CHAPTER 3

AIRFRAME CONSTRUCTION

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Introduction

1. Aircraft are always designed and built to carry out specified tasks. The final overall shape of the aircraft will often be governed by its task requirement. The words "high speed" cause thoughts of a slim, well streamlined shape while the words "transport" cause thoughts of a bulky shape and many engines. Whatever the task required the main component parts of all fixed wing aircraft bear the same names although the final shapes will vary to suit the task.

2. An airframe must be designed to be as light and strong as is possible with the available materials; this is known as a high strength/weight ratio. If this were ignored much of the engine power would be absorbed in getting the aircraft airborne leaving little power available to support fuel and other loads. Metal is the main material used to give strength, and ranges from stainless alloys to light alloys.

Fuselage

3. This component will have the greatest shape variation according to the task and may vary from high speed interceptor to long distance transport aircraft. The usual method of construction is known as stressed skin, that is to say the outer covering of skin of metal absorbs the stresses and strains set up in flight and on the ground. The portion of a fuselage shown in Fig. 1 is built up in a jig to position the frames and stringers, and the skin after being clamped into position, is riveted to the frames and stringers as required.

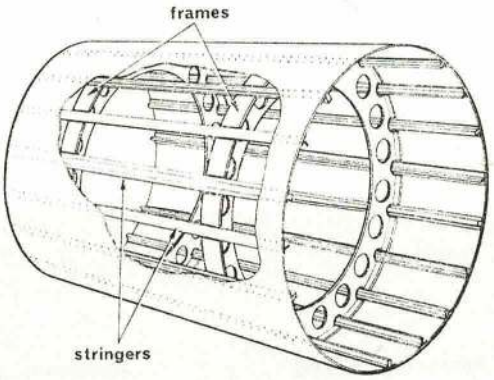


Fig. 1. Section of stressed skin fuselage.

4. The method of attaching the skin with round head rivets spoils the skin surface and increases drag. This has been overcome by using countersunk rivet heads and synthetic adhesives having a bonding strength equal to riveting. Specially strengthened frames are built into the fuselage to form attachment points for the main and tail planes.

Main Plane

5. The main planes are designed to produce lift which is transmitted to the fuselage. Stressed skin construction is used, the main planes being built up on two main spars which run the length of the wing. The root or fuselage ends of the spars are shaped to form attachment points for the wing to the fuselage. For ease of assembly, transport or repair, fitted bolts secure the root ends to the fuselage. The spars are made of box or girder construction and the ribs are attached to them in a fore and aft direction. These are usually made in three parts, nose, inter-spar and trailing edge. Stringers are fitted between the spars and run from root end to wing tip and are secured to the inter-spar ribs. When the skin is finally secured at all points the assembly becomes a rigid structure with no internal bracing.

6. As the main plane is supported at one end only it is known as a cantilever. The stresses at the root end being greater than at the tip the section is deeper or thicker and this depth of section decreases to the wing tip. Wing tips, being easily damaged, are often made detachable for ease

