Biplane Gap & Stagger

Abstracted by Mike Nassise

Gap and stagger are a pair of terms used to describe a biplane's layout which a modeler should well understand when building a multi-wing mode/- Editor.

The gap on a biplane is the distance between the two wings. It is measured as the vertical distance between the chord lines of the two airfoils. All biplanes must, obviously, have a certain gap and, in general, this should be as large as possible. For satisfactory flight efficiency a minimum figure is usually stated as gap:' wing chord (or chord of the largest wing if these are of unequal size). There is no theoretical upper limit, but above a gap of about 1.5 the max chord, each wing acts as a single monoplane wing with no inter-wing interference.

This brings up the point that it should be possible, with a large enough gap, to produce a biplane where the total area is equally as effective as that of a monoplane wing of the same area. Unfortunately, this ignores "scale effect" or the fact that, as far as models are concerned, larger wings and larger wing chords are more efficient than smaller wings. The monoplane and biplane compared in fig. I. for example, have the same span and total wing area. However, the chord of each biplane wing is only one half the chord ofthe monoplane wing. Each biplane wing, therefore, is less than one half as efficient as the monoplane wing owing to the reduced chord. Preserving the same chord, the biplane span is reduced to a ridiculous figure with each wing having an aspect ratio of only 3/1. This low aspect ratio will result in increased induced drag and the reduced span will also be insufficient for stability, especially in controlling torque. A large gap, therefore, in spite of being desirable, is still no cure for biplane inefficiency problems.

FIG 1.

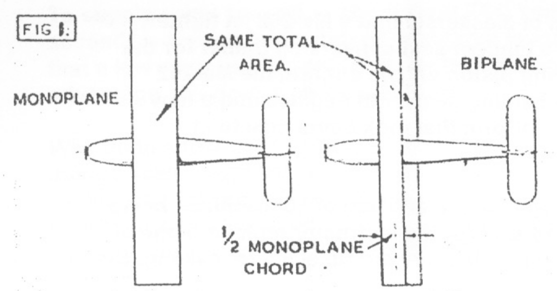
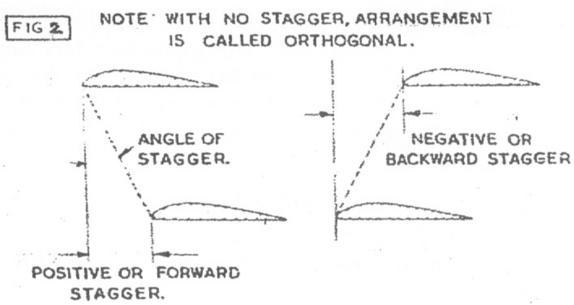
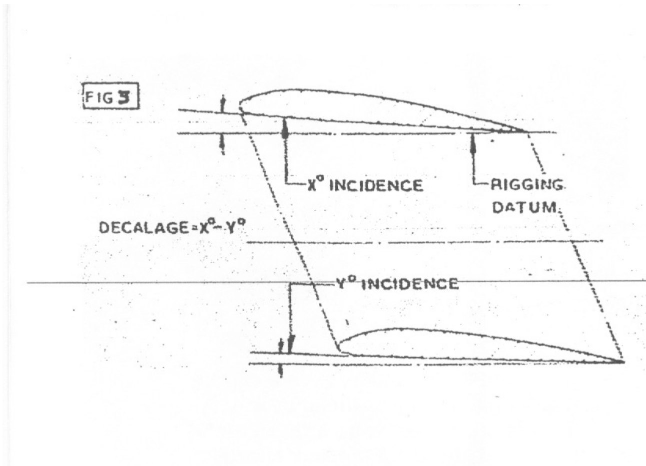


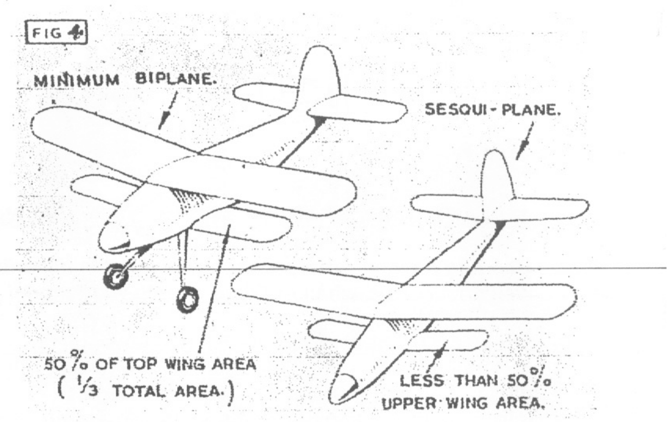
FIG 2.



Somewhat the same effect as gap can be produced by locating one wing of a biplane backwards or forwards relative to the other. This is known as stagger - backwards or forwards. depending on the relative position of the upper wing - fig.2- •. Theoretically, forward stagger is best and the use of stagger enables the gap to be reduced for the same overall efficiency. If both wings are rigged to lift comparable degrees, the upper wing with forward stagger actually has less drag than the lower one. In other words, the enter of drag of the biplane arrangement is lowered, which can have a stabilizing effect under power.

However, some biplane designers prefer to use stagger for another stabilizing purpose by introducing decalage. Oecalage is a difference in rigging incidences between the two wings - fig. a. If the top wing is set at a greater angle of incidence the combination is said to have positive decalage; if the lower wing has the greater incidence, negative decalage. Positive decalage is more usual with forward stagger.





With positive decalage the upper wing will reach its stalling angle before the lower one. Used with positive or forward stagger, therefore, the lower wing will act like a short-coupled tailplane to improve longitudinal stability. When the upper wing has stalled, the lower wing, farther aft, will still be lifting strongly helping to correct the stall. The effect, however is small compared with tailplane power for similar correction, and positive decalage does not seem a worthwhile inclusion solely on this score.

The size and proportions of the biplane's two wings are the next factors to consider. As far as overall efficiency goes it seems that the larger one wing of the combination is, in proportion to the other, the better, until monoplane efficiency is achieved when the larger wing is 100 percent. There is a limit, however, to what constitutes a biplane and when it becomes a monoplane with an additional stub wing or winglet. The usual limit is where the lower wing is not less than one half the area of the upper wing - fig.4f,. If the lower wing is smaller than this then the layout is called a sesqui-plane. Some Nieuport biplanes of World War I were actually sesqui-planes.

Reviewing the biplane arrangement, as far as we have gone, we have established that we want a large gap, while stagger can also be used to produce a similar slight increase in efficiency. However, our biplane arrangement is still inferior when compared to a monoplane wing. The performance of a biplane does not compare favorably with that of an orthodox monoplane as regards duration. Basically, the biplane layout is adopted to obtain more wing area at reduced structural cost.

If not suitable for duration flying, therefore, why do people build biplanes at all? One of the chief reasons is that the biplane is attractive, both in appearance and flight. It is possible to approach to a near-scale layout with a biplane. Slightly less dihedral is needed, for example, which coupled with a shorter span, gives a certain '"full size" illusion. As a sports model the biplane becomes an attractive proposition and something "out of the Rut."

Via the March 1951 Issue of Aeromodeler Magazine