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REPORT NO. B-1358

DATE 27 April 1937

SUBJECT FR-1358

Report of Test on Propeller Shaft Revolution Indicator System

Manufactured and Submitted by Pitometer Log Corporation, New York, N.Y.

BY

NAVAL RESEARCH LABORATORY

BELLEVUE, D. C.

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NAVY DEPARTMENT

BUREAU OF ENGINEERING

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on

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NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

Number of Pages: Text - 6 Tables - 1 Plates - 8

Authorization: BuEng. ltr. S62-2/L5(1-5-Ds) of 7 January 1937.

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

Tested by: _____
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Distribution:
BuEng. (5).

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APPENDICES

AUTHORIZATION.

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

Reference: (a) BuEng. ltr. S62-2/L5(1-5-Ds) of 7 Jan. 1937.
(b) Specifications SGS(65)-10b of 15 June 1936 - Propeller Shaft Revolution Indicators and Counters.
(c) Contractor's Drawing No. SK 742, Alt. #0, covering R.P.M. indicator.

OBJECT OF TEST.

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

ABSTRACT OF TEST.

3. The submitted system, shown by Plates 1 to 8, inclusive, was set up at this Laboratory and carefully observed while under test for conformance with the specifications, reference (b), in so far as they were applicable. The order in which the tests were conducted is outlined therein under paragraph F-2.

RECOMMENDATIONS.

(a) In view of the system having complied with the major requirements of the specifications, it is recommended that it be approved for Naval use, subject to the correction of the deficiencies noted under "Conclusions," contained herein.

DESCRIPTION OF MATERIAL UNDER TEST.

4. This propeller shaft revolution indicator equipment was manufactured and submitted for test by the Pitometer Log Corporation, New York, N.Y., and intended for use on destroyers and submarines. It is designed to give "instantaneous" indication of r.p.m., to count total revolutions, and to indicate direction of rotation of the propeller shaft.

5. The system submitted is for a single shaft installation, and consists of the following units:

1 Propeller shaft transmitter.
1 R.P.M. indicator with dial lighting.
2 R.P.M. indicators without dial lighting.

Shaft Transmitter.

6. The shaft transmitter is shown by Plates 1 and 2. It is located in a watertight BE metal case having an extending shaft which is driven from the propeller shaft through suitable gears. The transmitter shaft rotates at exactly three times the speed of the propeller shaft. Inside the transmitter case, this speed is reduced to 1/10 propeller shaft speed by means of worm gears. This rotation is then transmitted through a uni-directional gear mechanism which drives a work shaft. The uni-directional gear mechanism causes the work shaft to rotate only in one direction, irrespective of the direction of rotation of the propeller shaft. It is also a function of the uni-directional gear device to operate contacts for controlling direction of rotation targets located in the r.p.m. indicators. The work shaft drives a self-synchronous, type A generator (at 1/10 the propeller shaft speed) and also drives a Veeder counter which counts shaft revolutions.

R.P.M. Indicator.

7. The r.p.m. indicator units are identical except that one embodies dial illumination. The latter is shown on manufacturer's drawing, reference (c), and by Plates 4 to 8, inclusive. The indicator is mounted in a watertight cast aluminum alloy case and consists principally of the following parts:

1 Type M self-synchronous motor.
1 Synchronous motor (Holtzer Cabot capacitor type).
1 Veeder mechanical six place counter.
1 Positioning roller and disc assembly.
1 Pointer and shaft assembly.
1 Dial graduated from 0 to 400 r.p.m. in steps of 1 r.p.m.

Operation of the R.P.M. Indicator.

8. The self-synchronous type M motor, piece 19, is driven at exactly 3/10 of propeller shaft r.p.m. Located on its shaft is gear, piece 24, which meshes with gear, piece 25, ratio 1 to 2. Gear 25 has

sprocket, piece 42, mounted on it which in turn drives counter, piece 45, through sprocket, piece 43, and chain, piece 44. The ratio between sprockets, pieces 42 and 43, is 2 to 3. The shaft of counter, piece 45, thus turns at 1/10 of propeller shaft speed and the counter counts total propeller shaft revolutions.

