27 April 1937 NRL Report No. S-1359

NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report of Test

on

FR-1359

Propeller Shaft Revolution Indicator Equipment.

Manufactured and Submitted by

Electric Tachometer Corporation
Philadelphia, Pa.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

Number of Pages: Text - 6 Tables - 1 Plates - 7

Authorization: BuEng. ltr. S65-5/L5(2-10-Dc) of 13 February 1937

Date of Test: February, March and April, 1937.

Tested by: _____
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Distribution:
BuEng.(5)

mbe

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Appendices

AUTHORIZATION

1. This test was authorized by reference (a) and other references pertinent to this problem are listed as (b) and (c).

Reference: (a) Buang.ltr. S65-5/L5(2-10-Ds) of 13 February 1937.
(b) Specifications SGS(65)-10b - Propeller Shaft Revolution Indicator and Counters, of 15 June 1936.
(c) Manufacturer's Drwg. of R.P.M. Indicator R-4 - File No. 2146.

OBJECT OF TEST

2. The object of this test was to determine how closely the subject shaft revolution indicator equipment complied with the specifications, reference (b), and its suitability for the Naval service.

3. The subject shaft equipment, shown by Plates 1 to 7 inclusive, was set up at this Laboratory and carefully checked for conformance with the specifications, reference (b), in so far as they were applicable. All tests were conducted in the order required for type approval tests, paragraph F-2.

CONCLUSIONS

(a) This instantaneous type propeller shaft system, manufactured and submitted by the Electric Tachometer Corporation, Philadelphia, Pa., complies with the specifications except as noted here below:

(1) Under the shock test, trouble was experienced with the pointer and dial due to faulty mounting in both cases. The dial rotated in its clamping ring and the pointer loosened on the shaft. After repairs, the test was continued and except for momentary changes in indication following each impact, the indicator performed normally.

(2) Under test for vibration integrity, the capacitor for the synchronous motor failed. After replacement of the capacitor the indicator withstood the entire test. However, at the close of this test, the studs holding the type A motor clamping ring and the connection block securing screws were loosened.

(3) Under the dielectric test, the type M motor in the r.p.m. indicator failed, the breakdown occurring in the rotor. The insulation resistance following this test was zero.

(4) Under test for watertightness, approximately 20 cc of water leaked in around one of the screws securing the alignment spline.

(5) The dial and pointer of the indicator are of a temporary nature but represent the type shown on manufacturer's drawing, reference (c). The graduations are in steps of 2 r.p.m. and are cut through the black, into the translucent white lamination. The dial is illuminated by two TS-53 lamps mounted behind it. When viewed in a totally dark room it was found that the illumination of the graduations and numerals was uneven, while the pointer was barely visible. The counter was illuminated, but considerable direct light escaped and it was possible to see one of the lamps when viewed from an angle of approximately 70 degrees.

(6) Under test for accuracy at a shaft speed of 450 r.p.m., it was noted that the maximum speed which could be indicated by the r.p.m. indicator was 440 r.p.m. This limit is established by stop pin, piece 22.

(7) The transmitter weight exceeds that allowed by 3 pounds, six ounces.

(8) No nameplates were provided on either of the instruments submitted.

RECOMMENDATION

(a) The subject system, although having failed to comply with the specifications in their entirety, meets the major requirements, namely, endurance, accuracy and ruggedness. Therefore it is recommended that it be approved for naval use, subject to correction of the deficiencies, noted under "Conclusions" of this report.

DESCRIPTION OF MATERIAL UNDER TEST

4. This propeller shaft indicating equipment is manufactured by the Electric Tachometer Corporation, Philadelphia, Pa., and was submitted for type approval tests. The items submitted consisted of one shaft transmitter and one r.p.m. indicator.

5. Propeller Shaft Transmitter. The propeller shaft transmitter, shown by Plates 1 and 2, is housed in a watertight BE case from which a shaft extends through a watertight stuffing gland.

6. The main shaft is housed in heavy ball bearings and drives a type A motor through a 15:1 reduction gear. This shaft is driven by the propeller shaft through a 3:1 gear ratio, so that a speed of 400 r.p.m. of the propeller shaft produces a speed of 1200 r.p.m. at the main transmitter shaft.

7. The six figure counter provided, counts unit revolutions of the propeller shaft and is driven independently through sprockets and a chain from the main transmitter shaft, so that the type A motor may be removed from its housing without disturbing the functioning of the revolution counter. The counter is visible through a watertight glass window located in the top of the case cover.

8. The uni-directional gear mechanism causes the work shaft to rotate in one direction regardless of the direction of rotation of the propeller shaft.

