MR No. L5B13b
1104
Grumman F6F-3
Pt. 3

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WARTIME REPORT

ORIGINALLY ISSUED

February 1945 as
Memorandum Report L5B13b

FLIGHT MEASUREMENTS OF THE FLYING QUALITIES OF AN F6F-3 AIRPLANE (BUAER NO. 04776)

III - STALLING CHARACTERISTICS

By Walter C. Williams and John P. Reeder

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NACA

WASHINGTON

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

MEMORANDUM REPORT

for the

Bureau of Aeronautics, Navy Department

FLIGHT MEASUREMENTS OF THE FLYING QUALITIES OF AN F6F-3 AIRPLANE (BUAER NO. 04776)

III - STALLING CHARACTERISTICS

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INTRODUCTION

At the request of the Bureau of Aeronautics, Navy Department, flight measurements were made of the flying qualities of an F6F-3 airplane. The results of measurements of the longitudinal stability and control and lateral and directional stability and control are presented in references 1 and 2, respectively. The present paper presents results of tests made to determine the stalling characteristics of the subject airplane. The entire flying-qualities test program was conducted at the Langley Field Laboratory of the NACA.

AIRPLANE

General views of the F6F-3 airplane are shown in figures 1 and 2. Figure 3 is a three-view layout of the subject airplane. Pertinent details and dimensions of the F6F-3 are given in reference 1.

INSTRUMENTATION

Standard NACA photographically recording instruments were used to measure the various quantities necessary to determine the flying qualities of the subject airplane. A detailed description of the instrumentation used in the present tests is presented in reference 1.

TESTS, RESULTS, AND DISCUSSION

The various flight conditions used in the present tests are defined below.

Condition	Flaps	Landing gear	Canopy	Cowl flaps	Oil and intercooler shutters	RPM	Manifold pressure (in. Hg)
Gliding	Up	Up	Closed	Closed	Closed	Engine idling	
Climbing	Up	Up	Closed	Closed	Closed	2550	43
Landing	Down	Down	Open	Closed	Closed	Engine idling	
Approach	Down	Down	Open	Closed	Closed	2550	23
Wave-off	Down	Down	Open	Open	Open	2550	43

The gross weight of the airplane for the present tests was approximately 11,200 pounds at take-off. The weight was corrected for gas consumption during the flight in calculating the values of lift coefficient presented herein. Lift coefficient as used in the present paper is calculated using the normal component of acceleration and is actually the normal-force coefficient. Differences between the two coefficients, however, are small.

The stalling characteristics of the F6F-3 airplane in steady flight were determined in stalls made by gradually decreasing the speed in straight flight. The motions of the airplane and of the controls were recorded during the stall approach and in some cases after the stall. The stability characteristics and the maximum lift coefficients during the stall approaches were determined. A camera had been installed in the airplane in order to check the rate of roll during low-speed aileron rolls. The camera installation was then used to make some tuft studies of the left wing. These tuft studies are rather limited and no particular effort was made to obtain a complete series of tuft pictures. Figure 1 shows the tufts on the wing.

Time histories of stall approaches in the various conditions of flight are given in figures 4 to 13. Tuft studies corresponding to figures 4 and 12 are given in figures 14 and 15. The stalling characteristics may be summarized as follows:

(a) In the gliding condition (figs. 4 and 5) stall warning was afforded by a howl in the duct on the underside of the engine cowling (see fig. 2) beginning about 18 miles per hour above the stall and by an increased general vibration of the airplane felt in the stick and rudder pedals about 5 miles per hour above the stall. In addition, there was a very mild buffeting beginning 1 to 2 miles per hour above the stall and increasing in intensity as the initial roll off to the left occurred. This buffeting preceding the roll-off cannot be relied upon as a stall warning since it was obtained only with very slow approaches to the stall. In the stall, where the pilot attempted to hold the rudder and ailerons fixed after the initial roll-off (fig. 4), a rolling and mild pitching oscillation set in which increased in amplitude until the complete stall. Tuft pictures of the left wing taken during this run (fig. 14) show that the wing alternately stalled and unstalled during the oscillation. Use of the rudder and ailerons after the initial roll-off (fig. 5) resulted in diminished motion of the airplane up to the final stall. Maximum lift coefficient in the gliding condition varied from 1.35 to 1.45.

(b) In the climbing condition (figs. 6 and 7), general vibration of the airplane increased noticeably about 7 miles per hour above the stall. About 2 miles per hour above the stall a very mild buffeting set in. The intensity of this buffeting increased as roll-off to the right occurred. In the control-fixed stall (fig. 6), there was mild rolling and pitching up to the final roll-off. Use of the controls (fig. 7) resulted in rather violent motions of the airplane as the pilot overcontrolled. Maximum lift coefficient in the climbing condition varied from about 2.1 to 2.2.

(c) In the landing condition (figs. 8 and 9), a duct howl preceded the stall as in the gliding condition and a very mild buffet set in 1 or 2 miles per hour above the stall. As in the gliding and climbing conditions the buffet preceding the stall is noticeable only in a very slow stall approach. The stick-fixed stability was high for this condition and the stick was well back at the stall. The initial roll-off in all cases was to the left. In the control-fixed stall (fig. 8) the initial roll-off was followed by a rolling and pitching oscillation. Figure 9 shows that the pilot in attempting to control the airplane through the stall overcontrolled

which resulted in more violent motions of the airplane than with control fixed. Maximum lift coefficient varied from 2.15 to 2.25.

(d) In the approach condition (figs. 10 and 11) there was no stall warning. The initial roll-off was to the left. After the initial roll-off there was some buffeting of the airplane. A control-fixed stall is shown in figure 10. As shown in figure 11 the initial roll-off could be checked by use of the ailerons. Maximum lift coefficient in the approach condition varied from 2.35 to 2.45.

(e) In the wave-off condition (figs. 12 and 13), there was no stall warning whatsoever. The initial roll-off was to the right and was more severe than in any of the other conditions tested. This roll-off could be checked, however, by use of ailerons and rudder as shown in figure 13. Tuft pictures of the left wing made during the run shown on figure 12 show in figure 15 that the stall begins at the root and progresses outward. It should be noted, however, that the airplane rolled to the right in this run; and, therefore, the stall will be more extensive than that shown in figure 15 for the left wing. Maximum lift coefficient was approximately 3.0 in the wave-off condition.

In turning flight some stall warning was afforded by a mild buffeting of the entire airplane. The airplane initially pitched out of the turn, then pitched into the turn. During this pitching oscillation, which was probably caused by alternate stalling and unstalling of the wing, the airplane also went through a mild rolling oscillation. The final roll-off was mild and easily controllable. Maximum lift coefficient in accelerated flight in the climbing condition was approximately 1.4. Time histories of wind-up turns down to the stall are shown in reference 1.

CONCLUSIONS

1. Stall warnings existed in steady flight for the gliding, climbing, and landing conditions in the form of increased vibration, a duct howl in the power-off conditions, and gentle buffeting. The buffeting is not a reliable warning as it is obtained only if the stall approach is

very slow. No stall warning existed for the approach or wave-off conditions.

2. The initial roll-off was mild in most cases and could be checked by the use of ailerons and rudder. In cases where little or no control was used after the initial roll-off, mild rolling, and pitching oscillations set in and continued through the stall.

3. In accelerated flight, stall warning was afforded by buffeting of the entire airplane. The resultant pitching and rolling oscillations, as well as the final roll-off, were mild and easily controllable.

Langley Memorial Aeronautical Laboratory
National Advisory Committee for Aeronautics
Langley Field, Va., February 13, 1945

REFERENCES

1. Williams, Walter C., and Reeder, John P.: Flight Measurements of the Flying Qualities of an F6F-3 Airplane (BuAer No. 04776). I - Longitudinal Stability and Control. NACA MR No. L5B13, 1945.

2. Williams, Walter C., and Reeder, John P.: Flight Measurements of the Flying Qualities of an F6F-3 Airplane (BuAer No. 04776). II - Lateral and Directional Stability and Control. NACA MR No. L5B13a, 1945.

