MAR 16 194_ REC'D

1

RM No. SL9C14

Status: INACTIVE by authority T. T. Neill per memo. for E. B. Jackson dated 3/22/55.

5390

232

NACA

RESEARCH MEMORANDUM

for the

Naval Research Laboratory, Department of the Navy

CALIBRATION TESTS OF A JAPANESE LOG RODMETER

By

Elmo J. Mottard

Langley Aeronautical Laboratory
Langley Air Force Base, Va.

NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS

WASHINGTON

MAR 9 1949

14

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESEARCH MEMORANDUM

for the

Naval Research Laboratory, Department of the Navy

CALIBRATION TESTS OF A JAPANESE LOG RODMETER

By Elmo J. Mottard

SUMMARY

A Japanese log rodmeter of the rotating-vane impeller type, with a commutator on the impeller shaft, was calibrated in Langley tank no. 1. The rotational speed of two impellers was determined for forward speeds up to 24 knots at angles of yaw up to ±10°. In general, the rotational speeds of two apparently identical impellers tested in the rodmeter decreased with increasing yaw angle, right yaw causing a greater decrease than left yaw. The difference in calibration between the two impellers was approximately the same as that produced by a change in yaw angle from 5° left to 5° right. Evidence of cavitation within the impeller fairing appeared at speeds above 24 knots.

INTRODUCTION

At the request of the Naval Research Laboratory, Department of the Navy, a Japanese log rodmeter was calibrated in Langley tank no. 1. This rodmeter was a rotating-vane impeller type having a commutator on the impeller shaft for remote indication of impeller revolutions. The rotational speed of the impeller was determined at constant speeds up to 24 knots and angles of yaw up to ±10°. Two impellers were tested. Part of the tests were observed by Mr. Clarence B. House of the Naval Research Laboratory.

DESCRIPTION OF THE RODMETER

Photographs of the rodmeter and of the impeller are shown in figures 1 and 2, respectively. Pertinent dimensions of the rodmeter are included in figure 3.

The supporting tube for the impeller was of circular cross section having a maximum diameter of 3 inches tapering to a minimum diameter of $1\frac{9}{16}$ inches at the top of the circular fairing, or shroud, which enclosed the impeller. The end of the supporting tube faired into the top of this shroud.

The impeller was supported on small vertical streamline struts so that the front of the impeller hub protruded slightly from the leading edge of the shroud. The maximum diameter of the impeller hub was $1\frac{1}{4}$ inches. The impeller diameter was $2\frac{3}{8}$ inches and the distance between the tips of the impeller blades and the shroud was approximately 0.1 inch.

The impeller blades were supported on a metal shaft which turned on jewel bearings. Imbedded in the shaft was a thin strip of insulating material, and the shaft, together with fixed metal brushes, served as a commutator. The entire mechanism was exposed to the water.

INSTALLATION AND PROCEDURE

Langley tank no. 1 and the towing carriage are described in reference 1. The testing apparatus is shown in figure 3. A rectangular steel plate was located 6 inches below the water surface to prevent downward passage of air to the impeller. The vertical sides attached to this plate served as spray shields.

Yaw angles were measured from the center line of the impeller shaft, and yaw adjustments were made by turning the rodmeter in the clamps which held it to the towing gear. The yaw which displaced the front of the rod to the right was defined as right yaw. The center line of the rod was vertical and the draft was 18 inches from the center line of the impeller shaft throughout the tests.

Impeller revolutions, carriage distance, and time were recorded by an oscillograph. The impeller commutator, which operated in the circuit shown in figure 4, caused a deflection of a recording galvanometer for each revolution of the impeller.

Two apparently identical impellers, numbered 79 and 80, were calibrated. Impeller 79 was towed at constant speeds up to 24 knots at yaw angles of 0° and 5°, and 10° to the left and right. Impeller 80 was towed under the same conditions as impeller 79, but only at yaw angles of 0° and 10° left, and 10° right.

Cavitation speeds were noted, but accurate observation of cavitation on the impeller was hindered by the surrounding fairing.

RESULTS AND DISCUSSION

The results of the tests are plotted in figures 5 and 6 which show the variation in frequency in cycles per second (revolutions per second of the impeller) and frequency-speed ratio with speed for both impellers. The effect of yaw angle is shown in figure 7. Comparison of the two impellers at 0° yaw is shown in figure 8. The general shape of the curves of frequency against speed is somewhat similar for all yaw angles and for both impellers. The curves are not straight lines, but are reproducible, as shown by the check points plotted on figure 5(a). The variation of the frequency-speed ratio with speed for the yaw angles investigated was found to be between about 7 and 13 percent over a speed range of 2 to 24 knots. Test results of the two impellers at 0° yaw show approximately the same discrepancy as that produced by a change in yaw angle from 5° left to 5° right of impeller 79.

In general, the frequency decreases with increasing yaw angle, right yaw causing a greater decrease than left yaw. A difference in frequency between right and left yaw would occur if the effect of left yaw on the impeller blades above the hub were different from the effect of right yaw on the blades below the hub, and vice versa. This condition would exist if the velocity or direction of the flow above and below the impeller hub were not the same. It is probable, therefore, that the observed difference in frequency between right and left yaw is caused by a difference in the flow above and below the impeller hub due to the presence of the supporting tube and the dissymmetry of the impeller fairing.

Cavitation was observed on the tapered section of the supporting tube at speeds of 18.4 to 20.7 knots. The impeller fairing obstructed the view of the impeller and its supporting struts, but bubbles emerged from within the fairing at speeds of 23.7 to 24.9 knots, indicating that cavitation was occurring within the fairing.

No excessive vibration of the rod occurred during the tests and no trouble was experienced with the bearings or commutators of the impellers.

CONCLUDING REMARKS

In general, the rotational speed of the impeller decreased with increasing yaw angle, right yaw causing a greater decrease than left yaw.

The difference in calibration found between two impellers was approximately the same as that produced by a change in yaw angle from 5° left to 5° right on one impeller.

Cavitation was observed on the tapered section of the supporting tube at speeds of 18.4 to 20.7 knots. Evidence of cavitation within the impeller fairing appeared at speeds of 23.7 to 24.9 knots.

The impellers functioned satisfactorily during the tests, without failure of either bearings or commutators.

Langley Aeronautical Laboratory
National Advisory Committee for Aeronautics
Langley Air Force Base, Va.