9. Gear, piece 25, is fixed to lead screw, piece 26, and drives this at 3/20 of the propeller shaft speed. It therefore rotates at 60 r.p.m. when the propeller shaft is rotating at 400 r.p.m. Threaded on to the lead screw, piece 26, is a friction roller, piece 32, whose outside diameter is 2".50. This roller is driven by friction disc, piece 22, mounted on the shaft of the synchronous motor, piece 21. This shaft rotates at exactly 60 r.p.m. It is held in contact with roller, piece 32, by a spring incorporated in motor, piece 21. The roller, piece 32, adjusts itself on the thread lead screw, piece 26. At 400 r.p.m. of the propeller shaft this position will be exactly 1".25 from the center of disc, piece 22.

10. The roller, piece 32, is mounted in carriage, piece 37, which moves with the roller, Rack, piece 39, is mounted in this carriage and meshes with gear, piece 69. These are so disposed that pointer shaft makes one complete revolution for 1" 25 motion of rack, piece 39.

11. The dial is finished in dull black with engraved white markings and is divided into 400 parts, each of which therefore corresponds to 1 r.p.m. of the propeller shaft. Disc, piece 22, is large enough so that roller can move to a position equivalent to 450 r.p.m. of the propeller shaft.

12. The limit switch, piece 50, is so disposed that, when the roller reaches the center of the disc, it operates the switch, which in turn deenergizes motor, piece 21.

13. The backing signal, piece 52, is a magnetic drop which is energized when the propeller shaft is rotating in reverse and deenergized when rotating ahead.

14. The indicator is mounted to shock ring, piece 14, with four shock absorbing bushings, piece 15, and mounting screws, piece 16.

15. The indicator units are interchangeable. This is made convenient by the use of an 8 pole plug and jack assembly, piece 23.

16. Two lifting handles, piece 49, and three removal support studs, piece 48, are provided on each of the indicators.

17. Flexible lead wires connect the indicator unit (through jack and plug assembly) to the line terminal block located in the bottom of the case.

18. Two internal bosses, both drilled and tapped for 1".25 I.P.S. Navy type terminal tubes, and four mounting lugs are provided on each of the indicator cases.

19. The Cory ringlight assembly, piece 56, and two lamps, piece 57, are employed in one of the indicators for lighting the dial. Transformer, piece 67, supplies the correct voltage for the TS-53 dial lamps. Dimming of the lamps is obtained by rheostat, piece 60, and rheostat shaft, piece 62.

20. The cases are painted with zinc-chromate followed with aluminum, finished in gray on the outside, and white on the inside. The case covers are secured with six 5/16" bronze screws. Steel liners are provided in the clearance holes and tapped steel inserts thread into the case.

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, of 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.

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.
Current: Alternating	Alternating.
Frequency: 60 cycles	60 Cycles.
Endurance: Par. F-2c(1)	*See remarks under "Conclusions," par. 25.
Shock tests: Par. F-2c(2)b and F-2c(2)c.	*See remarks under "Conclusions," par. 25.
Accuracy tests: Par. F-2c(3).	Satisfactory; see Table 1.
Vibration tests: Par. F-2c(4).	*See remarks under "Conclusions," par. 25.
Voltage and frequency compensation: Par. F-2c(5)b.	Satisfactory operations under the specified conditions. Test not conducted on synchronous disc motors - not applicable.
Inclination tests: Par. E-12f.	Satisfactory operation under the specified conditions.

Requirements	Test Values
Dielectric tests: Par. F-2c(5)f.	Satisfactory, no breakdowns occurring.
Insulation tests: Par. F-2C(5)g.	Satisfactory, 200 megohms by 500 volt megger.
Watertight tests: Par. 5-2c(5)i.	Satisfactory, no leaks occurring.
Weight and dimensions: Par. E-10.	Complied with.

Instrument	Weight		Dimensions		
	Lbs.	Ozs.	Height	Width	Depth
Transmitter	44	12	15"0	18"0	6"0
Indicator (dial lighting)	36	4	11"25	10"0	9"625
Indicator	33	13	11"25	10"0	9"625

*Denotes failure to comply with the specifications.

CONCLUSIONS.

25. During the required 500 hour endurance test, trouble developed in the shaft transmitter at the 450th hour, due to failure of the bronze work shaft gear. This gear, which is driven by the worm, was badly worn due to improper mounting or manufacture. The defective gear was replaced by the manufacturer and the test was successfully completed.

26. Under test for shock integrity, one section of the ring type lighting broke at the 17th blow, the break occurring at the right angle bend. Trouble also developed in the two remaining indicators, producing erratic readings. An examination disclosed the jamming of the type M motor gears in one indicator and badly burned motor brush springs in the other. The jamming of the motor gears was due to faulty workmanship, shims being used to center the motor and thus allow for an oversize hole in the main mounting plate, piece 18. The brush trouble was due to the whipping of the brush springs which shorted at the time of impact. These defects were corrected by the manufacturer and each indicator then withstood the required 20 shocks of 250-foot pounds each.

