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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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[redacted] MEMORANDUM REPORT
for
Army Air Corps, Materiel Division
and
Bureau of Air Commerce

RESULTS OF LANDING TESTS OF KELLETT YG-1 AUTOGIRO (A. C. R. 35-278)

By R. R. GILRUTH

November 15, 1937

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SUMMARY

Flight tests were made with a Kellett YG-1 autogiro to determine the relationship between the ground reaction and the vertical velocity at contact for landings of the flared and gliding three-point types. The data obtained are presented in the form of time histories of the linear accelerations at the center of gravity resulting from the initial landing impact. In addition, the attitude angle and velocity of the autogiro at contact were measured. The landings were all mild as compared to those representative of airplanes tested in this manner, the maximum vertical velocity being 4.4 feet per second with a corresponding normal acceleration of 2.35 g.

INTRODUCTION

At the suggestion of the Army Air Corps, Materiel Division (reference 2) and the Bureau of Air Commerce (reference 1) the National Advisory Committee for Aeronautics

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is conducting a series of tests to measure the magnitude and direction of the loads developed and also the flight path and attitude of airplanes at contact for various types of landings. The present tests, which are fifth in a series of similar tests of various airplanes, were made with a Kellett YG-1 autogiro made available by the Army Air Corps. Tests have previously been made with a Consolidated TB-2 airplane (reference 3), a North American BT-9 airplane (reference 4), a Boeing P-26 airplane (reference 5), and a Curtiss XF13C-3 airplane (reference 6).

APPARATUS AND TESTS

The YG-1 autogiro used in this investigation (figs. 1 and 2) is a direct-control, wingless type of the following specifications:

Gross weight as flown ----- 2,060 lb.
Rotor diameter ---------- 40 ft.
Brake horsepower --------- 225 hp.

A series of 15 flared and glide-type landings were made, out of which usable records were obtained from 9. An accelerometer was installed at the center of gravity of the autogiro and was oriented to record accelerations parallel to the X and Z axes. An attempt was made to measure pitching accelerations with a turnmeter; however, none of the records were usable. The attitude angle and

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the velocity of the autogiro at contact were obtained with a recording phototheodolite.

RESULTS AND DISCUSSION

The landing data are presented in the form of time histories (figs. 3 to 7, inclusive). The linear accelerations in these figures are the accelerations recorded at the center of gravity of the autogiro, the normal and longitudinal components being perpendicular and parallel to the thrust axis, respectively. The maximum accelerations and the results obtained from the phototheodolite are summarized in table I. Figure 8 shows the variation of the maximum recorded vertical accelerations at the center of gravity with the vertical velocity of the autogiro at the instant of contact.

The resultant forces acting on the autogiro are indicated by the recorded accelerations and are made up of aerodynamic forces as well as ground reactions. The vertical accelerations experienced immediately prior to contact varied from 1 g to 0.8 g which shows the range of the vertical component of the aerodynamic forces existent at contact. An indication of the variance of this component throughout the period of impact was obtained by noting the rotor coning angle as recorded by the theodolite camera. In all the landings of this investigation the coning angles

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showed no appreciable change during that time, indicating that the accelerations representative of ground reactions were from 1 to 0.8 g less than the recorded values. This may not be generally true as shown by a case observed in landings of reference 3, where a coning angle of 0° was noted following a severe landing. A further analysis of the present data to determine the division of ground loads between the main wheel and tail wheel units was not possible due to the lack of pitching acceleration data. In addition, the longitudinal moment of inertia of the autogiro, also necessary for such division, was not known.

As a point of interest it is well to note in the calculation of chassis loads from the acceleration data that the effective mass of the rotor is a function of the weight distribution along the blades. For a uniform distribution the effective mass is one-fourth the total mass of the rotor. It should be further noted that all the landings presented are mild, and it is probable that they do not represent as severe conditions as would be experienced in routine service.

Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., November 15, 1937.

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REFERENCES

1. N. A. C. A. Let. Apr. 30, 1936, CW:MW.

2. N. A. C. A. Let. May 28, 1936, CW.MNM.

3. Reed, Warren D.: Results of Landing Tests with Consolidated PB-2 Airplane. Confidential Memo. Report, N. A. C. A., Nov. 1936.

4. Reed, Warren D.: Results of Landing Tests with a North American B7-9A Airplane (A. C. R. 36-88). Confidential Memo. Report, N. A. C. A., July 1937.

5. Reed, Warren D.: Results of Landing Tests with a Boeing P-26A Airplane (A. C. R. 33-37). Confidential Memo. Report, N. A. C. A., July 1937.

