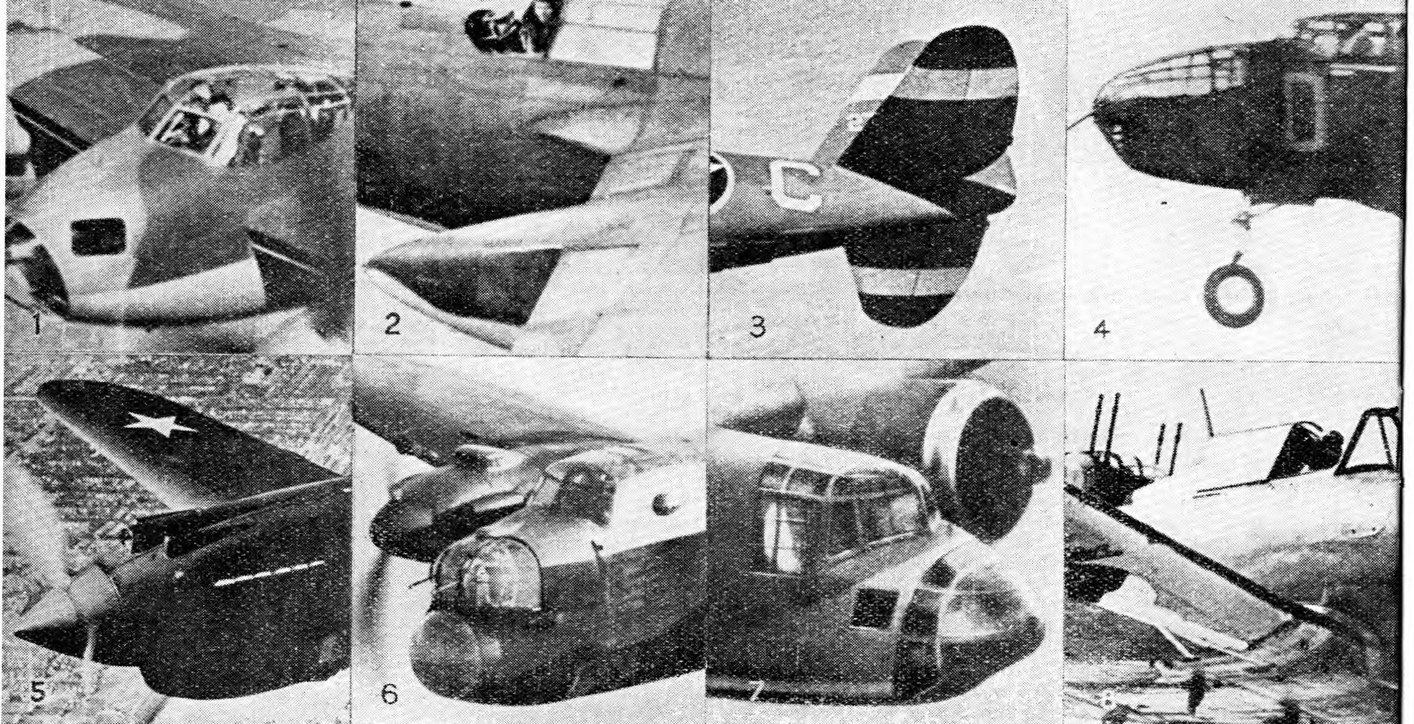
The Ranger 6-440-C5 motor gives more power than the C2 of the PT-19B, the output at sea-level being 200 h.p. at 2,450 r.p.m.

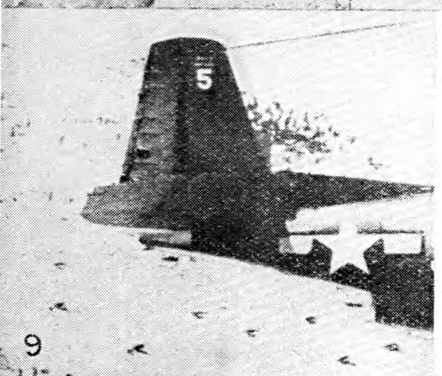
Over 470 modifications had to be made to fit the Cornell for service with the R.C.A.F. For instance, a cockpit enclosure and a heater were added to protect the crew from the severe weather in certain parts and at certain seasons in the North. The greater complexity of equipment enables intermediate as well as elementary training to be carried out.



