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FR-1284

NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report

on

Test of Wind Intensity and Direction Indicating Equipment,

Manufactured and Submitted

by

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Authorization: BuEng. ltr. L5/NP14(9-7-Ds) of 10 October 1935.

Date of Test: November 1935; June and July 1936.

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Table of Contents

Appendix

AUTHORIZATION

1. This test was authorized by reference (a) and another reference pertinent to this problem is listed as reference (b).

Reference: (a) BuEng. ltr. L5/NP14(9-7-Ds) of 10 October 1935.
(b) Specifications SGS(65)-130, Wind Intensity and Direction Indicating Equipment, dated 2 January 1936.

OBJECT OF TEST

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

ABSTRACT OF TEST

3. The subject system, shown by Plates 1 to 8, inclusive, was interconnected electrically and tested for conformance with the specifications, reference (b), except as modified orally by the Bureau relative to endurance and accuracy tests. The wind tunnel tests, outlined in paragraph F-2c of reference (b), were conducted by the Bureau of Standards and the results are given by Plate 9. The inspection of the equipment to ascertain that the material submitted was in strict accordance with the specifications concluded the test.

Conclusions

(a) This system, although not submitted as a finished product, complies with the major requirements of the specifications, namely, endurance, accuracy and ability to withstand shock. The fact that it requires no frequency controlled supply for accurate operation, should prove to be of great advantage.

(b) The results of the wind tunnel tests conducted at the Bureau of standards, (Plate 9), are particularly good especially regarding the sensitivity of the wind direction indicator system. The time required for the pointer to indicate a change of 180° in wind direction was approximately 1 minute 8 seconds or 2.64° per second. The maximum allowable rate is 3° per second.

(c) The transmitter leaked under the splash test, as described in paragraph 28.

(d) The dual indicator case, when tested for watertightness as described in paragraph 27, leaked badly.

Recommendations

(a) Although the transmitter leaked under the splash test, as described in paragraph 28, this test for this particular instrument is a more severe one than normally encountered under service conditions. It is therefore recommended that the Bureau consider waiving this failure. The Bureau's attention is invited to the relative saving in weight of this instrument. This instrument weighs 22.5 lbs. while that tested and reported under NRL-Report No. B-1226 of 16 December 1935, weighs 61 lbs. Since this instrument will be installed in a mast mounting, it will be of advantage, especially so when servicing.

(b) In view of the accuracy, sensitivity and ruggedness of this system, all of which are considered to be of major importance, and of its compliance with the greater part of the specifications, it is recommended that it be approved for Naval use subject to correction of defects noted in this report.

(c) It is further recommended that the equipment furnished on the first contract or order be submitted to this Laboratory for suitability tests.

DESCRIPTION OF MATERIAL UNDER TEST

4. The system submitted, shown by Plates 1 to 8 inclusive, is a combination of a chronometric wind velocity and a self-synchronous wind direction indicator system. It is comprised of a transmitter in a splash-proof case and two (2) master indicators in a dual watertight case.

Transmitter

5. The transmitter incorporates a three-cup Robinson-type anemometer having a speed of 920 r.p.m. for a velocity of 80 knots and a 3-foot wind vane, with their rotatable shafts concentrically mounted and communicating their motion to the inside of a watertight case. The assembly is such that by the loosening of a single screw either the cup shaft assembly or the wind vane shaft assembly may be removed from the case for inspection and service. The motion of the anemometer cup shaft is transferred through a pair of spur gears to a cam shaft whose followers make electrical contacts in such a fashion that the electrical circuit is closed in a definite manner to minimize the possibility of sparking or sending through a double impulse. The weight of the cam shaft is carried on a hardened steel thrust bearing to reduce friction and allow the cups to start at low velocities. The wind vane shaft is geared in a 1:1 ratio to a type "A" self-synchronous generator. This motor and the contacting assembly are mounted on the top cover of the transmitter case. The cover is held by four (4) through bolts and the case is provided with a hand hole and cover, giving free access to the terminal blocks secured to the mechanism. The case is provided with a boss tapped for 1 inch standard terminal tube.

Wind Direction Indicator

6. The wind direction unit includes a type "M" self-synchronous motor which takes its position in accordance with the direction transmitted from the wind direction transmitter. The pointer is positioned by a follow-up mechanism through suitable gears, thus reducing the load on the wind vane and allowing the system to indicate true direction of the wind at low velocities. For type "A" equipment, a self-synchronous generator would be included and positioned by the follow-up mechanism. Further details in the construction of the unit are shown by Plate 4 from which it may be seen that the 6-inch dial has a black background and is graduated in white. The graduations are in steps of 5° and numbered every 10° from zero to 360°.

Wind Velocity Indicator

7. This unit is housed in the same dual case as the wind direction indicator and is comprised of an electric chronometric tachometer. By means of electro-magnets and ratchet wheels, the impulses from the transmitter contacts are counted. A 15 second counting period has been assigned so that the number of contacts per period is equal to the knots of wind velocity. The counting mechanism is duplicated so that while one magnet is counting and causing a ratchet wheel to turn, a second ratchet wheel

is returning to zero position. A third ratchet wheel, integral with the pointer, indicates the highest position counted by either of the counting magnet ratching wheels, and at the end of one counting period is released by the disengagement of a pawl. The pointer is then free to assume a lower position. The proper timing of the counting magnets and the releasing of the pointer and magnet ratchet wheels is accomplished by means of a cam shaft. The cam shaft is driven at a constant speed by a motor wound main spring having a rugged clock escapement to control the speed. The counting magnet control is in the form of a cam operated change-over switch which alternately energizes first one and then the other of the counting magnets. The aluminum alloy case is provided with two (2) hand hole covers for free access to the terminal blocks and two (2) bosses tapped for 1-1/4 inch terminal tubes.

