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TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 368

THE VARIATION IN PRESSURE IN THE CABIN OF AN  
AIRPLANE IN FLIGHT

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Summary

The pressure in the cabin of a Fairchild cabin monoplane was surveyed in flight, and was found to decrease with increased air speed over the fuselage and to vary with the number and location of openings in the cabin. The maximum depression of 2.2 inches of water (equivalent pressure altitude at sea level of 152 feet) occurred at the high speed of the airplane in level flight with the cabin closed. Any pressure-operated instruments installed in the cabin would be affected by this cabin-pressure depression. These tests were conducted at the Langley Memorial Aeronautical Laboratory.

Introduction

The increased importance of correct altimeters for blind flying (if pressure-type instruments are to be used), and the effect which their location would have on their indication, have made it important to study the variation in static pressure within representative airplanes for various conditions of flight. The variation in pressures in an open cockpit of an

airplane in flight have been measured (Reference 1). It was found that true static pressure did not exist in the cockpit, and that any instruments installed therein which depended upon it for their operation would give incorrect indications. The present investigation was undertaken to determine the pressures in a cabin-type airplane.

This investigation was conducted on a Fairchild cabin monoplane at the Langley Memorial Aeronautical Laboratory of the National Advisory Committee for Aeronautics. The pressures at 18 points in the cabin were measured in flight throughout the useful speed range of the airplane (60 to 130 m.p.h.) in climbs, glides, and level flights. The number and location of openings into the cabin was varied by opening windows in various combinations. The pressures measured were compared with the static pressure obtained from a Pitot-static air-speed head suspended 65 feet below the airplane.

#### Method and Apparatus

The airplane used in these tests was a Fairchild cabin monoplane (FC2-W2) powered with a Pratt and Whitney "Wasp" engine, (Figure 1). A standard N.A.C.A. two-cell pressure-recording instrument was used (Reference 2); one cell recorded air speed and the other static pressure difference. A swivel-type Pitot-static air-speed head was mounted on the left wing strut as shown in Figures 2a and 2b. This instrument was used in measuring air speed and, by means of a ~~tee~~ in the static side, afforded a ref-

erence for measuring the cabin pressures. The swivel-type air-speed head was calibrated both for static pressure and air speed with a trailing Pitot-static air-speed head suspended 65 feet below the airplane. The pressure in the cabin was obtained by means of a hand-held static head which was placed successively in 18 positions, the locations of which are shown in Figures 3a, 3b, and 3c. These figures also show the cabin heater and window locations.

The flight tests were made at an altitude of 1500 feet, and consisted of full-throttle climbs, level flights, and power-off glides covering the normal range of 60 to 130 m.p.h. In these three conditions of flight, pressures were measured with the cabin entirely closed. Then, in full-throttle climbs only, pressure surveys were made with each of the following openings in the cabin: heater, right front window, left front window, right rear window, left rear window, and both front windows.

#### Accuracy

The accuracy of the measured pressures is believed to be within  $\pm 3$  per cent.

The accuracy of the indicated air speed is believed to be within  $\pm 1$  m.p.h.

#### Results and Discussion

The results of the tests are presented in the form of curves in Figures 4 and 5. In both of these, the cabin pressure variations in inches of water were plotted as ordinates

and indicated air speeds in miles per hour as abscissas. The cabin pressure reduction increased with increased air speed and slipstream velocity, and varied with cabin opening, the heater having no effect, however. Under some conditions the cabin pressure was higher than true static.

While analyzing the data, it was noticed that the recorded pressure was unsteady and difficult to determine in regions near open windows, but that it was quite constant throughout the rest of the cabin and did not vary more than  $\pm 0.05$  inch of water from the average. When the pressure variation was plotted against indicated air speed, all 18 points fell in a small group regardless of the position in the cabin at which they were taken.