FAIRCHILD PT-26 CORNELL

Span	36 ft.	Max. speed (sea level)	126 m.p.h.
Length . . .	27 ft. 8 ins.	Stalling speed (with flaps)	54 m.p.h.
Height . . .	7 ft. 7$\frac{1}{2}$ ins.	Climb . .	690 ft. per min.
Gross weight . .	2,700 lbs.	Service ceiling . .	17,800 ft.
Empty weight . .	2,001 lbs.	Normal range . .	450 miles





POINTS WORTH NOTING

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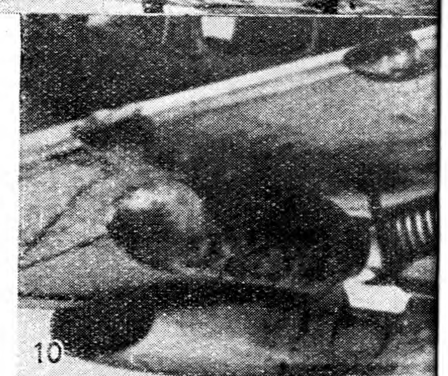

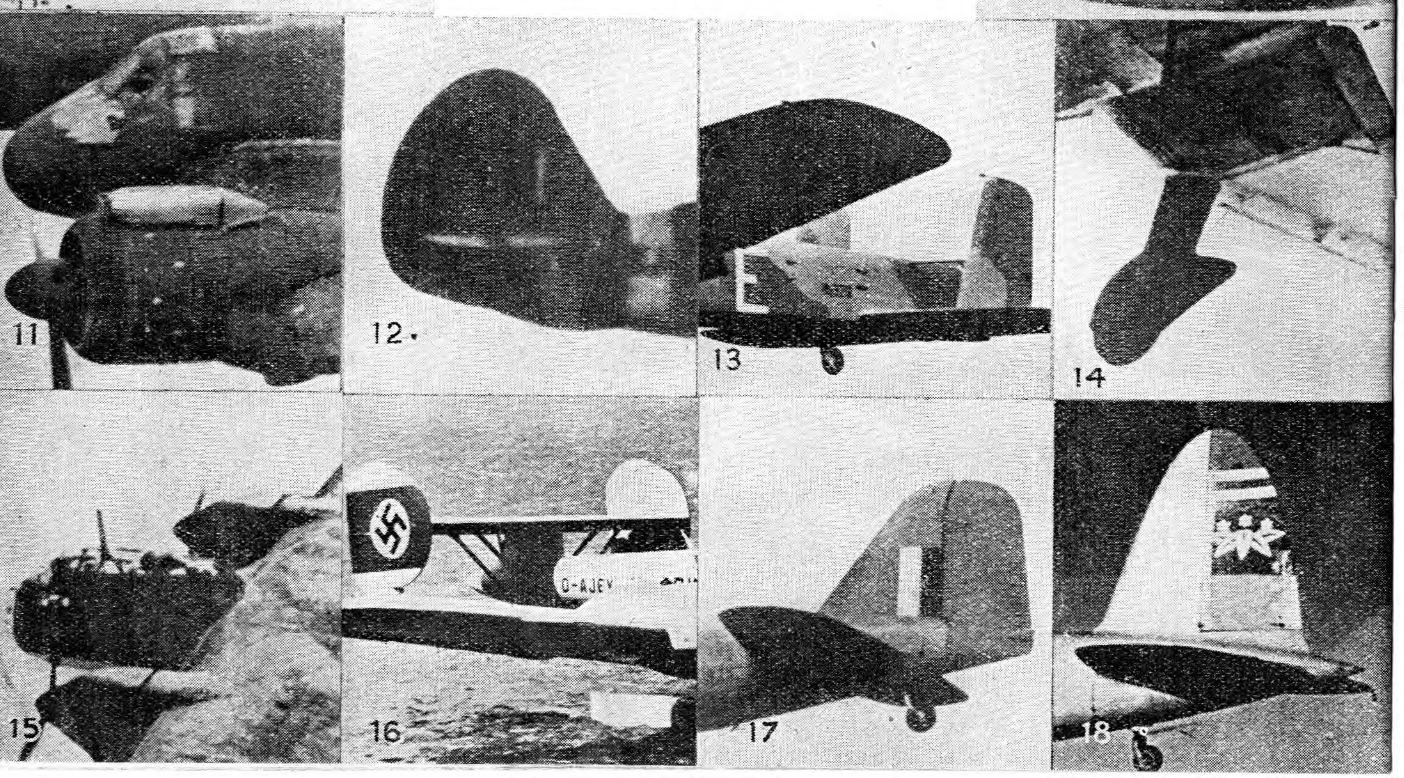

BEGONE U.S.!

John Sinclair

The story of the Wireless Mechanic and the part he plays in maintaining airborne equipment fit for service —

WHETHER it be a Stirling that has "pranged" or a wireless set that has refused to "play," the term "U.S." is employed to signify that it is "unserviceable."

In this article it is proposed to indicate some of the precautions taken by wireless mechanics to satisfy themselves that the airborne radio equipment for which they are responsible is 100 per cent operational.

Types of Communications Equipment

Bomber radio equipment falls into five general headings. First, that used for purely local communications, i.e. air to ground during take-off or in landing; second, that used for communications between aircraft flying in close proximity to one another; third, that used for long-distance communication and D.F. purposes; fourth, that used for inter-communicating purposes inside the aircraft, and lastly, the special equipment used to provide aids to navigation.

Intercom. equipment is not in itself *radio* equipment, but the apparatus used is part of the radio installation, and for that reason must be included.

Aerial Systems

In order to communicate by means of wireless telegraphy some form of aerial system is essential. The erection of efficient aerial systems for ground stations (except under battle conditions) present few serious difficulties, but the problems confronting the aircraft-radio engineer are considerable, for within the limits of physical and limited dimensions he must design radiating devices which will provide reasonable efficiency over a fairly wide band of radio frequencies. Further, he must take care to see that the aerial systems do not affect, to any appreciable extent, the speed of the aircraft—a most important point. They must be made secure by attaching to the fuselage, and if of a trailing nature they must be capable of quick release and even quicker retraction.