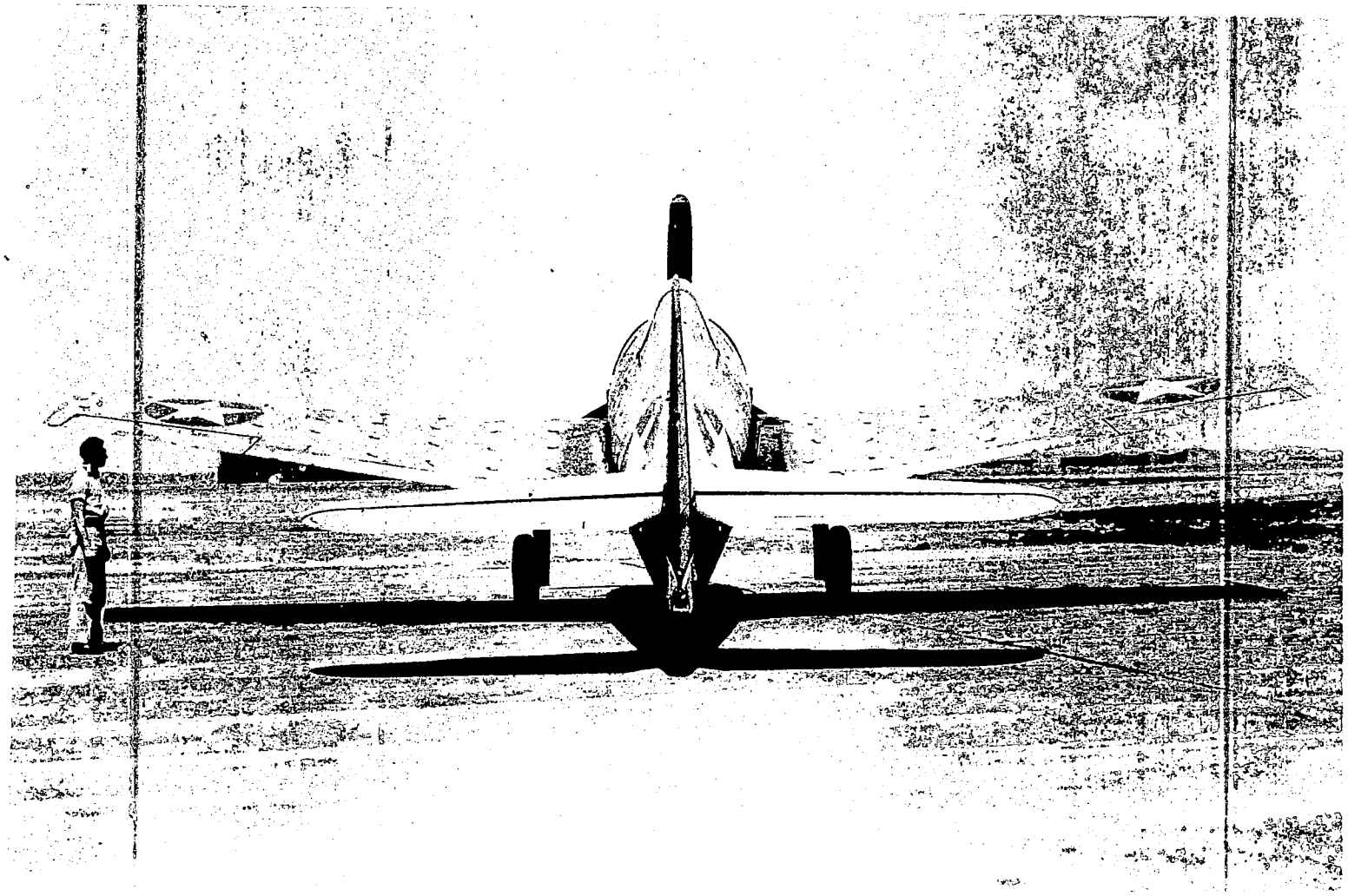

Figure 1.- Rear view of the F6F-3 airplane.

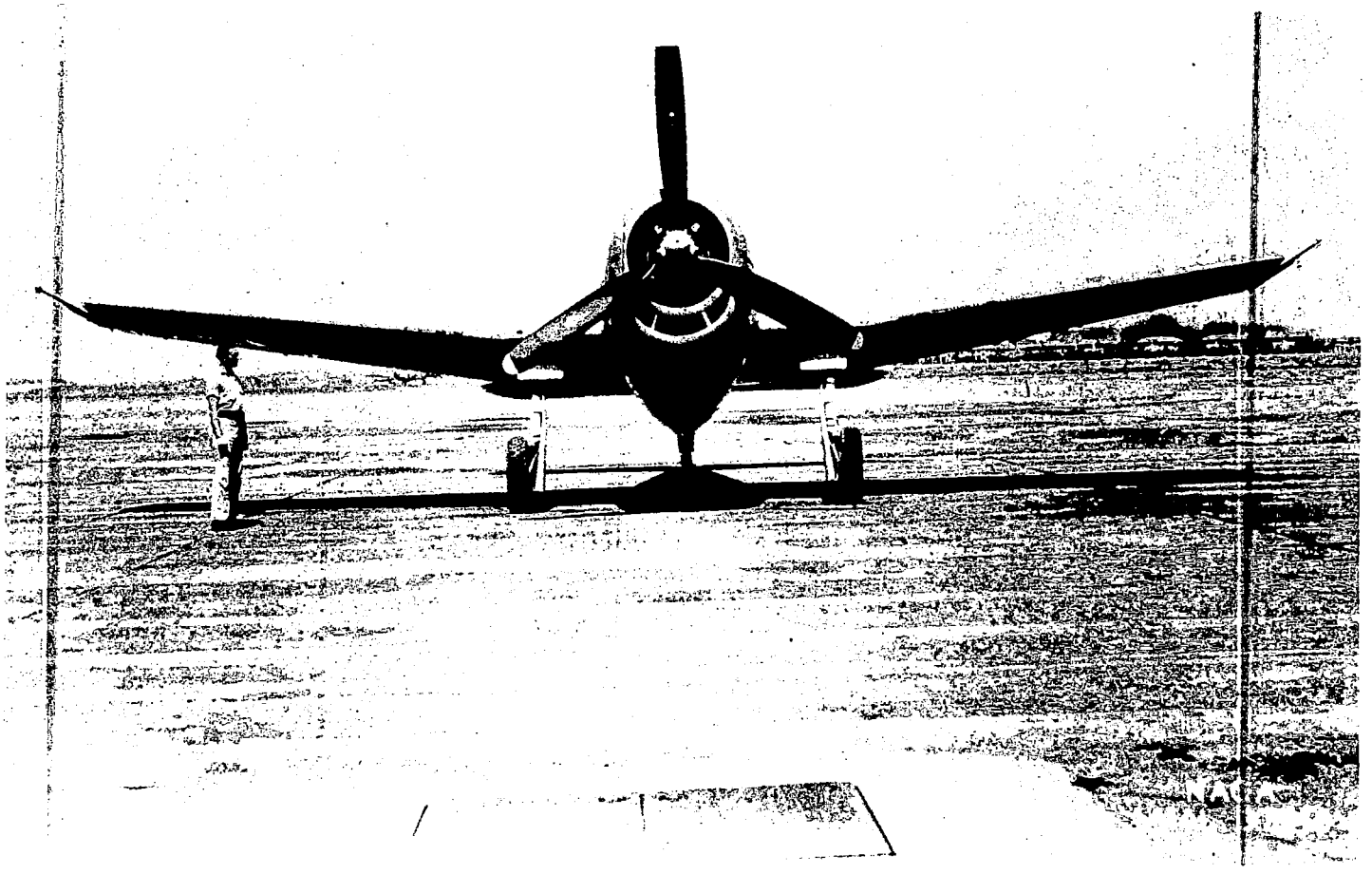

Figure 2.- Front view of the F6F-3 airplane.