Elmo J. Mottard

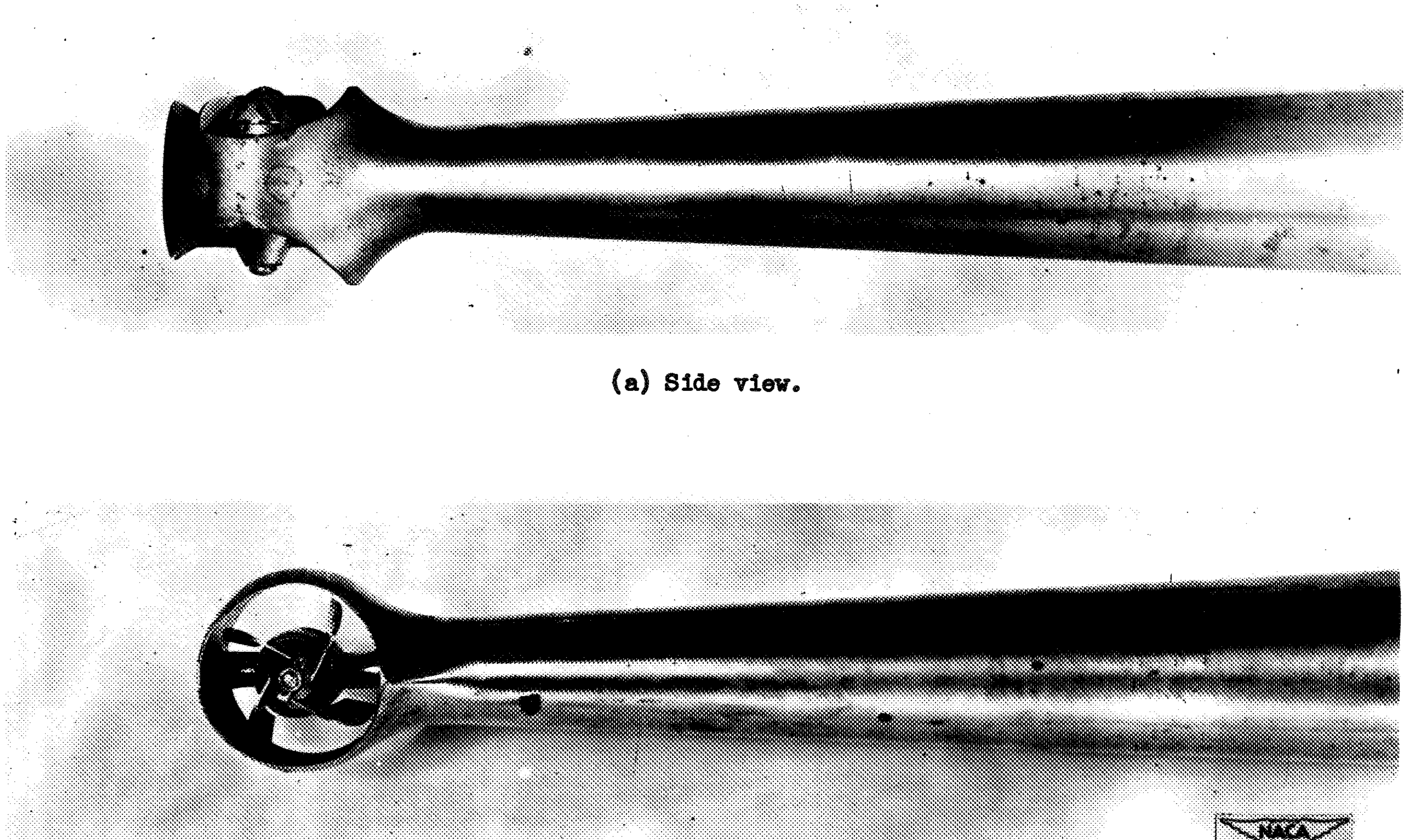
Elmo J. Mottard
Aeronautical Research Scientist

Approved: John B. Parkinson
John B. Parkinson
Chief of Hydrodynamics Division

DLMc

REFERENCE

1. Truscott, Starr: The Enlarged N.A.C.A. Tank, and Some of Its Work. NACA TM No. 918, 1939.



(a) Side view.

(b) Front view.

Figure 1.– Japanese log rodmeter.

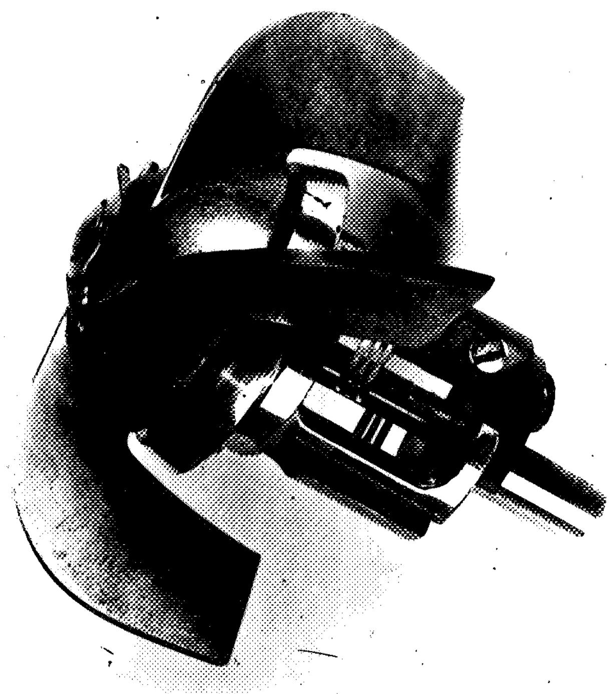


Figure 2.— Japanese log rodmeter. Impeller.

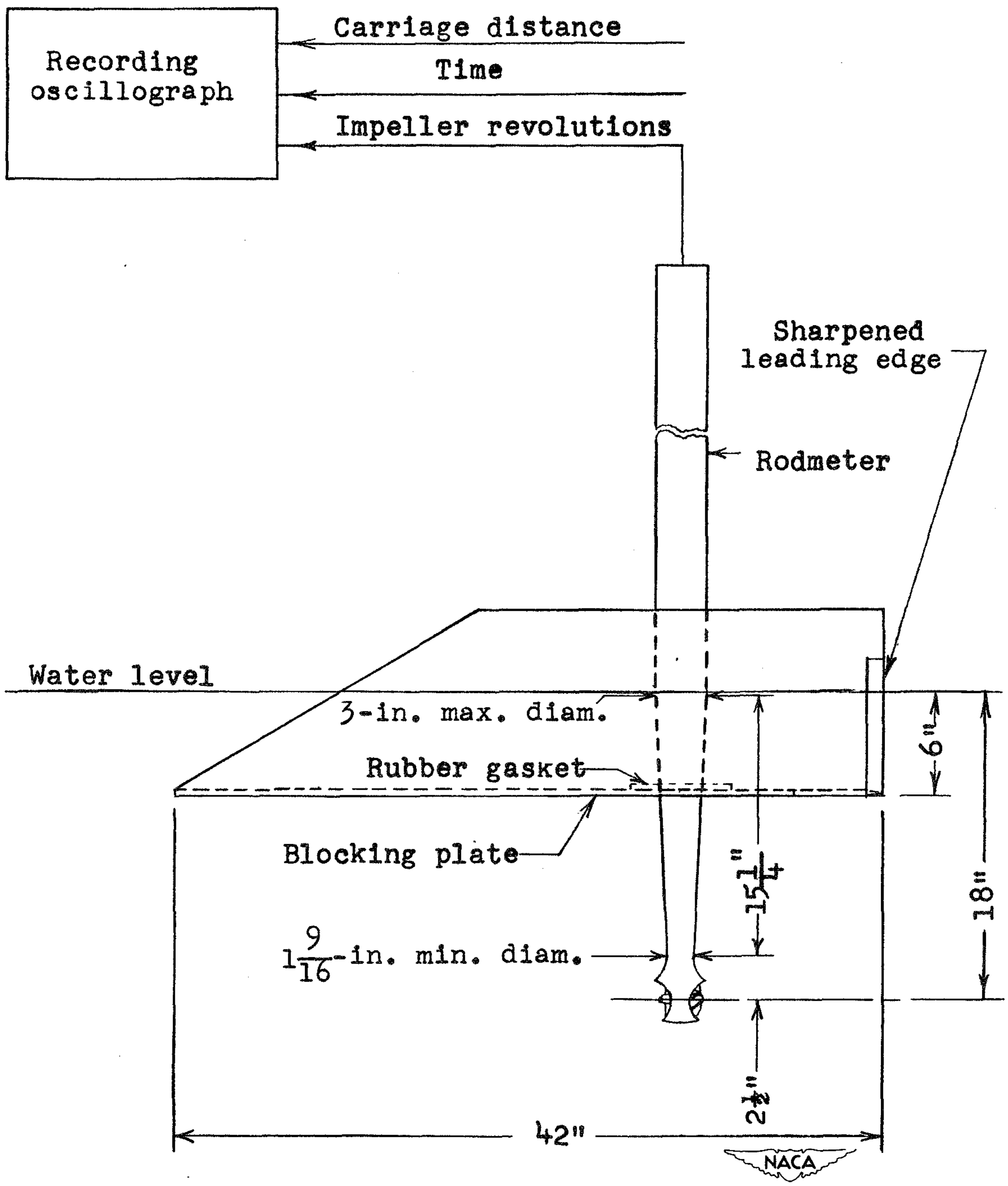


Figure 3.– Apparatus for calibration of Japanese log rodmeter.

