CHAPTER 1

INSTRUCTORS GUIDE

AIRFRAME DESIGN FEATURES

Page 33.4.1-1 Para 1

1. The change in aircraft design from biplanes to monolane has been brought about by the ever-increasing need to fly at higher speeds. During the biplane age, only low powered aero-engines were built, and as the biplane could not fly much beyond w50 mph, a light-weight structure, braced externally with struts and wires, was suitable. As the action of the airflow (air loads) on the aircraft was low, doped fabric was satisfactory for covering the wings, fuselage, etc. The internal strength members (spars) of the biplane wing are maintained parallel to one another and are of constant thickness throughout their length. Owing to the external bracing, which takes most of the lift forces, the spars are subject to reduced bending loads and great depth in this is not necessary.

2. The braced monoplane design is used mainly for small high wing aircraft. The bracing struts relieve the spars of much of the life forces and a form of wing construction similar to the biplane is used. To resist the greater bending loads, the spars are deeper than those of the biplane. In this type of design, frontal area and relative drag are much less than the biplane of corresponding span.

3. Most modern aircraft are cantilever monoplanes ie the wings are supported at one end only and decrease in thickness both in plan and elevation towards the wing tip. Air loads increase with the square of the airspeed and at 615 mph are six times as great as at the 250 mph achieved by the fastest biplane. A fabric wing covering is therefore no longer suitable and a heavier and more rigid material, such as plywood or thin metal must be used ie high speed cantilever monoplanes are of stressed skin construction. With the elimination of all external bracing, the use of stressed skin construction, retractable alighting gear and powerful aero-engines, aircraft speeds of over 15000 mph have been achieved which is a great improvement on fabric covered aircraft with a maximum speed of about 250 mph.

Page 33.4.1-3 Para 3

4. The fuselage is the body of the aircraft to which the other components such as mainplanes, tail unit and undercarriage are attached. The fuselage contains the pilotís cockpit and may also be fitted with fuel tanks, guns and sometimes the engine, it accommodates the aircraft and may be provided with a bomb bay or space for freight. An external fuel tank, termed the ventral fuel tank, may also be fitted.

Page 33.4.1-3 Para 4

5. The tailplane reduces pitching movement in flight. It is attached to the rear end of the fuselage and may consist of a single place or separate port and starboard planes. The tailplane may be fixed or suitable mechanism may be incorporated to that its angle to the airflow can be adjusted in flight.

6. The fin, which is the vertical part of the tail, may be built as one with the fuselage or may be a separate component bolted to the fuselage. Some aircraft are fitted with an upper and lower fin. The fin provides directional stability.

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7. The undercarriage gear may be fixed or retractable. A retractable undercarriage is divided into two identical units, ie port undercarriage unit and starboard undercarriage unit. Each unit includes a strut-braced oleo leg which, together with the tyre, absorbs the chock of landing. The alighting gear also supports the weight of the aircraft when it is on the ground. Most retraceable undercarriage units are hydraulically operated.

CHAPTER 2

AIRFRAME DESIGN FEATURES ñ STRUCTURES

Materials

Page 33.4.2-1 Para 1

1. Wood. Wooden structures have a high strength/weight ratio, are cheap to produce, very easy to make and readily absorbed vibration. But wood does not have uniform qualities, is difficult to obtain in long lengths free from disease and defects, and is difficult to join without reducing its strength. It is also affected by climatic conditions and is inflammable.

2. Metal. Metal structures are designed to have a high strength/weight ratio, but because they require special tools and highly skilled labour are more expensive to produce than wooden structures. Metal has uniform qualities and strength and absorbs vibration, though it may fail without warning due to fatigue. Although metal will not readily burn, it is subject to corrosion.

3. Composite. In a composite structure, metal is used for the main structural members for which suitable wood is difficult to obtain, and wood is used for the less important parts. Thus the good qualities of each material are used to the best advantage.

CHAPTER 5

WINGS

Page 33.4.5-1 Para 1

1. Wings - Fabric Covered. The shape of a wing is governed by the root end, wing tip, and leading and trailing edge. The space provided for the aileron is termed the aileron gap. The main strength members of the wing are the spars, which extend from the root end to the wing tip and consist of upper and lower booms riveted to a spar web. Attached to the spars and the leading and trailing edges are the ribs, which maintain the correct aerofoil shape, and to which the fabric covering is secured.

2. As the wing is a cantilever structure ie supported at one end only, it has great depth at the root end (where the stresses are greater) and decreases in thickness, both in plan and elevation towards the wing tip. The wing is attached to the fuselage or centre section by engaging the root end fittings of the spars with the attachment points on the fuselage or centre section, and securing the root end bolts.

Page 33.4.5-2 Para 3

3. Wings - Stressed Skin. The normal type of stressed skin wing consists of a front spar and a rear spar, together with main ribs, nose ribs, stringers, leading and trailing edges, wing tip and an alclad covering. Internal bracing is not used as the alclad covering gives enough rigidity to the wing.

