STATIC TEST OF THE BOEING (PW-9) PURSUIT AIRPLANE

(AIRPLANE SECTION REPORT)

Prepared by D. B. Weaver
Engineering Division, Air Service
McCook Field, Dayton, Ohio
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CERTIFICATE: By direction of the Secretary of War the matter contained herein is published as administrative information and is required for the proper transaction of the public business.
STATIC TEST OF THE BOEING (PW-9) PURSUIT AIRPLANE

Airplane: Boeing Pursuit (PW-9).
Type: I.
Total weight: 2910 pounds.
Wing cellule weight: 498.5 pounds.
Wing area: 241.7 square feet.
Engine: Curtiss D-12.

DESCRIPTION

Description: The PW-9 is a biplane, wings taper in both dimensions. Gottingen 436 airfoil. Wings and stabilizer were wood structures. Fuselage, chassis, elevator, rudder and fin were welded steel structures. Actual speed at ground 160.9 miles per hour. Built by the Boeing Airplane Co., Seattle, Wash.

RESULTS OF TEST

<table>
<thead>
<tr>
<th>Date</th>
<th>Part tested</th>
<th>Load required</th>
<th>Pounds per square foot or factor supported</th>
<th>Failed at</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov. 10, 1923</td>
<td>Horizontal stabilizer</td>
<td>35 pounds</td>
<td>50 pounds per sq. ft.</td>
<td>1.2 pounds</td>
<td>No</td>
</tr>
<tr>
<td>Do</td>
<td>Elevator</td>
<td>do</td>
<td>do</td>
<td>1.85 pounds</td>
<td></td>
</tr>
<tr>
<td>Do</td>
<td>Elevator control</td>
<td>do</td>
<td>do</td>
<td>1.94 pounds</td>
<td></td>
</tr>
<tr>
<td>Nov. 12, 1923</td>
<td>Vertical fin</td>
<td>30 pounds</td>
<td>50 pounds per sq. ft.</td>
<td>1.91 pounds</td>
<td></td>
</tr>
<tr>
<td>Do</td>
<td>Rudder</td>
<td>do</td>
<td>do</td>
<td>1.91 pounds</td>
<td></td>
</tr>
<tr>
<td>Do</td>
<td>Rudder control</td>
<td>do</td>
<td>do</td>
<td>1.91 pounds</td>
<td></td>
</tr>
<tr>
<td>Nov. 16, 1923</td>
<td>Ailerons</td>
<td>35 pounds</td>
<td>35 pounds per sq. ft.</td>
<td>1.3 pounds</td>
<td></td>
</tr>
<tr>
<td>Do</td>
<td>Aileron control</td>
<td>do</td>
<td>do</td>
<td>1.3 pounds</td>
<td></td>
</tr>
</tbody>
</table>

WING CELLULAR

- High incidence: 8.5 old; 12 new.
- Low incidence: 5.5 old; 6.5 new.
- Reverse load: 3.5 old; 4.0 new.
- Six-foot length of leading edge: Factor 14.
- Fuselage: 7.6; 8.0.
- Tail skid: 30 inches.
- Chassis: 24-inch drop full load: 48-inch drop load.
- Axle: Shock absorber.

Failure:
- Front member of right N strut buckled as the load was applied.
- The fuselage cross tube between longerons connecting the flying wires pulled in two.
- None.
- Both satisfactory.
- Several members were badly bent but the fuselage did not collapse.
- Fuselage badly bent; further test useless because of design not suited to static test conditions.
- Right rear strut buckled.

WITNESSES

- Lieut. E. W. Dichtman: Stabilizer and elevator; rudder and fin tests.
- Lieut. C. W. Pyle: High incidence wing test.
- Maj. Leslie MacDill: Rudder and fin, and fuselage tests.
- C. L. Egtvedt: Reverse load, tail skid and chassis tests.
- A. S. Niles: All wing cellule tests.
- W. E. Savage: All tests, except tail skid test.
- E. R. Weaver: All tests.
- D. B. Weaver: All tests.

DATE AND PLACE

All tests were conducted at McCook Field, Dayton, Ohio, on the dates listed in the preceding table.

(1)
GENERAL RECOMMENDATIONS

STABILIZER AND ELEVATOR
None.

RUDDER AND FIN
None.

WING CELLULE TESTS
Reverse load—none.

Low and high incidence conditions. Redesign the portion of the fuselage where the flying wire fittings are located. Change the position of the pins in the strut to spar fittings.

AILERONS
Redesign the cable pulley brackets and the control stick support.

LEADING EDGE
None.

FUSELAGE
None (except change called for in wing tests).

TAIL SKID
Redesign the assembly.

CHASSIS
Increase the strength of the struts.

