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TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 456

THE AERODYNAMIC EFFECT OF A RETRACTABLE LANDING GEAR

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SUMMARY

Tests were conducted in the N.A.C.A. full-scale wind tunnel at the request of the Army Air Corps to determine the effect of retractable landing-gear openings in the bottom surface of a wing upon the take-off characteristics of a Lockheed Altair airplane. The tests were extended to include the determination of the lift and drag characteristics throughout the angle-of-attack range with the landing gear both retracted and extended.

Covering the wheel openings in the wing with sheet metal when the wheels were extended reduced the drag only 2 per cent at a lift coefficient of 1.0, which was assumed for the take-off condition. Therefore, the wheel openings in the bottom side of the wing have a negligible effect upon the take-off of the airplane. Retracting the landing gear reduced the minimum drag of the complete airplane 50 per cent.

INTRODUCTION

A somewhat excessive length of run had been required by a certain low-wing monoplane, a Lockheed Altair, during take-off. This airplane has a landing gear that is completely housed in the wing when retracted; and when it is extended, openings having an area equal to the side area of the struts and wheels are exposed on the lower surface of the wing. It was desired to know whether these openings were causing the detrimental effect upon the take-off characteristics. Consequently, at the request of the Army Air Corps tests were conducted upon this airplane in the N.A.C.A. full-scale wind tunnel to determine the effect of the wing openings upon the lift and drag characteristics.

## TESTS AND APPARATUS

The airplane was mounted in the wind tunnel as shown in Figure 1. The lift and drag forces were measured with the wheels retracted, with the wheels extended and wheel wells open, and with the wheels extended and the wells covered with sheet metal. The tests were conducted at an air speed of approximately 60 miles per hour. Figure 2 shows the landing gear extended and the wheel wells open. A description of the tunnel and balance equipment is given in reference 1.

## DISCUSSION OF RESULTS

The primary purpose of the investigation was to determine the effect of the landing-gear openings in the wing upon the lift and drag characteristics during take-off. Assuming an angle of attack for take-off that would give a lift coefficient of 1.0, and comparing the curves on Figure 3 for conditions with landing gear extended and wheel wells both open and closed, it can be seen that closing the wells reduced the drag coefficient only 2 per cent. Therefore, it can be said that the openings in the wing for the retractable landing gear of the Lockheed Altair have a negligible effect upon the take-off of the airplane.

Because of its retractable feature, the landing gear on the Lockheed Altair is not aerodynamically clean. It is interesting to note, however, that retracting the gear reduces the minimum drag of the complete airplane 50 per cent. It is therefore apparent that, if the landing gear proper is streamlined to reduce the drag, the take-off characteristics will be improved; but such a change, if carried to the extreme, would have a detrimental effect upon the landing characteristics and might necessitate the installation of some device to reduce the landing distance required.

## CONCLUSIONS

A retractable landing gear of the type on the Lockheed Altair may, when extended, account for 50 per cent of the minimum drag of an airplane, but the openings that house the

gear in the bottom surface of the wing have a negligible effect upon the lift and drag characteristics when the gear is extended.

Langley Memorial Aeronautical Laboratory,  
National Advisory Committee for Aeronautics,  
Langley Field, Va., March 16, 1933.

