TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

No. 115.

THE EFFECT OF LONGITUDINAL MOMENT OF INERTIA UPON DYNAMIC STABILITY.

By F. H. Norton and T. Carroll.
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Summary.

Free flight tests have been carried out by the National Advisory Committee for Aeronautics to show whether the longitudinal oscillations of a standard S.E.5A airplane are noticeably affected if its longitudinal moment of inertia is increased. These oscillations were taken by means of a self-recording instrument, the airplane having first its ordinary moment of inertia and then one increased by 14%. The period of oscillation was slightly longer after the increase of the moment of inertia, but the damping was not affected.

Introduction.

It has been shown by a mathematical study of the motion of an airplane undergoing an oscillation,* that an increase in the moment of inertia of the airplane tends to make the oscillation unstable. As it is sometimes desirable from the point of view of the designer to increase the moment of inertia of an airplane,

* Thomson, "Applied Aerodynamics," p. 208.

it was thought that some actual tests to determine its effect on the damping would be of interest. As far as it is known no other tests of this nature have ever been made.

Method.

The airplane used in this test was an S.E.5A (Fig. 1), selected because of its static longitudinal stability and because of the comparative ease with which the longitudinal moment of inertia could be increased. In the two runs made the conditions were exactly the same excepting for the distribution of weight. In each case the airplane was allowed to oscillate with free controls, while the oscillation was recorded by means of a N.A.C.A. recording air-speed meter. The characteristics of the airplane and the conditions of flight are given in the following table:

Total weight of airplane, ...	2000 lbs.
Trimming speed, about	60 m.p.h.
Longitudinal moment of inertia, ...	1860 slugs feet.
Controls, ...	Free.
R.P.M. of motor, ...	1350

The moment of inertia of the airplane was estimated to be 1860 slugs feet^2 which should be within a few per cent of the actual value. The increased moment of inertia due to moving from the C.G. a 150-pound weight to the nose of the airplane and

a 47-pound weight to the tail amounts to 252 slugs feet^2 or about 13.6% increase.

Results.

Two records were made with each distribution of weight. One of the air-speed curves is shown in Fig. 2. The period and damping of the four sets of records are shown in the following table:

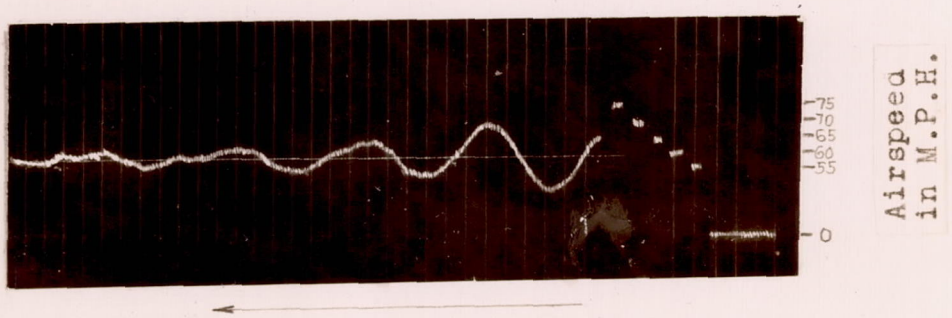
Condition	Periods in seconds.	Periods to damp to one-half amplitude.
I = 1860 slug feet^2	19.3	1.2
	18.6	1.1
I = 2112 slug feet^2	18.8	1.2
	20.3	1.1

It could not be noticed that the maneuverability was in any way affected by the distribution of weights.

Conclusions.

It may be concluded from these results that an increase in the moment of inertia, at least up to 15% on types of airplane similar to S.E.5 will have no appreciable effect on the dynamic stability.

Fig.1 SE5a used in these tests.



Timing lines at 3 sec. intervals.

Fig.2 Airspeed record of an oscillation.