

THE ANGLE OF ATTACK INDICATOR

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NO instrument in aviation has been so neglected, and yet offers such a possibility for indicating the attitude and flight condition of the aircraft, as has been the angle of attack indicator. The Wright brothers used an angle of attack meter, consisting of a ribbon in the flight stream of the air in front of the main airfoil, to indicate the relative wind on the main plane. The very fact that the angle of attack indicator gives a true indication of the reserve lift of the airfoil makes its contribution to the knowledge of the pilot much more valuable than any other indicator on the airplane. The airspeed indicator is, in contrast, an instrument which indicates a history or summation of the past attitudes of the aircraft, whereas the angle of attack indicator gives an immediate knowledge of the flight attitude of the airplane. It is for these reasons that soaring will be more efficiently performed by the use of the angle of attack indicator.

In some of the early gliding of the Germans an angle of attack indicator consisting of a ribbon on the top of the fuselage was used. This indicator also indicated the relative slip or skid of the glider. However, the upwardly deflected flow over the fuselage caused errors so that it did not give a true indication of the angle of attack. It is, perhaps, for this reason that its use was not explored further.

An angle of attack indicator is a much simpler instrument than any of the pressure types of instruments; such as the airspeed, the altimeter, and the rate of climb. Essentially, it is a wind vane which always points in the direction of the relative wind at the position where it is located. If the vane is located on the side of the fuselage rather than the top, as was done in the German experiments, it will give a much more exact measurement of the angle of attack of the wing. Since the vane is on the side of the fuselage, it is difficult to observe it inside the cockpit and therefore, a remote indicator is required. Figure 1 is a simple configuration of such an instrument. The vane is on a rotatable shaft mounted on a bearing in the side wall of the fuselage and inside the cockpit is a long needle which is read against a scale fastened to the side of the cockpit. If it is desired to indicate on a circular scale instrument similar to an altimeter, a gearing is required to transpose the motion of the vane through 90°.

If the vane is to be stable and if the indication is to be a steady indication, due consideration must be given the design of the vane. In particular, the vane must be very light and should have a relatively high aspect ratio in order for it to be stable. The stability of wind vanes has been studied* and the results of the study can readily be used in the design of a finished instrument.

The application of the angle of attack indicator to soaring flight is particularly promising because soaring

flight requires an accurate and immediate knowledge of the attitude of the wing with respect to the flight path. It is this attitude which determines the reserve lift of the wing. Every soaring pilot has at one time experienced a stall due to the fact that the stalling speed in a turn is somewhat higher than the stalling speed in machine flight. If the pilot begins circling without increasing the speed to compensate for the increased loading on the wings due to centrifugal force, a stall is imminent. It is immediately apparent then that for this condition the airspeed indicator is not sufficient as a true indicator of the reserve lift of the main wing.

It is also a well known fact that the best $\frac{L}{D}$ of a sailplane occurs at one fixed value of angle of attack. This is, of course, also true for the angle of attack at minimum sinking speed. In contrast, the indicated airspeed at best $\frac{L}{D}$ changes with the wing loading of the airplane. Therefore, a heavy pilot must fly at a higher speed than a light pilot. Future advantages inherent in the use of the angle of attack for informing the pilot of the flight condition of his sailplane are immediately apparent. Fundamentally, the angle of attack indicator is really a stall warning device and, therefore, it can very easily eliminate many of the accidents occurring in the training stages of soaring. If it is desired, a warning signal can be given when the angle of attack reaches a dangerous stall. For one of the finest treatments of the angle of attack indicator as a flight condition indicator, the reader is referred to Wolfgang Langewiesche's "Stick and Rudder."

It has been mentioned that the attitude of an aircraft is not absolutely determined by the airspeed indi-



The angle of attack indicator as installed in the SSA's Laister-Kauffmann.

* "Theory of Soaring Flight," Part 7, W. B. Klemperer, SOARING, May-June, 1945, Vol IX, Nos. 5-6.