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BUREAU OF ENGINEERING

Report

on

Test of Preliminary Model RU-4 Aircraft Radio Receiving Equipment.

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WASHINGTON, D.C.

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AUTHORIZATION FOR TEST

1. This problem was authorized by Bureau of Engineering letter, reference (a), and other additional references pertinent to this problem are listed as references (b) and (c).

Reference: (a) BuEng. ltr. NOs42340(7-29-W3) of 31 July 1935.
(b) Specifications RE 13A 471B.
(c) Contract NOs42340.

OBJECT OF TEST

2. The object of these tests was to determine how closely the preliminary Model RU-4 equipment meets the requirements of Specifications RE 13A 471B.

ABSTRACT OF TEST

3. The Model RU-4 equipment was set up in the Laboratory and given a general inspection of mechanical construction and wiring. The following detailed tests were conducted to determine specification compliance as regards electrical performance:

(a) Sensitivity, MCW and CW - antenna reception.
(b) Sensitivity, MCW and CW - loop reception.
(c) Selectivity, MCW.
(d) Noise output.
(e) Audio fidelity.
(f) Overload.
(g) Operation of manual and automatic sensitivity controls.
(h) Frequency stability under various conditions.
(i) Tuning characteristics.
(j) Resettability.
(k) Interchangeability of coils and tubes.
(l) D.C. voltages and currents.
(m) Operation of two receivers from the same dynamotor.

4. The equipment was then installed in an airplane and flight tests made, noting especially the action on antenna and loop, the effect of vibration, and the interaction between receivers.

Conclusions

(a) The preliminary Model RU-4 receiving equipment does not meet the requirements of the specifications, reference (b), in all respects.

(b) The general mechanical construction of the preliminary model is in accordance with the requirements of the specifications. Materials of high quality are used in all cases. The workmanship is excellent.

(c) The electrical performance in general is satisfactory. Unsatisfactory performance was found as follows:

(1) Frequency drift of the heterodyne oscillator is excessive, especially with change of temperature.

(2) The audio fidelity is poor.

(3) The selectivity at some frequencies is not as great as required by the specifications.

(d) The outlet for crystal frequency indicator power supply was incorrectly wired.

(e) Minor discrepancies between actual and specified dimensions and weights were noted.

(f) The dynamotor does not have ample rating to supply two receivers simultaneously.

(g) The equipment will be suitable for use in Naval aircraft if the contractor corrects the major defects noted herein.

Recommendations

It is recommended:

(a) That this equipment be considered unsatisfactory for use in Naval aircraft until the contractor corrects the defects noted herein to the satisfaction of the Bureau of Engineering, particularly as follows:

(1) Improve the frequency stability.

(2) Improve the selectivity at the frequencies where the receiver does not meet the requirements of the specifications.

(3) Supply a dynamotor of ample rating to operate two receivers from a common junction box.

(4) Improve the audio fidelity.

(5) Wire the CFI outlets so as to insure proper operation of these indicators.

(b) That specifications for future equipment of a similar nature refer to all receiver outputs in terms of power rather than voltage.

DESCRIPTION OF MATERIAL UNDER TEST

5. The equipment under test is radio receiving equipment intended for use in single seat fighting planes as well as other types of land and sea planes. The frequency range covered is 224 - 13,575 kilocycles, and the primary power source is a 12-volt storage battery which is normally across the charging generator.

6. The equipment as submitted by the Aircraft Radio Corporation of Boonton, New Jersey, consists of the following units:

(a) Receiver and mounting base.
(b) Dynamotor unit.
(c) Junction box.
(d) Switch box.
(e) Remote tuning control and cable.
(f) Plug-in coil sets and containers.
(g) Dual coil set and container.
(h) Connecting cables and associated plugs.

7. The receiver is contained in an aluminum case and mounted on a shock-absorbing base. It consists of a tuned radio frequency amplifier, detector, oscillator, audio frequency amplifier, and automatic sensitivity control. The tubes used are three type 38078 as radio frequency amplifiers, one type 38077 as detector, one type 38077 as an automatic sensitivity control tube, and one type 38233, one section of which is used as heterodyne oscillator and the other as audio frequency amplifier. All tuning is accomplished by a single control. A separate switch box controls the selection of manual or automatic sensitivity control and CW or MCW reception. The heater supply is direct from the battery and the plate supply from the dynamotor unit.

