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NAVY DEPARTMENT  
BUREAU OF ENGINEERING

Report of Test

on

Wind Intensity and Wind Direction Indicator System

Manufactured and Submitted

by

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## AUTHORIZATION

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

- Reference: (a) Eng.let. S65-5/L5(1-2-Ds) of 4 Jan. 1935.  
(b) Navy Dept. specifications SGS(65)10a of 15 April 1934.  
(c) Eng.Drwg. CV5-S65-1011-Alt. O.  
(d) Eng.Drwg. CV5-S65-1010-Alt. O.  
(e) Eng.Drwg. CV5-S65-1005-Alt. O.  
(f) Eng.Drwg. CV5-S65-1006-Alt. O.

## OBJECT OF TEST

2. The object of this test was to determine how closely the material submitted, complied with the requirements of the specifications for Propeller Shaft Revolution Indicators and Counters, reference (b), and its suitability as a Wind Intensity and Wind Direction Indicator System for the USS YORKTOWN and the USS ENTERPRISE.

## ABSTRACT OF TEST

3. The material submitted, shown by Plates 1, 2 and 4 was set up at this Laboratory and closely observed while under test for conformance with the specifications, reference (b). Particular attention was given the Master Transmitter Unit, while under test for shock integrity, in view of this instrument having failed under previous tests, and having been modified by the manufacturer. The units were carefully examined to ascertain whether they were in strict accordance with the specifications in the matter of materials, design and workmanship.

## CONCLUSIONS

- (a) This material as manufactured and submitted by Julien P. Friez & Sons, Inc., and intended for use as a Wind Intensity and Wind Direction System for the USS YORKTOWN and USS ENTERPRISE was not a complete system. However, in view of the principal units, namely, Master Transmitter, double Indicator and Synchro-Motor of the Masthead Transmitter, being submitted, it was possible to conduct the test for conformance with the major requirements of the specifications, reference (b).
- (b) The test results obtained indicate that the material submitted would be satisfactory for the Naval Service provided it is modified in accordance with "Comments" paragraphs, 32 to 40 inclusive.
- (c) The Bureau's attention is invited to the possibility of the accuracy of the system having been affected due to modifications by the manufacturer since the wind tunnel test was conducted by the Bureau of Standards. These modifications include a reduction in the ratio of gearing between the anemometer cups and the Synchro-Motor Transmitter.

## RECOMMENDATIONS

- (a) It is recommended that this material be approved for the Naval Service, subject to the correction of defects outlined under "Comments" of this report.

## DESCRIPTION OF MATERIAL UNDER TEST

4. The equipment tested was obtained as a preliminary model of the equipment which will be installed on the USS YORKTOWN and USS ENTERPRISE to indicate Wind Intensity and Wind Direction relative to the ship's bow.

5. The units submitted for test were as follows:

- Item 1 - One preliminary model 3 cup Masthead transmitter.
- Item 2 - One preliminary model Master Transmitter unit, less watertight case.
- Item 3 - One Double Indicator, containing two wind intensity dials instead of one wind intensity and one wind direction dial as required.
- Item 4 - One Wind Intensity and Wind Direction Recorder, previously approved for Naval use.

6. The principal unit of this system is the Master Transmitter. Its purpose is to convert the rotary motion of the anemometer, transmitted by a self-synchronous generator to a self-synchronous motor, into a position proportional to the rate of the rotary motion and to transmit this position to the Wind Intensity Indicators at various stations on the ship. The following parts are incorporated in its construction:

- 1 - Type M Synchro-Motor (Arma Engineering).
- 1 - Type B Synchro-Generator (Arma Engineering).
- 2 - Constant speed motors (Telechron 4 r.p.m.).
- 1 - Shaded-Pole Induction Motor (Barber-Colman).
- 1 - Shaded-Pole Induction Motor, reversible type (Barber-Colman).
- 2 - Micro-Switches, normally closed (Burgess Laboratories).
- 1 - Roller and disc positioning device, including rotating single pole double throw switch and oscillating mechanism.

7. The operation of the Master Transmitter is as follows:

At a wind velocity of 80 knots, the 3 cup anemometer revolves at 920 r.p.m. This speed is reduced to 92 r.p.m. by means of a 1:10 worm and worm wheel in the masthead unit. Hence, the synchro-motor in the master transmitter revolves at 92 r.p.m., at a wind intensity of 80 knots. This speed is further reduced by gears of ratios 108:26 and 1:24, giving a speed of 15.92 r.p.m. at the rotary switch.

8. The bakelite yoke carrying 2 poles of the rotary switch is frictionally mounted to a shaft. The roller carriage moves longitudinally on this shaft and transmits the rotational motion of the roller to it. The roller rides between 2 hardened steel discs, driven at 4 rpm by Telechron motors. The discs are held against the roller by adjustable thrust springs located in the bearing housings.