One of the first duties of a wireless mechanic is to check—in a mechanical sense—the aerial systems fitted to his "kite." All insulators must be inspected and the aerial wire examined for broken strands. The trailing aerial mechanism must be examined to see that it runs smoothly, whilst the D.F. aerial and its housing must be thoroughly inspected to see that it is mechanically sound. The insulation resistance of each aerial system must be checked with a megger, while lightning protectors and earth connections will come in for special and critical examination. Signs of rust will be immediately reported.

Because of the vulnerability of exposed parts and wiring, every aircraft is subjected to extensive servicing immediately after an operational flight.

Transmitters and Receivers

It is correct to state that the general-purpose aircraft transmitter-receiver is a sound mechanical-electrical job, free from the tiresome troubles that have brought many commercial sets into disrepute. Built for service under battle conditions, R.A.F. sets stand up to the strain in a remarkable manner.

Once a transmitter-receiver combination has been properly installed in an aircraft, routine tests usually suffice to ensure that all is well, but prior to commencing an operational flight it is the general rule to test the equipment in the air.

Static tests, to ensure that each valve is functioning properly, cannot be regarded as a substitute for an actual test of the radio properties of the equipment. Loose connections, for example, are more likely to show up when an aircraft is in flight than when it is stationary.

Certain types of faults can be diagnosed from experience gained through constant use; others—and they are usually the most elusive, require a sound theoretical knowledge of the circuit. Faults of an intermittent nature are perhaps the most difficult to locate as they are invariably due to faulty components, such as resistances and condensers.

