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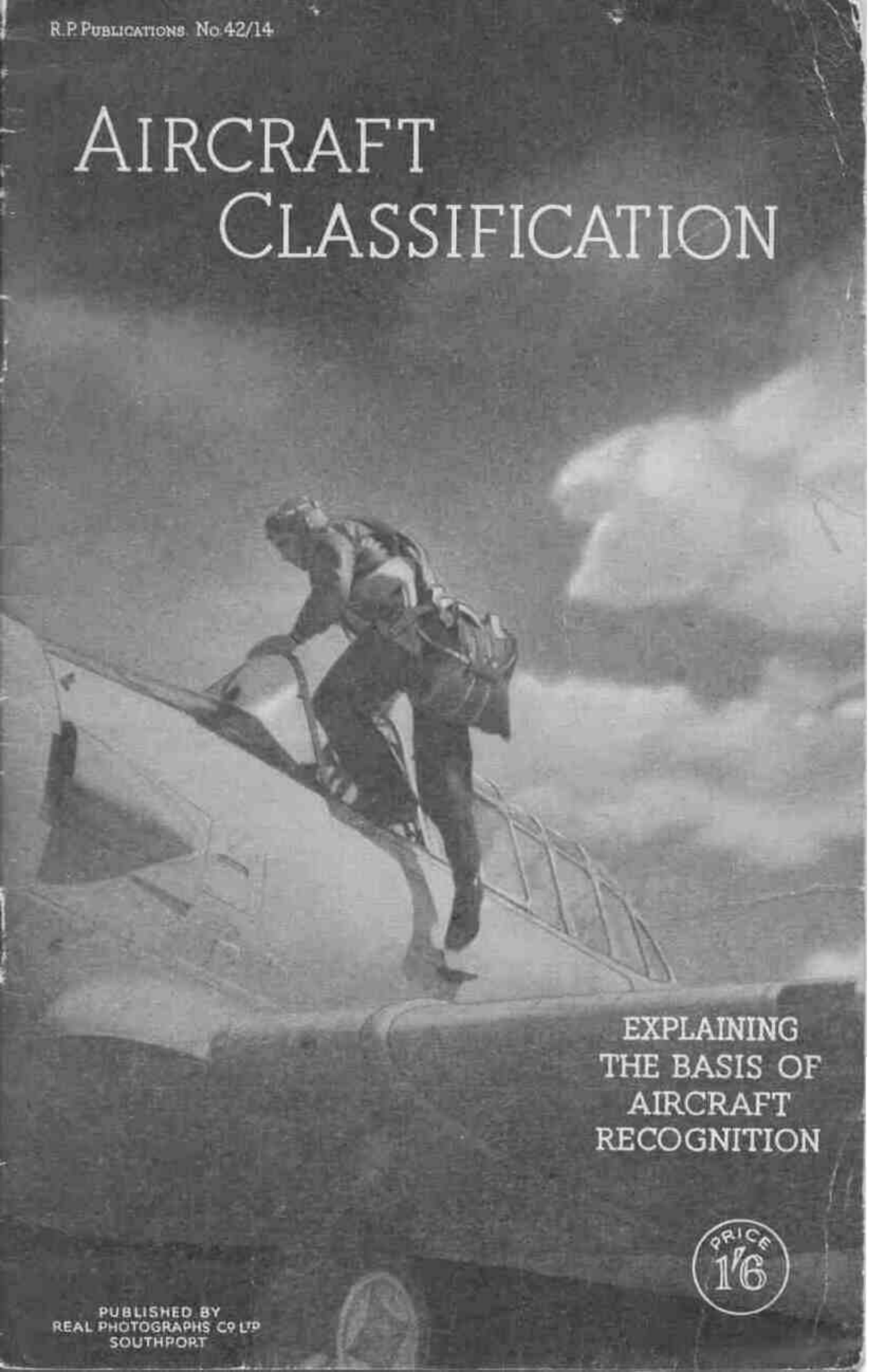
Aircraft Classification



EXPLAINING THE BASIS OF AIRCRAFT RECOGNITION

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AIRCRAFT CLASSIFICATION

WITH THE VAST INCREASE in the numbers of aircraft flying, and the introduction of so many new types, the art of Aircraft Recognition becomes more arduous and yet more intriguing as the months of war go by. It becomes increasingly evident that history is being made in the air at the present time.

To many people aviation, and particularly aircraft recognition, is an unexplored subject. Some do not attempt to interest themselves in it because the details appear so complicated. Obviously, the subject cannot be so difficult, since even the junior members of the A.T.C., and most schoolboys, can recognise almost any aeroplane at sight. Not only so, but they also discuss aircraft matters with an air of authority, as many parents know only too well ! It is the aim of this booklet to endeavour to help the beginner (whether son or parent) to become initiated in this fascinating subject. In peace-time it formed the basis of a popular hobby in the collection of our aircraft photographs and has been brought to the forefront for even greater interest and importance by the war in the air.

Each paragraph in the pages that follow has been set out to give the minimum of error and the maximum of simplicity. Our hopes are that this publication will bridge a gap for those who are willing to learn, but who have not had the good fortune to find the necessary information in such a concise form as is here presented.

The photographs in this booklet are selected from our extensive selection of some 1,700 aircraft photographs. The list number of each photograph is shown beneath the illustrations in the foregoing pages so that you may order copies of any particular photograph desired. Further details will be found on the top of page 18.

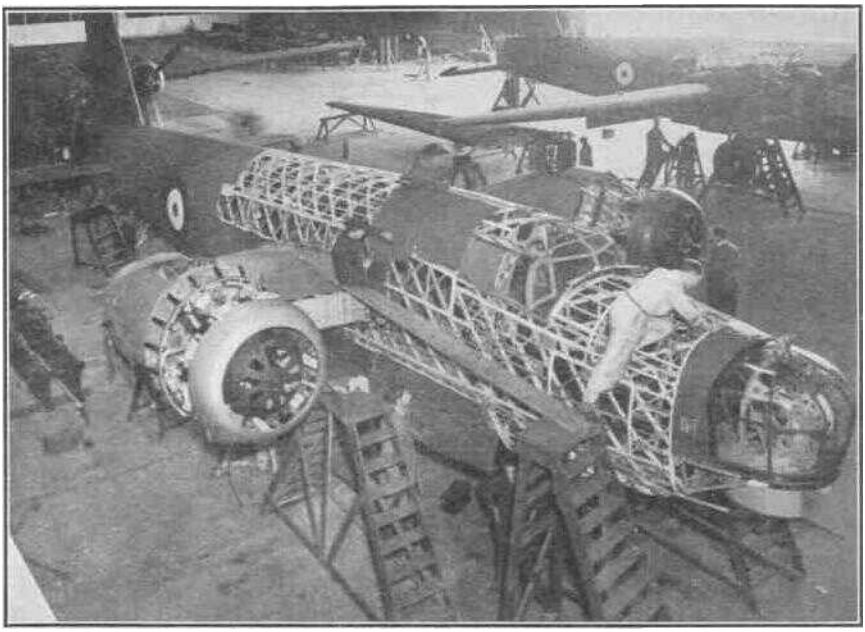


Photo. AI622. The fuselage of the Vickers "Wellington" Bomber is of geodetic construction. In the above photograph can be seen the network of curved members that forms the rigid framework. Amidships can be seen a worker applying the fabric covering.

An aeroplane may be divided into four main parts. These are : (1) The mam body, or FUSELAGE; (2) The WINGS or mainplanes; (3) The TAIL unit, and (4) The ENGINE or power unit.