REFERENCE

1. DeFrance, Smith J.: The N.A.C.A. Full-Scale Wind Tunnel. T.R. No. 459, N.A.C.A., 1933.

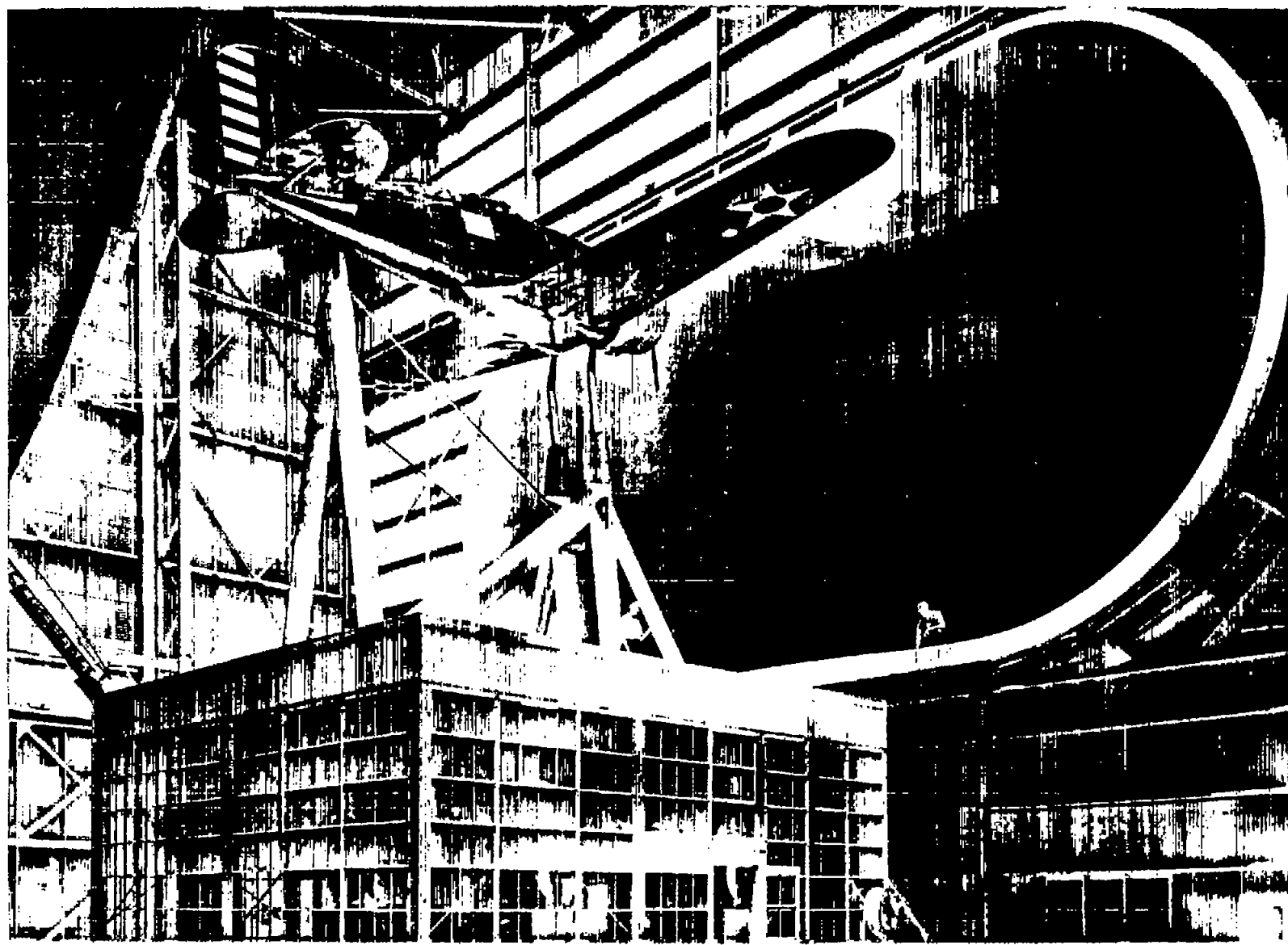


Figure 1.-Lockheed Altair ready for tests in the full-scale wind tunnel.