GENERAL DESCRIPTION

The PW-9 is a biplane propelled by a Curtiss D-12 engine, low compression, rated horsepower 375 at 2,000 revolutions per minute. It was designed and built by the Boeing Airplane Co., Seattle, Wash.

The wing cellule and stabilizer are of wood construction, excepting the welded steel interplane N and cabane struts. The fuselage, chassis, elevator, rudder, and fin are of the welded steel tube construction.

All surfaces are covered with cotton fabric.

The control surfaces are actuated by means of flexible steel cables.

For assembly drawings, see Figures 1 and 2.

The high speed at the ground is given by the Flight Test Section as 160.9 miles per hour.

Gross weight: 2910 pounds.
Disposable load: 920 square feet.
Total wing area: 241.7 square feet.
Wing loading in pounds per square foot: 12.7.
Weight per horsepower: 7.8 pounds.
Airfoil: Gottingen 436.

The equipment is according to the specifications in the contract.

WING CELLULE

DESCRIPTION

The upper wing is built in one continuous piece, around two box type spars, whose depth tapers both inboard and outboard from the point where the cabane struts are attached. The upper and lower wings taper both in chord and thickness dimensions.

The lower wing is made in two parts, a right and a left panel. Each panel is connected to the fuselage by two 3⁄4-inch diameter bolts and to the upper wing by means of an N-type interplane strut. See Figures 3 and 4 for general layout of the upper and lower wings.

Figure 5 is a drawing of the interplane strut.
Figure 6 is a drawing of the cabane struts.
A pair of 3⁄4-inch diameter streamline flying wires are employed, located in the plane of the front spars. In this same truss one 3⁄8-inch diameter streamline landing wire is positioned between the pair of flying wires. The truss of the rear spars does not contain any wire bracing.

Figure 7 gives the typical wing ribs and compression ribs.

The lower compression ribs between the spars are made of a solid piece of spruce with many large lightening holes. The spars are box type, having a spruce flange top and bottom, connected by a three-ply veneer web on both sides.

Figures 8 and 9 show the cross section of the spars.
Figure 10 is a sketch showing the strut to spar fitting, and how the strut is attached to the spar.

Weight of upper wing: 232 pounds.
Weight of the two lower wing panels: 111 pounds.
Area of the two lower wing panels: 81.12 square feet.
Area of upper wing: 160.6 square feet.
Structural weight of upper wing per square foot: 1.45 pounds.
Structural weight of lower wing per square foot: 1.37 pounds.
Weight of wires, housing, interplane and cabane struts: 40.5 pounds.
Weight of complete wing cellule: 415 pounds.
Structural weight of wing cellule per square foot: 1.72 pounds.

The lower wing has a positive stagger of 11 inches.

PROCEDURE FOR TEST (REVERSE FLIGHT CONDITION)

The airplane was assembled as for flight. It was supported through the fuselage so that the mean chord made an angle of 14 degrees with the horizontal, trailing edge down.

The center of gravity of the load was located 25 per cent of the chord length back of the leading edge of the wing.

The load was applied according to the loading schedule in Figure 11. After a load had been put on and supported for five minutes, deflection readings at points indicated along the spar (fig. 12) were taken. The wing tip retreat was measured as indicated in the same figure.

RESULTS

The required load factor of 4 was supported satisfactorily without any actual or indicated failures. Tabulated results are given on Figure 12 and lower wing spar deflection curves on Figure 13.

DISCUSSION

None.

CONCLUSION

The wing cellule answered the requirements satisfactorily.

PROCEDURE FOR TEST (LOW INCIDENCE CONDITION)

The airplane was set up in an inverted position so that the angle between the wing chord and the horizontal was 7° 15', trailing edge down.
The angle of incidence $\alpha$ of the wing at low incidence, and $\beta$ the angle between the vertical and resultant air force, are determined from wind tunnel data on the Gottingen 436 airfoil.

$$\angle a = -2^\circ 30'$$
$$\angle \beta = \cot^{-1} \L /D = \cot^{-1} 12 - 4^\circ 45'$$
$$\angle \gamma = \angle \beta - \angle a = 4^\circ 45' - (-2^\circ 30') = 7^\circ 15'$$

The center of gravity of the load was placed at 60 per cent of the chord from the leading edge of the wing.

The load was applied according to the loading schedule (fig. 14). At the points indicated (fig. 15) deflection and retreat readings were taken after each increment had been supported for five minutes.

**RESULTS**

The required factor (old specification) of 5.5 was put on, and after having supported the load for three minutes, the cross tubes between the lower longerons connecting the flying wires, pulled in two. See Figure 32 for photograph of failure; Figure 15 for tabulated deflection and retreat readings, and for wing spar deflection curves, Figure 16.