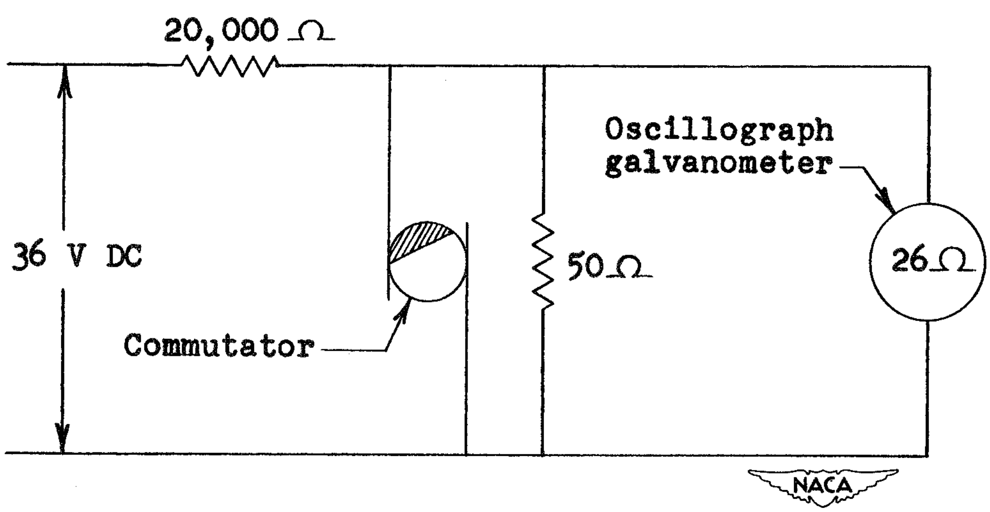
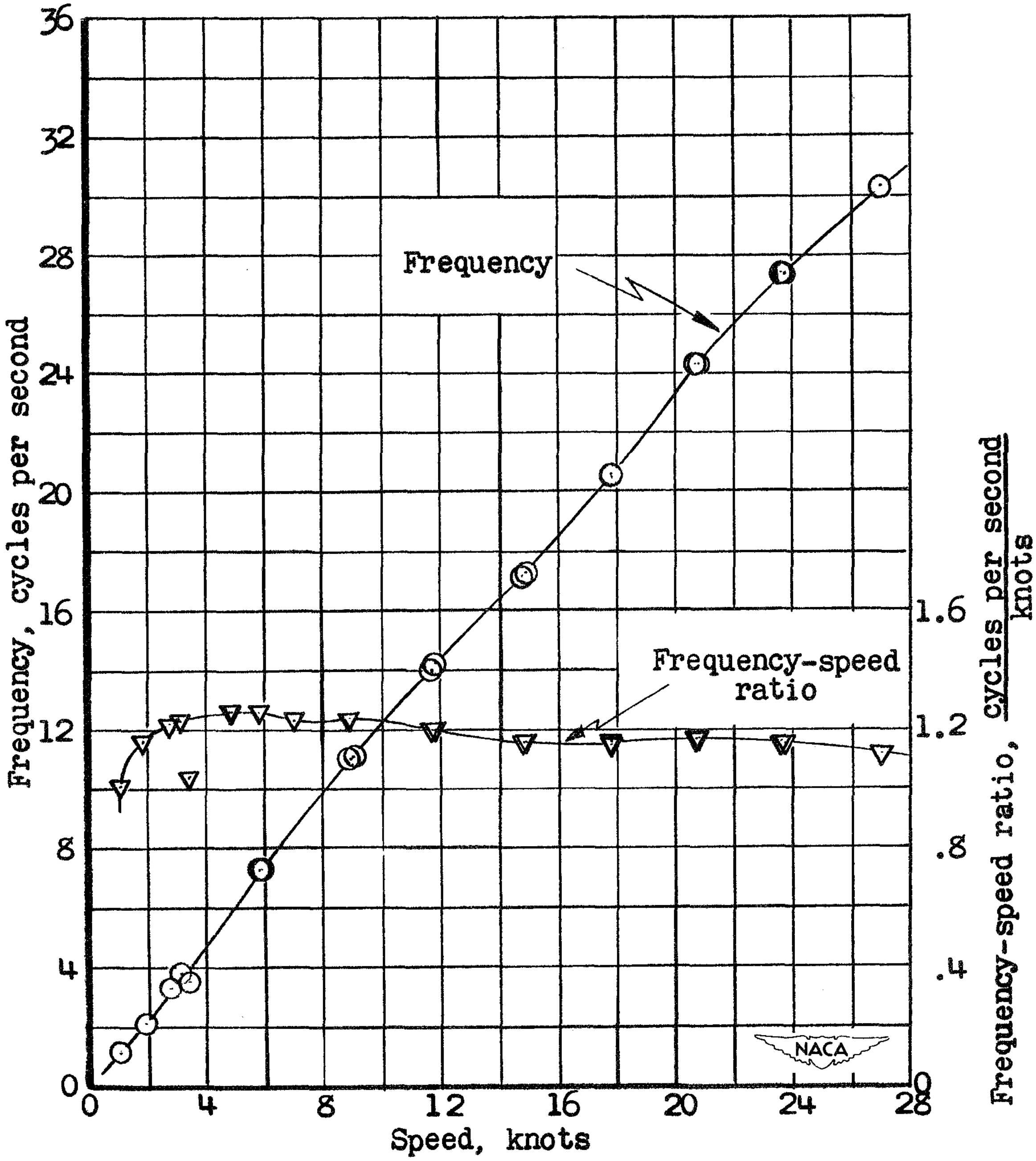
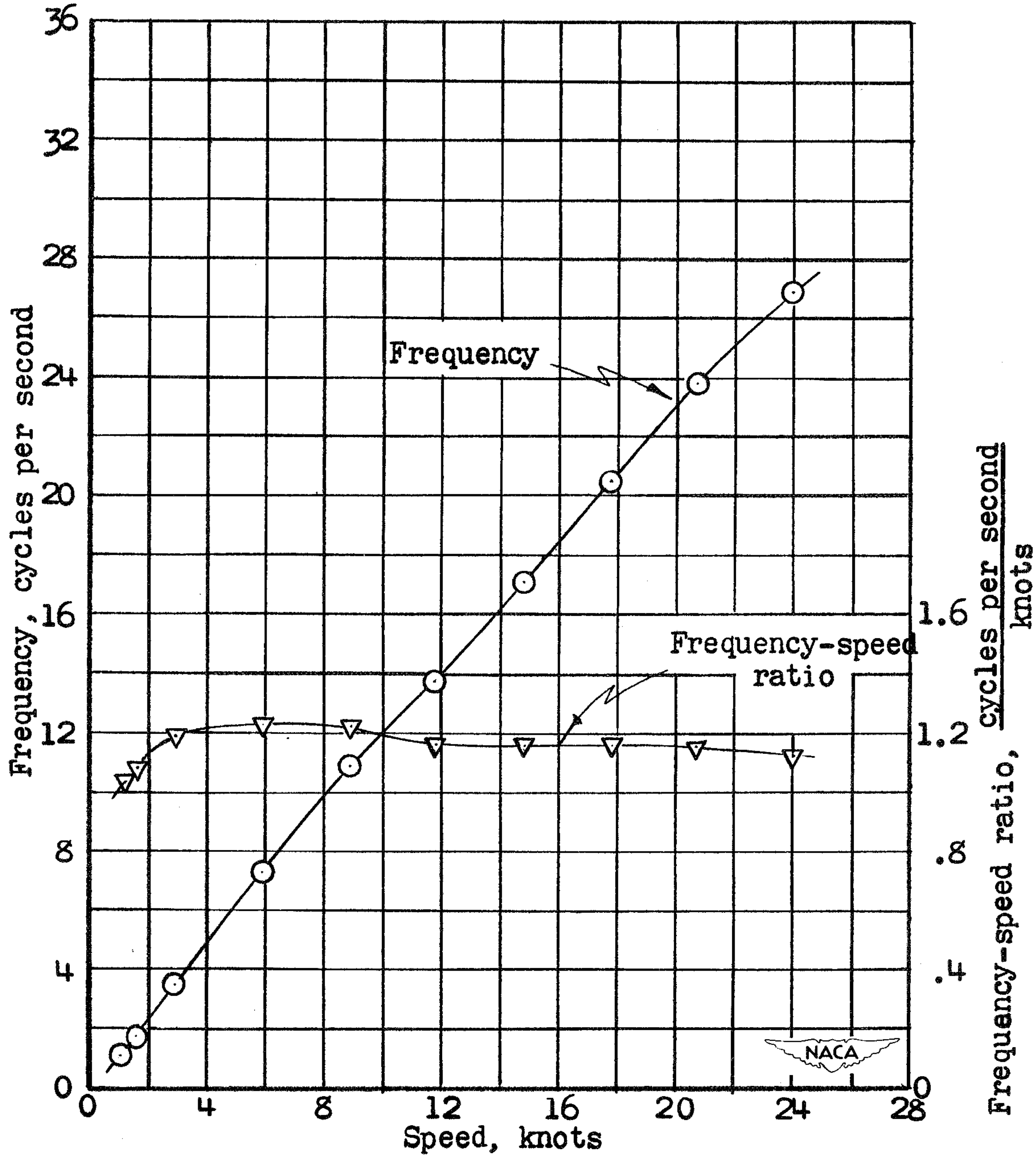


Figure 4.– Electrical circuit of Japanese log rodmeter.



