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NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report of Test

on

Pitometer Log System for Contract Suitability for Ships SS188 to SS193 Inclusive

NAVAL RESEARCH LABORATORY
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WASHINGTON, D.C.

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

Date of Test: May and June 1938.

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Conclusions

(a) The subject system, manufactured by Pitometer Log Corporation, and submitted for contract suitability tests, via the Inspector of Naval Material, New York, complied except for the following:

(1) The yardage transmitter is not designed to operate over the full speed range of the system and would not function correctly at speeds above 18 knots (approximately) when received. However, at the end of a 48 hour run, it operated at 22 knots when supplied at full rated voltage. At 10 percent under voltage (103.5 V.) the maximum accurate speed was 18 knots.

(2) The yardage transmitter failed to withstand the dielectric test. The failure occurred in the electromagnet windings.

(3) Trouble was occasionally experienced with the master repeater, due to the sticking of the roller carriage assembly at approximately 2 knots. Similar trouble occurred in the first master instrument furnished except that it stuck at 6-7 knots.

(4) It was noted that the manometer unit did not swing in the true vertical position. However, no effect was noticed in the operation of the system.

(b) It was noted that there is a condition under which the pointer of the master instrument will move in the reverse direction and jam at one end of the scale. This is brought about by energizing the system when the transmitting self-synchronous motor in the manometer is more than 180° out of step with the receiving motor in the master instrument. For example, this will occur with the manometer at 17 knots and the indicator at 0 knots, or with the manometer at 22 knots and the indicator at 15 knots.

Recommendations

(a) It is recommended that the subject system be approved for installation on ships SS188 to SS193 inclusive, subject to correction of deficiencies noted under "Conclusions".

AUTHORIZATION FOR TEST

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

Reference:
(a) BuEng. ltr. NOs-47866(4-28-Ds) of 9 May 1936.
(b) INM, NY, ltr. EN8/NOs-56682(A) of 29 April 1938, to BuEng., cc to NRL.
(c) Specification SGS(65)-151a, Electric Log Equipment of 1 February 1937.
(d) NRL Report No. B-1348 of 12 March 1937, covering test on Master Speed Repeater.
(e) Electric Boat Order No. B-1013-11.
(f) Contract NOs-56682.

OBJECT OF TEST

2. The object in conducting this test was to determine contract suitability in conformance with specification, reference (c).

ABSTRACT OF TEST

3. The system submitted is shown set up for test by photograph, Plate 1. Following tests required for contract suitability, it was carefully checked for compliance with the specification in the matter of materials and workmanship.

DESCRIPTION OF MATERIAL UNDER TEST

4. The subject log system is manufactured by Pitometer Log Corporation, New York, N. Y., and intended for installation on the U.S.S. SPEARFISH (SS190) following a satisfactory test for contract suitability. The parts of the system submitted were as follows:

1 - 22 knot manometer with mercury and parts.
1 - transmitter case #568.
1 - master speed repeater #569.
1 - speed and distance repeater #570.
1 - distance repeater (1/10 mile) #571.
1 - distance repeater (1/100 mile) #572.
1 - yardage transmitter #573.

5. The parts submitted, except for the yardage transmitter and yardage repeater, are identical to those furnished under Contract NOs-49574. The master speed repeater is identical to the one tested at this Laboratory and reported under reference (d).

Yardage Transmitter

6. The yardage transmitter is a mechanism which transforms the 10 per mile distance impulses from the log transmitter into 100 per mile (approximately 20 yards) impulses to be transmitted to the "yardage" indicators. Photograph, Plate 2, shows this instrument with case cover removed.

7. The 10 per mile a.c. impulses, consisting of one make and one break from the master distance contacts, are rectified by passing through a rectifier unit. This rectified current operates the d.c. electromagnet against a return spring, so that each make and break releases the escapement wheel one half tooth. This escapement wheel has 5 teeth and therefore makes two complete revolutions per mile. The right hand face gear of the differential is fastened to this escapement wheel while the other face gear is secured to a worm gear, having 100 teeth. Both face gears are loose on the shaft, interconnected by two pinions which are held on the differential spider, but are free to rotate. The differential spider is secured to the shaft and, through a lost motion coupling is connected to the sliding arm of the rheostat which controls the a.c. driving motor. The inner end of a torsion spring, contained in the spring housing, is fastened to the rheostat-differential shaft, thus supplying the power to drive the rheostat arm when the escapement wheel is released.

