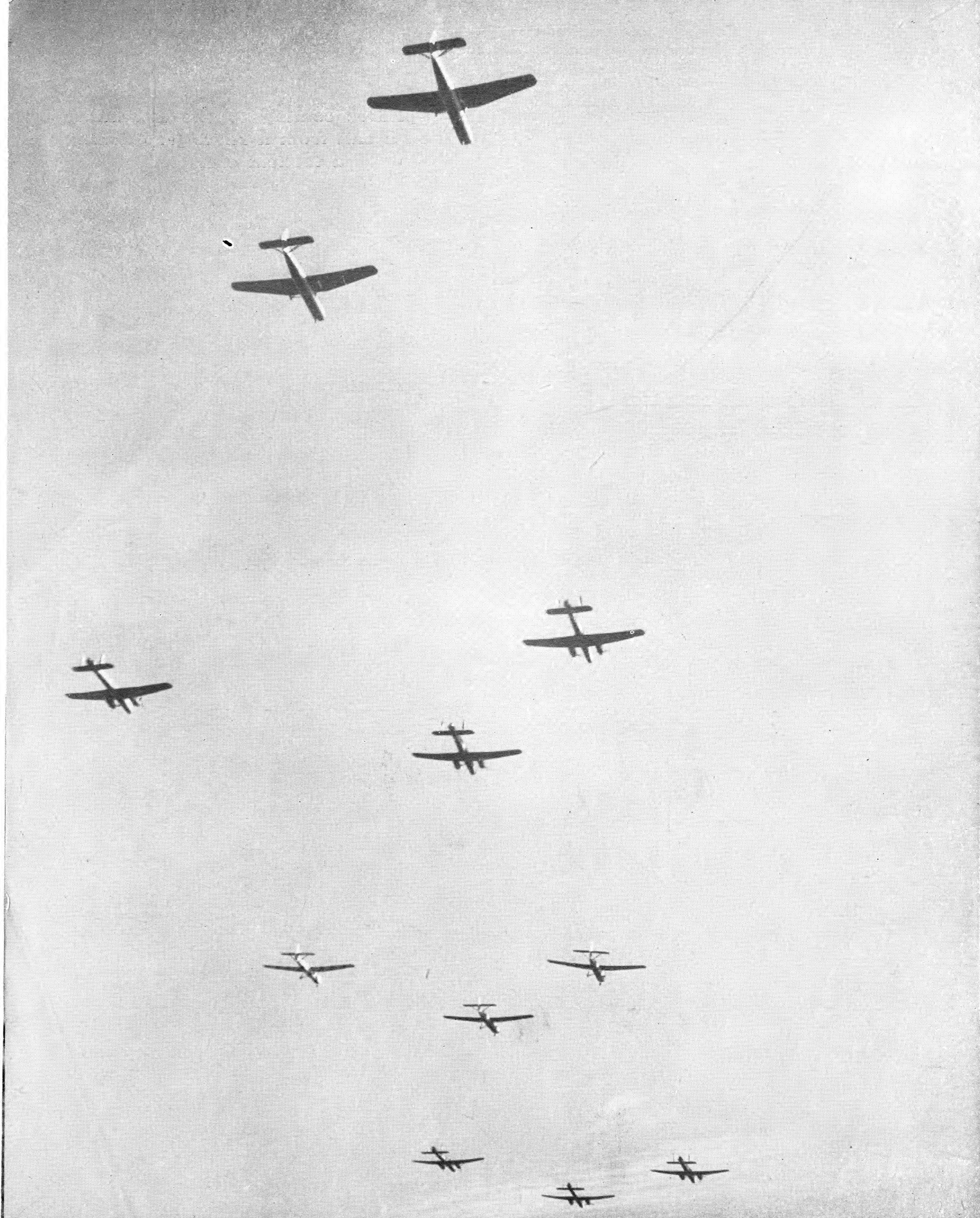
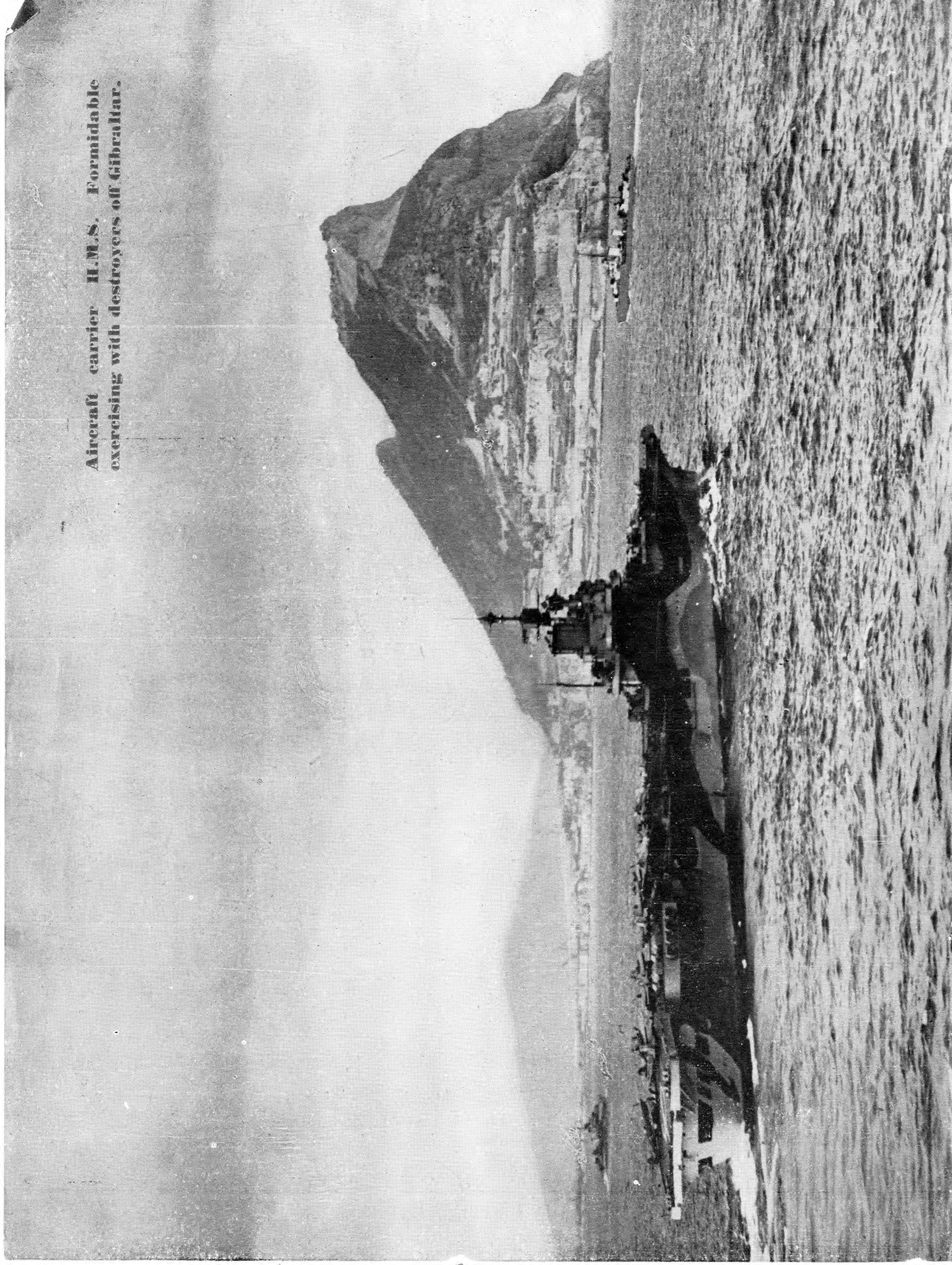


Whitleys towing Horsa troop-carrying gliders.

AIR TRAINING CORPS GAZETTE

VOLUME IV. No. 3.
MARCH 1944. Price 6d.

Air Chief Marshal Sir ARTHUR TEDDER, G.C.B.
Deputy Supreme Commander.



Aircraft carrier H.M.S. Formidable exercising with destroyers off Gibraltar.

AIR TRAINING CORPS GAZETTE

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The Chief Commandant's Message

I HAVE now been able, since taking over command of the A.T.C. at the beginning of February, to visit a number of units, and by the 1st March I should have seen a number more. I have been greatly impressed by the keenness shown by officers, civilian instructors and cadets of the squadrons and by the support given by local committees in the many different ways in which they can help.

R.A.F. Short-Course Undergraduates at dinner.

I have looked particularly into the scope of training which cadets are being given and into the facilities provided. These appear to me to be adequate, but I want special concentration upon training.

We continue to watch our numbers, but we must be sure that all we send on to the Royal Air Force and Fleet Air Arm for aircrew must be fully trained within the scope of the syllabus laid down. It is not sufficient to be "examination trained" only. The knowledge to be acquired must be learnt so that it sticks and that it will be available in moments of stress. For instance, "calculations" superficially learnt may not be of real help to a navigator who is forced to work out a problem in an emergency in the heat of action. Knowledge must be so ingrained that it becomes second nature.

Whilst I am satisfied that all are striving well towards what is needed, bear in mind that success or failure may depend upon your concentration on your training.