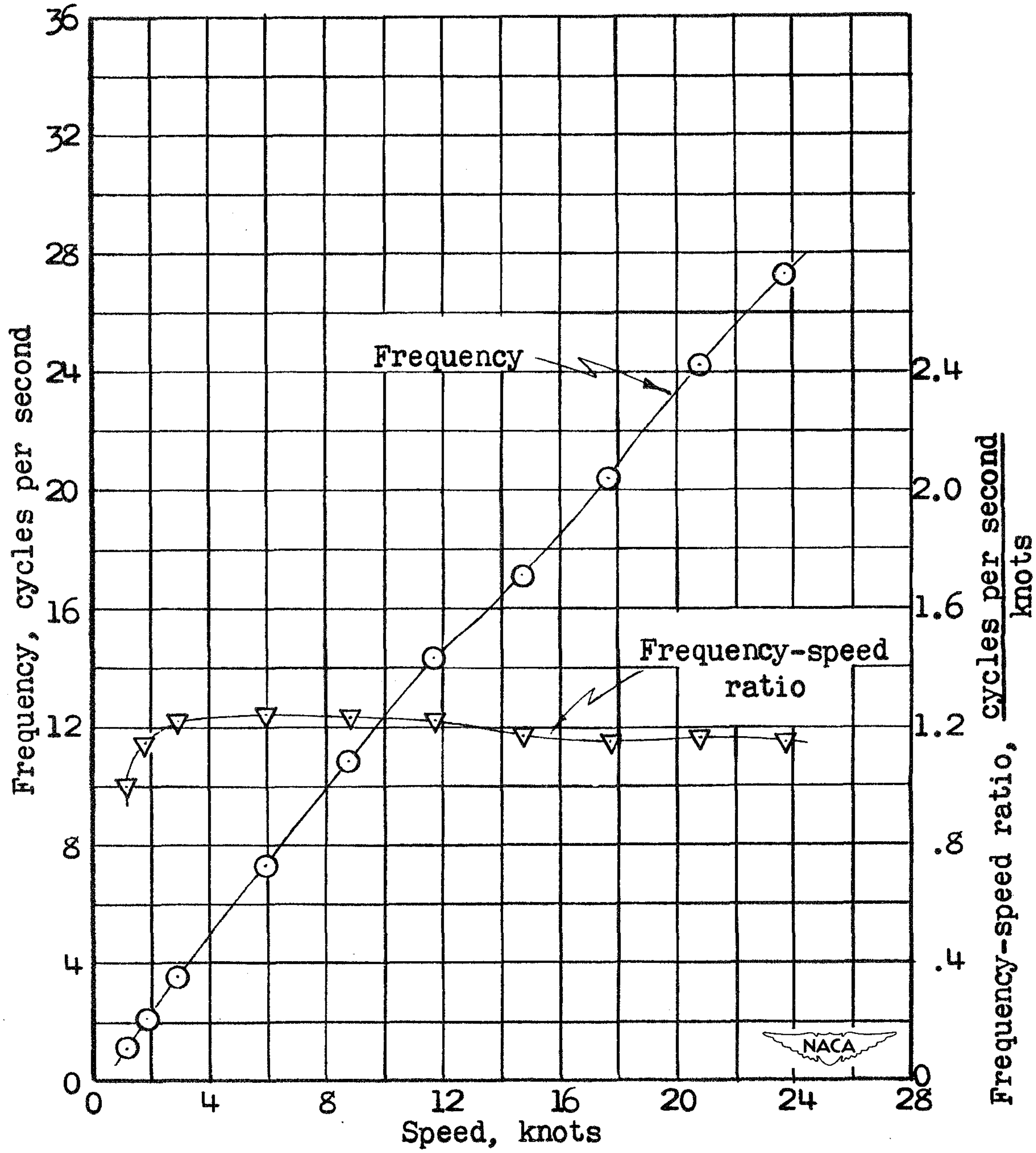
(a) 0^{0} yaw.

Figure 5.- Calibration of impeller 79.



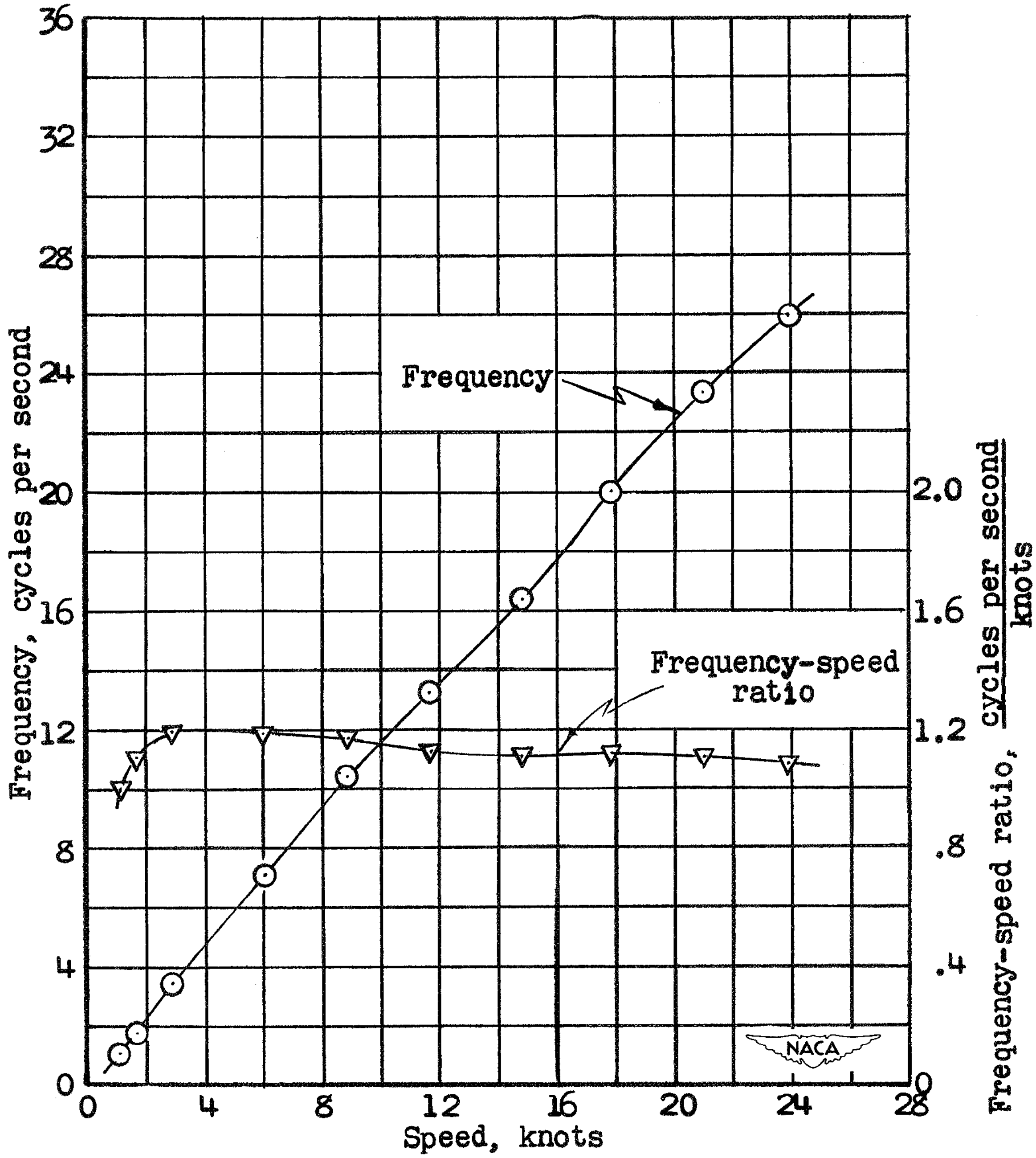
(b) 5° right yaw.