27. The results of the accuracy tests were satisfactory and are given in Table 1.

28. Under the specified vibration tests, all three indicators complied with the exception of one, which occasionally exceeded 400 r.p.m., the speed at which the system was operated. This trouble was corrected by the manufacturer by increasing the spring tension in the disc assembly, thereby preventing the disc from momentarily losing contact with the roller.

29. No nameplates have been provided on any of the units as required under paragraph D-17b.

30. The efficiency of the Cory ring type lighting could not be determined due to a fracture occurring during the shock test. However, previous indicators incorporating such lighting, have complied with the specifications in regard to shock, but failed to meet the requirements relative to the distance from which the dial could be read in a totally dark room.

31. The subject system, in the matter of material and general requirements, complies with the specifications.

32. As no frequency control unit accompanied the system, it was necessary to energize the synchronous motors in the indicators from a local regulated 60-cycle supply in order to determine the accuracy of the system.

33. The current consumed by the three synchronous motors (Holtzer Cabot, piece 21) was 0.25 amperes, at 115 volts, 60 cycles. The remainder of the system required 4.5 amperes.

TABLE 1

Results of Accuracy Tests
as per Paragraph F-2c(3).

Shaft R.P.M.	Indicator #1 R.P.M.		Indicator #2 (Ring Lighting) R.P.M.		Indicator #3 R.P.M.	
	Indication	Error	Indication	Error	Indication	Error
60	59.5	.5	59.0	1.0	59.5	.5
100	99.5	.5	99.0	1.0	99.5	.5
150	149.5	.5	149.0	1.0	149.5	.5
200	199.5	.5	199.0	1.0	199.5	.5
250	249.5	.5	249.0	1.0	249.5	.5
300	299.5	.5	299.0	1.0	299.5	.5
400	399.5	.5	399.0	1.0	399.5	.5
Par. E-11b.						
350	349.5	.5	349.0	1.0	349.5	.5
Par. E-12b.						
450	449.5	.5	449.0	1.0	449.5	.5

Note: The above readings are approximate as a dial having 400 divisions can not be read with great accuracy.

