25 February 1941

NRL Report No. B-1697

NAVY DEPARTMENT

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Report of Test

on

Underwater Electric Log Equipment
Contract NOs-71894

Submitted by

Bendix Aviation Corporation,
Marine Division,
Brooklyn, New York

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

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Authorization: BuShips ltr. S65-5/L5 (2-12-SS) of 2-17-40.

Date of Test: 11 December 1940 to 12 February 1941.

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Distribution: BuShips (5)

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AUTHORIZATION FOR TEST

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

Reference:
(a) BuShips ltr. S65-5/L5 (2-12-SS) of 2-17-40.
(b) Contract NOs-71984 - USS Terror, CM5.
(c) Specification SGS (65) - 151a of 1 February 1937.
(d) NRL Report B-1607 of 11 April 1940.
(e) Bendix Drwg. CAL-7520 - General Installation Arrangement.
(f) Bendix Drwg. CAL-8000 - Master Transmitter-Indicator.
(g) Bendix Drwg. CAL-8100 - Rodmeter Assembly.
(h) Bendix Drwg. CAL-8200 - Speed and Distance Indicator.
(i) Bendix Drwg. CAL-8220 (5 Sheets) Master Transmitter-Indicator, Interior Unit.
(j) Bendix Drwg. CAL-8270 - Speed and Distance Indicator, Interior Unit
(k) Bendix Drwg. CAL-8272 - Schematic Diagram.
(l) Bendix Drwg. CAL-8275 - Master Mileage Transmitter-Indicator with Speed Indicator.

OBJECT OF TEST

2. The object of this test was to determine conformance of the sample electric log equipment with the specification, reference (c), (as modified by contract, reference (b)), and its suitability for Naval use.

ABSTRACT OF TEST

3. The sample log equipment was set up at this Laboratory in conjunction with suitable test apparatus and its performance was carefully observed for compliance with the specifications. Following an initial accuracy test, tests were made to determine the effect of inclination, variation in supply voltage and frequency, endurance, shock, vibration, and hydrostatic pressures. Additional accuracy tests were made on several occasions to isolate the errors resulting from the several test conditions. An inspection of the sample to determine compliance in the matter of materials, design, and workmanship, concluded the test.

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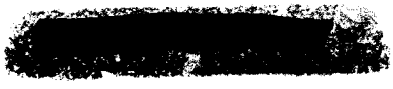
CONCLUSIONS

(a) This Underwater Log System, manufactured and submitted by Bendix Aviation Corporation, Marine Division, does not comply with specification, reference (c), in its entirety. The results of the tests indicate that it will be necessary to modify the equipment before it will be satisfactory for Naval use.



RECOMMENDATIONS

(a) It is recommended that the approval of this Underwater Log System for the USS Terror (CM5) be withheld pending the correction of the deficiencies noted under "Comments", paragraphs 24 and 25, and a satisfactory Laboratory test.

(b) It is further recommended that, if the present design is retained, the Master Mileage Transmitter-Indicator case be ventilated.

DESCRIPTION OF MATERIAL UNDER TEST

4. The equipment submitted for test was a 25 Knot Electric Log consisting of units as follows:

1 - Master Transmitter-Indicator (Speed)
1 - Master Mileage Transmitter-Indicator (Distance)
2 - Speed and Distance Indicators (Repeaters)

5. The Master Transmitter-Indicator is almost identical with the equivalent portion of the "Sal" log tested and reported by reference (d). It indicates and transmits ship's speed in knots and contains the mechanism necessary to obtain distance in nautical miles although it does not indicate distance. It is covered by drawings references (f), (i), and (k) and is shown by photographs, plates 13 to 17 inclusive.

6. The Master Mileage Transmitter-Indicator with Speed Indicator contains a torque amplifier of the saturation-transformer type which causes a power motor to run at a speed proportional to the ship's speed. The monitoring of this speed is accomplished through two modified type "N" Synchro-motors, one in this instrument and one in the Master Transmitter-Indicator. The output shaft of the power motor is geared to an odometer which registers nautical miles and to a type "B" Synchro-generator which transmits rotary motion to other odometers in the system. This instrument also indicates ship's speed by means of a type "M" Synchro-motor positioned by a type "B" Synchro-generator in the Master Transmitter-Indicator. It is covered by drawings, references, (k) and (l) and photographs, Plates 13, 18, 19, and 20.

7. The Speed and Distance Indicators are repeaters equipped with "ring type lighting" for dial and pointer illumination. The pointers are positioned by type "M" Synchro-motors and the odometers are driven by type "N" Synchro-motors. These instruments are covered by drawings references (h), (j), and (k) and are shown by photographs, Plates 13, 21, and 22.

PRINCIPLES OF THE BENDIX LOG (See drwg. CAL-8272)

8. A chamber #9, mounted below the waterline of the ship, is divided in two parts by means of a flexible bellows. That part of the chamber containing the upper part of the bellows is connected with the sea through the static aperture in the pitotstatic tube. Because of its position below the waterline, a certain water pressure acts downward on the inside of the bottom diaphragm #12 of the bellows. That part of the chamber containing the lower part of the bellows is connected with the sea through the pitot aperture at the bottom of the pitot tube which, in turn, extends 20" to 24" below the hull of the ship. Because of the relative positions of the chamber, static aperture, and pressure aperture, no motion will take place in the diaphragm when the ship is at rest.

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9. Motion of the diaphragm #12 will occur when the ship takes on a forward motion. Since the pressure will increase in the lower part of the chamber, the diaphragm #12 will move upward, forcing the contact arm #18 to pivot, causing the actuator motor #45 to start. Rotation of the actuator motor causes the large master cam #25 to rotate which, in turn, causes the master spring arm #23 to pivot. Pivoting of this arm causes loading of the contact arm through the large master spring #28. This loading forces the contact arm #18 back to its initial position, automatically shutting off the actuator motor #45. The log will then remain inactive until a further increase in pressure causes a recurrence of the above mentioned operation. A decrease in pressure will cause the actuator motor to operate in a reverse direction of that previously mentioned, thus rotating the cam so as to take a load off of the contact arm and allowing the contact arm to return to its initial position.

10. Further loading of the contact arm for corrective purposes is obtained by using an auxiliary spring #21 and arm #19. This arm is caused to pivot by motion of the slide #32. Thus, the loading of the contact arm by this spring will be dependent upon the angle at which the slide is set by the B adjustment. The motion of the slide #32 is obtained by means of a nut riding on a thread which is rotated by the actuator motor #45.

11. The speed in knots is indicated on a dial #26 by means of a pointer #27 which is fastened to the shaft which carries the master cam #25. Syncho-generator #48 positions all other pointers in the system.

12. This log system is equipped with three adjustments; "A" adjustment #29, "B" adjustment #33 and "C" adjustment #16. The "C" adjustment merely affects the zero setting of the instrument. The "A" adjustment affects all readings of the log by the same percentage. The "B" adjustment affects the readings either in a constant percentage rate of increase or a constant percentage rate of decrease. That is, the larger the reading, the greater the effect of the "B" adjustment. By means of these three adjustments, it is possible to calibrate the log for pitot tubes with different coefficients.

13. The distance mechanism consists of a screw thread #38, a friction pick-up wheel and carriage #39, a constant speed disc #40, a gear train and synchronous motor #41. As the screw #38 is caused to rotate by variation in ship speeds, the friction or distance integrating wheel #39 is caused to move radially along the surface of the disc #40. Since the number of revolutions turned by screw #38 is governed by the speed of the ship, it follows that the position of #39 on #40 will also be a function of the speed of the ship. As #39 is arranged so as to be at the center of the disc when pointer #27 is at the zero speed position, it is readily seen that as the speed goes up #39 will be moved radially along #40 and begin to rotate. Since the radial position of #39 is a function of the speed of the ship and #40 rotates at a constant speed, it follows that the speed of

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rotation of #39 is also a function of the ship's speed.

14. The friction wheel #39 is coupled to a "signal generator" #44 which transmits a rotating field to "signal receiver", #56. This receiver, through the rectifier #63, controls the output of the saturation amplifier transformer #64. The output of the amplifier is fed into the quadrature phase of power motor #54 which, in turn, drives units #55, #56 and #57. Since the speed at which #54 rotates is governed by the output of #56 which is directly coupled to #54, it follows that unit #56 rides as a monitor on power unit #54. The gear ratios and phase relations are such that if the rotor of #56 rotates more slowly than the signal field, power unit #54 will be caused to speed up. For the reverse condition, power unit #54 will slow down. The gear ratio 60 is so arranged that the odometer #57 will indicate true nautical miles. Synchro-generator #55 drives all other odometers in the system.

METHOD OF TEST

15. The subject equipment was set up at this Laboratory in conjunction with suitable testing equipment. The Master Transmitter-Indicator was calibrated by the manufacturer's representative against the manometers in the test equipment. These had scales giving equivalent speed in knots for a rodmeter coefficient of 0.96. The water manometer (with a static head of approximately 2 ft.) was used for speeds up to 8 knots and the mercury manometer (with a static head of approximately 10 feet) was used for speeds between 9 and 25 knots. The equipment was supplied with power at rated voltage and frequency.

16. Following this, the equipment was tested for accuracy while inclined 45 degrees in each direction. The accuracy was also checked with the supply varied $\pm$ 10% in voltage and $\pm$ 5 cycles in frequency. The supply to the synchronous motor was varied in voltage only, as the effect of a frequency variation in the supply to a synchronous motor is well known.

17. The equipment was then subjected to a 500 hour endurance test during which the pressure differential was varied to produce speed indications ranging from 0 to 25 knots and return at a rate of 1 cycle in 10 minutes. Except as noted, this test was made at room temperature.

18. The endurance test was interrupted after 200 hours in order to remove the units and install any lead wires necessary to measure the temperature rises of the component parts by the resistance method. Following this, the entire system was placed in a heating cabinet and operated for 50 hours at 65°C. The temperature rises of the various windings were measured during this period.

19. After 450 hours of the endurance test, another accuracy

test was made and each unit was subjected to the specified shock and vibration tests while the equipment was operated as under the endurance test. The accuracy was again checked and, as the calibration had changed, the Master Transmitter-Indicator was recalibrated in preparation for the next test and the remaining 50 hour period of the endurance test was completed.

20. An accuracy test was then conducted under conditions simulating those obtained on a submarine operating at a depth of 100 feet.

21. Next, the hydraulic parts of the Master Transmitter-Indicator were subjected to a hydrostatic pressure of 250 pounds per square inch as required by paragraph F-2m of reference, (c).

22. Following tests for dielectric strength and insulation resistance, an inspection was made of each unit to determine its conformance with the specifications relative to materials, design, and workmanship. A watertight test of the cases concluded the test.

RESULTS OF TESTS

23. The results of the tests conducted as described under "Method of Test" follow:

Requirements	Test Values
Supply: Shall be designed to operate from a 115 volt, 60 cycle power source having operating tolerances of ± 10% in both voltage and frequency.	Supplied with power from a 115 volt, 60 cycle controlled-frequency source except for special tests.
Power requirements of equipment: (not specified)	174 watts, 4.45 amperes, .34 P.F. for steady speed. 178 watts, 4.45 amperes, .35 P.F. for changing speed.
Accuracy: Errors in indicated speed or recorded miles shall never exceed the following: 6 percent at 4 knots 4 percent at 6 knots 3 percent at 9 knots 2 percent at 16 knots 1 percent at 20 knots and over.	
(a) At start of test:	Knots - Satisfactory. * Miles - Errors exceeded tolerance. See Table 1 and Plate 1.