**DISCUSSION**

Although the rear spars showed a generous amount of deflection, further test for low incidence condition was deemed unnecessary.

Due to the type of fitting between the interplane struts and the spar, the spar deflection caused an "S" shape bend in the interplane struts to an amount of one-half inch from the true centerline.

**CONCLUSION**

With the fuselage made strong enough and the struts to spar fitting pins relocated, so that they will be parallel to the wing ribs, the wing cellule will be satisfactory for the old requirements.

**RECOMMENDATIONS**

Redesign the portion of the fuselage where the flying wire fittings are located.

Change the position of the pins in the strut to spar fittings.

---

**Strength properties of flanges from Boeing pursuit wing beams**

<table>
<thead>
<tr>
<th>Location of—</th>
<th>Moisture content, per cent</th>
<th>Specific gravity</th>
<th>Modulus of—</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam</td>
<td>Flange</td>
<td></td>
<td>Rupture, lb. per sq. in.</td>
</tr>
<tr>
<td>Upper right:</td>
<td></td>
<td></td>
<td>11,455</td>
</tr>
<tr>
<td>Front</td>
<td>Top</td>
<td>9.63</td>
<td>0.345</td>
</tr>
<tr>
<td></td>
<td>Bottom</td>
<td>9.35</td>
<td>0.256</td>
</tr>
<tr>
<td>Rear</td>
<td>Top</td>
<td>9.86</td>
<td>0.341</td>
</tr>
<tr>
<td></td>
<td>Bottom</td>
<td>9.16</td>
<td>0.443</td>
</tr>
<tr>
<td>Lower left:</td>
<td></td>
<td></td>
<td>13,210</td>
</tr>
<tr>
<td>Front</td>
<td>Top</td>
<td>9.34</td>
<td>0.248</td>
</tr>
<tr>
<td></td>
<td>Bottom</td>
<td>9.68</td>
<td>0.302</td>
</tr>
<tr>
<td>Rear</td>
<td>Top</td>
<td>10.00</td>
<td>1,820</td>
</tr>
</tbody>
</table>

**PROCEDURE FOR TEST (HIGH INCIDENCE)**

The airplane was reset so that the angle between the wing chord and horizontal represented by $\gamma$ was $7^\circ$, leading edge down.

$$\angle a = 12^\circ 24'$$
$$\angle \beta = \cot^{-1} \L /D = \cot^{-1} 11.0 = 5^\circ 12'$$

The center of gravity of the load was located at 30 per cent of the wing chord.

The loads were placed according to the loading schedule, Figure 17. Deflection and retreat readings were taken at points indicated in Figure 18 after each load increment had been supported for five minutes.

**RESULTS**

Required load factor (old specifications) was 8.5; new specifications 12. At a factor of 7 the N struts were bent very noticeably. The bending increased with each added load increment. At a factor of 8 the test was delayed by the other side of the cross tubes between the lower longerons pulling out, a similar failure to the one during low incidence test.

As the jacks were let down at a load factor of 11, the front member of the right end strut failed, as shown in Figure 33. For tabulated deflection and retreat reading, see Figures 18 and 19. For wing spar deflection curves, see Figures 20 and 21.

**DISCUSSION**

The distortion and additional load imposed on the N strut by the spar deflection was an important factor in causing failure.

At a load factor of 8 the other side of the fuselage cross tubes pulled out. These tubes were rewelded and in addition a steel strap was connected from one side of the fuselage to the other side, carrying the stresses around the welds, instead of through them. This held satisfactorily.

The following test results were obtained by the material section from four wing spars, the right upper front and rear, and the left lower front and rear. Test specimens were taken from the spar flanges.
DISCUSSION OF RESULTS

The spruce in the flanges gave good and consistent strength properties. With the exception of work to maximum load for the bottom flange of the lower left rear beam, the strength properties of the flanges were slightly higher than those for spruce of average grade. The small size of the test specimens may have had a tendency to increase the strength properties slightly.

An examination of the small test specimens disclosed a few small compression failures in the bottom flange of the lower left rear beam, which may have resulted from the static test. In cross bending, this specimen failed in brush tension, giving the extremely low value in work to maximum load.

Furthermore, a slope in grain of approximately 1:12 was found in a portion of the bottom flange of the lower front left beam. This defect should have been noted before construction of the flange.

CONCLUSION

The strength properties of the spruce flanges were good and consistent.

The moisture content was satisfactory and uniform.

A few small compression failures were noted in the bottom flange of the lower left rear beam and the slope of the grain of 1:12 in the lower front left beam.