The effect of pressure change on instruments is worth considering and, as has been suggested (References 1 and 3), may be eliminated by providing instruments with air-tight cases and fittings for connection to properly located static openings. Such locations are difficult to find, and in the present tests had the swivel-type head position been used, the data obtained would have been as indicated by the lightly drawn curves in Figure 4. In all but the high-speed condition, the static pressure measured by the swivel-type head was greater than true static.

For blind flying and fog landing, an accurate and sensitive altimeter with adjustable zero so that it may be set to

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record height above ground level at the terminal airport is a useful addition to the usual flying instruments. At Langley Field, barometric pressure changes of 0.4 inch of mercury in 24 hours are common, and were a pilot away from the field for that long, his altimeter would indicate incorrectly by approximately 375 feet, which difference, under adverse conditions, might be radioed to him. If he were flying the airplane used in these tests at a speed of 70 m.p.h. in level flight with the cabin completely closed, a cabin-pressure depression of 0.6 inch of water or 43 feet would cause further error with the ordinary instrument installation, for which information could not be supplied. If the instrument had been connected to the static side of the swivel head, an error of 1.1 inches of water or 78 feet would have been present.

### Conclusions

The pressure in the cabin of a Fairchild cabin monoplane decreased with increased air speed over the fuselage. The decrease varied with the number and location of openings in the cabin; the greatest difference existed when the cabin was closed. The pressure throughout the cabin was practically constant. Any pressure-operated instruments installed in the cabin would, therefore, be acted upon by some pressure other than the true static pressure of free air. If instruments are sealed, precaution should be taken to insure that the external

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static head to which they are connected indicates true static pressure.

Langley Memorial Aeronautical Laboratory,  
National Advisory Committee for Aeronautics,  
Langley Field, Va., March 13, 1931.

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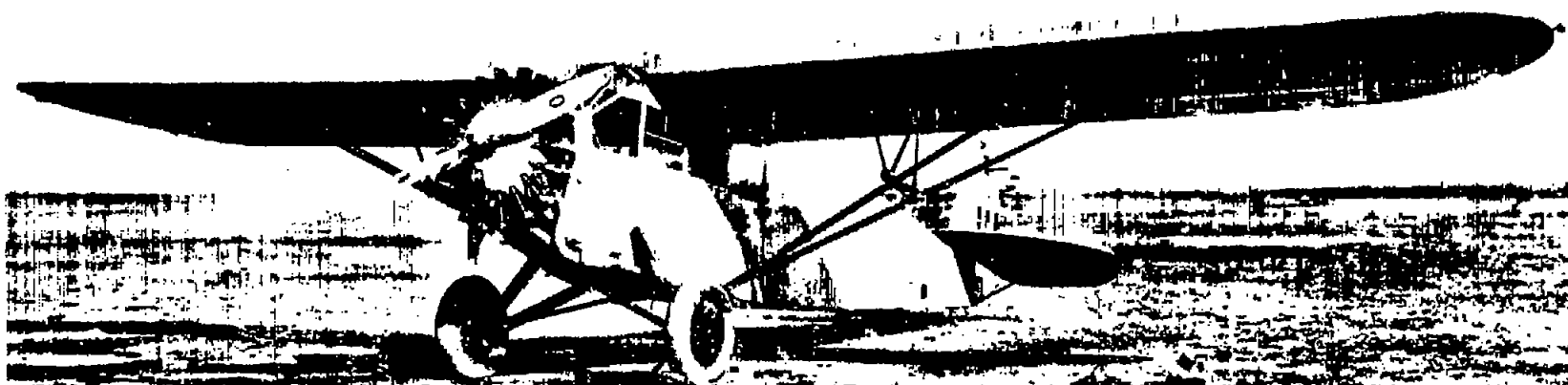


Fig.1 Fairchild cabin monoplane F02-W2.