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Requirements	Test Values
(b) Inclined 45° left:	* Knots and miles - Errors exceeded tolerance. See Table 2 and Plate 2.
(c) Inclined 45° right:	Knots - Satisfactory. * Miles - Errors exceeded tolerance. See Table 3 and Plate 3.
(d) Inclined 45° forward:	Knots - Satisfactory. * Miles - Errors exceeded tolerance. See Table 4 and Plate 4.
(e) Inclined 45° backward:	Knots - Satisfactory. * Miles - Errors exceeded tolerance. See Table 5 and Plate 5.
(f) With supply of 126.5 volts, 55 cycles:	* Knots - Errors slightly exceeded tolerance. * Miles - Errors exceeded tolerance. See Table 6 and Plate 6.
(g) With supply of 103.5 volts, 65 cycles:	Knots - Satisfactory. Miles - Satisfactory. See Table 7 and Plate 7.
(h) After 450 hours of endurance test:	* Knots - Errors exceeded tolerance. Miles - Satisfactory (usual negative errors in miles canceled by large positive errors in indicated knots) See Table 8 and Plate 8.
(i) Following Shock and Vibration:	Knots - Satisfactory. * Miles - Errors exceeded tolerance. See Table 9 and Plate 9.
(j) After recalibrating: (to remove large low scale errors and prepare for other tests)	Knots - Satisfactory. Miles - Errors not recorded. See Table 10-A and Plate 10.

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Requirements	Test Values
(k) During submerged test: (Not required for surface ship equipment)	Knots - Large negative errors. No indication below 4 knots. Miles - Errors not recorded. See Table 10-B and Plate 11.
(l) Following hydrostatic test:	* Knots - Very large negative errors. Miles - Errors not recorded. See Table 10-C and Plate 12.
Temperature rise: Not specified but determined during that portion of the endurance test conducted at 65°C. ambient. The usual requirement is 35°C. maximum rise.	* Temperature rises in Master Mileage Transmitter-Indicator were too high (42-50°C) See Table 11.
Endurance: The equipment shall be operated for 500 hours in accordance with paragraph F-2g.	* Satisfactory except for operation of Master Mileage Transmitter-Indicator. See "Comments on Results of Tests"
Shock and vibration: The equipment shall be reliably operative under the tests given in paragraph F-2i and shall sustain no damage.	* Not satisfactory. See "Comments on Results of Tests"
Pressure test: The entire hydraulic system shall be subjected to a hydrostatic test of 250 pounds per square inch. There shall be no evidence of leakage. Paragraph F-2m.	* Several leaks were noted and the zero position of the diaphragm shifted. See "Comments on Results of Tests"
Dielectric and insulation tests: An alternating potential of 1500 volts, 60 cycles shall be applied between each terminal and ground for 1 minute. Following this the insulation resistance at 500 volts shall be not less than 10 megohms.	* Breakdowns occurred in Pcs. 44, 56, 73, and 74 of drwg. CAL-8272. (500 volts, 60 cycles used for dielectric test on 6 volt lighting circuit) All other parts satisfactory.
Watertightness: Case shall be submerged in water to such a depth that the highest point is 3 feet below the surface. There shall be no evidence of leakage after 1 hour.	* The case of one Speed and Distance Indicator and the case of the Master Transmitter-Indicator leaked. See "Comments on Results of Tests"
Weights and Dimensions: Shall not exceed the following: Master Transmitter - Height 90", width 18", depth 12".	Master Transmitter-Indicator: Height 34", width 17", depth 11-5/8". Weight 132 lbs. 6 oz. (Not specified)

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Master Mileage Transmitter: Not covered by specification.	Master Mileage Transmitter: Height 14-7/8", width 14-7/8", depth 8-7/8". Weight 80 lbs. 4 oz. (Not specified)
Speed and Distance Indicator: Height 12", width 12", depth 8".	Speed and Distance Indicator: Height 12-1/8", width 10-1/2", depth 8-1/8". Weight 37 lbs. 3 oz. (Not specified)
Painting: All aluminum alloy parts shall be given a priming coat of zinc chromatic paint followed by two coats of aluminum paint and the finish coats of paint.	* No aluminum paint used.

* Denotes non-compliance with the specifications.

COMMENTS ON RESULTS OF TESTS

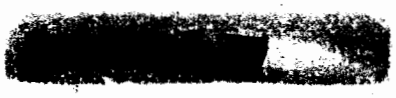
24. The following comments pertain to the test results:

(a) As shown by Table 1 and Plate 1, the initial accuracy of indicated knots complied with the specification. The errors in recorded miles exceeded the specified tolerance and were all negative.

(b) Inclining all instruments forward or backward produced little or no change in accuracy. Inclining them to the right produced negative errors in indicated knots at low scale values. For example, a manometer deflection of 1 knot produced no speed indication. Inclining the instruments to the left produced positive errors at low scale values. For example, the indicated speed was 1.5 knots for a true speed of zero knots. The results of these tests are given by Tables 2 to 5, and Plates 2 to 5, both inclusive.

(c) Tests with a supply of 126.5 volts, 55 cycles, produced no significant change in indicated knots but apparently increased the errors in recorded miles. Tests with a supply of 103.5 volts, 55 cycles, produced no significant change in indicated knots but apparently decreased the error in recorded miles. These results are given by Tables 6 and 7 and Plates 6 and 7.

(d) The equipment operated without mechanical or electrical failure throughout the endurance test except that on several occasions the Master Mileage Transmitter-Indicator was observed to operate at a rate that was out of proportion to the indicated ship's speed, causing the odometer to give a large positive error. It appears that there is something inherently unstable in its operation. There is a certain



amount of creepage of the Master Mileage power motor at zero ship's speed, resulting in a large angular displacement between the "signal generator" (44) and "signal receiver" (56), and causing considerable noise. If the supply is then turned off and restored, the Master Mileage instrument will start to run and will continue indefinitely although the roller of the "signal generator" is at the center of its driving disc and its shaft is not revolving. The mileage counters had consistent negative errors which it appears could be reduced approximately 2% by shifting the roller position.

(e) The accuracy of indicated knots following endurance is given by Table 8 and Plate 8. These values are somewhat doubtful as it was necessary to uncouple the linkage to the hydraulic unit and remove the chassis in order to install lead wires for temperature rise measurements. It is not believed that the chassis can be replaced without changing the "C" adjustment. Setting the "C" adjustment to a lower value would have brought the errors in indicated knots within the tolerances.

(f) The shock and vibration test caused the two main counterweights to loosen and it is believed that their supporting arms are bent slightly in the vicinity of the securing bolts. The arm of the counterweight provided for correcting errors due to inclining the equipment also bent so that the weight now touches the hydraulic chamber studs when the instrument is inclined 45°. Following this test, the counterweights were clamped in a central position (not necessarily correct but there were no reference marks) and the instrument was recalibrated. The ball bearing, piece 41, and shaft, piece 32, of the Master Mileage instrument moved outward under shock and jammed the entire gear train. After these parts were restored to their correct position, the instrument operated satisfactorily. There was no damage to the Speed and Distance Indicators as a result of these tests. The accuracy of the equipment following these tests is given by Table 9 and Plate 9.

(g) After recalibrating the Master Transmitter-Indicator, the errors in indicated speed were well within the specified tolerances. Under the 100-foot submergence test, no indication could be obtained for speeds below 4 knots. The accuracy under surface ship conditions was unchanged following this test. These results are given by Tables 10-A and 10-B and Plates 10 and 11.

(h) The hydrostatic test of 250 pounds per square inch caused slight leakage at all cocks and considerable leakage of the drain valves and the junction of pieces 1 and 3 of CAL-8220. Following this test, no indication could be obtained for any speed below 9 K. This change was so great that the "C" adjustment did not have sufficient range to compensate for it. These results are given by Table 10-C and Plate 12.

(i) At an ambient temperature of 65°C. the temperature rises of the parts in the Master Transmitter-Indicator ranged from 15 to 38°C. The rises for the parts in the Master Mileage Transmitter-

Indicator ranged from 42 to 50°C. The rises for the Speed and Distance Indicator ranged from 23 to 34°C. The numerals of the odometer in the Master Mileage Transmitter became slightly blurred and the dial graduations and pointer tarnished during the test. Complete results are given by Table 11.

(j) Under a dielectric test of 1500 volts, 60 cycles, alternating potential for the 115 volt circuits and 500 volts for the lighting circuits, the following parts broke down to ground. See drawing CAL-8272.

Pc. 56 - S_1-S_2-S_3 windings. (Special Type "N" motor.)

Pc. 73 - Secondary winding. (Lighting transformer.)

Pc. 44 - S_1-S_2-S_3 windings. (Special Type "N" motor.)

Pc. 74 - Discovered to be grounded. (Dimming rheostat.)

(k) The equipment can be adjusted to indicate speeds as low as 1.0 knot with fair accuracy. However, it is often necessary to change the "C" (zero) adjustment in order to maintain accuracy.

(l) In the Master Transmitter-Indicator, the action of the limit switches for the roller and disc assembly is unsatisfactory. At either 0 or 25 knots, the pointer oscillates due to repeated reversals of the power motor. This prevents satisfactory setting of the zero adjustment with the cocks in the by-pass position. Using the Laboratory test equipment, it was possible to accomplish approximately the same thing by adjusting for minimum error at about 1.5 knots, but this will not be feasible in the service without auxiliary equipment.

COMMENTS ON INSPECTION OF EQUIPMENT

25. The following comments are the result of an examination of the equipment to determine any defects and to ascertain what changes would be desirable.

Master Transmitter-Indicator

(a) The chassis has no handles to assist in its removal and replacement or extending dowels to rest it on when it is removed.

(b) There are a number of parts behind the chassis which are inaccessible for checking or lubricating. In order to reach them, it is necessary to remove the entire chassis. This requires uncoupling the zero adjusting micrometer and dropping the hydraulic assembly as far as possible. As the support for the compensating counterweight is too large to pass through the hole in the bottom of the case, the unit cannot be entirely removed and the micrometer assembly remains in a hazardous position. A larger hole or means to conveniently remove the micrometer without disturbing

the zero adjustment should be provided.

(c) The case cover has no dowels.

(d) There is no longitudinal reference line for the "A" adjustment.

(e) The limit switch mounting bracket should be more rugged and the switches should be provided with adjustable stops.

(f) All counterweights should be doweled at assembly.

(g) Pins such as piece 85 of CAL-8220-2 and piece 61 of CAL-8220-5 should be designed to prevent accidental removal.

(h) The cast iron lever-type handles provided for the cocks are a poor fit on the square shanks and will eventually ruin the flats. Non-removable handles are suggested.

(i) The engraved plate giving positions of maneuvering cosks is in error on both the instrument and the drawing.

(j) The terminals of transformer, piece 64 on CAL-8272, are not marked in accordance with the drawing. The leads and terminals of all components should be properly identified on instruments and drawings.

(k) The drain cocks leaked at normal surface ship heads.

(l) Under the watertight test, the case leaked at the gasket between it and the hydraulic unit.

(m) The usefulness of the "A" and "B" adjustments in the service might be increased if calibrating weights, such as furnished with the log equipment tested and reported by reference (d), were furnished with this equipment. These weights would provide means to check and maintain the accuracy of the system.

Master Mileage Transmitter-Indicator

(a) The larger gear shaft supporting block extends beyond the pins provided for supporting the instrument in the face down position.

(b) A transformer and resistor which form part of this instrument are located in the Master Transmitter-Indicator, apparently due to lack of space in this instrument case.

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(c) The use of open worm and worm wheels in the gear trains is unsatisfactory due to lubrication problems.

(d) The dowel pins used to align the chassis in the case are loose in the aluminum lugs.