Unfortunately, Service equipment is not at present generally available to A.T.C. squadrons, but this fact should not hamper instruction, provided facilities exist for servicing communication-type *commercial* receivers. Such receivers follow the same basic principles of design as their Service counterparts, and much valuable experience can be gained by studying the methods used by service engineers in locating sources of trouble.

If arrangements can be made for small parties of cadets to visit local wireless dealers, many useful hints and tips will be collected.

Batteries and Generators

Airborne equipment must, by force of circumstances, be operated from storage batteries (accumulators) or motor generators. A defective cell may bring disaster to an aircraft and death to its crew. Imagine what would happen if, during an air battle, the rear gunner was unable to give warning of an attack on the tail of his machine, because the intercom. was U.S. If the unserviceable condition of the intercom. was due to faulty servicing at base, the mechanics concerned would be guilty of gross negligence.

In carrying out daily routine inspections (D.R.I.s), wireless mechanics are required to pay special attention to all power supplies. The slightest suspicion of trouble must be traced to its source, for no chance dare be taken when the lives of airmen are at stake.

A cadet U/T for wireless mechanic cannot know too much about aircraft power supplies. For instance, he should not only know how to ascertain whether the specific gravity of an accumulator is "below par," but also what *happens* when that state of affairs occurs.

Service-type motor generators are robust and reliable, but under operational conditions a heavy strain is thrown upon them, to say nothing of the possibilities that exist of flak hitting the case and damaging the mechanism. Back at base, power supplies are scrutinised with meticulous care, and, prior to the next take-off, tests are conducted to ascertain that no damage or defects have occurred.

Summary

Summarising, we can say that the duty of the ground wireless mechanic is to examine, test and operate every single item of wireless equipment, prior to and after an operational flight. He is also responsible in many cases for the installation of special equipment, which is often a modification of an existing design.

Cadets who aspire to become wireless mechanics should make the very best of their opportunities whilst in "civvy street." Their work in the Service will be onerous, but full of interest; furthermore, and this a point to remember, *when they leave the Service they will have a useful trade at their finger-tips.*