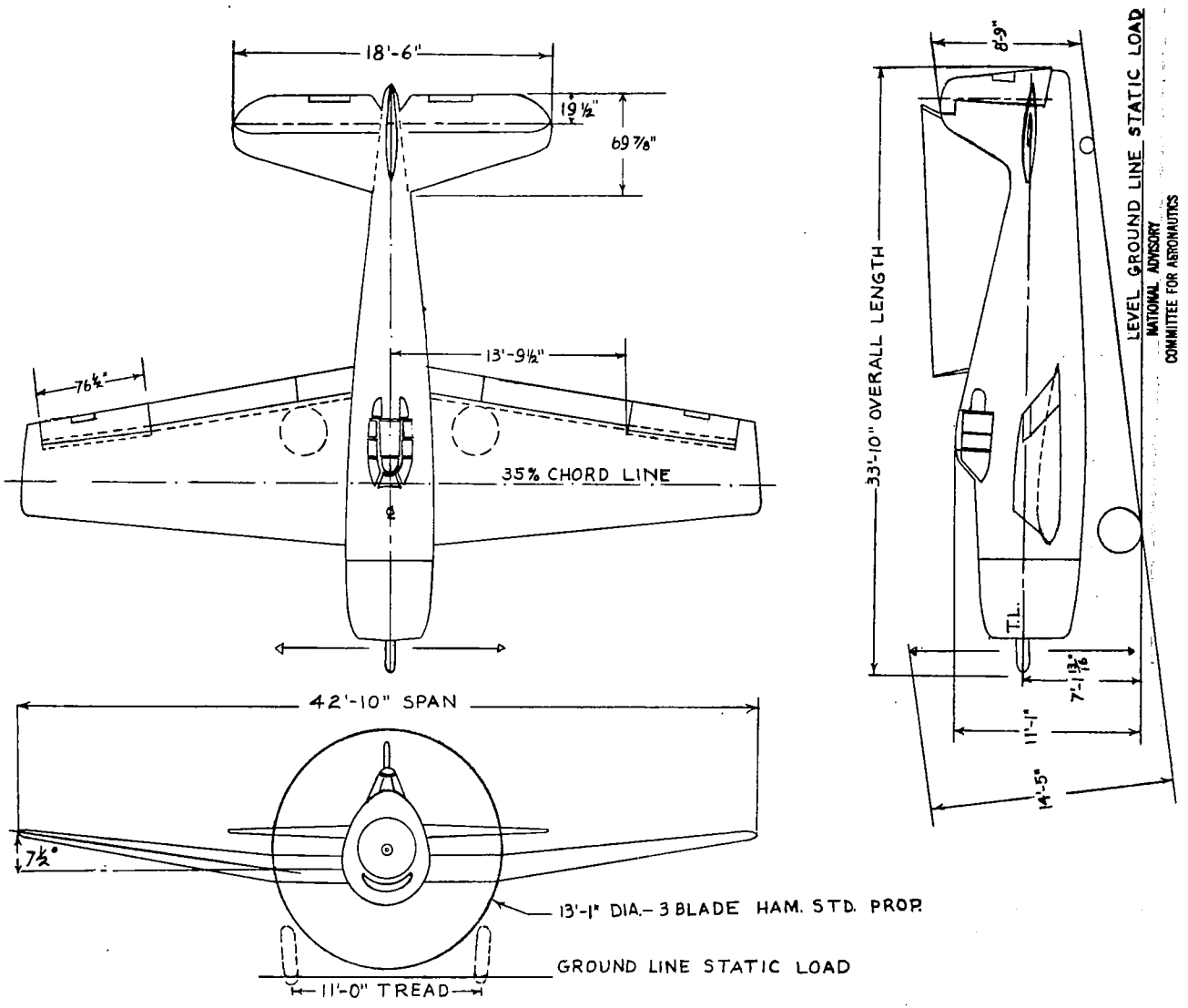

Figure 3. - Three-view layout of the F6F-3 airplane.

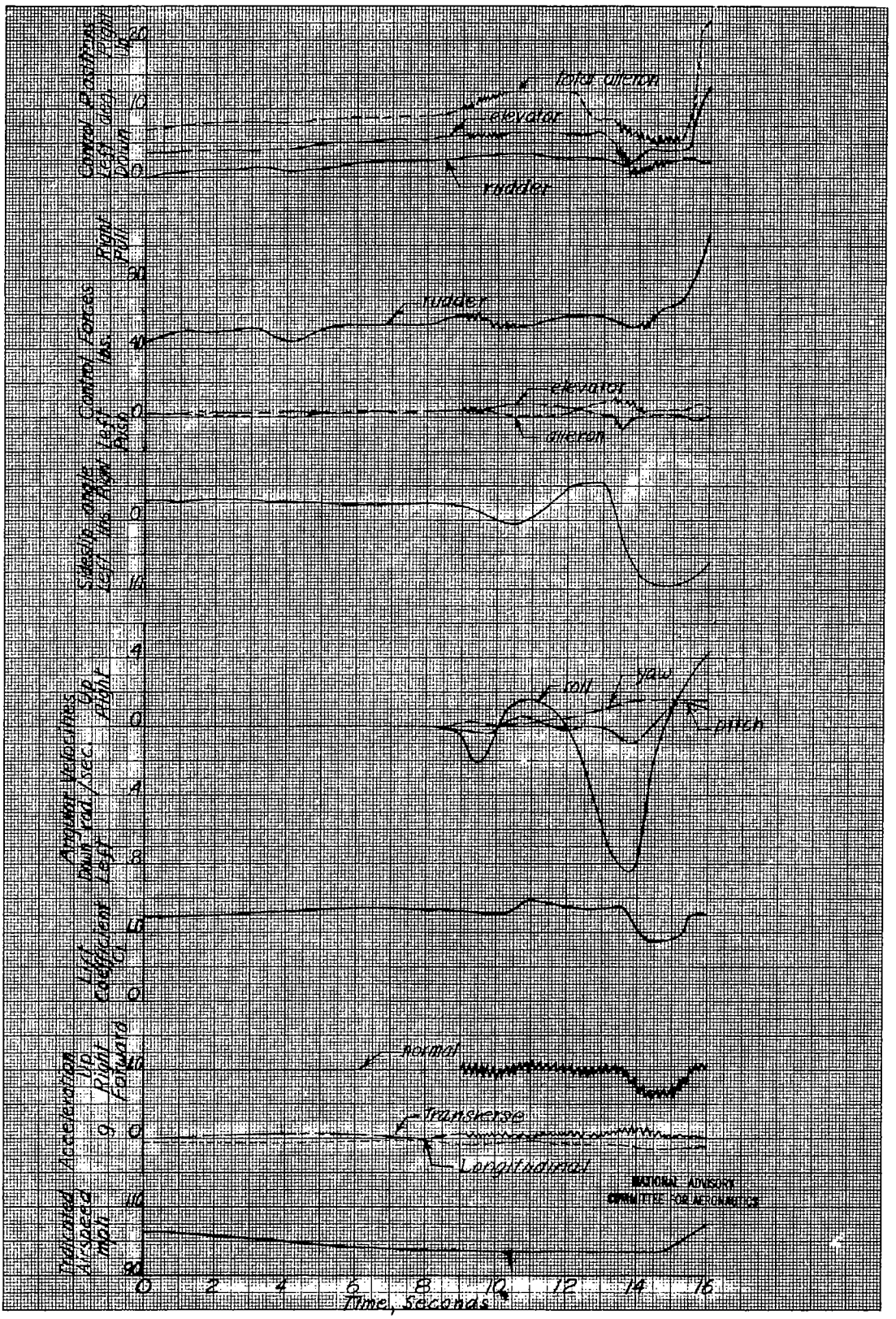

Figure 4. - Time history of a stall in gliding condition in which the pilot attempted to hold the aileron and rudder controls fixed after the initial roll-off. F6F-3 airplane.