Figure 5.– Continued.



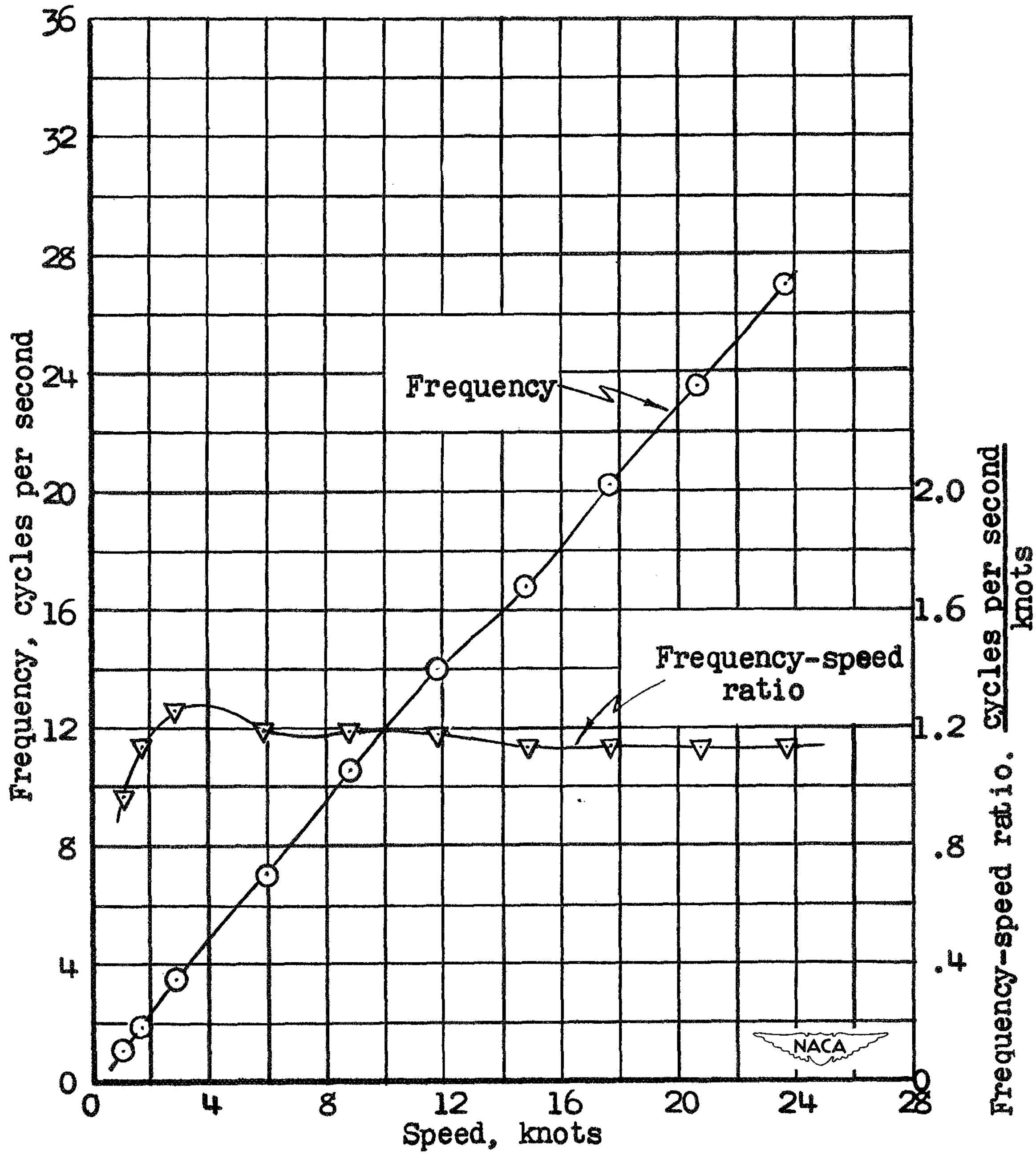
(c) 5^{o} left yaw.

Figure 5.– Continued.



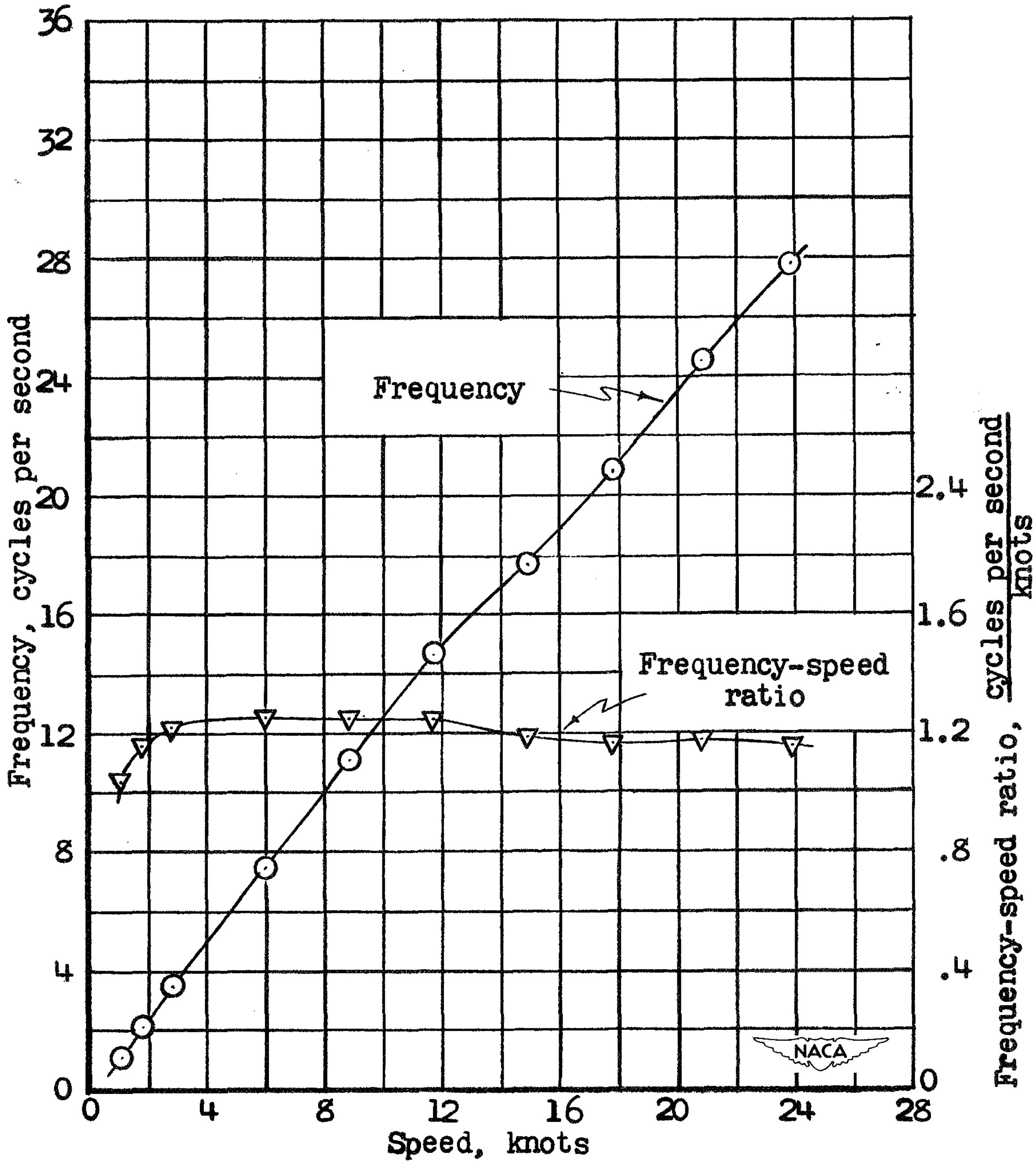
(d) 10^{0} right yaw.