BOOKS

Briefly and unofficially described

Father's Heinkel. Bernard Wicksteed. 160 pp. $7\frac{1}{2}'' \times 4\frac{7}{8}''$. Nicholson & Watson. 5/-. An amusing, racy story of an intelligence officer who volunteers for aircrew duties without letting his wife know, has adventures she won't believe, and finally gets a medal. ✻ **Target: Germany.** U.S.A.A.F. official story. 118 pp. $9\frac{1}{2}'' \times 7\frac{1}{2}''$. H.M.S.O. 1/6. The story of the American day-bombing, well told, well illustrated, and of great interest ✻ **Queens Die Proudly.** W. L. White. 227 pp. $7\frac{3}{8}'' \times 4\frac{7}{8}''$. Hamish Hamilton. 7/6. The story of the crew of a Flying Fortress operating in the Pacific just after Pearl Harbour. ✻ **The Luftwaffe.** C. G. Grey. 251 pp. $7\frac{1}{2}'' \times 5''$. Faber & Faber. 8/6. **The Rise and Fall of the Luftwaffe.** Hauptmann Hermann. 160 pp. $8\frac{1}{2}'' \times 5\frac{1}{2}''$. John Long. 12/6. Both of these books are concerned mainly with the pre-1939 Luftwaffe. Mr. Grey's is illustrated, but both would be improved by substituting more pictures for text. ✻ **There's Freedom in the Air.** An official story. $6\frac{1}{2}'' \times 8\frac{7}{8}''$. H.M.S.O. 6d. The official story of Allied air fighters. ✻ **Gliding and Soaring.** Major Alois Sitek and Flight Lieut. V. Blunt. 118 pp. $8\frac{3}{4}'' \times 5\frac{1}{4}''$. Alliance Press. 6/-. An exposition of the principles and technique of soaring and gliding. ✻ **Recognition of Operational Aircraft.** Capt. G. B. Ransford. 114 pp. $7\frac{1}{4}'' \times 4\frac{7}{8}''$. Pitman. 3/6. A new and simplified method of instruction in aircraft recognition. Devised by an Army officer, and tried out by him, it is well worth investigating. ✻ **Approach to Aircraft Recognition** (PART 2). J. G. M. Miller and D. M. Harris. 38 pp. $4\frac{3}{4}'' \times 7\frac{1}{4}''$. Argus Press. 9d. In this booklet the authors deal methodically with the lesser-known aircraft that appear in recognition tests. ✻ **Air Power and the Expanding Community.** Major Oliver Stewart, M.C., A.F.C., 232 pp. $9'' \times 6''$. Newnes. 15/-. A well-known journalist reviews the air situation and puts forward interesting ideas that merit the attention of the thoughtful reader. ✻ **Bombing Vindicated.** J. M. Spaight, C.B., C.B.E. 159 pp. $7\frac{1}{2}'' \times 4\frac{7}{8}''$. Godfrey Bles. 6/-. An illustrated survey of recent bombing developments. ✻ **International Air Transport.** Brig.-General Sir Osborne Mance, K.B.E., C.B., C.M.G., D.S.O. 117 pp. $8\frac{1}{2}'' \times 5\frac{1}{2}''$. O.U.P. 7/6. A survey, issued under the auspices of the Royal Institute of International Affairs, of past, present and future international air law, customs and administration. Unillustrated. ✻ **Civil Aviation.** Michael Young. 64 pp. $10'' \times 7\frac{1}{2}''$. Pilot Press. 4/6. An illustrated survey of today's civil aviation, with some speculation as to the future and an advocacy of world airways. ✻ **Sky Saga.** Thomas White. 60 pp. $7\frac{1}{2}'' \times 4\frac{3}{4}''$. Hutchinson. 5/-. A long narrative poem telling the story of Empire airmen in all parts of the Royal Air Force. ✻ **Elements of Aeroplane Hydraulics.** H. P. Lees. 95 pp. $6\frac{1}{2}'' \times 4\frac{1}{8}''$. Hutchinsons Publications. 2/6. Chapters on elementary principles, components, systems and maintenance, with 200 questions and answers. ✻ **Introductory Magnetism and Electricity.** T. M. Yarwood. 159 pp. $7\frac{1}{8}'' \times 4\frac{3}{4}''$. Macmillan. 2/6. The fundamental facts of magnetism and electricity presented in brief and simple form. ✻ **The Complete Morse Instructor** (SECTION ON SEMAPHORE). F. Tait. 57 pp. $8\frac{1}{4}'' \times 4\frac{7}{8}''$. Pitman. 2/-. An instructional textbook with a number of useful exercises. ✻ **The Morse Code.** N. Sandor, M.I.M.E., A.M.I.E.E. 17 pp. $8\frac{3}{4}'' \times 6\frac{3}{4}''$. Real Photographs Ltd. 2/-. Coloured illustrations suitable for teaching the Morse code in the nursery. Few cadets will need it. ✻ **Meteorology** (No 4). Lieut.-Col. R. M. Lester, F.R.Met.S., 63 pp. $6\frac{1}{2}'' \times 4\frac{1}{4}''$. Hutchinson's Publications. 2/6. A textbook that fails to reach the standards of the official handbooks in size and quality for price.

Aircrews should study Airfields

by Captain Norman Macmillan, M.C., A.F.C.

LOOKING back along the history of flying, and comparing past practice with current method, makes me inclined to suggest that the greatest change has occurred not in the types of aircraft, or their performance, but in the construction of aerodromes for their use. No doubt the change in aerodromes has followed the advance in aircraft, but today that sequence does not apply; it is the aerodrome which dictates the operational efficiency of aircraft.

The basic difference in aerodrome construction is the change from grass area to strip (or runway) construction. This imposes restrictions on aircraft pilotage which formerly did not exist, but in return it makes possible the employment of aircraft in circumstances which before might have precluded their use.

In the desert campaign of North Africa it was almost as important to get the aerodrome engineers up to the front line to make a new airfield for the fighters as it was to get the fighting troops' reinforcements there. Thus, and only thus, was it possible for the Desert Air Force to leapfrog forward from airfield to airfield and so maintain continuous fighter cover ahead of the Eighth Army.