E. L. Gossage, *Air Marshal, Chief Commandant and Director-General, A.T.C.*

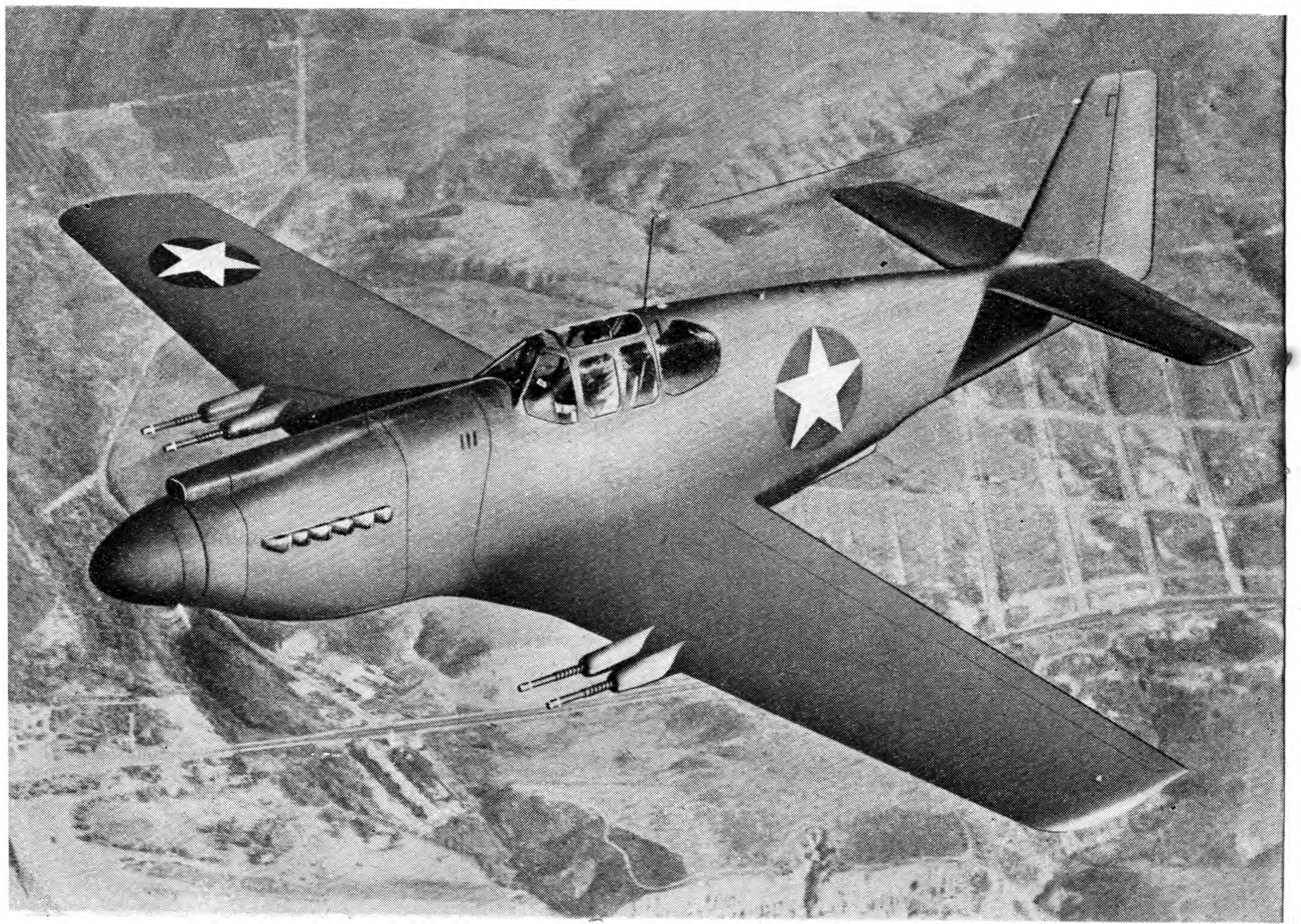
The Development of FIGHTER AIRCRAFT

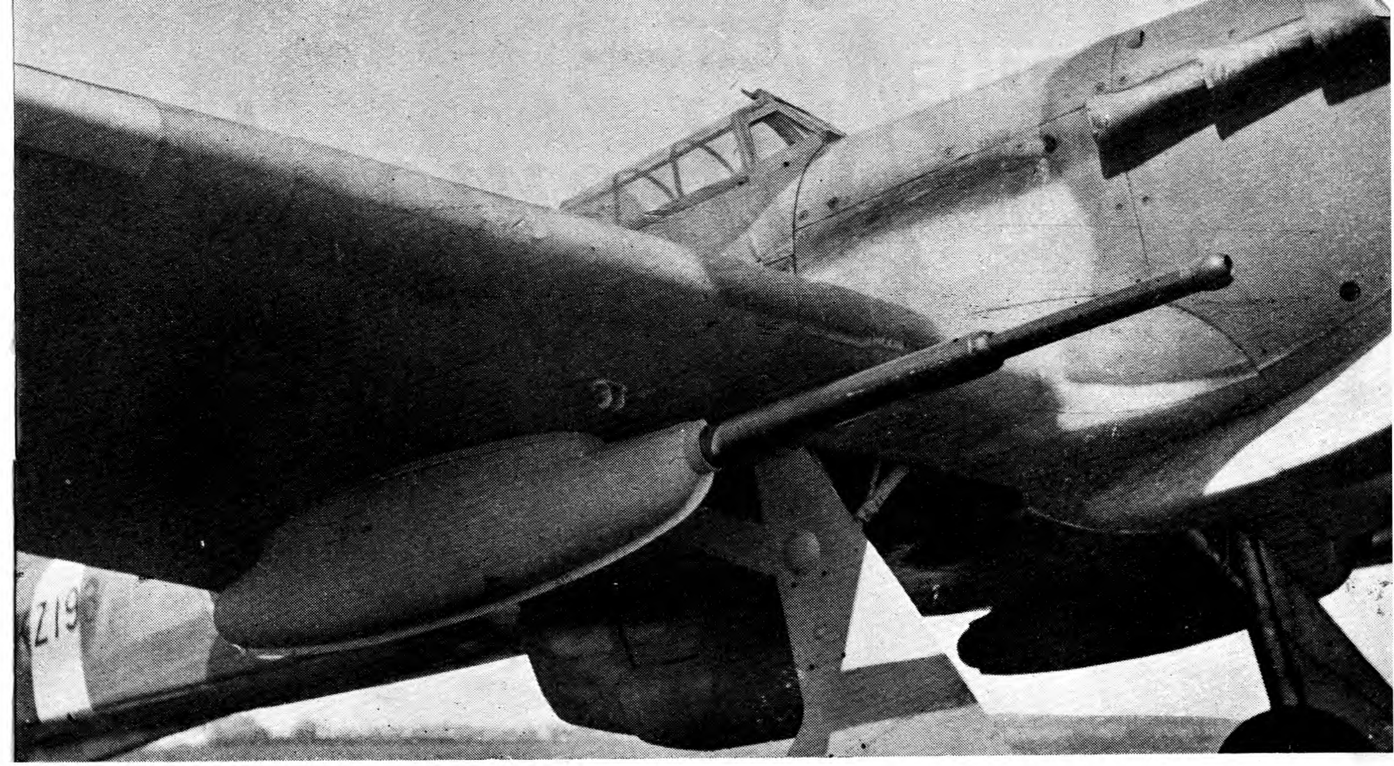
By John W. R. Taylor

As in the last war, fighter performance has improved by leaps and bounds since 1939. When the war started the standard R.A.F. fighter 'plane was the Hawker Hurricane I, with a very small number of Spitfires also in service. The maximum speed of the former was 335 m.p.h. at 17,000 ft. and its service ceiling 36,000 ft. Thus, from the point of view of speed alone, R.A.F. equipment was inferior to corresponding enemy front-line equipment, as the standard German fighter, the Messerschmitt Me 109E, had a maximum speed of 355 m.p.h. at 13,000 ft. But, as the Battle of Britain proved conclusively, speed is by no means the all-important factor in aerial combat; the Hurricanes by their superb manœuvrability and crushing fire-power took terrible toll of the speedy but relatively clumsy Messerschmitts. Nevertheless, speeds have steadily increased, and the German Focke-Wulf Fw 190 has a speed of 390 m.p.h. at 20,000 ft., while the Typhoon, Mosquito and Spitfire IX can all fly at "well over 400 m.p.h.," with no sacrifice of hitting power, as each carries a very formidable battery of cannons and machine-guns.

But the most noticeable point about modern air-fighting is the altitude at which it takes place. When the war started it was assumed that combats would be fought at between 5,000 ft. and 15,000 ft., but the Luftwaffe adopted a policy of high-flying in an attempt to get above our defences. Fighting often took place at 30,000 ft. Since then ceilings have gone up and up—35,000, 37,000, 40,000 ft. and beyond. The Hurricane Mark II is capable of reaching 41,000 ft., but fighting at such altitudes imposes great strain on pilots, and it is obvious that special machines for high-altitude combat will have to be evolved. The Spitfire IX and Messerschmitt Me 109G are both high-altitude fighters, but the fighter of the future must, of necessity, have a pressure-cabin to enable the pilot to withstand the strain of manœuvres at 40,000 ft. and over. The third important performance factor a modern fighter 'plane must possess is a good range. In the case of the Hurricane and Spitfire this obstacle has been overcome by carrying overload tanks under the wings and fuselage respectively. With two 45-gallon overload tanks the Hurricane has a range of well over 1,000 miles, and is fully operational, as the fitting of these tanks does not necessitate the removal of any of its guns. The tanks are jettisonable, and so do not interfere with the machine's combat efficiency. A good example of the usefulness of jettisonable tanks can be gained from the fact that the Lockheed Lightning could quite easily escort bombers to Berlin and back from England, with ample reserves for fighting, because of the two 150-gallon tanks carried under its centre section. The Lightning, indeed, should prove a very useful aircraft. Although its armament is not as great as that of British twin-engined fighters it has, in addition to good range, good manœuvrability and can, if necessary, carry a bomb load of 1,000 lb. instead of jettisonable tanks.

The Mustang, probably the best fighter America has produced to date. The new four-cannon version is shown below.





Tank Buster. A Hurricane IID, armed with two 40-mm. guns.

Armament

The question of fighter armament must necessarily be closely allied to performance. It is perfectly obvious that as one instals more guns and bombs on an aeroplane the speed, range and manœuvrability must suffer. A happy medium has to be found that gives the best combination of all these essentials.

Perhaps the outstanding example of all-round efficiency of which mention may be made at the moment is the Bristol Beaufighter. As with the Hurricane, this machine has met every demand made upon it. It started off as a high-performance day- and night-fighter with the unprecedented armament of four cannons and six machine-guns. Who does not remember with pride the way in which, on the occasion of the big night raid on London on May 10th, 1941, Beaufighters, with Hurricanes and Defiants, blasted 29 raiders out of the starry skies, with many other probable "kills."

Since then the Beaufighter has gone from success to success—long-range fighter patrols in the Bay of Biscay to protect our anti-submarine patrol bombers, intruder raids at night over enemy-occupied territory, bomber escort, and now the Beaufighter has been adapted for torpedo-bombing, and has met with incredible success. In spite of its heavy armament and fuel load, it is extremely manœuvrable and capable of flying at well over 300 m.p.h.

One of the clearest facts to emerge from the fighting of the last four years is that the day of the rifle-calibre (.303 in.) machine-gun is over. It is no longer good enough to shoot down heavily armoured fighters and bombers. Thus the Spitfire and Hurricane, whose eight machine-guns destroyed so many Huns before the latter fitted armour-plate, changed over to 20-mm. cannons late in 1940.

Now the 20-mm. cannon has become the standard weapon of British fighter aircraft. The Hurricane Mk. IIC, Typhoon and Whirlwind have four each, the Spitfire Mk. VB and IX have two and four machine-guns, the Mosquito four and four machine-guns. The Americans and the Germans have, since the early days of the war, favoured a combination of cannon and machine-guns, and thus the Focke-Wulf Fw 190 has four 20-mm. cannons and two rifle-calibre machine-guns, making it very formidable. In this case the machine-guns are merely used as "sighters" before opening up with the cannons. This economises on cannon shells, which are heavy and bulky, taking up a lot of the fighter's limited space. The Lockheed Lightning has the most complicated mixture of all, as its armament comprises two .300-in. and two .50-in. machine-guns and one 20-mm. cannon. The Americans prefer their .50-in. machine-gun to either the outmoded .300-in. or the weighty 20-mm. gun, as it combines a high rate of fire with great penetrating power. The Republic Thunderbolt has eight of these .50-in. guns, and thus packs a most commendable punch, all the more remarkable when one remembers that on the outbreak of war the standard armament on American fighters was one .50-in. and one .300-in. machine-gun.

Bombs

Quite apart from all this increase in armament, operational requirements have made other demands on fighter aircraft. In 1940 the first Messerschmitt Me 109E fighter-bombers appeared on the scene, followed shortly afterwards by the "Hurribomber." The Me 109E started off by carrying one 500-lb bomb, but this was found to impair its efficiency so much that after a time the load was reduced to 112 lb. The Hurricane, on the other hand, was at first fitted out to carry two 250-lb. bombs, and it was soon decided that this weight could be doubled. This means that the long-suffering Hurricane is now carrying the same weight of bombs that our heavy bombers—Hampdens and Whitleys—carried to Sylt in the early days of the war; surely a supreme achievement. Since these two fighter-bombers went into action they have been joined by many other fighters adapted for bomb-carrying. Thus we now see not only Hurricanes and Me 109s with bombs, but also Whirlwinds, Typhoons, Mosquitos, Spitfires, Kittyhawks, Focke-Wulf Fw 190s, Lightnings, Mustangs and many others, all adding low-level bombing to their other assets.

As the war progresses towards final victory for the Allied Nations, fighters will probably have to face even sterner tasks. Already the general clamour for a "tank-buster" has been met by that grand old warhorse the Hurricane, and it has won for itself fresh glory in the skies over North Africa, Sicily and Italy, fitted with two huge 40-mm. cannon slung under its wings.

CONTINUED ON PAGE 24

THE Albemarle

Well known for many years to cadets, the Albemarle, originally designed as a bomber, has recently made its first public appearance in print as a glider tug and armed freighter. Wing span is 59 ft. 11 ins. Two Bristol Hercules XI engines of 1,590 horse-power are said to give it a top speed of 250 m.p.h.

Ground Running of Aero Engines

by J. A. KYD

THE hallmark of a good pilot is the manner in which he checks every detail of his aircraft before he leaves the ground. One can see ground staff getting quite impatient sometimes when a test pilot has sat himself in the cockpit apparently ready to take off, only to spend at least five minutes doing, to the casual observer, very little. It is easy for a pilot to skip these apparently routine checks, but it is noteworthy that the really experienced and apparently carefree pilot invariably makes it a ritual.

On a large aircraft there are many checks to be made before take-off. Those on the engine, which are covered in this article, are possibly amongst the most important, although one check omitted out of all of them will leave a weak link in the chain, and no one check can be said to be less important than any other.

The Right Position

Let it be assumed that the pilot has just climbed into the cockpit of a single-engined fighter with its wheels chocked and its nose pointing into the wind to get the benefit of increased cooling. Before starting the engine he will look round to see that the slip-stream from the propeller will not blow dust on to any aircraft parked behind him. The ground crew will have placed the aircraft so that the nose is not directly over any loose gravel which might be sucked into the propeller blades during the engine run.

Fuel and Ignition

The pilot will check the fuel in his tanks on the contents gauge, ensure that the wheel brakes are on, turn on his fuel cocks, set the throttle to a position very slightly away from the rearward position and the propeller speed control to the fully-forward position (unless a de Havilland bracket-type propeller is fitted, when the control is placed in the fully-rearward position), set the mixture control to the "rich" position, if a two-speed supercharger is fitted he will ensure that the change-speed is in the "M" position (low gear), and, finally, he will check that his air-intake control is set to the "cold" position. The ignition must not be switched on yet, for the ground crew have to turn the engine over two or three times by pulling on the propeller blades. This serves the dual purpose of breaking down oil drag and of ensuring that there is no evidence of "hydraulicing." The latter occurs only in engines which have inverted cylinders, and is caused by oil or petrol draining into the cylinder heads and opposing the travel of the piston towards the cylinder head. Serious damage would occur to the engine if this was not discovered before it fired.

Starting Up

The pilot is now ready to start the engine, and he therefore switches on the ignition. To ensure that atomised fuel reaches the cylinders and that a fat spark is provided at the sparking-plug, the pilot works a priming-pump plunger, to inject fuel into the cylinders, and switches on a booster coil at the same time as he operates the starter. When the engine starts he releases the starter, but continues priming, and does not switch off the booster coil until the engine is running evenly.

As soon as the engine is running the pilot watches his oil-pressure gauge to ensure that the oil is circulating through the engine. He then lets the engine run for a few minutes, but at the same time increases the throttle opening gradually until the engine is running at a fast tick-over. (The propeller speed-control lever for a de Haviland bracket-type propeller would have been moved to the fully-forward position during this period.)

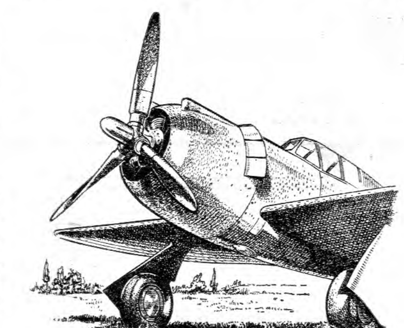
Supercharger

When the pilot observes that his oil temperature is satisfactory and that his cylinder-head temperature, in an air-cooled engine, or his coolant temperature in a liquid-cooled engine, is at the correct figure, he lets the wheel brakes off for a moment to allow the aircraft to press firmly against the chocks, and then opens the throttle to a medium boost and checks that his supercharger gear change and his propeller are both functioning correctly. The supercharger gear change is checked by moving the control lever into the "S" (high-speed) position and noting that either the r.p.m. indicator needle moves slightly or that the oil-pressure gauge needle flickers, depending upon the type of engine. The automatic boost control prevents the results of the change being shown on the boost gauge. The gear-change control lever is returned to the "M" position when the pilot is satisfied that the mechanism is functioning properly. The constant-speeding qualities of the propeller are checked by retracting the speed control lever until the r.p.m. commence to drop as shown on the engine-speed indicator. The propeller-speed control lever is then returned to the fully-forward position.

During the above tests a close watch will have been kept by the pilot for any signs of vibration, and if there were any evident the ground crew will be acquainted with the exact symptoms to enable them to track the cause of the trouble.