8. As the escapement wheel advances in steps, the torsion spring turns the differential spider and pinions and advances the rheostat arm. This reduces the resistance in series with the motor causing an increase in speed. The motor drives the worm gear, through a set of spur gears, ratio 1 to 2, and a single thread worm, steadily in the opposite direction to the escapement wheel, thus rewinding the spring and retarding the rheostat arm which in turn gradually reduces the speed of the motor.

9. The secondary shaft of this motor makes exactly 100 revolutions per mile. A cam is mounted on this shaft, operating a Burgess "micro-switch" by means of a roller and arm. The impulses given out from this device actuate the magnetic counters in the yardage indicators.

10. A fixed resistance is connected in series with the rheostat. A condenser is connected across the electromagnet terminals in order to reduce sparking on the master distance contacts.

Yardage Repeater

11. This unit is identical to the 1/10 mile repeater except that it indicates to 1/100 mile, (approximately 20 yards) and incorporates a mechanical reset and "on-off" switch.

Remainder of System

12. The remainder of the system is fully described in the Interior Communication instruction book No. 36A.

METHOD OF TEST

13. The system was first subjected to a 48 hour endurance test, during which time its speed was varied from 3 to 16 knots at the rate of one cycle in 2-1/2 minutes.

14. It was next checked for accuracy at speeds of 2, 4, 6, 9, 16, 20, and 22 knots for periods of one hour each, followed by a test for operation of the system at over and under voltage and frequency variations of $\pm$ 10 percent.

15. The yardage transmitter was placed in a temperature controlled cabinet and checked for accuracy and temperature rise at ambient temperature of 65° C. Following this, it was checked for ruggedness, using standard shock and vibration machines.

16. The test was concluded with the usual tests for dielectric strength and insulation resistance, and an inspection of the dial lighting and materials to ascertain conformance with the specifications.

RESULTS OF TESTS

Tests for Endurance

17. The performance of the system under a 48 hour run, during which time its speed was varied from 3 to 16 knots at the rate of one cycle in 2-1/2 minutes, was satisfactory. However, before beginning the test the manufacturer replaced the master speed repeater, due to the sticking of the roller carriage at approximately 6 knots.

Tests for Accuracy

18. The results of tests for accuracy following the endurance run are given in Table 1.

Operation at Voltage and Frequency Variations

19. The system operated satisfactorily under voltage and frequency variations of ± 10 percent. However, the supply to the synchronous integrator motor in the manometer was necessarily held at 60 cycles for correct timing. The maximum speed at which the yardage transmitter would function accurately was 18 knots at 103.5 volts, 60 cycles.

Temperature Rises

20. Measurements of temperature rises by the resistance method were made on representative windings in the various instruments. The results are given in Table 2, and they comply with the requirements.

Shock and Vibration Tests

21. The yardage transmitter, the only unit subjected to these tests, was unaffected.

Dielectric and Insulation Resistance Tests

22. All instruments withstood the required 1500 V.A.C. 60 cycles, applied between all current carrying parts and ground for a period of one minute, except the yardage transmitter. This instrument was grounded in the electromagnet windings. The insulation resistance by 1000 volt megger was approximately 200 megohms for all other instruments.

Dial Lighting

23. With the repeater indicator, the only illuminated instrument, placed in a totally dark room, the dial could be read from a maximum distance of six feet. The counter could not be read from a distance greater than six inches as it is practically un-illuminated. It was found that the rheostat enabled the lamp voltage to vary from 1.8 to 6.25 volts. Unlike the similar instrument previously tested, this instrument has no enclosing box for the lamps and some reflected light may be seen when viewing the counter from an angle.

CONCLUSIONS

24. The subject system, manufactured by Pitometer Log Corporation, and submitted for contract suitability tests, via the Inspector of Naval Material, New York, complied except for the following:

(a) The yardage transmitter is not designed to operate over the full speed range of the system and would not function correctly at speeds above 18 knots (spproximately) when received. However, at the end of a 48 hour run, it operated at 22 knots when supplied at full rated voltage. At 10 percent under voltage (103.5 V.) the maximum accurate speed was 18 knots.

(b) The yardage transmitter failed to withstand the dielectric test. The failure occurred in the electromagnet windings.