9. Combined with the uni-directional gear train is a switch for operating the direction of rotation target in the r.p.m. indicator.

10. This transmitter is essentially the same as that tested and reported under NRL Report No. B-1203 of 10 October 1935.

11. R.P.M. Indicator, R-4 Drawing 2146. This unit is shown by Plates 4 to 7 inclusive, and by manufacturer's drawing, reference (c).

12. The mechanism is housed in a cylindrical bronze case, piece 1, which is machined for cover of the same material and is provided with a rubber gasket to insure watertightness. The cover is secured to the case with six brass screws, piece 7.

13. The window is 3/16" thick and of flexible glass. The angle of vision of dial is approximately 45°.

14. A bronze plate, piece 3, forms the chassis of the mechanism and is provided with three hollow legs for supporting the mechanism when removed from the case. The legs also serve as distance pieces and for combination holding down screws and dowels, when the mechanism is bolted in place. Screws, piece 4, are so designed that they can be extended to form feet to support the mechanism upside down when it is removed from the case.

15. Two splines, piece 5, attached to the side of the case, act as guides for corresponding slots in supporting plate, piece 3.

16. The mechanism consists of a type A motor, piece 8, which is driven

from the motor in the shaft transmitter. A speed of 80 r.p.m. for this motor is equivalent to a shaft speed of 400 r.p.m.

17. The screw shaft, piece 9, supported in ball bearing brackets, piece 10, is driven through 1:1 spiral gears. Disc wheel, piece 16, attached to nut, piece 11, is thereby moved along the screw shaft and carries with it casing, piece 12. This casing is provided with ball bearing mountings so that it may move longitudinally without rotating.

18. Disc, piece 17, is driven by a synchronous 60 r.p.m. motor, piece 20, through the mechanism in casing, piece 18, by gearing, having a ratio of 4 to 1. As the speed of shaft, piece 9, varies, the disc nut and casing, piece 11 and 12, move to right if speed is increased and to the left if the speed decreases. The disc wheel moves across the face of disc until the speed equals that of the screw shaft and transmitter. As these movements take place, balanced pointer, piece 15, is actuated through rack, piece 13, and pinion, piece 14, to readings equivalent to displacement of nut, piece 11, across face of disc.

19. Dial, piece 19, is of black and white Formica with numerals and letters engraved through the black surface to the translucent white underneath. The dial is enclosed in a brass ring and supported by four dial posts.

20. A zero cut off switch, piece 21, is provided and operated through leverage which automatically opens the circuit to constant speed motor, piece 20, when the propeller shaft speed approaches zero.

21. A stop pin, piece 22, with engaging screw head operates to prevent disc wheel from overrunning the disc or jamming the right hand bearing, if the speed of the propeller shaft becomes great enough to tend to force the disc wheel beyond the diameter of the constant speed disc.

22. A guide and bracket, piece 23, are provided to prevent nut casing, piece 12, from turning with screw shaft, piece 9.

23. The dial is illuminated with two TS-53, 6-8 volt lamps. Transformer, piece 27, supplies the correct voltage for the dial lamps, and rheostat, piece 24, controls the brilliancy. The rheostat is operated by screw plug, piece 25. To operate, the plug is removed and reversed, being again replaced after the lamp brilliancy is adjusted.

24. The direction signal, piece 32, is a magnetic drop which is energized when the propeller shaft is rotating in reverse and deenergized when rotating ahead.

25. A six figure counter , piece 30, having white figures on a black background, and driven by chain drive, piece 31, through 1:2 sprockets, is supplied.

26. A circular jack, piece 29, is mounted in the bottom of the case to provide the necessary connections when the internal mechanism is inserted. The circular plug, piece 28, is mounted on the mechanism.

27. The case, piece 1, is provided with four lugs for panel mounting and has two internal bosses drilled and tapped for 1"25 (IPS) standard terminal tubes.

METHOD OF TEST

21. The system was first subjected to the 500 hour endurance test, the first part of which consisted of operating it at a propeller shaft speed of 400 r.p.m. for a period of 50 hours. At the end of this period the test was interrupted and the shock test, accuracy tests, and vibration tests, required under paragraph F-2c, reference (b), were conducted. During the remaining 450 hour test the shaft speed was varied through a range of 100 to 400 r.p.m. at the rate of approximately 40 r.p.m. The system was operated periodically at 400 r.p.m. to permit checking r.p.m. against the speed of the driving member. During these tests, the indicator disc motor was energized from a local regulated frequency, 60 cycle supply.

22. The remaining tests were made in the order specified for type approval tests, under reference (b).

23. The test was concluded with a general inspection of the equipment to determine the quality of workmanship and material used in its construction.