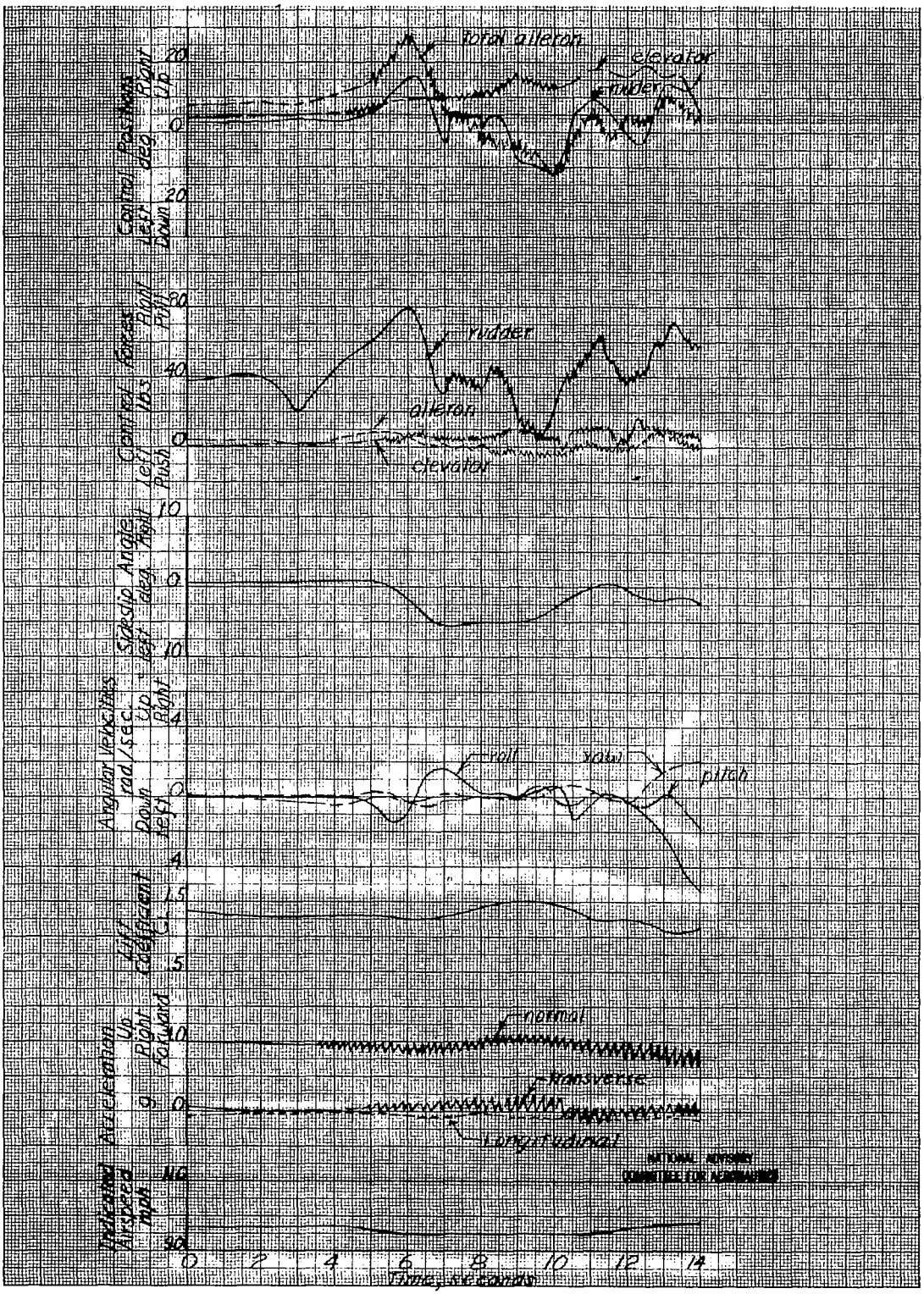

Figure 5. - Time history of a stall in the gliding condition in which the pilot attempted to control the airplane through the stall. F6F-3 airplane.

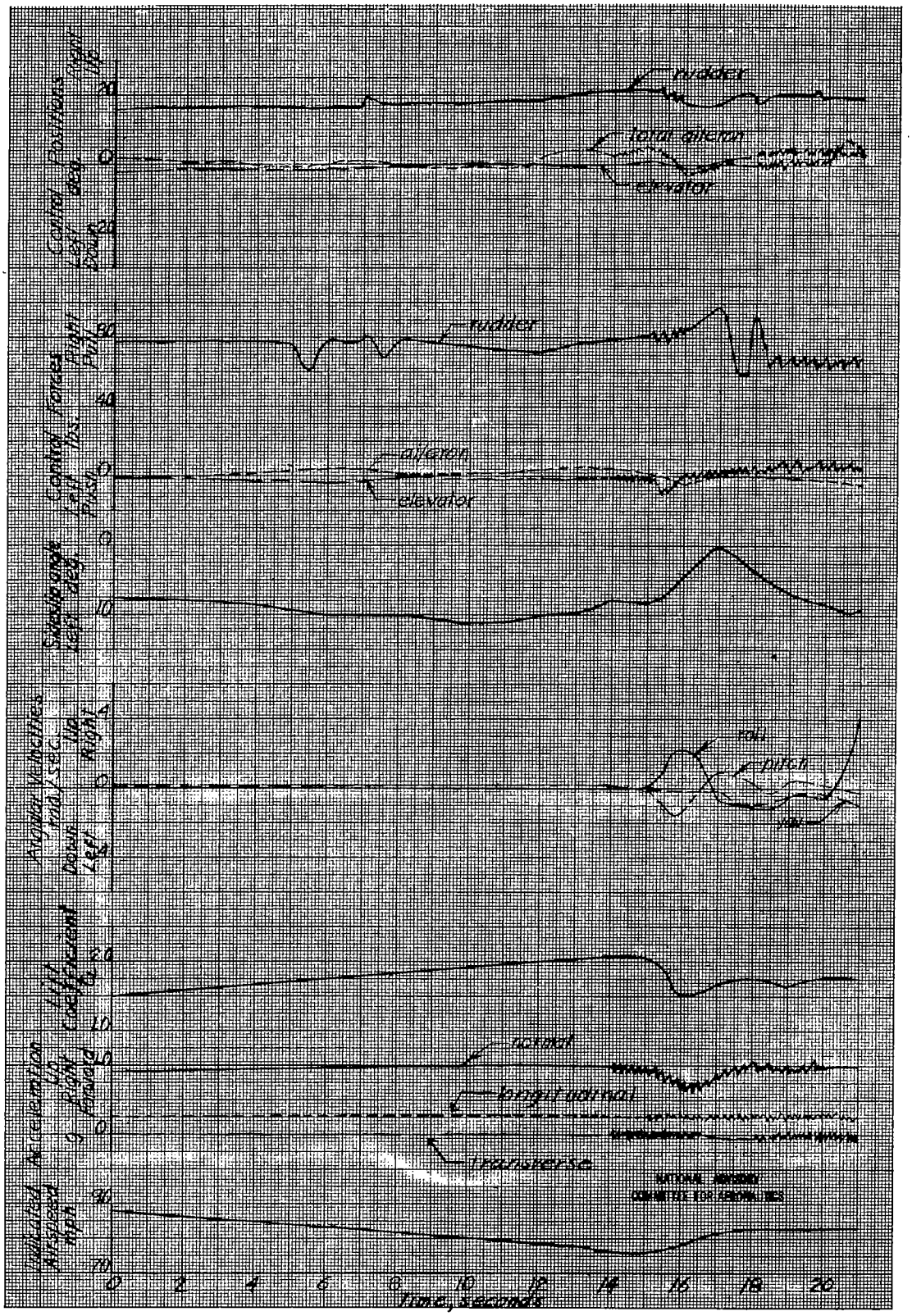

Figure 6. - Time history of a stall in the climbing condition in which the pilot attempted to hold the rudder and ailerons fixed after the initial roll-off. F6F-3 airplane.

