Circling Flight in a Radial Field of Flow

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Recent work on the structure of thermals has shown that in addition to vertical velocities the air forming the thermal has quite considerable horizontal velocities in a radial direction. Consideration of the effect of this flow on a glider circling in it leads to the slightly surprising conclusion that the rate of sink will be materially affected.

In normal circling flight (see Fig. 1) the centripetal force is provided by the inward vector of the lift force of the glider i.e. $L \sin \Phi$ which can be written $W \tan \Phi$ since $L \cos \Phi = W$.

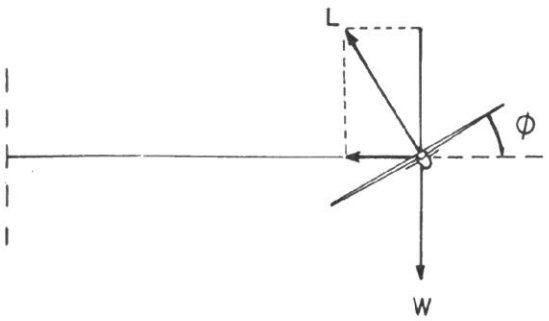
In order to maintain circular flight in the presence of outflow of velocity U_r, it is necessary that the glider be continuously headed inwards by a small angle ε as shown in Fig. 2. Note that relative to the air there is no change, but the effect of this direction change is that the inward lift vector is now no longer towards the centre of the circle, but has a backward component W tan Φ sin ε which is equivalent to an increase of drag and can only be overcome by an increase, s, in the rate of descent such that

$$sW = W \tan \Phi \sin \varepsilon \; V$$

$$s = \tan \Phi \frac{U_r}{V} V$$

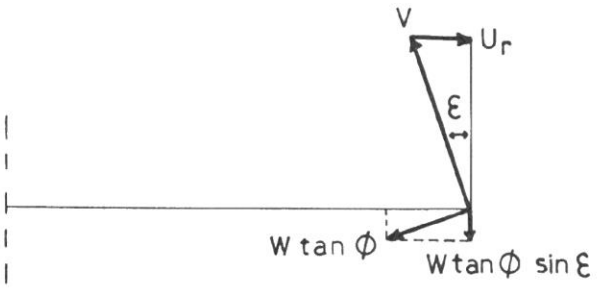
$$s = U_r \tan \Phi$$

that is the effect of radial flow is to produce an increment in the vertical velocity of the glider which is dependent only on the velocity of flow and angle of bank of the glider.



CROSS SECTION OF GLIDER IN NORMAL CIRCLING FLIGHT

Fig. 1



PLAN VIEW OF GLIDER CIRCLING IN OUTFLOW

Fig. 2

Separate print from OSTIV Section of the "Swiss Aero Review", No. 6/1958.