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NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report of Test on Wind Velocity System manufactured and submitted by the Submarine Signal Company Boston, Massachusetts

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

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Authorization: BuEng let.S65-5/L5(7-16-Ds) of 19 July 1935.

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Distribution: BuEng (5)

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Appendices

AUTHORIZATION FOR TEST

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

Reference: (a) BuEng let.S65-5/L5(7-16-Ds) of 19 July 1935.
(b) Navy Department Specifications SGS(65)10a of 1 March 1935.

OBJECT OF TEST

2. The object of this test was to determine the suitability of the subject system in conformance with specifications, ref.(b), required for "Propeller Shaft Revolution Indicators and Counters", in so far as they were applicable to "Wind Indicators and Wind Direction Systems".

ABSTRACT OF TEST

3. The system as received was set up at this Laboratory and tested for endurance, accuracy, operating characteristics at various voltages and frequencies and for shock integrity.

Conclusions

(a) This system as manufactured and submitted by the Submarine Signal Company, as a "Wind Velocity System" is not considered satisfactory for the Naval service for the following reasons.

(b) The anemometer transmitter generator at present positions only one repeater and, were additional repeaters added as would be necessary for a Naval installation, they might introduce an error in the system due to the additional load placed on the cups.

(c) The system, in its present design, is not sufficiently rugged to withstand the required shock of 250 foot pounds. This is particularly true of the non-watertight cases.

(d) This system does not appear to have any advantages over the roller and disc types, except its ability to function without controlled frequency input. This advantage is largely offset by its size, weight, complexity and probable cost.

(e) The Bureau's attention is invited to NRL Report No. B-1106 of 20 December 1934, in which a frequency controlled generator is reported. The combined weight of this equipment was 165 pounds, while the master supply and regardation units in the subject system total 247 pounds and require more space.

Recommendation

(a) It is recommended that this system in its present design be not approved for use as a Wind Velocity System in the Naval service for reasons given under "Conclusions", and "Comments", paragraphs 28 to 33 inclusive of this report.

DESCRIPTION OF MATERIAL UNDER TEST

4. The system submitted for test consists of one 3 cup anemometer transmitter, one master supply unit, one retardation unit, and one indicator-recorder.

5. The 3 cup anemometer transmitter contains one Selsyn transmitter, one single pole contactor, and one gear assembly, mounted in a splashproof steel case. The cups drive the Selsyn rotor and the contactor through a gear ratio of 1:9.

6. The master supply unit embodies 1 Thyraton, 4 rectifying tubes, and 2 amplifying tubes. The Thyraton has separate full wave grid and plate power supplies. It is protected by a combination thermal overload and thermal time delay relay, so arranged that the filament is heated before the plate circuit is closed. A plate current ammeter, range 0 - 1 ampere, is provided.

7. The grid of the Thyraton is normally held at a potential of approximately -5 volts. A variable resistor is provided so that potentials between 0 and -30 volts may be applied.

8. The master supply unit also contains a voltage amplifying circuit provided with a separate full wave power supply.

9. Terminals are provided on the case for connection to the 115 volt, A.C., 60 cycle supply and the other parts of the system.

10. The retardation unit consists of a series of chokes and condensers of undetermined values, arranged in a circuit similar to a filter circuit. It is provided with two input and two output terminals.

11. The indicator-recorder consists of a Selsyn motor having a pointer and a dial graduated in 100 arbitrary units. The motor also positions a radial pen by means of a gear sector and pinion device. This instrument contains a Telechron powered mechanism for driving the wax covered chart.

12. A brief description of the function of the circuit is as follows:

The anemometer cups rotate a Selsyn generator and contactor, mounted on a single shaft, at a speed nine times that of the cups. The contactor is connected across the input of two type 45 tubes, connected in parallel, changing the grid bias when the contact is made. As these tubes have a full wave plate supply, surges of current flow through the retardation unit connected in the plate circuit.

The retardation circuit supplies the timing element of the system by delaying the output of the paralleled type 45 tubes from reaching the grid of the Thyraton for a constant period. The grid of the Thyraton is normally held at a potential of approximately -5 volts supplied from a separate grid rectifier.

