TECHNICAL MEMORANDUM (NASA) 28

SMALL-AIRCRAFT FLIGHT EVALUATION OF RUSTRAK CHART RECORDER

In support of the NASA Omega Prototype Receiver project, three short flight evaluations of the RUSTRAK chart recorder were flown.

by

Richard J. Salter, Jr.
Robert W. Lilley
Avionics Engineering Center
Department of Electrical Engineering
Ohio University
Athens, Ohio 45701

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I. SUMMARY AND CONCLUSIONS

It was found that the RUSTRAK recorder was only slightly hampered by aircraft vibration while in level cruising flight or while taxiing, regardless of light turbulence or particular mounting configuration. No one mounting configuration was better than the other.

There is some (approximately $\frac{1}{4}$ inch) vibration error during climbs, descents, and touchdowns in choppy weather. However, it was found that improved performance resulted from setting the recorder on carpet rather than the metal floor plate. This suggests that padding the recorder with some cushioning, "shock-damping" material might reduce the engine vibration and wind chop effects.

II. OBJECTIVE

The RUSTRAK Model 288 Chart Recorder has been chosen for use with the Ohio University Omega Prototype Receivers. Since the prototype receivers will be used in general aviation aircraft, an evaluation of the recorder's operation in small planes was performed. Short automobile tests are also reported.

The recorder has been judged to perform satisfactorily in the laboratory. The objective of this airborne test was to determine what effect vibrations (the magnitude and frequency of which vary during each phase of aircraft operation) have on recorder operation. The idea was to flight test the recorder mounted in each of three possible configurations (i.e. three perpendicular axes), performing several common aircraft maneuvers for each configuration. It was desired to measure the magnitude of vibration errors and note which phases of aircraft operation produced these errors.

III. PROCEDURE

The recorder was operated from a 12-Volt Gell Cell supply with a voltage dividing resistor used to bias the "meter movement" recorder needle to the center of the chart paper (Figure 1).

The general aviation aircraft chosen for the recorder check-out was a Piper 140 and a Piper 180. Both aircraft were deemed "typical" of the type to be used with the Omega prototype receivers.

The recorder and Gell Cell were set on the floor in the right front of the aircraft for each test. The three configurations tested were: vertical/facing rear, sideways, and face-down (as illustrated in Figure 2). A typical series of aircraft operations performed for each configuration consisted of taxi, take-off, climb, cruise (or cruise, descent, landing, taxi).

IV. RESULTS

The chart in Figure 3 was made during the first flight in the Piper 140. The chart speed was 1 inch per hour, and a constant voltage was applied. Weather conditions were "calm" throughout the flight. Major flight events are explained below with reference to the event marks on the chart:

(1) This trace was made in a Volkswagon automobile enroute from Athens to the Ohio University Airport. The recorder was set vertically, facing rear on the VW glove box door. Although several rough bumps were hit, the trace remained relatively straight since the jolts usually occurred in-between sample times.

(2) The recorder was oriented vertically, facing rear on the aircraft's metal floor plate. During this event the aircraft turned downwind, made a standard approach-to-landing, performed a touch-and-go, and climbed-out to pattern altitude.

(3) The recorder was oriented sideways, facing rear on the metal floor plate. The aircraft turned downwind, made a standard approach-to-landing, performed a touch-and-go, and climbed-out to pattern altitude.

(4) With the recorder positioned face-down on the metal floor plate, the aircraft climbed from 1600 feet to 2500 feet and cruised in level flight.

(5) With the recorder positioned vertically, facing rear on the metal floor plate, the aircraft descended to pattern altitude, made a standard approach-to-landing, landed, and taxied to the opposite end of the runway.

(6) With the recorder positioned vertically, facing rear on the metal floor plate, the aircraft waited (engine idling) on the runway turn-off until traffic cleared.

(7) With the recorder oriented sideways, facing rear on the metal floor plate, the aircraft took-off, climbed to pattern altitude, made a standard approach-to-landing, and landed.

(8) With the recorder vertical, facing sideways on the metal floor plate, the aircraft taxied to the hangar and the engine was turned off.