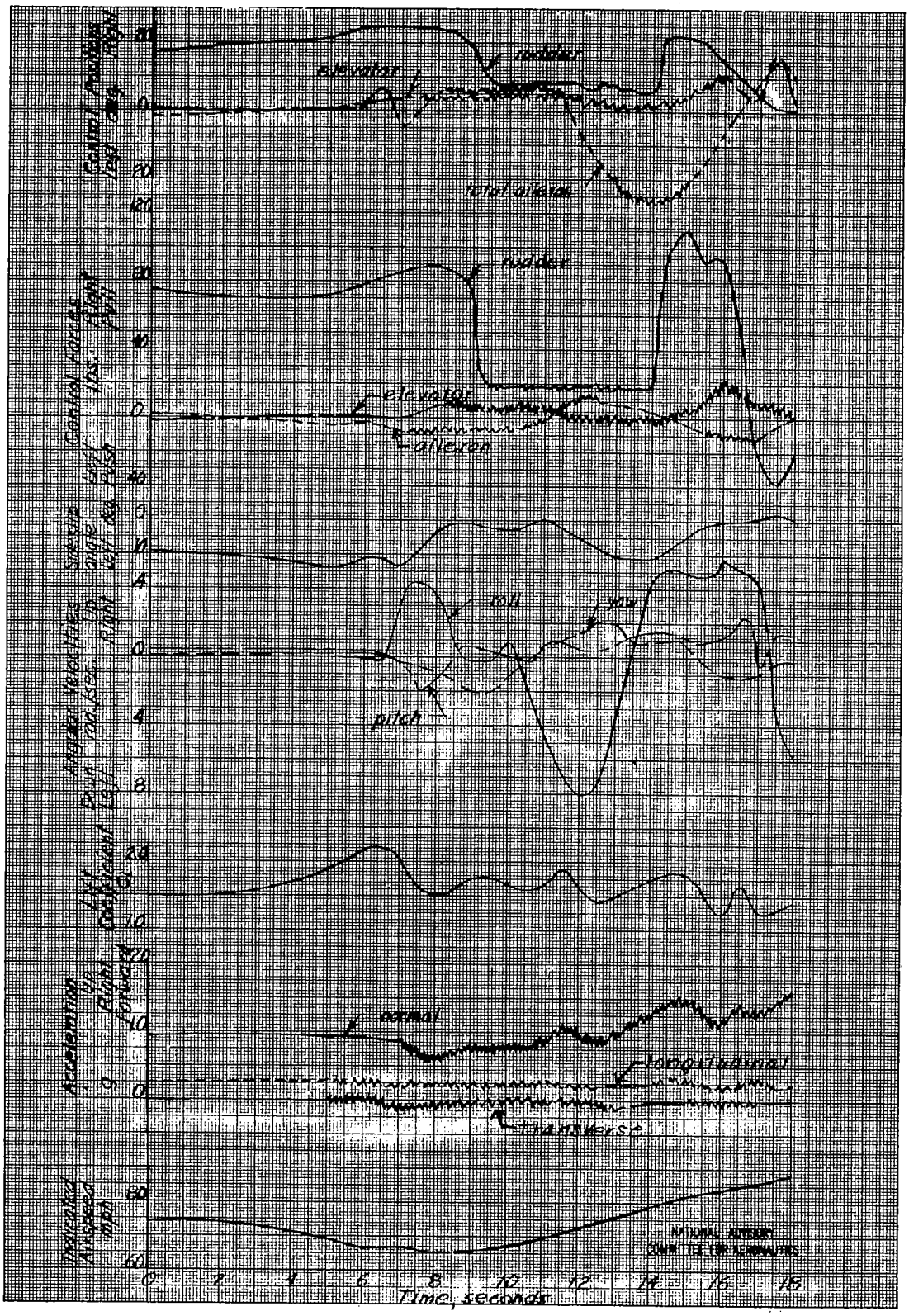

Figure 7. - Time history of a stall in the climbing condition in which the pilot attempted to control the airplane through the stall. F6F-3 airplane.

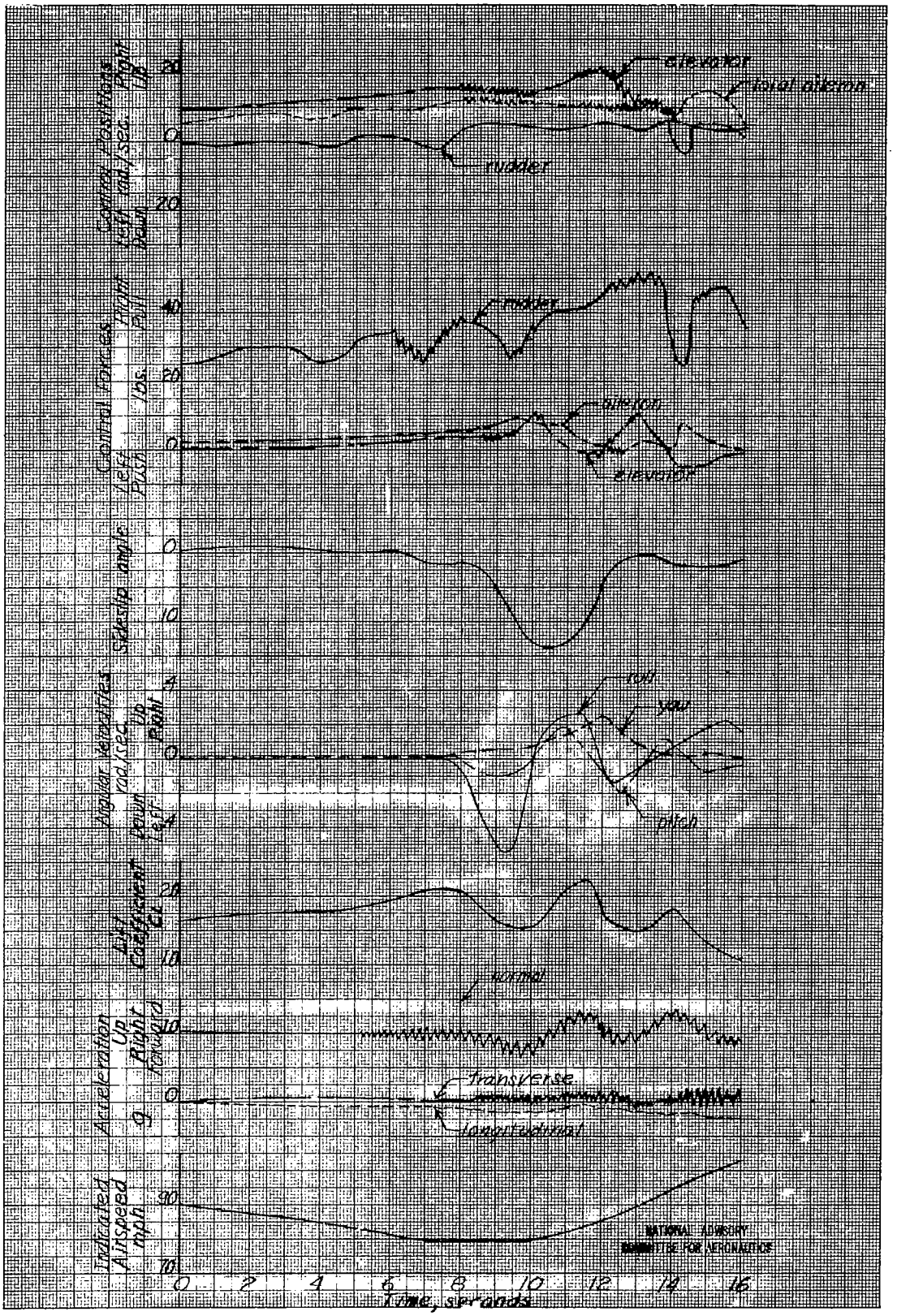

Figure 8. - Time history of a stall in the landing condition in which the pilot attempted to hold the rudder and ailerons fixed after the initial roll-off. F6F-3 airplane.