8. For type "A" equipment, the manufacturer proposes to place a chronometric velocity indicator in a single case and position one or more self-synchronous generators through a follow-up mechanism similar to that used in the wind direction indicator. Means are to be provided for dial lighting on instruments where required. Further details in the construction of the unit are shown by Plates 3, 5, 6, 7 and 8. The 6-inch dial shown is graduated in white on a black background from zero to 80 knots in steps of one knot and numbered at every fifth division.

METHOD OF TEST

9. The velocity indicator was first tested for endurance by operating it so that it indicated 50 knots over a period of 500 consecutive hours. As no transmitter unit accompanied the indicator, a contactor which gave long energizing impulses was used. No wind direction indicator was furnished at this time.

10. Following the completion of the endurance test, it was taken to the Bureau of Standards for wind tunnel tests. At this time the manufacturer delivered a transmitter, shown by Plates 1 and 2, and a wind direction indicator, shown by Plates 3 and 4, for use in connection with the test.

11. Next, the entire system was brought to this Laboratory and subjected to shock and additional endurance tests.

12. The shock integrity of the dual indicator was determined by placing it on a standard shock machine in the normal position and subjecting it to 20 blows of 250-foot pounds each while operating in the system at 50 knots.

13. Following the application of shock, the accuracy of the wind velocity indicator was determined by connecting it to a contactor driven at known speeds, which produced impulses equal to several wind velocities.

14. The system was then set up so that the transmitter cup shaft was driven at a speed equivalent to 62 knots, while the wind direction shaft was rotated at 1/3 r.p.m. This test was continued for a period of

100 consecutive hours, the direction of wind vane rotation being reversed every 24 hours.

15. It was next tested for operation at over and under normal voltage and frequency when inclined 45° from the vertical in any plane.

16. The temperature rise of one of the counting magnets was determined by the resistance method after energizing its winding for a period of 8 consecutive hours at an ambient temperature of 40°C. (104°F.).

17. The insulation resistance and dielectric strength of the instruments was next determined, after which the watertight and splash tests were conducted.

18. The inspection of the equipment for conformance with the specifications relative to materials, design and workmanship, concluded the test.

RESULTS OF TEST

Endurance

19. Under this test, described in paragraph 9, the wind velocity indicator operated satisfactorily. The greatest error observed was ± 1 knot, occurring intermittently.

20. Under the additional endurance test, described in paragraph 14, the entire system functioned satisfactorily.

Wind Tunnel Tests

21. The results of this test, conducted by the Bureau of Standards, are given as Plate 9 and this test was considered as replacing the accuracy and damping test outlined under paragraphs F-2d(2)b, (2)c, (2)d and F-2d(4)a, (4)b and (4)c of specifications, reference (b).

Shock Tests

22. The dual wind indicator was subjected to 20 blows of 250-foot pounds each while mounted on a standard shock machine in its normal position and operating in the system at 50 knots. Upon each impact it was noted that the hubs of the pointers struck the glass windows. The pointer of the wind velocity indicator was displaced approximately +5 knots upon each impact, but returned to the true velocity of 50 knots at the next counting period.

Accuracy Following Shock Tests

23. When checked for accuracy with the use of a contactor driven at known speeds, which produced impulses equivalent to 5, 15, 25, 35, 45, 60 and 75 knots, no increase in error of the velocity indicator was observed. The accuracy of the wind direction indicator was unaffected by the shock test.

24. The accuracy of the system was unaffected when the power supply was lowered to 105 volts at 65 cycles or raised to 125 volts at 55 cycles. However, the follow-up motor in the wind direction indicator occasionally failed to position the pointer when the power supply was lowered to 103.5 volts at 65 cycles, as required by the specifications. The wind velocity indicator operated satisfactorily at 92 volts, 65 cycles.

Insulation Resistance and Dielectric Tests

25. The minimum insulation resistance by 1000 volt megger between any electrical terminal and ground was 200 megohms.

26. All parts of the system withstood a potential of 1500 volts, a.c., 60 cycles, applied for one minute between current carrying parts and ground.

Watertight Integrity

27. The dual indicator case leaked badly when submerged in water to a depth of 3 feet for a period of one hour. This was due to the case cover being so constructed that it was impossible to compress the gasket sufficiently.

28. The transmitter case leaked 40 c.c. water when splashed with a 1"0 stream of water, under a head of 35 feet, from a distance of 10 feet, for a period of 5 minutes. This leak occurred when the stream of water struck the spindles and forced some water up under the protective skirts.

Temperature Rise

29. The temperature rise of one counting magnet was found to be 21.9° C. at 40°C. ambient, after having been energized for 8 consecutive hours. The allowable rise for such equipment is 30°C. at ambient of 40°C.