The Thyraton tube has a separate plate and filament supply and its output flows through the fields of the Selsyns. When its grid is made more positive by the potential impressed upon it by the retardation unit, it ionizes and a surge of current passes through the Selsyn motor and generator fields. A 5.0 mfd condenser is connected across the Thyraton plate circuit to enable the grid to regain control.

In operation, the cup transmitting Selsyn and contactor is rotated by the wind and the Selsyn indicator advances in a number of steps until it is in the same relative position to its field as the Selsyn transmitter at the time the impulse passes through both fields. As the speed of the cups is increased, the Selsyn generator rotates through a greater angle in the interval between the making of contact and the surge of current through the Selsyn fields, causing the indicator to advance further in the direction of the Selsyn transmitter rotation. A reduction in cup speed causes the indicator to move in the opposite direction and indicate a lower velocity.

NOTE: The terms "Thyraton" and "Selsyn" have been used because of their familiarity.

METHOD OF TEST

13. The system was first interconnected electrically and supplied with 115 volts, A.C., 60 cycles.

14. It was then operated for 500 continuous hours by removing the anemometer cups and driving the shaft at a speed of 198.3 r.p.m. by means of a constant speed motor and suitable gears.

15. Next, the system was tested for accuracy by driving the anemometer transmitter shaft at various speeds by changing the ratio of the gears between the driving motor and the shaft. During this test the system was operated for periods of two hours at each speed.

16. Following this, the system was tested to determine its operating characteristics while supplied with over and under voltage and frequency. The current consumption at normal ship's voltage and frequency was obtained at this time.

17. The master supply and the indicator-recorder units were then mounted in the normal position on a Bureau of Engineering shock stand and given various shocks, while operating in the system, to determine their ruggedness.

18. At the conclusion of the shock integrity test, each unit was examined for damage.

RESULTS OF TEST

Endurance:

19. During the first 100 hours of the 500 hour endurance run, the dial indication was 53 to 53.5 divisions. The error then increased until the pointer indicated from approximately 54.5 to 56. This defect was corrected by the manufacturer's representative who redressed the anemometer contactor rotor and placed a 0.5 mfd condenser in series with a 618 ohm resistor across the contacts.

20. The endurance test was resumed and the system operated until 500 hours had elapsed since the condenser and resistor were installed. The readings during this part of the test varied from 52.5 to 53.

21. Accuracy Test:

Cup Shaft r.p.m.	Computed Divisions using ratio 198.33 r.p.m. = 52.75 divisions	Indicated Divisions	Error Divisions
45	11.96	10.0	-1.96
75	19.95	18.0	-1.95
112.5	29.92	28.00	-0.92
150.0	39.90	38.25	-1.65
187.5	49.87	49.0	-0.87
225.0	59.87	59.75	-0.12
300.0	79.80	80.0	+0.20
337.5	89.76	90.25	+0.49

Shock Integrity Test:

22. While operating in the system and indicating approximately 92.0 divisions, the indicator-recorder was subjected to shocks ranging from 25 to 100 foot pounds. Five shocks each of 25, 50, and 100 foot pounds were applied with no visible effect other than the loosening of all securing lugs, one of which came off completely.

23. The same test was given the master supply unit except that it also withstood 5 shocks of 150 foot pounds without apparent damage. Immediately following each shock there was a period of approximately 40 seconds in which the system did not operate due to the time delay relay having been forced open by the shock. After having been subjected to 7 shocks of 250 foot pounds, the relay would not remain in a closed position due to the overload device de-energizing the relay coil. As the system was then inoperative, no further tests were conducted.

Under and Over Voltage and Frequency Test:

24. During this test the system was operated at a rate that should have given an indication of 39.90 divisions.

30. When tested for shock, the individual units did not comply with the requirement of being able to withstand 20 blows of 250 foot pounds each.

31. This system was tested as a shaft revolution indicator system by removing the anemometer cups and rotating the cup shaft with a constant speed motor through suitable gears. The results obtained from the accuracy test do not include any errors that might be present in the design of the cups or might arise from their rotating a Selsyn generator which positions all repeaters in the system.