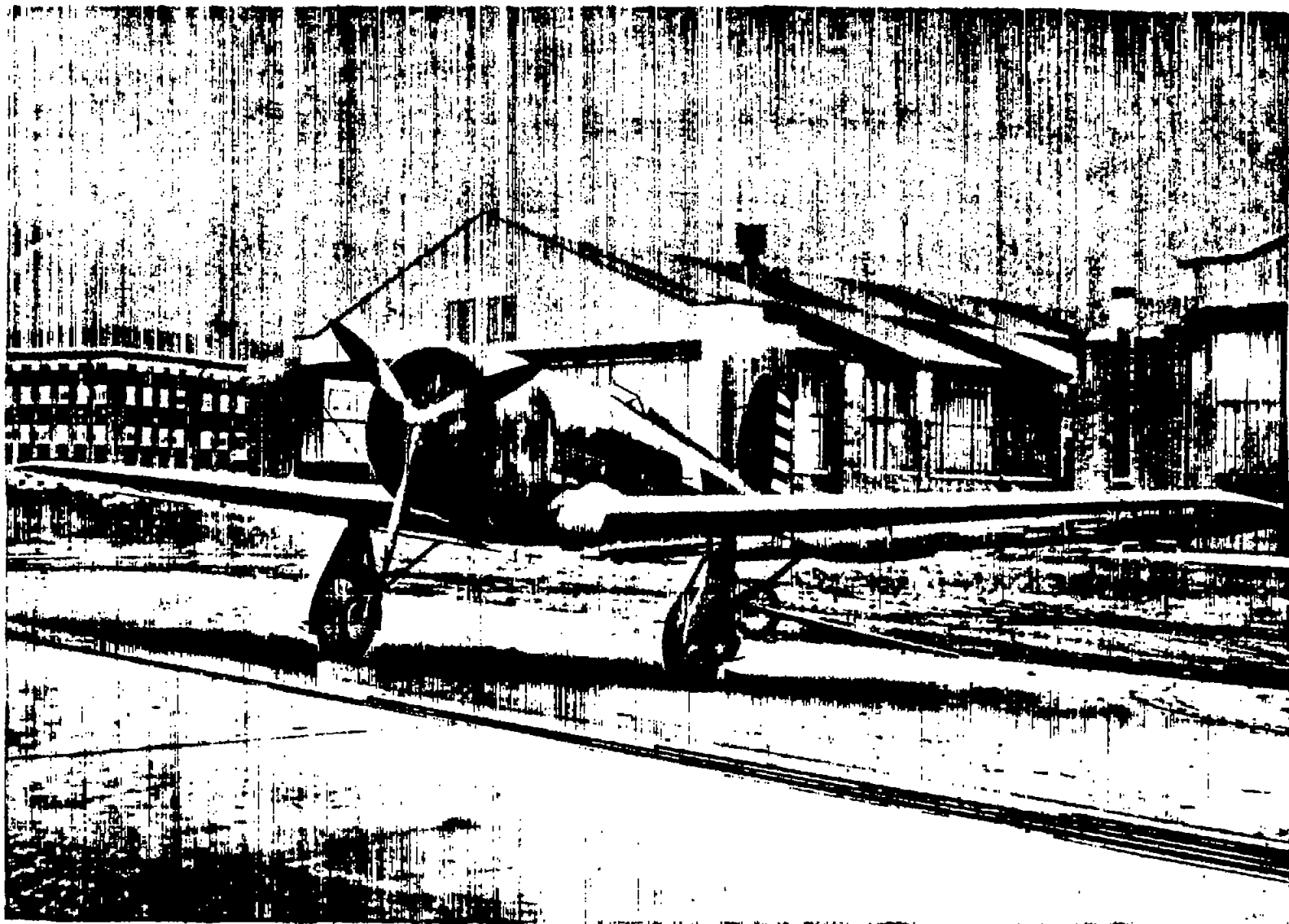


Figure 2.-Lockheed Altair with landing gear extended and wheel wells open.