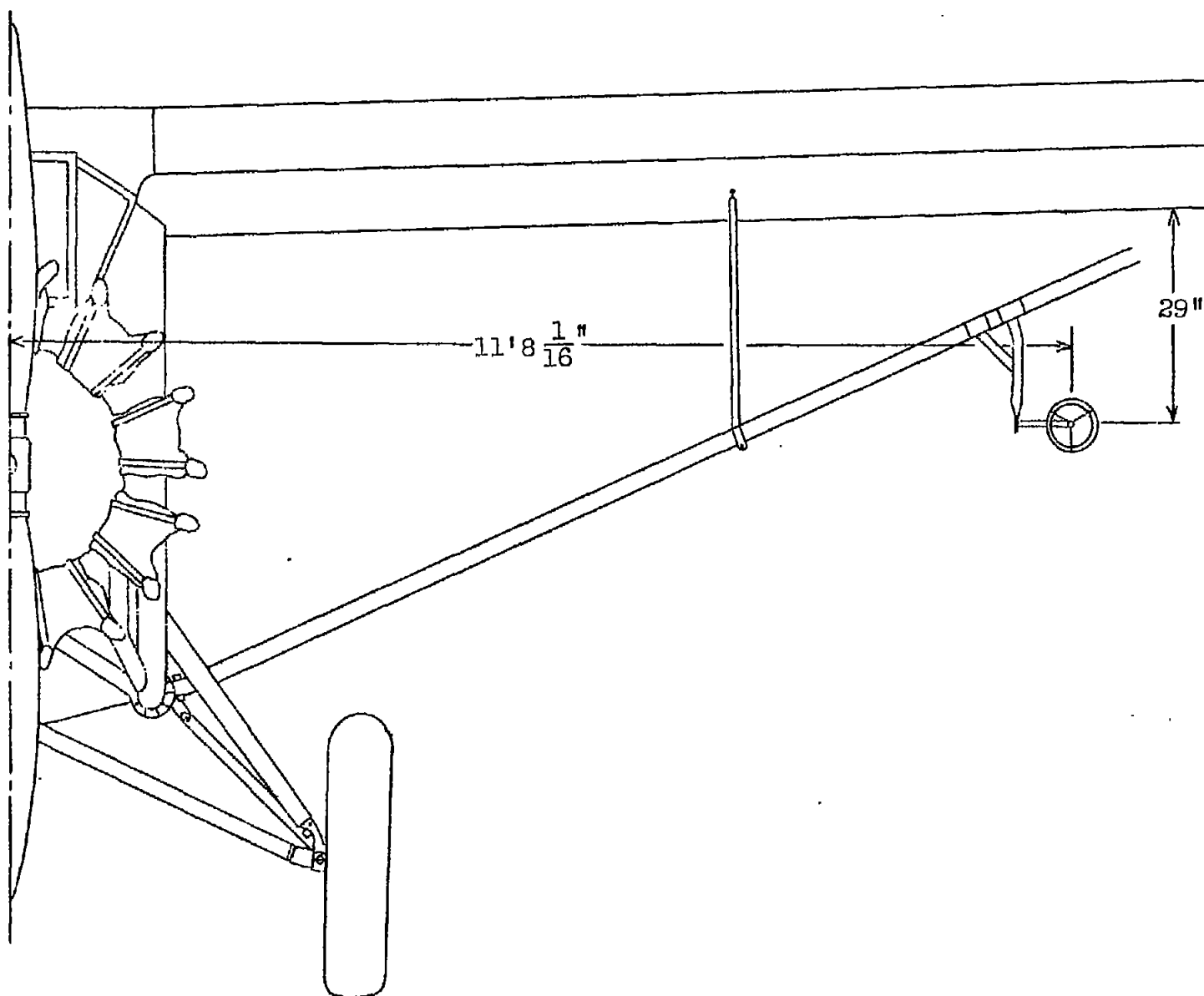


Fig. 2a, Location of swivel type air-speed head on Fairchild cabin monoplane.