(c) Trouble was occasionally experienced with the master repeater, due to the sticking of the roller carriage assembly at approximately 2 knots. Similar trouble occurred in the first master instrument furnished except that it stuck at 6-7 knots.

(d) It was noted that the manometer unit did not swing in the true vertical position. However, no effect was noticed in the operation of the system.

25. It was noted that there is a condition under which the pointer of the master instrument will move in the reverse direction and jam at one end of the scale. This is brought about by energizing the system when the transmitting self-synchronous motor in the manometer is more than 180° out of step with the receiving motor in the master instrument. For example, this will occur with the manometer at 17 knots and the indicator at 0 knots, or with the manometer at 22 knots and the indicator at 15 knots.

TABLE NO. 1

ACCURACY TESTS

1 Hour Runs at Room Temperature of 77° F.

Knots by Test Manometer	Allowable Error in Percent	INDICATOR INSTRUMENTS						COUNTER INSTRUMENTS							
		MANOMETER		MASTER		REPEATER		MANOMETER		REPEATER		MILEAGE COUNTER		YARDAGE COUNTER	
		Knots	Error in Percent	Knots	Error in Percent	Knots	Error in Percent	Miles	Error in Percent	Miles	Error in Percent	Miles	Error in Percent	Miles	Error in Percent
2	- - -	1.9	-5	1.8	-10	1.8	-10	1.95	-2.5	2.1	+5.0	2.1	+5.0	2.07	+3.5
4	6	3.9	-2.5	4.0	0	4.0	0	3.9	-2.5	3.9	-2.5	3.9	-2.5	4.05	+1.2
6	4	5.96	-0.66	6.0	0	6.0	0	5.95	-0.84	6.00	0	6.0	0	6.25	+4.1
9	3	9.0	0	9.05	+0.55	9.07	+ 0.77	9.0	0	9.1	+1.1	9.1	+1.1	9.1	+1.1
16	2	15.99	-0.06	15.97	-0.19	15.98	0.12	15.95	-0.31	16.1	+0.6	16.1	+0.6	16.19	+1.2
20	1	19.98	-0.1	20.02	+.1	20.08	+ .4	19.95	- .25	20.0	0	20.0	0	20.11	+0.5
22	1	21.98	-0.09	21.98	-0.09	22.0	0	22.0	0	22.1	+0.45	22.1	+0.45	22.21	+0.95

TABLE NO. 2

TABLE OF TEMPERATURE RISES

Taken during endurance run at 3 to 16K. - Ambient temperature 25° C.

INSTRUMENT	WINDING	TEMPERATURE RISE IN° C.
Manometer	Synchronous Motor	22.6
Master Repeater	Primary - Follow up Motor	32.4
Yardage Transmitter	Motor Field	22.3
Yardage Transmitter	Magnet	30.0
Mileage Counter	Magnet	20.0
Yardage Counter	Magnet	20.0

