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NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report of Test

on

Electric Log Equipment for USS SEMMES
Manufactured by Julien P. Friez & Sons,
Baltimore, Md., Contract NOs-59005.
Submitted via INM, Phila., Pa.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

Number of Pages: Text - 7 Table - 1 Plates - 5

Authorization: BuEng. ltr. NOs-47866(4-28-Ds) of 9 May 1936.

Date of Test: April, May and June, 1938.

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Distribution:
BuEng. (5)

mbe

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Appendices

AUTHORIZATION FOR TEST

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

Reference: (a) Bueng.ltr. NOs-47866(4-28-Ds) of 9 May 1936.
(b) Specifications SGS(65)-151a of 1 Feburary 1937.
(c) Contract NOs-59005 (USS SEMMES)

OBJECT OF TEST

2. The object of this test was to determine the suitability of the log system for acceptance under contract, reference (c).

ABSTRACT OF TEST

3. The subject equipment was set up at this Laboratory and while supplied with proper voltages, carefully checked for compliance with the specifications of the contract.

CONCLUSIONS

(a) This "Electric Log Equipment", manufactured by Julien P. Fries and Sons, Baltimore, Maryland, for U.S.S. SEMMES, under contract NOs-59005, complied with the requirements, except for its failure to operate when the 24 volt supply was reduced 10 percent. The same difficulty was experienced at an ambient temperature of 70°C. (158°F) with normal 24 volt supply. The failure was due to the counting magnets becoming inoperative when the current in the windings was reduced because of lowered input voltage or increase in resistance at the higher ambient temperature. Such a failure causes the indicator pointer to remain at zero on the dial.

(b) It was noted that the counting magnets in the speed indicators produced considerable noise as a result of the armatures striking against the pole pieces and stops. This noise, although not readily measured due to its intermittent character, is believed to be of an intensity which will be objectionable, particularly so for a bridge instrument.

RECOMMENDATIONS

(a) It is recommended that this equipment be approved under the contract, subject to satisfactory modification of the counter magnets in the speed indicators and a reduction in the noise produced by its operation.

DESCRIPTION OF MATERIAL UNDER TEST

4. The system submitted consists of one 6 volt d.c. relay, two ship's speed indicators, and one mileage indicator. It is designed to indicate ship's speed and distance traveled in nautical miles, in proportion to electrical impulses received from a submerged impeller which projects from the hull of the ship.

5. The specified rate of contacts is 500 per mile, equivalent to 292 contacts per minute for a speed of 35 knots.

6. In addition to the 6 volt, d.c. impulse circuit, the system requires a 24 volt d.c. source, for operating the electromagnets, and a 115 volt, 60 cycle controlled frequency supply for the synchronous disc motors. The Barber-Colman shaded-pole spring-winding motors are also operated from the 115 volt, 60 cycle, supply. Due to the action of the relay, the 6 volt impulses produce corresponding 24 volt impulses to the electromagnets in the indicators.

7. To produce an indication of ship's speed, use is made of the principle of matching a constant motion with a variable motion. This is done in the following manner:

> A rotating disc is driven through an internal geared synchronous motor at 6 revolutions per minute. Mounted on an axis, parallel to the plane of the disc, is a shaft carrying a roller which receives a rotary motion from the disc proportional to the radial position of the roller upon the disc. The roller shaft also carries a circular rack and a spiral gear or worm. The rack is meshed with a gear which carries a pointer while the spiral gear is meshed with another spiral gear whose rotation is derived by the escaping tooth-by-tooth ratchet wheel. This ratchet is released by means of an escape lever, actuated by an armature under the influence of an electromagnet, which is inserted in a 24 volt, d.c. circuit. The ratchet wheel is powered by a barrel spring, kept wound by a shaded pole induction motor.