RESULTS OF TEST

24. Following are the results of the tests:

Requirements	Test Values
Voltage of System: 115	115 Volts
Amperes: Not specified.	Synchronous Motor 0.140 Amps. Remainder of system 1.75 Amps.
Frequency: 60 cycles	60 cycles. (Regulated frequency)
Endurance: Par. F-2c(1)	Satisfactory operation throughout the test.
Shock tests: Para.F-2c(2)b and F-2c(2)c.	Satisfactory except for minor defects, noted under "Conclusions".
Accuracy tests: Par. F-2c(3).	Satisfactory, see Table 1.
Vibration tests: Par. F-2c(4).	*See comments under "Conclusions".
Voltage and frequency compensation: Par. F-2c(5)b.	Satisfactory, not applicable to the disc motor.
Inclination tests: Par. E-12f	Satisfactory, no apparent change in operation.
Dielectric tests: Par. F-2c(5)f.	*See comments under "Conclusions".
Insulation tests: Par. F-2c(5)g.	*Zero following the dielectric test.
Watertight tests: Par. F-2c(5)i.	*Case leaked approximately 20 cc of water.

Requirements	Test Values
Dials and pointers: Par. E-7	*Unsatisfactory, see comments under "Conclusions".
Weight - par. E-10	*Transmitter weight exceeded by 3 lbs. 6 ozs.

Dimensions - Par. E-10

Instrument	Weight	Dimensions
Transmitter	3 lbs. 6 oz.	9"375 x 11"0 x 12" 875
R.P.Indicator	35 lbs.	9"125 x 10"75 x 10"75

*Denotes failure to comply with the specifications.

CONCLUSIONS

25. This instantaneous type propeller shaft system, manufactured and submitted by the Electric Tachometer Corporation, Philadelphia, Pa., complies with the specifications except as noted here below:

(a) Under the shock test trouble was experienced with the pointer and dial due to faulty mounting in both cases. The dial rotated in its clamping ring and the pointer loosened on the shaft. After repairs, the test was continued and except for momentary changes in indication following each impact, the indicator performed normally.

(b) Under test for vibration integrity the capacitor for the synchronous motor failed. After replacement of the capacitor, the indicator withstood the entire test. However, at the close of this test, the studs holding the type A motor clamping ring and the connection block securing screws were loosened.

(c) Under the dielectric test, the type M motor in the r.p.m. indicator failed, the breakdown occurring in the rotor. The insulation resistance following this test was zero.

(d) Under test for watertightness, approximately 20 cc of water leaked in around one of the screws securing the alignment spline.

(e) The dial and pointer of the indicator are of a temporary nature but represent the type shown on manufacturer's drawing reference (c). The graduations are in steps of 2 r.p.m. and are cut through the black into the translucent white lamination. The dial is illuminated by two TS-53 lamps mounted behind it. When viewed in a totally dark room it was found that the illumination of the graduations and numerals was uneven, while the pointer was barely visible. The counter was illuminated but considerable direct light escaped and it was possible to see one of the lamps when viewed from an angle of approximately 70 degrees.

(f) Under test for accuracy at a shaft speed of 450 r.p.m., it was noted that the maximum speed which could be indicated by the r.p.m. indicator was 440 r.p.m. This limit is established by stop pin, piece 22.

(g) The transmitter weight exceeds that allowed by 3 pounds, 6 ozs.

(h) No nameplates were provided on either of the instruments submitted.

TABLE NO. 1

Results of accuracy tests made in accordance with specifications, par. F-2c(3).

Shaft R.P.M.	Indicator R.P.M.	
	Indication	Error
60	61.0	1.0
100	101.0	1.0
150	151.0	1.0
200	201.0	1.0
250	251.0	1.0
300	301.0	1.0
400	401.0	1.0
Par.E-11b		
350	351.0	1.0
Par.E-12b		
450	440.0	See "Conclusions".

Note: These readings are approximate as it is not possible to read the dial with great accuracy. At zero shaft speed, the indicator read zero on the dial.