9. The position of the roller carriage is varied by a Barber-Colman Shaded-Pole reversible motor, which positions the carriage by means of a rack and pinion, through suitable reduction gears. This rack also positions the Synchro-Generator, type B, in such a manner that it rotates a 45 tooth 64 pitch pinion on the generator shaft,  $330^{\circ}$  for 80 knots. At this velocity, the roller (1.017 dia.) has taken a position 2.024 from the center of the discs, a movement of 0.0253 per knot.

10. For protection of the roller carriage against jamming when the wind velocity exceeds 80 knots, a micro-switch is provided. Operation of this switch prevents further movement of the carriage toward the roller shaft bearing housing. A micro-switch is also provided to prevent excessive movement of the carriage in the opposite direction.

11. To reduce hunting of the positioning device to a minimum, the rotary switch is equipped with an oscillating device driven by a Barber-Colman induction motor through a suitable reduction gear. This device causes the center pole of the rotary switch to make contact first to one pole and then the other. The contacts of the rotary switch are protected against excessive arcing by two 0.5 MFD condensers, each in series with a 25 ohm resistor.

12. The Telechron 4 r.p.m. motors must be energized from a constant frequency supply of 60 cycle, 115 volts, such as a ship's clock circuit.

13. Terminal blocks are provided for connecting in the system. The entire mechanism is mounted on a cast aluminum alloy base provided with 6 holes for mounting in a watertight case. A photograph of the preliminary unit tested is given as plate 2. The unit is covered by Drawing, reference (d).

14. The Wind Intensity and Wind Direction Indicator consists of a watertight cast aluminum alloy case containing 2 type M synchro-motors with 2 radium painted dials, and 2 pointers activated by 12 Navy type VG2-A lamps. The wind intensity dial is calibrated from 0 to 80 knots, in increments of 1 knot over an angle of  $330^{\circ}$ . The wind direction dial, when furnished, will be graduated over an angle of  $360^{\circ}$  in increments of  $5^{\circ}$ . A photograph, furnished by the manufacturer, shows a completed bulkhead type indicator and is given as plate 4. The unit is covered by Drawing, reference (e). A similar unit for pedestal mounting is shown on photograph, plate 5, and covered by Drawing, reference (f).

15. The Wind Intensity and Wind Direction Recorder is enclosed in a watertight cast aluminum alloy case, designed for horizontal mounting. It is operated by a spring type, manually wound motor which drives the chart at the rate of 3 inches per hour. It contains 2 type M synchro-motors for positioning the 2 syphon pens. No tests were requested on this unit as it had been previously approved. However, the instrument

was used for checking the accuracy of the system while under test. A photograph furnished by the manufacturer is given as plate 6.

16. The preliminary Masthead Transmitter submitted for test consisted of a 3 cup anemometer coupled to a type M Synchro-motor through a worm and a worm wheel of 1:10 ratio. A complete Masthead Transmitter is shown on manufacturer's photograph, plate 7, and covered by drawing, reference (c).

#### METHOD OF TEST

17. The units furnished were first interconnected electrically and then operated for the required 500 hour period in order to test them for endurance. During all of the tests it was necessary to remove the Synchro-motor from the Masthead Transmitter Unit and drive it by means of a constant-speed motor through suitable ratios of gears. During the 500 hour test the Synchro-motor was driven at a speed equivalent to 65.21 knots.

18. At the conclusion of the endurance test, the system was operated for accuracy by rotating the Synchro-motor transmitter of the Masthead Transmitter at speeds corresponding to wind velocities of 65.21, 54.34, 43.47, 32.60, 21.73 and 13.04 knots for a period of 3 hours at each speed. During these tests, the indicated knots were carefully observed and the amount of "hunting" was recorded by the recording instrument furnished.

19. Next, the Master Transmitter Unit and the double Wind Intensity and Wind Direction Indicator were placed on a Bureau of Engineering shock machine and given 20-250 foot pound blows while mounted in the vertical plane, with the force of the blows tending to move the instruments from the bulkhead. An additional 20-250 foot pound blows was applied with the instruments mounted vertically but 90° from the bulkhead. The force of these blows tended to move the instruments edgewise.

20. Following the shock integrity tests, the accuracy test, as given in paragraph 18, was repeated.

21. An additional accuracy test was conducted with the Master Transmitter Unit and the double Wind Intensity and Wind Direction Indicator operating at a speed equivalent to 65.21 knots at an ambient temperature of 135°F.

22. The insulation resistance of the several units was determined before and after the dielectric test had been applied.

23. During the endurance test, the temperature rises of the Barber-Colman Shaded-Pole Induction Motors were obtained.

24. The efficiency of the dial illumination on the double Indicator, plate 4, was observed in a dark room.

25. Finally, the double Indicator was submerged in a salt water tank, to a depth of 3 feet for a period of 1 hour, to ascertain its watertight integrity.

