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NRL Report No. B-1411

FR-1411

NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report of Test

on

Tachometer, Centrifugal Type, Self-Synchronous Motor Coupled.

Manufactured by

Jones Motrola Company.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

Number of Pages: Text - 5 Tables - 1 Plates - 3

Authorization: BuEng.ltr. S65-5/L5 (9-10-Ds) of 20 September 1937.

Date of Test: October and November 1937.

Tested by: J. R. Coomes, Senior Engineering Aide.

J. S. Bryant, Senior Engineering Aide.

Prepared by: W. B. Roberts, Principal Engineering Aide, Chief of Section.

Reviewed by: R. A. Gano, Lieutenant, USN.

Approved by: H. M. Cooley, Captain, USN, Director.

Distribution:
BuEng. (5)

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Appendices

AUTHORIZATION

1. This test was authorized under reference (a) for conformance with reference (b), but was later modified by oral request of the Bureau in compliance with reference (c). Another reference pertinent to this problem is listed as reference (d).

Reference: (a) BuEng.ltr. S65-5/L5 (9-10-Ds) of 20 September 1937.
(b) Specifications SGS(65)-10b.
(c) Specifications 18T17.
(d) Specifications SGS(65)-42a.

OBJECT OF TEST

2. The object in conducting this test was to determine how closely the subject material complied with references (c) and (d), and its suitability for Naval use as a remote reading tachometer. It was also desired to determine the shock and vibration integrity of the tachometer.

ABSTRACT OF TEST

3. The tachometer was set up at this Laboratory as shown by photograph, Plate 2, and its performance was carefully checked for compliance with the specifications, in so far as they were applicable.

CONCLUSIONS

(a) The self-synchronous motors used demonstrate the practicability of this type of coupling between the tachometer and the shaft of which the speed is to be measured. However, no tests were made to determine their suitability for Naval use as alternatives for the types specified under specifications, reference (d).

(b) The results of the accuracy tests following the shock and vibration tests, Table 1 and Plate 1, indicate that the tachometer head is not sufficiently rugged for service use. An inspection disclosed a bent pointer shaft and considerable lost motion between the sector shaft and its bearings. In order to increase its shock integrity an outboard bearing should be provided for the pointer shaft.

(c) The cast alloy chassis should not contact the brass casting. A paper gasket, placed between these surfaces, should prove satisfactory as a preventative for corrosion resulting from galvanic action. This also applies to the back cover.

(d) It will be noted under reference (d) that the maximum allowable speed at which a self-synchronous motor may be rotated is 150 r.p.m. However, the self-synchronous motors submitted are equipped with carbon brushes and appear to be more suitable for operating at higher speeds. In order to indicate 1100 r.p.m. with the system submitted, the motors must be rotated at 550 r.p.m.

RECOMMENDATIONS

(a) It is recommended that in the event the Bureau considers this type of tachometer worthy of further consideration, a complete system, including a shaft transmitter, be submitted for a complete test. The system submitted does not incorporate approved type self-synchronous motors.

DESCRIPTION OF MATERIAL UNDER TEST

4. The tachometer submitted is of the centrifugal governor type having a dial reading from 100 to 1100 r.p.m. in steps of 20 r.p.m. The dial is brass and is marked with white figures and graduations on a black background.

5. The case is designed for gauge board mounting and is of splashproof design. It is made up of four parts, namely, a cast brass housing, a die cast chassis, a formed brass nickel-plated ring for securing the window, and a formed brass shell which encloses the mechanism.

6. All of the mechanism is mounted on the die cast chassis, ball bearings being employed for the governor shaft and main shaft. The drive shaft carries a phenolic gear which meshes with a brass gear on the governor shaft. As the shaft rotates the centrifugal force causes the fly-ball assembly to expand against the tension of a steel coil spring, causing a disc to move longitudinally along the fly-ball shaft. A pivoted follower carries on its shaft a sector gear which engages a pinion on the pointer shaft. A spiral spring returns the pointer to zero and causes the follower to remain in contact with the actuating disc.