(1) THE FUSELAGE

The Fuselage forms the main structural framework of the aeroplane, and may be constructed by one of several methods. Early aeroplanes were constructed in the form of a four-sided braced girder, covered with fabric. The four corner members, known as the longerons, were held in position by vertical and horizontal struts, the panels thus formed being cross-braced with wires. This form of fuselage was generally constructed of squared timber members, but

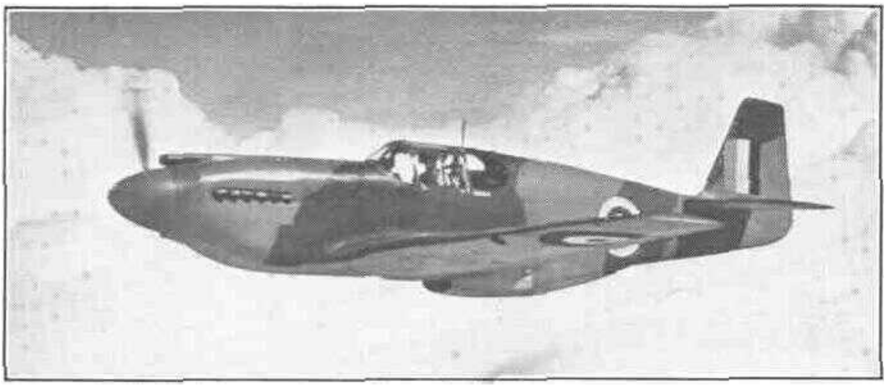


Photo. AI477. The North American "Mustang" has a typkally slender streamlined fuselage, in which it resembles the "Spitfire" The nose of both "Mustang" and "Spitfire" accommodates the engine.

later duralumin or steel tubes were introduced. Fabric-covering was replaced by either plywood or sheet-metal, which provided both covering and bracing. Sheet-metal covering is now almost universal, although a few aeroplanes—notably the Vickers "Wellington"—are still fabric-

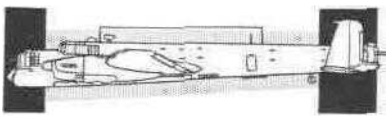


Fig. I. Long, "slab-sided" fuselage (Armstrong Whitworth "Whitley")

covered. Fabric-covering, too, is generally used on the metal framework of movable surfaces, *i.e.,* the rudder, elevators, etc., of modern aircraft.

In a more recent development, known as monocoque construction, the whole or the greater part of the main load is carried by the sheets of wood or metal with which the interior members are covered. Such a fuselage is generally of elliptical cross-section

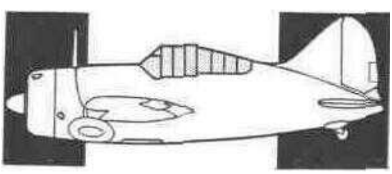


Fig. 2. Short, tubby fuselage (Brewster "Buffalo")

and may be formed either from all-wood, as in the D.H. "Albatross," or all-metal, as in the "Spitfire" and "Typhoon." Nowadays light alloy is generally used throughout, the plates being either riveted or welded in position.

The geodetic method of construction, used in the Vickers "Wellesley" and "Wellington" employs a rigid framework consisting of a network of curved members, the main internal vertical and horizontal members being eliminated. Geodetic fuselages are all-metal, and to date have been fabric-covered, compared with the sheet-metal covering of

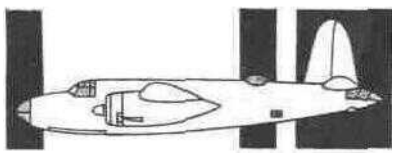


Fig. 3. Cigar-shaped fuselage (Martin "Marauder")

most of the modern all-metal monocoque constructions.

Fuselages vary in length and in section from the long rectangular, "slab-sided" fuselage of the Armstrong-Whitworth "Whitley" (Fig. 1) to the short round, "tubby" fuselage of the Brewster "Buffalo" (Fig. 2). There is a variety of intermediary

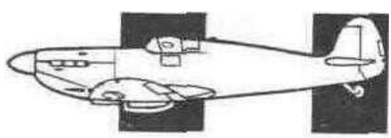


Fig. 4. Slender, streamlined fuselage (Vickers Supermarine "Spitfire")

forms, noteworthy among which are the cigar-shaped fuselages, such as that of the Martin "Marauder" (Fig. 3), and the slender streamlined fuselage of the Supermarine "Spitfire" or North American "Mustang." The shape of the fuselage is often a helpful guide to recognition in cases where two aeroplanes are similar in other respects.

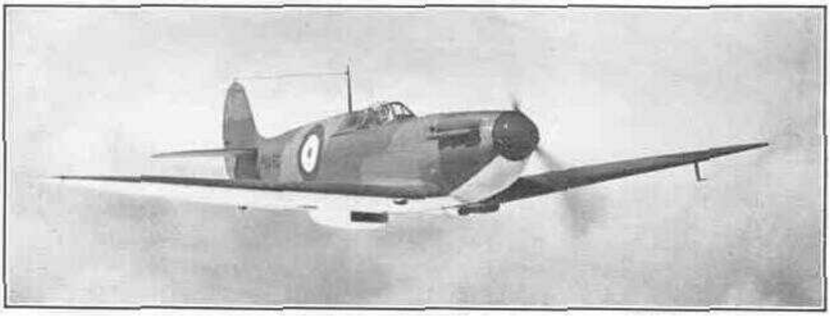


Photo. AIOOO. The nose of the "Spitfire" is taken up entirely by the engine. "AEROPLANE" Photograph

Nose of Fuselage

The noses of aircraft of different types are very rarely identical, and many variations may be incorporated in designs, according to the duties for which the aircraft is intended. The different designs of nose, which are often an aid to recognition, may be classified thus:

(1) Nose taken up by engine (Fig. 4).
(2) Longer types of nose with power-driven turrets and bomb-aimer's position (B, Fig. 5).
(3) Filled-in nose, perhaps with fixed armament (A, Fig. 5).
(4) Glazed nose (C, Fig. 5).

The "Spitfire" illustrated above, and the "Mustang," shown on page 3, are in the first category, since the noses are wholly taken up by the engines. Both the aircraft shown are in the single-engined class and we may safely say that the majority of this category have the power-unit fixed in the nose, as have those illustrated. An exception, however, is the Bell "Airacobra" Fighter. In this case the engine is mounted at the rear and behind the pilot's cockpit so that in this case the nose is not occupied by the engine. The "Airacobra" is unique, however, and there are no other such machines.

The longer nose, mentioned as the second type, is generally found in the multi-engined type of aircraft, in which it is usually required to carry some kind of armament,

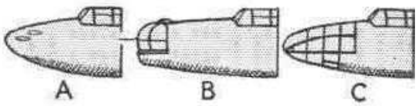


Fig. 5. THREE TYPES *OF* NOSES :

A: Filled-in nose perhaps with fixed armament. B: Mounting power-driven turret. C: Glazed, transparent (armament, etc.)

either fixed machine-guns or a power-driven turret. Larger aeroplanes, such as the Handley Page "Halifax," or the Boeing "Fortress" (see page 14) may also have a glazed bomb-aimer's position under the nose.

The third type is represented by the Douglas "Havoc" with its filled-in nose mounting fixed forward-firing machine-guns and/or cannon in the interior. The only outward indications of this are the small holes in the covering in front of the muzzle of each gun.