Figure 5.— Continued.



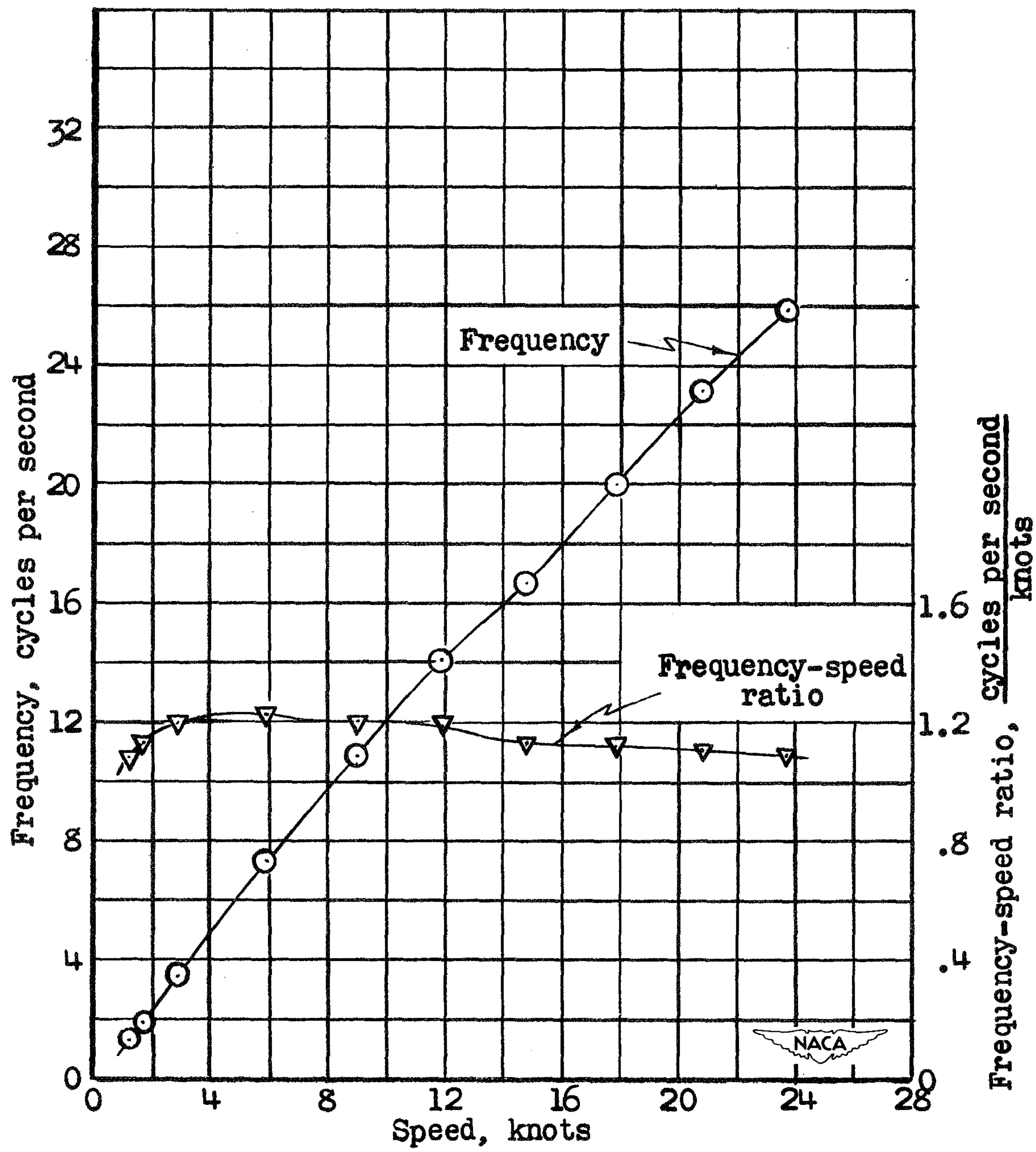
(e) 10^{0} left yaw.

Figure 5.– Concluded.



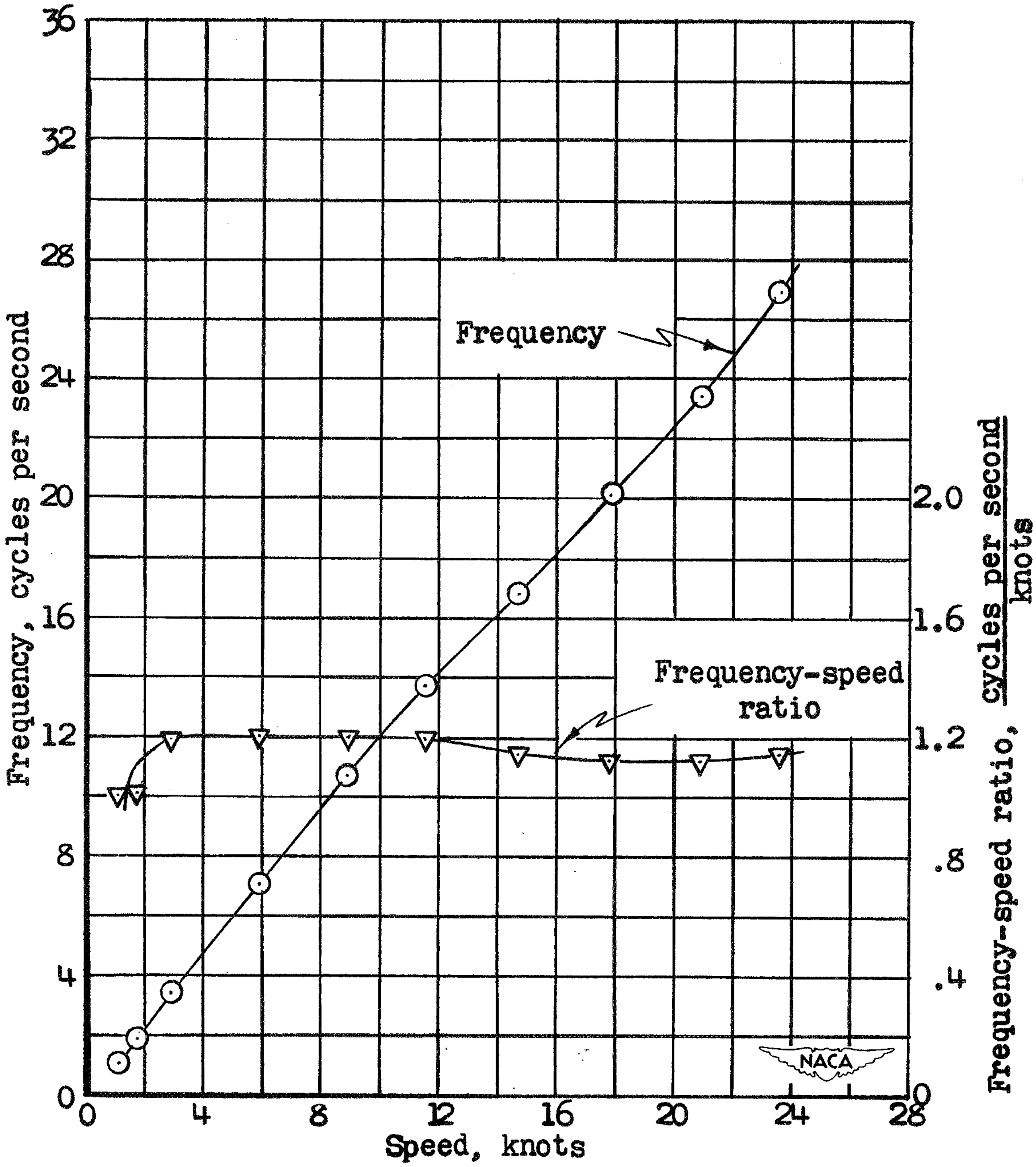
(a) 0° yaw.