RESULTS OF TEST

26. <u>Specifications</u>	<u>Requirements</u>	<u>Test Values</u>
Endurance	The complete system shall be operated for 500 hours continuously at approx. full speed.	*See comments, par. 27. Satisfactory operation for 500 continuous hours, at a speed equivalent to 65.21 knots, with exception of occasional surges.
Accuracy of system after completion of 500 hour endurance test.	Error shall not be greater than 1 knot $\pm$ , when tested as a Propeller Shaft Indicator System.	Approx. error of 1/2 knot $\pm$ at speeds equivalent to the following intensities for periods of 3 hours each. 13.04 knots 21.74 " 32.61 " 43.48 " 54.34 " 65.21 "
Shock test.	20-250 ft.lb. blows while under operation and mounted in the normal position.	Both Master Transmitter and double Indicator were satisfactory under shock, surging only at instant that shock was applied.
Accuracy test after shock.	Error shall not be greater than 1 knot, $\pm$ , when tested as a Propeller Shaft Revolution Indicator System.	Approx. error of 1/2 knot $\pm$ at speeds equivalent to the following intensities. 13.04 knots 21.74 " 32.61 " 43.48 " 54.34 " 65.21 "
Temperature compensation.	Error shall not be greater than 1 knot $\pm$ when tested at an ambient temperature of 135°F as a Propeller Shaft Revolution Indicator System.	No apparent change in accuracy when operated at a speed equivalent to 65.21 knots for a period of 24 hrs. with Master Transmitter and double Indicator located in a compartment, at ambient temperature of 135°F.

<u>Specifications</u>	<u>Requirements</u>	<u>Test Values</u>
Dielectric	1500 V. A.C., 60 cycle, applied between each terminal and ground for a period of one minute without breakdown.	*See comments, par. 32. All units withstood the test with exception of Barber-Colman motor which drives the oscillating contact device in the Master Transmitter.
Insulation resistance after dielectric test.	Shall not be less than 10 megohms when measured by 500 V. megger.	Minimum of 15 megohms on all units with exception of Barber-Colman motor.
Watertight integrity.	Shall not leak when submerged in a salt water tank to a depth of 3 ft. for a period of 1 hour.	*See comments, par. 33. Double Indicator unit, plate 4, leaked 60 cc of water.
Dial Illumination.	Shall be legible from a distance of 6 ft. in the dark.	*See comments, par. 34. Legible from a distance of 4 feet.
Temperature rise.	Shall not exceed 30°C at ambient of 40°C.	Maximum rise of 23.0°C.

Weights of instruments given by the manufacturer:

Double Indicator, bulkhead type	- 53.0 lbs.
" " pedestal type	- 75.0 "
Recorder	- 95.0 "
Transmitter (Anemometer)	- 110.0 "
Master Transmitter or Distributor	- 90 lbs.

COMMENTS ON RESULTS OF TEST

27. The system, shown by plate 1, when under test for the required 500 hour endurance run, showed an occasional error of plus or minus 2 knots. However, this was attributed to momentary variations in the frequency of the supply to the synchronous motor used for driving the Synchro-Motor transmitter. The fact that these errors occurred daily at approximately the same hour substantiates this supposition.

28. The maximum error occurring during the 3 hour accuracy tests, at speeds equivalent to 13.4, 21.74, 32.61, 43.48, 54.34, and 65.21 knots, was plus or minus 1/2 knot. These tests were made at hours at which the recorder chart for the endurance test showed practically no variations in the recorded knots.

29. When the Master Transmitter was under test for shock integrity, the pointers on the double Wind Intensity and Wind Direction

Indicator moved approximately 2 knots, but returned immediately to their normal positions.

30. The accuracy test, conducted after the application of the shock test, showed no additional error.

31. All of the accuracy tests were conducted as though the subject system were a shaft r.p.m. system and none of the test results includes any errors that may be introduced by the anemometer cups.

32. The Barber-Colman Shaded-Pole Induction Motor driving the oscillating contact device in the Master Transmitter did not withstand the 1500 volt dielectric test. All other parts of the subject system were satisfactory.

33. Under test for watertight integrity, the double Indicator case leaked 60 cc. of water. This defect was due to sand holes in the main casting. This casting has been marked at the location of the holes for the manufacturer's information.

34. The illumination in the double Indicator is not sufficient to permit its dials to be read from a distance of 6 feet in a dark room. The maximum distance from which the dials could be read was approximately 4 feet. However, few other instruments embodying the same design of lighting can be read from a distance of 6 feet.