8. The dynamotor unit consists of a dynamotor and filter. It operates directly from the storage battery, and gives an output of 360 volts at 100 m.a.

9. The units are connected by means of plug-in cables running to a junction box. Provision is made for operating two receivers independently from the same dynamotor.

METHOD OF TEST

10. The tests herein reported were conducted as nearly as possible in accordance with the governing specifications, reference (b). A visual inspection of workmanship was made, the component parts were examined, and the separate units measured and weighed.

11. Electrical tests were made using a storage battery as power source, the voltage being adjusted to 14 volts at the input terminals of the equipment. Unless otherwise noted, all MCW measurements were made with 30 per cent modulation of the carrier at 1000 cycles. The results are practically the same as for the frequency specified.

12. Sensitivity was measured using General Radio Model LC-A standard signal generator, serial No. 2. Standard output was 10 milliwatts, measured on a General Radio Type 583-A output power meter adjusted for 600 ohms, with the sensitivity control of the receiver at its maximum setting. The signal generator was connected to the receiver through an artificial antenna consisting of a .0001 microfarad capacitor mounted on the antenna binding post. The leads were kept less than six inches long. For loop measurements the input was applied to the loop terminals through a coil of negligible capacitance having an inductance of 0.2 millihenries and a mean resistance of 6 ohms; in addition the loop terminals were shunted by a fixed capacitance of .00005 microfarad.

13. Selectivity was measured by noting the number of kilocycles off resonance at which the sensitivity of the receiver was 1, 5, and 10 per cent of its maximum sensitivity.

14. Noise output was determined by removing the modulation from the input signal used in measuring the MCW sensitivity. The noise ratio is the ratio of the output thus obtained to the standard output, all receiver adjustments remaining as for the sensitivity measurement.

15. Audio fidelity was measured by using an external modulation source with the signal generator, and noting the audio output of the receiver for 30 per cent modulation at frequencies of 50 to 7000 cycles. Three different carrier frequencies were used for comparison.

16. Overload was measured by noting the output for increasing inputs. Distortion was determined by means of an oscillograph in the output circuit.

17. Frequency stability was determined by noting the change in frequency of the audio output with the receiver tuned to a harmonic of the crystal in the Model LD-2 heterodyne calibrator equipment. Audio frequencies were measured on the General Radio Type 617-A interpolation oscillator.

18. The equipment was installed in an airplane and flight tests conducted.

DATA RECORDED DURING TESTS

19. Complete data were recorded on all tests conducted. This information is contained in Tables 1 to 29 and Plates 1 to 9 inclusive, and is discussed under "Results."

DISCUSSION OF PROBABLE ERRORS

20. The overall limits of accuracy for the various measurements are estimated as follows:

Sensitivity	± 10%
Sensitivity, above 8000 kilocycles	± 20%
Selectivity	± 10%

Audio fidelity	± 5%
Overload	±10%
Sensitivity control characteristics	±10%
Audio frequency measurements	± 5 cycles
Current and voltage measurements	± 1%

RESULTS OF TESTS

21. In the following paragraphs of this report reference is made to the governing specifications RE 13A 471B under which this equipment was constructed. Where no specific reference is made to any particular paragraph it is to be understood that the equipment under test complies with this paragraph and that no further explanatory remarks are considered necessary.

22. Section I. The Model RU-4 equipment meets the general scope of this introductory section of the specifications.

23. Par. 2-2. The materials covered by this paragraph are satisfactory, in so far as could be determined without extensive disassembling.

24. Par. 2-3. The construction is satisfactory, unless specifically stated elsewhere in this report.

25. Par. 2-4. The workmanship is excellent.

26. Par. 2-5. The equipment is well protected from corrosive action.

27. Par. 2-6. Iron and steel have been used only where necessary.

28. Par. 2-7. The equipment was tested over a temperature range of -30°C. to +50°C., and was found to function normally except as specifically mentioned. All controls operated satisfactorily at -30°C. The manual sensitivity control was found to be noisy at +35°C., producing sharp clicks at each step of rotation. Some measurements made after the temperature runs showed the manual to automatic sensitivity ratio to be somewhat decreased, although it is not certain that these conditions were responsible for the change.