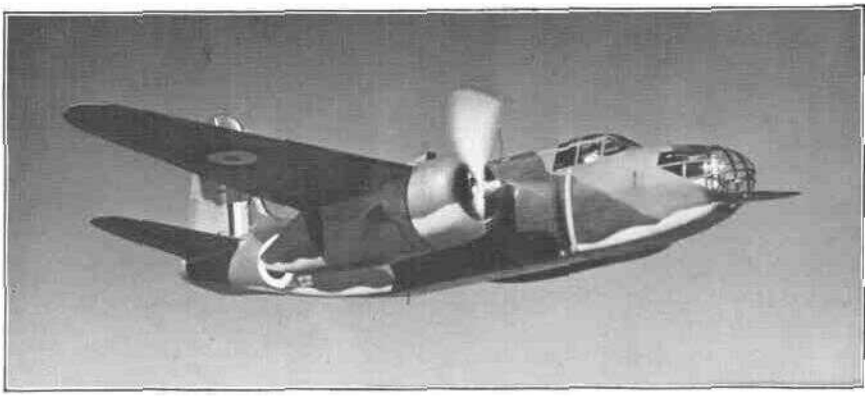


Photo. A1329. **The** Douglas "Boston" is a good example of an aeroplane with a glazed transparent nose.

(2) THE WINGS

The wings are the unit of the lifting surfaces, support for the aeroplane being obtained by the action of air forces on these surfaces when in motion through the air. Wings may be braced with wires, rods, or struts (Fig. 9); or they may be of cantilever construction and devoid of bracing (Fig. 8).

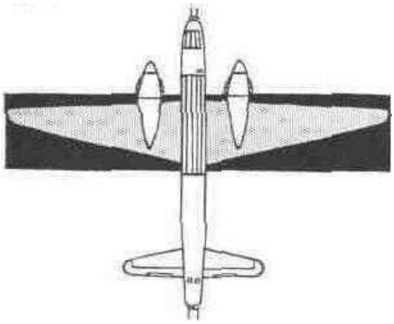


Fig. 6. Wings of high aspect ratio, (8.9) as in the Vickers "Wellington"

Normally the wings—whether braced or cantilever—are rigidly fixed to the fuselage. An exception is the Gyroplane, such as the Cierva Autogiro, in which the wings are arranged as blades that rotate freely like the arms of a windmill but in horizontal motion.

An aeroplane is classified by the number and arrangements of its wings (see page 6). Nearly all modern aeroplanes have cantilever wings and do not require any external struts or bracing as support. All the structure is contained inside the wing

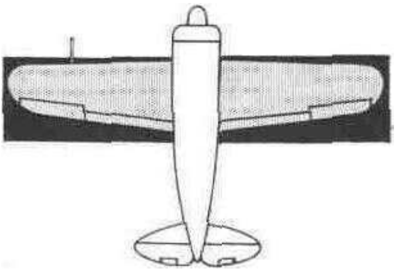


Fig. 7. Wings of low aspect ratio, (5.86) as in the Brewster "Buffalo"

covering, and *is* so designed—thick in the centre and tapering towards the tips—as to be capable of withstanding all bending and twisting actions.

The "front" of a wing is known as the leading-edge, and the "rear" is known as the trailing-edge.

AILERONS are hinged flaps well out on the trailing edge of the wings. They provide lateral control and are so arranged that when one is raised the other is lowered and vice versa.

FLAPS. Ailerons should not be confused with flaps. When fitted, these are usually on the trailing-edge, their purpose being to act as air brakes, by creating head resistance. Flaps also enable the camber to be varied, thus improving the lift at low speeds and giving increased control during the take-off or when landing.

Fig. 8. Low-wing (Vickers-Supermarine "Spitfire")

DIVE-BRAKES. Other flaps, acting as dive-brakes and fitted to Dive-bombers, are movable surfaces on the wing that lie parallel with the air flow when the aeroplane is in normal flight. When turned through 90° they increase head-resistance and thus reduce speed during a dive. They are generally used just before pulling out of a dive and after the bomb has been released.

Fig. *1* High-wing (Westland "Lysander")

Aeroplanes fitted with dive-brakes include the Blackburn "Skua" and the Junkers Ju 87 and Ju 88.

CAMBER is the curvature of a wing surface

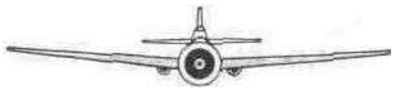


Fig. 10. Mid-wing (Grumman "Martlet")

and CHORD is the width of the wing from leading to trailing edge. In determining the chord, camber is disregarded, the width being measured in a straight line from the leading to trailing edges.

The distance between the two extremities of the wing is called the SPAN.

The ASPECT RATIO, or the ratio of the span to the mean chord, is arrived at by dividing the span by the chord. Where the wing tapers and the chord therefore varies, the

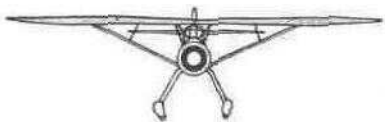


Fig. II. Parasol-type (Henschel Hs 126)

"AEROPLANE" Photograph

Photo. A1281. The Grumman "Martlet," in use with the Fleet Air Arm, is a mid-wing monoplane.

square of the span is divided by the area of the wing. High aspect ratio is represented by the Vickers "Wellington" (Fig. 6) whilst low aspect ratio is represented by the Brewster "Buffalo" (Fig. 7)

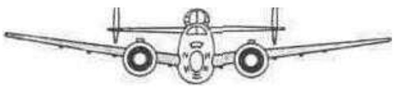


Fig. 12. Low mid-wing (Lockheed "Hudson")

Monoplanes

Monoplanes may be divided into four classes depending on the relative position of the wings with reference to the fuselage.

(a) Low-wing monoplanes, such as the Supermarine "Spitfire."

(b) Mid-wing monoplanes, such as the Grumman "Martlet."

(c) High-wing monoplanes, such as the Westland "Lysander."

(d) Gyroplanes, etc.

If the wings are low on the fuselage—that is, the leading-edge is level with the underside of the fuselage—the aircraft is a low-wing monoplane (Fig. 8). Correspondingly, when the leading-edge is level with the top of the fuselage it is a high-wing monoplane (Fig. 9) and the intermediate position gives the mid-wing type (Fig. 10). The high-wing group (c) may also include the parasol type represented by the Henschel Hs 126 (Fig. 11) where the mam-plane is attached to the fuselage by struts and is above and clear of it.

Sometimes a strict grouping is difficult, as in the case of the Lockheed "Hudson" (Fig. 12). Here the wings are not centrally placed and yet are not in the low-wing position, so the type is grouped intermediately between the mid-wing and the low-wing groups. In the case of the "Hudson" the wings appear nearer to the mid-wing position so the aeroplane is classed as a low mid-wing monoplane. The opposite type, represented by the Dornier Do 17 (Fig. 13) is another

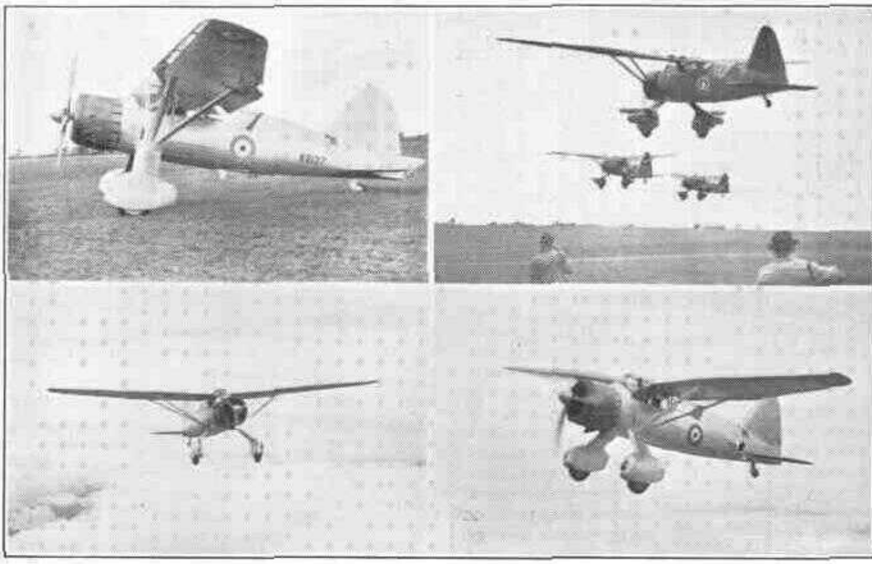
Fig. 13. High mid-wing (Dornier Do 17)

intermediary, this time between mid-wing and high-wing positions, and is known as a high mid-wing monoplane.