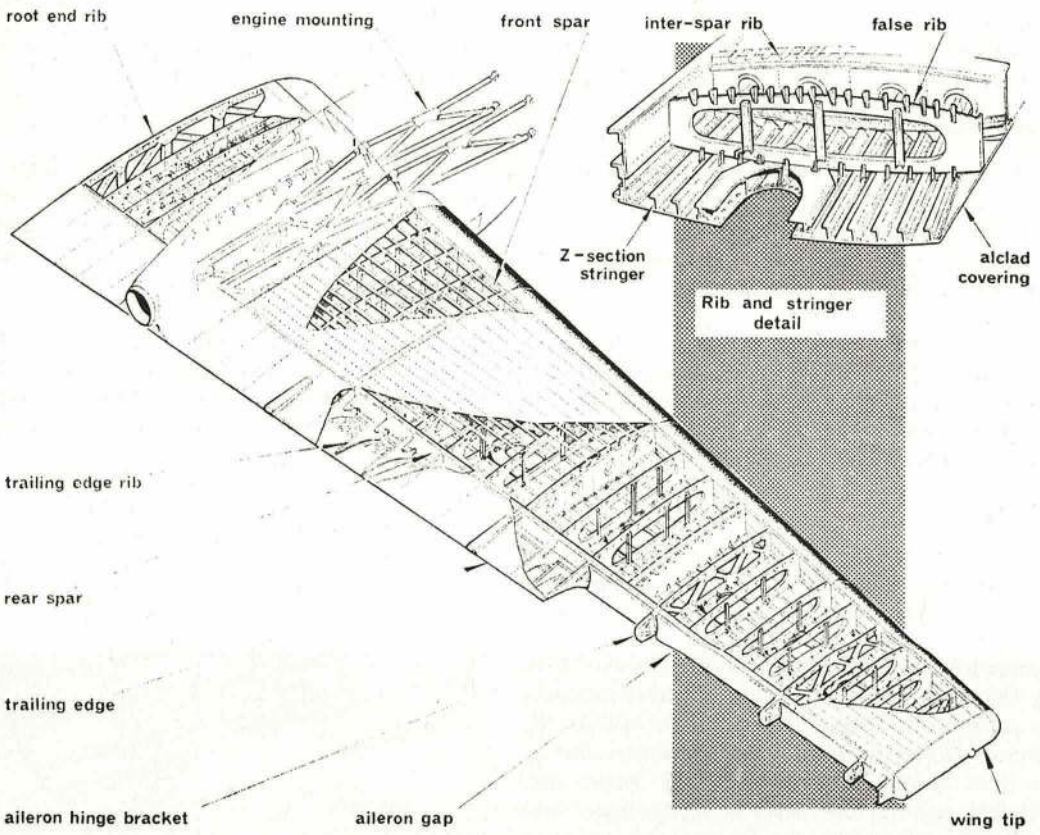
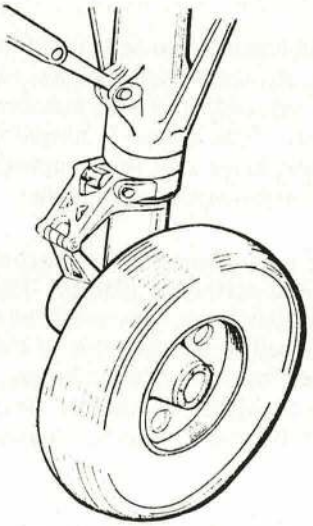
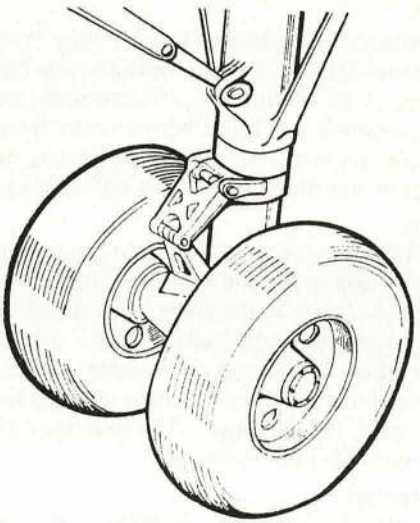


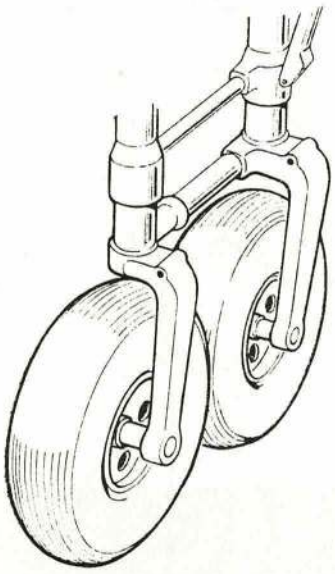
Fig. 2. Typical stressed skin main plane.



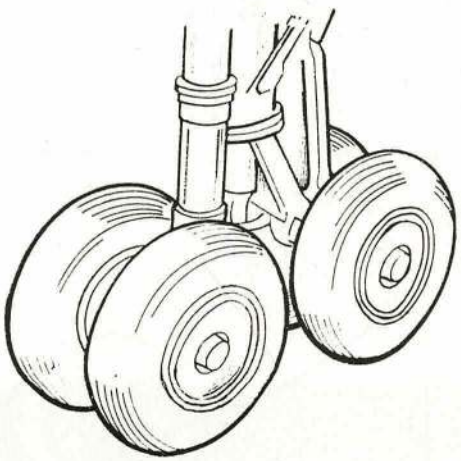
Single



Double



Tandem



Bogie

Fig. 3. Types of undercarriage unit.

of repair or renewal. The external finish of main planes is of particular importance. imperfections causing drag and loss of lift. Countersunk head rivets and screws are used to secure the skin to the ribs and spars.

Ailerons

7. Ailerons are required to be very rigid in construction and it is usual to construct the main spar and stressed skin so that the leading edge forms a D shape, the maximum thickness of the shape occurring at the main spar. The trailing edge forms the rear spar and skin attachment point. Ribs as required are fitted between the front and rear spars. The aileron is hinged to the rear spar of the main plane usually using one master or locating hinge and two supporting hinges. The supporting hinges are often self-aligning to allow for flexing of the main planes.