Weights and Dimensions

30. Weights and dimensions of the subject system follow:

Instrument	Weight	Dimensions
Transmitter	22.5 lbs.	Height - 2 ft. 4 in. Vane length - 3 ft. 0 in.
Dual indicator	53.0 lbs.	Height - 20"75 Width - 11"75 Depth - 8"50

Inspection of Material

31. Wind Velocity Indicator. It was noted that the steel cam followers on the operating levers had become loose during the test.

32. The present construction where the front plate, shown on Plate 6, supports and acts as a bearing for the cam and pointer shafts, prevents

observation of the working parts, making repairs very difficult.

33. It is noted that the counting magnet windings are connected in series with fixed resistors which could be eliminated by designing the windings for operation on full line voltage.

34. As this instrument is a bench made model and not a finished product, comments on minor details of construction, such as corrosion protection, method of securing springs, and wiring, are withheld.

35. It is noted that no dial illumination was incorporated in either of the indicators.

36. The intensity of the sound produced by the wind velocity indicator is such that it may prove to be objectionable. Possibly this could be reduced by lining the case with cork, using a suitable adhesive.

37. Transmitter and Wind Direction Indicator. Both of these units appear to be satisfactory in regard to design and construction, except that red fibre has been used in the collector ring assembly in the indicator.

CONCLUSIONS

38. This system, although not submitted as a finished product, complies with the major requirements of the specifications, namely, endurance, accuracy and ability to withstand shock. The fact that it requires no frequency controlled supply for accurate operation, should prove to be of great advantage.

39. The results of the wind tunnel tests conducted at the Bureau of Standards, (Plate 9), are particularly good especially regarding the sensitivity of the wind direction indicator system. The time required for the pointer to indicate a change of 180° in wind direction was approximately 1 minute 8 seconds or 2.64° per second. The maximum allowable rate is 3° per second.