The fourth group (d) is distinct from the others and consists of gyroplanes, helicopters and ornithopters. In gyroplanes, represented by the Cierva Autogyro used on Communications, the lifting surfaces are arranged in the form of an airscrew, or rotor, that is rotated in flight by the action of the air on the blades. This airscrew rotates horizontally on a vertical shaft, thus producing a vertical lift. Helicopters are somewhat similar except that the lifting airscrew is rotated by the engine. In ornithopters some of the lifting force and the propulsion would be derived from a mechanical bird-like flapping of the wings. Few successful helicopters and no ornithopters have yet been constructed.

Wings seen in plan view may be distinguished by the taper which, however, must not be confused with the sweep-back of the mainplane, caused by the angle at which it is set to the fuselage. When the wings, as seen in plan, are inclined towards the tail, relative to the fuselage (Fig. 14), they are said to be swept back, as in the D.H. "Tiger Moth" and the Henschel Hs 126.

As the wings are the most important part of an aircraft for recognition purposes, so the



"AEROPLANE" Photographs

Photo.O30. Four typical views of the Westland "Lysander "a high-wing monoplane engaged in Army Co-operation

taper is the important factor in the wing lay-out. The only method by which one may become familiar with wing-plans is by constant reference to photographs and silhouettes of the various aircraft. There are seven categories of taper :—

(a) No taper or unnoticeable taper (Fig. 15) as with the Fairey "Albacore."

(b) Moderate taper (Fig. 16) Avro "Anson."

(c) Full taper (Fig. 17). An example is the Lockheed "Hudson."

(d) Taper on leading edge only (Fig. 18) as in North American "Harvard."

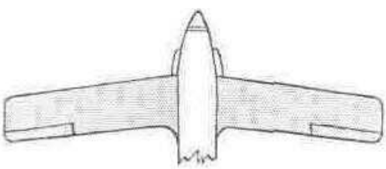


Fig. 14. Swept-back wings.

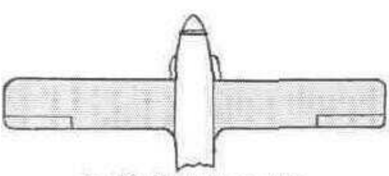


Fig. 15. No taper to wings.

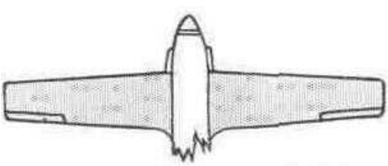


Fig. 16. Moderate taper to both edges

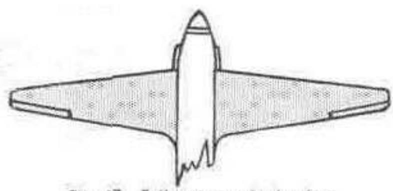


Fig. 17. Full taper to both edges

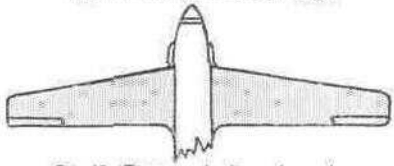


Fig. 18. Taper on leading edge only

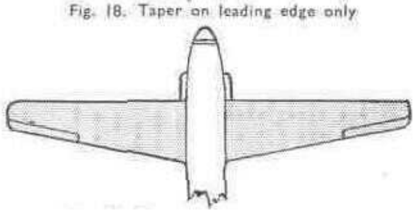


Fig. 19. Taper on trailing edge only

(e) Taper on trailing edge only (Fig. 19) as in the Douglas "Boston".
(f) Compound taper (Fig. 20) Junkers Ju88.
(g) Of elliptical plan (Fig. 21) Supermarine "Spitfire."

In most aeroplanes the wings are raised towards the tips in order to increase stability. This is known as DIHEDRAL ANGLE, It is the set of the wings in regard to the horizontal.

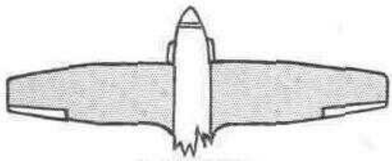


Fig. 20. Compound taper

Dihedral, which is most easily seen when the aeroplane is head on, may be negligible or considerable, according to the design, and it may arise from the wing root at the fuselage or from the centre section, and its degree may vary in different aero-

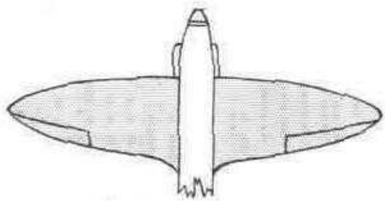


Fig. 21. Elliptical plan

planes. For example, little or no dihedral angle is evident in the Hawker "Hurricane" (Fig. 22); moderate dihedral in the Blackburn "Roc" (Fig. 23) and full dihedral by Supermarine "Spitfire" (Fig. 24).

In some aircraft there is no dihedral in the centre section but moderate dihedral in outer sections of the wings, as in the Bristol "Beaufort." In others, the North American "Harvard," for example, there is no dihedral in the centre section, but full dihedral in outer sections. The Blackburn "Skua" has dihedral near the wing tips.

When the wings are inclined upwards from the horizontal the dihedral is positive. When inclined downwards it is negative dihedral, or anhedral.

Wings that have dihedral near the fuselage, and little or no dihedral towards the tips, are known as "Gull-wings" because they resemble the out-stretched wings of a gull. A typical example is the Dornier Do 26 (Fig. 25). Gull-wings have angles of varying degrees, a moderate example of which is the N.A. "Mitchell." and of extreme Martin


Fig. 22. Slight dihedral angle


Fig. 23. Moderate dihedral angle


Fig. 21. Full dihedral angle

"Mariner," This may also be inverted when it is known as "inverted gull-wing," This may be moderate inverted gull-wing, as in the Miles "Master," (Fig. 26) or full inverted gull-wing, as in Ju 87B (Fig. 27).


Fig. 25. Cranked or Gull-wing


Fig. 26. Moderate Inverted Gull-wing

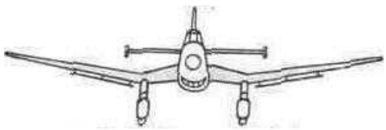


Fig. 27. Full inverted Gull-wing

Biplanes

Although by no means obsolete, very few biplanes are flying today. In this type two rigid wings are superimposed. In a Triplane, three rigid wings are superimposed. In a Quadruplane, four.

The wings of biplanes are divided into BAYS by interplane struts. There may be one (Fig. 28), two (Fig. 29), or even three bays. The distance between the upper and lower planes of a biplane is called the GAP.