Excepting the cross tubes of the fuselage in the plane of the wings, the wing cellule held satisfactorily the load for which it was designed. For the new requirement some redesigning is necessary before the wing cellule will be entirely satisfactory.

RECOMMENDATIONS

Redesign the portion of the fuselage supporting the flying wire fittings. Redesign the end strut spar fittings.

AILERON TEST

DESCRIPTION

The two ailerons were located in the trailing edge of the upper wing, each supported by four hinges. They were controlled by means of flexible steel cables, placed inside the wing on the back side of the rear spar. From the upper wing the cable extended to a pulley on the lower longeron and then to the control stick.

The aileron was built about a box-type spar. The rib webs were three-ply veneer, poplar core with mahogany sides. The web was capped with spruce strips, and terminated at the trailing edge, which was a 3/8-inch flexible steel cable. For an assembly drawing of the aileron, see Figure 22.

<table>
<thead>
<tr>
<th>Area of each aileron</th>
<th>7.77 square feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of each aileron</td>
<td>10.00 pounds</td>
</tr>
<tr>
<td>Structural weight per square foot of area</td>
<td>1.3 pounds</td>
</tr>
</tbody>
</table>

PROCEDURE FOR TEST

The aileron was assembled on the wing as for flight. With the control system in the neutral position, initial readings were taken.

A spring balance attached to the control stick was used to determine the pounds pull on the stick for each load increment added. Load increments of 5 pounds per square foot were put on, up to and including 225 pounds per square foot, after which 2 1/2 pounds increments were added for the remainder of the test.

RESULTS

<table>
<thead>
<tr>
<th>Load in Pounds pull per sq. ft.</th>
<th>Trailing edge of ailerons below neutral position</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>10</td>
<td>11/2</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>11/2</td>
</tr>
<tr>
<td>15</td>
<td>30</td>
<td>11/2</td>
</tr>
<tr>
<td>20</td>
<td>40</td>
<td>11/2</td>
</tr>
<tr>
<td>25</td>
<td>50</td>
<td>11</td>
</tr>
<tr>
<td>30</td>
<td>60</td>
<td>11 1/2</td>
</tr>
<tr>
<td>35</td>
<td>70</td>
<td>1 1/2</td>
</tr>
<tr>
<td>40</td>
<td>80</td>
<td>1/2</td>
</tr>
<tr>
<td>45</td>
<td>90</td>
<td>1/2</td>
</tr>
</tbody>
</table>

See Figure 34 showing how the pulley brackets bent under load. Part of the bracket from the other half of the wing is also shown in this figure.

Figure 35 shows how the control stick was bent.

DISCUSSION

In the pulley bracket, the location of the bolt holes does not permit the bracket to keep its original form and support the required load. The control stick support bent, due to being previously distorted by the end of the control stick, which bent the four angular legs, weakening them for the aileron load, which, when put on, caused the bracket to distort and shift the stick from its original position.

CONCLUSION

The ailerons were satisfactory, but their control system should be strengthened.

RECOMMENDATIONS

Redesign the cable pulley brackets and the control stick support.

LEADING EDGE STATIC TEST

DESCRIPTION

A 5-foot section of the upper wing leading edge was selected for the test. The leading edge extended forward of the vertical centerline of the front spar, an average distance equal to 16.23 per cent of the average chord for the section selected.

A 6-foot section was selected from the lower wing. The leading edge forward of the vertical centerline of the front spar amounted to 15.09 per cent of the average wing chord of the section.

Figure 23 gives the dimensions of the sections tested, locating them in respect to their original position when a part of the wing.

PROCEDURE FOR TEST

Each section was supported in an inverted position with points of support at the spar between the rib capstrips.
The load on the leading edge was counterbalanced by shot bags placed on the section along the rear spar. The factor of failure was computed as follows: For a leading edge having a length equal to 10 percent of the wing chord, one-half of the normal load per running foot on the entire wing, from which section was taken, was considered a load factor of one.

The load factor for the upper wing leading edge was .1623 \times \text{load factor just found, for the lower wing leading edge it is } 1.509 \times \text{load factor.}

Dividing the new factor into the load per foot run supported by the leading edge gives the load factor at which the leading edge failed.

**RESULTS**

A factor of 14 required.

\[
\frac{1.623 \times 2495 \cdot .336}{10} = 34.8 \text{ basic factor, upper wing.}
\]

\[
3900 \div 5 = 22.4 \text{ load factor at which the leading edge of wing failed.}
\]

\[
\frac{1.509 \times 2495 \cdot .664}{10} = 40.8 \text{ basic factor, lower wing.}
\]

\[
2265 \div 6 = 13.9 \text{ load factor at which failure occurred.}
\]

\[
\frac{30.58}{40.8} = 0.75 \text{ load factor at which failure occurred.}
\]

**DISCUSSION**

None.