Not once, but many times, the retreating Germans ploughed up the airfields they evacuated, hoping thus to retard the progress of the Desert Air Force. But the bulldozers, mechanical rollers and dredgers used in modern civil engineering made light work of the restoration of ploughed ground to a surface fit for aircraft. Often the fighters, who had taken off from one airfield, were directed while in flight to land at another many miles in advance of the first.

I should say it is almost certain that when the war is over and the R.A.F. settles down to post-war conditions there will be at least a nucleus staff of skilled airfield engineers, whose job will be military airfield design and construction, with a department capable of rapid expansion in emergency.

The strip system of airfield construction was used to good effect by the advance party of the North-West Expeditionary Force which went to the Narvik area of Norway in the spring of 1940. The party found a civil airfield of sorts, fit for use by the slow-landing Fokker civil monoplanes that had used the field, but unsuited for the Gladiator and Hurricane fighters that were to be flown ashore, followed perhaps by bombers. This airfield was situated in a forest of firs. Standing timber had been felled to make runways. They were too short for military purposes, for they did not enable aircraft to get into the air fast enough one after another, although they had been long enough when perhaps only a couple of Fokkers had taken off and landed during the passage of several hours. But it was a comparatively simple matter to fell more timber to level one runway—and box-drain it—because local labour could be used for the purpose. Thus, although the site was at first covered with snow and ice, and the runway jeopardised by the subsequent thaw, it was possible to create a strip suitable for the use of the fighters with sufficient rapidity to meet the strategical needs of the situation.

The airborne force landed in Northern Burma in March 1944 had an even more difficult airfield operation to tackle. The original force flew in gliders with the equipment necessary to make and defend the aerodromes. Three fields were selected for the first glider descent. The engineless aircraft flew through the night over 8,000-feet of jungle-covered hills, and came down swiftly one after another, some crash-landing in the jungle, others crashing into those already down. All manner of material was carried in the gliders—equipment for engineering, radio and signals, mules, jeeps, rations, arms, ammunition. The covering party moved out into the jungle (for the landing was made in country completely surrounded by Japanese forces), while airfield specialists got on with the construction of strips whereon Dakotas could land. The strips, probably overlaid with metal where necessary, were soon prepared. Air transports then came down with reinforcements and supplies.

Those gliders were employed as aircraft of 1914-18 might have been employed, for most of the aircraft then used could land in small fields. But 1914-18 aircraft could not have carried the loads, either in weight or bulk. In no other way but by the use of gliders could this advance force have been sent into the area where it went; and without that initial operation the main force could not have got there at all. We see it is necessary to possess some aircraft that can operate from small fields, so that they can open the way for the employment of more powerful aircraft.

So, even with the coming of the new order of airfield, there is still much profit to be derived from a study of the methods of the past. It is upon such knowledge that the topographical factors for or against the employment of advanced airborne forces can be decided. In this, glider instruction, too, will stand the A.T.C. cadet in good stead, for his knowledge of glider-flying will aid him not only to learn power-flying more rapidly, but to assess the possibilities of glider-borne operations.

Meanwhile, study airfield construction. Get to know (1) whether one runway strip will suffice or whether more are essential; (2) minimum length of strip needed for different aircraft under varying conditions of altitude and temperature; (3) the effect of geostrophic and thermal airflows in relation to the siting of main runway strips; and (4) the quickest way of preparing a strip under a variety of conditions. There is a steadily growing pool of knowledge of airfield construction, and no one concerned with practical aviation can begin to dip into this pool of knowledge too soon.

POINTS WORTH NOTING

(SEE PAGE 22)

1, De Havilland Mosquito; 2, Douglas Boston; 3, Republic Thunderbolt; 4, North American Mitchell; 5, Curtiss Tomahawk; 6, Avro Manchester; 7, Blackburn Botha; 8, Blackburn Roc; 9, Grumman Avenger; 10, North American Mustang (Invader); 11, Bristol Beaufighter; 12, Curtiss Mohawk; 13, Armstrong-Whitworth Whitley; 14, Junkers Ju 87 B; 15, Dornier 215; 16, Blohm and Voss Ha 139; 17, Fairey Fulmar; 18, Kawasaki Army KB-97.