Performance

The pilot then checks the engine performance at full throttle with the propeller-speed control lever in the fully-forward position. When a small-range (20 degrees) constant-speed propeller is fitted, this check is simple,



since the propeller will not have sufficient travel in the fine-pitch direction to allow the maximum permissible take-off r.p.m. to be attained, and the blades are consequently held against their fine-pitch stops. The pilot will know what r.p.m. to expect when at his take-off boost, and any loss of power will at once be evident in the shape of a drop in r.p.m. When a wide-range (35 degrees) propeller is fitted the check is usually made at about the highest boost that will still retain the blades against their fine-pitch stops, and the pilot will know from experience what r.p.m. to expect. If the check was made at full throttle the propeller would be constant-speeding, and any drop in power would be camouflaged by the blades going into a finer pitch to maintain the engine speed.

The final check that the pilot makes is to ensure that each of the magnetos is functioning properly. He does this, at a lower boost than take-off, by switching off each magneto in turn and checking that the r.p.m. do not fall, when the engine is operating on either magneto, by more than about five per cent of the speed.

Only when he is satisfied that all the above tests have been completed properly will the experienced pilot take off.

Aero-Engine STARTING SYSTEMS

by W. J. ROBERTS

THE modern aero-engine, owing to its large size and power output, presents much more difficulty in starting than the light engines of a few years ago. To "swing the prop," as on a Tiger or a Piper Cub, is not, of course, a practical proposition, and mechanical or other aids are necessary.

Starters fall into three main categories: mechanical (including hand starters), electric starters and gas or cartridge types. Whatever type of gear is adopted, two conditions are first required: (*a*) the induction system must be primed with fuel to ensure a quick response; (*b*) the ignition system must provide a good fat spark to fire the mixture.

These two points are taken care of by providing a priming pump which draws a small squirt of neat fuel from the tanks and shoots it into the cylinders to provide an initial charge, and by providing a starting magneto which gives a continuous stream of sparks at very low speed. This magneto is connected through the distributors of the main magnetos, and is switched off when the main magnetos are running fast enough to generate their own current.

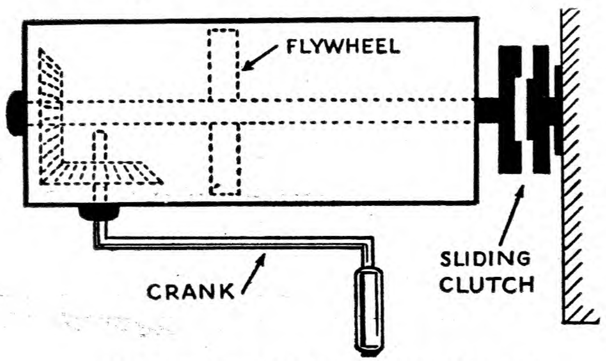


Fig. 1.: Diagram of hand-operated Inertia Starter.

Mechanical Starters

The first, and probably the simplest, form of starter is that shown in Fig. 1, and known as the inertia or impulse type. It is a development of the flywheel-driven toys we used to see before the war.

As will be seen from the sketch, it consists of a flywheel which is rotated, by the handle, through a set of gears. The handle is cranked until the flywheel is running at about 10,000 r.p.m., then removed or released and the clutch engaged. Owing to the energy stored up in the spinning flywheel the engine is turned fairly fast for a few revolutions, and will usually fire and start immediately. A ratchet gear is used to enable the engine to overtake the driving gears and run free.

Another form of hand starter is that in which the engine is driven direct by the crank. In this case the gear ratio is arranged to enable the average mechanic to turn the engine without undue exertion; as in the other type, a ratchet or free-wheel is used.

Electrical Systems

When electric starters are fitted they may be of two kinds — either a large edition of the familiar car-starter or an electrification of the inertia type already described.

Of the first type little need be said except to point out that owing to the heavy current required the power is normally provided from a large "ground battery" mounted on a truck and plugged into a socket to start the engine. The socket is of a special type, and must be turned round to be connected; this turning is arranged so as to disconnect the aircraft's own battery when the ground battery is plugged in (Fig. 2).

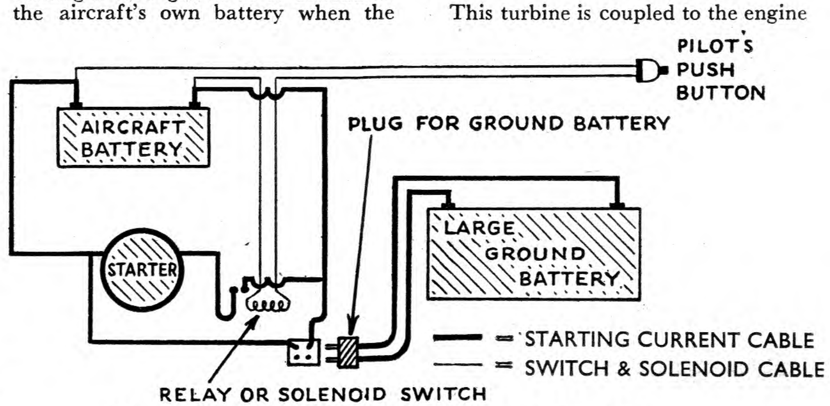


Fig. 2. Wiring Diagram for Electric Starter with Ground Battery.

In the case of the inertia starter, the electric motor is used only to spin the flywheel, and need not be quite so large. The switch is in the form of a knob, and is pushed in to energise the motor, held in till the flywheel runs up to speed, then pulled out to engage the starter clutch and switch off the current. An example is the Tomahawk.

A separate booster coil is frequently used in connection with electric starters in place of the starter magneto, the leads from the coil passing into the main distributor as before and providing sparks before the main magnetos are up to speed.

Gas and Cartridge Starters

The original gas starter system is not very often met with nowadays, but it is described as it is of interest. Compressed air, carried in a cylinder, is admitted by means of a hand control to an atomiser, in which it is mixed with petrol, and, by reason of pressure, quickly fills a distribution system with an air-gas mixture. This distribution system admits the gas to the cylinders in correct order.

The hand-starting magneto is then rotated smartly by hand, and, as the piston of at least one cylinder must be in the firing stroke position, the engine is driven round until it fires and runs on its normal induction system.

The remaining system is the cartridge starter as fitted to certain Merlin-engined Spitfires. A magazine containing about six cartridges is used, coupled to both a loading and a firing mechanism. The cartridge is charged with a chemical which liberates a high-pressure gas into a pipe connected to a small turbine.

This turbine is coupled to the engine in the same manner as a direct-starting motor, and drives the engine through gearing. In order to permit several starts the magazine may be rotated by means of a pull-wire, to bring the next cartridge into the breech for firing. Firing is usually done by electric spark. This system is rapidly gaining ground, and has the great advantage of simplicity and light weight.

The Future of Naval Aviation

by "Stringbag"

ALMOST unrecognised by the man in the street, the character of the British Navy is changing. The rise of naval air power, with functions outside the range of possibilities which were suspected in 1939, has added a third dimension second in importance to neither the surface of the sea nor the water under the sea. It is not the first change which has come upon His Majesty's Navy, and it will probably not be the last. The successive introduction of steam, the ironclad, the breech-loading gun, the torpedo and the revolving turret were previous landmarks of change. The introduction of seaborne aircraft is the last to date, and perhaps implies the greatest change of all. So much more has been discovered possible than was ever dreamed of a few years ago.

When the first torpedo attack from the air was made on a Turkish ship in the Dardanelles in 1915 it was appreciated the time might come when squadrons of bigger and better aircraft would be a formidable striking-force—a point fully realised by the Naval Staff. The past four and a half years have given all the proof needed, and approximately one million tons of enemy shipping lies on the sea-bed as the result of this kind of attack. But what was not foreseen with such clarity was the major role which the air was to play in any movement which takes place across the sea. No ship, whether it be a fishing trawler or an Atlantic liner, a motor-gunboat or a battleship, can afford to ignore the important and sometimes essential cover which can be provided from the air on a deep-sea passage. The whole of the Merchant Navy, as well as the surface vessels which fly the White Ensign, call upon the air for protection in the same manner, of course, as they used to demand from a destroyer and, more latterly, from a corvette or a frigate.

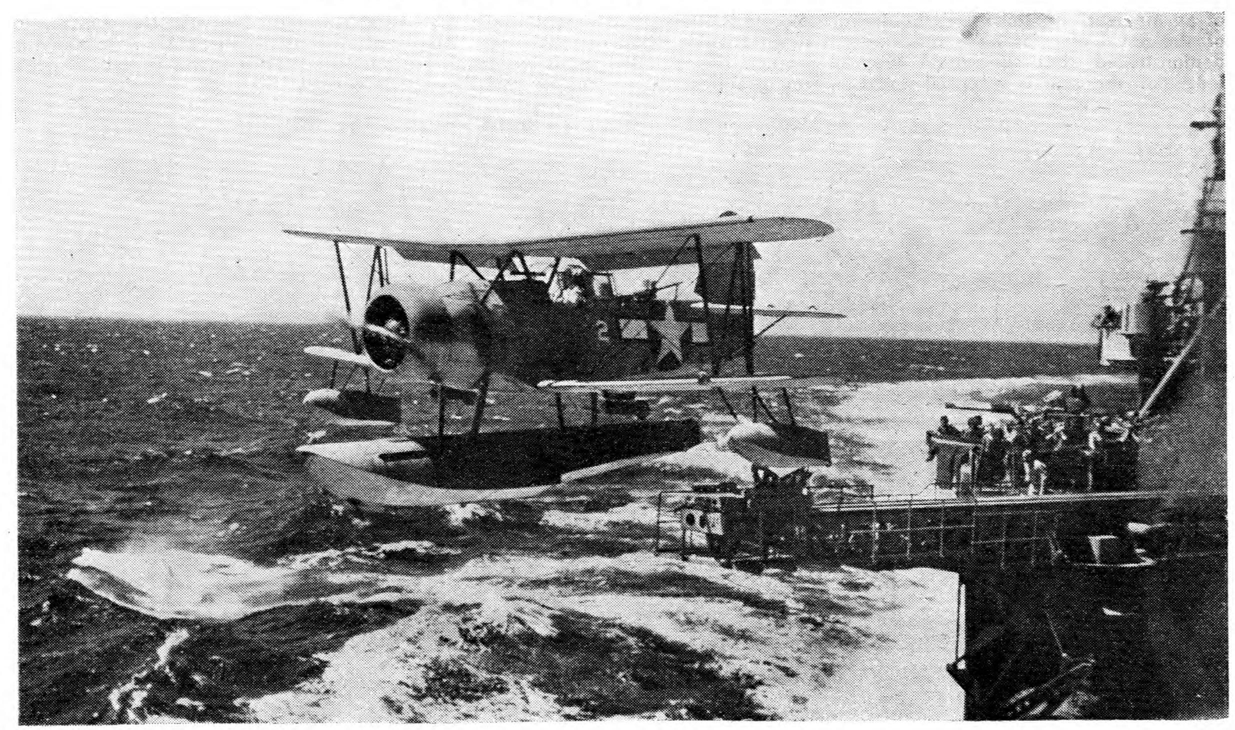
Nor is this the extent of the liability. The combined operations at Salerno showed that carrier-borne fighters were capable of providing the local-based protection of a most effective kind over strongly defended beaches. The operation was a turning-point in naval history, for it opened up the use of the Fleet Air Arm as an essential part of an assault force, a role which previously existed largely in theory, in spite of the success of the North-African landings. If attacks are made on an enemy coastline at the extreme range of R.A.F. fighters, Salerno has proved that the Navy has an alternative, and can still carry out its traditional role of putting the armed forces ashore.

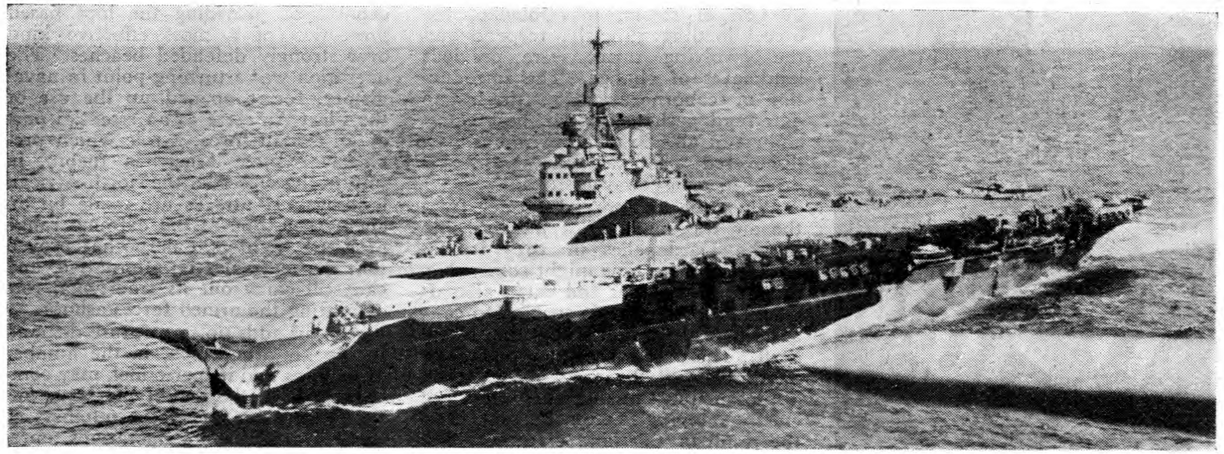
All this adds up to a future demand for an air arm which, in the number of its ships and its personnel, may compare with all the rest of the Navy put together. Even today the numbers of carriers available for operations represent a fleet which, by themselves, could not be regarded lightly. Considering that the total number of shipborne aircraft in 1922 was only 15, in 1925 57, and in 1938 a mere 162, and finally that only seven aircraft carriers were available in 1939, then the expansion is obviously sensational.

For 20 years ending in 1938 the aircraft of the Fleet Air Arm were under the executive control of the R.A.F. It was the R.A.F. who provided the aircraft, the maintenance crews and a large proportion of the flying personnel. The only naval officers who were concerned jointly with the sea were the observers. Those naval pilots who took up flying held simultaneous commissions in both Services.

That this combination is for ever a

A Curtiss Soci being launched by catapault from a United States cruiser.