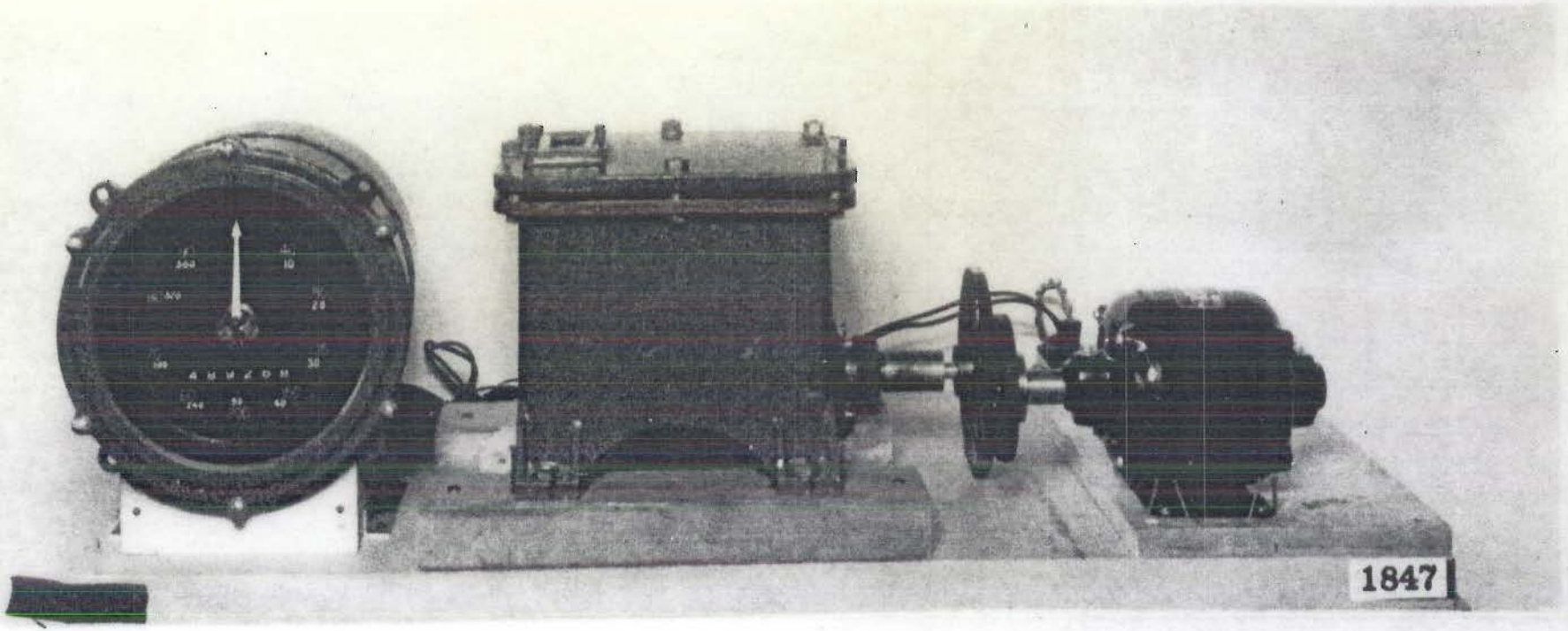
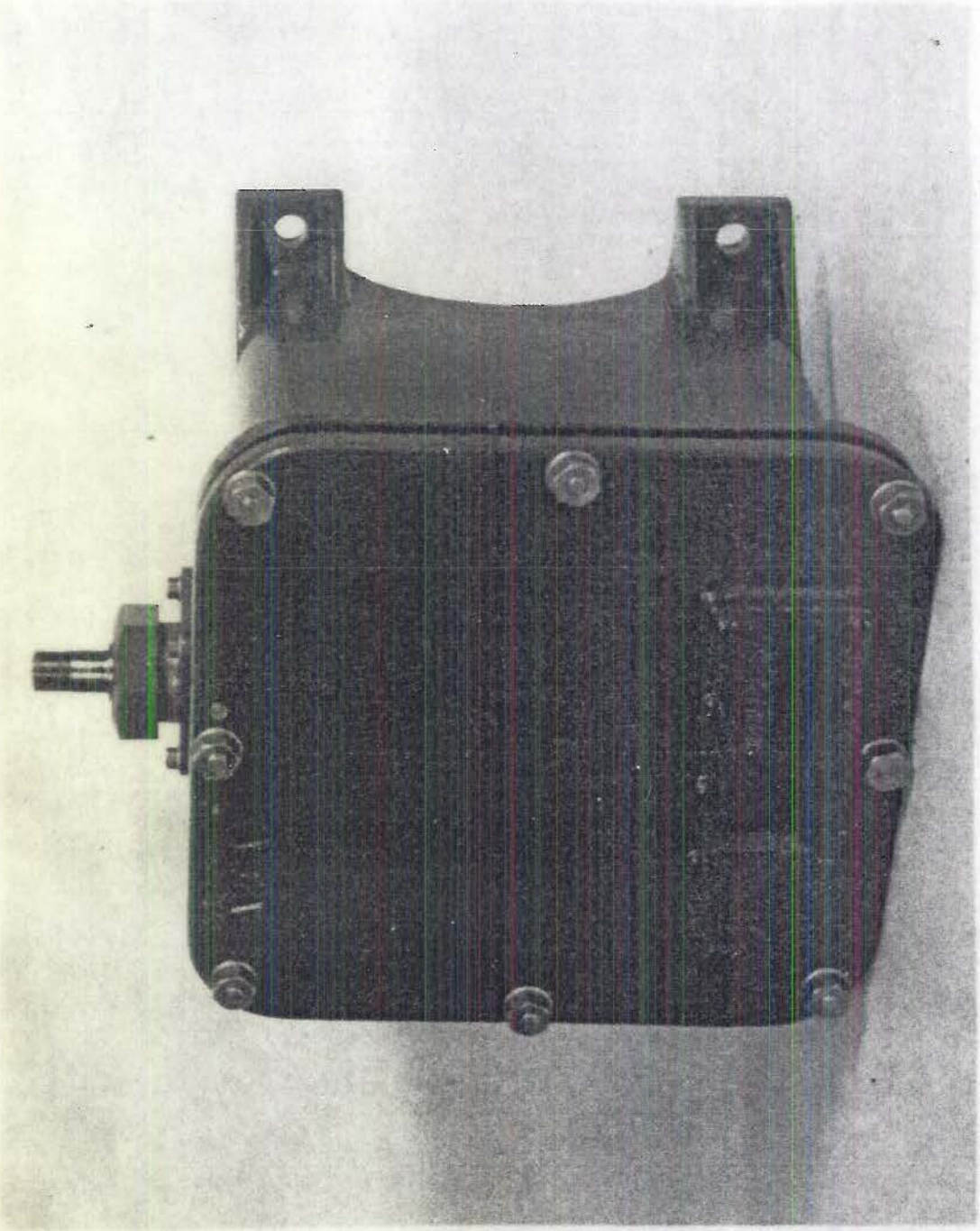