**CONCLUSION**

Both leading edges were satisfactory.

**RECOMMENDATIONS**

None.

**STABILIZER AND ELEVATOR TESTS**

**DESCRIPTION**

The stabilizer was built around two spruce spars, the front spar having an "I" cross-section, and was glued up of six thin spruce pieces to a similar curvature of the leading edge. The rear spar was made from one piece of spruce, routed on the stabilizer side, which provided clearance for the elevator spar. The leading edge was covered with \( \frac{3}{4} \)-inch three-ply veneer, mahogany side with poplar core. The stabilizer was adjustable, through the front spar, being hinged about the tubular elevator spar. There were two streamline wires per side, connecting the hinge, located 29\( \frac{1}{2} \) inches from the vertical centerline of the airplane, with the lower longeron and the fin mast.

For a general layout of the stabilizer, see Figure 24. For a photograph of the stabilizer structure, see Figure 36.

The ribs were made from \( \frac{3}{4} \)-inch mahogany sides, poplar core veneer, reinforced and capped with rectangular section spruce strips.

For typical rib drawing, see Figure 25.

The stabilizer and elevator were connected by means of six band type hinges. Through these hinges the rear spar of the stabilizer was connected to the fuselage. The elevator spar being positioned by means of a bearing on the tail post of the fuselage.

The elevator was of the steel tube type, with electrically welded joints, and fabric covered. Control was obtained by two pairs of flexible steel cables from the control stick to the control masts located on both sides of the fuselage.

See Figure 24 for an assembly drawing, and Figure 37 for a photograph.

Weight of stabilizer: 23.5 pounds.

Weight of elevator: 18.5 pounds.

Area of stabilizer: 18.75 square feet.

Area of elevator: 9.9 square feet.

**PROCEDURE FOR TEST**

The surfaces and control system were completely assembled as for flight. The fuselage was supported so that the thrust line was horizontal. A spring balance with block and tackle attached to the control stick was used to measure the pull required to actuate the elevators under load. Scales were suspended at points indicated in Figure 26, from which deflection readings were taken by means of a wye level.

The load was applied in increments of 5 pounds per square foot up to and including 25 pounds per square foot, and then in 25 pounds increments until failure resulted.

The average load per square foot on the elevator was assumed to be two-thirds the average load on the stabilizer. The stabilizer load was assumed to be uniform, and the elevator load as varying from a maximum at the hinge to one-third maximum at the trailing edge, which results in a center of pressure location for unbalanced surfaces at \( \frac{1}{3} \) of the mean chord.

**RESULTS**

Tabulated results are given in Figure 26. The stabilizer adjustment worked very well until a load of 25 pounds per square foot when the adjustment of the surfaces required all one hand could pull. At 30 pounds per square foot the adjustment mechanism could no longer be operated. After a load of 60 pounds per square foot was supported without failure, further testing was decided unnecessary for fear of damaging the fuselage.

**DISCUSSION**

None.

**CONCLUSION**

The tail surfaces and their control system was satisfactory.

**RECOMMENDATIONS**

None.

**RUDDER AND FIN TESTS**

**DESCRIPTION**

The structure of the rudder and fin was welded steel tube construction, fabric covered. Three hinges connected the rudder to the fuselage and fin. One of the three hinges was located on the tail post of the fuselage, the other two were on the fin mast. The fin mast
telescoped into the fuselage tail post for about an inch, being held there by the compression from the two wires connecting the fin mast to the elevator stabilizer hinges. See Figure 27 for an assembly drawing of the rudder and fin.

The rudder was controlled by means of a ½-inch diameter flexible steel cable. For a photograph of the vertical tail surfaces with the fabric removed, see Figure 38.

### Rudder and Fin

<table>
<thead>
<tr>
<th>Rudder</th>
<th>Fin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>6 lbs</td>
</tr>
<tr>
<td>Area</td>
<td>3.78 sq. ft.</td>
</tr>
<tr>
<td>Structural weight per square foot</td>
<td>1.31 lbs</td>
</tr>
</tbody>
</table>

**PROCEDURE FOR TEST**

The rudder and fin were assembled to the fuselage as for flight. To one end of the rudder bar the control cable was connected, to the other end of the rudder bar a spring balance with block and tackle was connected by means of which the force in pounds necessary to actuate the rudder under load was obtained. The fuselage was firmly supported on its side with the rudder and fin in a horizontal position. At the points indicated in Figure 28, scales were suspended in order that the deflection readings could be read by means of a wye level. The loading and taking of readings was the same as for the test of the stabilizer and elevators.

**RESULTS**

Required load—30 pounds per square foot.