40. The transmitter leaked under the splash test, as described in paragraph 28.

41. The dual indicator case, when tested for watertightness as described in paragraph 27, leaked badly.

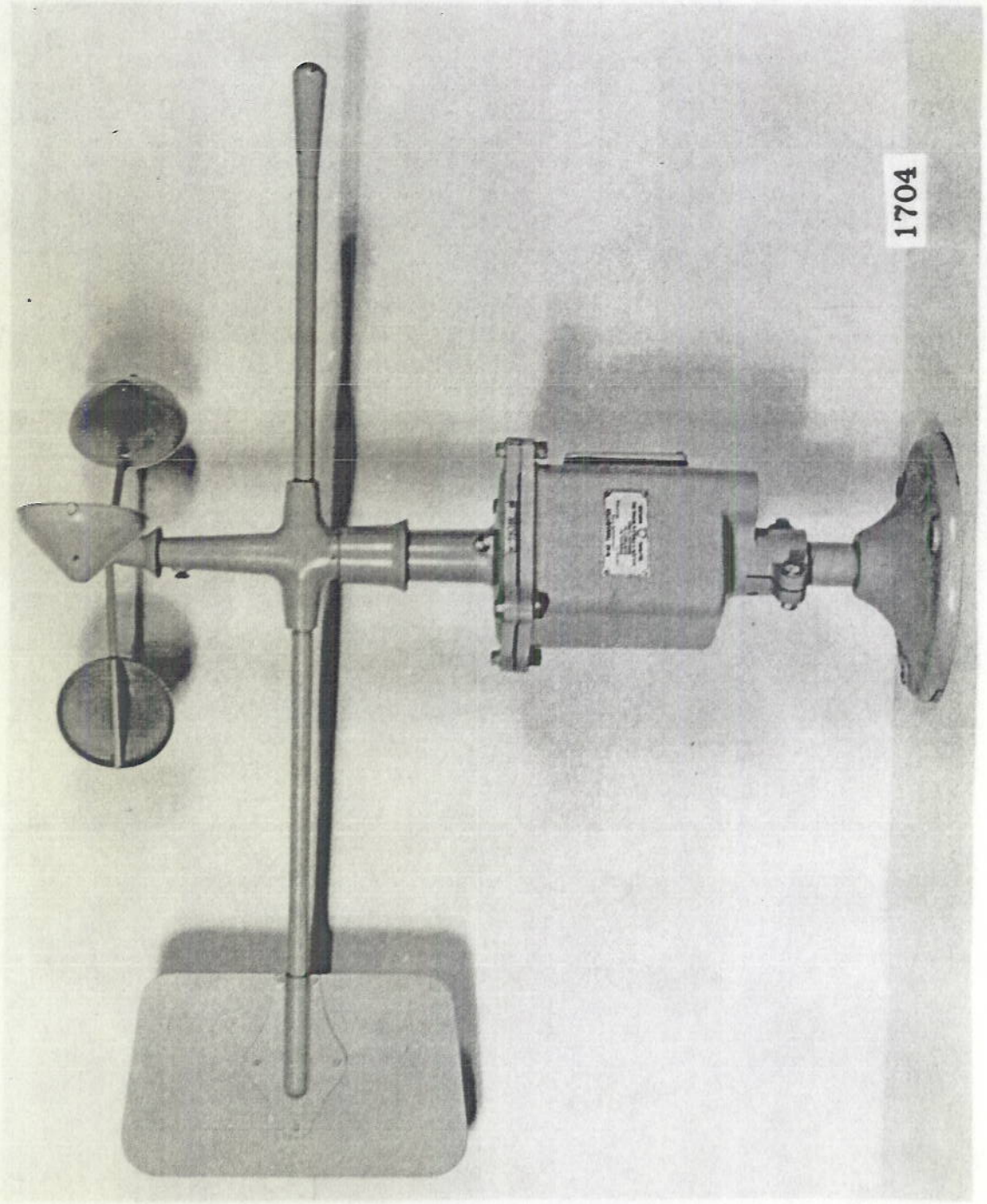

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Plate 1

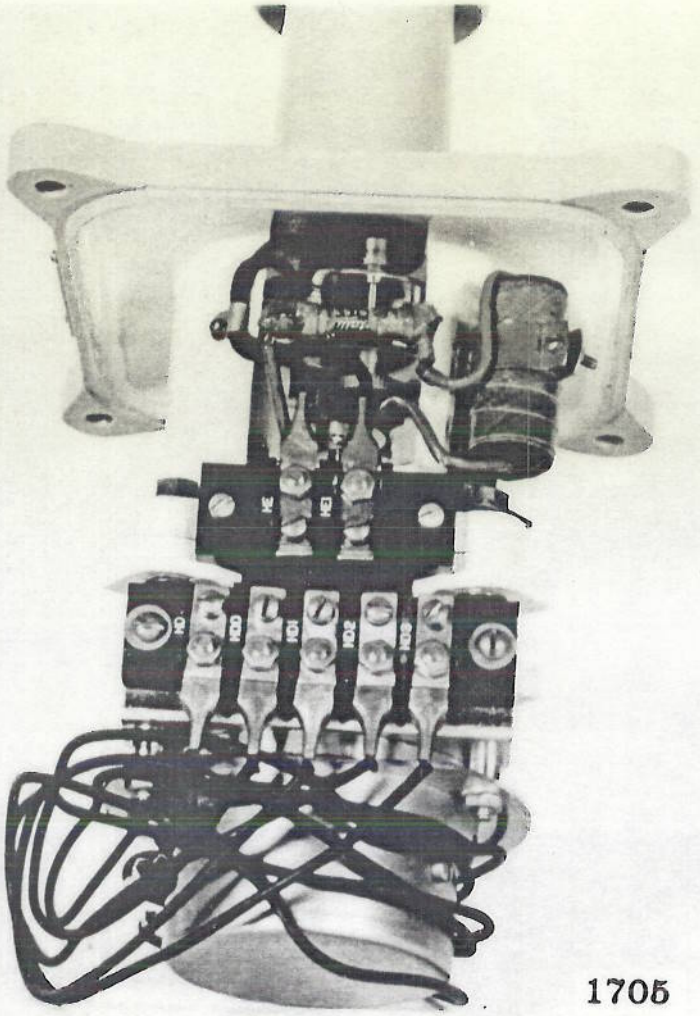

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Plate 2

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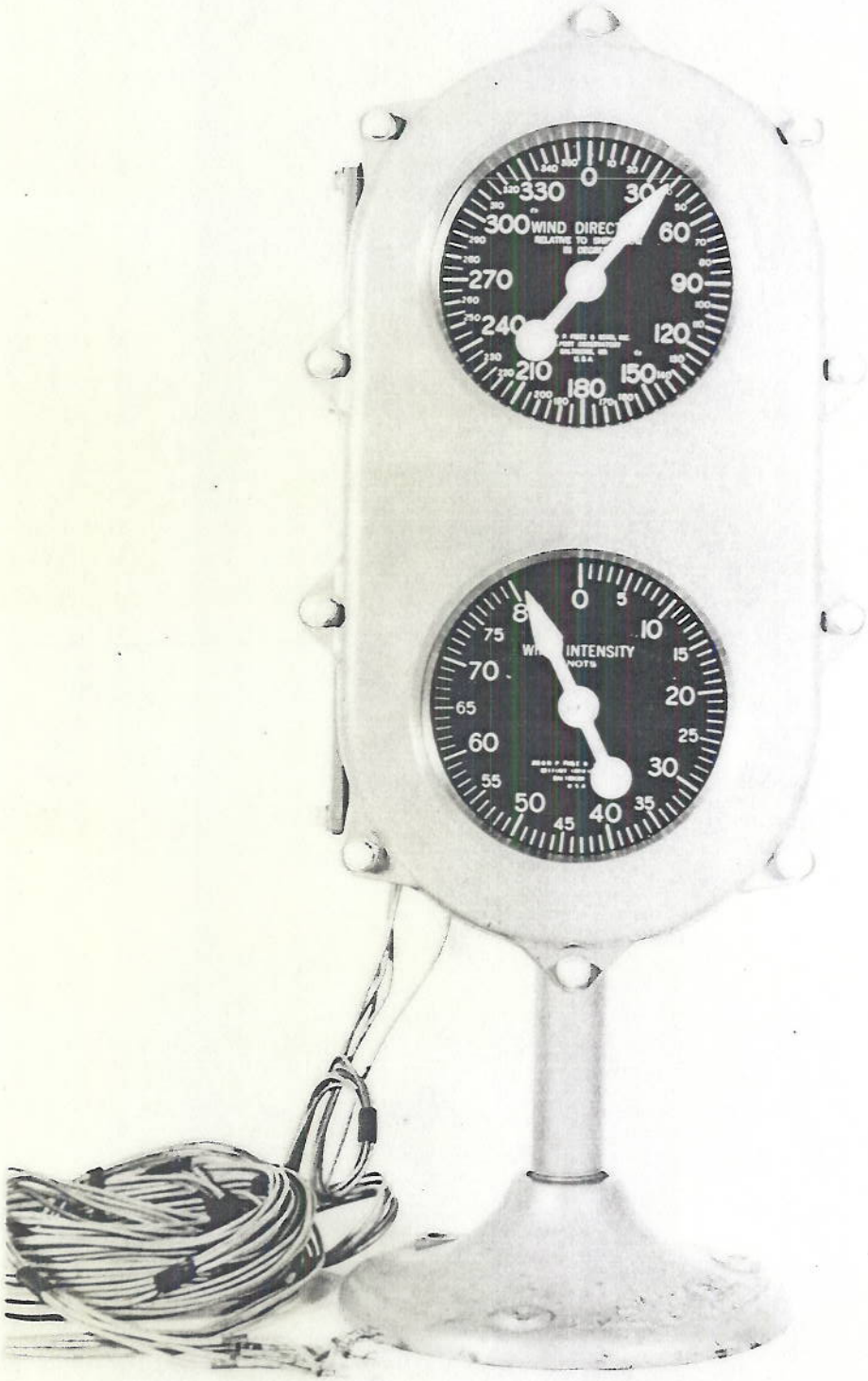