8. Should there be no movement of the ship, any rotational motion of the roller will cause the worm, turning in the worm wheel which is momentarily stationary, to find its way back to the center of the disc, at which point it ceases to give rotational motion. Then, if the submerged impeller were to be rotated at a speed proportional to the full scale of the instrument, in this case 35 knots, the worm wheel will begin to turn at a constant speed and will act upon the worm as a rack, pulling the shaft and its roller away from the center of the disc. As the roller leaves the center of the disc, it picks up rotational motion whose direction will tend to return it toward the center. The radial motion of the roller across the face of the disc will cease when the speed of rotation of its shaft is sufficient to cause the screw action of the worm to be equal and opposite to the

rotation of the worm wheel. For the assumed rate of 35 knots the roller will be near the periphery of the disc and the rack will have turned the pinion and pointer to indicate 35 knots on the dial. The radial distance of the roller from the center of the disc is a direct measure of the rate of the electrical impulses to the electromagnet and, therefore, a direct measure of the rate of rotation of the submerged impeller.

9. It may be seen by reference to the instrument itself that, for mechanical reasons, two opposed discs have been used to drive the roller. An idler pinion, opposite the pointer pinion, and an idler pinion opposite the worm wheel, are provided to act as bearings for the roller shaft. Therefore, the shaft is nearly free floating.

10. The indicator mechanism is mounted on or between two cast bronze plates. The entire chassis is mounted on four (4) rubber bushings and may be removed without disturbing the line connections due to the provided plugs and jacks. The indicators are enclosed in watertight cast aluminum alloy cases, designed for bulkhead mounting, having two (2) internal bosses tapped for 3/4 inch (IPS) terminal tubes. The mechanical construction of this unit is shown by photographs, Plates 2 and 3.

11. The mileage indicator consists of a "VEEDER" counter operated by a relay type electromagnet assembly through a ratchet and gear arrangement. The winding is shunted by a 0.25 mfd. condenser, located on the chassis. It indicates nautical miles to 99999.9. The indicator is mounted on a base of brass and is enclosed in a watertight cast aluminum alloy case, designed for bulkhead mounting, having two (2) bosses tapped for 3/4 inch (IPS) terminal tubes. The indicator is equipped with plugs and jacks which permit its removal without disturbing line connections. The mechanical construction of this unit is shown by photograph, Plate 5.

12. The relay is of the "BUNNELL" land telegraph type and has two (2) principal adjustments. One is used to limit the gap between the armature and pole faces and the other to adjust the armature spring tension. The relay is mounted on a base of phenolic material and enclosed in a watertight cast aluminum alloy case designed for bulkhead mounting, having two (2) external bosses tapped for 3/4 inch (IPS) terminal tubes. As shown in photograph, Plate 4, the relay is equipped with plugs and jacks which permit its removal without disturbing line connections.

13. The complete system is shown by photograph, Plate 1. A nameplate of non-corrosive material is provided on the cover of each instrument.

METHOD OF TEST

14. The system was first run for 50 hours, when supplied with current impulses, varying in rate over a range corresponding to 6 to 35 knots. This cycle was repeated every 3 minutes and 45 seconds. The

"on" and "off" periods of the impulses were of equal duration.

15. The system was next checked for accuracy over the entire range of the indicators.

16. Each instrument was then subjected to 20 shocks of 250 foot pounds on a standard Bureau of Engineering stand while operating in the system.

17. Each instrument was then subjected to 3 foot-pound blows while mounted on a standard vibrating machine and operating in the system. The blows were delivered at frequencies of 100, 150, 200, 250, 300 and 350 per minute, for periods of 30 minutes each.

18. Next followed tests for accuracy over the entire range of the indicators, followed by the remaining 450 hour test for endurance.

19. The system was next checked for operation with variations of $\pm$ 10 percent in voltage and each instrument inclined 45 degrees to the vertical in all planes.

20. The system was then placed in a temperature controlled cabinet and checked for operation at a temperature of 70°C. (158° F.). The temperature rises of the windings were obtained at this time, using the resistance method.

21. The test was concluded with the usual tests for watertightness, dielectric strength, insulation resistance, and an inspection of the equipment to ascertain whether the materials, design and workmanship, complied with the specifications.

