LANDING GEAR DESIGN

OSHKOSH '77

FORUM

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Condensed By Lu Sunderland

Second in a series of Oshkosh '77 Technical Forums condensed by Lu Sunderland from tapes made by Dave Yeoman. Ladislao Pazmany has approved this summary of his forum and has generously provided drawings from his excellent design manuals. Paz will have a book out soon on landing gear design.

A HISTORICAL SURVEY of early aircraft designs reveals that some features commonly believed to be fairly recent developments actually were employed on the very first airplanes. Landing gear design is a prime example. For instance, the first oleo shock absorber was designed in England by Duncan in 1915. His basic design is still used today in hydraulic shock absorbers. Duncan, an engineer, worked on guns and experimented with ways to absorb recoil. He applied this knowledge to aircraft as well.

The first retractable gear was patented by Martin in 1911 on the K3 Scout which was a small squarish biplane. The gear half-retracted into the wing straight aft. Another type of retractable gear was used on the Dayton-Wright Gordon Bennett single place racer of 1920. The gear, which retracted into the fuselage, was similar to many used today. In 1922 another designer, Fred Verville, had a retractable gear on his racer which retracted, with a screw jack, between the wing and the fuselage. A major innovation was the location of a wheel on the nose and it was used on the June Bug in 1908.

There are three general types of landing gear; namely, tailwheel, tricycle and tandem gear. Let us first consider how the designer would go about designing a tailwheel type gear.

TAILWHEEL CONFIGURATION

To set up the geometry of the tailwheel type landing gear, first it is necessary to locate the most forward center of gravity on a side view drawing. Then calculate the angle of attack for maximum lift coefficient during landing. This is normally 12° to 15°. When the main and tail gear are deflected 1 g, the wing angle of attack should fall in this range. The main gear should contact the ground at least 15° ahead of the most forward center of gravity with the aircraft in level attitude as shown in Figure 1. Next you must determine the length of the gear.

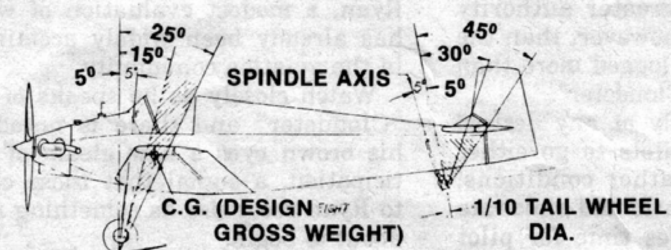

FIGURE 1

The C.G. should be located as shown in the front view (Figure 2).

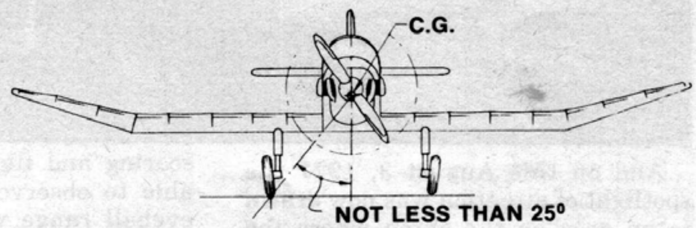

FIGURE 2

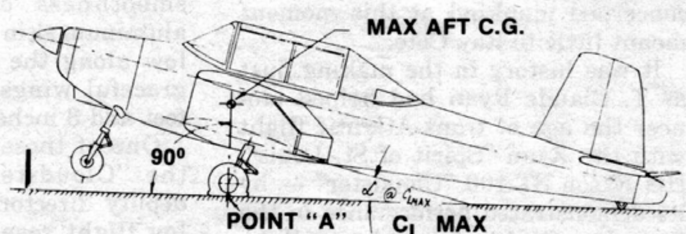

FIGURE 3

FAR Part 23 states that with the airplane in level attitude and the gear deflected for 1 g loading at gross weight, the propeller should have 9 inches clearance. Also, with one flat tire and the gear deflected, there must be some positive clearance between the propeller and ground.

Another way to locate the gear on a tail sitter is to use equations given in FAR Part 23 concerning reactions on the gear.

Vertical load $V_r = (n - L)W$

n = load factor which gear should take — normally about 3

L = lift coefficient of wing which should be taken as .66

Vertical load = (3 - .66)W = 2.33W

Drag reaction D is found as follows:

D = knW

k = friction coefficient — normally .25

n = load factor

W = weight

D = .25 x 3 x W = .75W

The resultant of these two forces, V_r and D, is usually at 15° to 18°.

$$\tan \Theta = \frac{D_r}{V_r} = \frac{.75W}{2.33W} = .322$$

$$\Theta = 18^\circ$$

Thus the gear should be located about 18° from the cg. If the resultant goes behind the cg, the aircraft could pitch over.

The tailwheel should be located as far aft as possible for best ground handling and to minimize loads in it.

On a front view, the angle between vertical and a line from cg to point of wheel contact with ground should be not less than 25°. See Figure 2. Too narrow a gear will make the aircraft tip over. For example in the Japanese motor glider, Nippy, the gear is narrow. It doesn't have outriggers so these angles are very small and requires a skilled pilot.