6. Reed, Warren D., and Gilruth, R. R.: Results of Landing Tests with a Curtiss XF13C-3 Airplane. Confidential Memo. Report, N. A. C. A., Aug. 1937.

7. Peck, William C.: Landing Characteristics of an Autogiro. T. N. No. 508, N. A. C. A., Nov. 1934.

TABLE I

Landing Data for YG-1 Autogyro

Run no. & Date	Vert. Velocity	MAX NORMAL ACCEL. A_z	CORR. LONGIT. ACCEL. A_x	Attitude angle at contact (main skids)	$\tan^{-1} \frac{A_x}{A_z}$	Angle of resultant with vertical	AR resultant	MAX Vertical accel.	C.G.-F Horiz. accel.	Ground speed at contact	Wind speed	Air speed	Pilot's Notes
4-11-37	f.p.s.	g	g	degrees	degrees	degrees	g	g	g	f.p.s.	f.p.s.	f.p.s.	
3	2.45	1.81	0.27	5.7°	8.4	14.1°	1.83	1.77	0.45	14.0	12.5	26.5	Power off; flared
6	2.70	2.04	.17	4.3°	4.3	8.6	2.05	2.03	.31	16.0	14	30	Power off; flared
9	1.80	1.93	.05	6.0°	1.5	7.5	1.93	1.91	.25	18.0	11	29	Power On; flared
10	2.55	2.13	.33	6.4°	8.8	15.2	2.15	2.07	.56	11	13.5	24.5	Power off; flared
11	1.3	1.61	.20	4.2°	7.0	11.2	1.62	1.59	.32	19.5	9	28.5	glide.
12	2.9	1.87	-.06	6.2°	-1.8	4.4	1.87	1.86	.14	14.5	14.5	29	Power on; flared
13	4.40	2.35	.07	5.0°	1.7	6.7	2.35	2.33	.27	31.5	16.5	1.9	Power off; flared
14	2.3	1.89	.20	4.5°	6.0	10.5	1.9	1.87	.34	15	12	27	glide
15	1.5	1.55	.09	6.5°	3.3	9.8	1.55	1.53	.26	27	17	44	Power on; flared

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Figure 1.- YG-1 autogiro - side view.

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Figure 2.—Gg-1 autogiro - one quarter front view.

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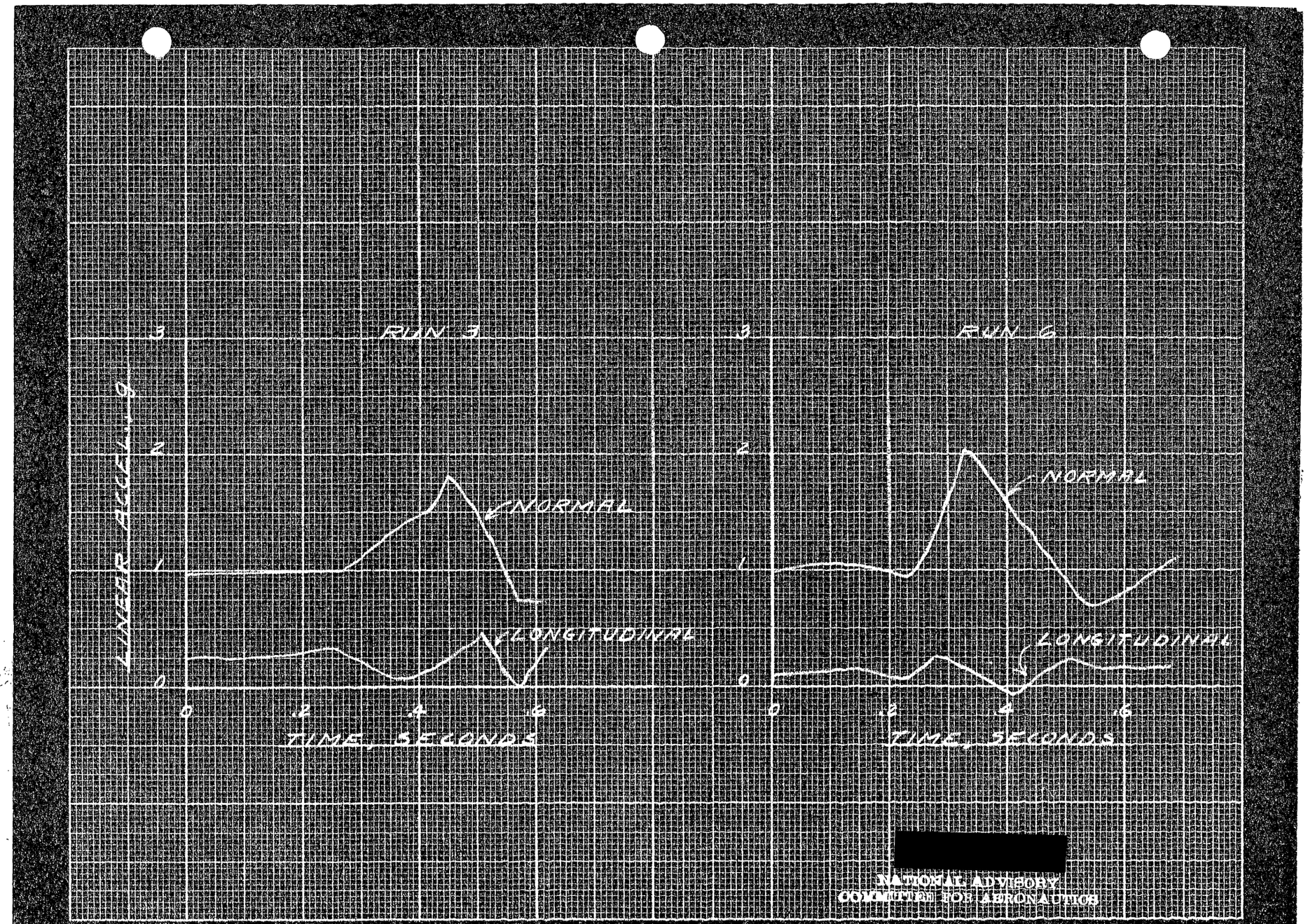