Plate 1



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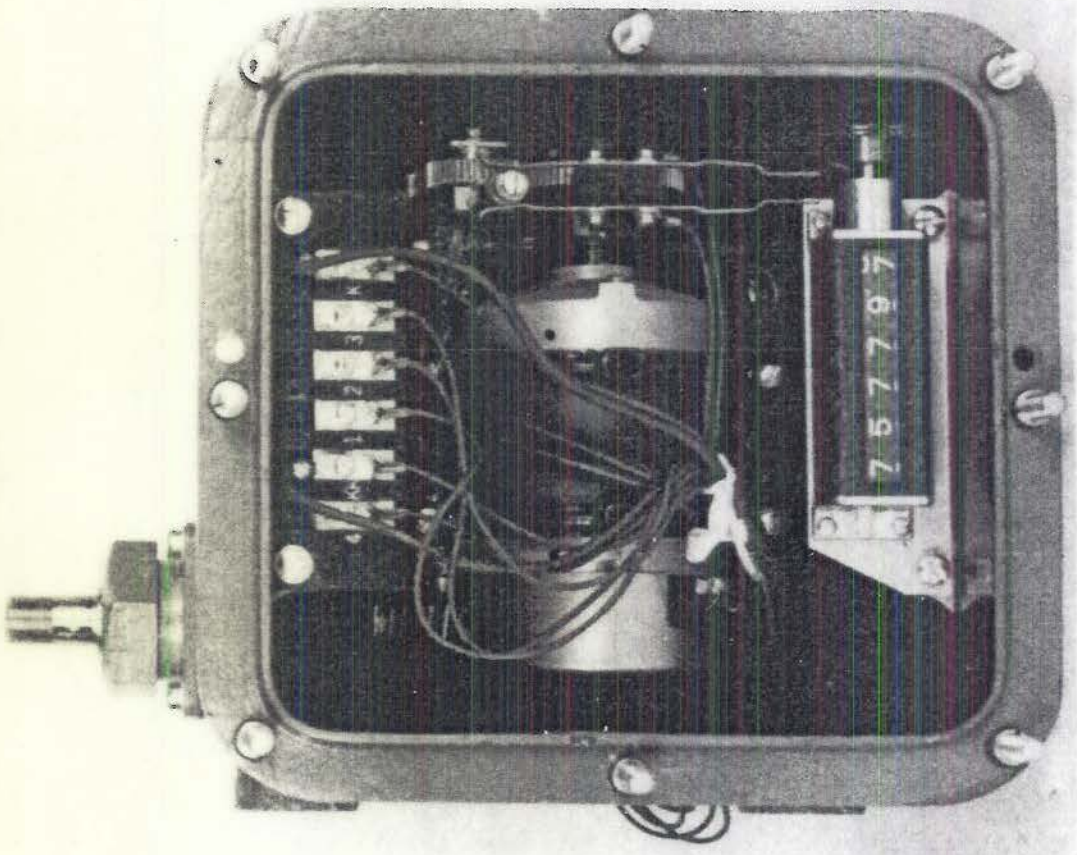

