CHAPTER 1: AIRFRAMES

The Longitudinal Axis.
The aircraft’s longitudinal axis is illustrated in Figure 1.14. Rotation about the longitudinal axis is termed roll. Roll is controlled by the ailerons.

The Lateral Axis.
The aircraft’s lateral axis is illustrated in Figure 1.14. Rotation about the lateral axis is termed pitch. Pitch is controlled by either the elevators, or by an all-moving tailplane or stabiliser.

The Normal Axis.
The aircraft’s normal axis is illustrated in Figure 1.14. Rotation about the normal axis is termed yaw. Yaw is controlled by the rudder.

THE FLYING CONTROLS.

Primary Flying Controls.
The primary flying controls control the aircraft in pitch, roll and yaw. The movement of the flying control surfaces in response to the movement of the cockpit controls in light aircraft is achieved mechanically. This means that the control surfaces are connected directly to the cockpit controls by a system of cables, rods, levers and chains.

Pitch Control.
Pitch control is obtained through the use of either elevators (see Figure 1.15), an all moving stabilator (see Figure 1.23) or canard control (see Figure 1.13). For the purpose of this chapter, we will assume that the aircraft has elevators fitted to the tail plane. The elevator is controlled by fore and aft movement of the control column or control wheel (see Figure 1.17). Rearward movement of the control column causes upward movement of the elevator which causes the aircraft to pitch nose upwards, and vice versa.

Roll Control.
Control in roll is achieved by ailerons (see Figure 1.16). Turning the control wheel or moving the control column to the right causes the right aileron to move up and the left aileron to move down, inducing roll to the right and vice versa.
In order to increase the effective radius at which the mass acts, the material of the rotor is distributed so that the greater part of its mass is near its rim.

**Gyroscopic Precession.**
Any spinning body, or gyroscope, will resist movement when a force is applied to it. If you were to hold the two ends of the axis of a wheel spinning towards you (when viewed from above), you would notice that if you attempted to tilt the axis, by lowering one end, the axis would not move very far in the direction you wished it to, but would instead move in the horizontal plane as if you had tried to push the end of the axis away from you (see Figure 15.3). This phenomenon is known as gyroscopic precession. The result of gyroscopic precession is that the line of action of any force applied to the spin axis moves through 90° in the direction of spin, before taking effect.

**Rate Gyroscopes.**
Rate gyroscopes are used to measure rate of angular displacement. In a rate gyroscope the gimbal in which the rotor is mounted is free to move in one plane only. This means that the rotor spin axis has only one degree of freedom. Turn Indicators are fitted with a rate gyroscope.
However, as we have learnt, thrust is generated by accelerating air rearwards. So, making the disk too solid will reduce the mass of air that can be drawn through the propeller and accelerated. To increase the number of blades efficiently, contra-rotating propellers could be used; that is, two propellers rotating in opposite directions on the same shaft. However, contra-rotating propellers are practicable only on very powerful propeller driven aircraft.

MOMENTS AND FORCES GENERATED BY A PROPELLER.

Because of its rotation, a propeller generates yawing, rolling and pitching moments. These are due to several different causes such as torque reaction, gyroscopic precession, spiral slipstream effect and asymmetric blade effect.

Torque Reaction.
If the propeller rotates clockwise, the equal and opposite reaction or torque will give the aircraft an anticlockwise rolling moment about the longitudinal axis. During take-off this will apply a greater download to the left main wheel, causing more rolling resistance on the left wheel making the aircraft want to yaw to the left. This is illustrated in Figure 9.11, where the left wheel is shown as having more pressure applied to it than the right wheel. In flight, torque reaction will also make the aircraft want to roll to the left with a clockwise rotating propeller. This effect is particularly noticeable when full power is applied to initiate a climb. Obviously, for a propeller rotating anti-clockwise, all the effects described in this section will be in the opposite direction.

Figure 9.11 Torque Effect.

Torque reaction will be greatest during high power, low Indicated Airspeed (IAS) flight conditions.
Each valve is only required to open and close once per working cycle.

The valves are kept concentric to the valve seats by valve guides. The valve seat is ground to form a gas tight seal with the face of the valve. The valves themselves, both inlet and exhaust, open and close the passages for the induction and scavenging of the gases.

The face of each valve is accurately machined to the same angle as the valve seat. The valve and the seat are then ‘lapped’ or ground together with an abrasive paste until a full contact is obtained.

The valve springs are manufactured from special spring steel, and they ensure that the valves remain closed except when they are being operated by the rocker assembly.

The springs are of the helical coil type, the usual practice being for two springs to be fitted to each valve, one inside the other.

This provides a safety factor, and also eliminates ‘valve bounce’, a condition created by the fact that each valve spring will have a resonant frequency (with the engine RPM) where it will be ineffective at closing the valve on its own.