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Fig.2b

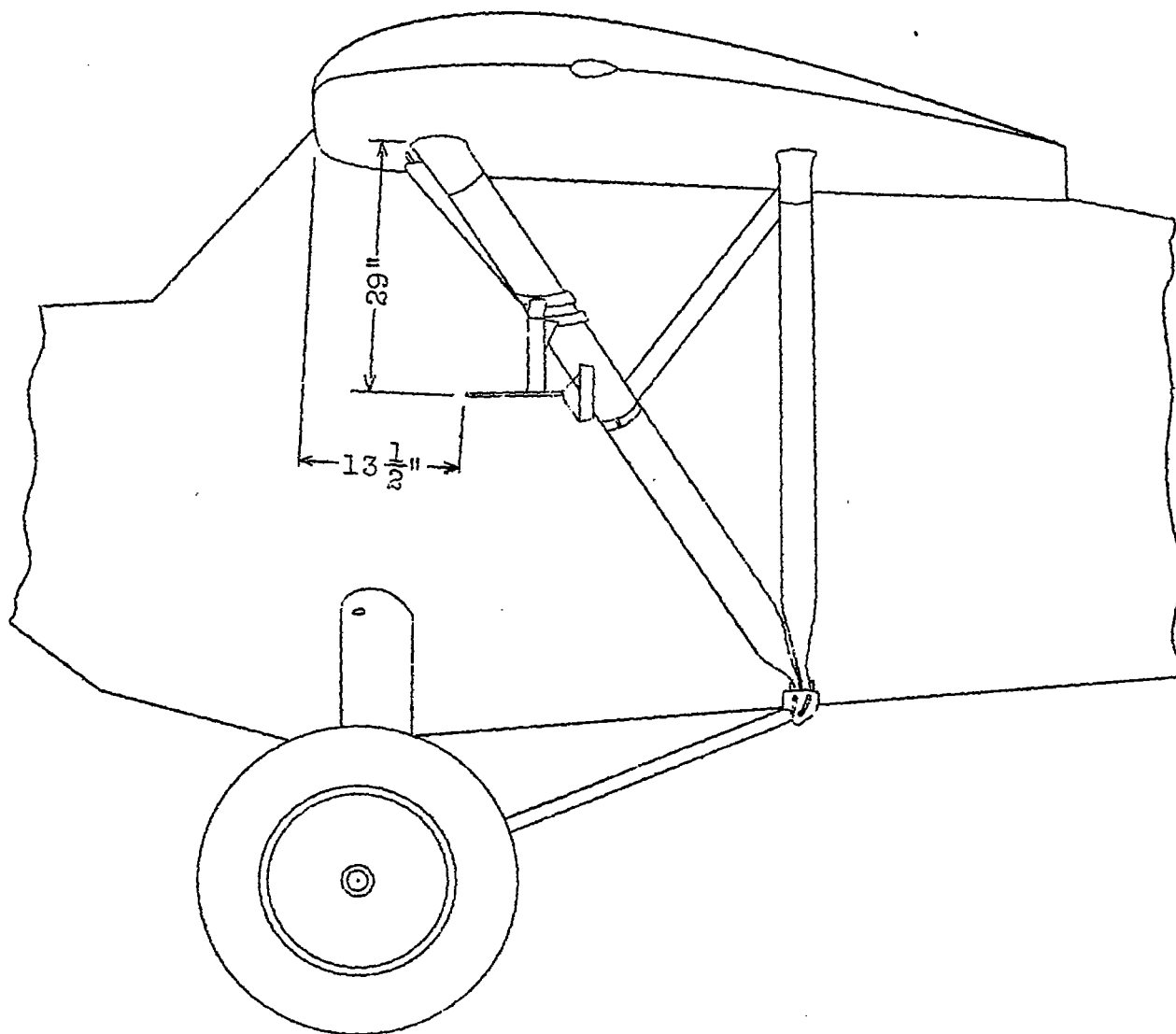