7. A self-synchronous motor of commercial type drives the tachometer through a gear ratio 1:2. This motor is driven by a self-synchronous generator, the shaft of which is rotated by the device of which it is desired to measure the speed. The self-synchronous units are designed for 115 volts, a.c., 60 cycle operation.

8. The tachometer indicates revolutions in either direction of rotation and a governor stop is provided to prevent the pointer from going beyond the full scale deflection.

9. The tachometer is 6".0 in diameter, 3".75 in depth, and weighs 3.75 pounds.

10. Further details in the design and construction of the tachometer are shown by photographs, Plates 2 and 3.

METHOD OF TEST

11. The tachometer was first tested for endurance by driving the self-synchronous generator with a constant speed motor, so geared as to indicate a speed of 400 r.p.m. The test was continuous for a period of 400 hours.

12. Following the test for endurance the tachometer was checked for accuracy by driving the generator with a constant speed motor so geared as to indicate speeds in increments of even hundreds over the entire scale, except that 120 r.p.m. was the lowest test speed used.

13. The tachometer was next placed on a standard Bureau of Engineering shock stand and subjected to 20 shocks of 250 foot pounds each while operating at 400 r.p.m.

14. It was then placed on a vibrating machine and, while operating at 400 r.p.m., subjected to six tests of 30 minutes each, during which blows of 3 foot pounds were delivered at frequencies of 100, 150, 200, 250, 300, and 350 per minute.

15. Following the shock and vibration tests the tachometer was again checked for accuracy as described in paragraph 12.

16. An inspection of the tachometer to determine conformance with the specifications in the matter of design, material and workmanship, concluded the test.

RESULTS OF TEST

17. The test results obtained were as follows:

Requirements	Test Values
Type: Centrifugal governor.	Centrifugal governor.
Range: Single.	Single, 100 to 1100 r.p.m. in steps of 20.
Rotation: Shall indicate revolutions in either direction without change or adjustment.	Complied.
Governor stop to prevent the hand from exceeding full scale deflection.	Complied.

Requirements	Test Values
Mounting: Gauge board.	Complied.
Means for adjustment: Shall be provided.	Provision made for zero adjustment.
Dial markings: Shall be black figures on a white background.	*White figures on a black background.
Endurance: Shall operate satisfactorily for 400 hours at two-thirds scale indication.	Operated continuously for 400 hours at 400 r.p.m.
Accuracy: Not more than 2 per cent error on any part of the scale.	*See Table 1 and Plate 1, results following endurance test.
Shock and vibration tests: Shall withstand the tests specified under late specifications for I.C. equipment. Tests made are outlined under paragraphs 13 and 14.	*See Table 1 and Plate 1, results following shock and vibration tests. Also remarks under conclusions.

* Denotes failure to comply with the specifications.

CONCLUSIONS

18. The self-synchronous motors used demonstrate the practicability of this type of coupling between the tachometer and the shaft of which the speed is to be measured. However, no tests were made to determine their suitability for Naval use as alternatives for the types specified under specifications, reference (d).

19. The results of the accuracy tests following the shock and vibration tests, Table 1 and Plate 1, indicate that the tachometer head is not sufficiently rugged for service use. An inspection disclosed a bent pointer shaft and considerable lost motion between the sector shaft and its bearings. In order to increase its shock integrity an outboard bearing should be provided for the pointer shaft.

20. The cast alloy chassis should not contact the brass casting. A paper gasket, placed between these surfaces, should prove satisfactory as a preventative for corrosion, resulting from galvanic action. This also applies to the back cover.

21. It will be noted under reference (d) that the maximum allowable speed at which a self-synchronous motor may be rotated is 150 r.p.m. However, the self-synchronous motors submitted are equipped with carbon brushes and appear to be more suitable for operating at higher speeds. In order to indicate 1100 r.p.m. with the system submitted, the motors must be rotated at 550 r.p.m.

