航空专业英语

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INSTRUCTION

本书是根据全国高校航空电子设备维修专业需求，结合学校向民用航空发展的实际，按照学校培养目标、教学计划，参考中国民用航空总局颁发的CCAR-147部民用航空维修基础培训大纲、CCAR-66部维修人员培训大纲、航空公司实际工作需求、国内外民用航空飞机资料，以及飞机维修所需的工具、材料、工艺等相关知识编写的。

本书编写的指导思想是一切从实际出发，突出实用特色，重点围绕民航飞机、发动机、航空电子维修以及飞机修理技术人员工作所需要的基本知识和技能。为此，本书以现在主流的民用飞机——波音飞机——为载体，以波音747为例进行内容组建，包括航空电源、飞行控制、通信导航、发动机、飞机结构、EICAS及常用工具等现代民用航空领域专业的有关词汇及相关的内容。

本书由刘志武、杨琼、林坤、唐宝昌编写。具体分工如下：唐宝昌老师编写第4，5，8，9和第10章；刘志武老师编写第1，7，16，17，18和第19章；杨琼老师编写第2，3，6，11和第15章，林坤老师编写了第12，13和第14章；王文静、薛艳妮负责插图。全书由尚三绪、白冰如编审。

编写一本适合民航飞机、航空电子、航空机电维修和飞机制造专业使用的航空专业英语教材及其辅导材料是我们多年来的心愿。由于编者水平有限，时间仓促，一定还存在许多不足和错误，恳请同行和广大读者给予批评指正，以便今后修订。

编写组

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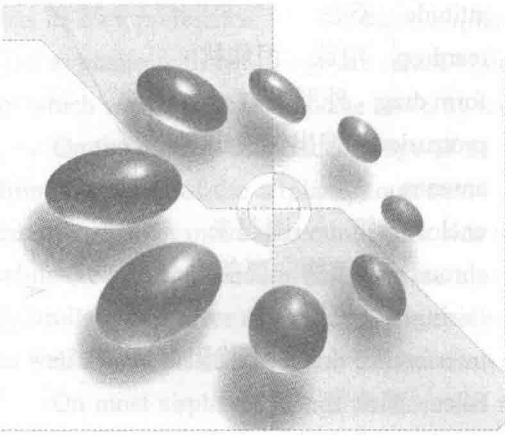

Unit 1 Aircraft Nomenclature

New Words

nomenclature　术语
axis（复数为 axes）　轴
horizontal　水平的，与地平线平行的，横的
longitudinal　经度的，纵向的，纵的
vertical　垂直的，竖的
perpendicular　垂直的，成直角的
center of gravity　重心
airframe　飞机机体
fuselage　飞机机身
tail assembly　尾翼组件
empennage　尾部，尾翼
cabin　驾驶舱，客舱，船舱
monoplane　单翼机
biplane　双翼机
triplane　三翼机
trailing edge　尾缘，后缘
aileron　副翼
flap　襟翼
lever　开关，杠杆
foolproof　不会出错的
lift　升力
weight　重力
thrust　推力
drag　阻力
wing's span　翼展
static flight　稳态飞行
airfoil　机翼
chord　弦线
relative wind　相对气流
angle of attack　迎角，攻角
magnitude　量，数值
conservation of energy　能量守恒
significant　显著的，重要的
partial vacuum　部分真空
downwash　下洗流
induced drag　诱导阻力
parasite drag　废阻力
molecule　分子

downward 向下地
simultaneously 同时地
dihedral 机翼反角
vertical stabilizer 垂直安定面
rudder 方向舵
pedal 踏板
elevator 升降舵，升降机
stabilator 全动式水平尾翼
skin 飞机蒙皮
cowl 发动机外罩
undercarriage 起落架
conventional landing gear 传统式起落架，后三点式起落架
tricycle configuration 前三点式起落架
retractable 可收放的
manifest 表示，显露
frontal area 迎面面积，迎风面积
attitude 姿态
teardrop 泪珠，泪珠状
form drag 外形阻力
protrusion 伸出，突出
antenna 天线
enclose 把……围起来
shroud 遮盖物，覆盖物
fairing 整流罩
interference drag 干扰阻力
fillet 整流带，整流片
density 密度
stall 失速
critical angle of attack 临界迎角，临界攻角

1 Axes of an Airplane

An airplane in flight is free to rotate about three axes: horizontal, longitudinal and vertical. Each axis is perpendicular to the others and each passes through the center of gravity. (Fig.1.1)