32. The present contact device, located in the anemometer transmitter, is not satisfactory. The rotor segment was badly pitted at the conclusion of the endurance test and it was necessary to machine it before conducting the accuracy test.

33. The present design of the indicator-recorder makes it possible for the indicator to give an incorrect reading due to the Selsyn being unable to travel more than approximately 370°. This is the result of its being linked to the recording pen by a gear sector and pinion which provides a stop to prevent the pen from exceeding the limits of the chart. This condition would occur if the recorder pen were in a position more than 180° from true wind velocity when the system was again energized. The error would also affect any repeaters in the circuit.

CONCLUSIONS

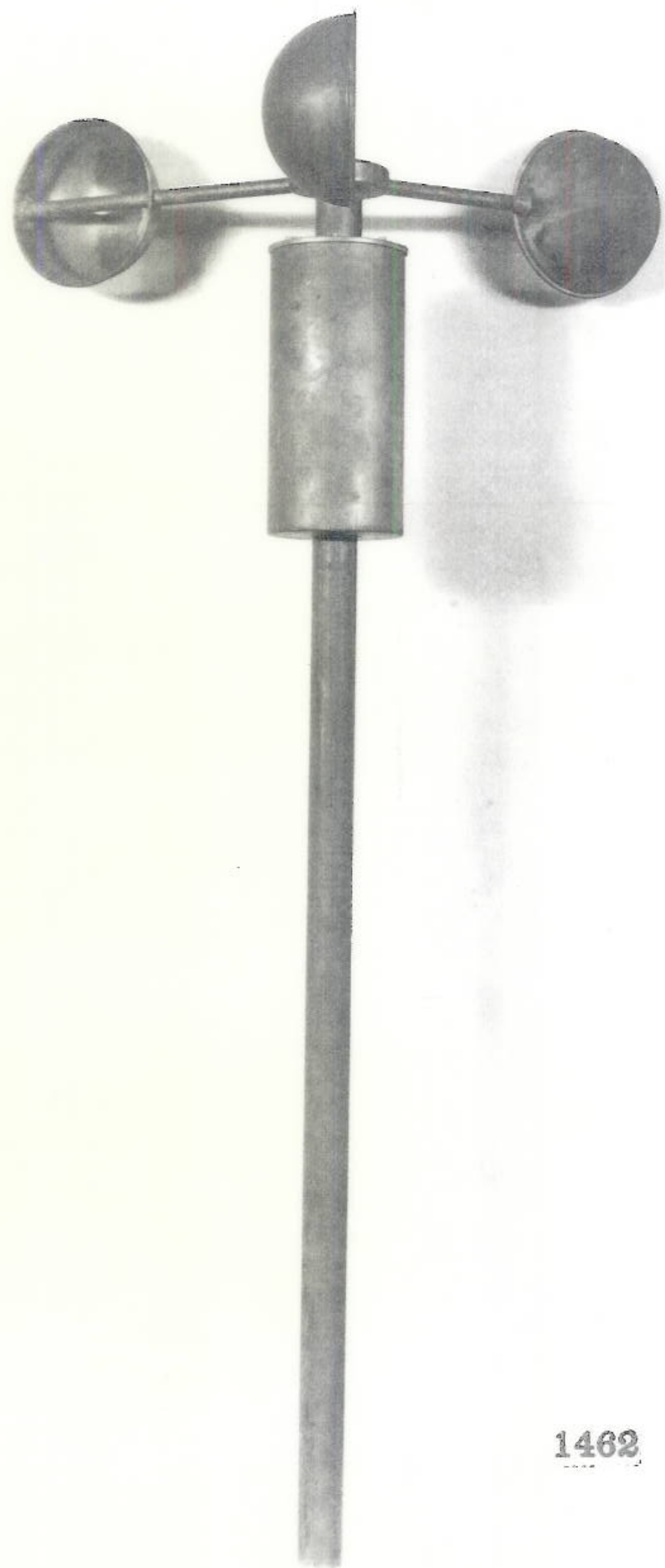
34. This system as manufactured and submitted by the Submarine Signal Company, as a "Wind Velocity System", is not considered satisfactory for the Naval service for the following reasons.