Figure 28 gives the deflection readings and pounds pull on the rudder bar per load increment.

A load of 50 pounds per square foot caused a permanent set in the fin ribs. When 57.5 pounds per square foot were supported, the load was about to fall off. No more load was added.

**DISCUSSION**

Figure 38 does not show how much the ribs were distorted, however; the ribs could be straightened to their original shape.

The addition of a small bolt through the lower end of the fin mast and the fuselage tail post, at the place where the former telescopes with the latter, would be very helpful in holding the fin to the fuselage in case one of the diagonal wires should break.

**CONCLUSION**

The fuselage held the required factor satisfactorily, and the rudder control worked very well.

**RECOMMENDATIONS**

None.

**FUSELAGE TEST**

**DESCRIPTION**

The fuselage was made from mild steel tubes, electrically welded together. For a general layout and tube sizes, see Figure 29.

Weight of fuselage—190 pounds.

**PROCEDURE FOR TEST**

The fuselage was supported in a test jig by the upper wing through the cabane struts and flying wires until they had supported their required portion of the load, after which the lower wing bearing points were allowed to support the remainder of the load applied.

The load was applied at four points, A to D, inclusive, Figure 30, according to the loading schedule. Scales were suspended from four points, E, F, G, and H, from which deflection readings were taken by means of a wye level. The load increments were supported for five minutes before readings were taken.

**RESULTS**

Factor of 7 required.

As the load was applied at a factor of 5 the rear spar cabane strut fitting, left side, pulled away from the spar, see Figure 39. At 6.5 the engine bearer strut, right side, began to buckle. At a factor of 8 the lower longerons, left side, buckled in the third bay forward of the tail post, see Figure 40. In the third and fourth bays from the tail post the vertical tubes were buckled.

For tabulated deflection readings, see Figure 30.

**DISCUSSION**

When the fabric was removed from the wing a rivet was found sheared off, due to shifting of the flying wire and strut to spar fitting, see Figure 41. This failure is credited to the fuselage test.

At a factor of 8 no load was put on the engine bearers.

When the cross tubes supporting the flying wire fittings have been made strong enough, the fuselage structure will be satisfactory.

**CONCLUSION**

The fuselage held the required factor satisfactorily.

**RECOMMENDATIONS**

None (except change called for in wing test).

**DYNAMIC TEST OF TAIL SKID**

**DESCRIPTION**

Photograph, Figure 42, shows the general design of the tail skid and shock absorbing unit. Foot control of the tail skid was provided by means of flexible steel cables connecting the rudder bar to the tail skid control mast. In each cable a steel spring with a fixed amount of travel was mounted, so that the shock and jerking of the tail skid when taxiing will not be transferred so severely to the rudder bar.

Weight of tail skid assembly—9½ pounds.

**PROCEDURE FOR TEST**

The chassis was intact with the fuselage and tail skid. The wheels of the chassis were placed on a platform inclined to the horizontal at an angle of 9½ degrees in the plane of the axle.

The load was placed on the tail post and at the vertical strut location along the fuselage, as shown in
Figure 42. The load was made equal to the tail skid reaction when the airplane was in a landing position, which amounted to 450 pounds.

The first drop was made from a 6-inch height and each successive drop from a 3 inch greater height than the last drop.

**RESULTS**

Required height of drop—30 inches.

The first six-inch drop distorted the rear part of the fuselage. This concluded the test. Figure 42 is a photograph of the failure.

**DISCUSSION**

The design of the tail skid and the shock absorbing unit was such that when the impact occurred in a landing position the shock absorber unit was ineffective, for it would not function. The only force that would cause the rubber to function, was the horizontal drag force present when the airplane was in motion and the tail skid sliding along on the ground. The resultant force from the drag and impact forces, which would actuate the tail skid and extend the shock absorber unit, was not present in a plain drop as used for the standard impact test and which frequently occurs in service.

**CONCLUSION**

The tail skid was not satisfactory.

**RECOMMENDATIONS**

Redesign the tail skid assembly.

**LANDING CHASSIS**

**DESCRIPTION**

The landing chassis was all steel with the exception of the axle fairing, which was wood framework with three-ply veneer covering. This fairing has a thick airfoil cross section, 18 inch chord, which gives 6.75 square feet of lifting surface as well as being the cross tie between the two struts.

97159—24—2

The struts are formed from sheet steel and acetylene welded at the trailing edge.

The shock absorber was wound with 3/4-inch diameter cord.

Weight of chassis, including wheels—107 pounds.

For an assembly drawing of chassis, see Figure 31.

**PROCEDURE FOR TEST**

With the chassis assembled to the fuselage and the tires inflated to an air pressure of 60 pounds per square inch, the tail end of the fuselage was connected through a hinge coupling to the test jig, so that the center of gravity of the airplane was vertically above the point of tangency of the wheels.