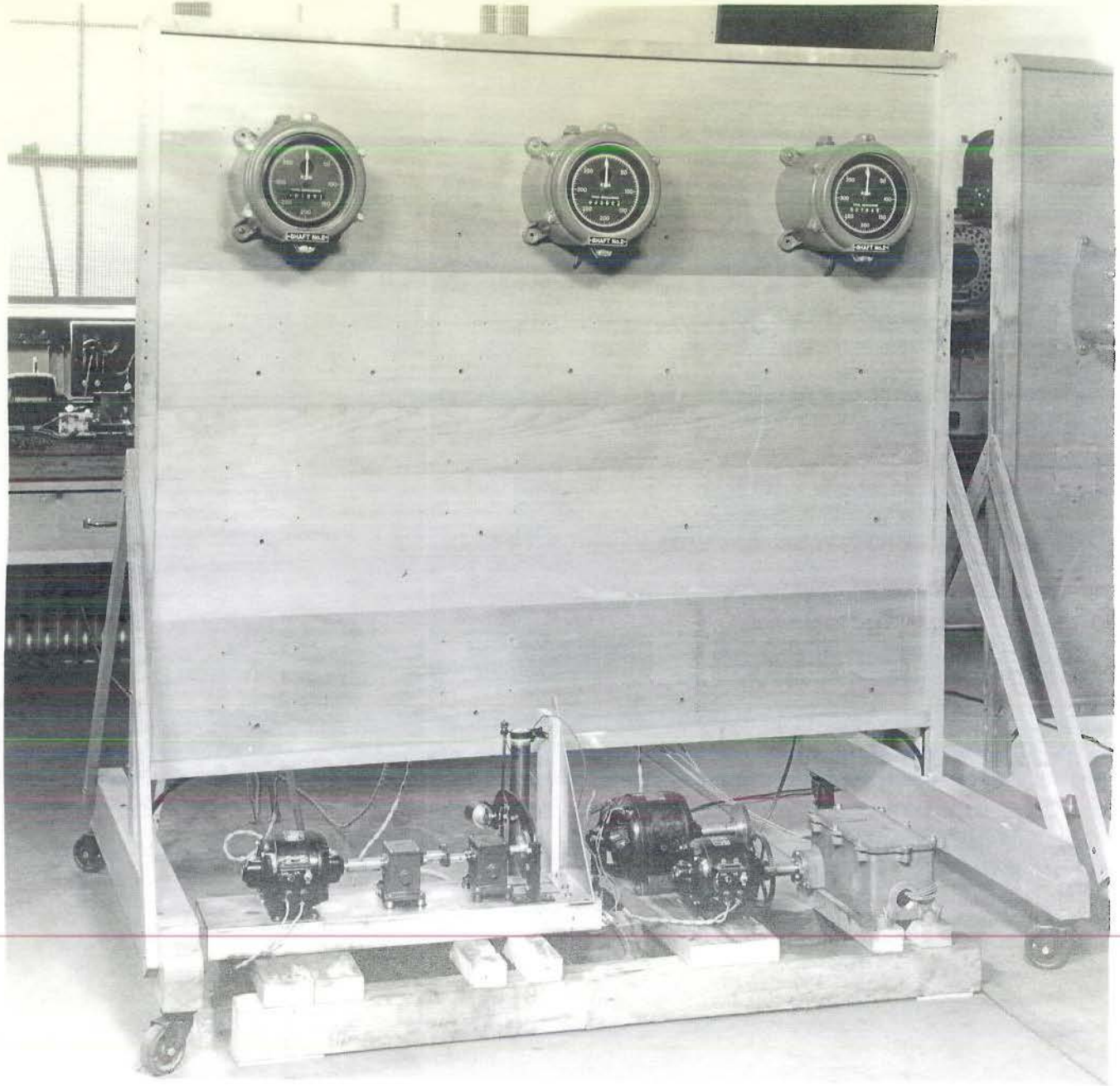
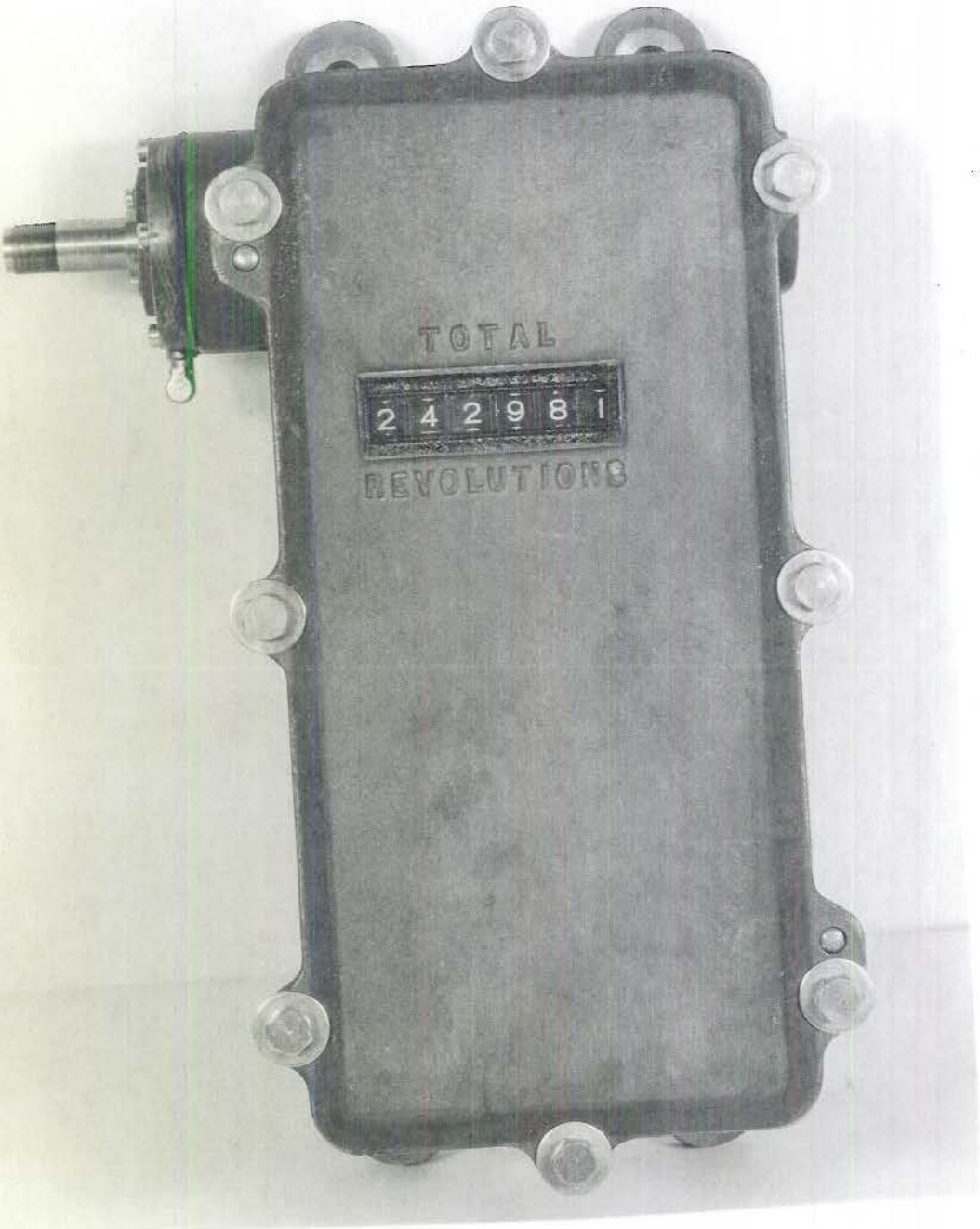