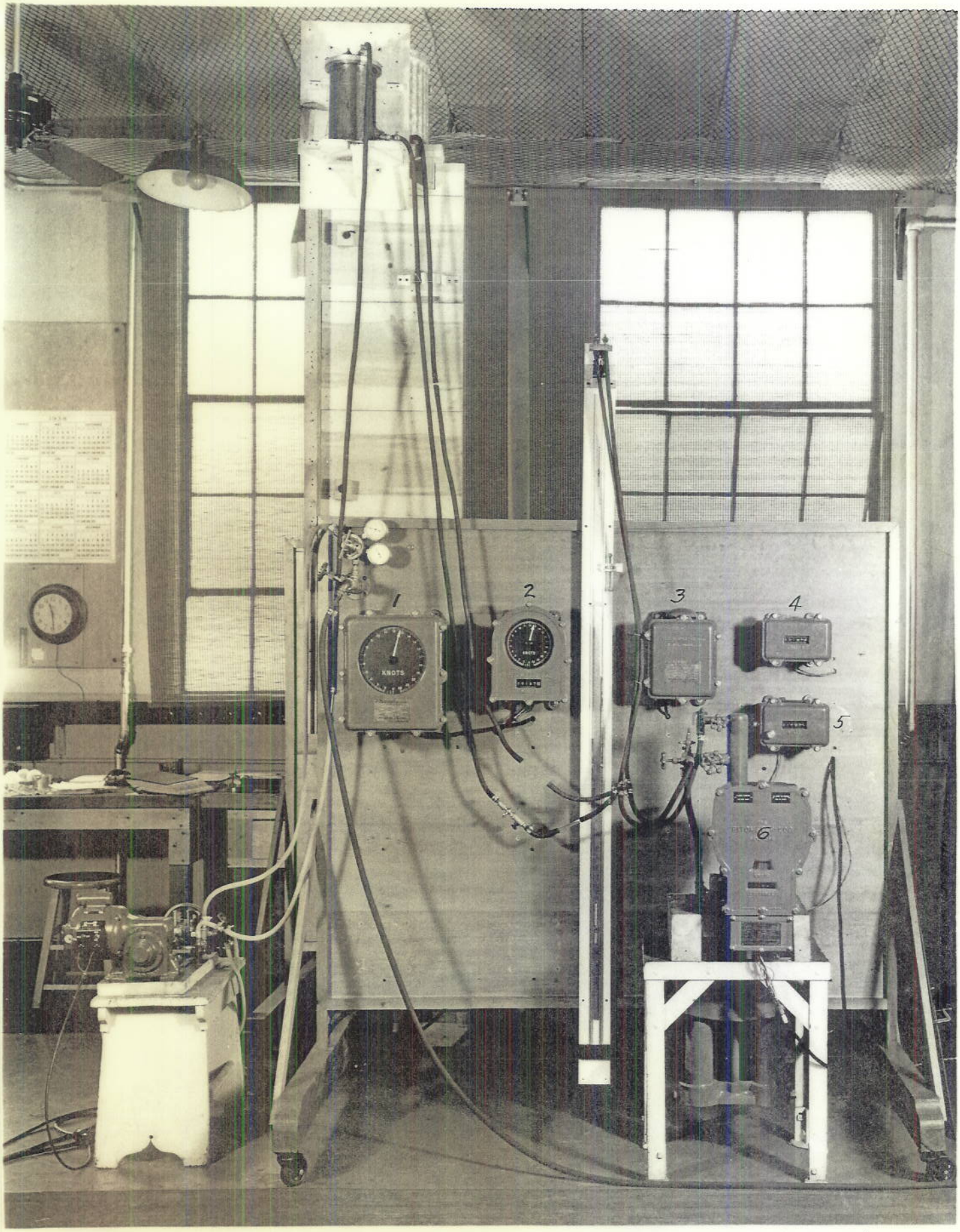
Taken after a 6-hour run at 22K - Ambient temperature 25° C.

Manometer	Synchronous Motor	23.0
Master Repeater	Primary - Follow up Motor	14.5
Yardage Transmitter	Motor Field	26.5
Yardage Transmitter	Magnet	29.0
Mileage Counter	Magnet	20.0
Yardage Counter	Magnet	18.3

Taken after a 2-hour run at 22 K - Ambient temperature 65° C.