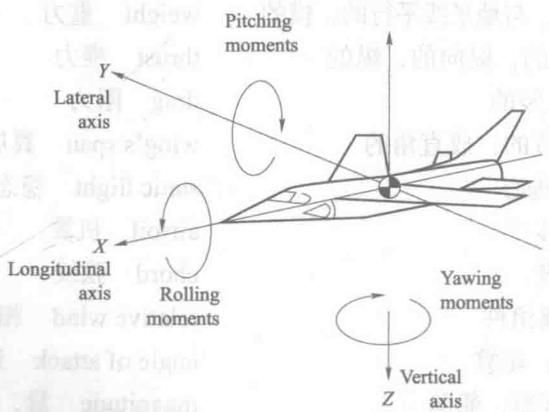

Fig.1.1 The three axes of an aircraft are mutually perpendicular, and all pass through the center of gravity of the aircraft.

2 The Parts of an Airplane

Although each manufacturer and each model have their own design features, these general components are found on every airplane and are called by the same names. The entire structure of an airplane is called the airframe. The components of the airframe are: the wing, the fuselage, and the tail assembly, or empennage.

Wings are the major characteristic of an airplane. Wings can be mounted above the cabin(high wing) , below the cabin (low wing) , or anywhere between (mid wing) . Each manufacturer has its own preference. Most modern airplanes are monoplanes; that is, they have one wing each. The airplanes with two wings are called biplanes. There have even been triplanes, the most famous of which was the Fokker triplane flown by the Red Baron in World War Ⅰ.

On the trailing (rearmost) edge of the wing are two sets of movable surfaces. Those farthest from the center of the airplane (outboard) are called ailerons. Ailerons move when you turn the control wheel or move the control stick side to side. They move in opposite directions, one going up while the other goes down. Flaps are the movable surfaces close to the center (inboard) . They are controlled by a lever or switch in the cockpit. Flaps only move downward (sometimes backward as well as downward) , and both flaps always move simultaneously.

On most airplanes, wings contain fuel tanks. This is both structurally efficient and practical. The weight of the fuel is distributed along the structure that is doing the lifting, and it leaves the rest of the airframe available for other things, like people and cargo.

When you observe an airplane from the front or rear, you will notice that the wings are not parallel to the ground but form a slight V. This angle is called the dihedral. The purpose of the dihedral will not be discussed in this book.

The fuselage is the body of the airplane. It holds the pilot, passengers, and cargo. The fuselage is designed to be as small as possible for performance reasons yet spacious enough for comfort.

The tail assembly or empennage consists of two sets of surfaces, usually one horizontal and one vertical. (There are some airplanes that use a V configuration, but these are not discussed here to reduce confusion.) The vertical element has a fixed part called the vertical stabilizer and a movable part called the rudder. The rudder is controlled by the pedals on the cockpit floor. The horizontal surface usually has a fixed horizontal stabilizer and a movable elevator. On some airplanes the entire horizontal surface moves, in which case it is called a stabilator. The elevator or stabilator is controlled by the fore and aft movement of the control wheel or stick.

The engine and propeller on most single-engine airplanes are mounted on the front of the fuselage. This is called the tractor (pulling) configuration. The protective skin around the engine is called the cowl. It provides a smooth exterior surface and channels cooling air around the engine.

The undercarriage of an airplane is its landing gear. Early airplanes had two main wheels under the fuselage or wings and a smaller wheel under the tail. Since this was the original method of designing landing gear, it is called conventional landing gear. Today most airplanes are designed with the main wheels farther aft on the fuselage or wing and with a nose wheel rather than a tail wheel. This is the tricycle configuration. Tricycle gear airplanes are easier to control on the ground, especially during landing.

The landing gear on an airplane is either fixed or retractable. The fixed gear is cheaper, easier to maintain, and foolproof (You don't have to remember to put it down before landing) . Aerodynamically, a retractable gear is preferable because with the wheels and struts placed inside the wing or fuselage, there is less interference with the flow of air.

3 Flight Theory

3.1 The Forces of Flight

An airplane in flight is at the center of a continuous tug-of-war between two pairs of opposing forces. Lift opposes weight, and thrust opposes drag.

In straight-and-level, unaccelerated flight the forces about the aircraft center of gravity are balanced. Lift acts upward and is opposed by weight and the aerodynamic tail load which acts downward. The thrust acting forward is opposed by the drag which acts rearward. Gravity constantly pulls the airplane toward the earth. We measure the effects of gravity by the weight of the aircraft and its cargo.

Thrust is any force acting in the same direction as the airplane flight path (the motion of the airplane through the air). Typically the power plant system (the engine and propeller) provides this force.