Speed and Distance Indicator

(a) The dial lighting lamps are supplied with 6.8 volts with 115 volts to primary of the lighting transformer. For longer lamp life, it has been the practice to keep the voltage down to 6 volts or less.

(b) The rheostat with combined switch has too much resistance (417 ohms). A 100 ohm rheostat with an open circuit position should be substituted so that the dimming adjustment will not be so critical.

(c) A large part of the inner surface of the plastic ring is visible to an observer from an angle of about 45 degrees to normal.

(d) The case of the one Speed and Distance Indicator tested for watertightness leaked through the drain valve in the bottom of the case although the valve was carefully tightened.

General

(a) None of the instruments has handles extending from the chassis.

(b) The dials are black with the base metal showing as a result of shallow engraving. On some instruments, this metal has tarnished during the test and the visibility of the graduations and pointers is now poor. The use of the usual white graduations on a black background is a specification requirement.

(c) The steel cover securing screws for all instruments fit the steel inserts too tightly.

(d) The supply to the synchronous motor should be separated from the other supplies.

(e) There is nothing in the drawings furnished to indicate whether dissimilar metals are used in the hydraulic parts such as bellows, diaphragm, tubing connections, or rodmeter. This should be stated and be subject to specific approval.

[redacted]

CONCLUSIONS

26. This Underwater Log System, manufactured and submitted by Bendix Aviation Corporation, Marine Division, does not comply with specification reference (c), in its entirety. The results of the tests indicate that it will be necessary to modify the equipment before it will be satisfactory for Naval use.

TABLE 1

Accuracy Test of Underwater Log
conducted before all other tests.

Settings for calibration - A=.434 B= -.25 C=.484

Manometer	Master Speed		Master Mileage		Indicator No. 1		Indicator No. 2		Master Mileage
Simulated Knots	Indicated Knots	Percent error	Indicated Knots	Percent error	Indicator Knots	Percent error	Indicated Knots	Percent error	Percent error in counted miles
0									
1 A	0.85	-15.0	0.84	-16.0	0.85	-15.0	0.83	-17.0	-20.55
1 D	1.04	+ 4.0	1.06	+ 6.0	1.06	+ 6.0	1.05	+ 5.0	- 3.78
2 A	2.00	0	1.96	- 2.0	1.96	- 2.0	1.94	- 3.0	- 7.50
2 D	2.02	+ 1.0	2.01	+ 0.5	2.02	+ 1.0	2.02	+ 1.0	- 5.12
3 A	3.06	+ 2.0	3.01	+ 0.3	3.01	+ 0.3	3.00	0	- 4.00
3 D	3.09	+ 3.0	3.01	+ 0.3	3.09	+ 3.0	3.10	+ 3.3	- 2.27
4 A	4.01	+ 0.3	3.98	- 0.5	3.99	- 0.3	3.94	- 1.5	- 5.00
4 D	4.03	+ 0.8	4.01	+ 0.3	4.02	+ 0.5	4.02	+ 0.5	- 3.41
5 A	5.00	0	4.90	- 2.0	4.93	- 1.4	4.90	- 2.0	- 4.72
5 D	5.00	0	5.00	0	5.00	0	5.00	0	- 5.00
6 A	6.05	+ 0.8	5.90	- 1.7	5.93	- 1.2	5.90	- 1.7	- 4.44
6 D	6.00	0	5.99	- 0.2	6.00	0	6.00	0	- 4.08
9 A	8.99	- 0.1	8.90	- 1.1	8.96	- 0.4	9.00	0	- 3.89
9 D	9.00	0	8.90	- 1.1	8.98	- 0.2	8.91	- 1.0	- 3.53
16 A	15.95	- 0.3	15.89	- 0.7	15.90	- 0.6	15.87	- 0.8	- 2.91
16 D	15.98	- 0.1	15.92	- 0.5	15.96	- 0.3	15.90	- 0.6	- 2.77
20 A	19.94	- 0.3	19.90	- 0.5	19.98	- 0.1	19.82	- 0.9	- 2.41
20 D	20.00	0	19.99	- 0.05	19.98	- 0.1	19.93	- 0.4	- 1.94
24 A	24.15	+ 0.6	24.00	0	24.01	+ 0.04	23.99	- 0.04	- 1.00
24 D	24.14	+ 0.6	24.03	+ 0.1	24.07	+ 0.3	24.02	+ 0.08	- 0.69
25 A	25.10	+ 0.4	25.00	0	25.00	0	25.00	0	- 1.22
25 D	25.10	+ 0.4	25.10	+ 0.4	25.09	+ 0.4	25.08	+ 0.3	- 1.27

Notes:

A - Accelerating
D - Decelerating
Supply - 115 Volts, 60 cycles

[redacted]

TABLE 2

Accuracy Test of Underwater Log
conducted with all Equipment Inclined 45° Left
Settings for calibration A = .434 B = -.25 C = .484

Manometer	Master Speed		Master Mileage		Indicator No. 1		Indicator No. 2		Master Mileage
Simulated Knots	Indicated Knots	Percent error	Indicated Knots	Percent error	Indicated Knots	Percent error	Indicated Knots	Percent error	Percent error in counted Miles
0	1.48		1.48		1.49		1.47		
1 A	1.89	+ 89.0	1.85	+ 85.0	1.87	+ 87.0	1.82	+ 82.0	+ 44.10
1 D	2.28	+128.0	2.30	+130.0	2.30	+130.0	2.29	+129.0	+ 53.66
2 A	2.85	+ 42.5	2.82	+ 41.0	2.83	+ 41.5	2.80	+ 40.0	+ 25.89
2 D	2.88	+ 44.0	2.90	+ 45.0	2.91	+ 45.5	2.90	+ 45.0	+ 27.36
3 A	3.60	+ 20.0	3.53	+ 17.7	3.54	+ 18.0	3.51	+ 17.0	+ 14.22
3 D	3.59	+ 19.7	3.58	+ 19.3	3.59	+ 19.7	3.58	+ 19.3	+ 14.41
4 A	4.35	+ 8.8	4.30	+ 7.5	4.31	+ 7.8	4.28	+ 7.0	+ 6.39
4 D	4.40	+ 10.0	4.41	+ 10.3	4.42	+ 10.5	4.40	+ 10.0	+ 8.05
5 A	5.10	+ 2.0	5.00	0	5.00	0	5.00	0	- 1.22
5 D	5.15	+ 3.0	5.11	+ 2.2	5.13	+ 2.6	5.12	+ 2.4	- 0.08
6 A	6.11	+ 1.8	6.05	+ 0.8	6.02	+ 0.3	6.01	+ 0.2	- 1.78
6 D	6.11	+ 1.8	6.10	+ 1.7	6.10	+ 1.7	6.10	+ 1.7	- 0.75
9 A	9.07	+ 0.8	8.98	- 0.2	9.01	+ 0.1	8.99	- 0.1	- 2.16
9 D	9.02	+ 0.2	9.00	0	9.03	+ 0.3	9.00	0	- 2.05
16 A	16.03	+ 0.2	16.00	0	16.00	0	15.93	- 0.4	- 1.33
16 D	16.02	+ 0.1	16.00	0	16.00	0	15.99	- 0.06	- 1.69
20 A	20.02	+ 0.1	19.98	- 0.1	19.97	- 0.2	19.89	- 0.6	- 1.55
20 D	20.01	+ 0.05	20.00	0	19.99	- 0.05	19.99	- 0.05	- 1.30
24 A	24.18	+ 0.8	24.07	+ 0.3	24.09	+ 0.4	24.02	+ 0.08	0
24 D	24.17	+ 0.7	24.10	+ 0.4	24.10	+ 0.7	24.08	+ 0.3	- 0.14
25 A	25.10	+ 0.4	25.10	+ 0.4	25.11	+ 0.4	25.05	+ 0.2	- 1.08
25 D	25.10	+ 0.4	25.10	+ 0.4	25.10	+ 0.4	25.09	+ 0.4	- 1.00

Notes:
A - Accelerating
D - Decelerating
Supply - 115 Volts, 60 cycles

[redacted]

TABLE 3

Accuracy Test of Underwater Log
conducted with all Equipment Inclined 45° Right
Settings for calibration A = .434 B = -.25 C = .484

Manometer Simulated Knots	Master Speed Indicated Knots	Master Speed Percent error	Master Mileage Indicated Knots	Master Mileage Percent error	Indicator No. 1 Indicated Knots	Indicator No. 1 Percent error	Indicator No. 2 Indicated Knots	Indicator No. 2 Percent error	Master Mileage Percent error in counted Miles
0	0		0		0		0		
1 A	0		0		0		0		
1 D	0		0		0		0		
2 A	1.73	- 13.5	1.70	- 15.0	1.70	- 15.0	1.69	- 15.5	- 23.61
2 D	1.78	- 11.0	1.77	- 11.5	1.77	- 11.5	1.74	- 13.0	- 24.28
3 A	2.92	- 2.7	2.89	- 3.7	2.88	- 4.0	2.84	- 5.3	- 7.61
3 D	2.90	- 3.3	2.88	- 4.0	2.88	- 4.0	2.88	- 4.0	- 7.66
4 A	4.00	0	3.93	- 1.8	3.93	- 1.8	3.93	- 1.8	- 4.22
4 D	4.00	0	3.94	- 1.5	3.95	- 1.3	3.95	- 1.3	- 6.39
5 A	4.99	- 0.2	4.90	- 2.0	4.90	- 2.0	4.89	- 2.2	- 5.22
5 D	5.00	0	4.93	- 1.4	4.95	- 1.0	4.95	- 1.0	- 4.28
6 A	5.97	- 0.5	5.90	- 1.7	5.91	- 1.5	5.89	- 1.8	- 3.50
6 D	5.98	- 0.3	5.90	- 1.7	5.93	- 1.2	5.92	- 1.3	- 3.33
9 A	9.03	+ 0.3	8.99	- 0.1	9.01	+ 0.1	8.99	- 0.1	- 2.77
9 D	9.00	0	8.97	- 0.3	9.00	0	8.99	- 0.1	- 2.66
16 A	15.95	- 0.3	15.88	- 0.8	15.90	- 0.6	15.83	- 1.1	- 3.47
16 D	15.98	- 0.1	15.93	- 0.4	15.93	- 0.4	15.92	- 0.5	- 2.91
20 A	19.99	- 0.1	19.90	- 0.5	19.87	- 0.7	19.82	- 0.9	- 2.80
20 D	19.97	- 0.2	19.90	- 0.5	19.89	- 0.6	19.88	- 0.6	- 2.16
24 A	24.01	+ 0.04	23.99	- 0.04	24.00	0	23.96	- 0.2	- 1.66
24 D	24.02	+ 0.08	24.03	+ 0.1	24.05	+ 0.2	24.01	+ 0.04	- 1.58
25 A	25.10	+ 0.4	25.00	0	25.00	0	25.09	+ 0.4	- 1.47
25 D	25.10	+ 0.4	25.02	+ 0.1	25.05	+ 0.2	25.02	+ 0.1	- 1.61

Notes:
A - Accelerating
D - Decelerating
Supply - 115 Volts, 60 cycles

[redacted]

TABLE 4

Accuracy Test of Underwater Log
conducted with all Equipment Inclined 45° Forward
Settings for calibration A = .434 B = -.25 C = .484