The position of the mainplanes is constant, and so there is only the one classification. There are special points of identification common only to this class, however, as for instance whether the wings are of equal or unequal span. In the latter, the top wing is of greater span than the lower wing. Other points are the tail-units, shape of wings, and type of undercarriage. As with monoplanes, there are many alternative forms of engine.

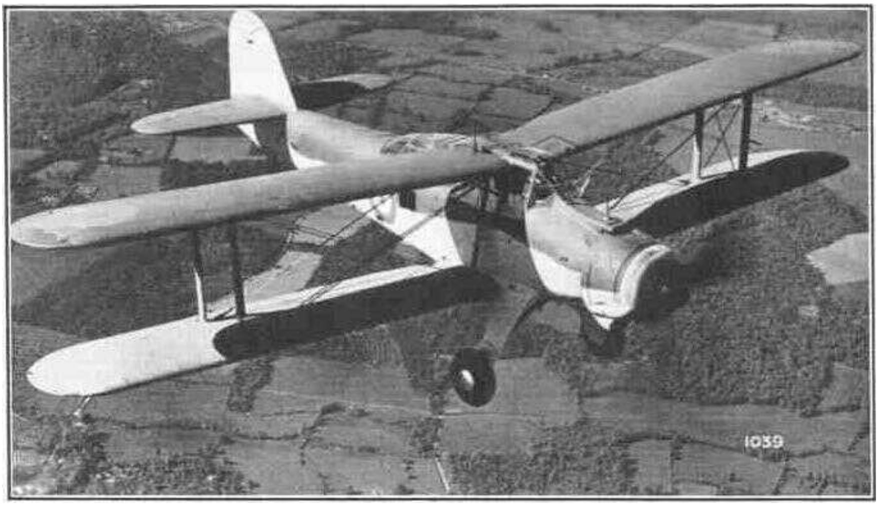


Photo. AI039. The Fairey "Albacore," a single bay Biplane, is used by the Fleet Air Arm for Torpedo attack.

tail unit, etc., but the number of types in the class is small.

Fig. 28. Single-bay biplane

Fig. 29. Two-bay biplane

Sometimes the wings are staggered, one being set forward or behind the other and supported by sloping instead of vertical interplane struts. When the upper wing is set forward of the lower wing (B, Fig. 30), it is said to have "forward stagger," as in the Gloster "Gladiator" and Hawker "Audax." On the other hand, if the position of the

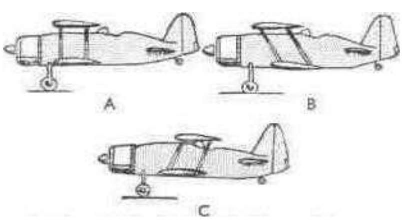


Fig. 30. A: No stagger. B: Forward stagger. C: Backward stagger.

wings is reversed and the lower wing is set forward of the upper (C, Fig. 30), the planes have "backward stagger" as in the Beechcraft D.17R.

Seaplanes

Seaplanes, which may be either monoplanes or biplanes, are aircraft that are designed to operate from water. They are divided into three groups :

(1) Flying-boats, such as the Short "Sunderland."
(2) Float-planes, such as the Blohm und Voss Ha 139.
(3) Amphibians, such as the Supermarine "Walrus."

FLYING-BOATS have a boat-like hull in place of a fuselage (Fig. 31), and are designed

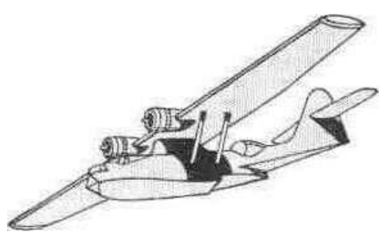


Fig. 31. "Catalina" Flying-boat

for long-distance flights over the sea.

The hull is stabilised when riding on the water by wing floats, or wing-tip floats. Some, as in the Consolidated "Catalina," are retractable to reduce head resistance. Other types have short stub-wings built on to the

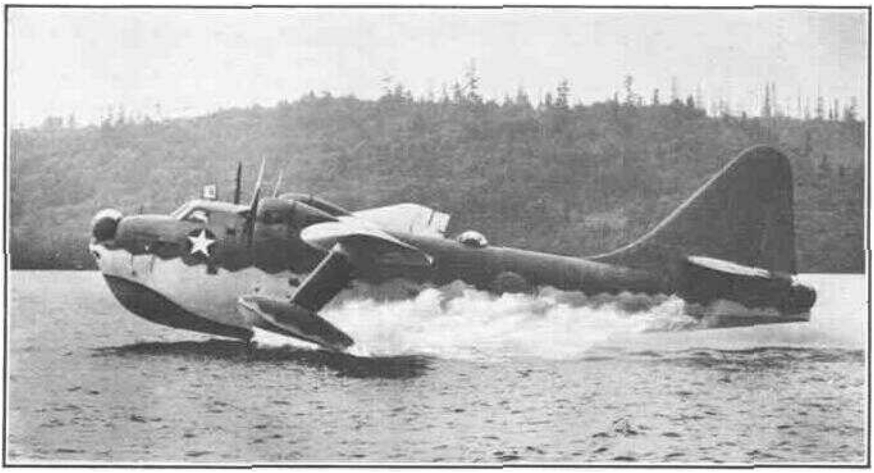


Photo. AI697. The Boeing "Sea Ranger," a large twin-engined Flying-boat constructed in the U.S.A.

hull near the water-line, as with the Dornier Do 18K and Do 24. These are known as "sea-wings" or SPONSONS, and they replace the wing-tip floats. Their purpose is to give lateral stability on the water, particularly when riding a rough sea.

Monoplane Flying-boats are generally of the high-wing type, with engines mounted on the leading edge, as in the "Sunderland" and "Catalina"; or mounted on top of it, as in the Do 26.

FLOAT-PLANES are aeroplanes on which pontoon-floats replace the landing-wheels, thus enabling the aircraft to operate on water (Fig. 32). Sometimes there is a single float placed centrally, with small stabilising floats or sponsons towards the wing tips.

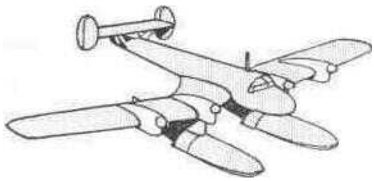


Fig. *32.* Float-plane

AMPHIBIANS have floats or a hull and a wheeled undercarriage so that they can alight and fly off from either land or water, or from the deck of an Aircraft-Carrier (Fig. 33).

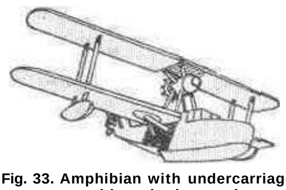


Fig. 33. Amphibian with undercarriage retracted into the lower wing.

(3) THE TAIL UNIT

The tail unit includes the tail-plane, fin and rudder (Fig. 34). Its function is also to provide stability and directional control.

The TAIL-PLANE is the horizontal surface to which is attached a hinged elevator at the after end of the fuselage (Fig. 34). Tail-planes have varying dihedral; and, when seen in plan, varying taper as described for wings.

TRIMMING TABS are small devices which are used to adjust the aerodynamic balance ol the control surfaces (Figs. 34 and 35).

The purpose of the ELEVATOR (Fig. 34), is to maintain longitudinal control of the aeroplane, enabling it to dive or to climb, or to travel in level flight.