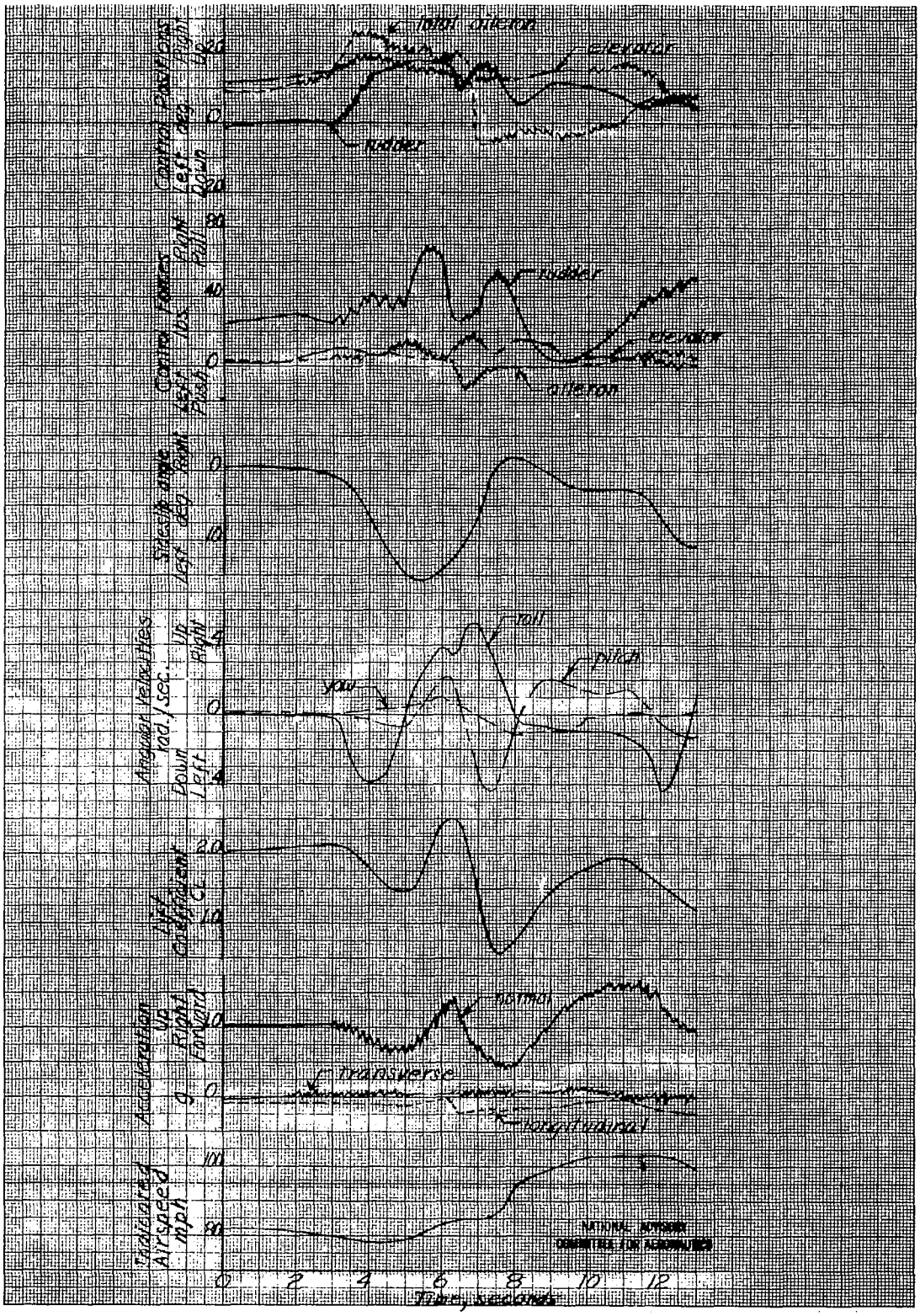

Figure 9. - Time history of a stall in the landing condition in which the pilot attempted to control the airplane through the stall. F6F-3 airplane.

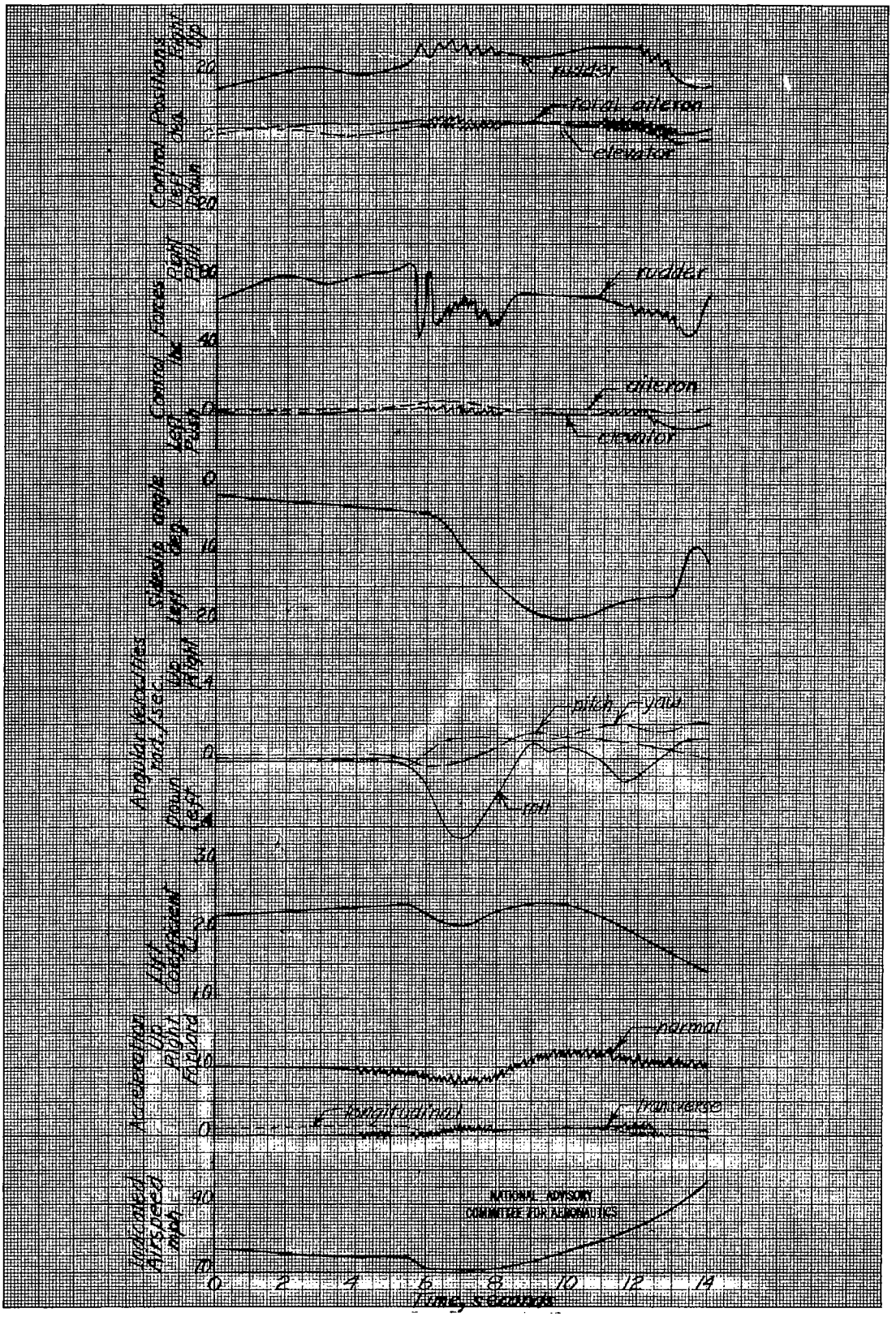

Figure 10. - Time history of a stall in the approach condition in which the pilot attempted to hold the rudder and ailerons fixed after the initial roll-off. F6F-3 airplane.

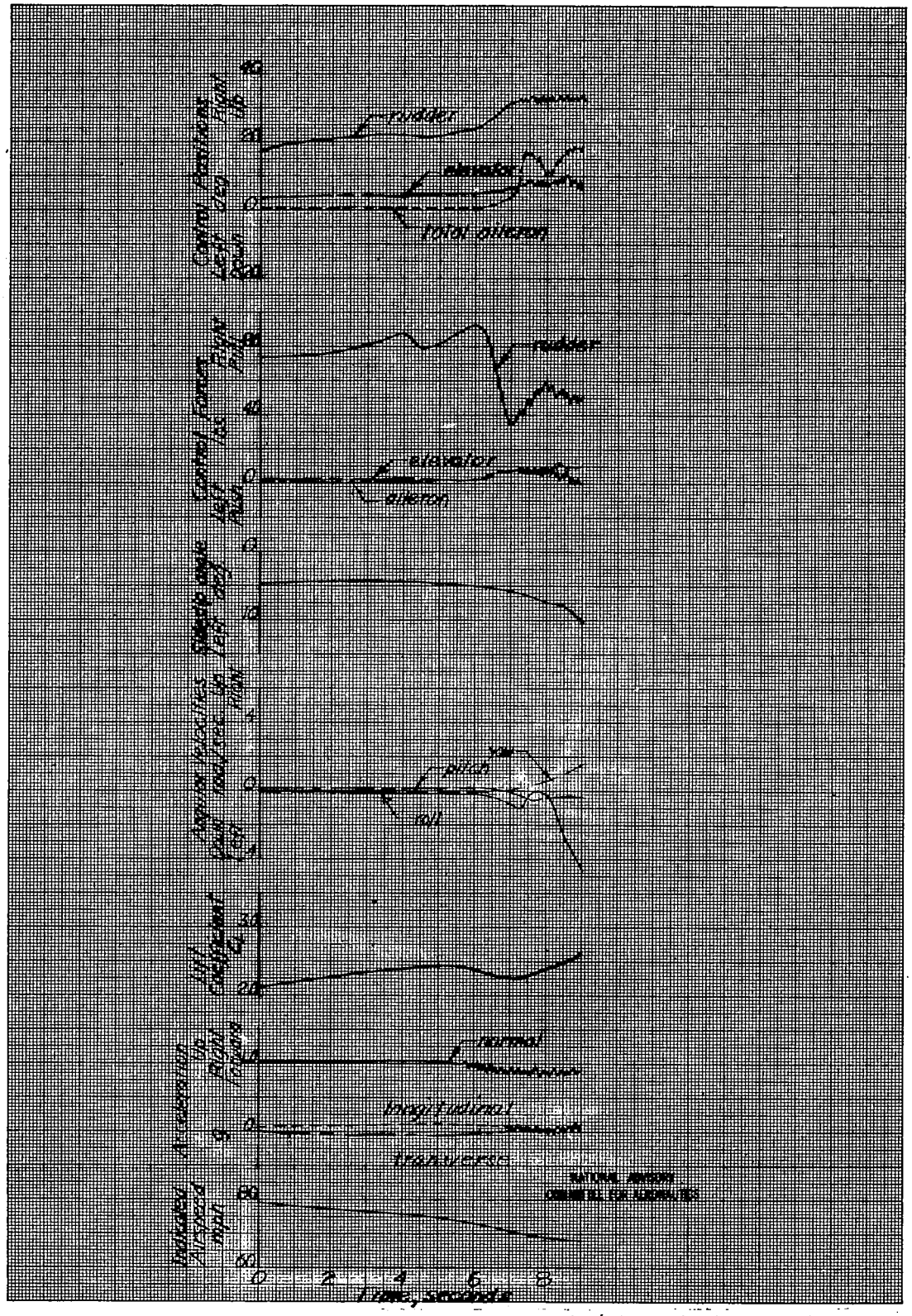

Figure 11. - Time history of a stall in the approach condition in which the pilot attempted to control the airplane through the stall. F6F-3 airplane.