To simulate the combination of direct load and side thrust, an auxiliary platform was placed under the wheels, built at an angle of 9½ degrees to the horizontal. When the impact occurred the ratio of side load to down load was 1 to 6.

The reaction at the wheels with the fuselage in flying position was 2,650 pounds. In order to insure safety to everything concerned while testing, one-half the load was used dropped from twice the height. Height of first drop 6 inches.

**RESULTS**

Required height of drop 24 inches with full load, or 48 inches with half load, which for all practical purposes are the same when the height of drop is small.

The chassis held for a 39 inch drop; when dropped from a 41 inch height, the right rear strut began to buckle, as shown in Figure 43.

The shock absorber units functioned satisfactorily.

**DISCUSSION**

None.

**CONCLUSION**

The chassis was not strong enough.

**RECOMMENDATIONS**

Increase the strength of the chassis struts.
NOTE - ALL PLYWOOD, BIRCH FACES, POPULAR CORE.
CAP STRIPS AND STRUT MEMBERS SPRECE.

SECTION AA

SECTION BB

SECTION DD

SECTION CC (PLAIN RIB)

SECTION DD' FOR PLAIN RIB

SECTION DD FOR PLAIN RIB

SECTION AA ON PLAIN RIB

FIG. 7

BOEING PURSUIT WING RIB DETAILS

FIG. 8

FIG. 9
BOEING PURSUIT
UPPER FRONT SPAR
OUTBOARD FITTING

FIG. 10

BOEING PURSUIT
REVERSE LOAD STATE TEST

FIG. 12

<table>
<thead>
<tr>
<th>LOAD</th>
<th>DEFLECTIONS</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A  B  C  D  E  F  G  H  I  J  K  L</td>
<td>UPPER</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RIGHT</td>
</tr>
<tr>
<td>2</td>
<td>0  1  2</td>
<td>3  4  5</td>
</tr>
<tr>
<td>3</td>
<td>1  2  3</td>
<td>4  5  6</td>
</tr>
<tr>
<td>3.5</td>
<td>2  3  4</td>
<td>5  6  7</td>
</tr>
<tr>
<td>4</td>
<td>3  4  5</td>
<td>6  7  8</td>
</tr>
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</table>

FIG. 11
LOADING SCHEDULE FOR LOW INCIDENCE CONDITION

<table>
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<tr>
<th>LOAD FACTOR</th>
<th>UPPER WING</th>
<th>LOWER WING</th>
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<td>3</td>
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<td>404</td>
</tr>
<tr>
<td>4</td>
<td>500</td>
<td>608</td>
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<tr>
<td>5</td>
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<td>569</td>
</tr>
<tr>
<td>6</td>
<td>565</td>
<td>600</td>
</tr>
</tbody>
</table>

LOW INCIDENCE STATIC TEST

- Held 3 minutes. Lower front cross tubes pulled in two, between the lower longitudinal.
FIG. 19

BOMBING PURSUIT
HIGH-INCLINEER STATIC TEST
INCL. 45.10

<table>
<thead>
<tr>
<th>LOAD FACTOR</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
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<td>9</td>
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<td>38</td>
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<td>16</td>
<td>29</td>
<td>51</td>
<td>-3</td>
<td>+9</td>
<td>+7</td>
</tr>
<tr>
<td>8</td>
<td>31</td>
<td>16</td>
<td>10</td>
<td>4</td>
<td>4</td>
<td>23</td>
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<td>31</td>
<td>57</td>
<td>-4</td>
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<td>34</td>
<td>17</td>
<td>12</td>
<td>5</td>
<td>9</td>
<td>13</td>
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<td>45</td>
<td>45</td>
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<td>4</td>
<td>5</td>
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<td>36</td>
<td>64</td>
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<tr>
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<td>36</td>
<td>18</td>
<td>10</td>
<td>6</td>
<td>9</td>
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<td>69</td>
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<tr>
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<td>7</td>
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<td>16</td>
<td>30</td>
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<td>14</td>
<td>5</td>
<td>6</td>
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<td>41</td>
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<tr>
<td>10</td>
<td>43</td>
<td>22</td>
<td>12</td>
<td>7</td>
<td>10</td>
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<td>17</td>
<td>34</td>
<td>61</td>
<td>63</td>
<td>36</td>
<td>18</td>
<td>5</td>
<td>6</td>
<td>24</td>
<td>48</td>
<td>87</td>
</tr>
</tbody>
</table>