(9) The recorder was sideways, facing rear on the VW's glove box door enroute from the Ohio University Airport to Athens.

Figure 4 shows the chart obtained on the second flight, in the Piper 140. The recorder was positioned on the metal floor plate throughout the flight. Chart speed was 1 inch per 10 minutes, and weather condition was "light turbulence" with frequent "moderate chop". An explanation for each phase of the flight is given below with reference to the event marks on the chart:

(1) With the recorder vertical, facing rear, the aircraft taxied from the hangar, performed engine run-up, and took-off.

(2) With the recorder vertical, facing rear, the aircraft climbed from 1200 feet to 3500 feet. There was light and choppy turbulence throughout the climb.

(3) With the recorder set sideways, facing rear, the aircraft cruised in level flight. There was light turbulence throughout the cruise.

(4) With the recorder set sideways, facing rear, the aircraft cruised at 3500 feet, made a steep descent to pattern altitude, made a standard approach-to-landing, and landed.

(5) With the recorder setting sideways, facing rear, the aircraft taxied to the hangar and powered down.

Figure 5 shows the chart obtained during the flight in the Piper 180. The recorder circuit for this flight appears in Figure 5. The recorder was set on the carpet on the floor in the right front of the aircraft, vertical facing rear. The weather conditions throughout the flight were "light turbulence". Chart speed was 10 minutes per inch. The explanation for the phases of the flight follows:

(1) The aircraft taxied, performed engine run-up, and took-off.

(2) The aircraft climbed from 1600 to 3500 feet.

(3) The aircraft cruised in level flight.

(4) The aircraft descended to pattern altitude.

(5) The aircraft performed a standard approach-to-landing, and landed.

(6) The aircraft taxied to the hangar and powered down.

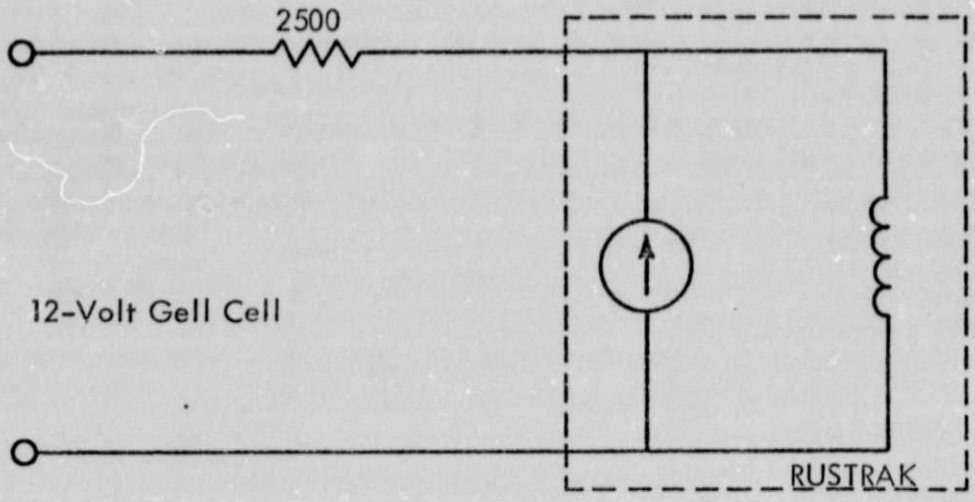

Figure 1. Bias Circuit Used.