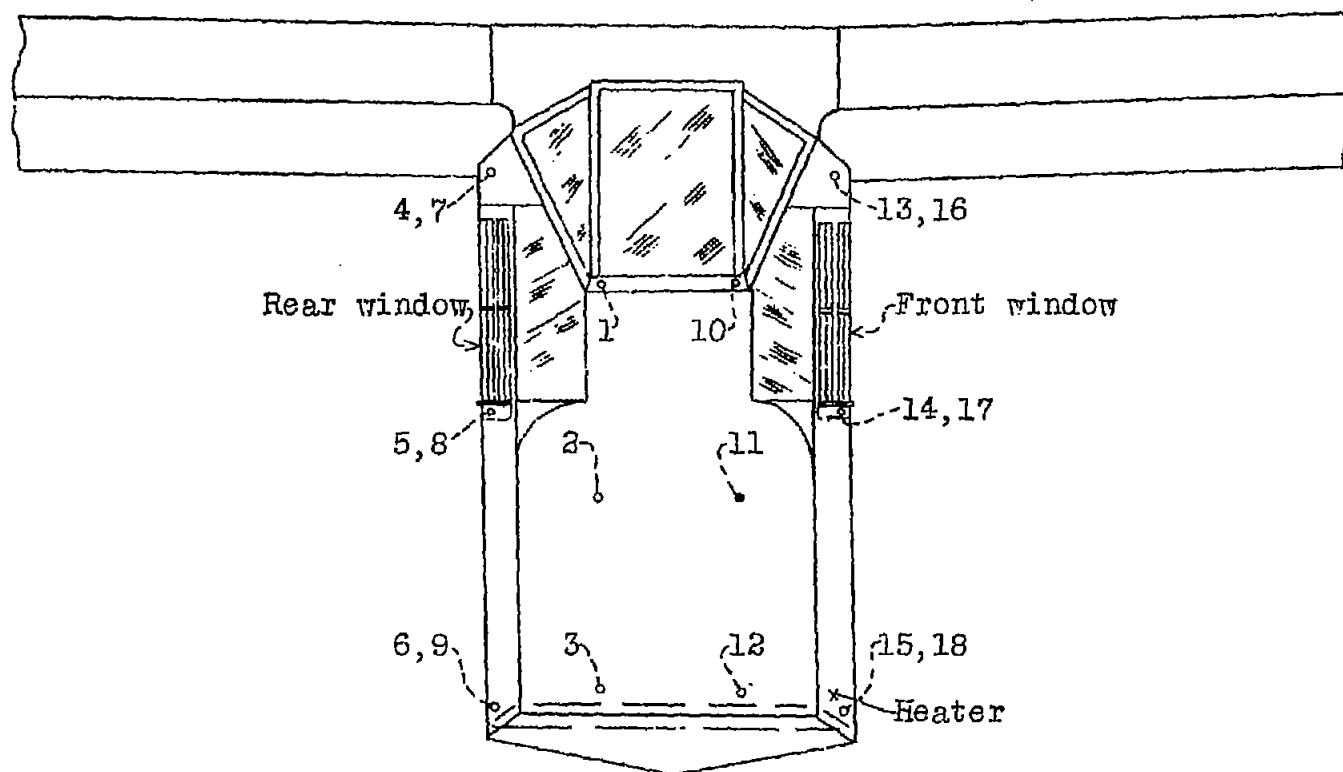
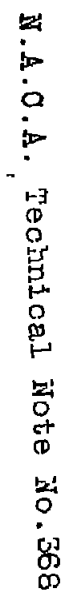