Lift and drag are the forces produced by the motion of the airplane through the air. Lift acts perpendicular (at a 90-degree angle) to both the flight path and the wing's span (the wing-tip to wing-tip direction). Drag is any force acting parallel to the flight path but in the opposite direction. Whenever the airplane is flying at a constant airspeed along a steady flight path (a steady climb, a steady descent, or straight and level), it is in static flight conditions. In static flight the opposing forces on the airplane are balanced: that is, lift equals weight and thrust equals drag. Whenever an airplane is turning, changing the speed, or changing the rate of climb, or descent, the opposing forces are not balanced. However, under any changing condition the airplane is always attempting to equalize the opposing forces and return to static flight.

3.2 The Creation of Lift

The actions of the physical forces that support an aircraft in flight are not visible. Two basic laws of physics, Newton's Third Law of Motion and Bernoulli's Principle, help explain the phenomenon of flight.

Newton's Third Law of Motion states that for every action there is an equal and opposite reaction. If you could observe the airflow in front of and behind an airplane in flight, you would see that the air behind the airplane is redirectedly downward. The downward force caused by the wing is called downwash. The action of redirecting the air down causes the reaction of lifting the airplane. Only when the mass of air directed down by the wings equals the mass of the airplane does the airplane fly. Air rushing around and down behind the wings makes an airplane fly.

3.2.1 Airfoils

Any structure that moves through the air for the purpose of obtaining a useful reaction is called an airfoil. Although airfoils are found in a number of places on an airplane, such as the wings, tail surfaces, and propellers, the wing is the most important. The special shape of the wing is the secret to its success. The airfoil has a rounded leading edge and a sharp trailing edge. The curved shape of the upper and lower surfaces is called camber. The chord (or chord line) is a hypothetical straight line that passes through the leading and trailing edges of the airfoil.

3.2.2 Relative Wind and Angle of Attack

The stream of air approaching the airfoil is called relative wind since it is a moving mass of air and has a direction relative to the airfoil. The direction of the relative wind is exactly opposite that of the flight path of the airfoil. In fact, relative wind is the result of the flight path. The angle that the relative wind makes with the chord line is called the angle of attack. When describing the magnitude of this angle, the term low angle of attack means a small angle between the relative wind and the chord line. As the angle between the relative wind and the chord line increases, the angle of attack gets higher. The wing's relative wind is a result of the flight path of the entire airplane.

Newton's Law describes the effect the wing has on the air it passes through: the wing redirects air downward. It does not, however, explain how the wing makes this happen. Bernoulli's Principle explains what the wing does to the air to cause it to be redirected downward.

3.2.3 Bernoulli's Principle

The eighteenth-century Swiss physicist Daniel Bernoulli discovered that if air was forced through a tube with a constriction in it (a venturi tube) , the pressure of the air was the same at both ends but less at the constriction. The reason for this, he theorized, was that the mass of air had to speed up in order to pass the constriction. The total energy of the air at any point in the tube must be constant because of the conservation of energy (a law of physics that holds at all times) . Bernoulli then deduced that at the constriction, more energy was used to accelerate the air molecules, leaving less energy to exert pressure on the walls of the tube. He determined that any time the velocity of air is increased, its pressure is decreased. He observed that the reverse is also true: when the velocity of air is reduced, its pressure increases.

How does this principle apply to airfoils? The special shape of an airfoil causes the air passing over it to speed up while the air below the airfoil is slowed. The change that occurs along the upper surface is the most significant of the two. The higher-velocity air over the top of the airfoil results in a large low-pressure area above the wing. The decreased air velocity below the airfoil creates a smaller high-pressure area below the wing.

The large low-pressure area (which could also be called a partial vacuum) pulls the wing up into it. The action of pulling up on the wing causes a reaction of pulling down on the passing airflow. A similar activity is taking place below the wing, but on a much smaller scale. High pressure below the wing acts by pushing it up, causing the reaction of pushing the air down.

The net result is an upward force on the wing called the resultant force. The portion of this resultant force that acts perpendicular to the flight path (or relative wind) is called lift. The downward force transmitted to the passing airflow is downwash. The most important point to remember is that the upper surface of the wing produces most of the force we call lift.

3.3 The Creation of Drag

Induced Drag. Drag is any force acting parallel to the flight path but in the opposite direction.

The resultant force created by an airfoil is basically in the correct direction for lift, but not exactly. Note that the resultant force is not perpendicular to the relative wind; it slants slightly toward the direction of the relative wind. Break this force down into two components and show that while lift is created (perpendicular to the relative wind); some drag is also induced by the creation of lift. This component of the wing's resultant force is called induced drag.