35. The anemometer transmitter generator at present positions only one repeater and, were additional repeaters added as would be necessary for a Naval installation, they might introduce an error in the system due to the additional load placed on the cups.

36. The system, in its present design, is not sufficiently rugged to withstand the required shock of 250 foot pounds. This is particularly true of the non-watertight cases.

37. This system does not appear to have any advantages over the roller and disc types, except its ability to function without controlled frequency input. This advantage is largely offset by its size, weight, complexity, and probable cost.

38. The Bureau's attention is invited to NRL Report No. B-1106 of 20 December 1934, in which a frequency controlled generator is reported. The combined weight of this equipment was 165 pounds, while the master supply and retardation units in the subject system total 247 pounds and require more space.



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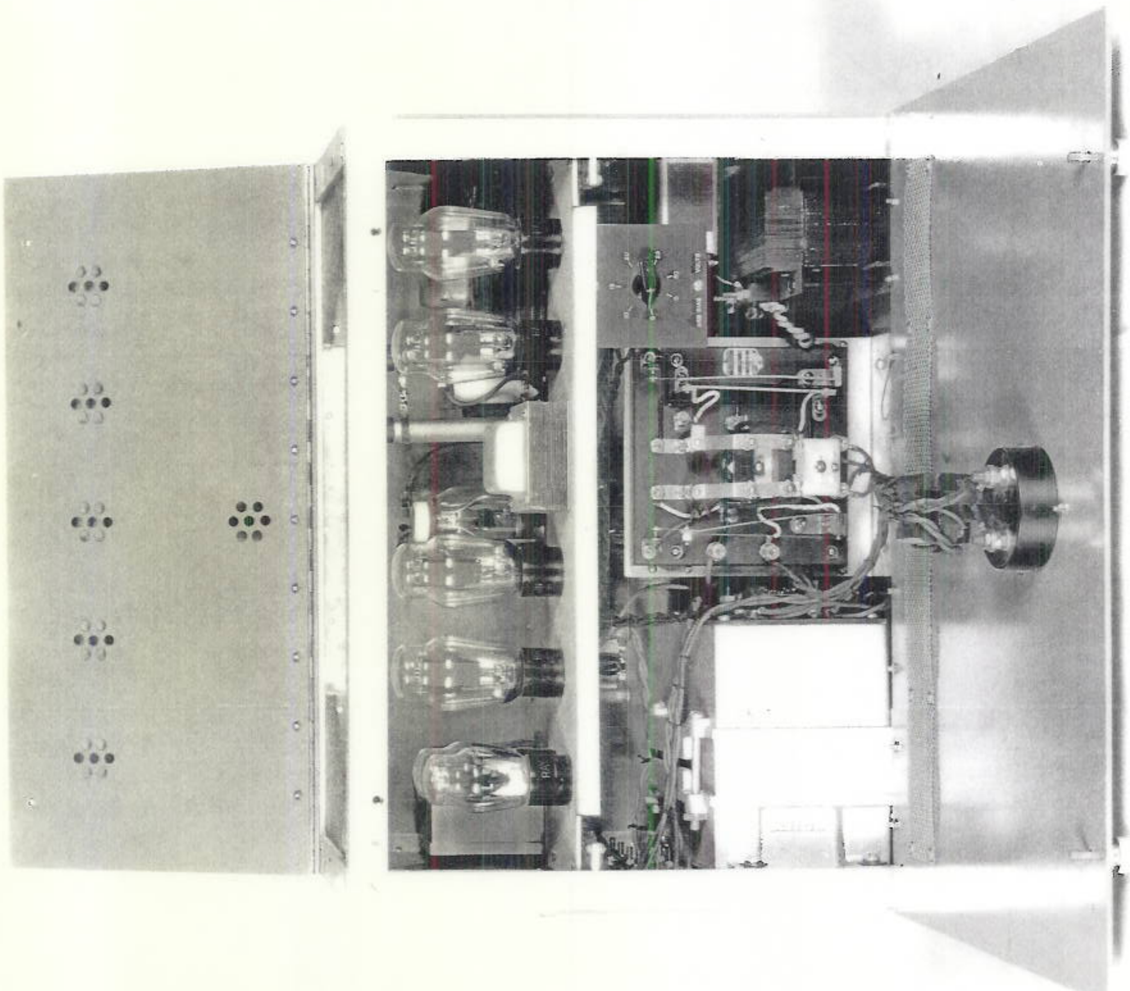