Plate 1



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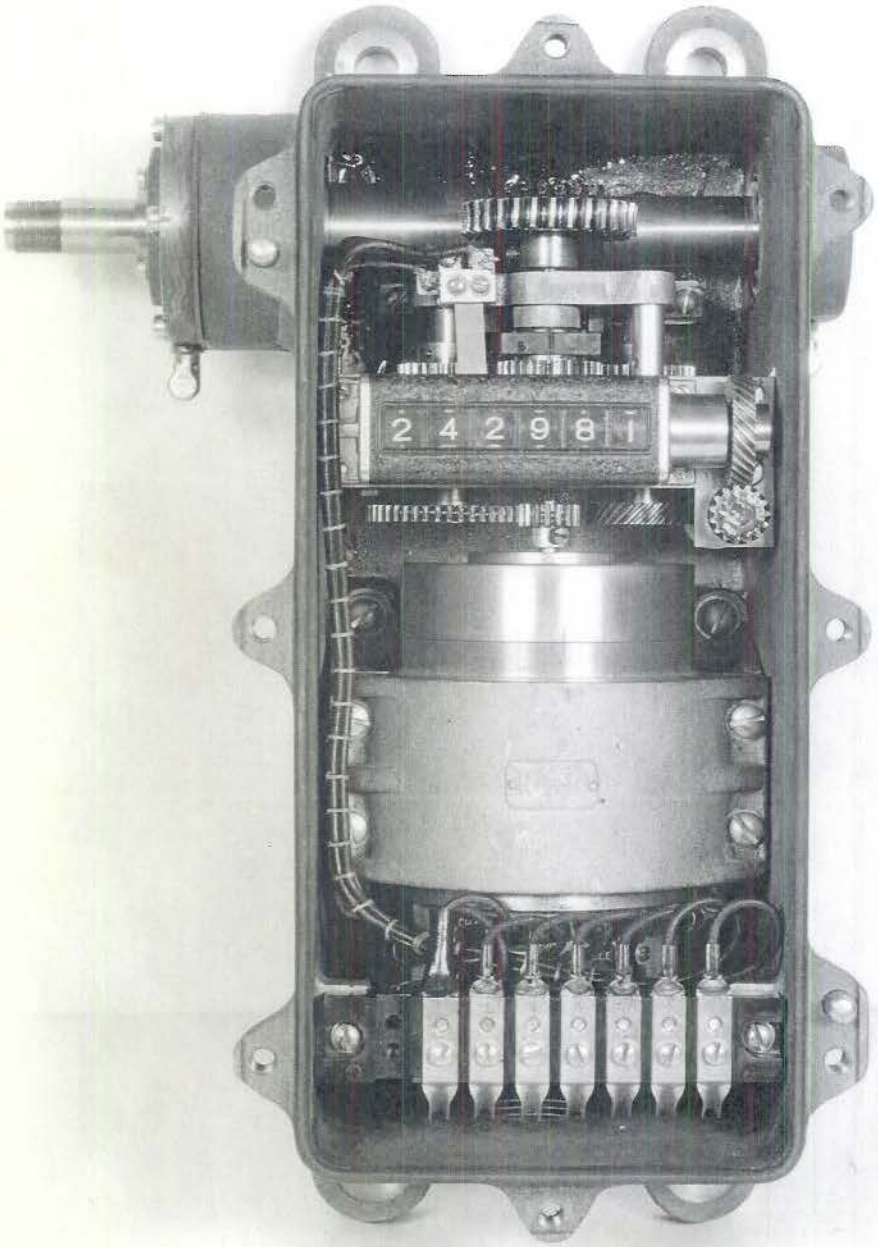