29. Par. 2-8. The equipment is suitably protected as required by this paragraph.

30. Par. 2-9. Ventilation is provided by a series of holes on the left-hand side of the receiver unit.

31. Par. 2-10. Continuous operation is possible without damage.

32. Par. 2-11. No test equipment is available for acceleration tests; however, the receiver withstood vibration and shock during flight tests.

33. Par. 2-12. Wooden dowels are used as supports for some of the lower frequency coils. The dowels are very well impregnated and should be satisfactory.

34. Par. 2-13. Parts are satisfactorily interchangeable, but identification markings and type numbers are not complete.

35. Par. 2-14. Name plates and unit identifications were not supplied.

36. Par. 2-16. Parts and wiring are secured against vibrational effects as specified.

37. Par. 2-17. This provision is satisfactory if protective caps are on the unused plug receptacles of the junction box.

38. Par. 2-18. All sealing and insulating compounds proved satisfactory at the temperatures at which the receiver was tested.

39. Par. 2-19. The receiver unit is mounted satisfactorily by means of live rubber shock absorbers.

40. Par. 2-20. Wiring is in accordance with the requirements of this paragraph.

41. Par. 2-24. No samples of wire were furnished for test, and it was considered unwise to remove any from the equipment.

42. Par. 2-25. No samples of wire were available for test.

43. Par. 2-26. Cable connections are as specified.

44. Par. 2-27. Sufficient shock and vibration protection is obtained through the receiver unit mounting.

45. Par. 2-29. The frequency ranges 224 - 350 kilocycles and 350 - 545 kilocycles are combined in a dual coil set as specified in reference (c).

46. Par. 2-31. No electrical indicating instruments are used in the equipment supplied.

47. Par. 2-32. Operation of controls is in accordance with this paragraph.

48. Par. 2-33. The finish of units and cabinets is satisfactory. Pure aluminum is used in their construction.

49. Par. 2-34. The foil paper capacitors used in this equipment are of types which have proved satisfactory. Over the temperature range of the receiver tests there was no evidence of deterioration.

50. Par. 2-35. No samples of fixed capacitors were furnished.

51. Par. 2-36. All audio transformers and chokes are in accordance with the specifications. Coils proved to be satisfactory under the conditions of the receiver tests.

52. Par. 2-37. No electrolytic condensers are used.

53. Par. 2-38. Provision is made only for low impedance phones, as covered by Addendum No. 1, of 7 December 1934, to reference (b).

54. Par. 2-40. The metal cabinets and cable shields are already grounded to the negative lead from the power source.

55. Par. 2-41. Six vacuum tubes are used, one being type 38233, which contains two units used as heterodyne oscillator and audio frequency amplifier respectively.

56. Par. 2-42. Three types of tubes are used: 38077, 38078, and 38233.

57. Par. 2-43. All tubes are of approved types.

58. Par. 2-44. Operation of the equipment is satisfactory with any tubes meeting Navy standard specifications for the type specified.

59. Par. 2-45. The equipment is completely shielded, the shields of all units being at a common ground potential to which the negative side of the power supply is also connected.

60. Par. 2-46. (1) All component parts withstood the temperature tests of the equipment, except that the manual sensitivity control became noisy at +35°C.

(2) The Laboratory is not equipped to make this test.

61. Par. 2-47. This test was not performed.

62. Par. 2-48. No samples were furnished for the immersion test.

63. Par. 2-50. Bolts, studs, screws, nuts, etc., conform to the requirements of this paragraph of the specifications.

64. Par. 2-51. Operation was satisfactory during temperature tests, except as specifically stated. The Laboratory is not equipped to make humidity tests.

65. Par. 2-52. In this case two receivers were operated from the same dynamotor unit, as provided for in the junction box. The results are given in Table 25. It is seen that there is a relatively small amount of interaction through the common power supply. The increase of signal heard by the use of an antenna (in this instance afforded by the connections to the signal generator) shows considerable radiation from the oscillator. In all cases the interaction is stronger when the receiver being listened on is tuned to exactly one-half the frequency of the other. This is due to the fact that in this equipment the second harmonic of the oscillator is used to give the beat note.

