NATIONAL ADVISORY COMMITTEE
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TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

No. 119

THE ELIMINATION OF DEAD CENTER IN THE CONTROLS OF AIRPLANES WITH THICK SECTIONS.

By Thomas Carroll,
Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics.

November, 1922.

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In several instances where control flaps are placed in the trailing edges of thick sections, it has appeared that a dead center is existent about the neutral position. This was first noticed in the summer of 1921 during the stability testing of a JN4h airplane with a special thick sectioned horizontal stabilizer. In this case the elevators, which were designed so that their contours formed a continuation of the normal airfoil contour of the stabilizer, were found to be noticeably dead for a considerable travel on either side of the neutral position. Remedial measures were prevented by the loss of the empennage in the fire which destroyed the hangars in which they were stored at Langley Field. Another instance has been found in the rudder of the new Army airship (blimp) now being flown at Langley Field.

This condition has also been experienced in the rudder action of the XB1A observation airplane. With the rudder near the neutral position, a noticeable dead center or lack of control is apparent to the pilot at all cruising speeds. This gives the impression of extremely slack controls, as the pressure reaction on the foot bar is negligible. An impairment of the efficiency

of the control is apparent, the control being moved through a considerable angle without directional change.

Examination of smoke pictures of the airflow around struts and airfoils indicates that the cause of the phenomenon may be as shown in Figure 2. The streamline airflow about the thick fin does not follow the surface of the rudder, and consequently the rudder can be moved between the boundaries of the intervening turbulent zone without developing an aerodynamic force.

In order to alleviate this condition, a modification of the present rudder was designed and built for the XB1A at the Langley Field laboratory of the National Advisory Committee for Aeronautics, which modified rudder was intended to remedy the condition by thickening the section sufficiently to fill in the zone of turbulent flow and thus eliminate the dead center. The new rudder is illustrated in plan form by Figure 1.

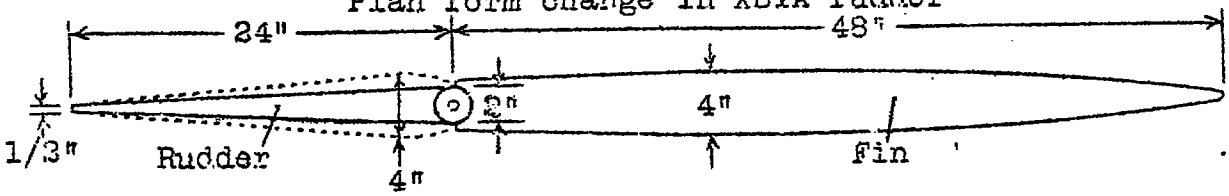
This new rudder was installed and the airplane flown by three pilots who were familiar with the performance of the standard equipment. Each of these pilots report that the rudder action is benefitted to the extent that the slackness or dead center is eliminated and the lag in the action with regard to directional change is very decidedly reduced.

It would be very interesting to carry on experiments along this line to determine the exact thicknesses and shapes which are most efficient, and to make careful measurements of the efficiencies, but the thing of paramount interest is that the practicability of

the method has been demonstrated in flight on a service type airplane.

The utility of the modification is obvious; as internally braced thick wings and empennages are becoming more prevalent, the efficiency of the control surfaces in conjunction with thick sections must be increased, if the control characteristics are to be as satisfactory as with the older thin sections.