Manometer	Master Speed		Master Mileage		Indicator No. 1		Indicator No. 2		Master Mileage
Simulated Knots	Indicated Knots	Percent error	Indicated Knots	Percent error	Indicated Knots	Percent error	Indicated Knots	Percent error	Percent error in counted Miles
0	0		0		0		0		
1 A	1.03	+ 3.0	1.01	+ 1.0	1.03	+ 3.0	1.00	0	- 11.66
1 D	1.11	+11.0	1.12	+12.0	1.11	+11.0	1.11	+ 11.0	+ 0.19
2 A	2.00	0	1.96	- 2.0	1.96	- 2.0	1.92	- 4.0	- 9.44
2 D	2.02	+ 1.0	2.03	+ 1.5	2.02	+ 1.0	2.02	+ 1.0	- 6.05
3 A	3.10	+ 3.3	3.08	+ 2.7	3.09	+ 3.0	3.05	+ 1.7	- 0.61
3 D	3.12	+ 4.0	3.13	+ 4.3	3.12	+ 4.0	3.13	+ 4.3	+ 1.39
4 A	4.01	+ 0.3	4.00	0	4.00	0	4.00	0	- 1.16
4 D	4.07	+ 1.8	4.04	+ 1.0	4.03	+ 0.8	4.03	+ 0.8	- 0.47
5 A	5.01	+ 0.2	4.99	- 0.2	5.00	0	4.99	- 0.2	- 2.50
5 D	5.01	+ 0.2	5.01	+ 0.2	5.01	+ 0.2	5.01	+ 0.2	- 1.61
6 A	6.01	+ 0.2	5.97	- 0.5	5.98	- 0.3	5.92	- 1.3	- 4.14
6 D	6.00	0	6.00	0	6.00	0	6.00	0	- 1.86
9 A	8.98	- 0.2	8.90	- 1.1	8.95	- 0.5	8.90	- 1.1	- 3.89
9 D	8.97	- 0.3	8.90	- 1.1	8.96	- 0.5	9.02	+ 0.2	- 4.33
16 A	16.03	+ 0.2	15.99	- 0.06	16.00	0	15.92	- 0.5	- 0.55
16 D	16.00	0	16.00	0	16.00	0	15.98	- 0.1	- 1.05
20 A	19.91	- 0.5	19.85	- 0.8	19.85	- 0.8	19.80	- 1.0	- 1.39
20 D	19.92	- 0.4	19.88	- 0.6	19.87	- 0.7	19.85	- 0.8	- 2.72
24 A	24.10	+ 0.4	24.00	0	23.98	- 0.1	23.94	- 0.3	- 1.00
24 D	24.12	+ 0.5	24.03	+ 0.1	24.07	+ 0.3	24.03	+ 0.1	- 0.86
25 A	25.10	+ 0.4	25.00	0	25.00	0	24.99	- 0.04	- 0.92
25 D	25.10	+ 0.4	25.01	+ 0.04	25.01	+ 0.04	25.01	+ 0.04	- 0.89

Notes:
A - Accelerating
D - Decelerating
Supply 115 Volts, 60 cycles

[redacted]

TABLE 5

Accuracy Test of Underwater Log
conducted with all Equipment Inclined 45° Backward
Settings for calibration A = .434 B = -.25 C = .484

Manometer	Master Speed		Master Mileage		Indicator No. 1		Indicator No. 2		Master Mileage
Simulated Knots	Indicated Knots	Percent error	Indicated Knots	Percent error	Indicated Knots	Percent error	Indicated Knots	Percent error	Percent error in counted Miles
0	0		0		0		0		
1 A	0.66	- 34.0	0.60	- 40.0	0.60	- 40.0	0.59	- 41.0	- 73.20
1 D	0.90	- 10.0	0.89	- 11.0	0.90	- 10.0	0.90	- 10.0	- 20.82
2 A	1.93	- 3.5	1.90	- 5.0	1.90	- 5.0	1.88	- 6.0	- 9.28
2 D	2.00	0	2.00	0	2.00	0	2.00	0	- 8.33
3 A	3.00	0	2.93	- 2.3	2.94	- 2.0	2.91	- 3.0	- 4.70
3 D	3.06	+ 2.0	3.02	+ 0.7	3.03	+ 1.0	3.04	+ 1.3	- 2.42
4 A	4.00	0	3.94	- 1.5	3.96	- 1.0	3.93	- 1.8	- 3.89
4 D	4.00	0	4.00	0	4.00	0	4.00	0	- 3.39
5 A	5.00	0	4.92	- 1.6	4.96	- 0.8	4.93	- 1.4	- 3.61
5 D	5.00	0	4.99	- 0.2	4.99	- 0.2	4.99	- 0.2	- 3.36
6 A	6.00	0	5.90	- 1.7	5.93	- 1.2	5.90	- 1.7	- 2.94
6 D	6.00	0	5.98	- 0.3	6.00	0	6.00	0	- 2.42
9 A	8.99	- 0.1	8.90	- 1.1	8.97	- 0.3	8.91	- 1.0	- 2.53
9 D	9.00	0	8.93	- 0.8	8.99	- 0.1	8.96	- 0.5	- 2.66
16 A	16.00	0	15.92	- 0.5	15.97	- 0.2	15.88	- 0.8	- 0.75
16 D	16.01	+ 0.1	16.00	0	16.01	+ 0.1	15.99	- 0.1	- 1.58
20 A	20.01	+ 0.1	19.99	- 0.1	19.99	- 0.1	19.90	- 0.5	- 1.53
20 D	20.09	+ 0.5	20.00	0	20.00	0	20.01	+ 0.1	- 1.89
24 A	24.20	+ 0.8	24.07	+ 0.3	24.07	+ 0.3	24.00	0	- 0.72
24 D	24.20	+ 0.8	24.10	+ 0.4	24.13	+ 0.5	24.08	+ 0.3	- 0.78
25 A	25.10	+ 0.4	25.09	+ 0.4	25.11	+ 0.4	25.05	+ 0.2	- 0.72
25 D	25.10	+ 0.4	25.10	+ 0.4	25.11	+ 0.4	25.01	+ 0.04	- 0.78

Notes:
A - Accelerating
D - Decelerating
Supply 115 Volts, 60 cycles

[redacted]

TABLE 6

Accuracy Test of Underwater Log
with Supply of 126.5 Volts, 55 cycles
Settings for calibration A = .434 B = -.25 C = .484

Manometer	Master Speed		Master Mileage		Indicator No. 1		Indicator No. 2		Master Mileage
Simulated Knots	Indicated Knots	Percent error	Indicated Knots	Percent error	Indicated Knots	Percent error	Indicated Knots	Percent error	Percent error in counted Miles
0	0		0		0		0		
1 A	0.85	- 15.0	0.80	- 20.0	0.81	- 19.0	0.80	- 20.0	- 17.10
1 D	0.97	- 3.0	0.97	- 3.0	0.94	- 6.0	0.93	- 7.0	- 13.09
2 A	1.91	- 4.5	1.89	- 5.5	1.88	- 6.0	1.87	- 6.5	- 2.83
2 D	1.92	- 4.0	1.92	- 4.0	1.93	- 3.5	1.89	- 5.5	- 1.00
3 A	2.96	- 1.3	2.90	- 3.3	2.91	- 3.0	2.90	- 3.3	+ 3.03
3 D	2.98	- 0.7	2.97	- 1.0	2.97	- 1.0	2.95	- 1.7	+ 3.72
4 A	3.99	- 0.3	3.91	- 2.3	3.92	- 2.0	3.92	- 2.0	- 8.89
4 D	3.99	- 0.3	3.92	- 2.0	3.95	- 1.3	3.94	- 1.5	- 9.41
5 A	4.94	- 1.2	4.85	- 3.0	4.87	- 2.6	4.85	- 3.0	- 8.17
5 D	4.95	- 1.0	4.90	- 2.0	4.91	- 1.8	4.9	- 2.0	- 7.95
6 A	5.91	- 1.5	5.85	- 2.5	5.87	- 2.2	5.85	- 2.5	- 7.25
6 D	5.91	- 1.5	5.88	- 2.0	5.90	- 1.7	5.88	- 2.0	- 7.34
9 A	9.10	+ 1.1	9.00	0	9.05	+ 0.6	9.00	0	- 3.19
9 D	9.08	+ 0.9	9.00	0	9.06	+ 0.7	9.01	+ 0.1	- 3.70
16 A	16.00	0	15.97	- 0.2	15.97	- 0.2	15.90	- 0.6	- 0.39
16 D	16.02	+ 0.1	16.00	0	16.00	0	15.98	- 0.1	- 0.86
20 A	20.01	+ 0.1	20.00	0	19.99	- 0.1	19.91	- 0.5	- 2.61
20 D	20.02	+ 0.1	20.00	0	20.00	0	19.99	- 0.1	- 2.28
24 A	24.26	+ 1.1	24.10	+ 0.4	24.13	+ 0.5	24.09	+ 0.4	- 1.39
24 D	24.28	+ 1.2	24.18	+ 0.8	24.20	+ 0.8	24.12	+ 0.5	- 1.19
25 A	25.10	+ 0.4	25.10	+ 0.4	25.10	+ 0.4	25.10	+ 0.4	- 1.33
25 D	25.10	+ 0.4	25.10	+ 0.4	25.10	+ 0.4	25.10	+ 0.4	- 1.42

Notes:

A - Accelerating
D - Decelerating
Supply to synchronous motor 126.5 volts, 60 cycles.

[redacted]

TABLE 7

Accuracy Test of Underwater Log
with Supply of 103.5 Volts, 65 cycles
Settings for calibration A = .434 B = -.25 C = .484

Manometer	Master Speed		Master Mileage		Indicator No. 1		Indicator No. 2		Master Mileage
Simulated Knots	Indicated Knots	Percent error	Indicated Knots	Percent error	Indicated Knots	Percent error	Indicated Knots	Percent error	Percent error in counted Miles
0	0		0		0		0		
1 A	0.89	- 11.0	0.82	- 18.0	0.82	- 18.0	0.80	- 20.0	- 24.80
1 D	0.91	- 9.0	0.93	- 7.0	0.95	- 5.0	0.93	- 7.0	- 18.11
2 A	1.99	- 0.5	1.90	- 5.0	1.92	- 4.0	1.90	- 5.0	- 6.03
2 D	1.99	- 0.5	1.97	- 1.5	1.99	- 0.5	1.99	- 0.5	- 5.22
3 A	3.07	+ 2.3	3.00	0	3.00	0	2.99	- 0.3	- 1.39
3 D	3.08	+ 2.7	3.07	+ 2.3	3.08	+ 2.7	3.08	+ 2.7	- 0.89
4 A	4.03	+ 0.8	3.98	- 0.5	3.99	- 0.3	3.94	- 1.5	- 2.39
4 D	4.03	+ 0.8	4.02	+ 0.5	4.07	+ 1.8	4.04	+ 1.0	- 2.00
5 A	5.01	+ 0.2	4.96	- 0.8	4.99	- 0.2	4.98	- 0.4	- 2.33
5 D	5.01	+ 0.2	5.00	0	5.05	+ 1.0	5.01	+ 0.2	- 1.94
6 A	6.02	+ 0.3	5.93	- 1.2	5.95	- 0.8	5.92	- 1.3	- 2.25
6 D	6.02	+ 0.3	6.00	0	6.03	+ 0.5	6.00	0	- 1.97
9 A	9.01	+ 0.1	8.95	- 0.6	9.00	0	8.93	- 0.8	- 1.33
9 D	9.01	+ 0.1	9.00	0	9.05	+ 0.6	9.01	+ 0.1	- 1.33
16 A	16.04	+ 0.3	16.00	0	16.00	0	15.94	- 0.4	- 0.81
16 D	16.03	+ 0.2	16.07	+ 0.4	16.08	+ 0.5	16.05	+ 0.3	- 0.55
20 A	20.01	+ 0.1	20.00	0	20.00	0	19.93	- 0.4	- 1.03
20 D	20.02	+ 0.1	20.50	+ 0.3	20.07	+ 0.4	20.01	+ 0.1	- 0.56
24 A	24.25	+ 1.0	24.10	+ 0.4	24.13	+ 0.5	24.08	+ 0.3	- 0.69
24 D	24.25	+ 1.0	24.19	+ 0.8	24.20	+ 0.8	24.17	+ 0.7	- 0.56
25 A	25.10	+ 0.4	25.10	+ 0.4	25.11	+ 0.4	25.10	+ 0.4	- 0.72
25 D	25.10	+ 0.4	25.10	+ 0.4	25.13	+ 0.5	25.10	+ 0.4	- 0.79

Notes:

A - Accelerating
D - Decelerating
Supply to synchronous motor 103.5 volts, 60 cycles.