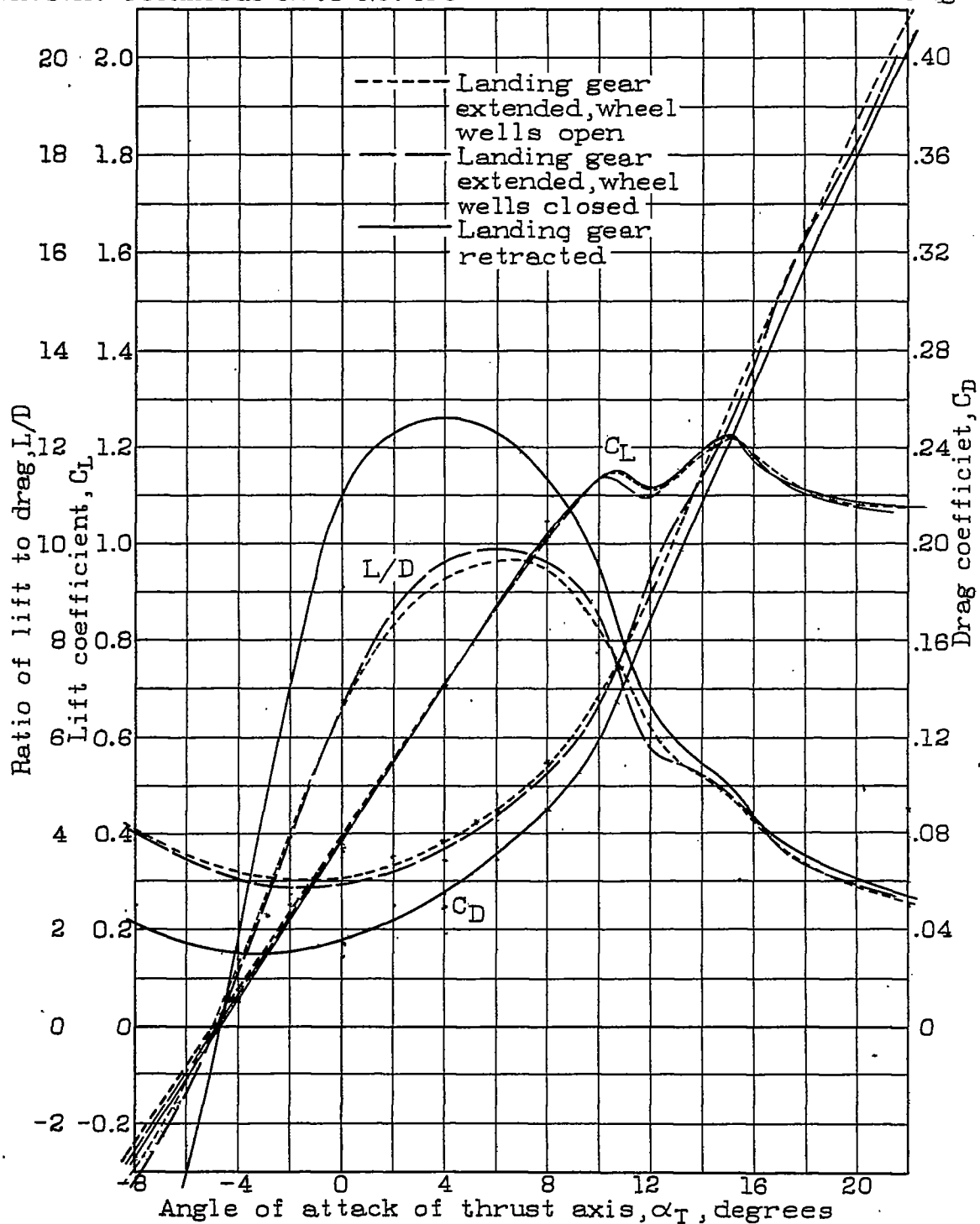


Figure 3.-Lift and drag characteristics of Lockheed Altair with landing gear both extended and retracted. Propeller off, stabilizer and elevator at  $0^\circ$  to thrust axis. Wing area = 294 sq.ft. Corrected for jet boundary.