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The Time Constants of Biplane Wind Vanes (II)

by

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Abstract

Biplane wind vanes with four interplane angles and a box wind vane of the German Fuess type are tested in the wind tunnel concerning the time constant of their damped oscillation in the tunnel current. The observation is carried out in four steps of wind speed up to 20 m/s. The time constants are investigated with respect to the interplane angle and compared with that of the Fuess type which is rather inferior to the biplane type, contrary to the declaration given by the manufacturer.

1. Objective of the experiment

With some improvements in the experiment instrumentation, biplane wind vanes are tested again in the wind tunnel and their time constants of the damped oscillation performed in the tunnel current are obtained for four interplane angles. A wind vane of the German Fuess type is experimented in the similar manner and compared with the biplane type. The aim is to clarify the characteristics of such a box type wind vane.

2. Test set-up

The test set-up is similar to that of the foregoing report [1] except that the support bearing of the vane is improved so as to decrease the friction and that the exact zero point can be observed in the electromagnetic oscillograph which registers the mode of vane oscillation with the aid of a sliding resistance at the vertical shaft upper end and a contacting pointer at the vane boss.

The current speed in which the vane performs a damped free oscillation from a certain initial deviation (ca. 70°) is varied in four steps, viz., 5, 10, 15 and 20 m/s.

The tested biplane wind vanes are illustrated in Fig. 1. The dimensions are the same as those of the shorter arm vane experimented in the first report, except that the forward end length of the arm is halved.

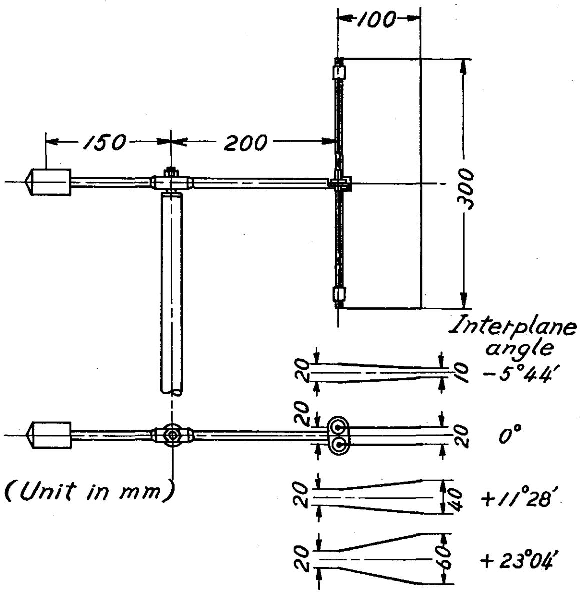

Fig. 1. Tested biplane wind vane.

The box type wind vane is constructed as pictured in Fig. 2. It is similar to the German Fuess type only in principle, as exact dimensions are not known to us. To compare the performance of the biplane vanes with that of the Fuess type the upper and bottom ends of the former vane are closed with paper which has negligible effect upon the moment of inertia of the oscillating system.

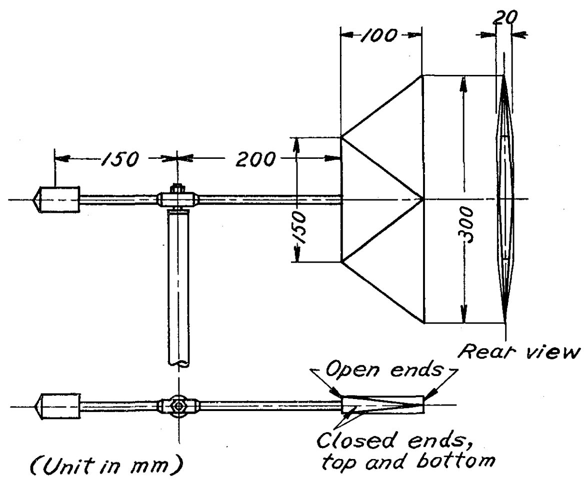

Fig. 2. The Fuess type wind vane.