Figure 3.- Accelerations recorded in landing tests of YG-1 autogiro, test runs 3 and 6.

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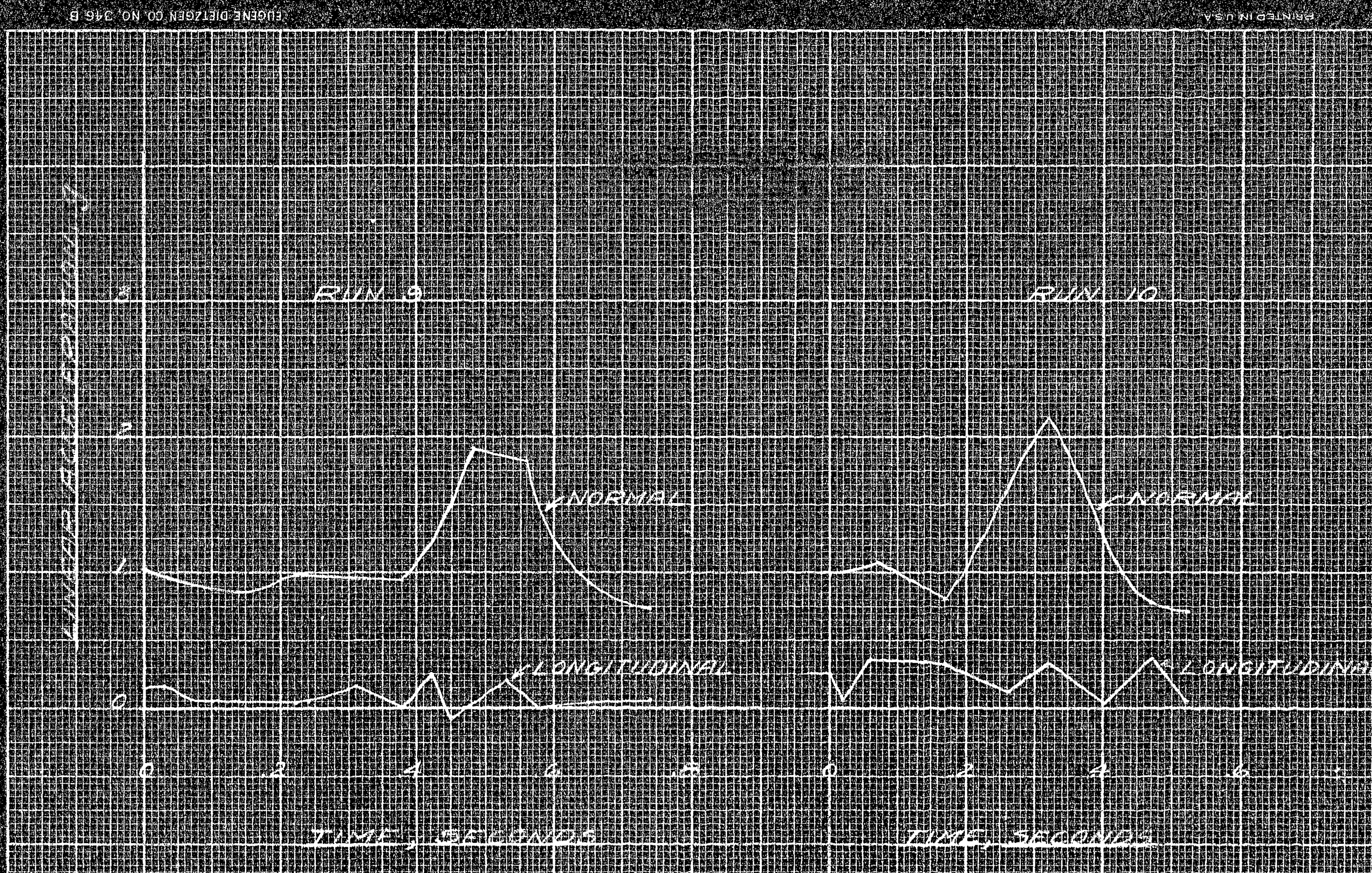