The RUDDER is a movable surface and is hinged to the fin (Fig. 34). Its purpose is to provide directional control as in the case of a ship. A balanced rudder (or a balanced elevator) is so arranged that the pressure of the air on a small area tends to balance the pressure on a larger area, thus relieving the

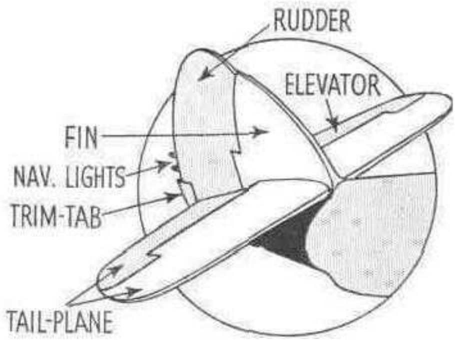


Fig. 34. Simple tail-unit

"AEROPLANE" Photograph

Photo. A740. When the fins and rudders are placed inboard of the tips of the tail-plane, as in the Armstrong-Whitworth "Whitley," they are said to be inset.

pilot of much physical strain at the controls.

A simple tail consists of a single-fin, rudder, tailplane, and elevator, as in the Bristol "Beaufighter" (Fig. 34). A compound tail has twin fins and rudders, as in the Handley Page "Hampden" (Fig. 35).

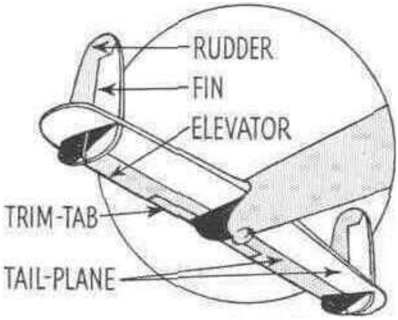


Fig. 35. Compound tail-unit

In early versions the Avro "Manchester," twin-engined bomber, had triple fins and twin rudders, but these were reduced to twin-fins and rudders in later versions, as was also the case with the de Havilland "Flamingo."

The position of the fins and rudders varies (Fig. 36). In the Messerschmitt Me 110 they are at the extreme tips or are outrigged (B, Fig. 36). They may be in any position on the tailplane, however, and if placed inboard of the tips, are said to be "inset" as on the Armstrong Whitworth "Whitley" (E, Fig. 36).

The "Pterodactyl," a very uncommon type of aeroplane, is tail-less, the functions of the tail being performed by specially-designed wings. One example of this type is the new Northrop tail-less fighter, a development of which the U.S. Army Air Force have ordered to be produced in quantity.

Aspect ratio, explained in regard to wings on page 5, applies equally to tail-planes, fins, and rudders. Here aspect ratio is also the relation between two dimensions. Instead of being determined (as in the case of wings and tail-planes) by dividing the span by the mean chord, it is calculated in the case of fins and rudders, by the height divided by the mean distance from the leading to the trailing edge.

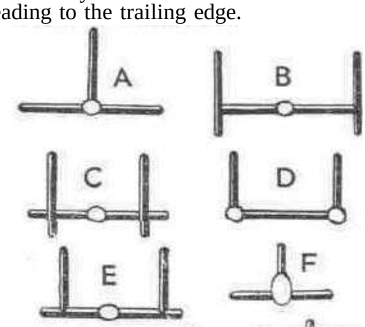


Fig. 36. VARYING POSITIONS OF FINS AND RUDDERS—

A: Single fin and rudder. B: Twin fins and rudders outrigged. C: Twin fins and rudders inset from tips and threaded by tail-plane. D: Twin tail-booms. E: Twin fins and rudders inset from tips and above tail-plane, *f:* Tail-plane low on fuselage. G: Tail-plane through fuselage. H: Tail-plane high on fuselage. I: Tail-plane on fin.

Undercarriage

On the early types of aeroplanes, fixed landing-gear was general. Even today some aeroplanes are fitted with a static or non-retracting undercarriage to eliminate complications and for ease of maintenance. An example of such is the Gloster "Gladiator" (Fig. 37). In this case the undercarriage is of

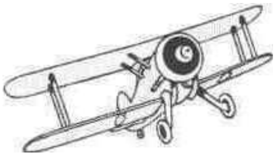


Fig. 37. Cantilever fixed undercarriage

the cantilever type, the other type—that of a braced fixed undercarriage as is used in the Bristol "Bombay" (Fig. 38). In some cases

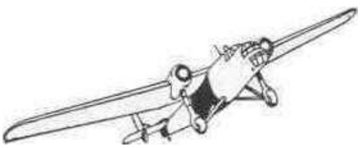
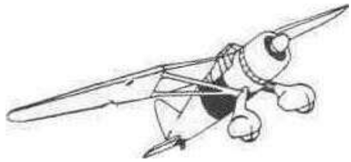


Fig. 38. Braced fixed undercarriage

head-resistance is reduced to a certain extent by streamlining. The legs and wheels are enclosed in fairings, known as "spats" or "trousers," as in the Westland "Lysander" (Fig. 39). This eases the air-flow over the projecting parts and helps to reduce the drag of the whole aircraft.

The undercarriages of most modern aircraft are retractable in order to reduce the head resistance when the aeroplane is in flight. In some types the lower parts of the wheels remain exposed when in flight. Such undercarriages are known as semi-retractable and are exemplified by the Avro "Anson" and Fairey "Battle" (see page 13).

In nearly all fast single-engined Fighter



Fig, 39. Spatted fixed undercarriage

aircraft of today the undercarriage retracts flush with the wings (Fig. 40). Of this type the Supermarine "Spitfire" and Hawker

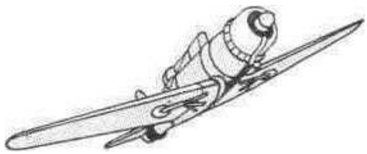


Fig. 40. Undercarriage retracting flush with mainplane

"Hurricane" are the most obvious examples that come to mind. Although in the former the undercarriage retracts outwards and in the latter inwards, the principle is the same in both cases. In the Curtiss "Hawk" series of Fighters the wheels turn through 90° to lie flat in wells in the undersides of the wings (Figs. 44 and 45). In some air-

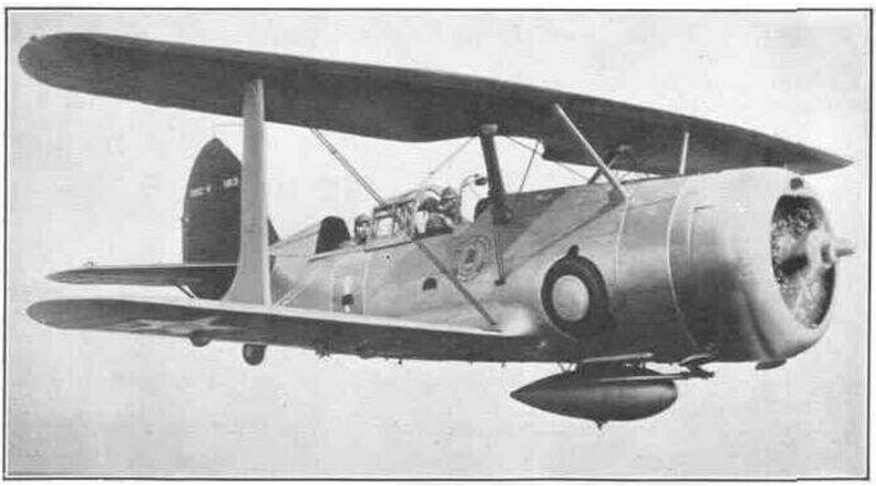


Photo. AI39I. Curtiss "Helldiver 77" two-seat Scout Bomber of the U.S. Navy. The inwards-retracting undercarriage is clearly seen in its retracted position, both wheels lying flush with the contour of the fuselage.