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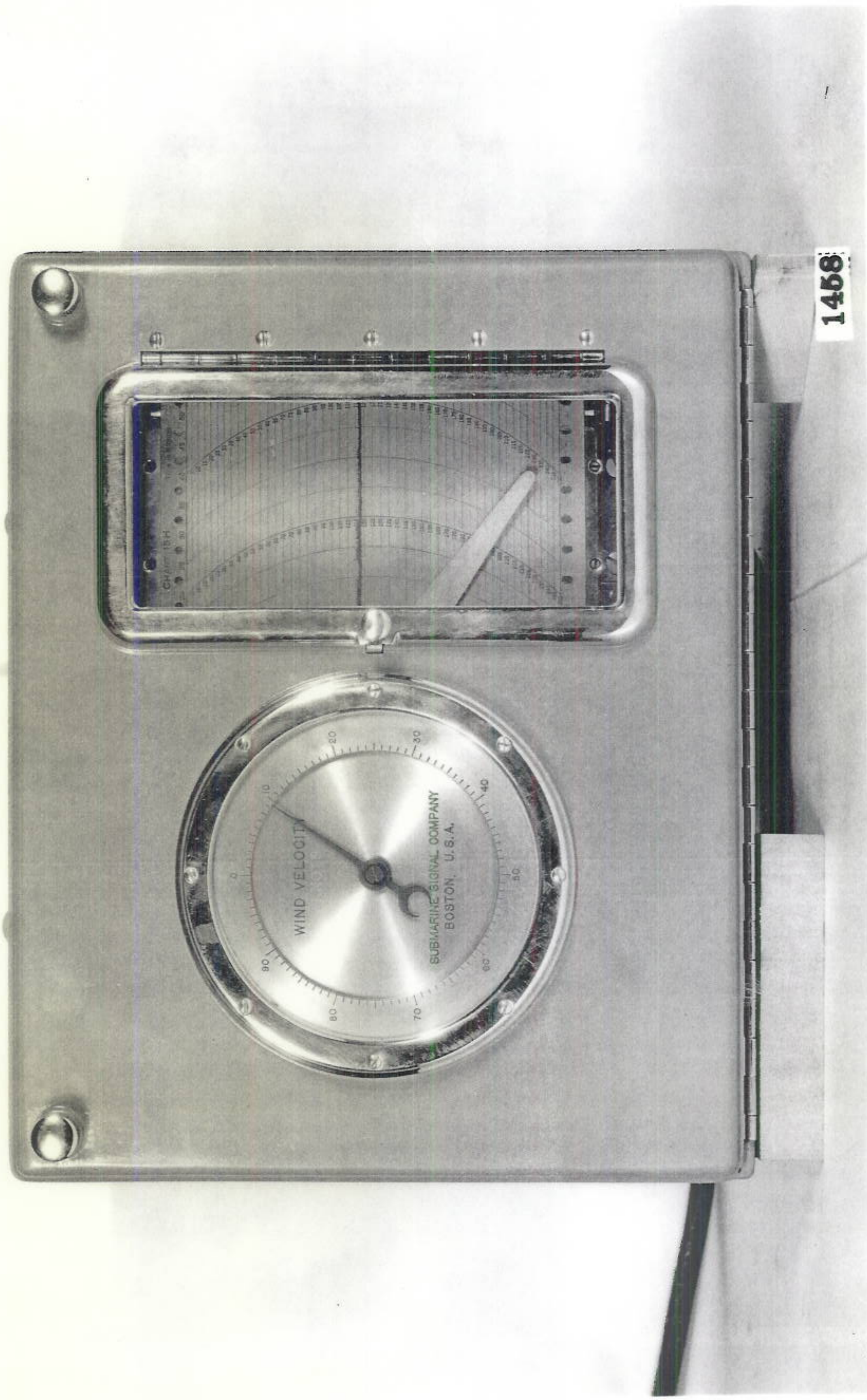