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Figure 4.- Accelerations recorded in landing tests of YG-1 autogiro, test runs 9 and 10.

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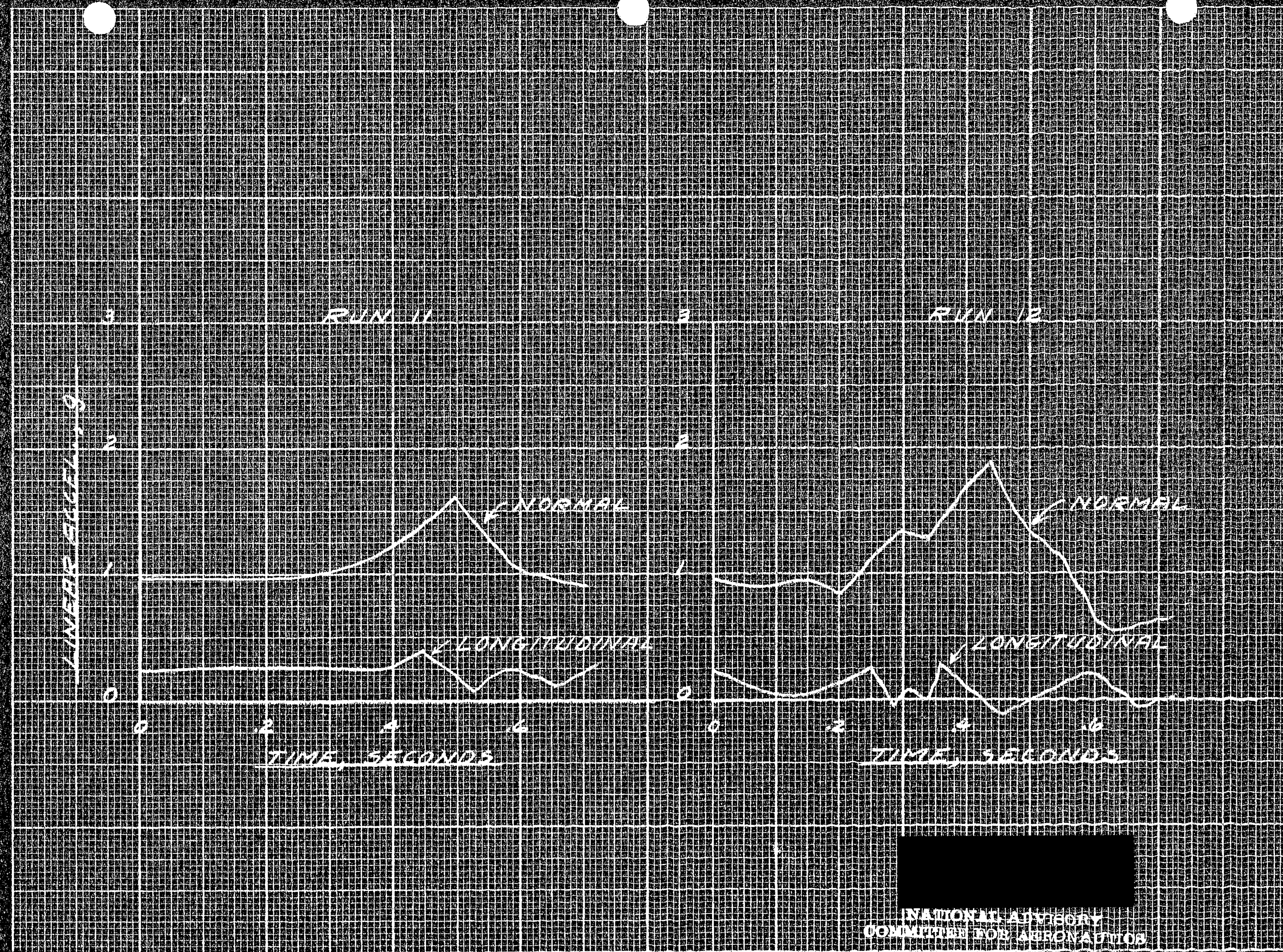

Figure 5.- Accelerations recorded in landing tests of YG-1 autogiro, test runs 11 and 12.