Fig.2b Location of swivel type air-speed head on  
Fairchild cabin monoplane.



Section A-A

Fig. 3a Pressure survey points in Fairchild cabin monoplane.



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Fig.3c

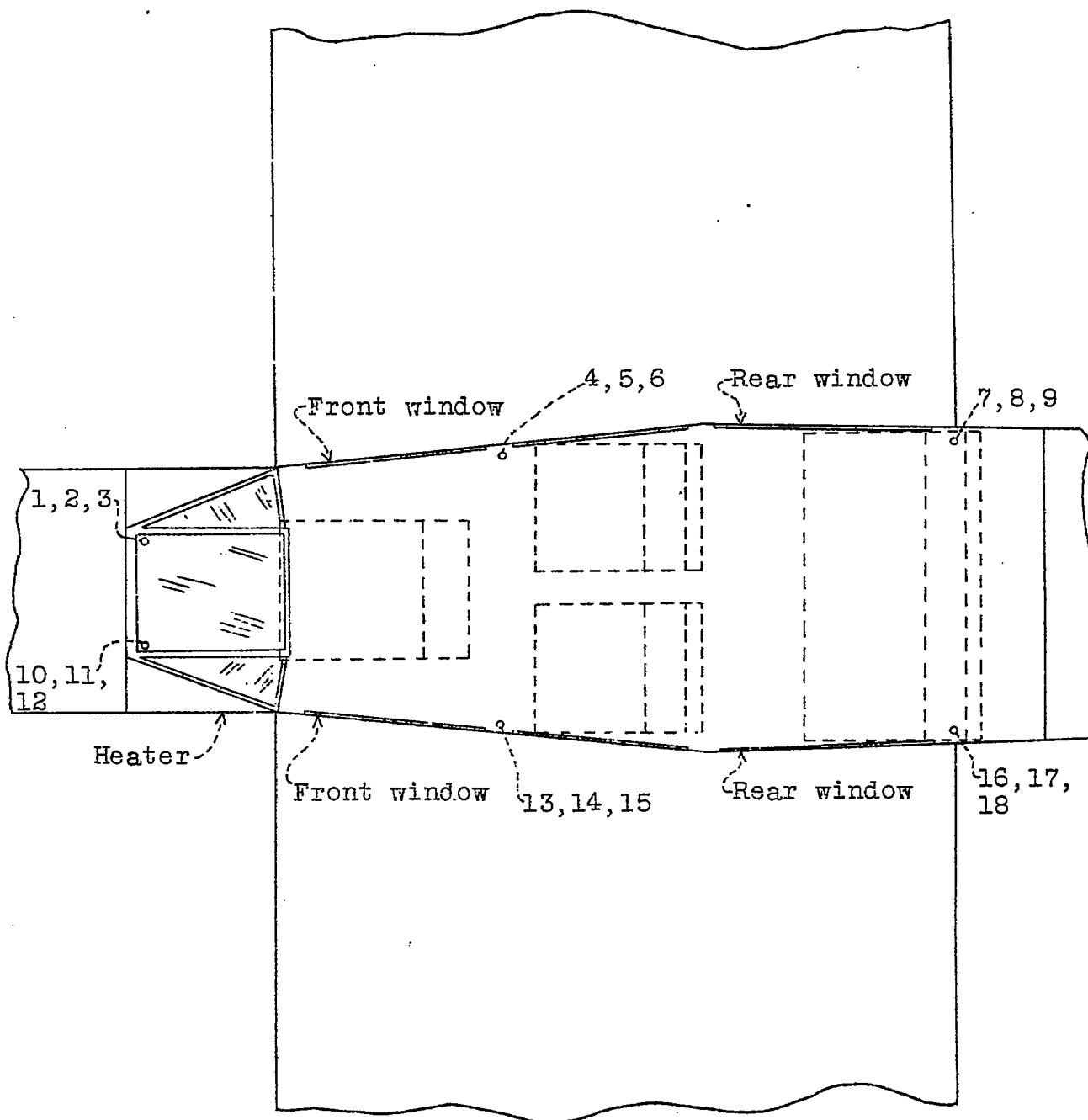


Fig.3c Pressure survey points in Fairchild cabin monoplane.