Plan form change in XBIA rudder



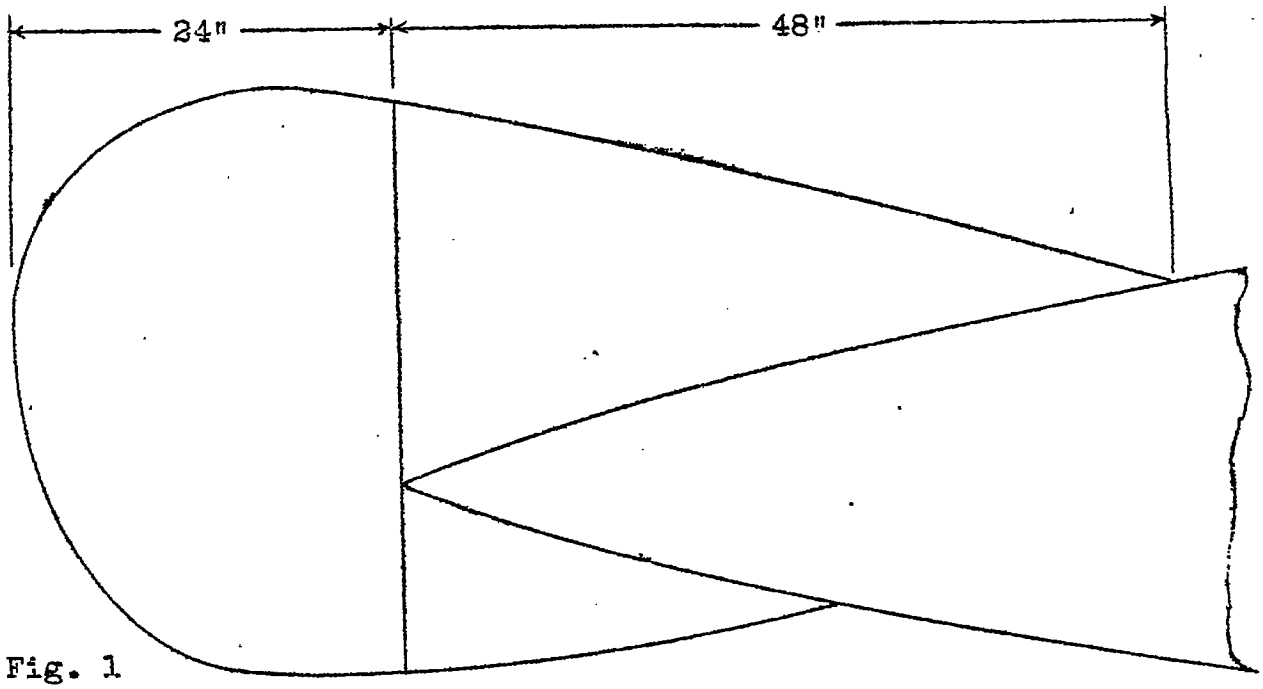
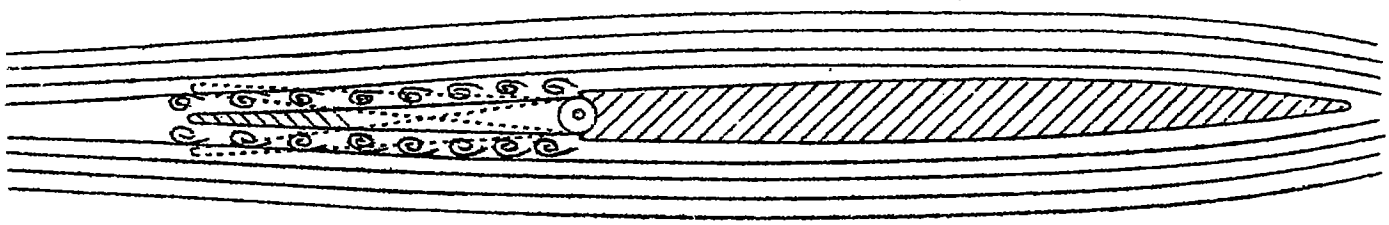


Fig. 1



Flow about old rudder

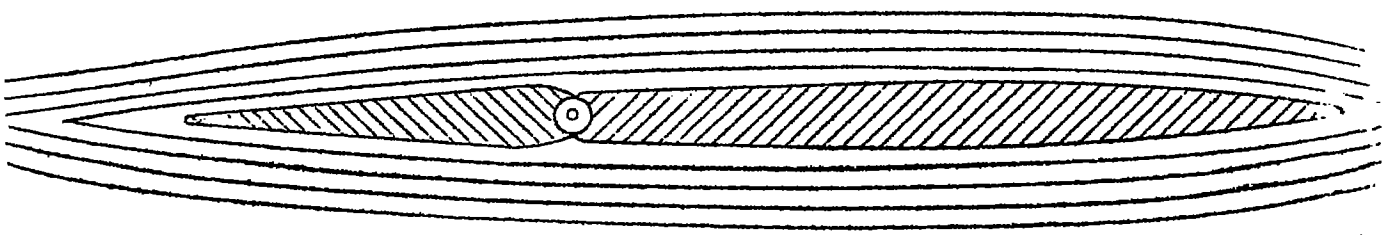


Fig. 2 Flow about new rudder