RESULTS OF TEST

Tests for Endurance

22. The performance of the system under a 500 hour run, during which time its speed was varied from 6 to 35 knots at the rate of one cycle in 3 minutes and 45 seconds, was satisfactory when the system was energized at rated voltages.

Tests for Accuracy

23. The results of tests for accuracy, following completion of 50 hours of the 500 hour endurance test, and following the shock, vibration and the remainder of the endurance test, are given in the table. All results were within the allowable error.

Shock and Vibration Tests

24. The individual units were unaffected by the application of the shock and vibration tests, conducted as outlined in paragraphs

16 and 17.

Operation at Voltage Variations

25. The system would not function properly when the 24 volt supply was reduced 10 percent (21.6 volts). In addition, it would not operate correctly at 24 volts when the system was located in a temperature controlled cabinet at 70°C. Reducing the 6 volt supply to 5.4 volts had no effect on the operation of the system. The supply to the synchronous motors and Barber-Colman induction motors was held at 60 cycles for correct timing, while the voltage was reduced to 103.5 without effect.

Temperature Rises (Allowable 30°C. at ambient of 70°C.)

26. Tests were made on representative windings, using the resistance method, and the results were as follows:

Indicator electromagnet winding - -	16.41°C.
Mileage counter electromagnet winding -	15.49°C
Bunnell telegraph relay - - - - - -	10.71°C
Synchronous motor windings - - - -	23.8°C
Barber-Colman shaded pole motor - -	23.8°C

Dielectric and Insulation Tests

27. The 115 volt equipment withstood the required 1500 V. a.c., 60 cycles, applied between all current carrying parts and ground for one minute. The 6 and 24 volt equipment withstood the required 500 V. a.c., 60 cycles for one minute. The insulation resistance for all of the equipment was approximately 200 megohms by 1000 volt megger.

Tests for Watertightness

28. No water was found in the cases, following their immersion in water to a depth of 3 feet for a period of one hour.

Inspection of Equipment

29. An inspection of the equipment showed the materials to be in accordance with the specifications.

Current Consumption

30. The current consumed by the system was as follows:

115 V. a.c., 60 cycle supply - - - - - -	0.44 amperes
24 V. d.c., supply - - - - - -	0.46 "
6 V. d.c. supply - - - - - -	0.04 "

Weights and Dimensions

31. The weight and dimensions of representative instruments

were as follows:

Instrument	Weight	Dimensions
Indicator	40 lbs. 0 oz.	13"625 x 12"0 x 8"5
Mileage indicator	5 lbs. 13 oz.	8"5 x 5"5 x 4"375
Relay	5 lbs. 2 oz.	8"5 x 5"5 x 4"375

CONCLUSIONS

32. This "Electric Log Equipment", manufactured by Julién P. Friez and Sons, Baltimore, Maryland, for USS SEMMES, under contract NOs-59005, complied with the requirements, except for its failure to operate when the 24 volt supply was reduced 10 percent. The same difficulty was experienced at an ambient temperature of 70°C. (158°F) with normal 24 volt supply. The failure was due to the counting magnets becoming inoperative when the current in the windings was reduced because of lowered input voltage or increase in resistance at the higher ambient temperature. Such a failure causes the indicator pointer to remain at zero on the dial.

33. It was noted that the counting magnets in the speed indicators produced considerable noise as a result of the armatures striking against the pole pieces and stops. This noise, although not readily measured due to its intermittent character, is believed to be of an intensity which will be objectionable, particularly so for a bridge instrument.