Figure 6.– Calibration of impeller 80.



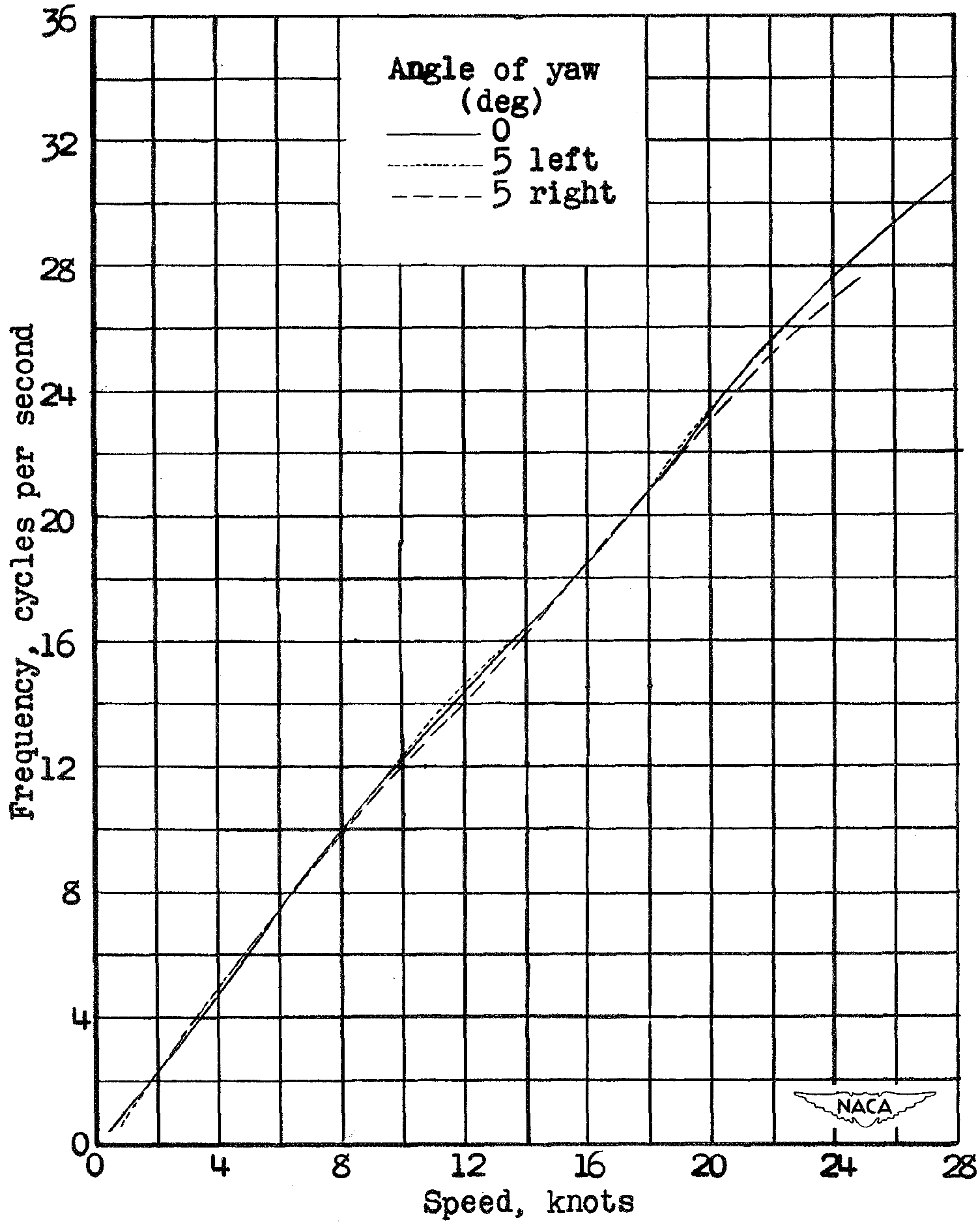
(b) 10° right yaw.

Figure 6.– Continued.



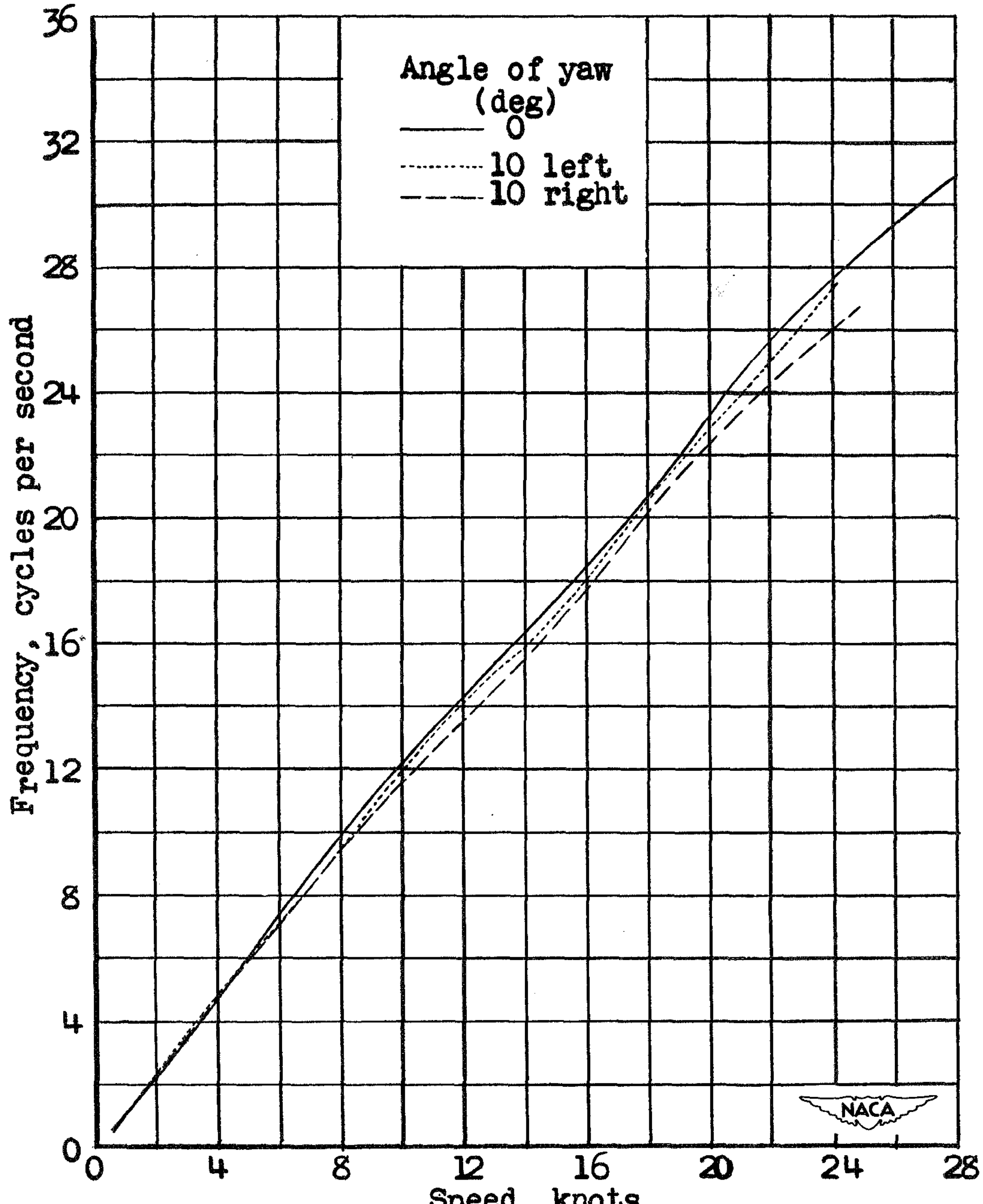
(c) 10^{0} left yaw.

Figure 6.– Concluded.