H.M.S. Formidable.

thing of the past is universally accepted. It is clear that unless the R.A.F. builds and operates its own ships, creating, as it were, a second Navy, it must continue to have its parallel in the Fleet Air Arm as we understand it today.

The burden thereby placed upon the Admiralty is a big one, and here hangs the story of change and adaptation. Events have proved that naval officers are as competent in charge of an aircraft as they are in charge of a ship, that their qualities of airmanship, courage and determination are not less than are expected by tradition of a naval officer. British sailors have equally proved that training alone is required to fit them with the technical qualities needed for the maintenance of an air fleet. Furthermore, incidents of the naval air war have repeatedly demonstrated that specialised knowledge of the sea is essential to the aircrews. Successful attacks—and there have been hundreds of them—have all cemented the conclusion that an intimate knowledge of ships and their ways was a contributory factor to their success. The probable disposition of an enemy convoy, or a unit of his battle fleet, the estimation of their course and speed and the identification of their class are all matters pertaining to the seaman rather than the airman. The man who flies from a carrier is first a sailor and only second an airman. On such assumptions the future of naval power must be based.

To ensure the successful edifice of organisation which will be required to maintain the air arm at concert-pitch, every single officer in the Navy will require to have air experience. This dictum is already recognised, and every new regular officer, whatever his branch, has included in his basic training practical experience of the Fleet Air Arm. A member of the Board of Admiralty for air has been installed in the shape of the Fifth Sea Lord, while the rapid promotions of less senior officers have staffed the many branches required for the official management of a great air fleet with men who have a common background of the sea and the air over the sea. Many of these promotions have been made far earlier than could possibly have been the case in peace-time. But, as has been discovered in a hundred different aspects of war, youth is competent to assume responsibility when it has the chance. The internal framework of a great air fleet of the future has been erected, and it will only remain at some future date to settle finally the problem of supplies, of joint research and development with the R.A.F., to ensure that the Fleet Air Arm remains a most powerful factor in the Empire's defence.

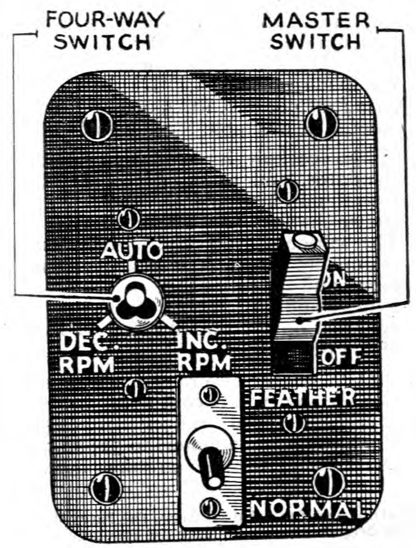
Grumman Martlets on the flight deck of a British aircraft carrier.

Electrically Operated Propellers

by J. A. KYD

ALTHOUGH this article is primarily about the Rotol Electric Propeller, it applies equally well to the American Curtiss - Wright propeller, which is similar, at any rate as far as its operation is concerned, to the former.

The principle of control of the hydraulically operated variable-pitch propeller, in which the engine speed is varied by adjusting the propeller speed-control lever in the cockpit, is well known. In the case of the electrically operated propeller there are additional means of control which allow the pilot to operate the propeller in several different ways. If the pilot masters the features in this system not only will he have an additional safeguard, as will be explained later, but he will derive some satisfaction from the knowledge that he is using to the full a rather complicated piece of mechanism.



It is quite beyond the scope of an article of this size to discuss the mechanism of the electric propeller and the governor unit, so we will confine ourselves only to what the pilot can see in the cockpit.

Speed-Control Lever

The propeller speed-control lever is mounted adjacent to the throttle, and, as with other types of propeller, a forward movement of the lever increases the speed at which the governor unit is set to control, by varying the pitch of the propeller blades to suit, and vice versa. Mounted either on the instrument panel in front of the pilot, or sometimes on a panel at the left-hand side of the cockpit, there are two and sometimes three switches, each of which has a direct bearing on the operation of the propeller.

The Master Switch

The first of these switches is the master switch for the whole of the propeller's electrical circuit. If the engine were started with this switch "off" the propeller would be virtually a fixed-pitch type. This master switch also functions as a fuse; if there is a short circuit, or an overload of some kind, the switch will automatically jump out of engagement. This safety device is usually thermally operated, and it is worth while trying to engage the switch again when the thermal throw-out mechanism has been allowed a minute or two to cool down.

Four-way Switch

The second switch is the important one as far as operating the propeller is concerned. It is a four-way switch, and, in fact, it is sometimes found in the form of four separate switches. In its most normal form it consists of a toggle, and its four possible positions give the following results:

1. Toggle centralised: Propeller blades fixed.
2. Toggle in the upward position: Propeller governor unit operative and the engine speed controlled in the normal manner with the speed-control lever.
3. Toggle switch *held* downwards to the right (the toggle will not stay in this position of its own accord): Manual control of the propeller blade pitch to increase the engine speed by moving the blades to a finer pitch.
4. Toggle switch *held* downwards to the left (remarks as for 3): Manual control of the propeller blade pitch to decrease the engine speed by moving the blades to a coarser pitch.

The Feathering Switch

The third switch is used for feathering, and is therefore not usually found in single-engined aircraft. It is a simple "on" or "off" switch, and will feather the propeller blades whatever the position of the speed-control lever or of the four-way switch. The master switch must be "on." The feathering switch when in the "on" position brings a voltage booster into action to speed up the turning of the blades to the feathered position. A slower feathering action can be accomplished by holding the four-way switch in the decrease r.p.m. position.

Procedure

The best way to discuss the use of the various means of control is to watch the action of a pilot from the moment that he waves the chocks away to take-off until his wheels touch the runway at the end of the flight.

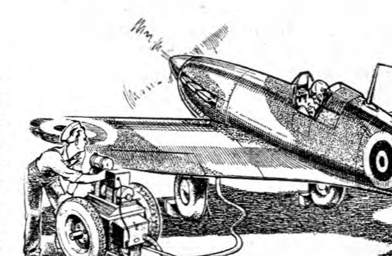
When he opens his throttle to take off, his four-way switch must be in the upward (automatic) position. This allows the governor unit to control the engine speed at the setting fixed by the speed-control lever (fully forward for take-off). Take-off in fixed pitch would be dangerous, since the pitch would not be progressively coarsened by the action of the governor unit to keep the engine speed constant, and serious overspeeding would occur. Climbing and diving are both done under constant-speed control, and so is level flight, when sudden manœuvre may be necessary at any moment. Long flights at a constant altitude may be done in fixed pitch, that is, with the four-way switch in the central position. Adjustments to the engine speed to synchronise r.p.m., etc., are then made by pressing the four-way switch into the increase or decrease r.p.m. position, as applicable.

Advantage of Fixed Pitch

Flying in fixed pitch has the advantage that any loss in engine power through icing, or a defect, will at once become evident through a drop in the engine speed. Under constant-speed control a loss of power is camouflaged by the fining of the blade pitch, and until the power has got dangerously low there will be no drop in engine speed. When returning to constant-speed control from fixed-pitch operation the pilot should check that his speed-control control lever is set to a position which will give him about the same r.p.m. as was being obtained in fixed pitch.

Land with Constant-Speed Control

Landing should be done under the constant-speed control, since, if an emergency arises, and another circuit of the airfield is necessary, the throttle can be opened with the knowledge that the most suitable engine speed will be obtained and held.



JAP Fighter

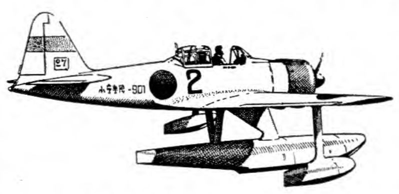
by ROY CROSS

KNOWN erroneously to the general public as the Zero, the Mitsubishi Navy 0 series forms the equipment of the majority of Japanese naval fighter squadrons. The Zero achieved a measure of success upon its initial appearance in action, largely because of its excellent rate of climb and manœuvrability as compared with the heavier American types which were at that time opposed to it.

The Navy 0 is a low-wing monoplane single-seater shipboard fighter of all-metal stressed-skin construction. The design is orthodox, with no outstanding features, and in detail is obviously "cribbed" from the best foreign types. The performance is quite good, taking into consideration the medium output of the motor, and has been obtained by using a very light primary structure, careful consideration of detail aerodynamic finish, and an excellent finish utilising flush riveting and a coat of lacquer; the workmanship is good. American experts consider that due to the remarkable structural lightness, the Navy 0 may not have such a long operational life or be able to take so much punishment as contemporary Allied types. Another point is that the absence or scarcity of armour protection and leak-proof tanks, coupled with the light build, make the aircraft "easy meat" once it is in the sights.

A captured example of the Navy 0 has been extensively test-flown by U.S. Navy pilots, and will now be handed over to the U.S. Army establishment at Wright Field, Dayton, Ohio, to be dissected and examined in detail. The machine is reported to manœuvre "like a trainer" at medium speeds; the controls are light and response immediate. The ailerons extend nearly two-thirds the length of the wing, and large flaps reduce the landing-speed. The wing does not break for stowage, as on most shipborne aircraft; only the tips, under two feet either side, fold to provide room in the limited space available on an aircraft carrier. A retractable deck-landing hook is fitted, and buoyancy in the event of a forced landing upon the water is ensured by built-in watertight compartments in the wing and a flotation bag in the rear fuselage.

The undercarriage is cantilever, and retracts hydraulically into the wings, in which it is totally enclosed. As each wheel enters the housing in the wing a small flap closes over it and seals the cavity to the airflow. Wing fuel tanks are installed, one on either side of the fuselage between spars, and may be rapidly disconnected and lowered through panels in the wing undersurface to facilitate servicing, inspection or replacement. A fuselage tank is situated just forward of the pilot, his feet protruding under it, and a long-range plywood external drop-tank for 87 U.S. gallons may be slung



The Navy 2 Floatplane Fighter.

beneath the centre section. The internal tanks were not leakproof on early models, but it is possible that the latests versions have protected tanks. Armour, too, is reported to have been found on current types.

Armament is usually two 20-mm. cannon and two 7.7-mm. machine-guns. One 20-mm. gun is in each wing, and the 7.7-mm. guns are mounted in front of the cockpit under the decking. The wing cannon are lighter than, but closely resemble, the Swiss Oerlikon weapons of the same calibre. Sixty rounds are provided for each cannon. The two synchronised fuselage guns have accommodation for up to 500 rounds. The wing cannon may be cut out to enable only the 7.7-mm. guns to fire. Racks for the carrying of a light bomb-load may be fitted beneath the wing, or the long-range tank can be discarded in favour of a single bomb.

Two-way radio equipment, and instruments in the cockpit, are copies of reputable American makes, and as such may be assumed to be of a high standard of efficiency. In fact, the machine was flown in the U.S.A. with the original Japanese instruments, suitably recalibrated and labelled in English. The constant-speed metal airscrew is a close copy of a Hamilton Standard type.

Either a Nakajima Sakae NK I or a Mitsubishi Kinsei Mk. 44 motor is fitted, and in each case the design is a clever combination of the best features of various American models. The Kinsei in particular is said to be reliable, although the performance is not spectacular. A 14-cylinder two-row radial, the Kinsei gives 1,050 h.p. at 2,500 r.p.m. at take-off and at 5,500 feet. The Nakajima motor fitted to the first machines has a rather lower output of 900 h.p. at 15,000 feet, with 1,000 h.p. available for take-off.

The cockpit is small by Western standards, and at first sight the controls and instruments seem to be strewn haphazardly round the walls. The various levers and switches are reasonably accessible in practice, however, and a full range of accurate flying and engine instruments is mounted on a crowded panel in front of the pilot.

Data on the several models in service is somewhat confused, but the maximum speed ranges from 315 m.p.h. (Nakajima motor) to 328 m.p.h. (Mitsubishi Kinsei) on the normal models, while a more recent clipped-wing type, the 02, will do approximately 340 m.p.h.

Mitsubishi Navy 0, code name Zeke and previously known alternatively as the Zero or S-ooN. One Nakajima Sakae NK I motor, 840 h.p. at 13,000 ft., 1,000 h.p. for take-off. Span, 38 ft. 5 in.; length, 29 ft. 7 in.; wing area, 256 sq. ft.; weight, empty 3,775 lb., loaded 5,207 lb.; maximum speed, 315 m.p.h. at 10,000 ft.; range with external tank, 1,600 miles.

Navy 01 *Zeke.* Previously known as S-ooW. Mitsubishi Kinsei MK 44 motor. Span, 40 ft.; wing area, 265 sq. ft.; maximum speed, 328 m.p.h. at about 16,000 ft.

Navy 02 *Hamp.* Clipped-wing variation of Zeke, with slightly more powerful version of the Kinsei, developing up to 1,200 h.p. Span, 35 ft.; maximum speed about 340 m.p.h. at 16,000 ft. Probably has armour protection.

Navy 2 *Rufe.* Floatplane fighter. Similar to Navy 0, but with floats. Armament is four 12.7-mm. guns and maximum speed a little under 300 m.p.h.

That the Navy 0 has had a rough time at the hands of modern Allied fighters now serving in the Pacific area is proved by the fact that it is now beginning to be withdrawn in favour of new types.

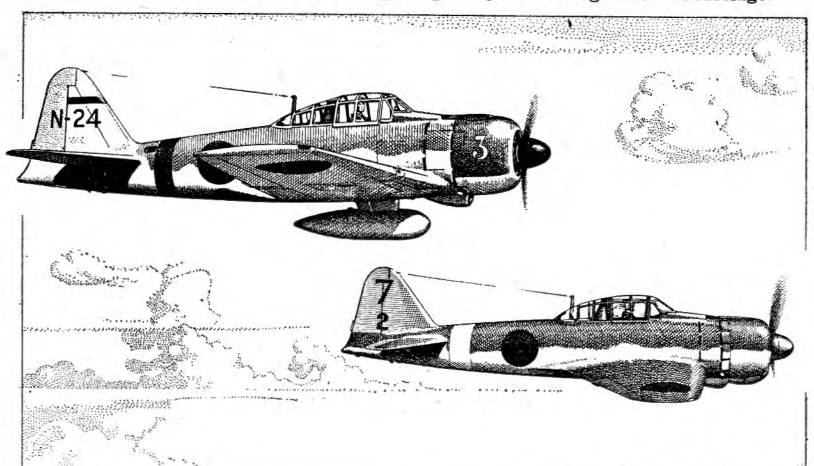
New Army Designs

Turning to the Army fighters, we find that the trend is towards machines that conform more to the Western ideal in fighter design. The latest Army models have engines comparable, at least in power, to those of current Allied types serving in the Far-East theatre, and are heavily armoured. Little concise data is available, but the types given below represent the best which the Japanese can put in the air at the moment.