TABLE

RESULTS OF ACCURACY TESTS

Speed		Allowable Error		Before Shock and Vibration Tests				After Shock, Vibration and Endurance Tests			
				#1 Indicator		#2 Indicator		#1 Indicator		#2 Indicator	
Knots	Contacts per minute	Knots	%	Indicated Knots	% Error	Indicated Knots	% Error	Indicated Knots	% Error	Indicated Knots	% Error
4	33	±.24	± 6.0	4.1	+2.50	3.9	-2.50	3.8	-5.00	3.9	-2.50
6	50	±.24	± 4.0	6.1	+1.66	5.9	-1.66	5.8	-3.33	5.9	-1.66
9	75	±.27	± 3.0	8.9	-1.11	8.9	-1.11	8.8	-2.22	8.9	-1.11
12	100	±.30	±2.5	11.9	-0.83	11.9	-0.83	11.9	-0.83	11.9	-0.83
16	133	±.32	± 2.0	15.9	-0.62	15.9	-0.62	16.0	0.0	15.9	-0.62
20	167	±.20	± 1.0	19.9	-0.50	19.9	-0.50	20.1	+0.50	20.0	0.0
24	200	±.24	± 1.0	23.8	-0.83	23.9	-0.41	24.2	+0.83	20.1	+0.41
35	292	±.35	± 1.0	34.8	-0.57	34.9	-0.28	35.2	+0.57	35.1	+0.28

Note: The mileage indicator was found accurate throughout all tests. All tests are based on the specified 500 contacts per nautical mile.