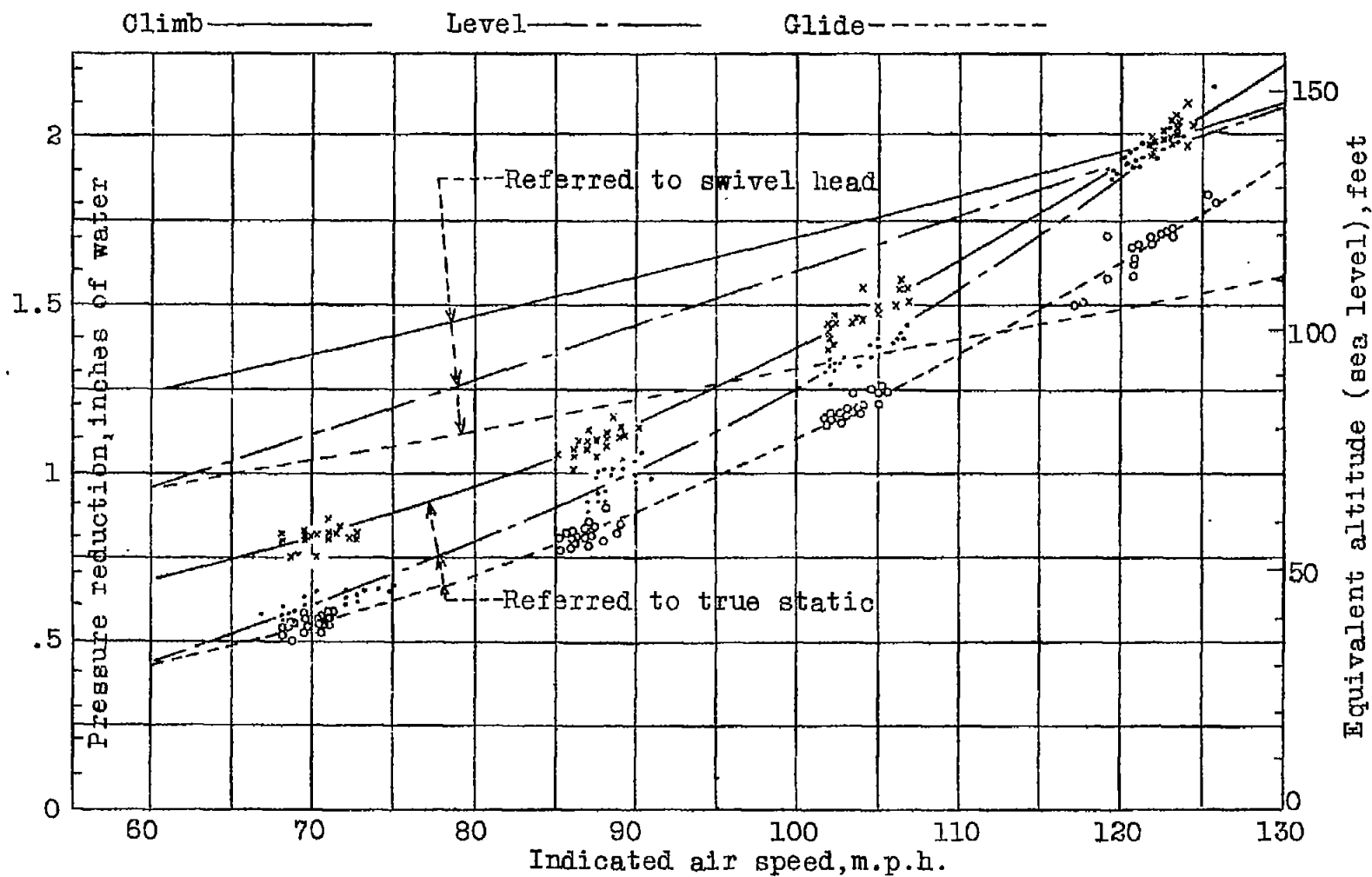


Fig.4 Variation of cabin pressure in Fairchild cabin monoplane.