Army 3 *Tony.* A Mitsubishi design, the Tony is powered by an in-line engine, most probably one of the later of the Mercedes-Benz DB601 series built under licence in Japan. A low-wing monoplane, it is armed with either two heavy machine-guns and two cannon, or four machine-guns of mixed calibre, is heavily armoured, and can carry two long-range drop tanks. Speed about 330 m.p.h. at 15,000 ft.; bomb load (alternative to drop tanks), 1,000 lb. Although less vulnerable than the Navy 0 series, the "Tony" has probably had to sacrifice manœuvrability and general performance.

Shoki Interceptor Fighter. A brand-new design, with features of both the Reggiane Re 2000 (Italy) and the Republic Lancer (U.S.A.) about it, the Shoki is an all-metal low-wing monoplane with a two-row radial motor and a blister-type cockpit cover. No data is available.

The clipped-wing Mitsubishi Navy 02 Hamp (top) and the original Zero, the Navy 0. The Hamp is shown fitted with a long-range drop-tank slung under the fuselage.



A shadow on the Rising Sun. The Lockheed Lightning.

Torpedo Problems

by B. J. HURREN

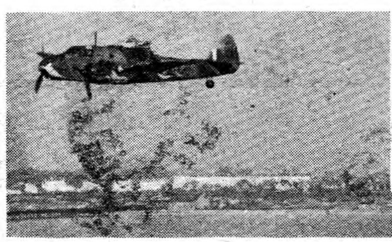
THE initial successes of the Fleet Air Arm torpedo squadrons, especially at Oran and Taranto, where a major sea victory was scored by a handful of obsolescent biplanes, caused at an early stage in the war a revision of opinion as to the value of this striking weapon.

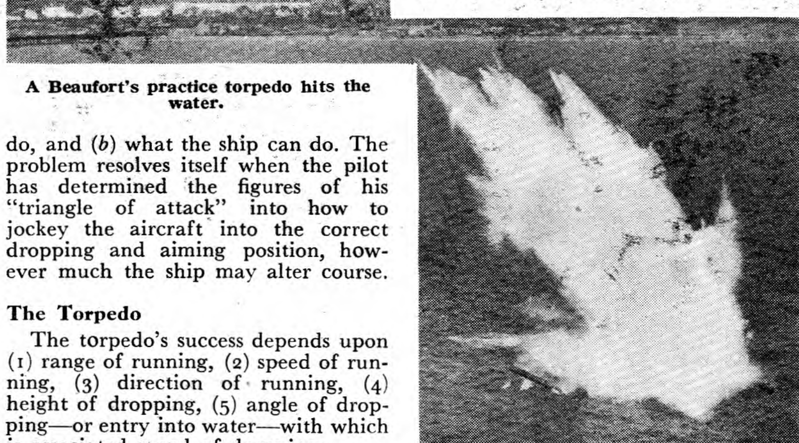
Consequent upon this many R.A.F. torpedo squadrons came into being for sea operations over narrow waters. It has been announced that the Wellington bomber has a version equipped to carry two torpedoes, and the Beaufighter has a single-torpedo version.

Pilots who converted to torpedo work found a new thrill in flying. No longer had they to endure the monotony of long flights without event—as on many bombing missions—but were required to be ever alert to what may be described as an infinitely variable problem.

Let us avoid, for the moment, the difficult question of ship recognition, in itself a complicated art, since with cloud or smokescreen or night cover frequently only the merest glimpse of the target is sighted in the pre-attack stage.

The art of scoring a hit with torpedo against a moving ship has two basic factors: (*a*) what the torpedo can do, and (*b*) what the ship can do. The problem resolves itself when the pilot has determined the figures of his "triangle of attack" into how to jockey the aircraft into the correct dropping and aiming position, however much the ship may alter course.





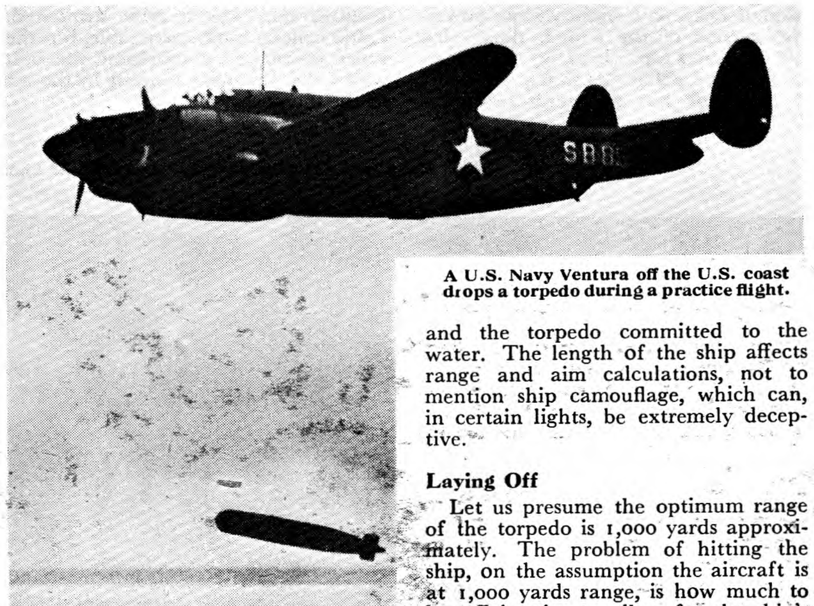
A Beaufort's practice torpedo hits the water.

The Torpedo

The torpedo's success depends upon (1) range of running, (2) speed of running, (3) direction of running, (4) height of dropping, (5) angle of dropping—or entry into water—with which is associated speed of dropping.

If in (1) you drop at a distance beyond the maximum running range, you might as well not drop at all. In (2) you must govern your aim-off by the speed of approach to the ship. (3) is governed by (1) and (2) and the angle made by the ship's course to the fore-and-aft line of the aircraft when dropping a torpedo. With (4), if you drop too high the torpedo may break its back or at best run erratically, and if too low you may damage yourself by the splash. With (5) a too-fast or too-steep angle of entry will cause the torpedo to plunge very deep, whilst a too-fast or too-shallow entry may upset the gyro if not break the torpedo casing.

Obviously torpedo-dropping is an art not readily acquired. It must be "not too much, not too little—just right!" to achieve success.



A U.S. Navy Ventura off the U.S. coast drops a torpedo during a practice flight.

The Ship

The ship factor is also a variable. The dropping pilot must gauge its speed—which may vary at the captain's discretion *whilst the torpedo is running*, and likewise its course may be altered after aim has been made and the torpedo committed to the water. The length of the ship affects range and aim calculations, not to mention ship camouflage, which can, in certain lights, be extremely deceptive.

Laying Off

Let us presume the optimum range of the torpedo is 1,000 yards approximately. The problem of hitting the ship, on the assumption the aircraft is at 1,000 yards range, is how much to lay-off in aim to allow for the ship's movement whilst the torpedo is running 1,000 yards.

Suppose the torpedo has a running speed of 30 knots, it will travel half a sea mile in one minute. It will take one minute to run 1,013 yards.

In one minute, presuming the ship to hold a constant speed and course, the ship will travel approximately 422 yards at 25 knots; 338 yards at 20 knots; 253 yards at 15 knots; 203 yards at 12 knots; 167 yards at 10 knots; 135 yards at 8 knots; and 118 yards at 7 knots.

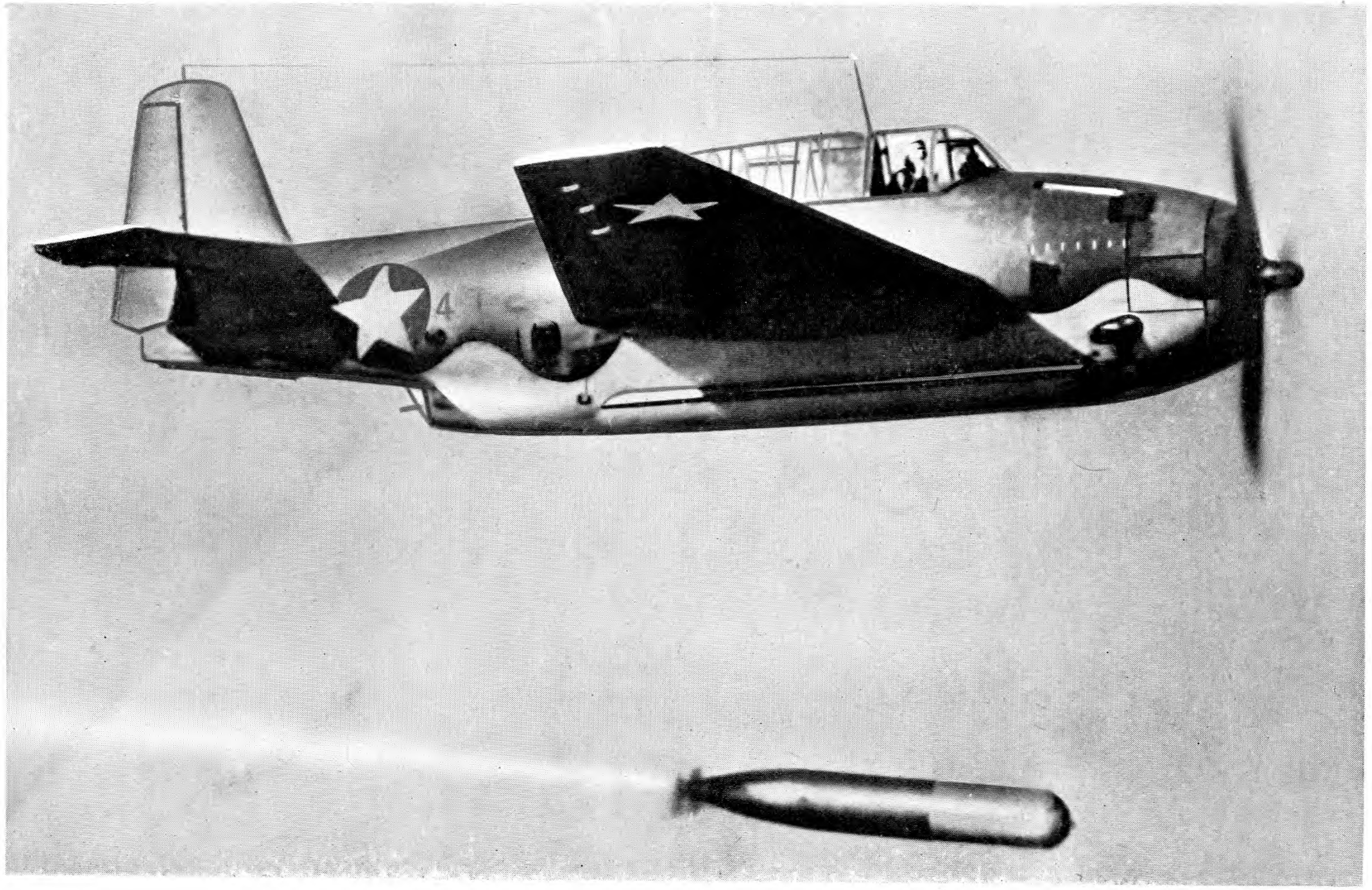
The pilot, dropping from 1,000 yards range, has therefore first to estimate the speed of the ship and then aim-off the required number of yards. This can be done by long practice in ship-distances with remarkable accuracy, even at night. (Of course, the slowness of the Swordfish is an assistance in making last-second corrections to aim-off and dropping range, a vital factor for night work, whilst the speed of the Beaufighter enables a surprise attack and often catches the enemy ship napping.)

CONTINUED ON PAGE 17

The Albacore, although not a great improvement on the Swordfish, has done some useful torpedo work in the war.