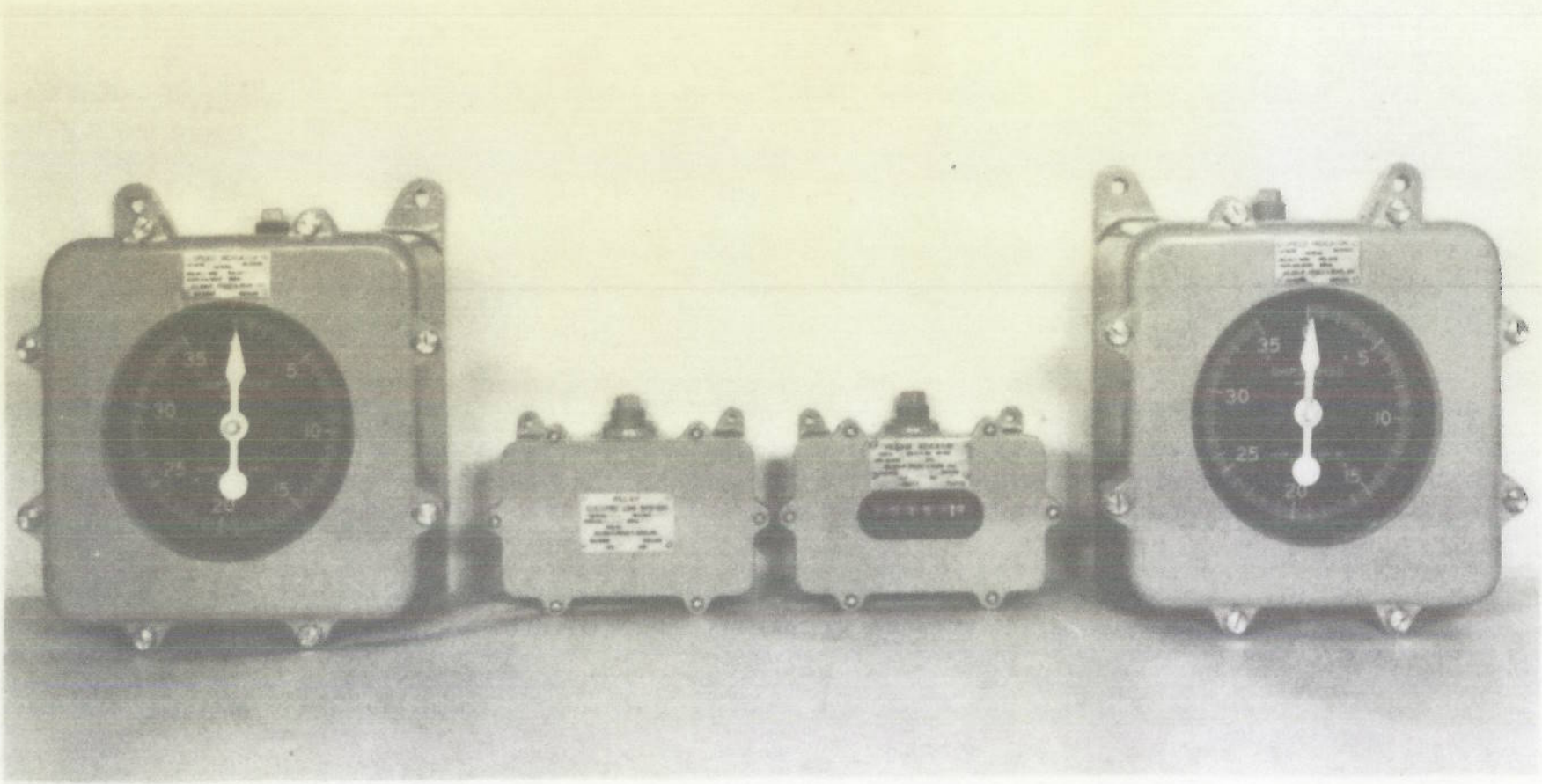
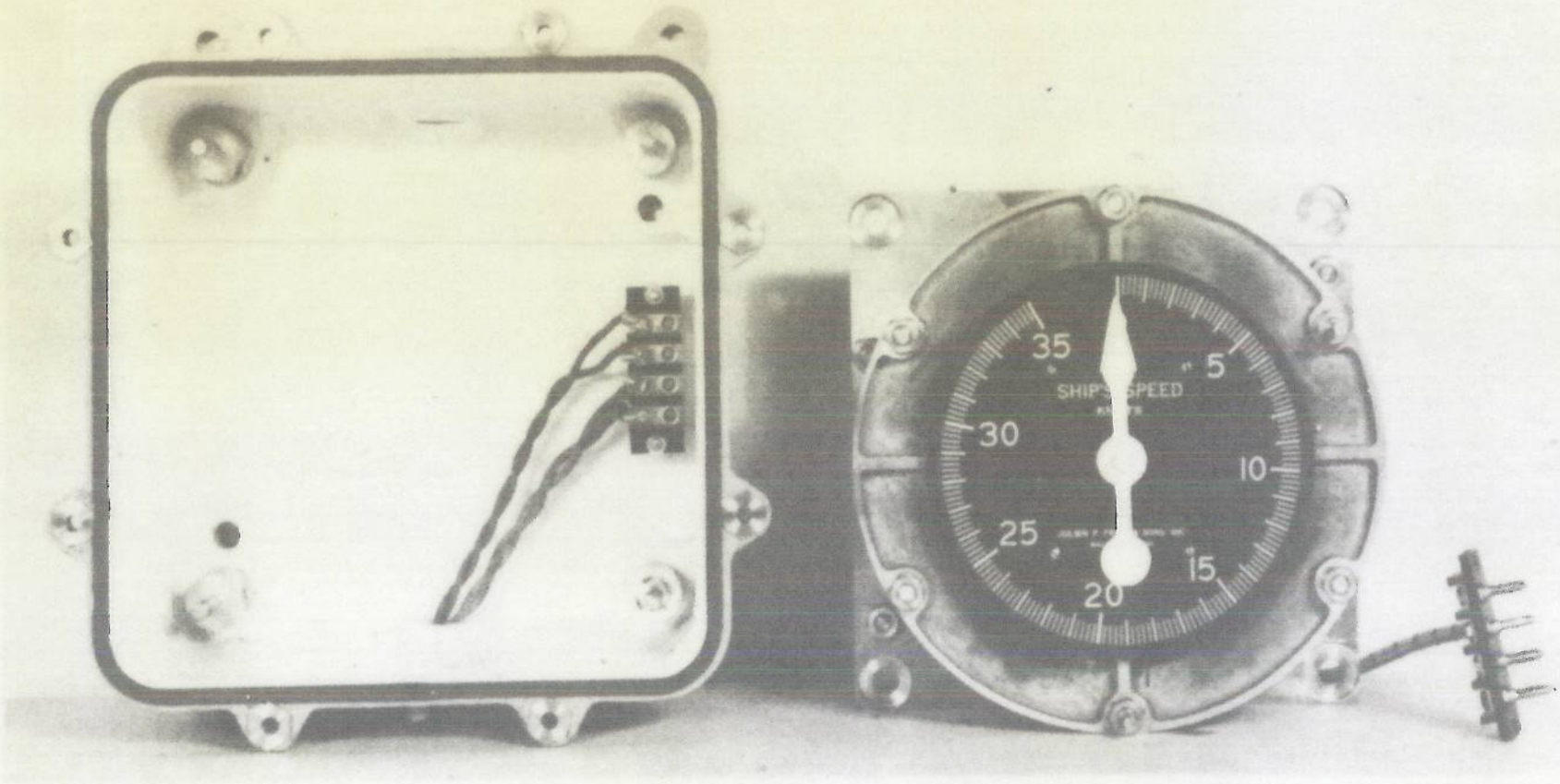