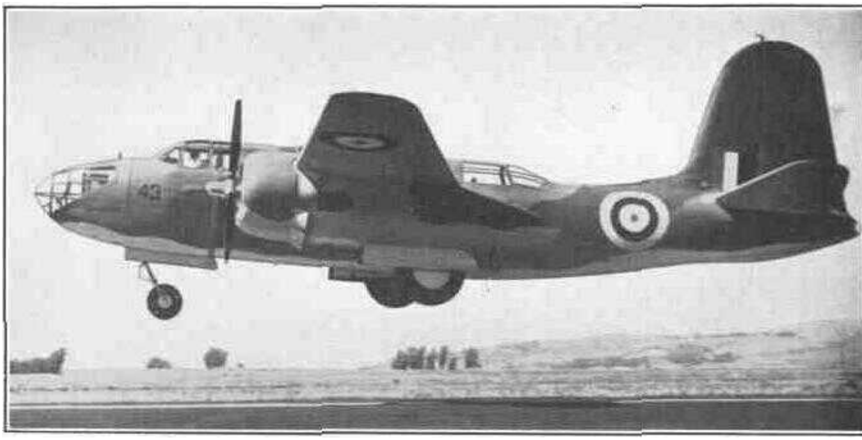


Photo. AI5I7. A Douglas "Boston" with its tricycle-type undercarriage in the act of retracting at take-off.

craft, such as the Curtiss "Cleveland," the undercarriage retracts inwards, the wheels fitting into the contour of the fuselage (Fig. 41).

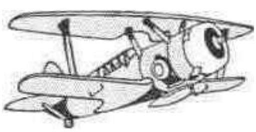


Fig. 41. Undercarriage retracting into fuselage

In many of the multi-engined types, such as the Bristol "Beaufighter," the undercarriage is designed to retract backwards into the engine nacelles and is invisible when the aircraft is in flight (Fig. 42). Most modern multi-engined Bombers are fitted with this type of undercarriage. The only other main type of retraction used in large aircraft is that in which the undercarriage moves through 90° so that it lies flat along the under-surfaces of the wing. An example of this type is the big Consolidated "Liberator" four-engined Bomber.

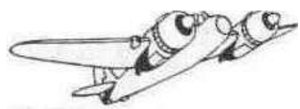


Fig. 42. Undercarriage retracting into nacelles

Tail-Wheels

With all but the tricycle-type of undercarriage—as used, for example, on the Douglas "Boston"—a tail-wheel or a tail-skid is necessary to give a three-point base.

AI6. The Fairey 'Battle" has a semi-retractable undercarriage. Note that wheels remain partially visible in flight.

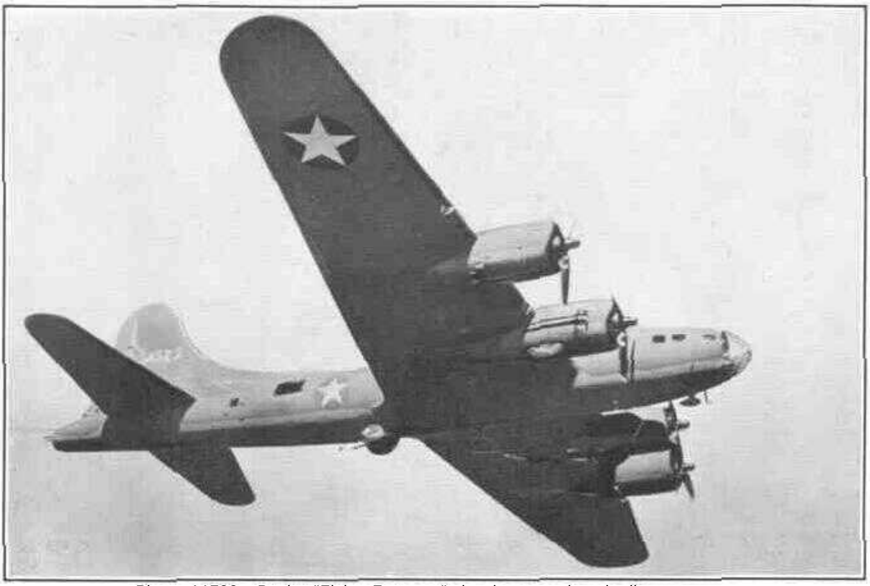


Photo. A1706. Boeing "Flying Fortress," showing ventral, and tail gun-turrets.

In identification, distinctions between the different tail-wheel installations should not be overlooked. For recognition purposes tail-wheels may be divided into three categories :

(1) Fixed, or non-retracting.

(2) Partially-retracting.

(3) Fully-retracting.

An example of (1) fixed tail-wheel is the Brewster "Buffalo" ; of (2) partially retractable tail-wheel, the Handley Page "Hampden" and early "Halifaxes" ; aircraft in this category are not as common as those in the other two. Many American types, such as "Mustangs" and "Tomahawks," have (3) a fully retractable tail-wheel.

Aircraft with tricycle-type undercarriage do not, of course, have any tail-wheel. Some however, may be fitted with a tail-skid, which can be utilised in case of emergency. Before the War some aircraft had skids fitted instead of the tail wheels now commonly used. An example of this type was the Ju *52/3m* civilian version that later had the skid replaced with a tail-wheel when it went into use as a Troop-carrier.

Gun Turrets

On many aircraft, defensive armament is mounted in power-driven turrets. These may be carried in various positions, but usually are in the nose and tail of multi-engined aircraft (A and G Fig. 43). Cther positions are in a ventral or in a side-blister (C and D, Fig. 43). An example of the former is in the Handley Page "Hampden" and of the latter in the Boeing "Fortress I."

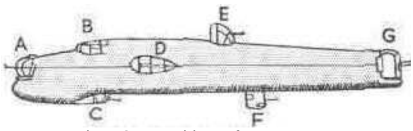


Fig. 43. Position of turrets, etc.

A: Nose. B: Cockpit. C: Ventral or under gun-position. D: Side-blister. E: Dorsal. F: "Dust-bin." G: Tail or rear

When on the top of the fuselage the turret is said to be in the dorsal position (E, Fig. 43). In single-engined aircraft as, for example, the Blackburn "Roc" or Boulton Paul "Defiant," the dorsal position is necessarily employed. Although there are very few of this class of aircraft in operation at the present time, the type is easy to identify by the fact that the turret stands out against the smooth upper line of the fuselage. On the Boulton Paul "Defiant" one of the special recognition points is the large glazed top of the gun-turret that can be seen in either head-on or side view.

Some aircraft may be positively identified by the size and positioning of the gun-turret alone, as for example the Lockheed "Hudson." Although this is not to be regarded as a general circumstance, all gun-positions provide a useful aid to identification.

Photo. AI455. Vickers "Wellington" showing nose and tail-gun-turrets.

(4) ENGINES

Engines may be radial or in-line, and are air-cooled and liquid-cooled respectively.

In the early rotary engines, such as the "Gnome" and the "Clerget" of the 1914-18 War, the cylinders rotated around a stationary crankshaft, the propeller being attached to the cylinders. In modern radial engines, the cylinders are arranged around a central crankshaft and remain stationary while the crankshaft revolves, as in motor-car practice. In this category are the Bristol "Taurus," the Wright "Whirlwind" and "Cyclone," etc. When greater power is required it is obtained by doubling the rows of cylinders, which are then placed one behind the other as in the Bristol "Hercules" or Pratt & Whitney "Twin Wasp."