35. Upon examination of the material used in connection with the Master Transmitter, it was noticed that the manufacturer had consistently used brass or bronze in contact with aluminum. This is contrary to specifications.

36. When mounted in a plane  $30^{\circ}$  from vertical, top forward, the Master Transmitter introduced an additional error of approximately minus  $1/2$  knot, when operating at 65.21 knots.

37. The present diameter (3.97) of the 4 r.p.m. discs is insufficient for 80 knots. Inasmuch as the roller must move 0.0253 from the center of the discs for each knot, a radius of 2.024 is required for 80 knots. To allow for intensities exceeding 80 knots, the discs should have a diameter of at least 4.25.

38. The wiring of the Master Transmitter is unsatisfactory and the various wires used are not in accordance with the specifications.

39. This system required 23 seconds to reach 65.2 knots, starting from rest.

40. The current consumed by each Telechron Synchronous Motor was 0.052 amperes at 115 volts, or 6 watts.

## CONCLUSIONS

41. This material as manufactured and submitted by Julien P. Friez and Sons, Inc., and intended for use as a Wind Intensity and Wind Direction System for the USS YORKTOWN and USS ENTERPRISE was not a complete system. However, in view of the principal units, namely, Master Transmitter, double Indicator and Synchro-Motor of the Masthead Transmitter being submitted, it was possible to conduct the test for conformance with the major requirements of the specifications, reference (b).

42. The test results obtained indicate that the material submitted would be satisfactory for the Naval Service provided it is modified in accordance with "Comments", paragraphs 32 to 40 inclusive.

43. The Bureau's attention is invited to the possibility of the accuracy of the system having been affected due to modifications by the manufacturer since the wind tunnel test was conducted by the Bureau of Standards. These modifications include a reduction in the ratio of gearing between the anemometer cups and the Synchro-Motor Transmitter.