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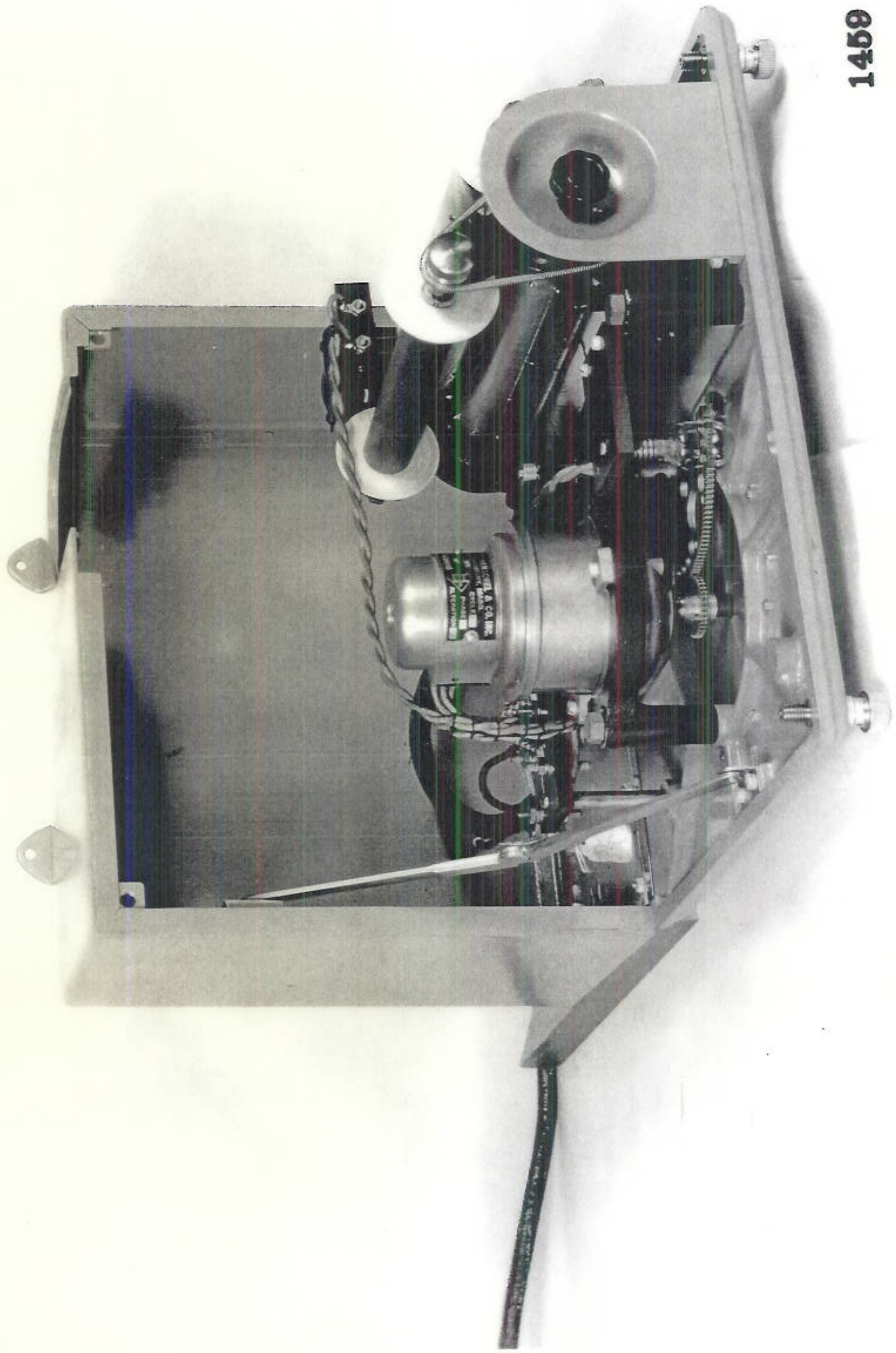