[redacted]

TABLE 8

Accuracy Test of Underwater Log
Following 450 hours Endurance
Settings for calibration A = .434 B = −.25 C = .478

Manometer	Master Speed		Master Mileage		Indicator No. 1		Indicator No. 2		Master Mileage
Simulated Knots	Indicated Knots	Percent error	Indicated Knots	Percent error	Indicated Knots	Percent error	Indicated Knots	Percent error	Percent error in counted Miles
0	0		0		0		0		
1 A	0.80	− 20.0	0.75	− 25.0	0.77	− 23.0	0.72	− 28.0	− 13.33
1 D	1.09	+ 9.0	1.03	+ 3.0	1.05	+ 5.0	1.02	+ 2.0	+ 0.45
2 A	2.15	+ 7.5	2.10	+ 5.0	2.11	+ 5.5	2.09	+ 4.5	+ 1.64
2 D	2.20	+ 10.0	2.18	+ 9.0	2.18	+ 9.0	2.19	+ 9.5	+ 4.39
3 A	3.29	+ 9.6	3.21	+ 7.0	3.21	+ 7.0	3.21	+ 7.0	+ 4.47
3 D	3.30	+ 10.0	3.28	+ 9.3	3.28	+ 9.3	3.28	+ 9.3	+ 5.47
4 A	4.29	+ 7.3	4.20	+ 5.0	4.20	+ 5.0	4.19	+ 4.8	+ 2.14
4 D	4.30	+ 7.5	4.29	+ 7.3	4.27	+ 6.8	4.27	+ 6.8	+ 3.42
5 A	5.19	+ 3.8	5.22	+ 4.4	5.22	+ 4.4	5.20	+ 4.0	+ 1.58
5 D	5.30	+ 6.0	5.25	+ 5.0	5.25	+ 5.0	5.27	+ 5.4	+ 1.94
6 A	6.29	+ 4.8	6.21	+ 3.5	6.22	+ 3.7	6.20	+ 3.3	+ 1.39
6 D	6.30	+ 5.0	6.25	+ 4.2	6.28	+ 4.7	6.24	+ 4.0	+ 1.64
9 A	9.27	+ 3.0	9.20	+ 2.2	9.25	+ 2.8	9.20	+ 2.2	− 0.05
9 D	9.30	+ 3.3	9.25	+ 2.8	9.27	+ 3.0	9.23	+ 2.6	+ 0.28
16 A	16.25	+ 1.6	16.30	+ 1.9	16.33	+ 2.1	16.20	+ 1.3	− 0.19
16 D	16.31	+ 1.9	16.25	+ 1.6	16.24	+ 1.5	16.22	+ 1.4	− 0.36
20 A	20.28	+ 1.4	20.19	+ 0.9	20.20	+ 1.0	20.12	+ 0.6	− 0.83
20 D	20.28	+ 1.4	20.20	+ 1.0	20.21	+ 1.1	20.15	+ 0.8	− 0.92
24 A	24.35	+ 1.5	24.20	+ 0.8	24.22	+ 0.9	24.15	+ 0.6	− 0.36
24 D	24.35	+ 1.5	24.20	+ 0.8	24.26	+ 1.1	24.20	+ 0.8	− 0.39
25 A	25.10	+ 0.4	25.20	+ 0.8	25.10	+ 0.4	25.15	+ 0.6	− 0.61
25 D	25.10	+ 0.4	25.10	+ 0.4	25.19	+ 0.8	25.15	+ 0.6	− 0.72

Notes:
A − Accelerating
D − Decelerating
Supply 115 Volts, 60 cycles

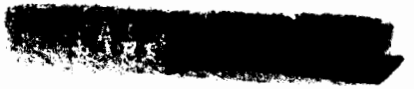

TABLE 9

Accuracy Test of Underwater Log
Following Shock and Vibration
Settings for calibration A = .434 B = −.25 C = .478

Manometer Simulated Knots	Master Speed Indicated Knots	Master Speed Percent error	Master Mileage Indicated Knots	Master Mileage Percent error	Indicator No. 1 Indicated Knots	Indicator No. 1 Percent error	Indicator No. 2 Indicated Knots	Indicator No. 2 Percent error	Master Mileage Percent error in counted Miles
0	0		0		0		0		
1 A	0		0		0		0		
1 D	0		0		0		0		
2 A	0.81	− 59.5	0.79	− 60.5	0.78	− 61.0	0.79	− 60.5	− 158.50
2 D	1.20	− 40.0	1.15	− 42.5	1.19	− 40.5	1.19	− 40.5	− 82.95
3 A	2.70	− 10.0	2.63	− 12.3	2.66	− 11.3	2.67	− 11.0	− 17.60
3 D	2.71	− 9.7	2.69	− 10.3	2.71	− 9.7	2.72	− 9.3	− 15.21
4 A	3.90	− 2.5	3.82	− 4.5	3.83	− 4.3	3.86	− 3.5	− 7.70
4 D	3.90	− 2.5	3.85	− 3.8	3.86	− 3.5	3.90	− 2.5	− 6.75
5 A	4.98	− 0.4	4.89	− 2.2	4.90	− 2.0	4.90	− 2.0	− 5.36
5 D	5.00	0	4.90	− 2.0	4.96	− 0.8	4.97	− 0.6	− 4.25
6 A	6.00	0	5.90	− 1.7	5.91	− 1.5	5.90	− 1.7	− 4.83
6 D	6.00	0	5.97	− 0.5	6.00	0	5.98	− 0.3	− 3.81
9 A	9.08	+ 0.9	9.05	+ 0.6	9.07	+ 0.8	9.08	+ 0.9	− 2.08
9 D	9.05	+ 0.6	9.00	0	9.05	+ 0.6	9.02	+ 0.2	− 1.36
16 A	16.07	+ 0.4	16.02	+ 0.1	16.02	+ 0.1	16.00	0	− 3.12
16 D	16.05	+ 0.3	16.05	+ 0.3	16.03	+ 0.2	16.01	+ 0.1	− 3.33
20 A	20.00	0	19.95	− 0.3	19.92	− 0.4	19.98	− 0.1	− 3.25
20 D	20.00	0	19.95	− 0.3	19.92	− 0.4	19.92	− 0.4	− 3.25
24 A	24.15	+ 0.6	24.00	0	24.00	0	24.03	+ 0.1	− 1.19
24 D	24.15	+ 0.6	24.00	0	24.00	0	24.04	+ 0.2	− 1.25
25 A	25.10	+ 0.4	25.00	0	25.01	+ 0.04	25.05	+ 0.2	− 1.36
25 D	25.10	+ 0.4	25.00	0	25.00	0	25.00	0	− 1.55

Notes:
A − Accelerating
D − Decelerating
Supply 115 Volts, 60 cycles

TABLE 10

Accuracy Test of Underwater Log
Settings for calibration A = .365 B = -.350 C = .405

Manometer	A After recalibrating following shock and vibration		B Under conditions simulating 100 foot submergence		C Following hydrostatic test of 250 Lbs/sq. in.	
Simulated Knots	Indicated Knots	Percent error	Indicated Knots	Percent error	Indicated Knots	Percent error
0	0	0	0	0	0	
1 A	.90	- 10.0	0		0	
1 D	1.15	+ 15.0	0		0	
2 A	2.10	+ 5.0	0		0	
2 D	2.20	+ 10.0	0		0	
3 A	3.20	+ 6.6	0		0	
3 D	3.20	+ 6.6	0		0	
4 A	4.20	+ 5.0	2.30	- 42.5	0	
4 D	4.20	+ 5.0	2.31	- 42.3	0	
5 A	5.15	+ 3.0	3.89	- 22.2	0	
5 D	5.20	+ 4.0	3.89	- 22.2	0	
6 A	6.20	+ 3.3	5.10	- 15.0	0	
6 D	6.10	+ 1.6	5.10	- 15.0	0	
9 A	9.1	+ 1.1	8.56	- 4.9	6.32	- 29.8
9 D	9.1	+ 1.1	8.51	- 5.4	6.36	- 29.3
16 A	15.98	- 0.1	15.72	- 1.8	14.50	- 9.4
16 D	16.00	0	15.70	- 1.9	14.55	- 9.1
20 A	19.90	- 0.5	19.63	- 1.9	18.70	- 6.5
20 D	19.90	- 0.5	19.65	- 1.8	18.75	- 6.3
24 A	23.92	- 0.3	23.71	- 1.2	23.00	- 4.2
24 D	23.95	- 0.2	23.73	- 1.1	23.02	- 4.1
25 A	24.93	- 0.3	24.75	- 1.0	24.10	- 3.6
25 D	24.95	- 0.2	24.75	- 1.0	24.11	- 3.6

Notes:
A - Accelerating
D - Decelerating
Supply 115 Volts, 60 cycles
Values given are indications of Master Transmitter-Indicator

[redacted]

TABLE 11

Temperature Rises of Component Parts
During Endurance Test at 65°C.

Instrument	Name of Part	Part Number from Drwg. CAL-8272	Windings	Maximum temperature rise in °C
Master	Synchronous motor	41	Main	24.3
Transmitter	Type "N" Synchro(modified)	44	S_1-S_2	34.5
Indicator	Type "N" Synchro(modified)	44	R_1-R_2-R_3	31.0
	Actuator Motor	45	Main	23.9
	Type "B" Synchro	48	S_1-S_2	26.5
	Type "B" Synchro	48	R_1-R_2-R_3	38.4
	Transformer	61	Primary	15.0
Master	Type "M" Synchro	51	S_1-S_2	44.5
Mileage	Type "M" Synchro	51	R_1-R_2-R_3	45.2
Transmitter	Power motor	54	Main	50.1
Indicator	Type "B" Synchro	55	S_1-S_2	48.8
	Type "B" Synchro	55	R_1-R_2-R_3	47.8
	Type "N" Synchro(modified)	56	S_1-S_2	48.8
	Type "N" Synchro(modified)	56	R_1-R_2-R_3	46.0
	Transformer	64	1-2	46.0
	Transformer	64	3-4	42.7
	Transformer	64	P_1-P_2	46.8
	Transformer	64	S_1-S_2	48.3
Speed	Type "M" Synchro	67	S_1-S_2	22.7
and	Type "M" Synchro	67	R_1-R_2-R_3	29.0
Distance	Type "N" Synchro	70	S_1-S_2	33.9
Indicator	Type "N" Synchro	70	R_1-R_2-R_3	28.7