Plate 1



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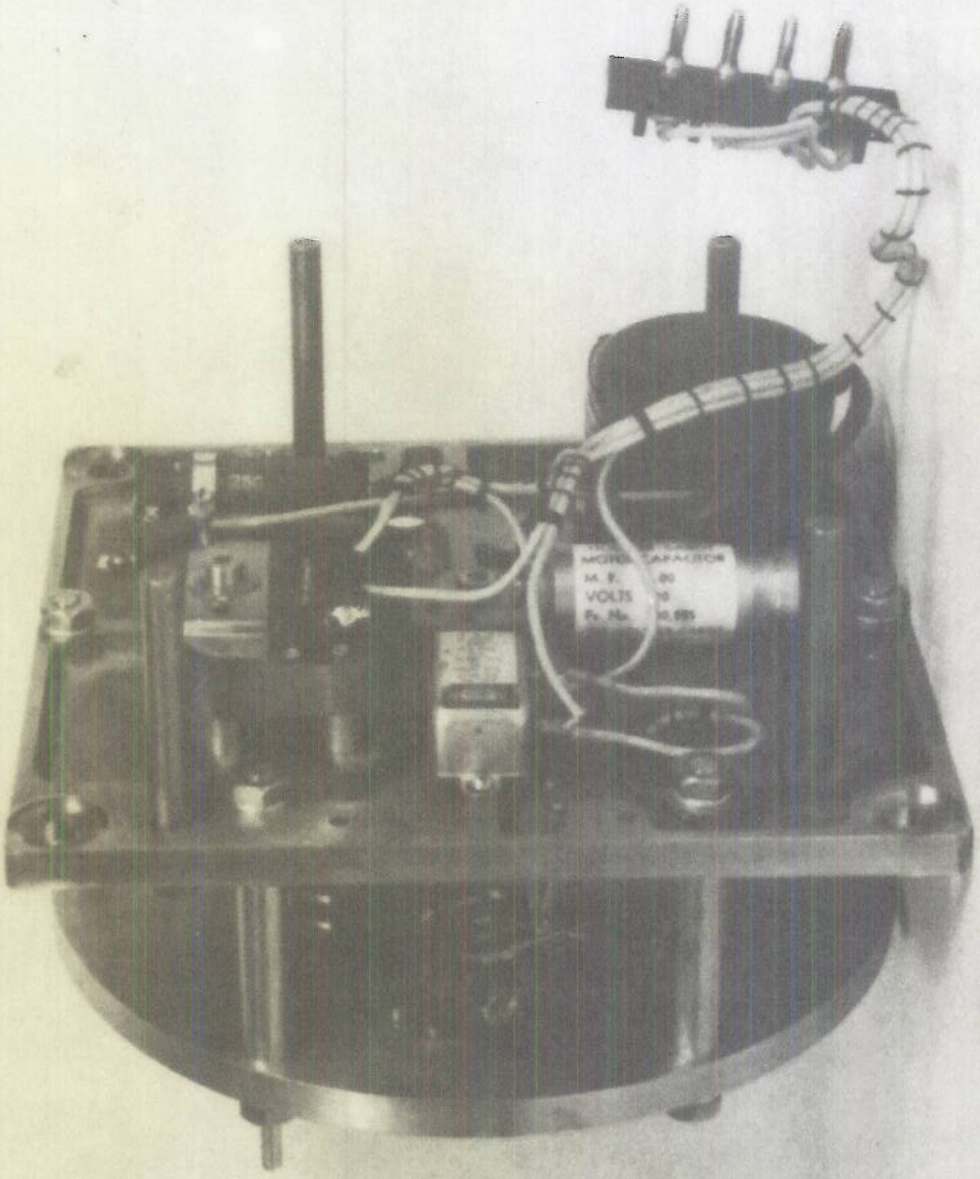