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Plate 3

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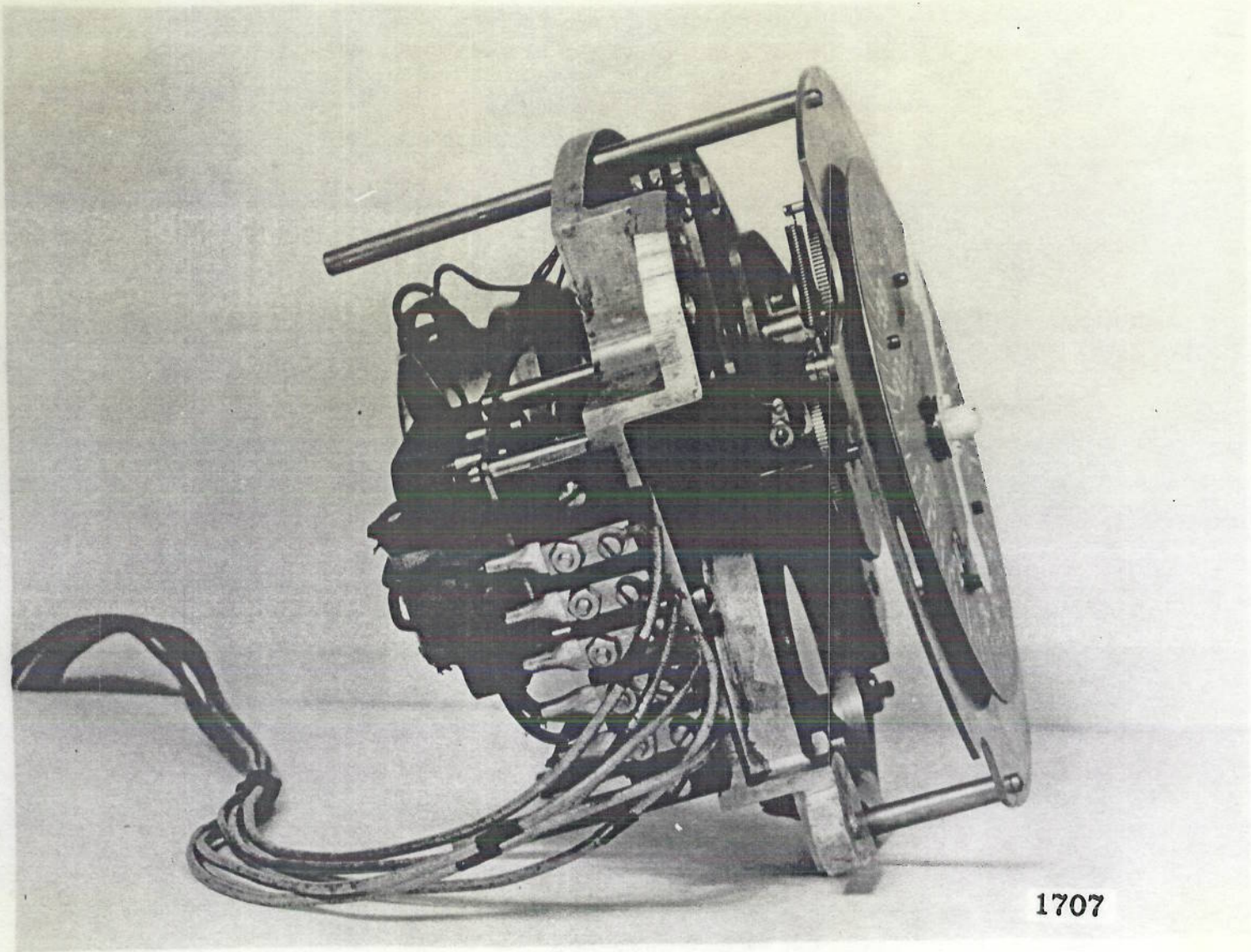