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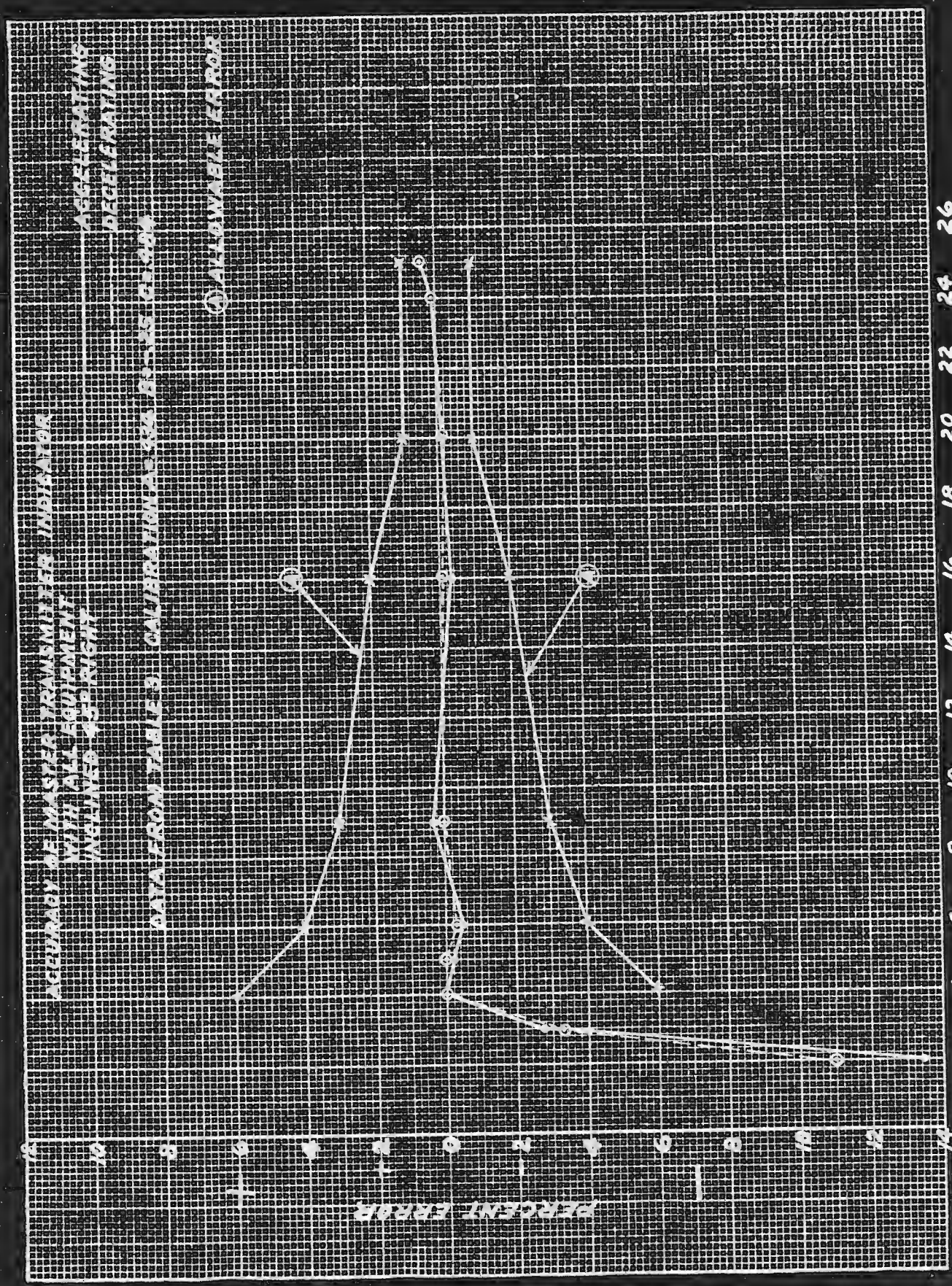

PLATE 3

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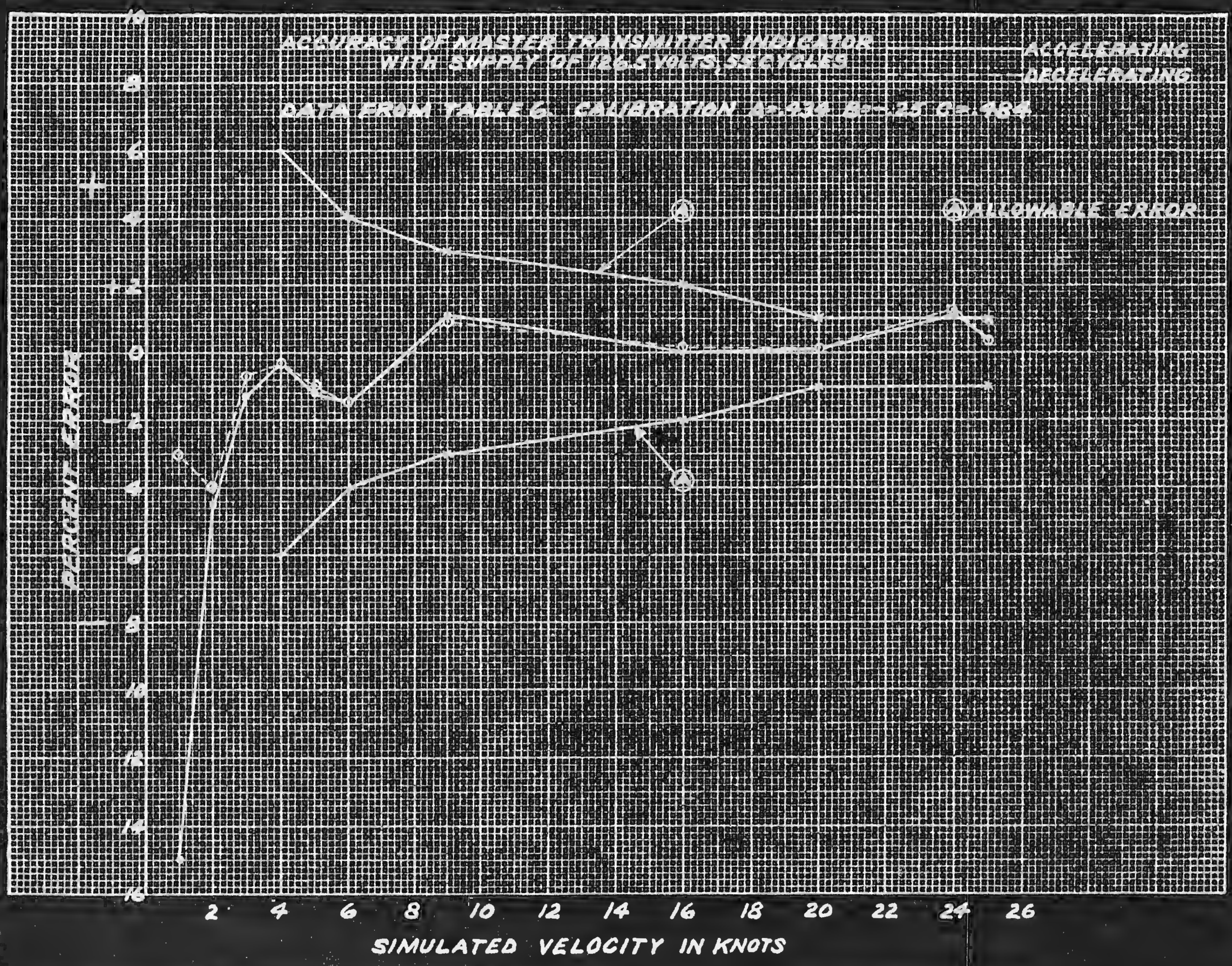

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PLATE 9

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PLATE V

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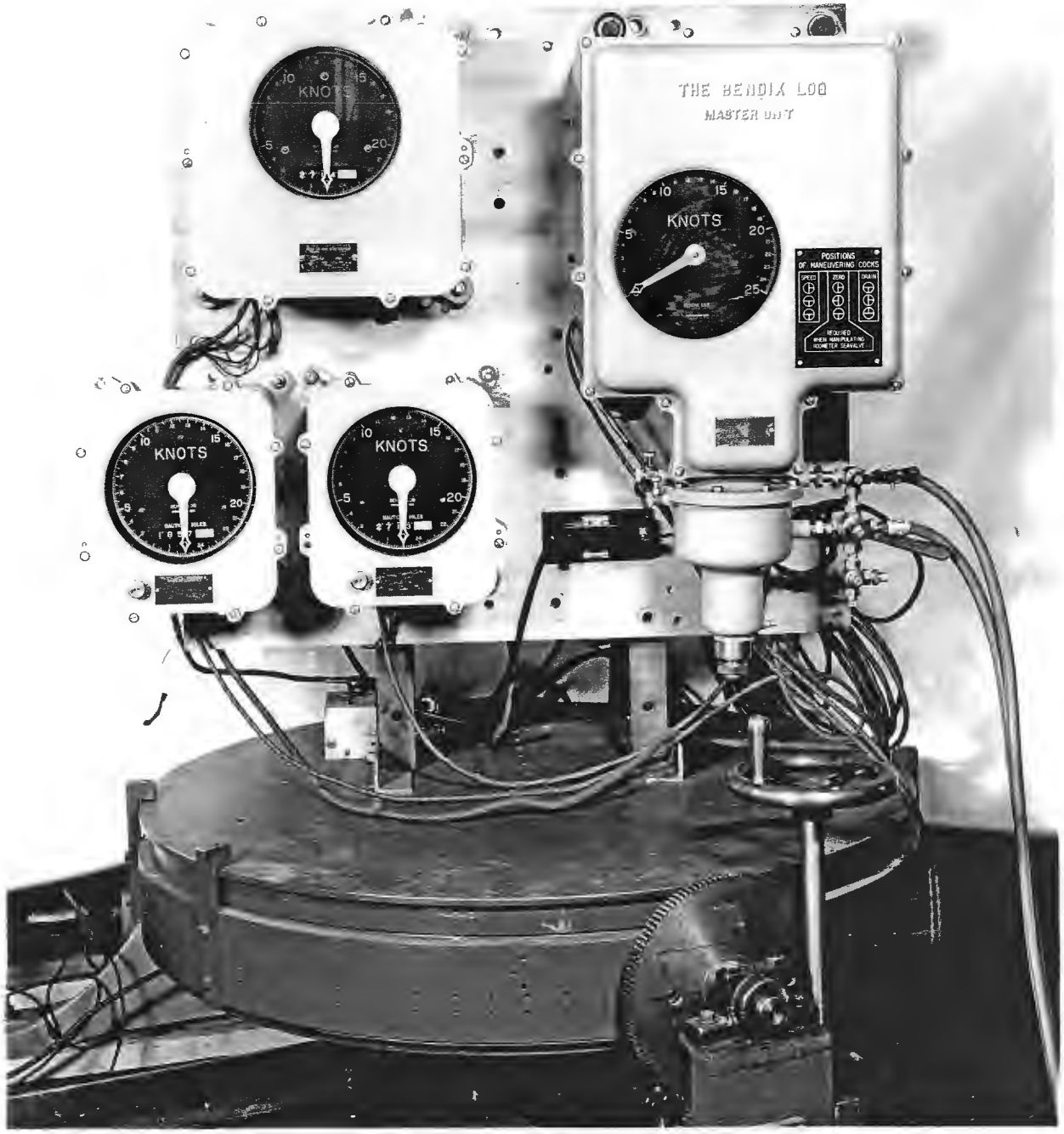
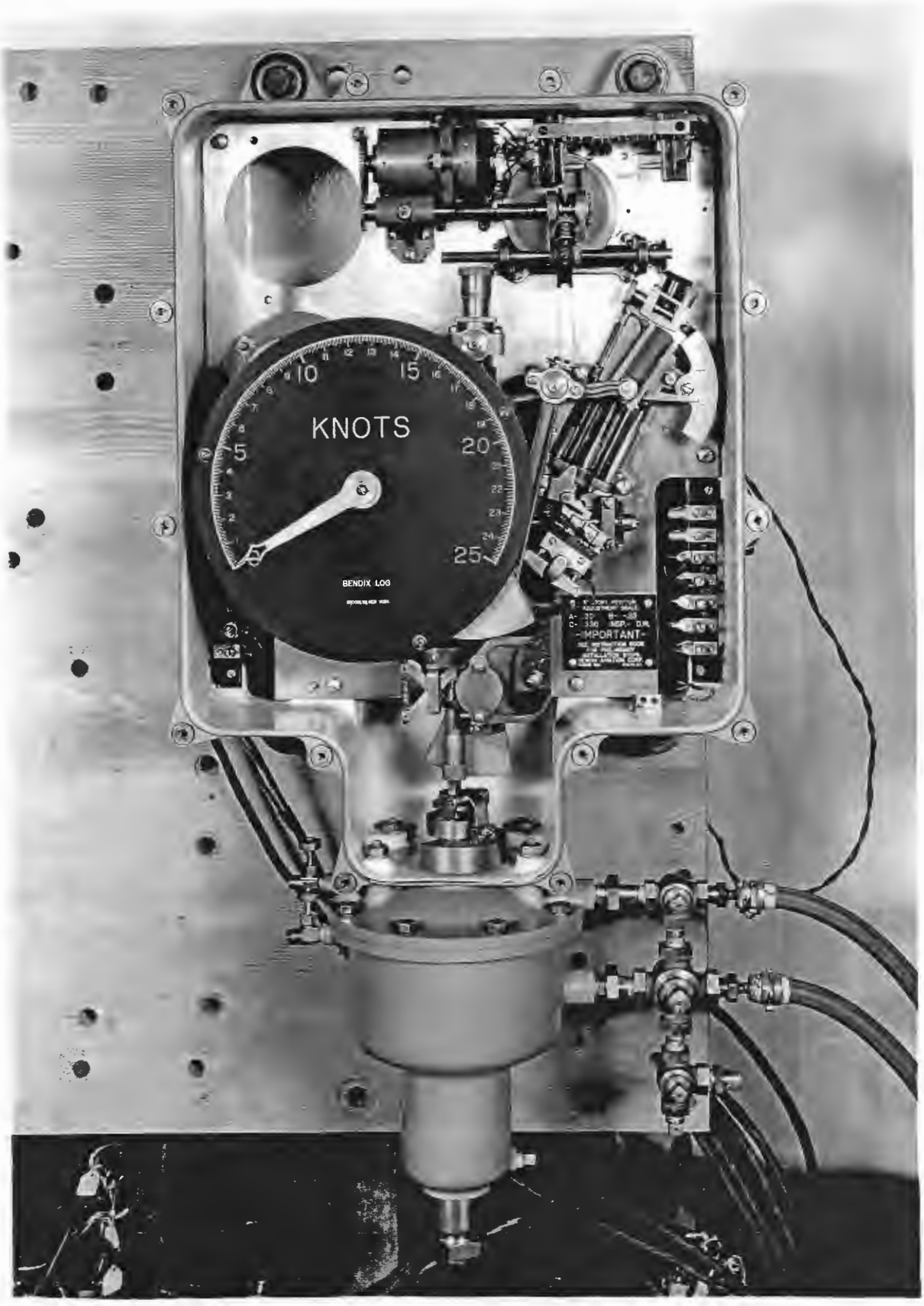
PLATE 12