(1) **Parasite drag.** Any solid object (an airplane, for instance) that moves through the air must disturb and displace the air molecules along its path. The air molecules resist this disturbance, and the resistance is manifested as a drag force called parasite drag. The amount of parasite drag depends on a number of interacting factors, such as the size of the object, its shape, and the roughness of its surface.

The effective size of an object as it moves through the air is called its frontal area. You can visualize frontal area as the shadow an object would cast if a light source came from the same direction as the relative wind. A given object's frontal area can vary depending on its attitude with respect to the relative wind, just as the shape of its shadow depends on how it is presented to the light. In general, the larger the frontal area, the higher the drag force. However, the shape of the object also has a powerful effect on drag. A flat plate facing the wind broadside creates a very large drag force, but if the same frontal area is enclosed in a teardrop shape, the drag is reduced enormously. This aspect of parasite drag, which depends on both the frontal area and the shape of the object, is called form drag.

Most aircraft have protrusions that add unwanted but necessary frontal area, such as radio antennas, wing struts, or fixed landing gear. Aircraft designers often enclose these items in a metal or plastic shroud called a fairing, which is shaped and oriented to reduce drag as much as possible. The slowing of air molecules due to skin friction drag is another component of parasite drag. Smooth surfaces are obviously better than rough ones. The amount of skin friction drag is proportional to the total amount of surface area of the object.

When two different shapes are joined together, such as a wing and a fuselage, air may not flow smoothly near the intersection, creating interference drag. Designers often add a specially shaped piece of metal or plastic, called a fillet, to blend the surfaces and reduce the interference drag.

(2) **Total drag.** The total drag on an airplane in flight is the combination of its induced drag and parasite drag.

3.4 Factors that Influence Lift and Drag

The aerodynamic forces on an airplane are influenced by four variables:

① Its size and shape.

② The density of the air through which it is flying.

③ The angle of attack of its wing.

④ The speed at which it is moving through the air.

(1) **Size and shape.** Although the manufacturer determines the basic size and shape of an airplane, the pilot does have some ability to modify shape by using the control surfaces. A

discussion of these controls in detail will take up greater space, so for now we will assume that size and shape remain constant.

(2) **Air density.** An airplane creates forces by moving air molecules around, so naturally those forces are influenced by the density of the air. Density is the number of molecules in a given volume of air. Lift and drag increase with air density because more molecules are being affected (all other factors being constant). The relationship between air density and the way an airplane performs is the subject of performance, which is not discussed here. We likewise assume that air density is not changing.

(3) **Lift and drag versus angle of attack:** stalls. The most direct way a pilot can control lift is through the angle of attack of the wing. Increasing the angle of attack increases lift and induced drag (all other things being equal).

There is, however, an upper limit to what the wing can do. At low angles of attack, the airflow follows the airfoil surface closely and is efficiently redirected downward. As the angle of attack increases, the airflow begins to separate from the upper surface of the airfoil at its trailing edge, and this separation produces an area of disturbed air. The separated airflow hinders the creation of downwash and increases drag significantly. This separation continues to increase as the angle of attack increases. When enough lift-producing downwash is replaced by swirling eddies of disturbed air, lift begins to decrease. At this point the airfoil is stalled.

By definition, a stall occurs when lift decreases as a result of an increase in the angle of attack. The angle of attack at which the stall begins is called the critical angle of attack.

It must be emphasized that only the angle of attack is responsible for the stall process; neither the speed nor the attitude of the aircraft controls it. An airfoil stalls any time the critical angle of attack is exceeded. A stall can occur at any airspeed and in any aircraft attitude. The only way to recover from a stall is to reduce the angle of attack.

Aircraft structure (See Fig.1.2 and Fig.1.3)

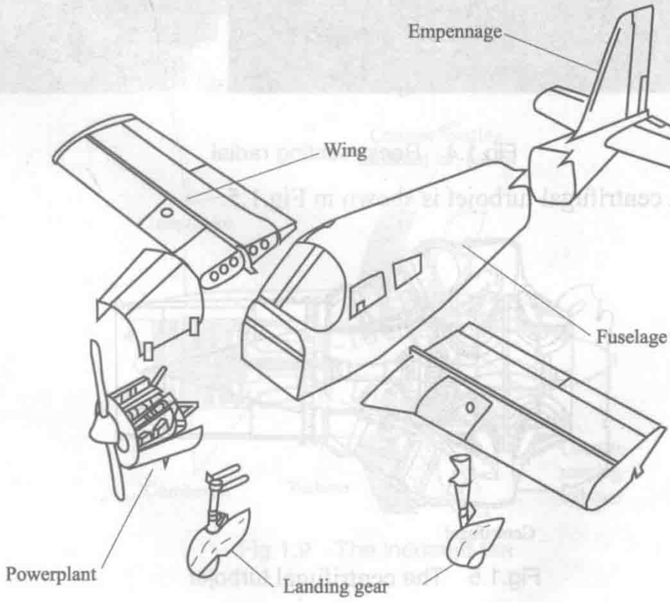

Fig.1.2 Aircraft structure (Ⅰ)