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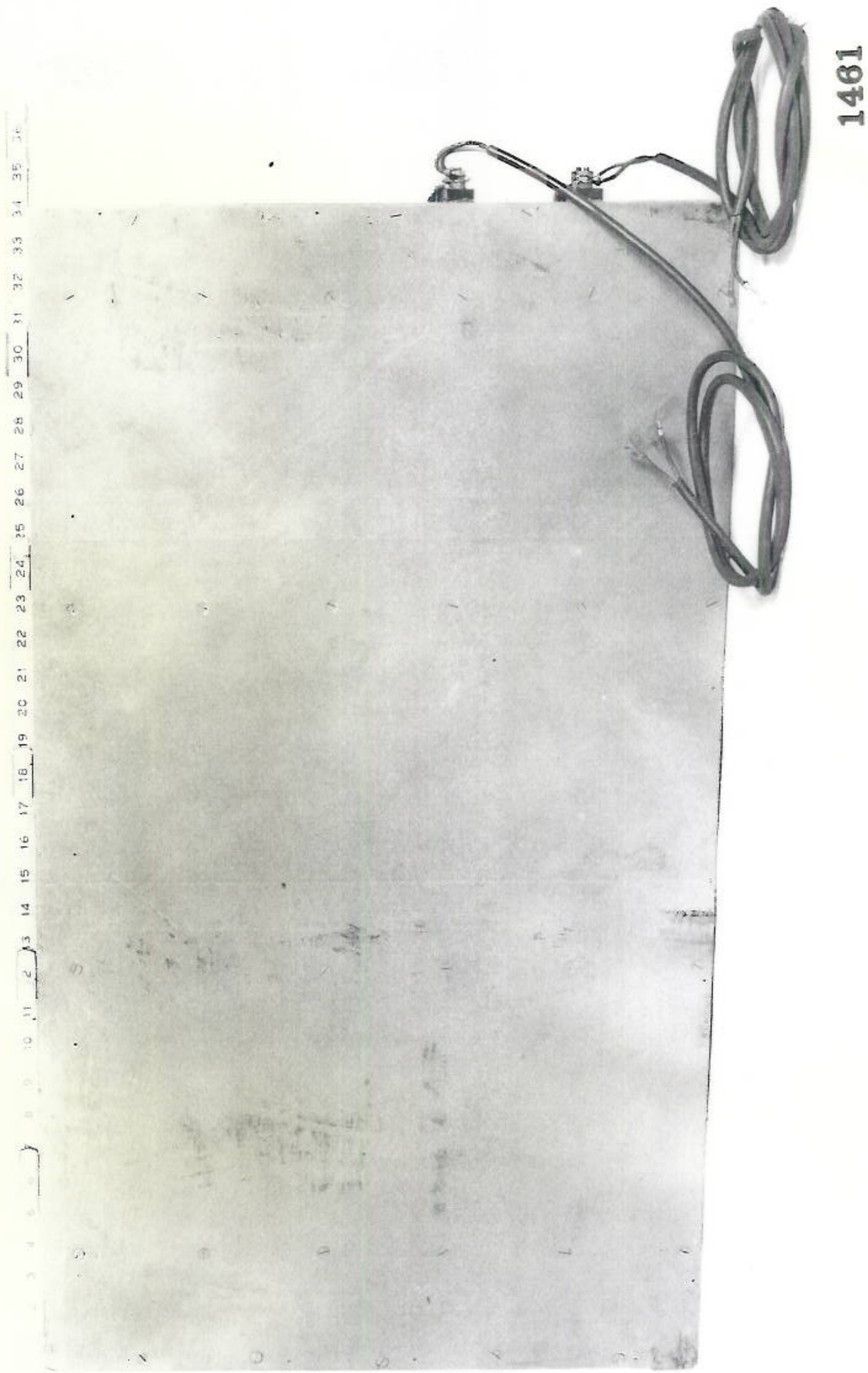