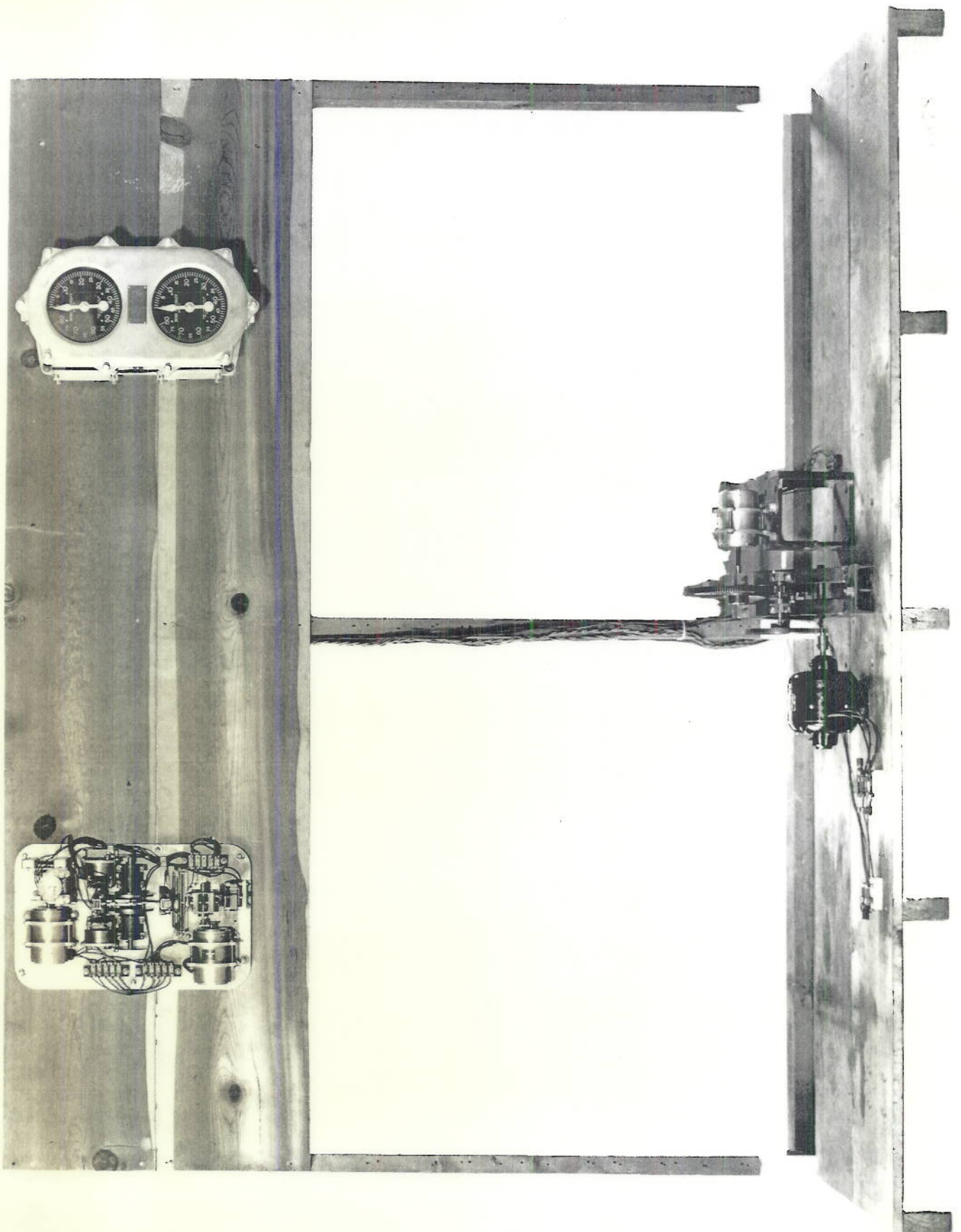


Plate 1

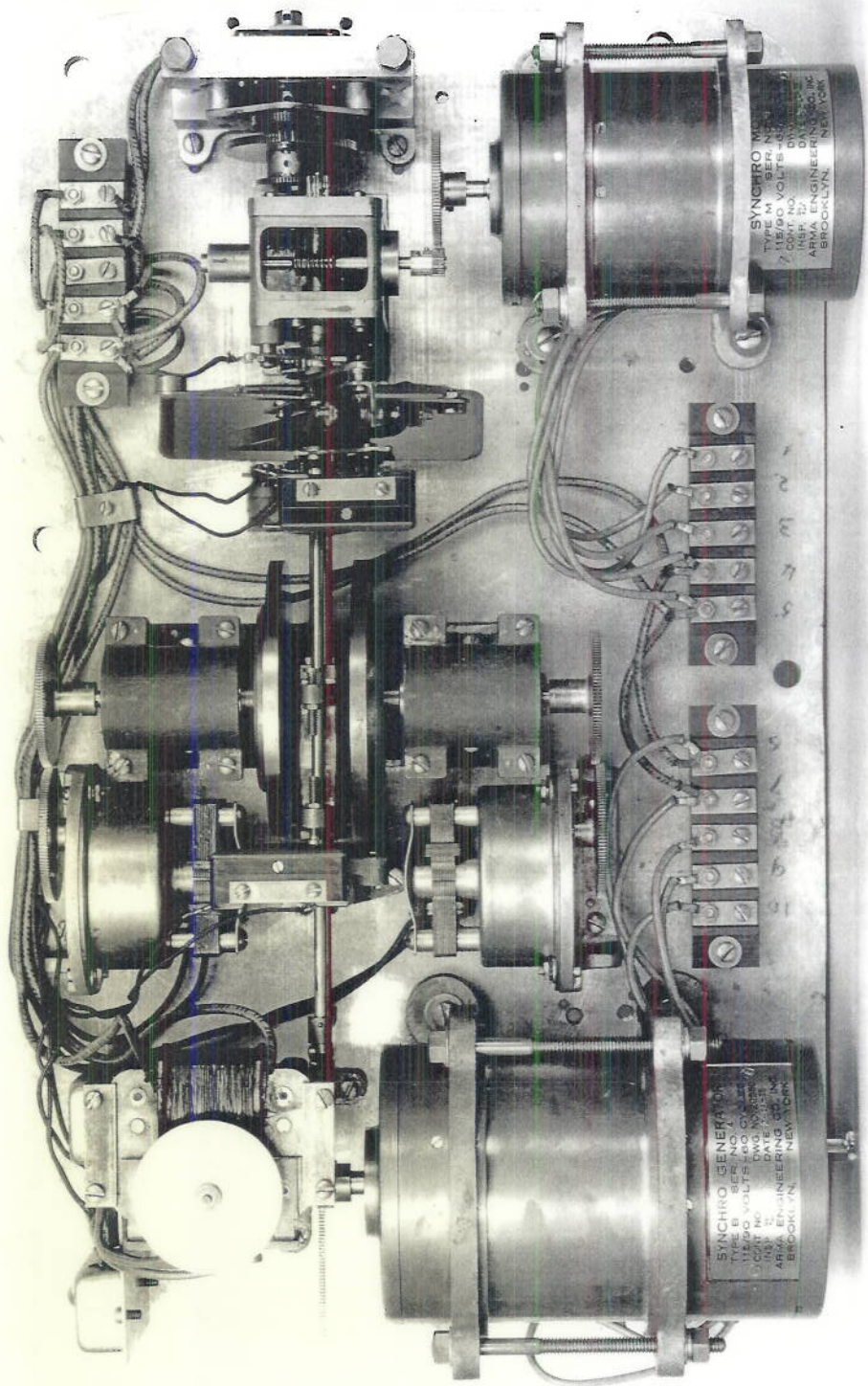


Plate 2

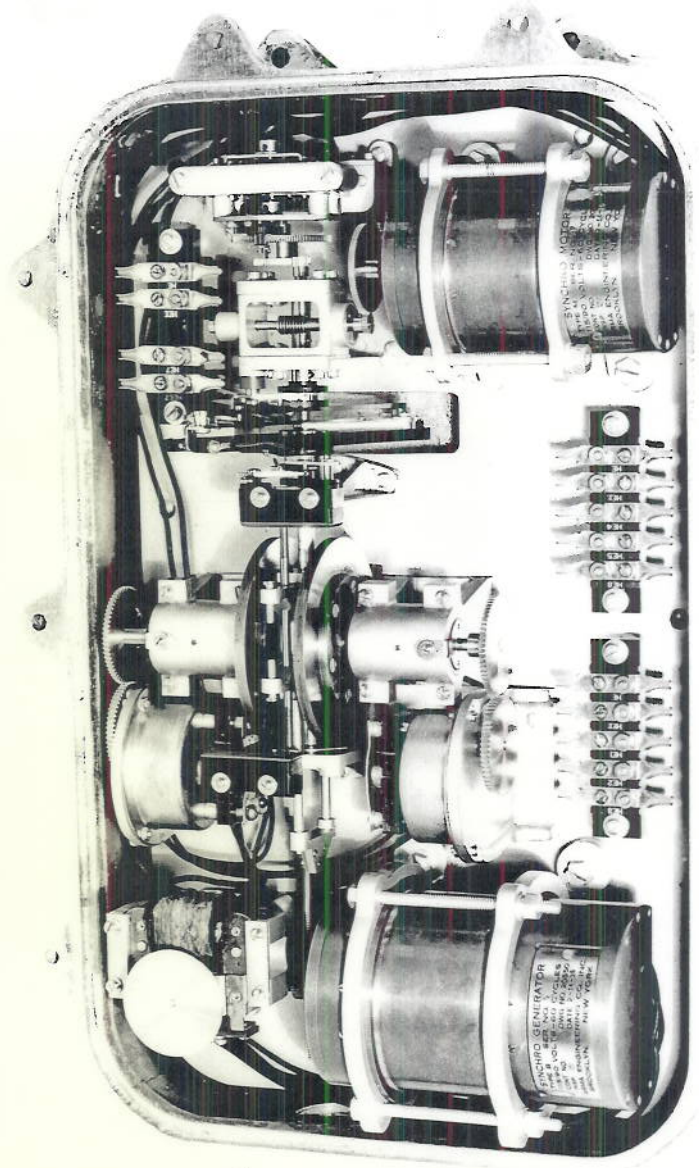
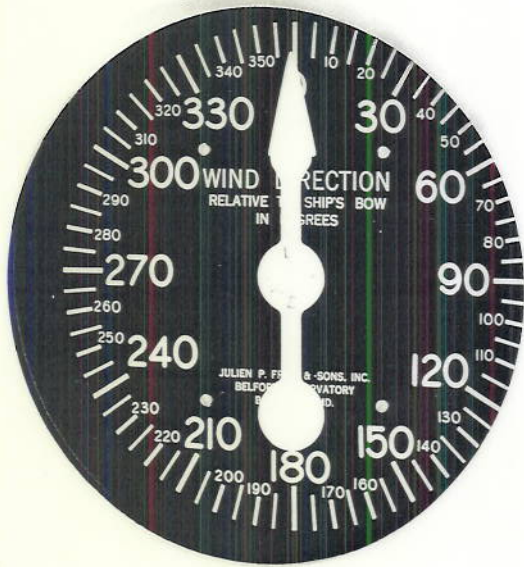


Plate 3



WIND INDICATOR  
SELF-SYNCHRONOUS MOTOR TYPE  
115 VOLTS 60 CYCLE  
DRAWING NO. CV-555 1005 ALT-0  
MANUFACTURED 1934  
JULIEN P. FRIEZ & SONS, INC.  
BALTIMORE MARYLAND