Plate 4

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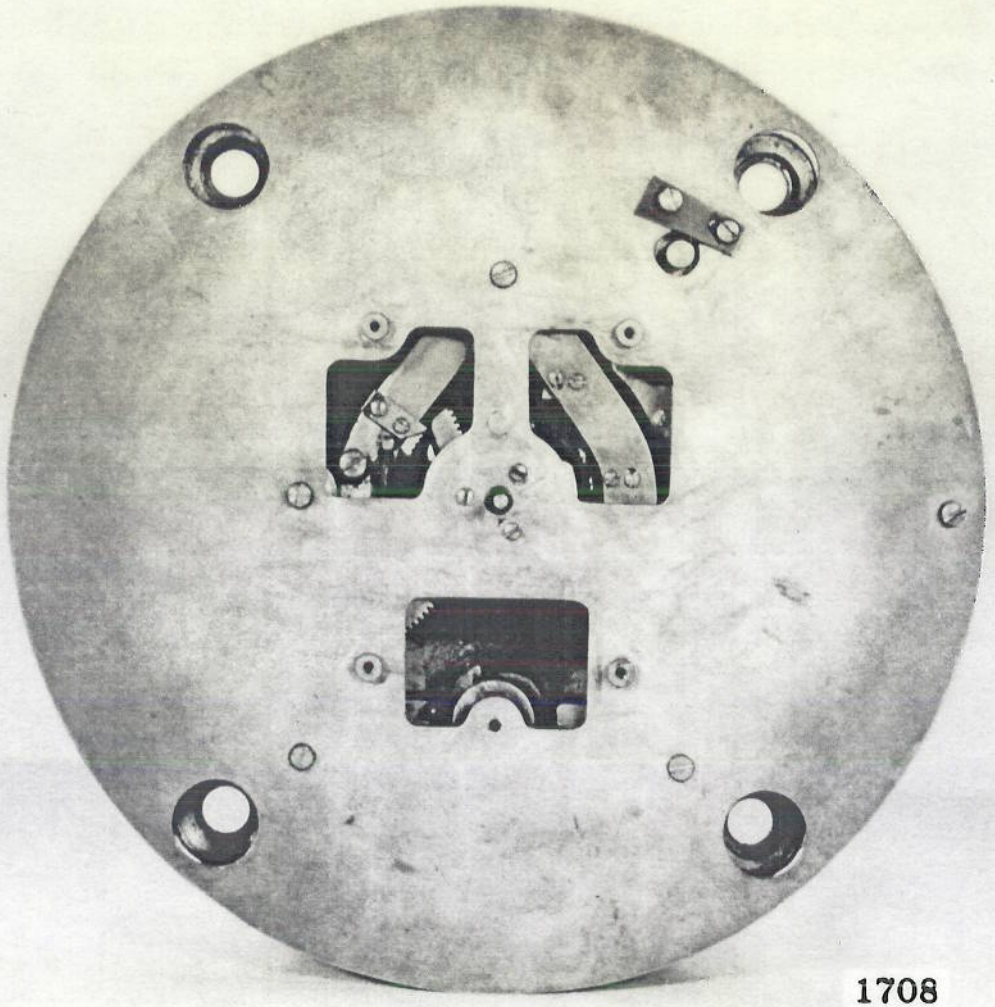