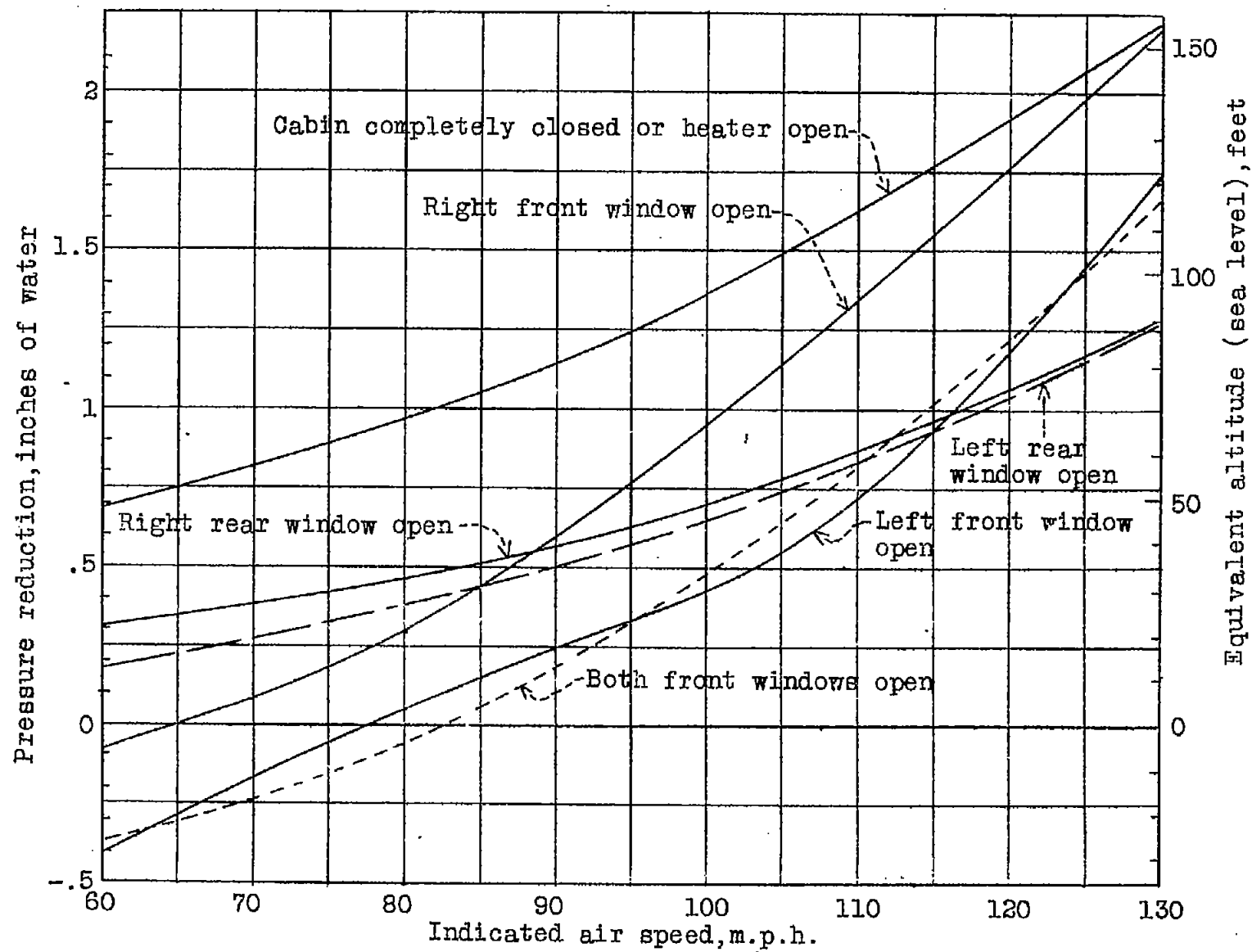


Fig. 5 Variation of cabin pressure during full-throttle climbs, Fairchild cabin monoplane.