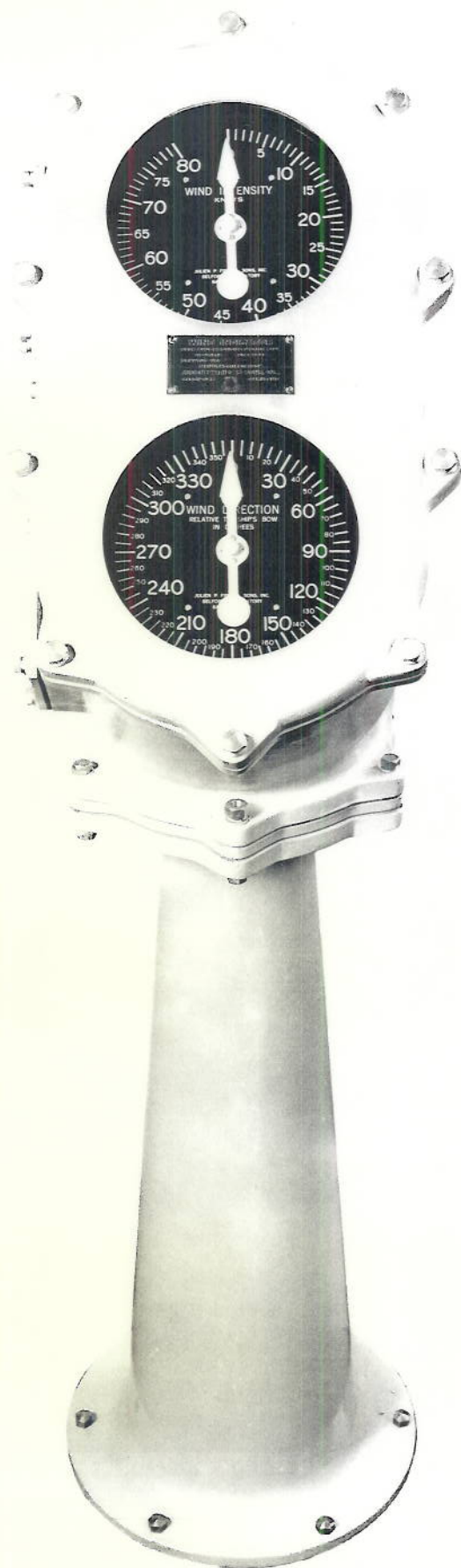


Plate 5

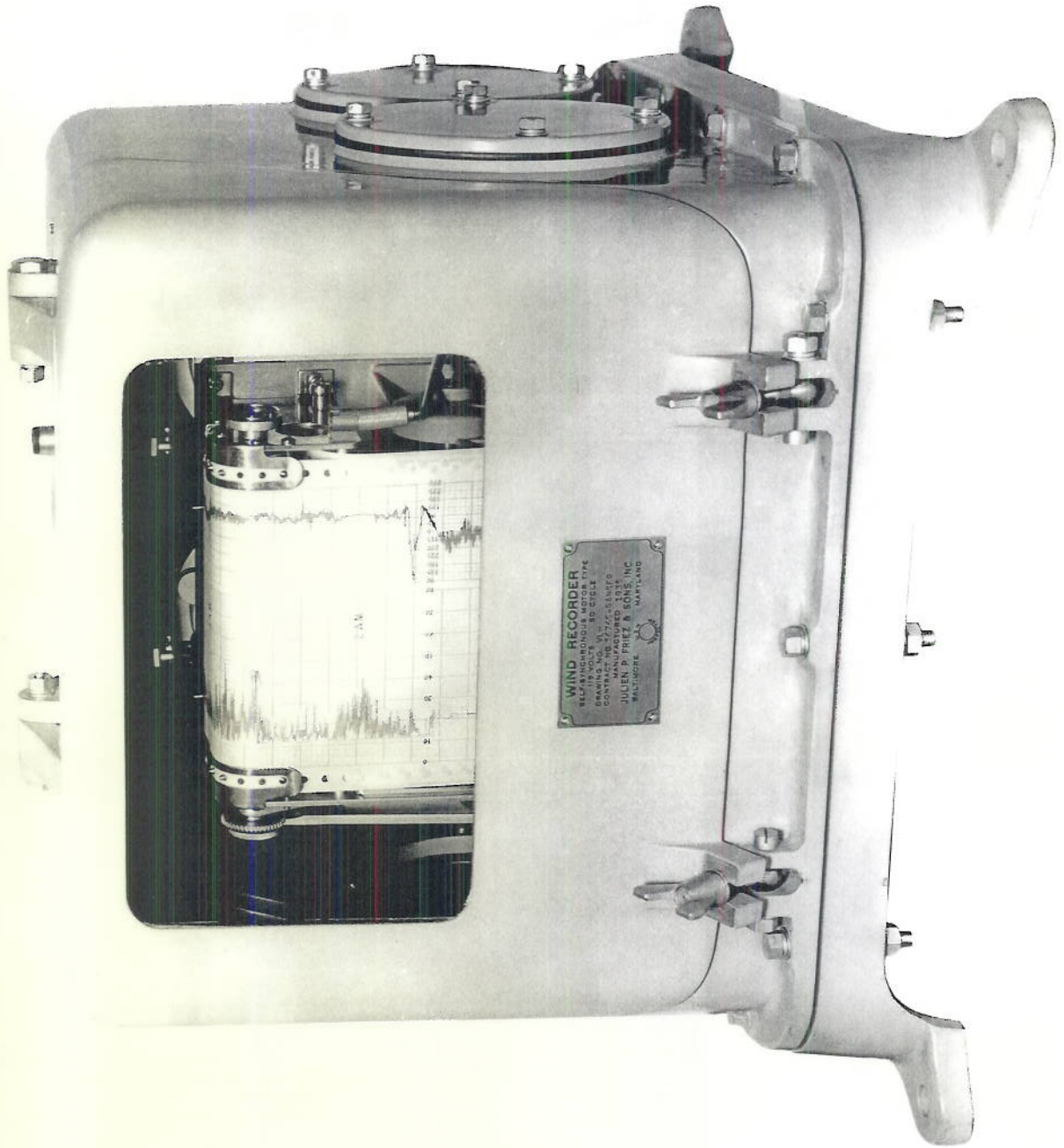