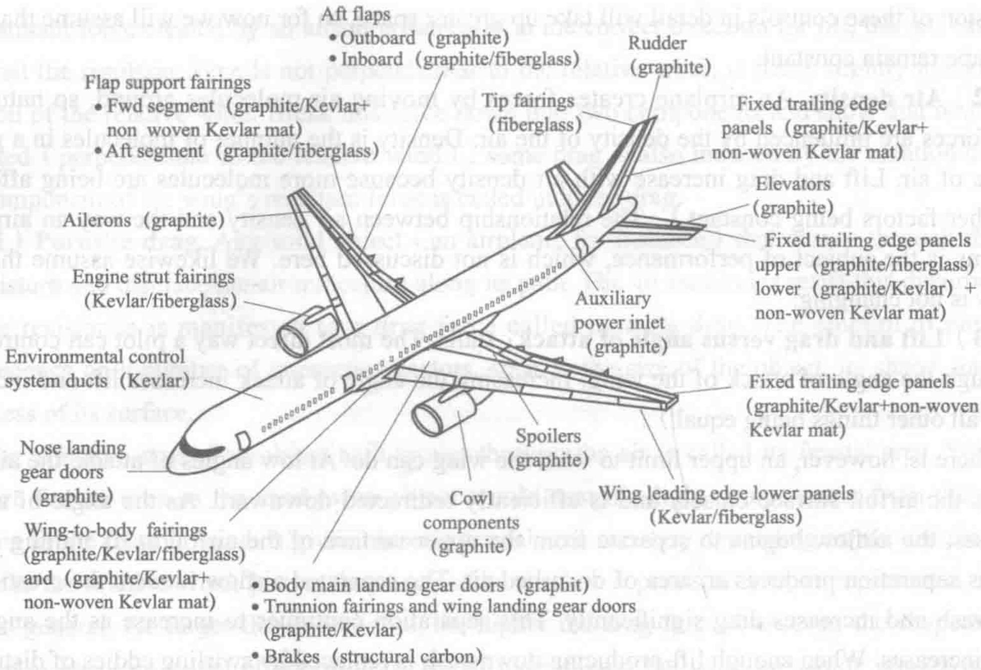

Fig.1.3 Aircraft structure (Ⅱ)

Engine type (See Fig.1.4)

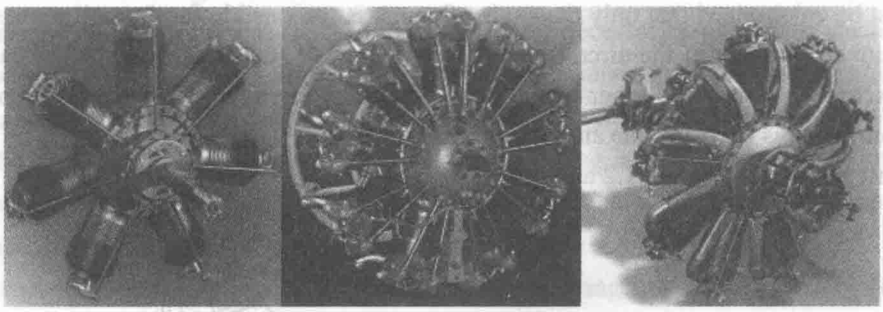

Fig.1.4 Reciprocating radial

The structure of a centrifugal turbojet is shown in Fig.1.5.

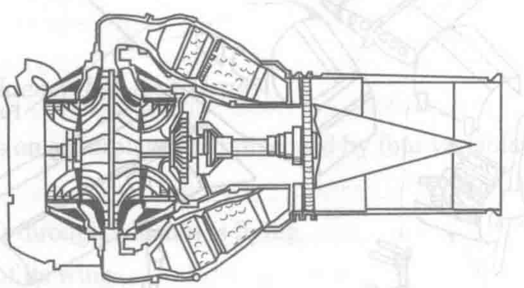

Fig.1.5 The centrifugal turbojet