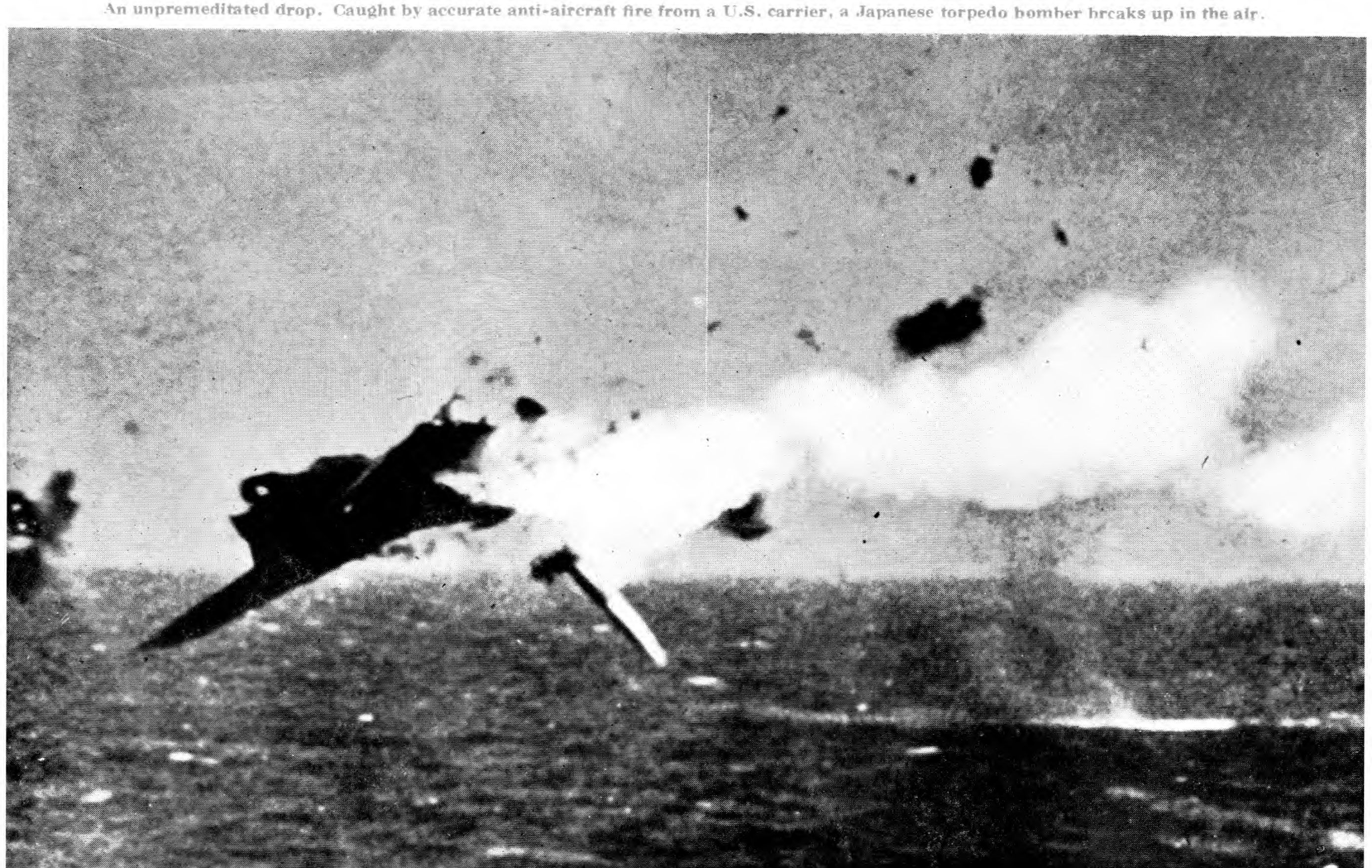
The Beaufighter has been used with great success as a torpedo bomber.

THE AVRO LANCASTER.



Leaving a trail of vapour behind, a torpedo dropped from a Grumman Avenger falls towards the water. Although a genuine photograph, this print has been retouched, and the keen spotter will notice that the top of the rudder of the Avenger appears as part of the fin.

An unpremeditated drop. Caught by accurate anti-aircraft fire from a U.S. carrier, a Japanese torpedo bomber breaks up in the air.



TORPEDO PROBLEMS

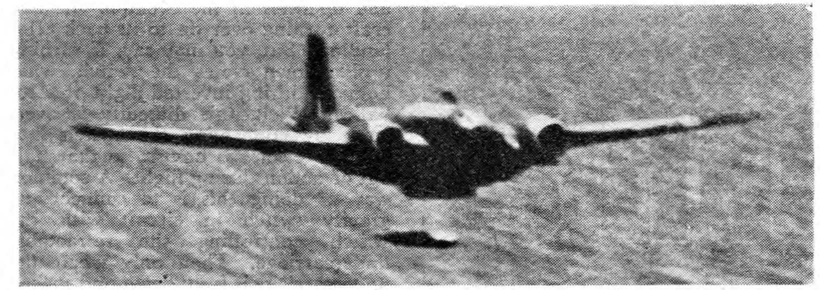
CONTINUED FROM PAGE 12

Evasion

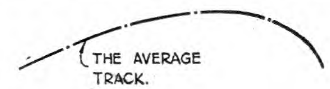
It can be seen that an alert captain can (*a*) anticipate what the attacking aircraft can do, and will attempt to do, and (*b*) that by adept handling of his ship he can comb an oncoming torpedo track by turning *towards* it or, if he has the speed of a destroyer, outpace the torpedo by turning away.

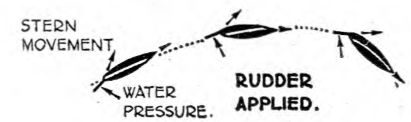
Thus few individual attacks are successful, whilst a converging attack, well synchronised, forces the ship to decide instantaneously what action it can take to avoid the most dangerous torpedo, then turning to avoid that torpedo whilst presenting a much improved target to the originally less-dangerous torpedo.

The art of gauging a ship's speed is to be learned by practice. The size of the ship, its length, the wake it is leaving and the extent of its bow wave all figure in the pointers that may qualify the pilot's estimate.

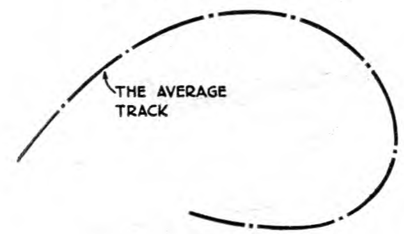


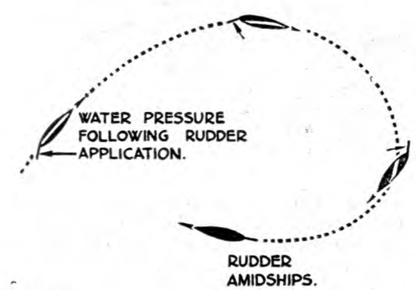
A Wellington's torpedo on the way down. Torpedo-carrying Wellingtons have operated against Axis shipping in the Mediterranean.



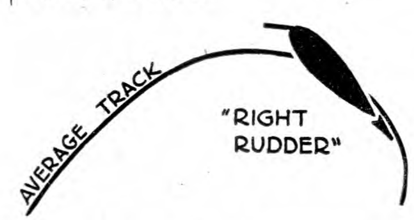


THE "SKID" OF A SHIP.





NOTE:
IN THE TURN THE SHIP'S STERN IS OFF THE AVERAGE TRACK BUT ITS CENTRE OF POISE IS ON IT.



AN ENLARGEMENT.

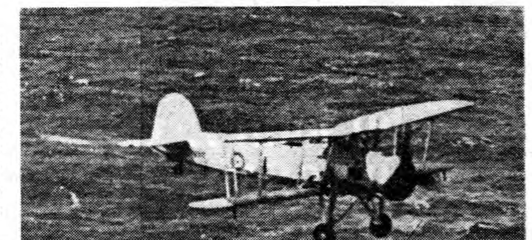
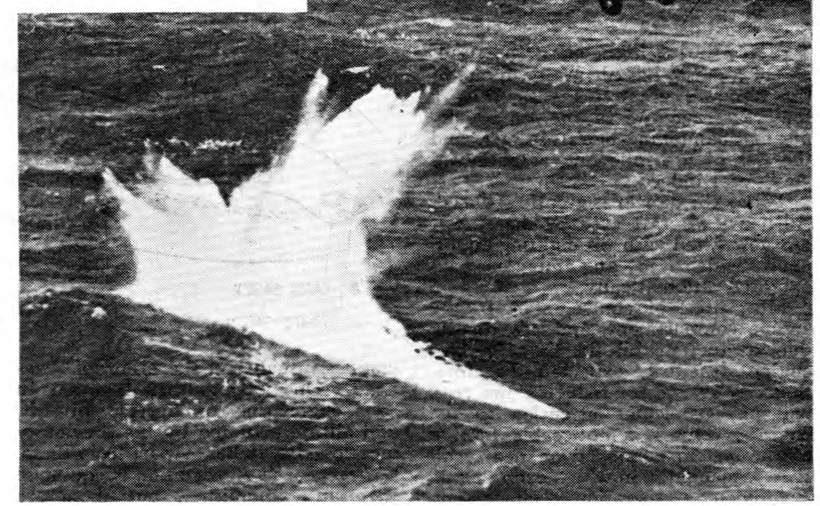
How the Ship Turns

One interesting fact is that the ship always turns directly on the line of a helix or circle, although it follows an average line. In non-nautical language, the ship altering course may be presumed to take up a succession of positions rather than steer a clean line.

The rudder is at the stern of the ship. If "right rudder" is applied as in flying, the aftermost part of the rudder moves to the right (starboard) of the ship's fore-and-aft line. Pressure of oncoming water on this surface causes the ship's stern to be pushed to the left (port). But as the pressure is only caused by the ship being under way, the stern moves left and forward —in a direction north-west if the ship is heading north. Hence the bows "turn to the right," exactly as in flying, whilst the ship heels over to the left, as it cannot (as in flying) apply bank and rudder in a turn.

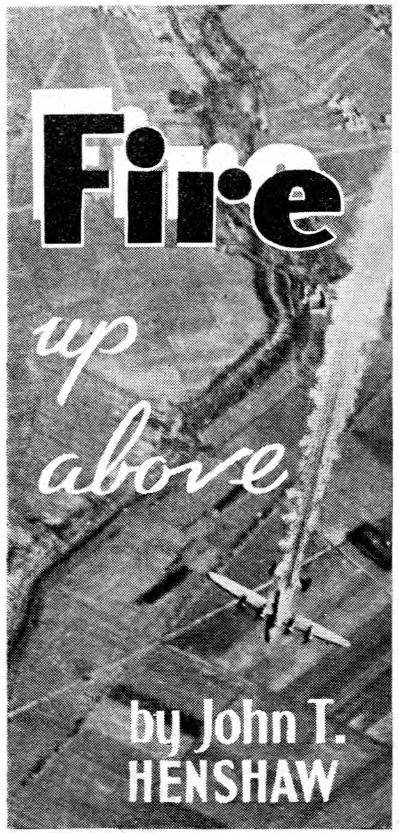
The track of a ship in a turn is shown diagrammatically, the size of the rudder being exaggerated for demonstration purposes.

Thus frequently the first indication a pilot has of the ship altering course as he swoops to attack is the evidence in the wake of application of rudder, this causing a violent disturbance in the sea.

More than half a million tons of enemy shipping have fallen to Swordfish torpedoes.

It can be seen that torpedo attack is a battle of wits. The pilot requires an alert mind to figure out first the intricacies of placing himself in the best position for attack and, secondly, having made up his mind, to be ready and able to make split-second adjustments to his decision according to the behaviour of the ship attacked.



Fire up above

by John T. HENSHAW

FIRE, during flight or as the result of a crash, has always been one of the airman's greatest perils. Only a few years ago fire in the air usually meant abandoning one's aircraft, and the risk of fire following a crash was very great indeed.

Today the danger is greatly reduced. All heavy aircraft used by the R.A.F. are now fitted with fire-fighting equipment which, in an emergency, is operated automatically.

Most fires, of course, start in the engine compartment, and are usually due to fuel or oil flooding the hot engine. It is to be expected, therefore, that any system for reducing fire risks will pay particular attention to the engines. This is a noticeable feature of the system employed on nearly all R.A.F. machines, in which each engine is protected. Operation is effected by a series of automatic and manual switches wired into an electrical circuit.

As shown on the diagram, four types of switches are fitted in each circuit to meet all possible emergencies.

The crash or inertia switch is fitted in the forward portion of the hull or fuselage, and is, as its name suggests, operated in the event of a crash. The action is entirely automatic, and is almost instantaneous with the aircraft striking the ground.

The gravity switch is also mounted in the forward part of the fuselage, and operates in the event of the aircraft turning over on to its back after landing. But, you may say, if turning upside down closes the switch, what happens during inverted flight or aerobatics? Well, this difficulty is overcome by connecting the switch into another electrical circuit, so that it is out of action during flight. A common way of doing this is to connect the gravity switch in circuit with the switch controlling the retractable undercarriage. Then only when the undercarriage is fully down and locked ready for landing is the gravity switch on. When the undercarriage is retracted the switch is off.

Two flame- or temperature-operated switches are fitted in each engine compartment, one near the carburettor and the other at the rear of the engine. These, as their name suggests, are actuated by contact with a flame or by a rise to about 150 degrees C. in the surrounding temperature.

The remaining switch or push-button control is for manual operation. One button is fitted for each engine, and all are mounted within easy reach of the pilot, so that they are ready at hand in any emergency.

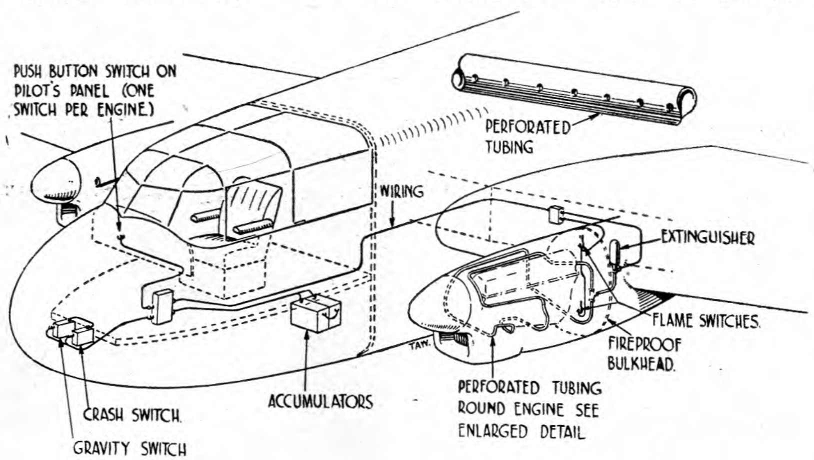
The extinguishers themselves are mounted conveniently close to the tration is required, through special nozzles.

If an engine catches fire during flight or on the ground the flame switch, operated by the flames or the rise in temperature in the engine bay, immediately energises the extinguisher. The methyl bromide is released under pressure and surges along the tubing, spraying the engine and nacelles through the nozzles and perforated piping. In this way the engine compartment is flooded with the chemical, and dense flame-quenching fumes are produced.

A further effect of the methyl bromide is to evaporate rapidly when released, thus cooling any metal with which it is in contact. In this way hot metal is cooled below the flash-point of petrol or oil, and so prevented from igniting any fuel which may drip from fractured pipes or shattered tanks.

In the event of a crash the inertia switch instantly actuates the extinguisher in each engine bay. Every engine is smothered with the chemical almost immediately the crash occurs. The hot parts are cooled before leaking fuel or oil can reach them, and the risk of fire is greatly reduced.