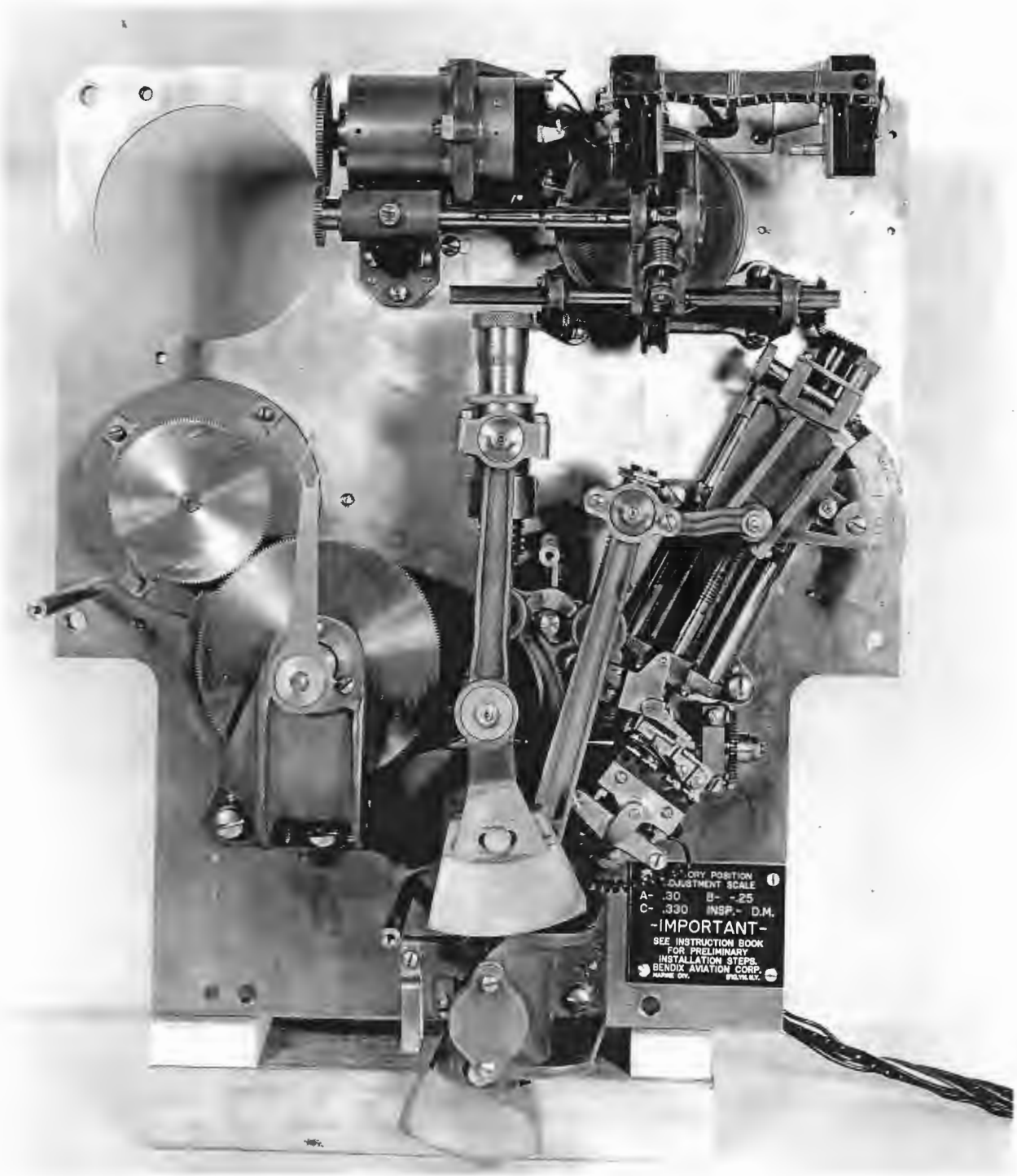
Log system set up for test on tilting machine.

Plate 13.



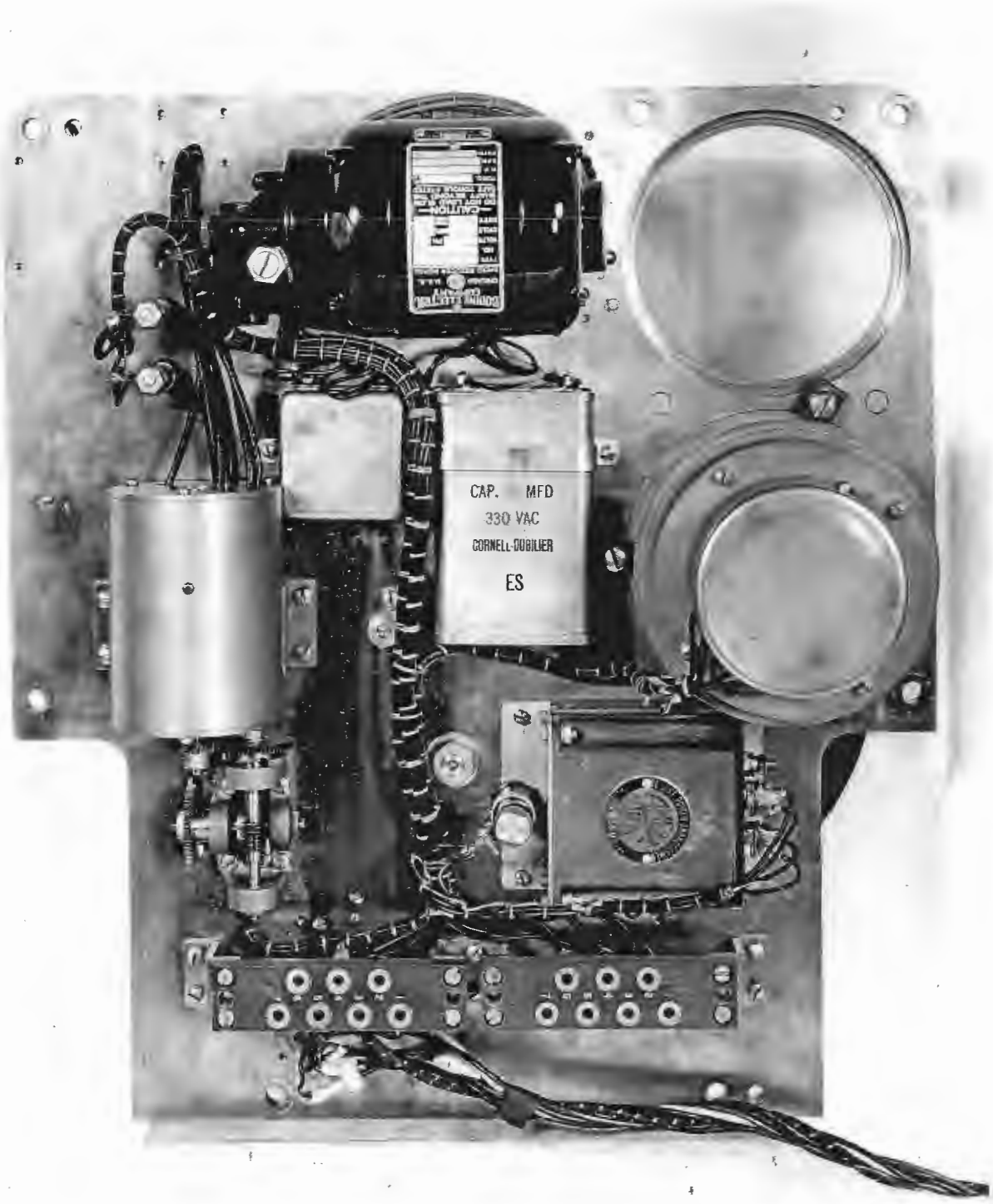
Master Transmitter - Indicator Unit, Case Cover Removed.

Plate 14.



Master Transmitter - Indicator Unit, Dial Removed.

Plate 15.



Master Transmitter - Indicator Unit, Rear View.