RIGHT INTERCLASS STRUT (FRONT MEMBER) FAILED AS JUMPS WERE LET DOWN

FIG. 20

FIG. 21


LOADING SCHEDULE AND TABLE OF DEFLECTIONS OF BORING PURSUIT

<table>
<thead>
<tr>
<th>LBS</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>10</td>
<td>15</td>
<td>20</td>
<td>25</td>
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<td>40</td>
<td>45</td>
</tr>
<tr>
<td>10</td>
<td>15</td>
<td>20</td>
<td>25</td>
<td>30</td>
<td>35</td>
<td>40</td>
<td>45</td>
<td>50</td>
</tr>
<tr>
<td>15</td>
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<td>25</td>
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<td>40</td>
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<td>25</td>
<td>30</td>
<td>35</td>
<td>40</td>
<td>45</td>
<td>50</td>
<td>55</td>
<td>60</td>
</tr>
</tbody>
</table>

WORKED WELL

WORKED WITH ONE HAND

FAILED

VERY NARROW

LOCKED

HELD THE FOLLOWING LOADS: 100 PER 50 FT, 375, 40, 42.5, 45, 47.5, 50, 57.5, 65, 67.5, AND 70 WITHOUT FAILURE.

STABILIZER HEIGHT 25.5-LBS. AREA 18.75 SQ. FT.
ELEVATION - 18.5 - 30

FIG. 26

FIG. 27
Vertical tail surface Boeing pursuit

<table>
<thead>
<tr>
<th>Loading</th>
<th>Pull on Rudder</th>
<th>Deflections</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pounds</td>
<td>Ft. Per Rudder</td>
<td>Bar</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>5</td>
<td>23</td>
<td>40</td>
<td>1</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>36</td>
<td>50</td>
<td>2</td>
<td>14</td>
<td>9</td>
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<tr>
<td>15</td>
<td>48</td>
<td>68</td>
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<td>18</td>
<td>12</td>
</tr>
<tr>
<td>20</td>
<td>62</td>
<td>80</td>
<td>4</td>
<td>18</td>
<td>17</td>
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<tr>
<td>22.8</td>
<td>72</td>
<td>105</td>
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<td>18</td>
<td>19</td>
</tr>
<tr>
<td>25</td>
<td>80</td>
<td>110</td>
<td>6</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>27.5</td>
<td>100</td>
<td>120</td>
<td>7</td>
<td>3.3</td>
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<td>110</td>
<td>144</td>
<td>8</td>
<td>3.5</td>
<td>20</td>
</tr>
</tbody>
</table>

Hold 23.5, 23.8, 23.9, 24.0, 24.5, 25.0, 25.5 and 33 pounds per sq. ft.
Load 310 lb. at 314 pounds per sq. ft.

Fig. 28

Tube sizes:
- **Symbol:** DIA. WALL
- **A:** 1 25 053
- **B:** 1 25 053
- **C:** 2 039
- **D:** .75 039
- **E:** .625 039
- **F:** .500 035

Fig. 29
### Boeing Pursuit Fuselage Static Test

<table>
<thead>
<tr>
<th>LOAD FACTOR</th>
<th>LOADS IN POUNDS</th>
<th>DEFLECTIONS IN INCHES</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5400 4754 644 644</td>
<td>0.4 0.9 1.1 2.2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5400 4424 996 686</td>
<td>0.4 1.1 1.4 2.9</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4800 2992 1088 928</td>
<td>0.4 1.3 1.7 3.7</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>6000 3550 1700 1170</td>
<td>0.6 1.8 2.5 5.7</td>
<td>Left rear sparicone struts to spar fitting pulled out as tracks were lowered blocks were placed under lower longitudinal.</td>
</tr>
<tr>
<td>5.5</td>
<td>6600 4129 1876 1291</td>
<td>0.6 1.8 2.5 5.6</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>7200 4598 2032 1412</td>
<td>0.6 1.9 2.6 5.9</td>
<td></td>
</tr>
<tr>
<td>6.5</td>
<td>7800 4897 2228 1535</td>
<td>0.6 1.9 2.6 6.0</td>
<td>R.H. engine bearer strut began to buckle.</td>
</tr>
<tr>
<td>7</td>
<td>8400 5266 2404 1654</td>
<td>0.5 1.9 2.6 6.2</td>
<td></td>
</tr>
<tr>
<td>7.5</td>
<td>9000 5645 2580 1775</td>
<td>0.5 2.0 2.7 6.3</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>9600 6024 2756 1896</td>
<td>Held</td>
<td>L.H. lower longitudinal buckled in 3rd bay from tail post and vertical struts in 3rd and 4th bulkheads buckled.</td>
</tr>
</tbody>
</table>

**Fig. 30**

---

### Typical Strut Section

**Fig. 21**
FIG. 38

FIG. 39