# THE CENTRE OF PRESSURE

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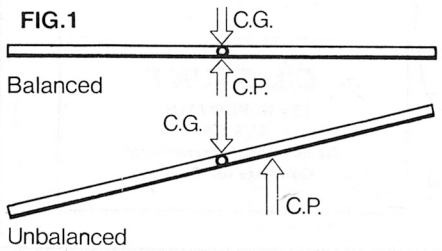
How often do we read in constructional articles and kit-building instructions for free-flight models: "Before flight balance model at the point shown and test glide. If nose-heavy put packing under trailing edge of tailplane." Now this method of initial trimming is common knowledge to most of us, but to a large number there is only an obscure connection between the balance point (centre of gravity) and the tailplane incidence. The connecting link is, of course, the centre of lift, or, as it is more usually stated, the centre of pressure.

Balance a poker horizontally on one finger. Balance will only occur at one point, when the finger is placed under the centre of gravity of the poker. Move the finger noticeably either way and one end or the other of the poker will fall. The finger can be likened to the centre of pressure of our lifting surfaces and this position occurs longitudinally in our model where there is an aerodynamic concentration of the lift forces of the combined wing and tailplane surfaces.

Most models are designed to glide with their fuselage attitudes within a few degrees either way of the horizontal, and to do so it is obvious, from our poker example, that a force arrangement with the C.P. vertically, or nearly vertically in line with the C.G. should maintain this attitude in the glide. The ideal arrangement, used on piloted aircraft is to have the C.P. nominally above the C.G., but this set-up is too "knife-edged" for models unless we have some method of elevator control to re-trim the machine from frequent changes of attitude. For our purpose it is necessary to have the C.G. slightly ahead of the C.P. so that in the event of disturbance or loss of speed the model will tend to drop its nose, and dive slightly to regain a stable attitude. This is most essential in passing from powered to gliding flight when the thrust disappears, speed drops suddenly and the model would normally stall without some built-in method of increasing speed and lift.

Now, like the C.G., the term C.P. is often used loosely to define the fore and aft position of the lift point of a surface, or a combination of surfaces. In actual fact, of course, it can be defined as an exact point, and assuming our lifting areas to be symmetrically disposed about our fore and aft centre line, it is obvious that it will also lie on this centre line. This point is called the neutral point (Fig. 2).

If a model has a warped wing the lift on one side will exceed the lift on the other, and the neutral point will consequently be displaced towards the side giving the most lift. We can again see here our old friend the unbalanced poker, and it is this displacement which causes the model to bank (Fig. 3).



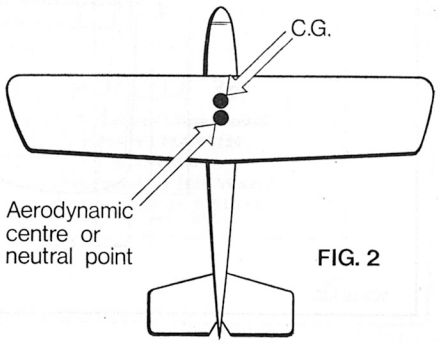




FIG. 2



In the case of a simple rectangular wing of say Clark Y section the C.P. lies roughly one-third back from the leading edge when the wing is at an angle of attack of 4°. If the angle of attack increases the C.P. moves forward, and when it decreases (high speed) the C.P. moves backward. This characteristic is, in a way, unfortunate for us, since, should our model be flying in a nose up, partially stalled condition, nothing could be better for it than a sharp rearward movement of the lift point to behind the C.G. restoring it to a level attitude. The reverse happens, however, tending to make matters still worse. However, in practice, the lifting moment of our tailplane is normally sufficient to damp out the worst of these changes in attack angles.

Until fairly recently it was considered that the sole function of a tailplane should be to stabilise the model against fore and aft disturbances. The tailplane was therefore of a symetrical streamlined section and rigged to fly at 0° angle of attack, giving no lift. In other words, it merely held the main plane "in the groove" at, say, 4° attack. If you look at old-time glider plans you will see in most cases that the balance point is roughly one-third back from the main plane leading edge since the main plane was normally the only lifting surface.

However, times have changed, and now our tailplane often lifts as well. This means that the C.P. is now a resultant force from wing and tail, and the more lift the tail is designed to give the farther back moves the total reaction. Thus, generally speaking, the larger the tailplane the farther back goes the C.P. and thus the C.G. This is particularly noticeable on power duration designs with large tailplanes where the C.P. can be anything between 50–100% from the wing leading edge (Fig. 4).

What we must remember is that although the balance point on a design may seem a long way back, the C.P. is always a little farther back still.

We can now see that if we have built our model to a proven plan with the tail and wing incidences correct, and the model balancing where indicated, a good glide should result showing that our C.G. and C.P. are in their right places. Usually slight inaccuracies have crept into our incidence setting, however, giving us a C.P. too far forward or rearward of our C.G. If a model shows a stalling tendency on gliding our C.P. is too far forward, and to bring it back we increase the lift on the tailplane by packing the leading edge. It must be emphasised that this method can only be used for trimming out *small* inaccuracies. If used to extremes we shall reduce or increase the angle of attack of our wing on which we rely for most of our lift, to a point where it is operating at very inefficient lift/drag ratios, and induce unpleasant stability characteristics. Therefore, if your model needs packing to a point where the wing–tail incidences differ much from 2–4 always move your C.G. position first by weight adjustments or ballast.

In conclusion, unless you fully understand what you are aiming for, never be tempted into altering your hard-won glide stability to cure power-on troubles. Thrust line adjustments with your motor will take care of most of these.

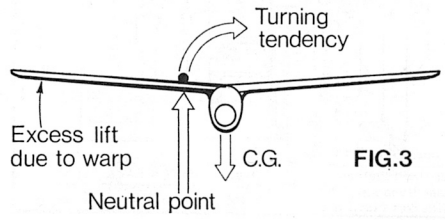



FIG.3