If the aircraft should overturn on landing all the engines are again pro-



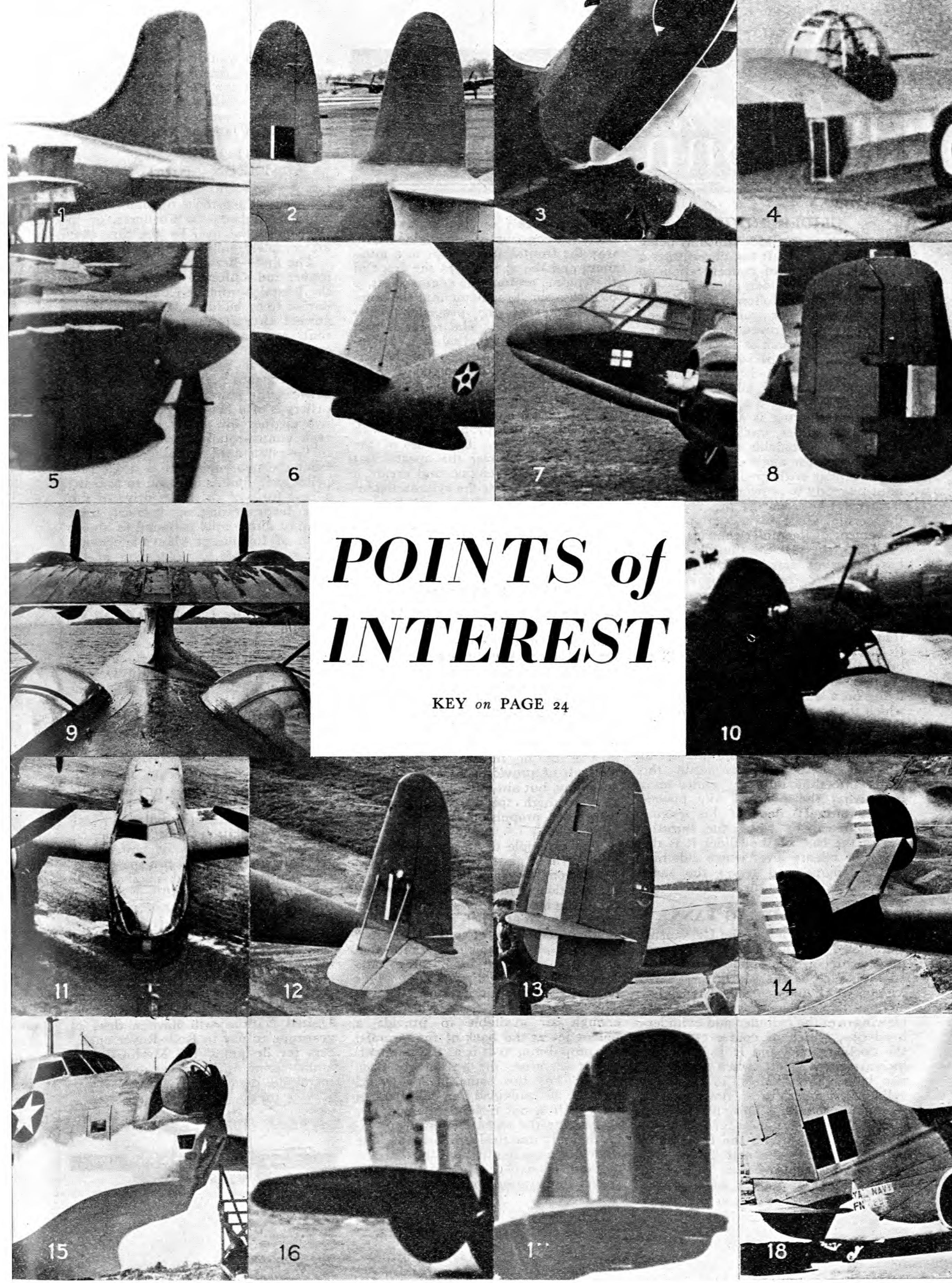
engines, usually on the fireproof bulkhead. One extinguisher is fitted in each engine bay on Service aircraft, and all are actuated by the previously mentioned switches. Apart from these, however, each crew station is equipped with an extinguisher, but these are always hand-operated, and do not, on Service aircraft, comprise part of the automatic fire-fighting equipment.

In all cases, though, the extinguisher consists of a metal bottle charged with methyl bromide at about 60 lb./sq. in. pressure. From the extinguisher, spray pipes are led around the engine nacelle, as shown on the illustration. All danger points such as the air intake, carburettor system or any pockets where fuel may collect are embraced by the circuit, the fire-quenching chemical being sprayed through the perforated piping or, where a concen-

tected. The gravity switch, as we have seen earlier, operates immediately the aircraft turns on its back, but the effect is exactly the same as that of the crash switch. The extinguisher at each engine is energised and all the engine compartments are smothered.

The above-mentioned switches are, as we have seen, operated without any action whatever on the part of the pilot. In fact, he could not operate them himself if he wanted to. It is, however, very desirable that he should have a means of control, and this is provided for by the push-button switch.

In the unlikely event of one of the automatic switches failing to act, he has an alternative control ready at hand, and in any other emergency he can smother any or all of his engines quickly and effectively.



POINTS of INTEREST

KEY on PAGE 24

Technical Reconnaissance

GLIDER TOWING

THE flying of a glider which is being towed by an aircraft tug necessitates a very high degree of concentration on the part of the glider pilot. The tug pilot has only to follow a few simple rules such as not going into steep climbs, turns or dives, and avoiding cloud flying as much as possible. However, cloud flying is sometimes inevitable, and under such conditions the glider pilot has to watch the tow rope like a cat watching a mouse. It is not often that the tug is actually out of sight of the glider, but in the event of this being unavoidable the glider pilot has to watch the angle of the tow rope to the glider with great care, and he must be ready to answer any deviation from what he learns by practice to be the correct angle by a corresponding movement of the glider controls.

During the take-off the glider pilot has to unstick first and then hold the glider in the correct relationship to the tug throughout the latter's take-off and climb. If the glider rises too high before the tug is off the ground it will result in the tug being tail-light, and its pilot will have extreme difficulty in becoming airborne.

Flying a towed glider is rather like flying on a track, and the direction in which the track leads is in the hands of the tug pilot. The glider pilot is dependent on somebody else's engine, and if that engine and the aircraft to which it belongs looks like getting the glider into difficulties the glider pilot does what the pilot of any power-driven aircraft does if his engine breaks down—he closes the throttle, but in the case of the glider it is the tow rope release lever which rids him of the engine and serves the same function as the throttle.

ENGINE COOLING FANS

RADIAL engines such as the Centaurus, Hercules, Pegasus or Cheetah are completely aircooled as opposed to in-line engines, such as the Merlin or Sabre, which are liquid-cooled. The radial engines depend upon the slipstream blowing over the cylinder and cylinder-head fins, which of course constitute the cooling area, and it is becoming increasingly difficult, when there are two banks of cylinders, to keep the cylinder temperatures down to a reasonable figure. This particularly applies to the rear bank of cylinders. The cooling air passes the front bank before it gets to the rear banks, and so gets warmed up before it reaches the latter. Another thing which makes cooling difficult on two-bank radials is that by constructing an engine in this way the frontal area is kept to a minimum and the aperture at the front of the engine, around the engine shaft, is of such a small diameter that the aerofoil section of the propeller blades does not cover it. The result is that the cooling of the cylinders is dependent on the forward speed of the aircraft and not on the forced draught from the propeller blades.

To obtain better cooling, small fans are now being made which fasten to the back of the propeller hub, with which they rotate. The vanes of the fan completely cover the aperture at the front of the engine and create a forced draught over the cylinders. This arrangement not only cuts out previous cooling problems, but will allow very much more scope in the design of high-power low frontal area radial engines.

JET PROPULSION

LITTLE can be said about jet propulsion at the moment. We have been told nothing more than most of us knew, for few were unaware that jet-propelled aircraft were flying in various parts of the country.

It is undoubtedly the opening of a new era in aeronautics, but it is unlikely that wide-scale use will be made of it for several years to come. The idea is by no means new, and the methods of providing a propulsive jet are many, but aircraft capable of flight at very high speeds were necessary before jet propulsion could be efficiently utilised.

The principle of the scheme is for some form of gas to be ejected at great speed from the rear of the aircraft and the reaction of this gas against the aircraft provides the forward thrust. The system apparently being used in this country makes use of normal air from the atmosphere, which is compressed and then expanded by burning some fuel in it for providing the jet. This naturally has its limitations, since at very great heights there will not be enough air available to provide a potent jet at the back of the aircraft. Jet propulsion, as it is at the moment, is not therefore the answer to space travel. For this some means would have to be provided for supplying a jet which is not dependent upon air, and so far the rocket system seems to be the only practical proposition. The difficulty here lies in the fact that the amount of explosive charge for the rocket to maintain continuous flight of any duration would weigh an excessive amount. It is, however, by no means unlikely that some explosive will soon be available which has not only a very good power-to-weight ratio, but which can have its burning very easily controlled.

BRABAZON AND TUDOR

LORD BEAVERBROOK recently announced the existence of plans for the building of two new air-liners, or, if the war is not over by the time they are complete, military transports.

The first—Brabazon—is a hundred-tonner and is probably the aircraft that the Bristol Aeroplane Company are reported to be building. It follows fairly normal aircraft-design practice except that, as announced, it has "a completely new form of drive." This statement is rather misleading, for what it means is that the transmission between the power plant and the propellers is of a new design. Apparently two engines are being used to drive each contra-rotating propeller, and it is the system of coupling the drive from the two engines to a single propeller shaft that is referred to as being a new form of drive. A drive of this type incorporating, as it must, some form of differential is bound to absorb some of the power plant's efficiency, and is probably an admission of the fact that single engines of sufficient power do not exist.

The second—Tudor—is a 32-tonner with a pressure cabin: that is all we are told. However, it is a fairly shrewd guess to say that it must be a pressure-cabin version of the York, which it was suggested was required, in the December issue of this journal. The name given to this aircraft alone indicates that it is from the same stable as the Lancaster and York.

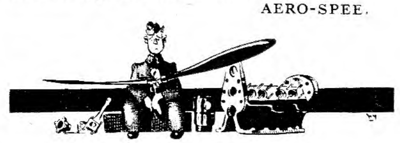
MERLIN MUSTANG

THE Mustang P51-B is the latest aircraft to owe its success to the Merlin engine. It is, of course, an American aircraft, and the Merlin 68 with which it is fitted is itself built in America. This Merlin develops its power at a great altitude, having a two-speed, two-stage supercharger, and is eqlivalent to the British Merlin 61 fitted in latest Spitfires.

Although the Spitfire is the prettier of the two aircraft and looks faster than the Mustang, there is not much to choose between them in performance, judging by accounts.

When the history of this war comes to be written it will be found that the United Nations will have a debt of gratitude to pay to Rolls-Royce engineers for designing the Merlin engine and stepping up its power to meet the increasing demands of war.

AERO-SPEE.



Cat's Eyes

By a Surgeon-Commander R.N.V.R.

If you know how your eyes work at night you'll be able to shoot down the Jerry or Jap before he even knows he's got a neighbour. On the other hand, if you are going to be an observer, of what use are months of highly skilled training if you can't see a ship that's there and report back its presence to the Admiral, whose elongated spyglass you are?

The eye has a lens focused by muscles, a diaphragm or pupil which is stopped down to a pin-point in bright light, or opened wide as an owl's in starlight, and a sensitive film at the back of the eye. It is, in fact, a miniature camera, but whereas the film of the camera is coated with thousands of chemical granules, the film or retina of the eye has thousands of sensitive nerve-endings which are of two different kinds. One lot, the cones, are used in bright light; the other, the rods, are used in night light.

The Rods and the Cones

They differ in distribution and function, and herein lies the secret. The greatest concentration of *cones* occurs at the central point of the retina, so that when you stare a thing in the face the image is focused clearly (and in colour) on the cones, from sunlight down to bright starlight, but they are blind to anything dimmer.

The *rods,* on the other hand, can see the faintest stars, and are clustered most thickly in a ring around the central point. They report no colour to the brain, so "all cats look grey in the dark." Nor do they focus sharply, but they can detect a dim mass, and even better a mass that is moving. They will report a light which is a thousand times dimmer than the minimum required for the cones to see by.

The rest of the retina is occupied by cones and rods in less degree, and the cones get fewer away from the centre, until at the outer edge of the retina only rods are present. As you read this print you can still see things "out of the corner of your eye," but not clearly.

Dim Views

Knowing this setup of cones and rods, we can now understand why it is that when we scan the starlit sky we can see the brighter stars perfectly by looking straight at them—they focus on the central cones. A little to one side we shall be conscious of fainter stars, but when we shift our gaze to look straight at one and get a clearer view it disappears like the Cheshire cat's grin. This is most tantalising, but we can never hope to get a clear-cut focus on extremely dim objects. So here's the first tip: *To see a faint object by night look five degrees to one side of it.*

Here is another interesting set of facts which comes into play. In the camera the light causes a chemical change in the granules of film emulsion, so that when the film is developed we have a picture of what the camera saw. In the eye a similar change takes place, but instead of emulsion we have a substance called visual purple. It is affected in proportion to the strength of the light shining on it, and is completely bleached by strong light. This change is not permanent, because the eye is alive, and the visual purple is replaced reasonably well in ten minutes, but not fully for half an hour. This process is called dark adaption.

Bleaching Your Eyes

You can do a simple experiment, and realise this bleaching process for yourself. Lying in bed at night, gaze steadily at the electric-light filament for half a minute. Turn out the light, and after a while you will see an after-image of the filament, because that area of visual purple has been bleached. The "image" may turn green with a crimson edge, then fade and recur in complementary colours as crimson with a green edge. The whole image gradually fades as the visual purple is regenerated, but until this happens this spot is "dud." So bring into play areas which are fresh *by moving the eyes* around the object instead of peering at it fixedly, and *give your eyes time to become dark-adapted* before taking off, or you may hit a tree-top, or meet a Jerry before you're ready to. In practice this means sitting in the crew-room in the dark for half an hour before taking off on ops.; and half an hour seems an awful long time; but there are further facts of which we can make use. The "bright light" cones are sensitive to all wavelengths of light, including red, but the "night light" rods are quite blind to red, and we use this knowledge by providing red goggles for waiting crews, who can thus read the papers while becoming dark-adapted. If the light on instrument panels of aircraft and in the gangways and chartrooms of ships is red, night vision is not destroyed. Even so, keep all lighting down to a minimum, even if it is red, not forgetting gunsight illumination.