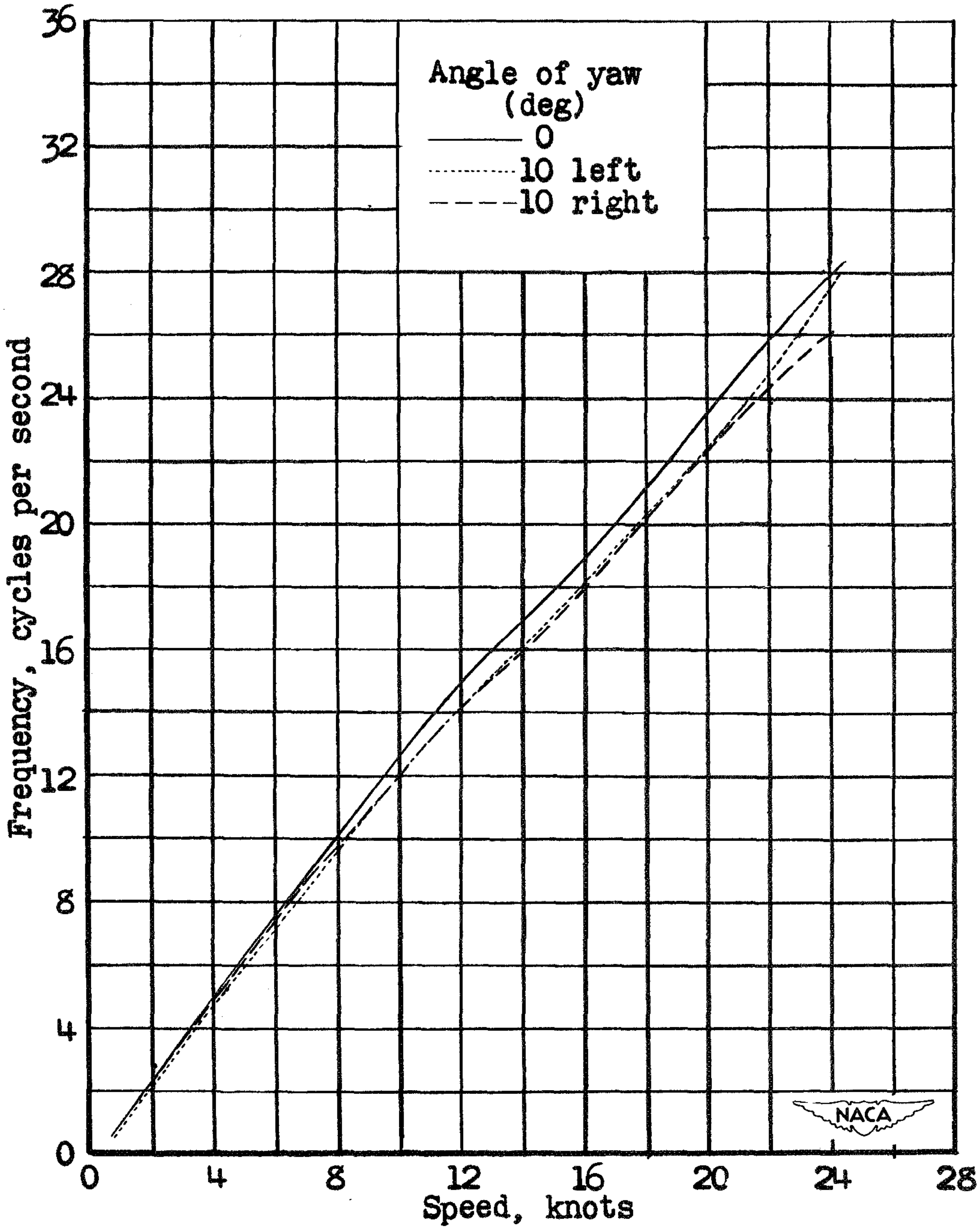
(a) Impeller no. 79; angles of yaw, 0°, 5° right, 5° left.

Figure 7.- Effect of yaw on Japanese log rodmeter.



(b) Impeller no. 79; angles of yaw, 0^{0}, 10^{0} right, 10^{0} left.

Figure 7.— Continued.



(c) Impeller no. 80; angles of yaw, 0°, 10° right, 10° left.

Figure 7.– Concluded.

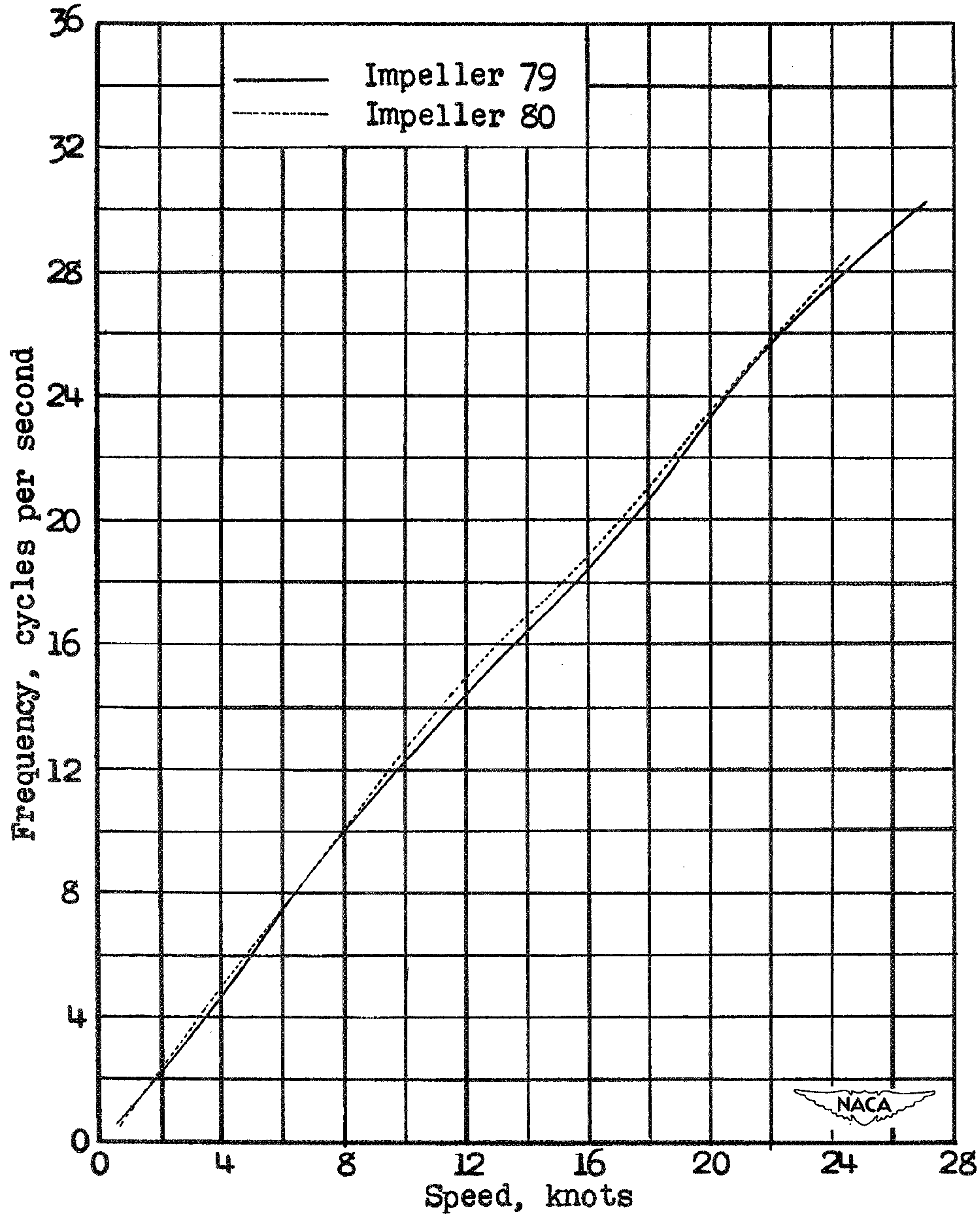


Figure 8.- Comparison of two impellers at 0° yaw.