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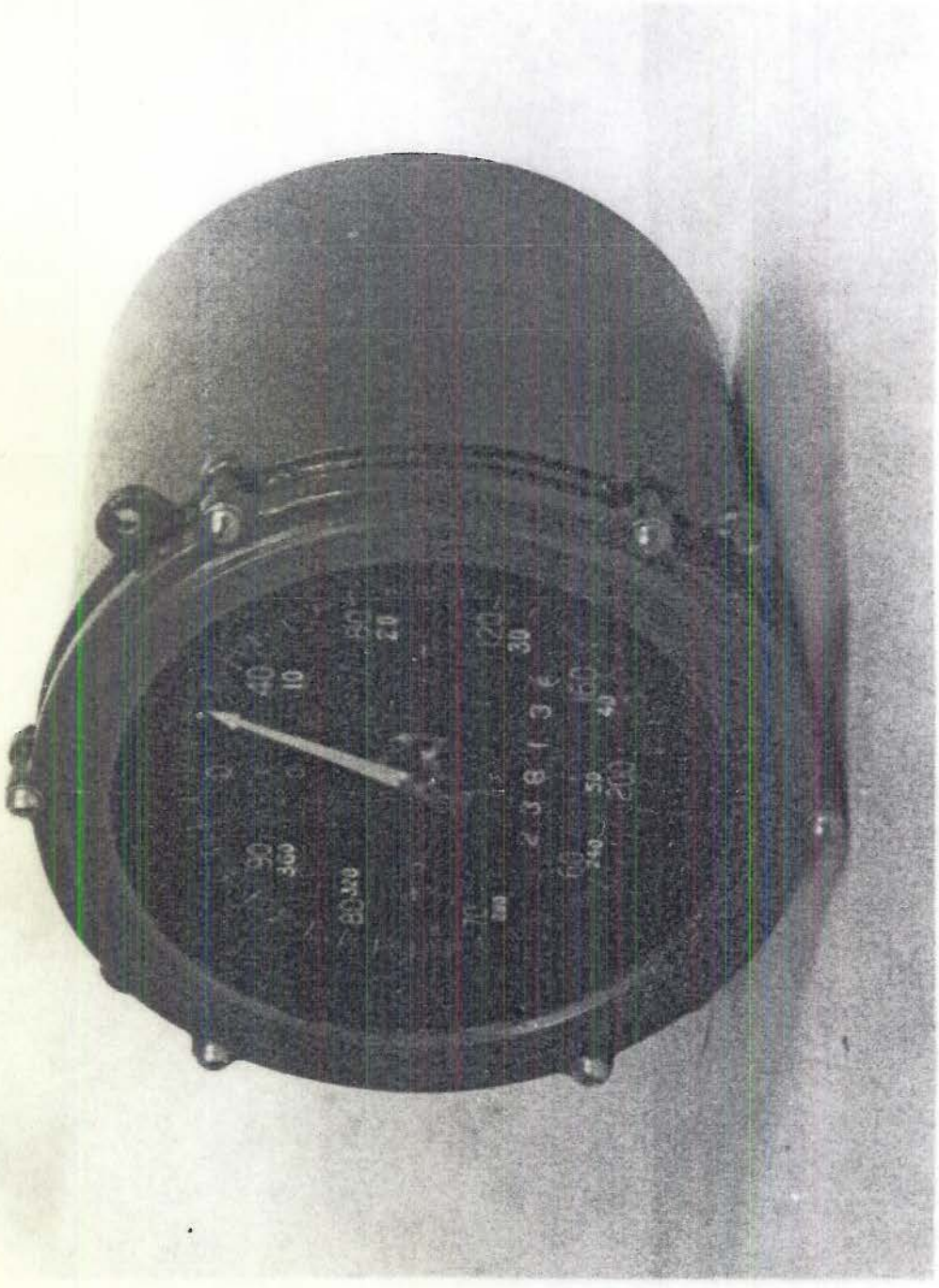