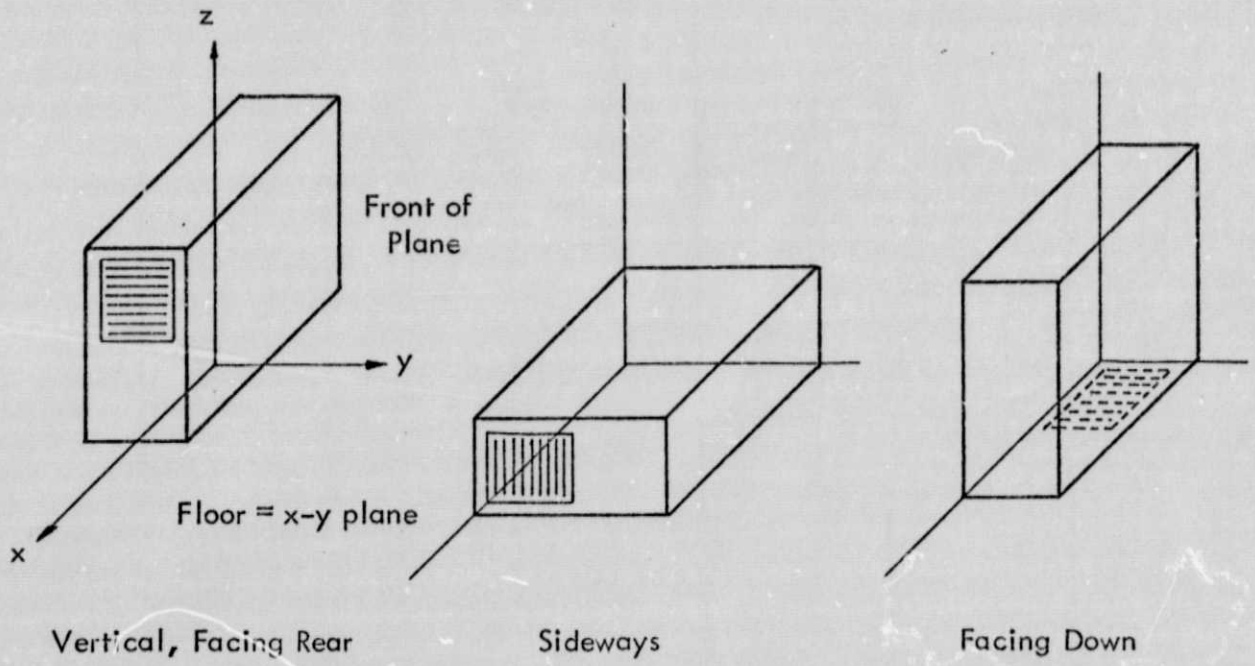

Figure 2. Recorder Mounting Configurations.

Figure 3. Piper 140 Flight Recording (1 Hour/Inch Speed).

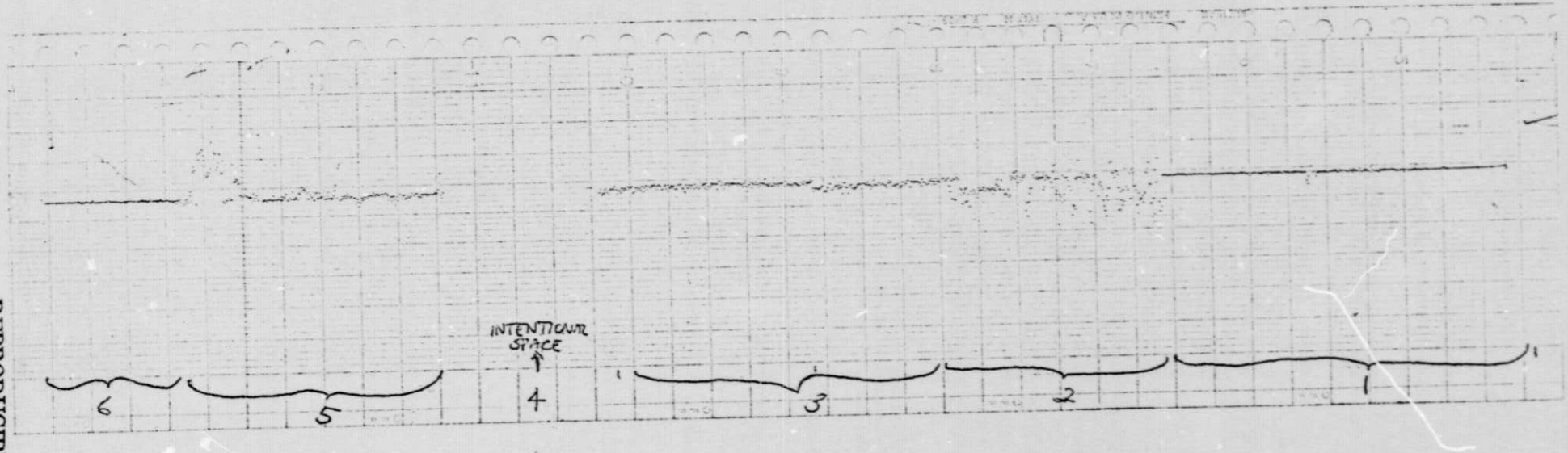

Figure 4. Piper 140 Flight Recording (10 Minutes/Inch Speed).