CHAPTER 6

FUSELAGE AND TAIL UNITS

Page 33.4.6-2 Para 5

1. Fuselage - Stressed Skin. The normal type of stressed skin fuselage consists of transverse frames or formers, positioned with lengthways members such as longerons or stringers, and the whole covered with a light alloy covering (alclad). The framework of a stressed skin structure is of relatively light weight as the alclad covering provides rigidity and takes the stresses induced by flight. The stressed skin structure also provides a good streamlined shape and fairing is not usually necessary.

Page 33.4.6-4 Para 8

2. Tailplane - Stressed Skin. The stressed skin tailplane is of similar construction to the stressed skin wing. To enable the pilot to trim the aircraft in flight, some tailplanes have a tail-adjusting gear. When this device, which can be electrically or mechanically operated, is fitted, one of the tailplane spars is hinged to the fuselage and the other spar is connected to the tail-adjusting gear, operation of the device changes the angle of attack of the tailplane.

CHAPTER 7

ENGINE INSTALLATION

Comparison of Piston and Gas turbine Engines

Page 33.4.7-1 Para 1

1. When comparing gas turbine (turbo-jet) engines and piston engines for aircraft use, you should consider three factors. The mechanical features, the effect of altitude on each type of engine and the propulsive efficiency. For where the turbo-jet engine produces a thrust (a straight force in pound), the piston engine produces power (foot pounds per minute). To obtain a comparison of engine performance, the method of propulsion (propulsive jet and propeller respectively) should be included in the appraisal.

MECHANICAL FEATURES

2. In considering the relative advantages of each power unit it may be said that the piston engine:

a. Runs efficiently over the full range of engine rpm and can therefore cruise economically at low power and also develop full power irrespective of forward speed.

b. Has the lower specific fuel consumption.

c. Has quicker acceleration.

d. Is cheaper to make. Butó

e. Has the lower power/weight ratio.

3. Conversely, it can be said of the turbo-jet that:

a. There are no intermittent loads on the bearings and it consequently runs smoothly and without vibration.

b. It has the higher thrust/weight ratio.

c. It is mechanically simpler and has fewer moving parts.

d. Less maintenance is needed.

e. High-octane fuel is not necessary.

f. No ignition system is required during engine running. But ñ

g. It is efficient at high engine rpm only.

h. It has relatively slow acceleration.

j. It is of high initial cost.

k. Thrust initially falls with an increase in forward speed although this loss is gradually regained above 350 mph.

CHAPTER 9

CONTROLS

Elevators

Page 33.4.9-1 Para 1

1. The elevators are hinged surfaces by means of which the aircraft climbs or dives. They are hinged to the tailplane and moved by operating the control column forwards and backwards; forward movement of the control column lowers the elevators; backward movement raises them.

Rudder

2. The rudder is a hinged surface used in turning the aircraft to port or starboard. The rudder is hinged to the fin and rear end of the fuselage and moved by operating the rudder bar or pedals in the cockpit. Left foot forward, the rudder moves to port; right foot forward the rudder moves to starboard. The tailplane, fin, elevators and rudder are called the ìtail unitî.

Flaps

3. The flaps are hinged surfaces at the rear of the wings, inboard of the ailerons that, when lowered, make the aircraft approach more slowly and steeply. The flaps move by operating a lever or hand-wheel in the cockpit and may be hydraulically, electrically or manually controlled.

Self Assessment Questions - Answer Sheet

Chapter 1 Page 33.4.1-7

1. c
2. c
3. Support the aircraft on the ground and to absorb landing shocks, allowing the aircraft to land smoothly without bouncing.
4. Using different materials.

Chapter 2 Page 33.4.2-8

1. d
2. Cantilever structure.
3. Stringers and stiffeners to prevent the skin of the aircraft buckling.

Chapter 3 Page 33.4.3-7

1. Wing Loading
2. Using smaller wings
3. Aspect Ratio $= \frac{Span^2}{Area}$

Chapter 4 Page 33.4.4-8

1. Alloys, steels, titanium and plastics
2. By the use of a fatigue meter and comparing with the manufacturerís tests.

Chapter 5 Page 33.4.5-7

1. The internal structure, such as spars and ribs, and the skin, which can be metal, fabric or composites.
2. They can be machined from a single piece of alloy, called a Billet.

Self Assessment Questions - Answer Sheet cont...

Chapter 6 Page 33.4.6-6

1. The nose section
   The centre section
   The aft or rear section

Chapter 8 Page 33.4.8-7

1. A type of shock absorber on the undercarriage
2. A sequencer valve
3. Drum and disc brakes

Chapter 9 Page 33.4.9-9

1. Elevators controls pitch
   Rudder control yaw
   Ailerons control roll

2. Manual, power assisted and power operated control systems

Chapter 10 Page 33.4.10-6

1. Instrument Landing System

Chapter 11 Page 33.4.11-13

1. Oil
2. High-pressure air
3. By the use of a humidistat
4. By the use of a constant-speed drive
5. 115 volt, 400 Hz, 3-phase and 28 volt, DC

Self Assessment Questions - Answer Sheet cont...

Chapter 12 Page 33.4.12-9

1. An attitude indicator indicates to a pilot the position of the horizon relative to the aircraft, also known as the artificial horizon.
2. An altimeter is used in an aircraft to indicate the height above the reference height.
3. A vertical speed indicator is used in an aircraft to show aircraft climbing or descending, and how quickly.