YOU SHOULD KNOW THEM

(SEE PAGE 20)

1, Messerschmitt 109E; 2, Curtiss Helldiver; 3, Fw 190; 4, Fairey Swordfish; 5, Blohm and Voss 138; 6, Martin Marauders; 7, Grumman Wildcat; 8, Grumman Avenger; 9, Armstrong-Whitworth Albemarle; 10, De Havilland Hornet Moth; 11, Henschel 126; 12, Hawker Sea Hurricane; 13, Curtiss Kittyhawk; 14, Hawker Typhoon; 15, Bristol Beaufort; 16, Martin Baltimore; 17, Westland Whirlwind; 18, Vultee Vanguard; 19, Lockheed Ventura; 20, Douglas Dauntless; 21, Taylorcraft Auster; 22, Heinkel 60 floatplane; 23, Boeing Fortresses; 24, Junkers Ju 88; 25, North American Mustang; 26, Northrop A17; 27, Bristol Blenheim; 28, Bristol Beaufighter; 29, Miles Master I; 30, North American Mitchell.

Keeping out the Cold

CONTINUED FROM PAGE 12

fine heating elements in a similar manner to the pilot's jacket, but includes heating for the lower portion of the trunk and legs in addition.

Preparation for a long flight at high altitude is a long business, and the assistance of a member of the ground staff is essential.

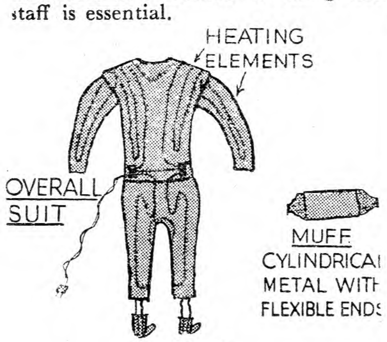

Fig. 3.

The great advantage of electricity from the aircraft point of view is that it involves very little additional weight, as there is already an electrical system in the machine. By giving the airman a plug and a reasonable length of flexible lead, he is enabled to move about and change position with a moderate degree of freedom.

Additional Equipment

Numerous other items of equipment are provided with similar electrical heating arrangements. The gunner, for example, is frequently supplied with a heated muff into which the hands and wrists are inserted when not in action. Airborne troops and paratroops are provided with special clothing, the design of which is a development of that used in Arctic expeditions.

One other form of heated equipment is especially worthy of mention that is the sleeping-bag or "casualty bag" used for the care of wounded and injured aircrews on the long flight home. In the early days a considerable number of men who had been wounded and had suffered from loss of blood died on the way home. This was due to the fact that vitality was lowered by the injury, and they literally froze to death. The method now adopted is to put the injured member of the crew into the "bag," and thus keep him warm until base is reached and proper attention can be obtained.

★ *FOR GENERAL READING*

Your Editor, Leonard Taylor, is also Editor of *SYNOPSIS*, a quarterly (non-aeronautical) magazine containing interesting extracts from the best British journals and books. On sale at bookstalls and newsagents at the end of May. Price One Shilling

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The Vickers Warwick

The Warwick is in service with the Royal Air Force as a passenger and freight carrier, in addition to other capacities.

It is a mid-wing monoplane, and is powered by two Pratt and Whitney Double Wasp Engines of either the S.1A4-G or 2.SB-G types of 1,850 and 2,000 b.h.p. respectively.

There are many exterior features of the Warwick which disclose that it has taken its origin from the Wellington, one of the geodetic productions of Vickers Armstrongs Limited (Aircraft Section).

Like the Wellington, the Warwick is operating in many theatres of war.

Span	96 ft. 8½ in.
Length (overall) (on ground)	70 ft. 6 in.
Height	18 ft. 6 in.
Wing Area (gross) . .	1,006 sq. ft.
The total airworthy weight is	45,000 lb.