TABLE I

ACCURACY TEST RESULTS — ALLOWABLE ERROR 2%

DRIVEN RPM	FOLLOWING ENDURANCE TEST		FOLLOWING SHOCK & VIBRATION TESTS	
	Average Indicated RPM	% Error	Average Indicated RPM	% Error
120	127.5	+ 6.25	132.5	+ 10.42
200	200.0	0.00	200.0	0.00
300	292.5	- 2.50	287.5	- 4.16
400	392.5	- 1.87	382.5	- 4.37
500	492.5	- 1.50	482.5	- 3.50
600	592.5	- 1.25	582.5	- 2.92
700	692.5	- 1.07	687.5	- 1.79
800	792.5	- 0.94	787.5	- 1.56
900	887.5	- 1.39	877.5	- 2.50
1000	987.5	- 1.25	972.5	- 2.75
1100	1087.5	- 1.14	1072.5	- 2.50

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

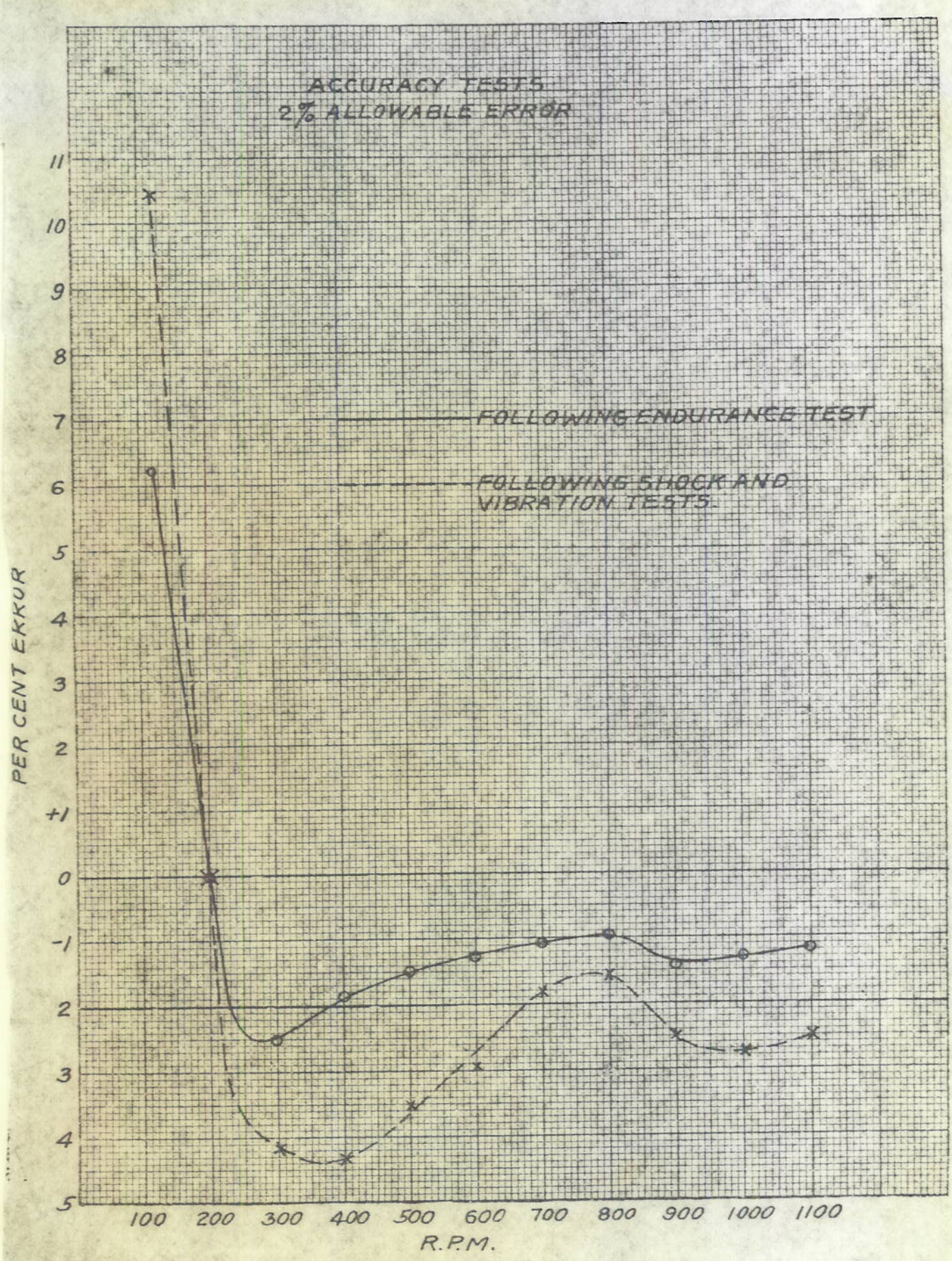

PLATE I

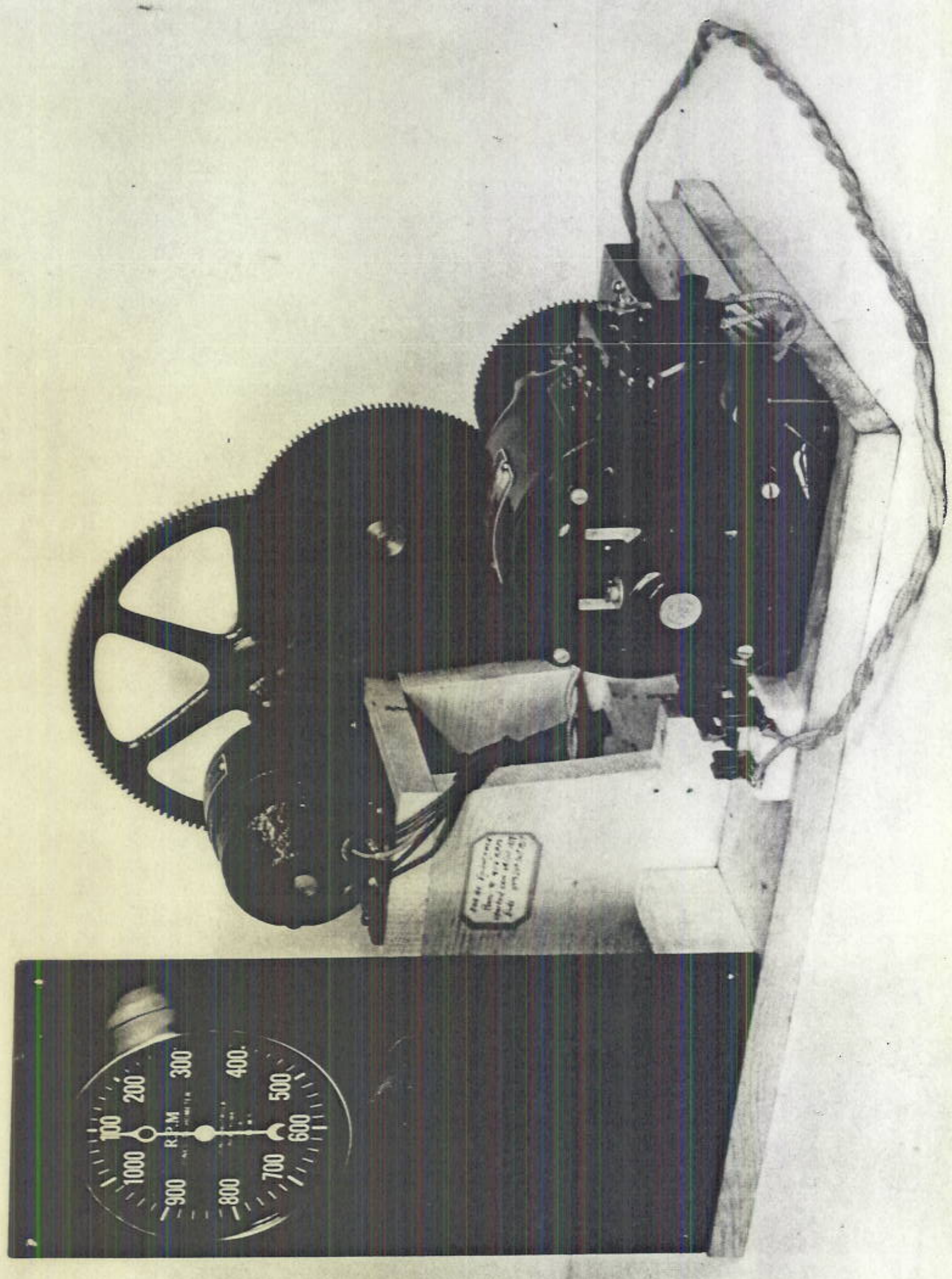

Plate 2

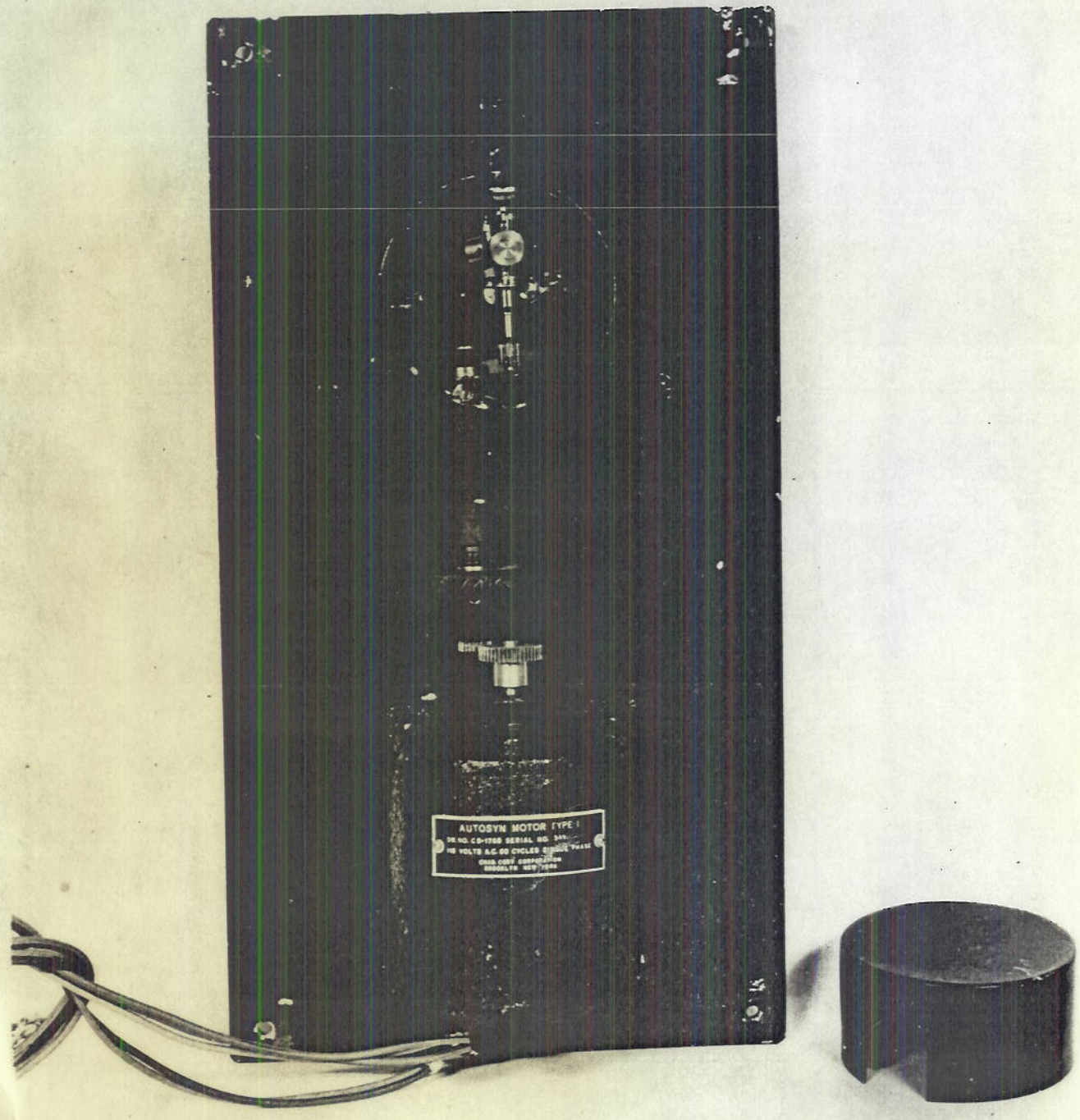

Plate 3