In-line engines are similar to motor-car engines in that their cylinders are arranged in a line. The cylinder-blocks may be in one line, as in the D.H. "Gipsy"; or they may be of the Vee-type where two blocks of six cylinders are arranged at an angle one to the other, as in the Rolls-Royce "Merlin" ; or again there may be four in-line blocks each of six cylinders arranged in the form of the

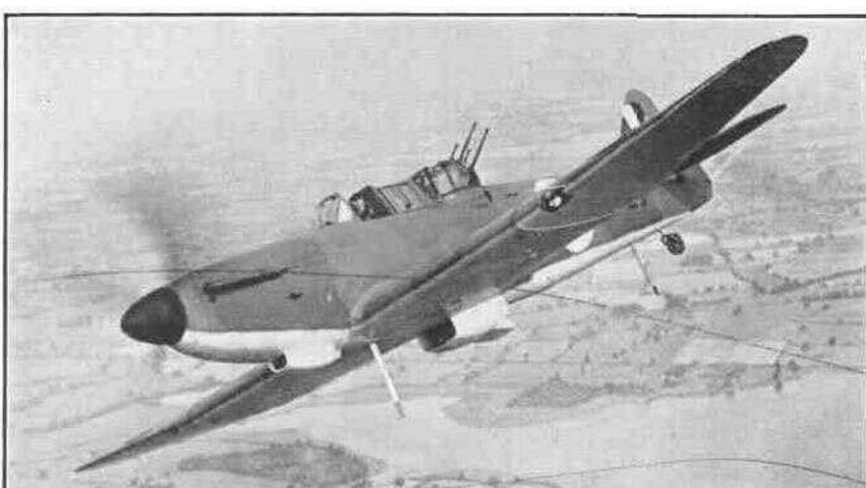


Photo. AI296. The gun-turret of the Boulton Paul "Defiant" is a special recognition point, for its glazed cop can be seen in either head-on or side view.

Photo. A1412. The North American "Harvard" has a 600 h.p. Pratt and Whitney "Wasp" radial air-cooled engine. The wings are tapered on leading-edge only.

letter H, as in the Napier "Rapier" and "Dagger."

An in-line engine gives a clear sharp outline to the nose of an aircraft, as with the Curtiss "Tomahawk" (Fig. 44), whilst a radial engine gives the nose a blunt appearance, as in the Curtiss "Mohawk" (Fig. 45). One or two exceptional aeroplanes, such as the Junkers Ju 88, have liquid-cooled in-line engines cowled in such a manner that

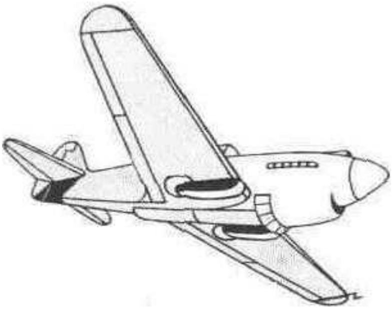


Fig. 44. Liquid-cooled in-line engine

outwardly they are indistinguishable from radial engines.

Aeroplanes with single or two engines constitute the larger group. Those with three engines are uncommon—the German Ju 52/3m is an example. Four-engined aeroplanes are generally Air-liners, Heavy Bombers, or large Flying-boats, such as the Blohm und Voss Ha.139 (Fig. 32).

When there are two or more engines they are usually enclosed in streamlined nacelles mounted on the wings. In some cases these may be mounted completely above the wing; in others they may be in the central position; or they may be beneath the wing when they are said to be "under-slung." The nacelles may be short as on the Bristol "Bombay" (Fig. 38), or may project behind the trailing edge of the wings as on the Douglas "Boston" (see top of page 13).

The airscrew may be in front, or (as a propeller) behind the engine according to whether the aeroplane is of a tractor or pusher. There are only a few pusher-type aeroplanes flying today, the best known being the Supermarine "Walrus," (Fig. 33). In some cases two engines may be mounted in tandem, one driving a tractor and the other driving a pusher. An example is the Dornier Do 18 Flying-boat.

In the early days of aviation the airscrew was termed the propeller, irrespective of its position. As this word denotes a pushing effect, as in a ship, it is obviously incorrect when used in reference to a tractor type, and so "airscrew" was substituted for "propeller" In America, however, the airscrew is still referred to as the propeller irrespective of whether the aeroplane is a tractor or a pusher. Further, the Air Ministry also refer to propeller as they feel that the term "airscrew" might be mistaken for "air-crew," so they use the word "propeller" universally. Despite this, we shall continue to describe the driving force of a tractor as being supplied by an airscrew and in a pusher by a propeller, as we feel these are the correct designations.

Cooling Systems

The early aeroplane engines were air-cooled but subsequently water-cooling was introduced. When radiators were first used,

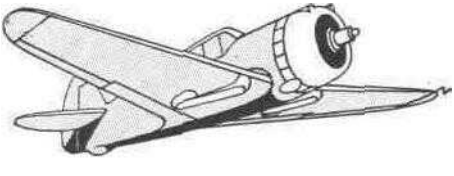


Fig. 45. Air-cooled radial engine

Photo. A1691. Hawker "Hurricane" showing radiator centrally placed beneath fuselage. "Aeroplane" Photograph

the cooling-system was based on motor car practice, with a centrifugal pump delivering water to the cylinder-jackets and cylinder-heads. Generally, the radiators were of the honeycomb type and were mounted below the fuselage or on the nacelles that carried the engine. In a few cases, skin-radiators were fitted on the leading edges of the wings, but as a considerable area was necessary and as the weight was greater in comparison with the honeycomb-type of radiator, this type never became popular.

In modern practice the drag imposed by the earlier honeycomb radiators is reduced by the use of high-temperature coolants. The area of the radiator surface necessary to provide efficient cooling for any given engine depends very largely on the difference in temperature between the liquid to be cooled and that of the air used for cooling. When the former is at a higher temperature the cooling effect *is* improved, so that in effect a radiator of less area can be used. To attain this end certain special liquids have been introduced. One of these—ethylene-glycol—has a boiling point of about 187°C., thus giving a considerable margin for the use of higher temperatures as compared with water, and allowing a radiator of perhaps only half the area—or even less—to be used.

Radiators vary in design and position according to the duty of the aircraft and the type of engine to which they are fitted. The main radiator of the "Spitfire V," for instance, is underneath the starboard wing and although the Fairey "Fulmar" has the same type of engine—a Rolls-Royce "Merlin"—the radiator of the latter is situated under the nose of the aircraft. There are no radiators on radial engines, of course, for they are air-cooled, the air being drawn in through the open frontage of the cowling. For recognition purposes this fact enables some distinction to be made as between the two types of engines. But although visible in silhouette, radiators on the whole are not to be relied on for positive identification.

Mark Numbers

The variation of types of British aeroplanes is denoted by Mark numbers. Although at first these may seem confusing, after a time the different Marks come naturally to mind. Mark I implies that the aeroplane is the first type of that particular aircraft to be produced; Mark II, the second type, and so on. Mark numbers may reach IV or V, or even higher. Small differences in design, or the addition of alternative armament, may result in the addition of a letter after the number, as for example "Hurricane IIC" or Messerschmitt Me 109F. The differences in the mark numbers of the principal aircraft are fully explained in our booklets "AIRCRAFT COMPARISONS," further details of which are given on page 19.

The variation in American types is denoted by certain designation numbers, and in U.S. Naval aircraft the purpose of the aeroplane is denoted by certain code letters embodied in the designation. To the uninitiated these seem somewhat difficult to understand, but the system is easy to follow once it is understood "how it works." It is fully explained, with relevant Tables, in our special publication "AMERICAN TYPE DESIGNATIONS," (see page 19).