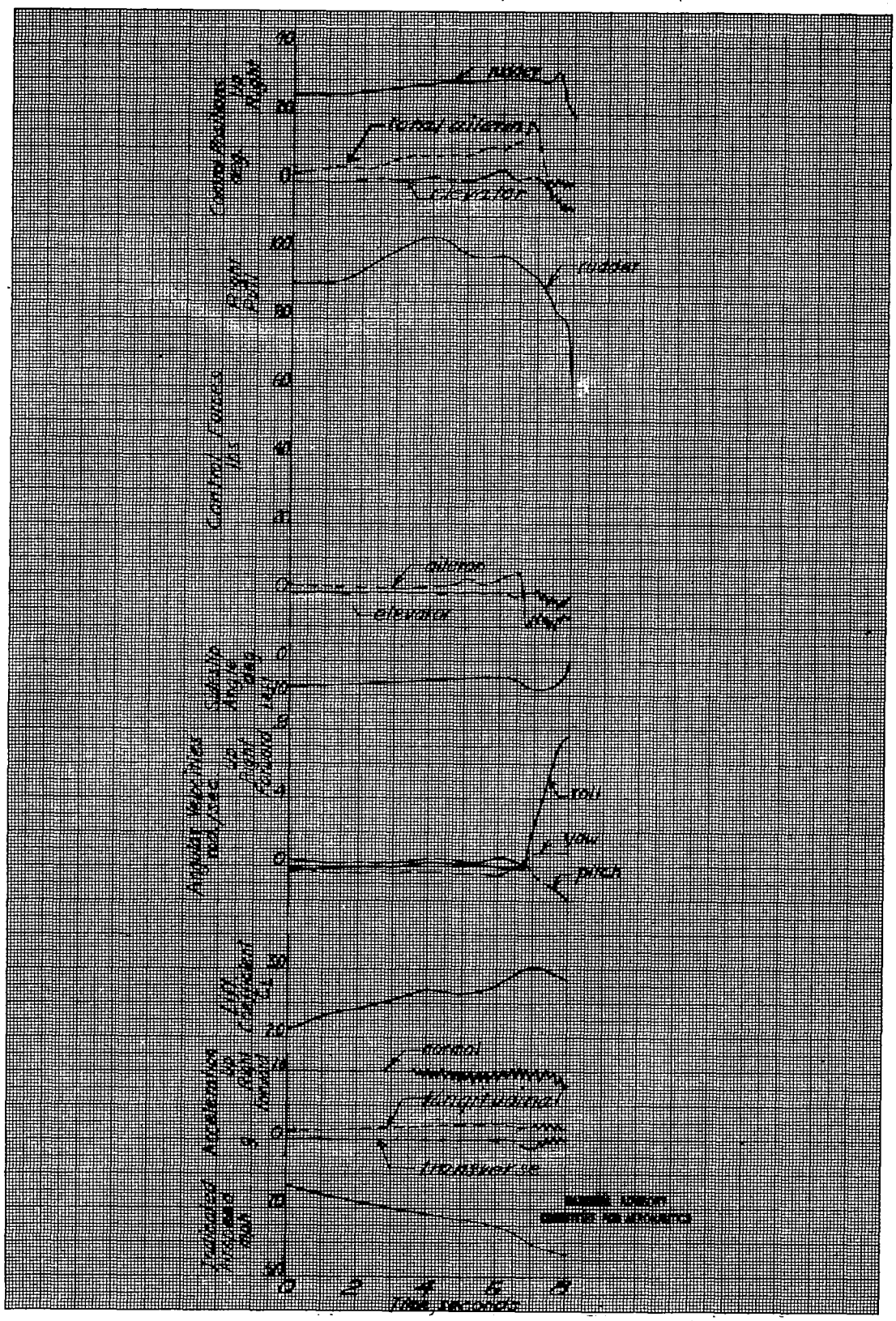

Figure 12. - Time history of a stall in the wave-off conditions. (Recording instruments were turned off after initial roll-off.) F6F-3 airplane.

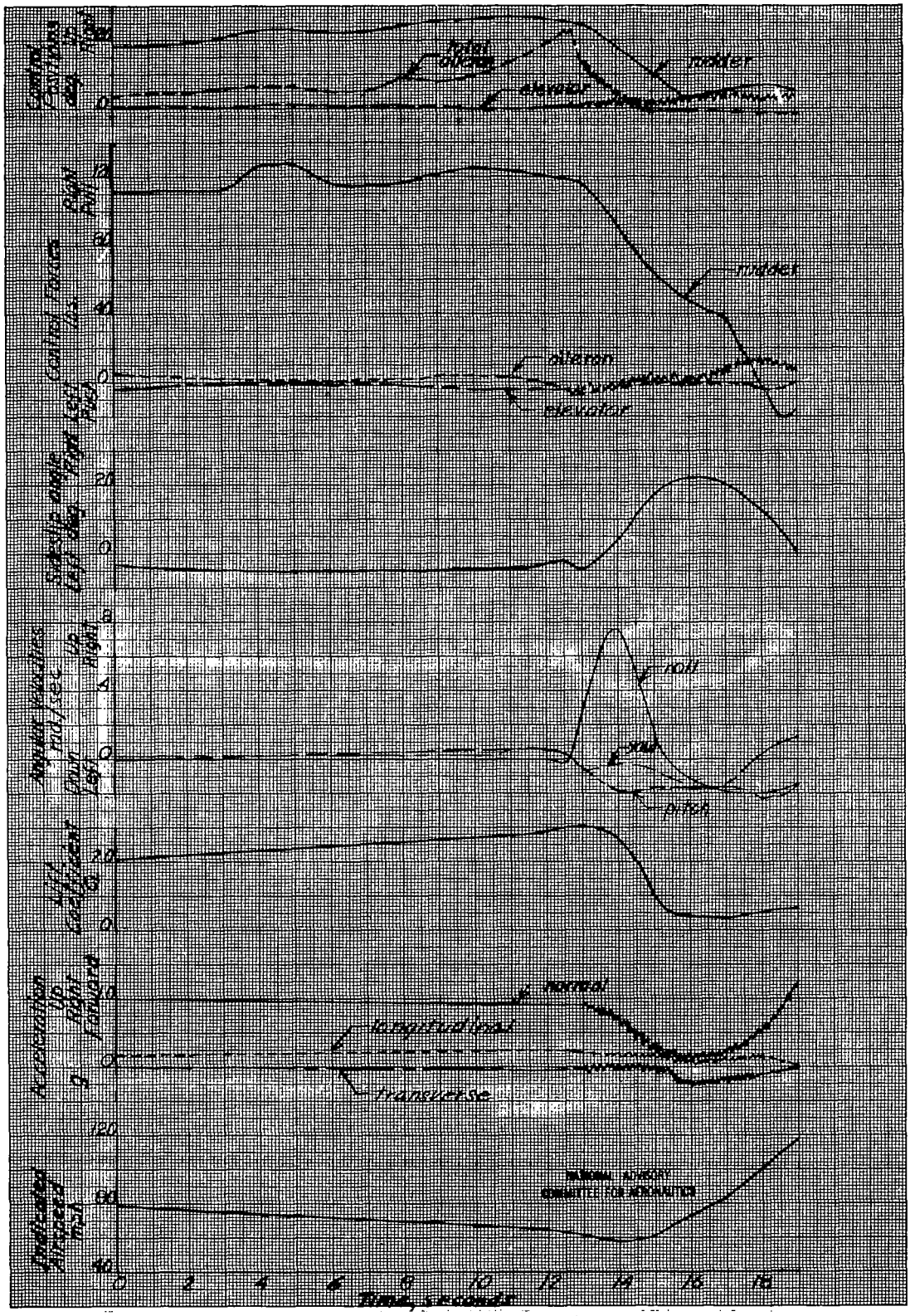

Figure 13. - Time history of a stall in the wave-off condition in which the pilot attempted to control the airplane through the stall. F6F-3 airplane.