The vanes are all assembled with flat plates of aluminium of thickness 1 mm, and the moment of inertia is strictly kept constant, which is calculated from the weight of the components to be 0.0032 kg m s^2.

3. Experimental results

As described in the first report the time constant of a wind vane is proportional to the moment of inertia, and inversely proportional to the air force coefficient of the aerodynamic system, vane area, wind speed and square of arm length.

In Figs. 3 and 4 the product of the time constant and wind speed is presented for various interplane angles.

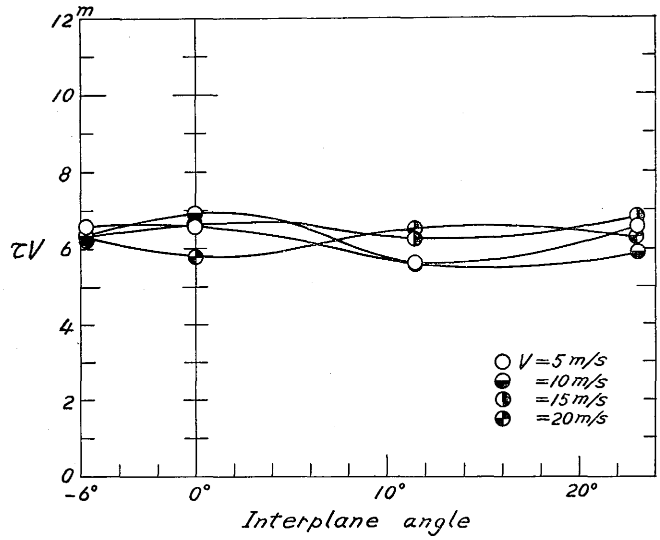

Fig. 3. Time constant τ multiplied by wind speed V, biplane wind vane with open ends (M. R. I. wind tunnel).

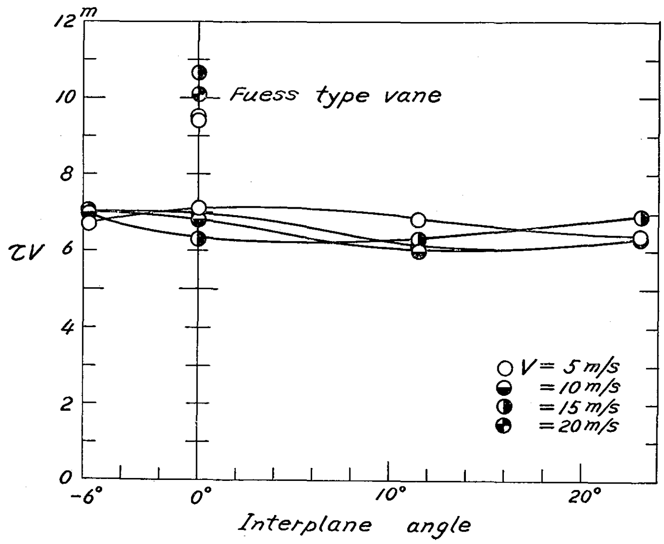

Fig. 4. Time constant τ multiplied by wind speed V, biplane wind vane with closed ends and Fuess type vane (M. R. I. wind tunnel.)

First it can be seen that no optimum interplane angle exists for biplane arrangement. Box arrangement has no merit, either. The Fuess type cannot claim superiority to the ordinary biplane vane, even if its time constant multiplied with wind speed is decreased by the ratio of vane areas, viz., $0.0225\,m^2/0.0300\,m^2=0.75$ to correct the area difference of both systems. It is rather slightly inferior to the biplane type after the correction.

4. Conclusions

1) Interplane angle has nothing to do with the time constant of the biplane wind vane, at least for the range experimented here.

2) Box arrangement has no merit for the biplane arrangement.

3) The Fuess type is slightly inferior to the biplane type after every correction is considered.

Reference

[1] Sanuki, M., S. Kimura, N. Tsuda, and S. Toyama, 1956: The Time Constants of Biplane Wind Vanes, Pap. Met. Geophys. *6*, p. 244.