Keep an Eye up Your Sleeve

Once your eyes have become dark-adapted, keep them so. If you come into contact with bright light shut one eye, whether in meeting the headlights of a car while cycling or being coned in the beam of searchlights. *In the case of searchlights, put one hand over the shut eye.* As soon as you have weaved your way out you will at least have one eye to spot the night-fighter waiting for you, instead of being blind to his presence for several minutes, and he will get the shock, not you.

Keep it Clean

Another point: If there are scratches or if there is dirt on the Perspex windshields or turrets, light will be broken up or scattered. *"Keep your Perspex clean!"* is an obvious but easily neglected tip. During the Battle of Britain one tired pilot chased three Mes in the distance. His flight obediently followed, guessing that their eyesight was not so good as their leader's, who suddenly realised that he was seeing three specks on the windscreen. At night this is even more important, and rear gunners on night raids now have a movable panel, so that they look straight into the night—and is it cold! Still, it is better to see and be cold than fail to see and be warmed by a stream of hot lead.

Eyes Need Oxygen

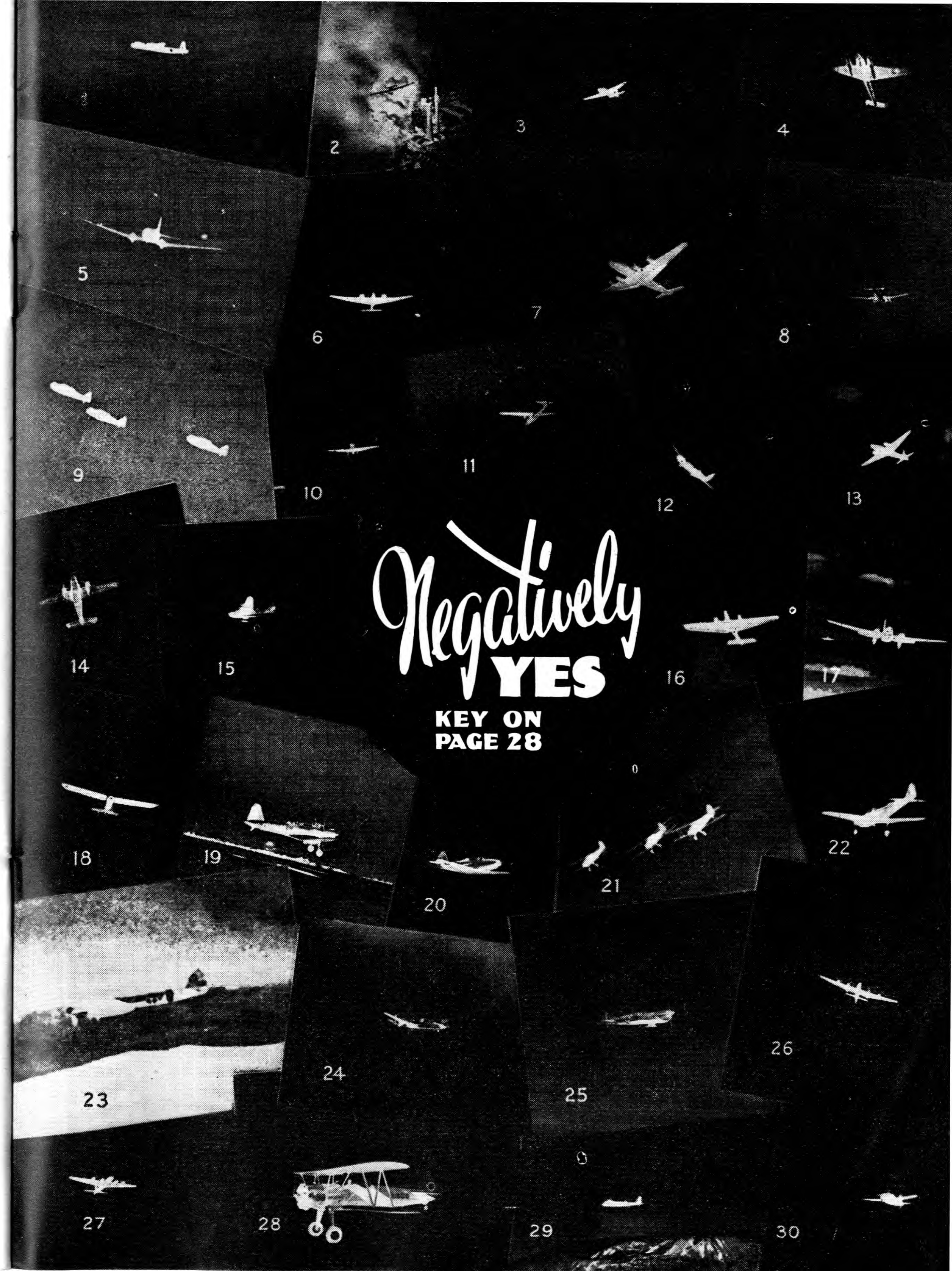
The eyes need oxygen. Visual purple when bleached requires oxygen to re-form, and night vision depends on visual purple. If there has been any oxygen lack, when it is turned on the first result is a rosy glow in the eyes, which does not help in an emergency when you are suddenly attacked. So oxygen is now used at night from ground-level.

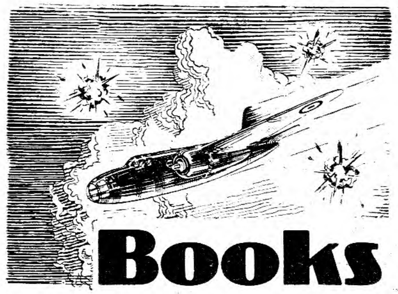
Who are good night fighters?

If you are tested for night vision and are poor, you can't alter it, but you can learn to use what you've got, and anyhow there are plenty of daylight jobs to be done.

You mav meet pilots with poor night vision who are excellent night flyers, others may be indifferent night pilots even though they have excellent night vision. Don't be misled. The tests are all right. The point is that one lands normally on a flarepath, or in the Fleet Air Arm one is "batted in" by illuminated bats, and one is using the cones and not the night-vision rods in such cases. The real test is in a forced landing, or battling with night-fighters, or spotting a surface raider by starlight. Then good and well-trained night vision tells.

Get dark-adapted before taking off. Keep dark-adapted. Use the dimmest lighting possible in the cockpit, gun-sights, etc. Cover an eye if caught in glare. Avoid the temptation to look straight at a faint object. Look to one side, and keep the eyes moving. Keep goggles and Perspex clean. Use oxygen from ground level.





Books

UNOFFICIALLY REVIEWED

Ace Air Reporter

By Harry Harper. 151 pages. $5'' \times 7\frac{1}{2}''$. John Gifford Ltd. 8/6.

Harry Harper, who has been an air reporter since the earliest days of aviation, tells many good stories of the good old days.

American War Planes in Action

By Sydney E. Veale. 48 pages. $9'' \times 11''$. Pilot Press. 5/-.

America's war problems were at one time different and less pressing than ours, with the result that her aircraft developed on different lines. Mr. Veale here tells the story of how they were quickly adapted to the needs of this war and how they have distinguished themselves in action. The book is well illustrated and a pleasure to read. There is a long list with full details of all types at the end which will be found most useful.

Aircraft of the Fighting Powers

(Vol. IV.) By H. J. Cooper and O. G. Thetford. Harborough Publishing Co. Ltd. 21/-.

Dealing with the aircraft used by the belligerent nations in 1943, this is a complete work in itself, whilst still remaining complementary to the earlier volumes of the series.

76 aircraft are illustrated, of which 16 are British, 47 American, 10 German, and 1 each Canadian, Japanese and Russian.

Each aircraft is shown in three-view drawings to 1/72nd-in. scale, and at least one, and in many cases several, excellent photographs are given.

The technical data is comprehensive, and includes all the information released at the time of going to press, together with the type history, modifications, etc., and operational details of each aircraft.

The information appears commendably accurate. Altogether a very worthy successor to the previous volumes, the high standard of which is fully maintained, and worth a guinea of any enthusiast's money. L. F.

The Men Who Fly

By Flight Lieutenant Hector Hawton. 165 pages. $5\frac{1}{2}'' \times 7\frac{1}{2}''$. Nelson. 5/-.

An interesting account of the work of the Royal Air Force. We all know that our men and our machines are superb, but the fact that a third thing is necessary if they are to fight effectively, and that is organisation. He shows how each bombing raid, each fighter sweep and each sortie depends for its success on good organisation and loyal co-operation of many remote from flying. Well worth adding to squadron libraries.

Automobile Electrical Maintenance

By A. W. Judge. Sir Isaac Pitman & Sons, Ltd. 279 pages. $6\frac{1}{2}'' \times 4\frac{3}{4}''$. 7/6.

A thoroughly practical book, covering all aspects of the subject.

A brief introductory description of the various circuits involved is followed by chapters dealing at length with the adjustment and overhaul of each component, and several of these contain fault-finding charts which should aid in rapid diagnosis.

Commercial testing apparatus is described, and there is some useful information on the reconditioning of accumulators.

Well illustrated and produced on good paper. L. F.

E.V.B. Waterslide Transfers

E. V. Barnes, North Cheam, Surrey. 2/-.

These are the latest aids for the aeromodeller. No longer need we see these small 1/72nd-in. scale models spoilt by reason of a bad paint job. This modern method consists of a complete set of waterslide transfers, sectioned, for covering the entire model.

Supplied in an attractive envelope, on the back of which are full instructions, the transfers are printed in authentic colours with squadron markings and camouflage.

We find by trial that, given the requisite delicacy of handling, these transfers are easy to apply and produce a first-clas result at a very modest price. An extensive range is available, based on a well-known series of 1/72nd scale of drawings. L. F.

The Development of Fighter Aircraft

CONTINUED FROM PAGE 3

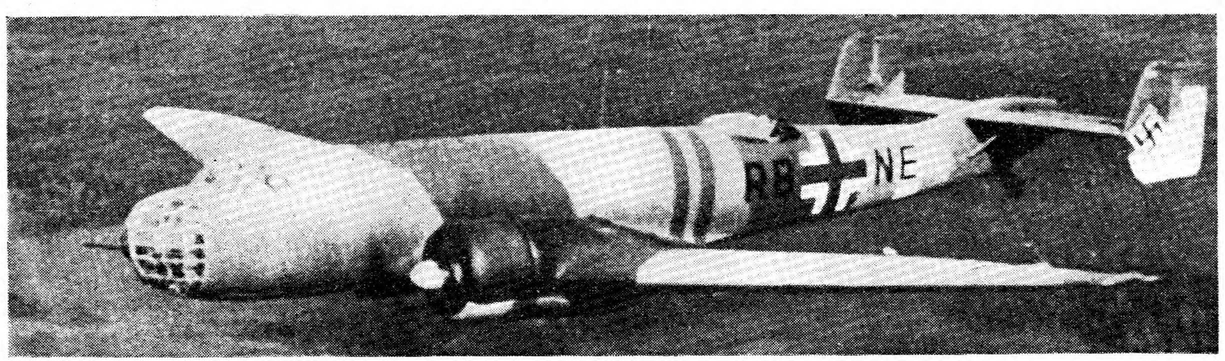
Many other experiments have been carried out with fighters. Some, such as the Mosquito, Spitfire and Lightning, have had all their guns removed and, with cameras installed instead, have been used for high-speed daylight reconnaissance. Rocket projectiles have also begun to make a name for themselves. The Russians are using large rocket-bombs on their Stormovik dive-bombers and Hurricanes, and the Germans are reported to have tried to break un formations of Fortresses over Europe with large numbers of rocket-bombs shot from a gun under the belly of their fighters. Here again the future may hold many surprises, but it is safe to assume that the British aircraft industry will not have neglected this new weapon.

Points of Interest

SEE PAGE 19

1, Douglas Skymaster; 2, Avro York; 3, Curtiss Kittyhawk; 4, Avro Anson; 5, Supermarine Spitfire VB (tropical); 6, Brewster Bermuda; 7, Airspeed Envoy; 8, North American Mitchell; 9, Consolidated Catalina; 10, Grumman Goose; 11, Armstrong-Whitworth Albemarle; 12, General Aircraft Hotspur (modified tail); 13, Lockheed Hudson; 14, Consolidated Coronado; 15, Boeing Sea Ranger; 16, Bristol Bombay; 17, Handley Page Hampden; 18, Curtiss Seamew.

A Junkers Ju 86B.



Negatively Yes

(These are negative prints of daylight photographs)

SEE PAGE 23

1, Short Stirling; 2, Consolidated Liberator; 3, Grumman Avenger; 4, Messerschmitt Jaguar; 5, Douglas Dakota; 6, Handley Page Hampden; 7, Douglas Skymaster; 8, Lockheed Hudson; 9, North American Harvard II; 10, Hawker Hurricane; 11, Consolidated Catalina; 12, Bristol Blenheim; 13, Vickers-Armstrongs Wellington; 14, De Havilland Flamingo; 15, Short Sunderland; 16, Junkers Ju 52 3/m; 17, Douglas Digby; 18, Vultee-Stinson Vigilant; 19, Vought-Sikorsky Chesapeake; 20, Bell Airacobra; 21, Fairey Albacore; 22, Fairey Fulmar; 23, Junkers Ju 88; 24, Bristol Beaufort; 25, Supermarine Spitfire (tropical); 26, Handley Page Halifax; 27, Boeing Fortress II; 28, Boeing PT-17 (supplied to China); 29, Blackburn Botha; 30, Brewster Buffalo.

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Spitfires coming to the assistance on a call from a radio jeep during a tactical exercise.