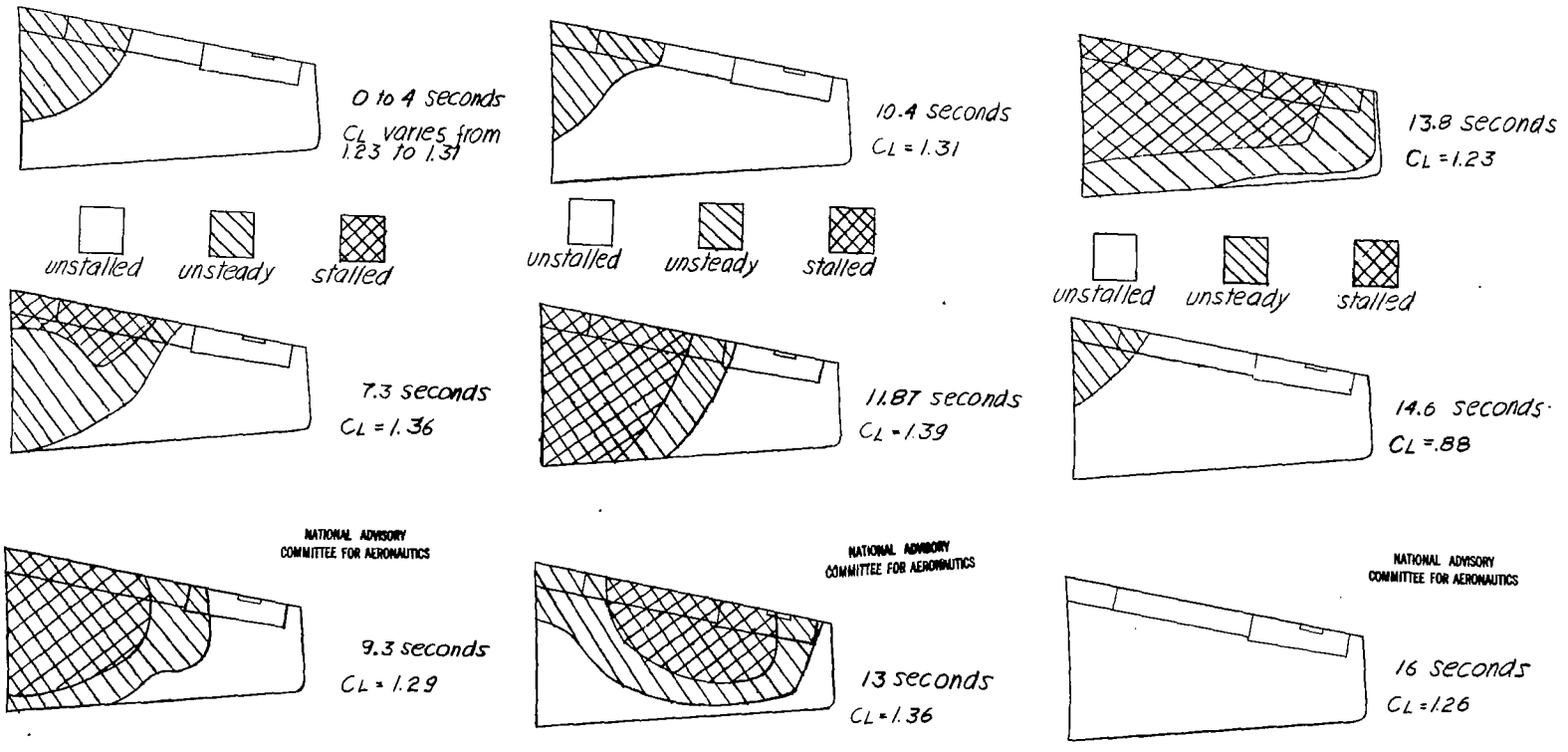

Figure 14.- Tuft studies of left wing during the stall in the gliding condition shown in figure 4. F6F-3 airplane.

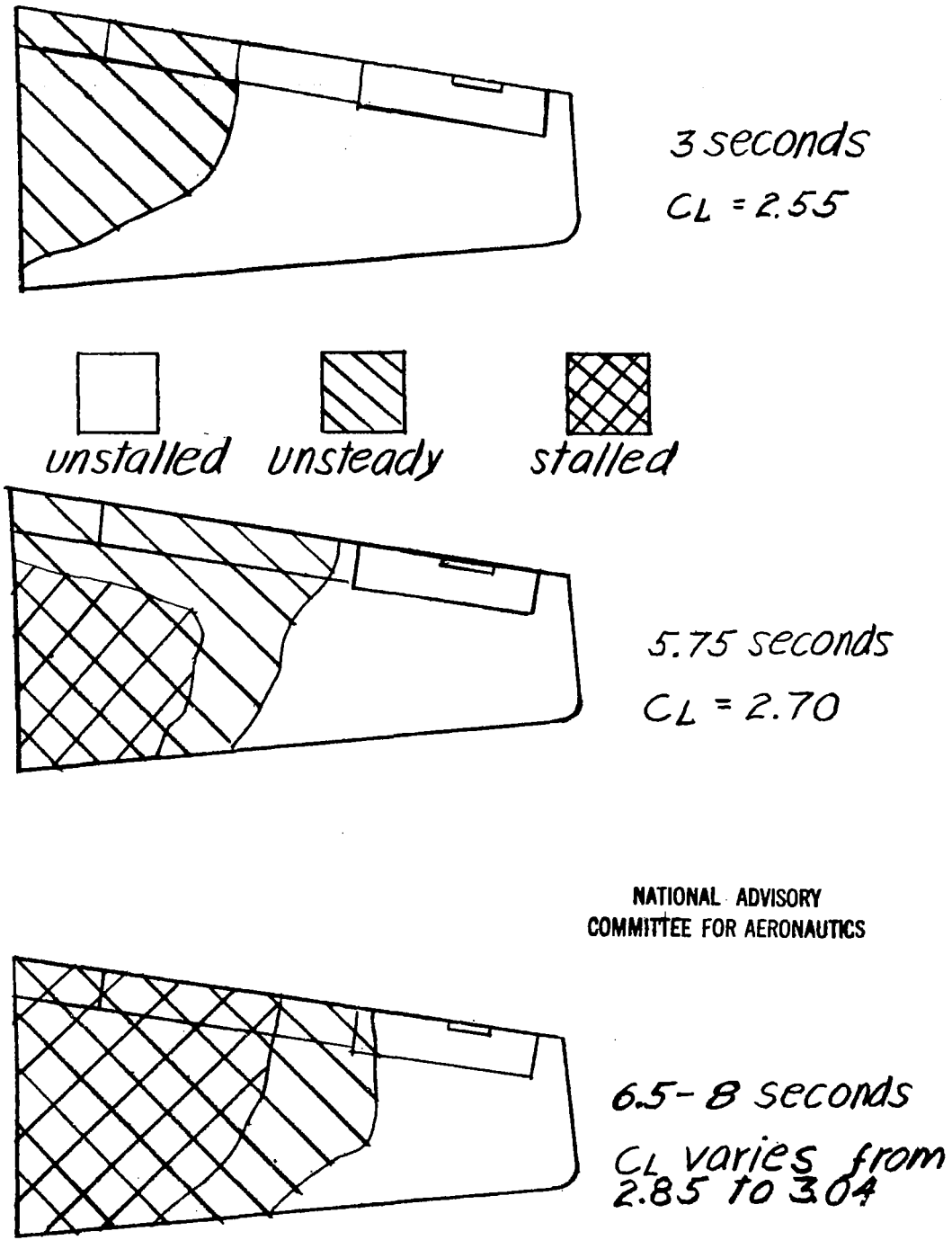

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Figure 15.- Tuft studies of left wing during stall in wave-off condition shown in figure 12. F6F-3 airplane.

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