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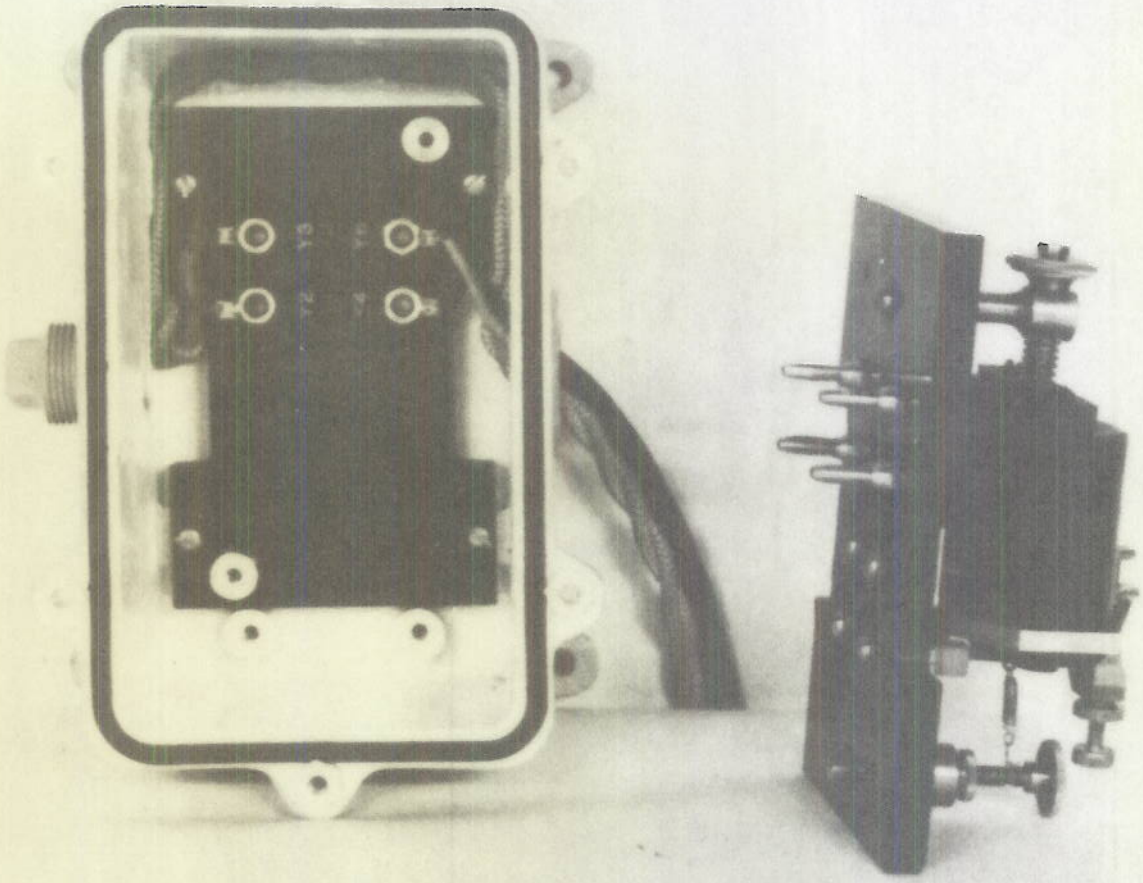