Tail Unit

8. The tail plane is constructed in a manner similar to the main planes. The attachment to the fuselage is either as one complete unit or separate port and starboard planes. The elevators have one spar only at the front, the trailing edge forming the rear spar; ribs are fitted as required between front spar and trailing edge. The elevators are hinged to the rear spar of the tail plane being located by datum or master hinges and supported by self-aligning hinges. The fin, constructed in the same manner as the main plane can be either detachable from, or built integral with, the fuselage. The rear spar of the fin carries the rudder which is hinged again by master and self-aligning hinges.

Undercarriage

9. An aircraft is usually supported on the ground by three units forming an undercarriage. that is, two main wheels or assemblies and a nose or tail wheel. As these units will cause high drag in flight they are usually made retractable.

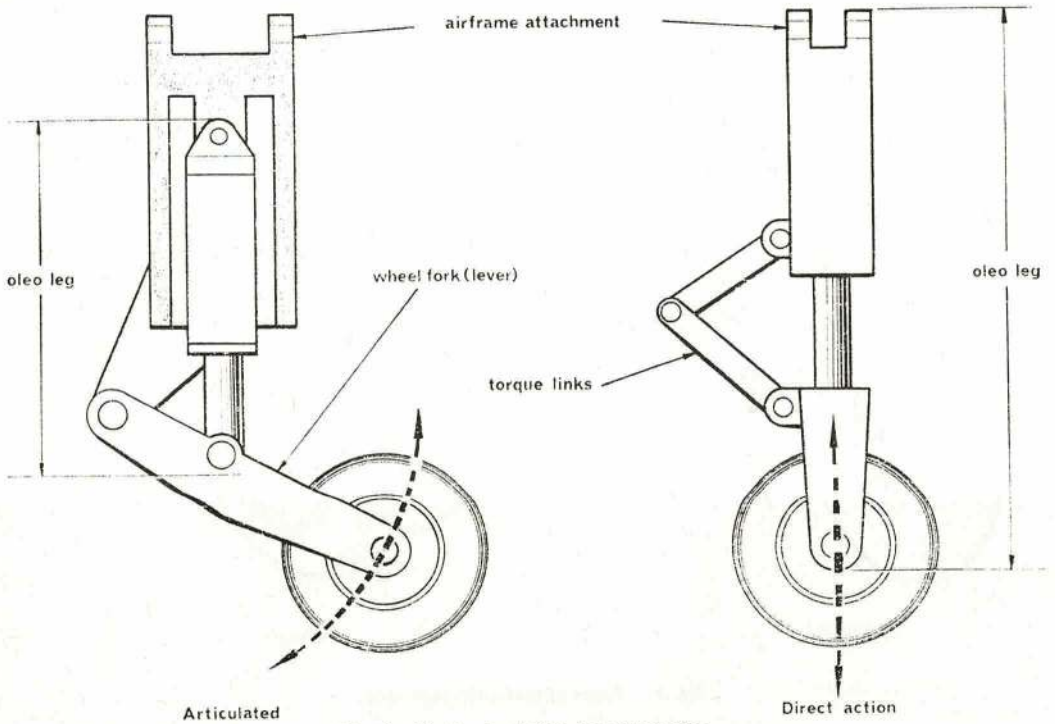


Fig. 4. Methods of oleo leg suspension.

10. The type of undercarriage unit used is governed by the wheel loading. This is defined as the static load on each wheel when the aircraft is fully loaded ready for take-off. As runways are built to withstand a certain unit loading the wheels will sink into the runway if this loading is exceeded. By using two or more wheels as in Fig. 3 the load is shared and spread over a larger area. Wheels and tyres can be smaller and this often simplifies stowage problems as less depth of wing root is required. Multi-wheel assemblies have the added advantage that the effect of one tyre burst on landing is greatly reduced.

11. Each of the wheel units is mounted on an oleo leg which embodies a shock absorber. This can be either air and oil termed oleo-pneumatic or oil only termed oil compression. The operation of the oleo leg may be either by direct action or by articulation (Fig. 4). The direct action leg must be built strong enough to absorb landing loads and side and drag loads on the piston and cylinder walls. The articulated leg has its side and drag loads absorbed by its supporting members. Finally the lever action of the articulated leg shortens the shock absorber stroke thereby allowing a shorter undercarriage.