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Plate 5

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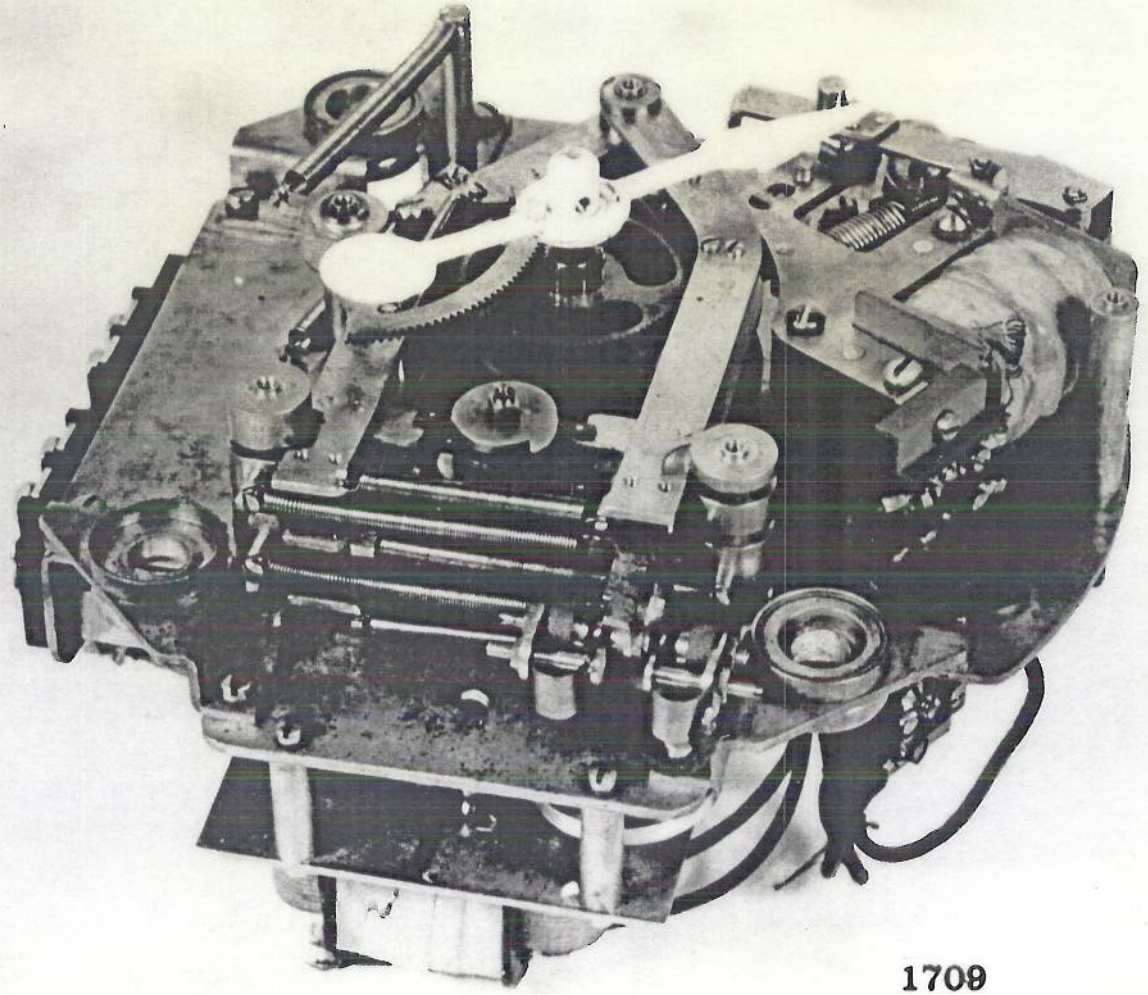

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Plate 6

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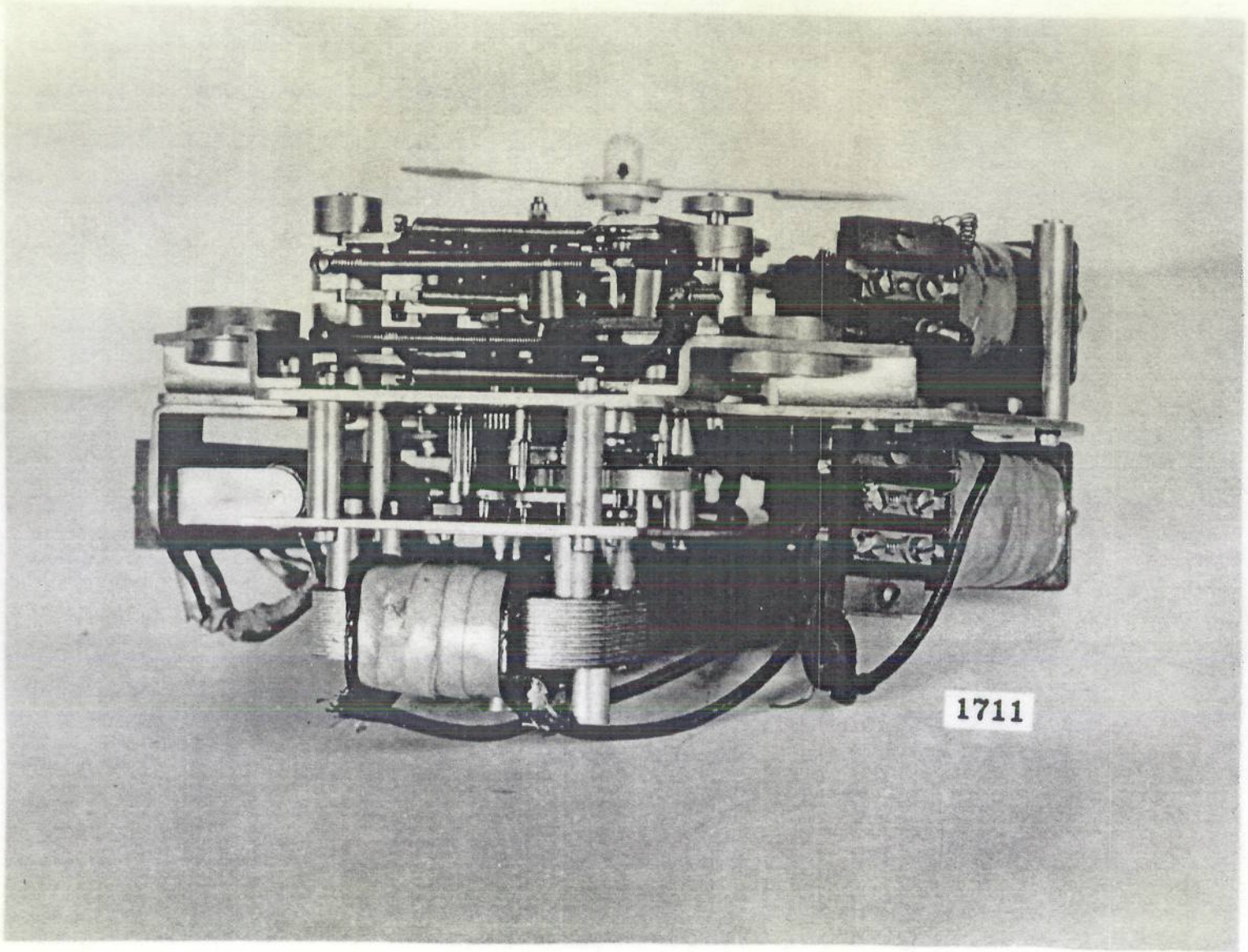
Plate 7