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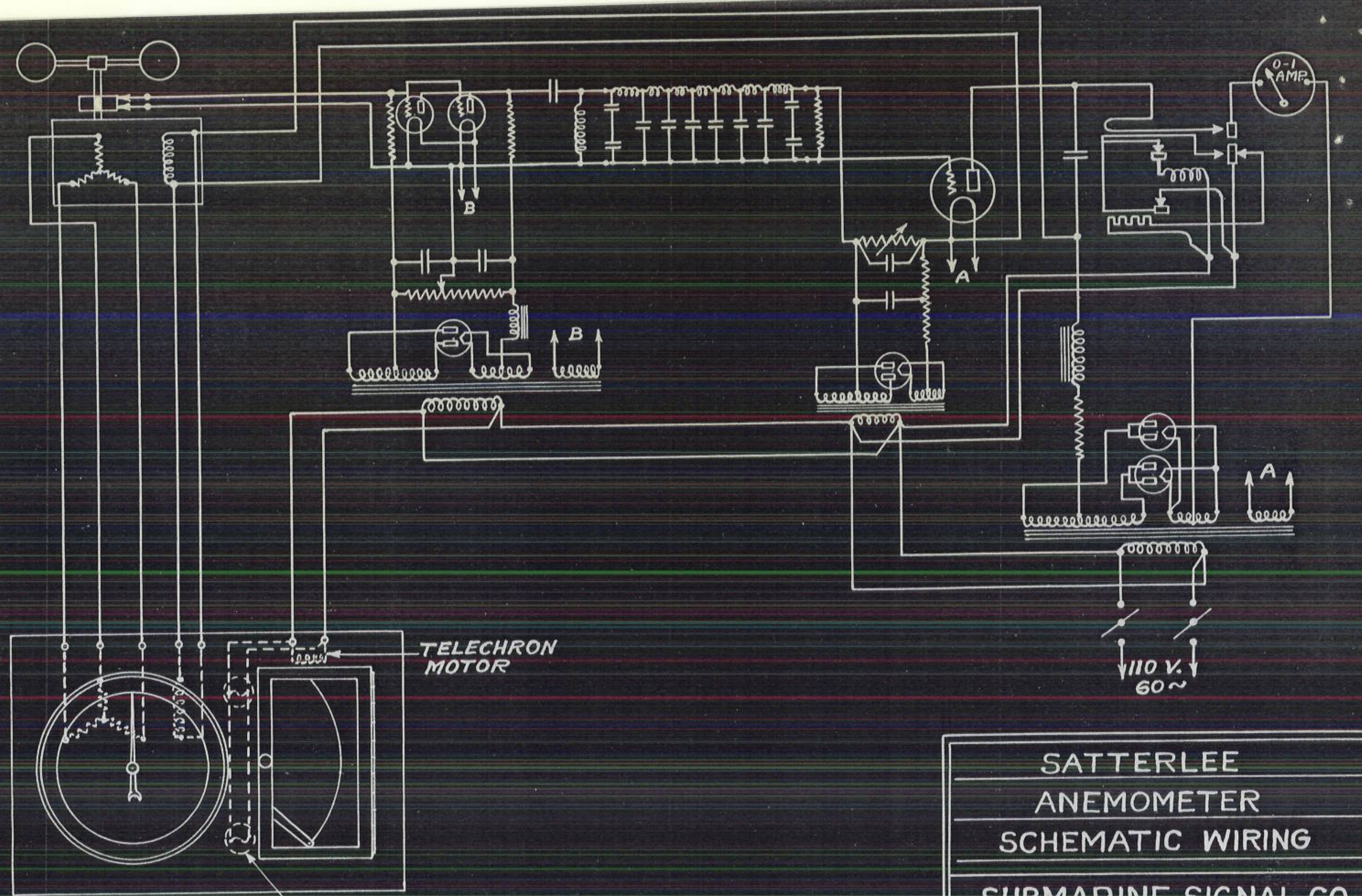

SATTERLEE
ANEMOMETER
SCHEMATIC WIRING

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BOSTON, MASS., U.S.A.

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PLATE 6