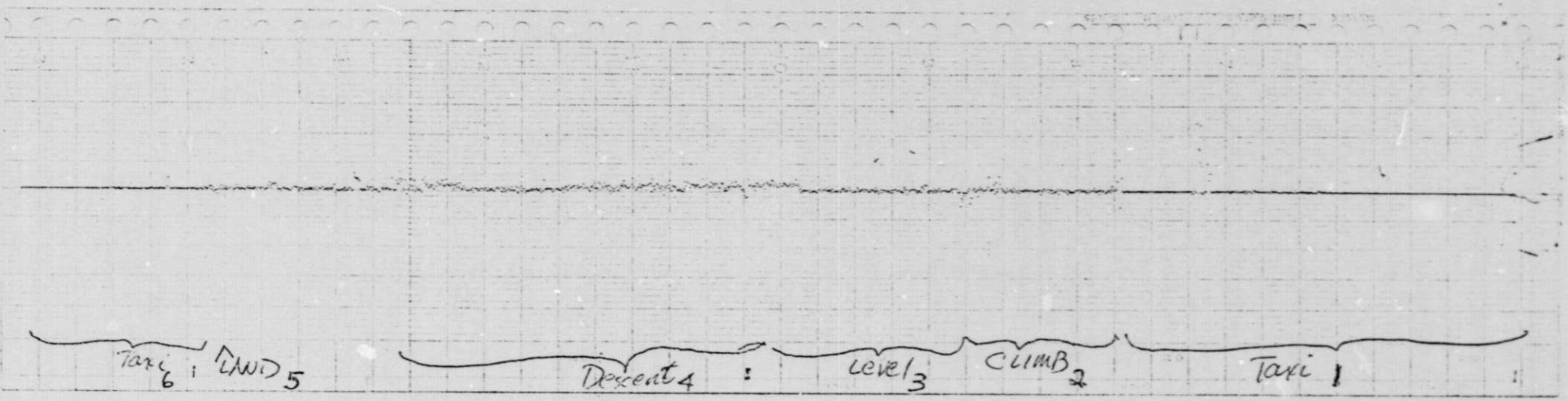

Figure 5. Piper 180 Flight Recording (10 Minutes/Inch Speed).

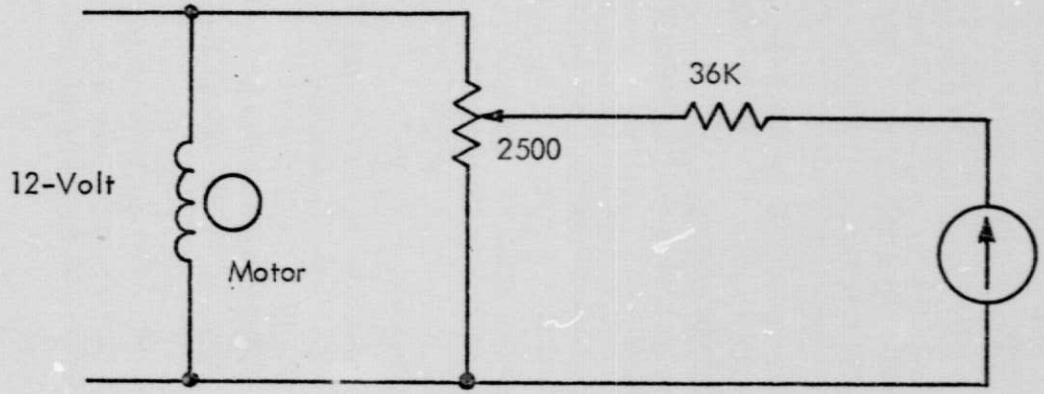

Figure 6. Circuit for Piper 180 Flight.