Plate 6

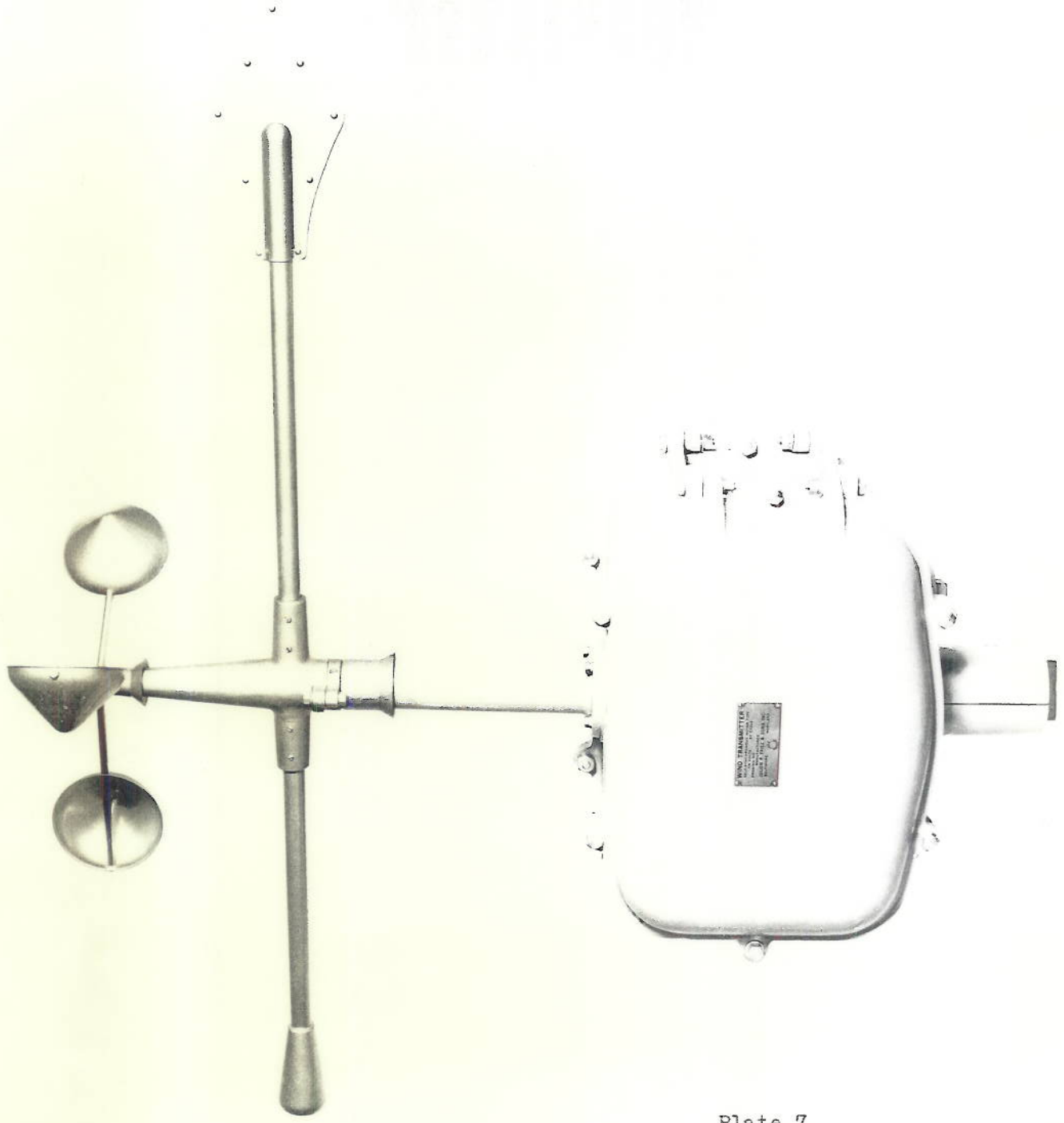


Plate 7