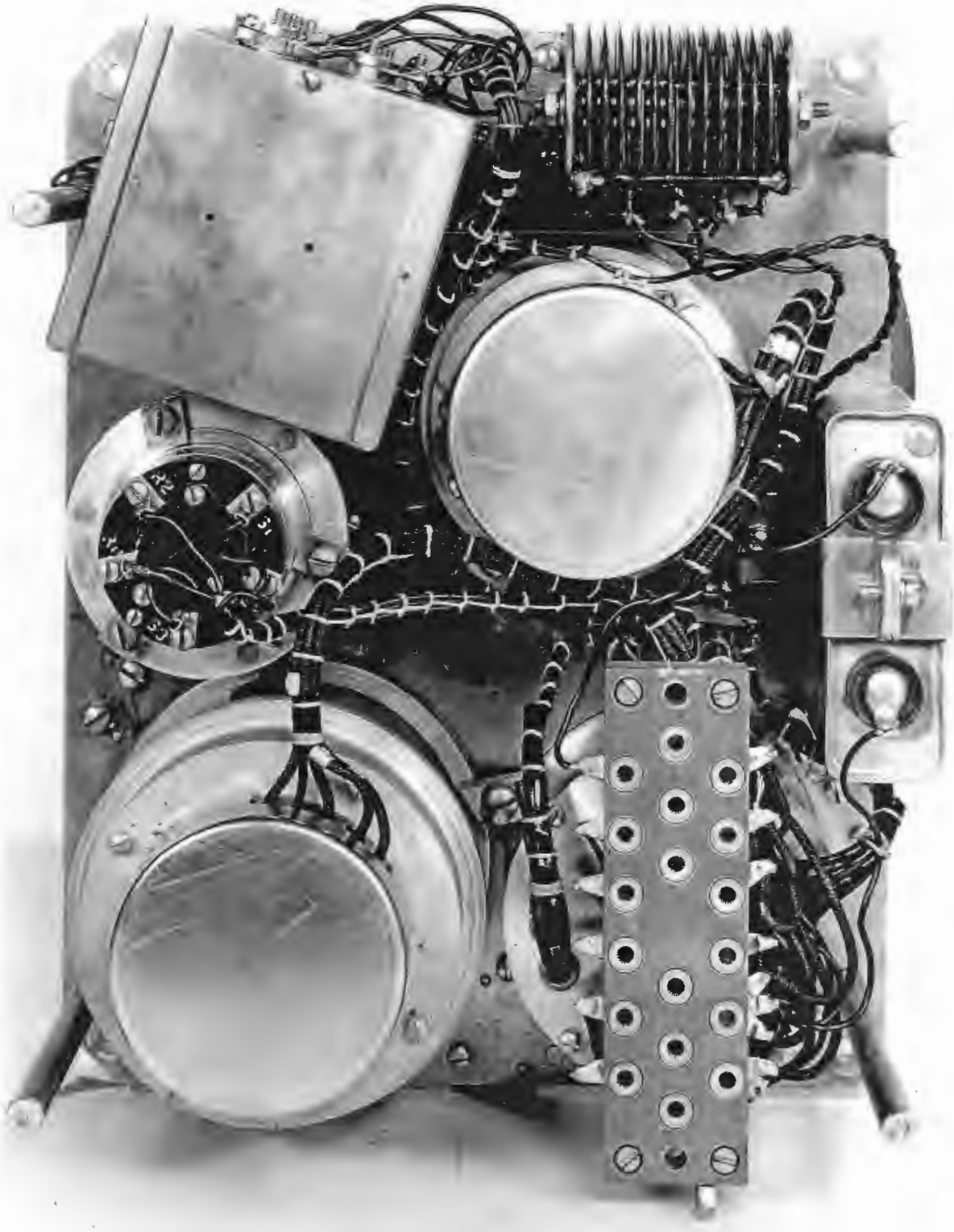
Plate 16.

Master Transmitter - Indicator Case.

Plate 17

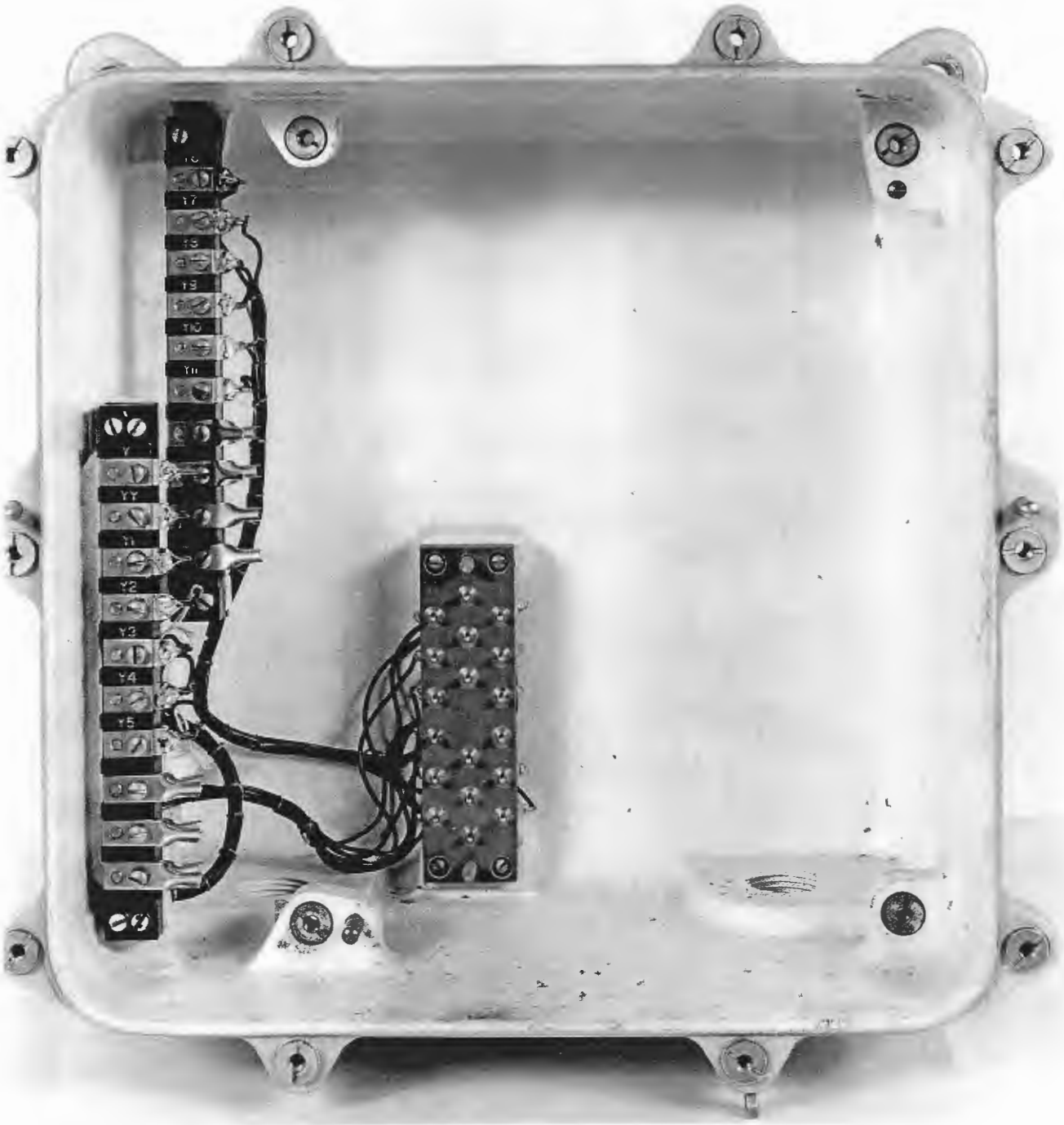
Master Mileage Transmitter - Indicator Unit, Front View.

Plate 18



Master Mileage Transmitter - Indicator Unit, Rear View

Plate 19

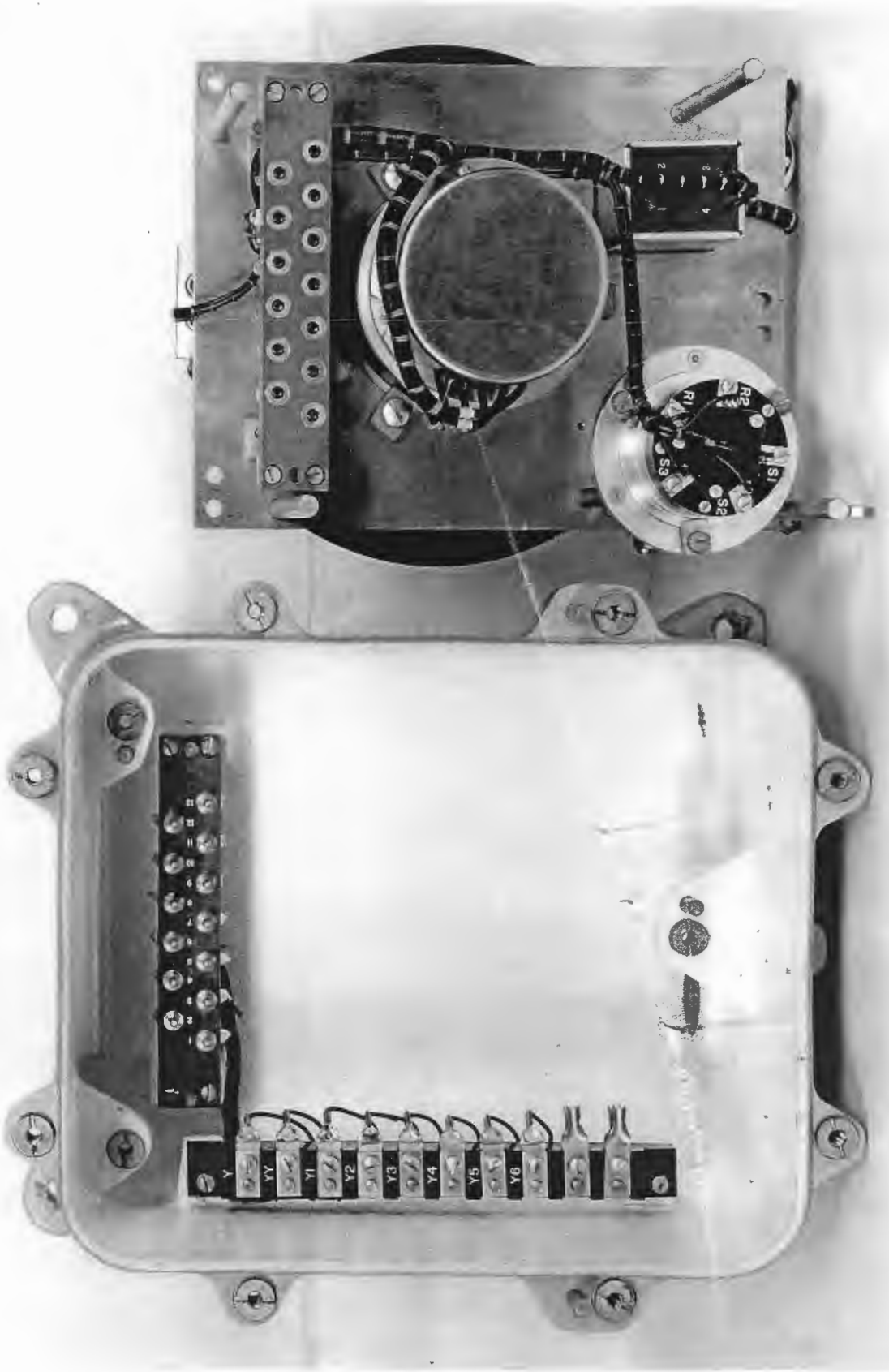


Master Mileage Transmitter - Indicator Case

Plate 20

Speed and Distance Indicator Unit, Front View

Plate 21



Speed and Distance Indicator Unit, Rear View, and case.

Plate 22