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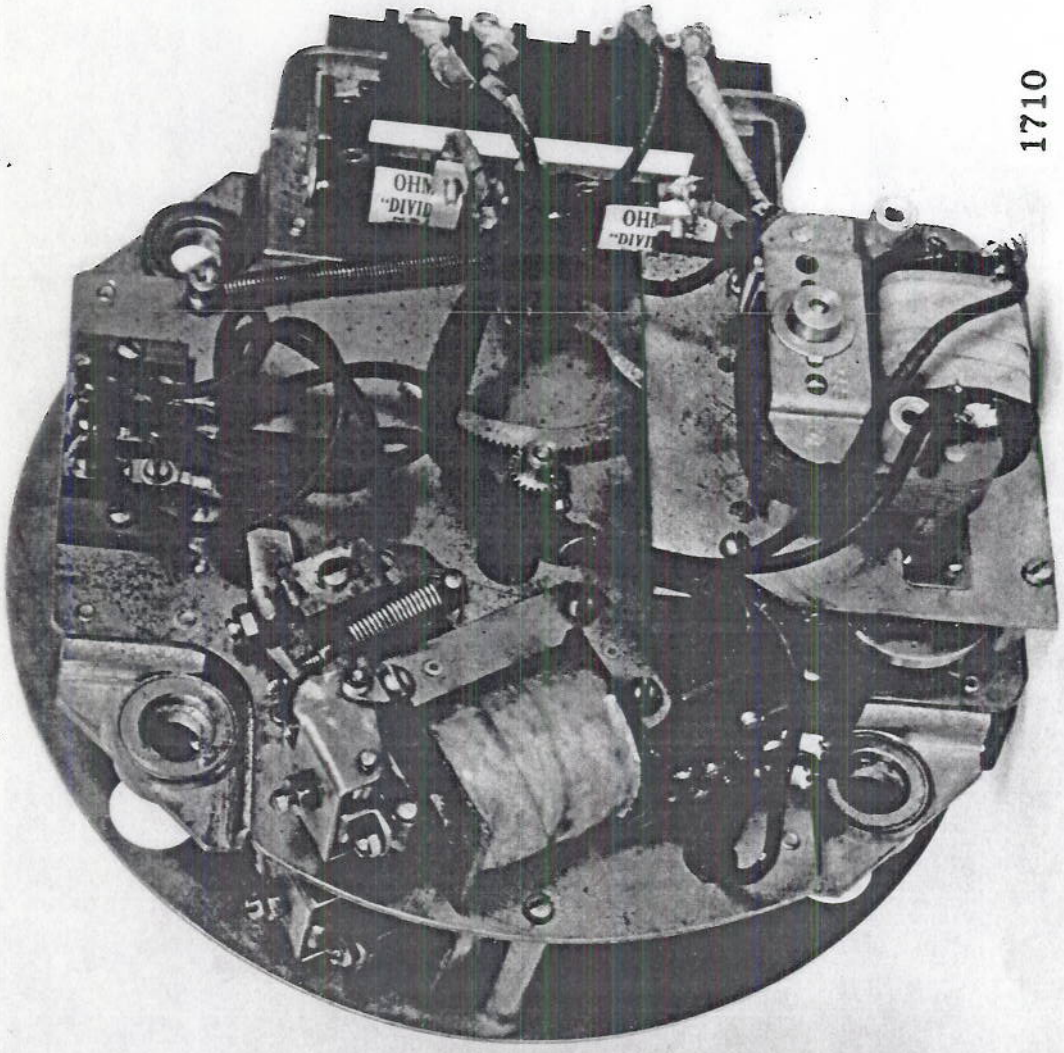

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Plate 8

National Bureau of Standards 4 1/2 Foot Wind Tunnel

June 11, 1936.

Test of Wind Intensity Indicator

Chronometric Type

True Wind Speed Knots	Indicated Wind Speed Knots (average over one minute)	True Wind Speed Knots	Indicated Wind Speed Knots (average over one minute)
0	0 or 1	32.4	32.5
2.2	1.3	37.3	37.5
4.4	4.0	42.7	42.3
7.8	7.0	48.7	49.5
9.5	9.3	50.6	51.8
12.2	12.0	54.0	54.8
14.2	14.2	58.6	60.0
15.5	15.5	63.9	65.5
18.5	18.5	68.6	69.3
24.0	24.0	70.3	72.0
26.5	27.0		

Starting Speed - - - - - - - - - 2.0 knots

Stopping Speed - - - - - - - - - 1.6 knots

Air Temperature	26 to 29°C
Pressure	757 mm Hg
Turbulence	0.7%

Test of Wind Direction Indicator

Displacement of Vane from zero	Failure to return to zero in wind of 5 knots by the following amount
+5°	+2°
-5°	-2°
+15°	+2½°
-15°	-2°

PLATE 9