Plate 3

Plate 4

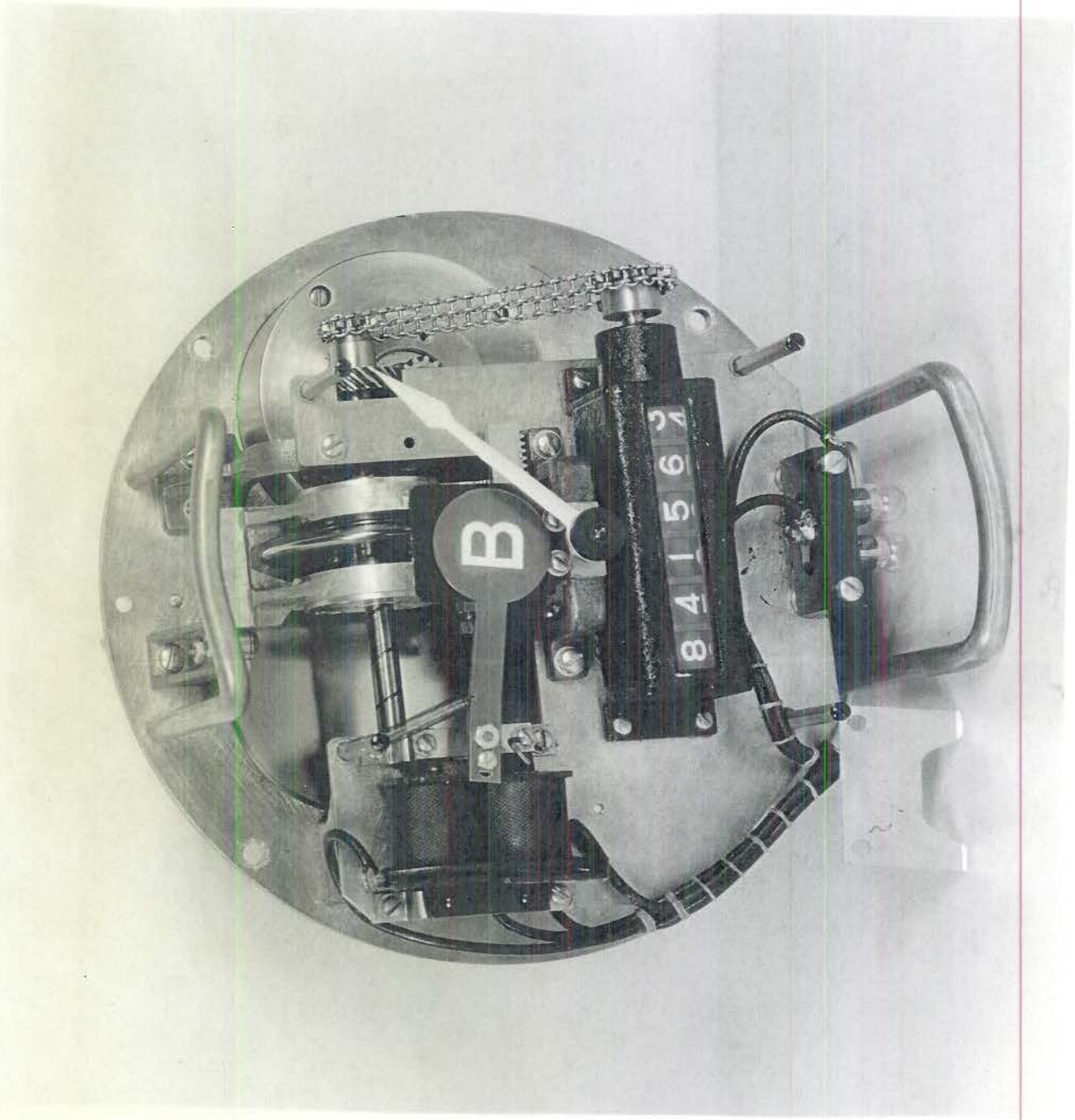

Plate 5


11
1K
12
1KK
13
8K
14
8KK

Plate 8