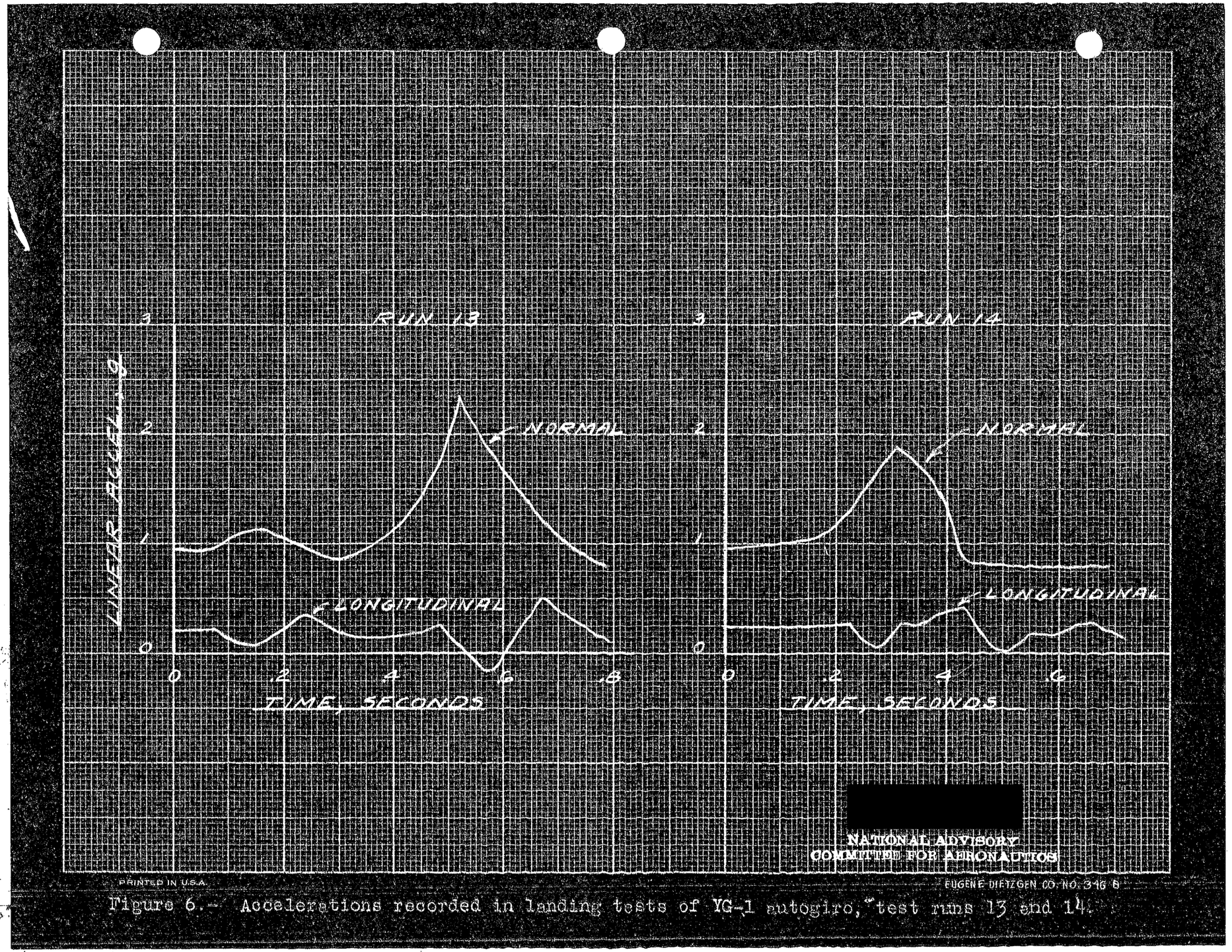

Figure 6.- Accelerations recorded in landing tests of YG-1 autogiro, test runs 13 and 14.

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Figure 7.- Accelerations recorded in landing tests of YG-1 autogiro, test run 15.

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Figure 9.- Variation of vertical acceleration recorded at the center of gravity with the vertical velocity at contact, YO-1 autogiro.