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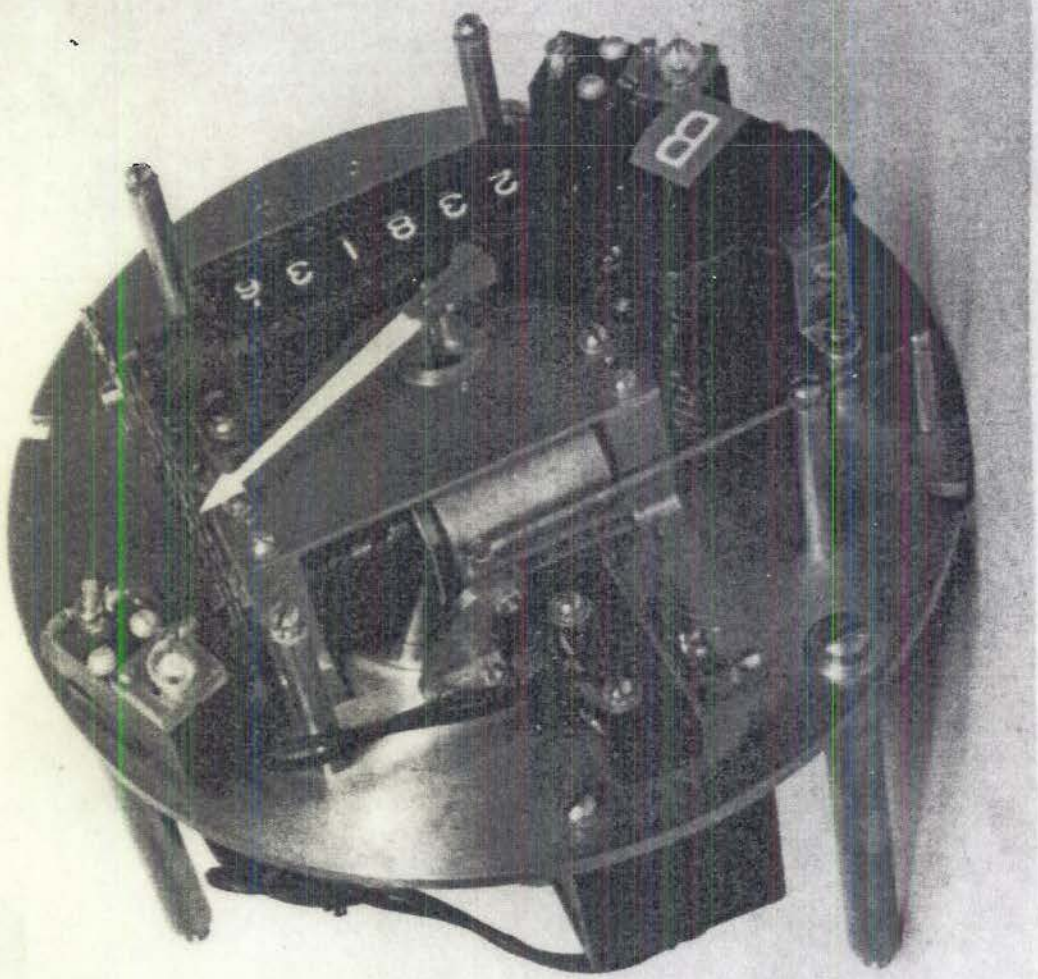