Plate 4

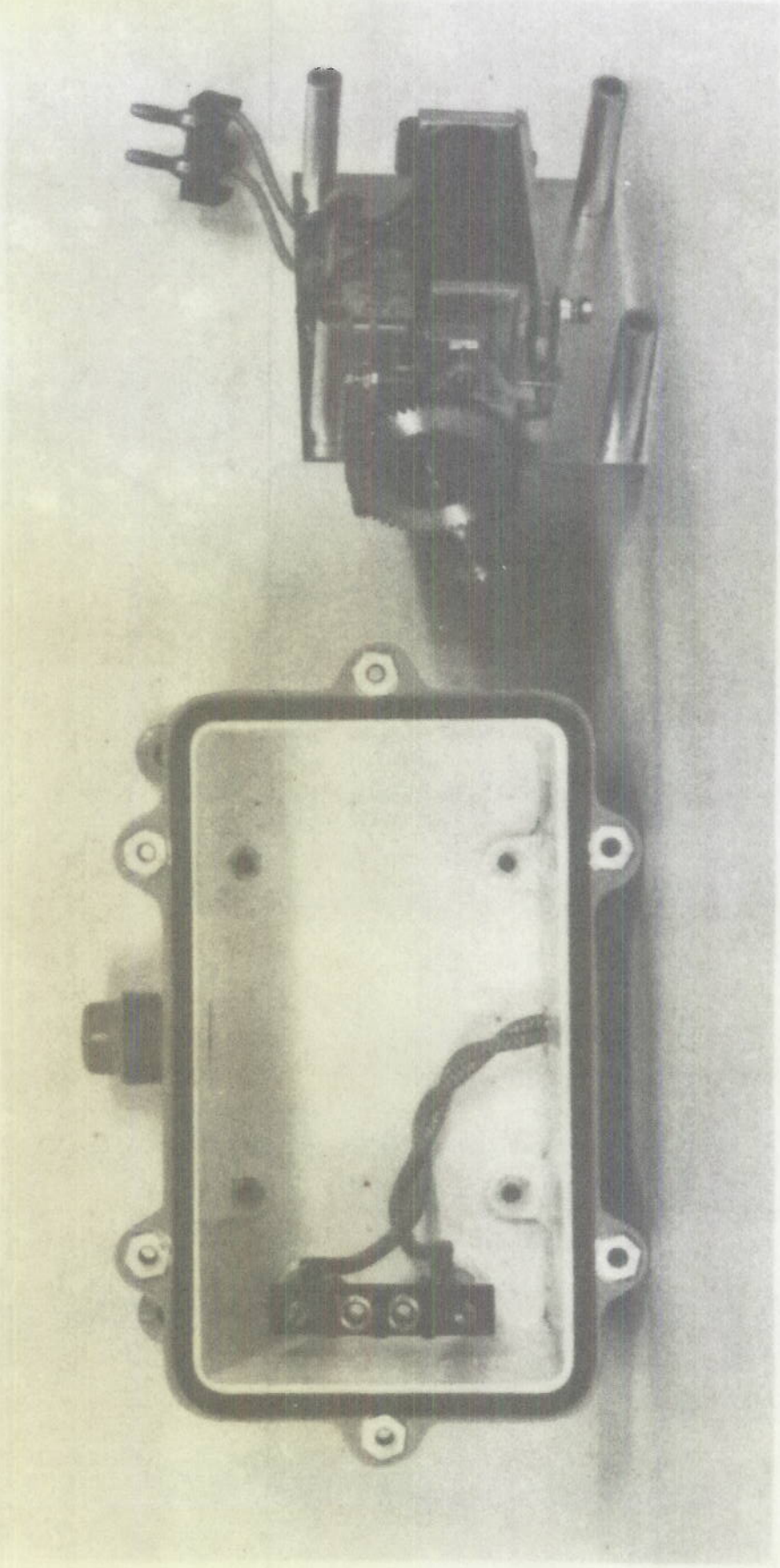

Plate 5