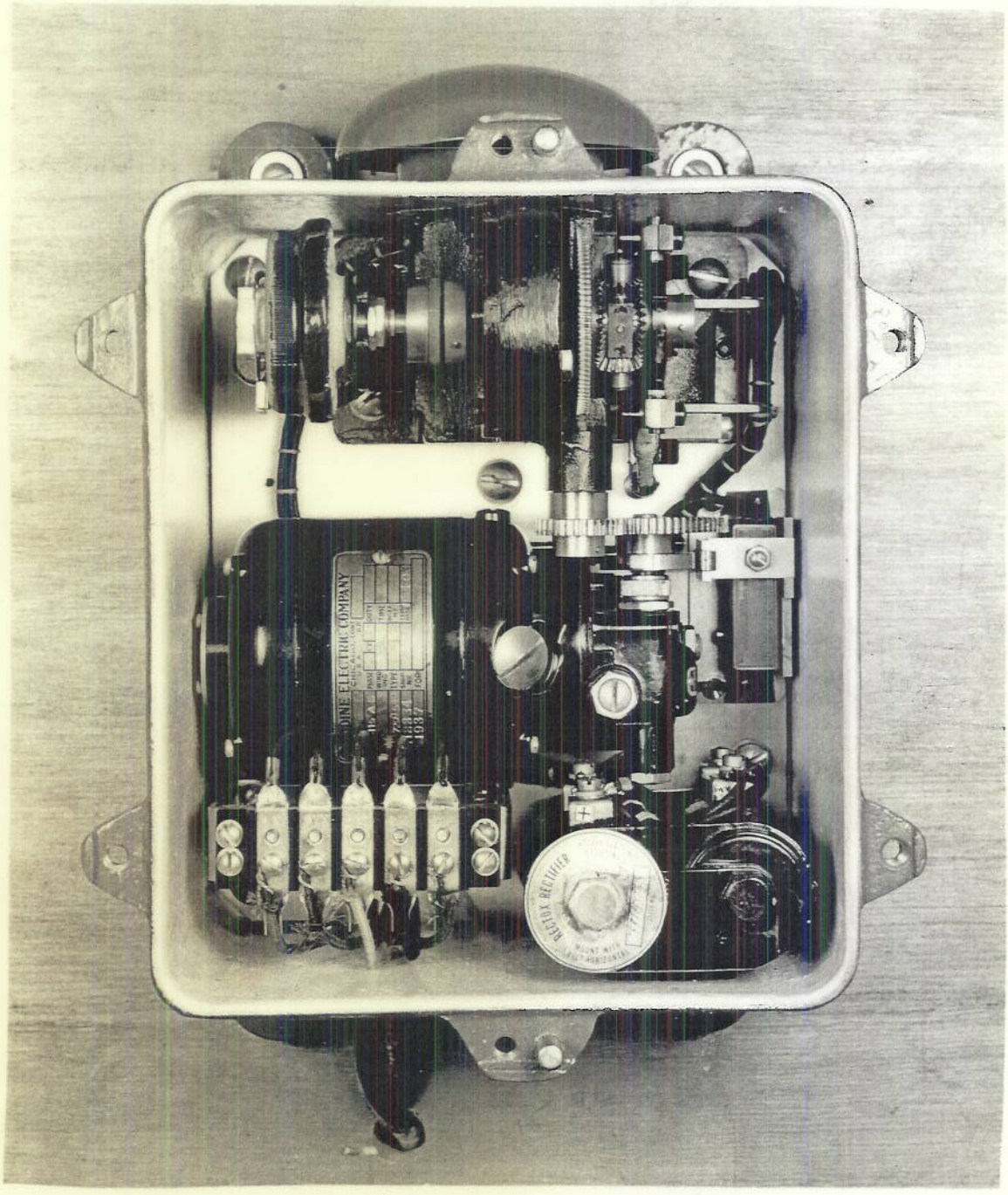
INSTRUMENT	SYNCHRONOUS MOTOR	TEMPERATURE RISE IN °C.
Yardage Transmitter	Motor Field	20.0
Yardage Transmitter	Magnet	23.2

Note:- Unnumbered parts used for conducting test.



1-Master Speed Repeater
2-Speed and Distance Repeater

4-Distance Repeater (1/10 mile)
5-Distance Repeater (1/100 mile)



Transmitter for 1/100 Mile Distance Repeater.

PLATE 2

EDGAR K. WILSON, Vice-Pres — EDWARD S. COLE, Pres — JOHN R. COLE, Sec-Treas.

PITOMETER LOG CORPORATION

237 LAFAYETTE STREET
NEW YORK

May 23, 1938.

BASIC FORMULA FOR DETERMINING KNOT - MERCURY DEFLECTION

$$V = C\sqrt{2gD\left(\frac{x}{x_1} - 1\right)}$$

V = Feet per second.
C = 0.96 coefficient.
g = 32.16
D = Deflection in feet of mercury.
x = 13.58 - Specific gravity of mercury.
x_1 = 1.026 - Specific gravity of sea water.

$$d = .047196\ K^2$$

d = Deflection in inches of mercury.
1 Knot = 6080.26 ft. hour = 1.689 ft. per second.

Knot	Mercury Deflection	Knot	Mercury Deflection
0	0	21	20.813"
1	.0472"	22	22.843"
2	.1888"	23	24.967"
3	.4248"	24	27.185"
4	.7551"	25	29.497"
5	1.180"	26	31.904"
6	1.699"	27	34.406"
7	2.313"	28	37.002"
8	3.021"	29	39.692"
9	3.823"	30	42.476"
10	4.720"	31	45.355"
11	5.711"	32	48.329"
12	6.796"	33	51.396"
13	7.976"	34	54.559"
14	9.250"	35	57.814"
15	10.618"	36	61.165"
16	12.081"	37	64.611"
17	13.639"	38	68.151"
18	15.291"	39	71.785"
19	17.038"	40	75.514"
20	18.878"		