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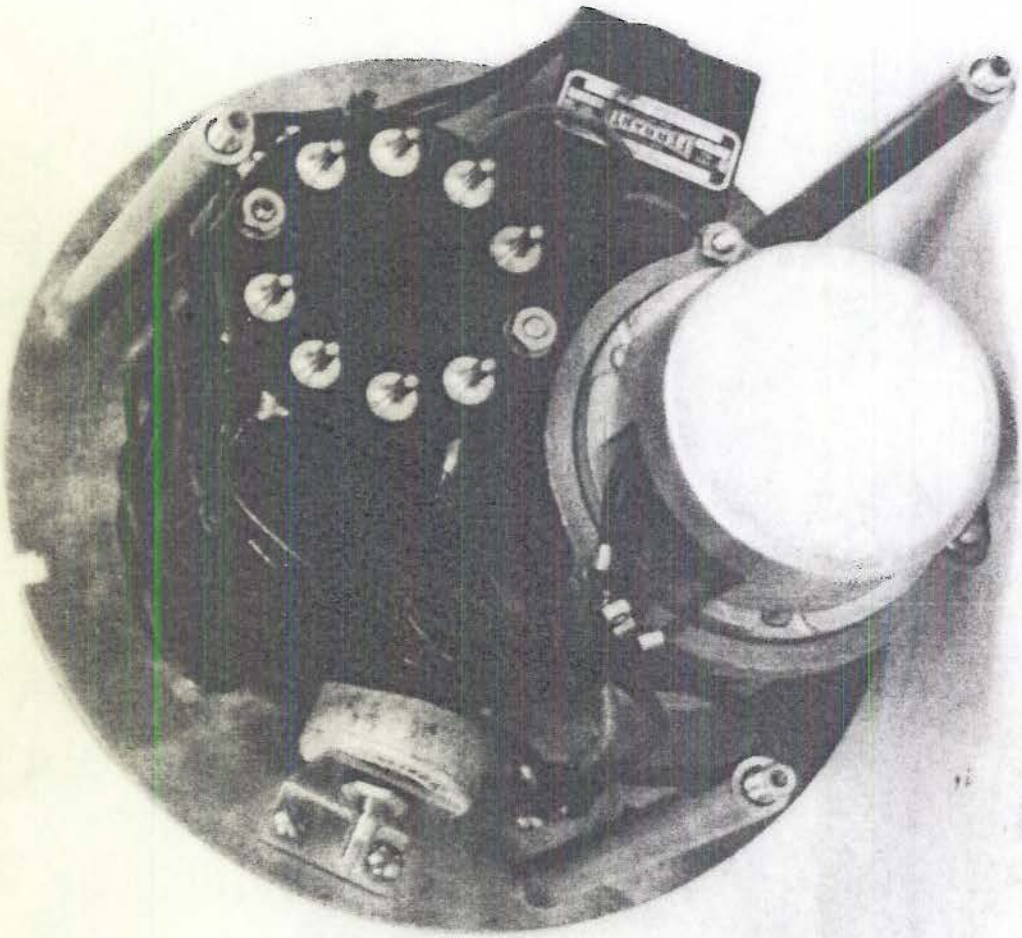

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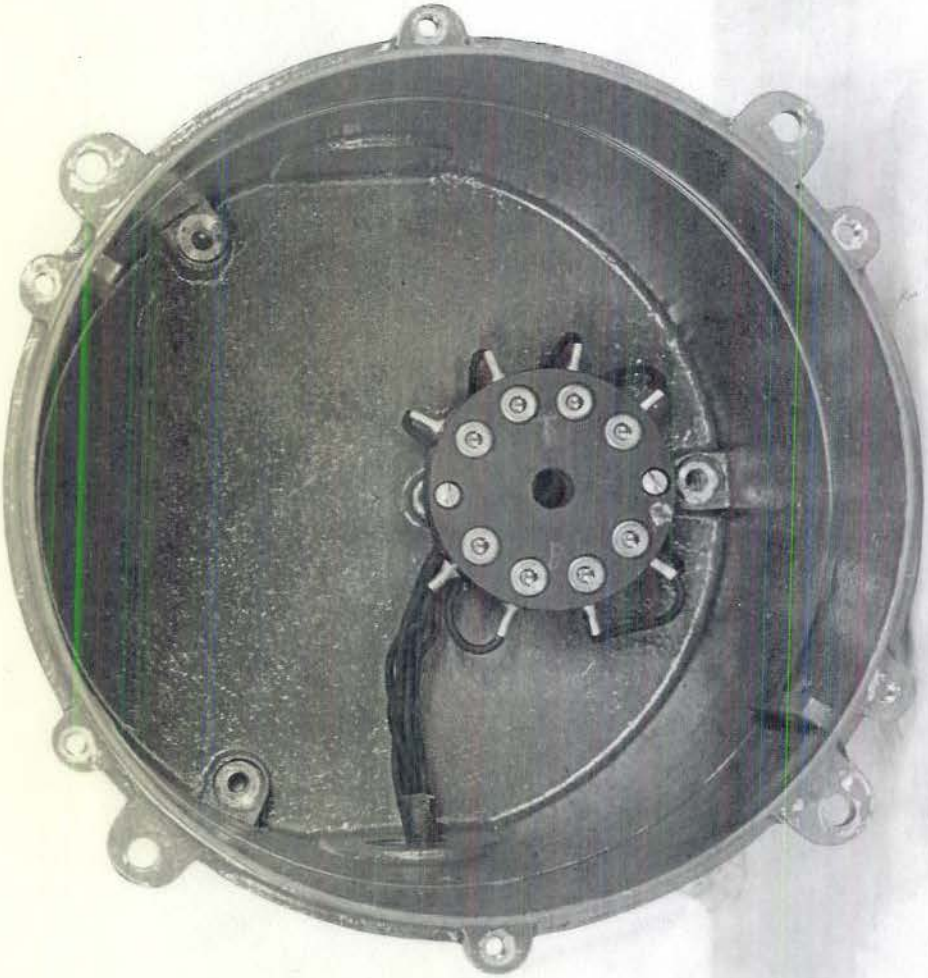

Plate 7