66. Par. 2-53. Operation is not satisfactory with a crystal frequency indicator. Outlets 74 and 76 on the junction box are improperly wired. Terminal No. 25 should be +12 volts, No. 27 should be ground, and No. 35 should be positive high voltage.

67. Par. 3-2. Items (9), (11), (16), (17), (18), (19), and (20) were not submitted for test. Only one set of vacuum tubes, item (14), was furnished.

68. Par. 3-3. The junction box is as specified, except that the fuses are located under a small removable cover projecting above the upper surface. This cover is 17/32" high, making the overall dimensions 7-3/8" x 5-1/2" x 2-25/32". The weight is two pounds. In addition to the required plug connections, provision is made for cables leading to a second receiver and switch box. This allows operation of two receivers independently from the same dynamotor.

69. Par. 3-4. The dynamotor unit conforms to the dimensions specified and contains the accessory electrical parts required. Its weight is 9 pounds 4 ounces. The dynamotor is of satisfactory mechanical design, but its output rating is only 100 m.a. Reference to Table 22 shows that the total current taken by two receivers when operating is 130 m.a. One receiver requires 76 m.a., and when the 30 m.a. are allowed for the I.C. system and crystal frequency indicator the total is also above the rated limit.

70. Par. 3-5. Receiver unit.

(1) This unit contains the circuits as required.

(2) The dimensions of the cabinet are as given.

(3) The weight of the unit complete with one single-range coil set, but without vacuum tubes, is 13 pounds 4 ounces. The average weight of a single-range coil set is 1 pound 12 ounces without container, and 2 pounds 4 ounces with container.

(4) The controls and connections are satisfactory, except that half divisions are not graduated between the 100 main divisions of the tuning dial. The selector switch for the dual ganged coil set is mounted on the coil set itself, as allowed under (5).

(5) All the controls mentioned in (4) are mounted on the front panel, the tuning control, dial, and outlets being on the right-hand portion as specified. The selector switch on the dual coil set is on the front end of the coil set, adjacent to the front panel.

(6) Coil sets are as specified.

(7) Coil sets may be changed in the 5-1/2 inches allowed.

(8) Access to vacuum tubes is by a removable panel in the top of the receiver cabinet.

(9) Satisfactory.

71. Par. 3-6. The receiver mounting base is in accordance with the specifications. Its weight is 10 ounces.

72. Par. 3-7. The receiver switch box contains the required parts and controls, and the markings are as specified except that "MCW" is used instead of "Voice." The weight is 14 ounces. The dimensions are 5-1/16" x 3-5/8" x 2-3/8", due to the use of a mounting plate differing from that shown on Sheet 52B of reference (b). The D.C. meter, meter holder, cable, and plug were not supplied.

73. Par. 3-8. The receiver remote tuning control and mechanical linkage are in accordance with specifications. The tuning control weighs 14 ounces. The mechanical linkage is 121 inches in length, with a weight of 1.9 ounces per foot. There is a tendency for torque lash to counteract play in the receiver dial gearing which makes the average setting more accurate with the remote tuning control than with the local, as determined by actual frequency response. Direction of rotation is also less important. See Table 20. The adjustable fiducial mark is not held rigidly in position, however, so that other errors may be introduced.

74. Par. 3-9. The receiver local tuning control conforms to the specifications, except that the disk is not knurled. The weight is two ounces. Attention is called here to Table 20, which shows a decided change in frequency when the control is reset in the opposite direction. This is apparently distinct from backlash of gearing and probably indicates end-play in the main shaft.

75. Par. 3-10. The antenna-loop switch local control is satisfactory and is detachable.

76. Par. 3-11. No remote control or linkage is provided for the antenna-loop switch.

77. Par. 3-12. The local control on the dual coil set is satisfactory.

78. Par. 3-13. No remote control or linkage is provided for the dual coil set switch.

79. Par. 3-14. The plug-in coil sets and containers are in accordance with the specifications.

80. Par. 3-15. The general construction of the connecting cables and plugs is in accordance with the specifications. Lengths and weights are given in Table 28, and show some minor discrepancies. Plug receptacles No. 74 and No. 76 are provided in the junction box, **but are incorrectly wired.**

81. Par. 3-16. Antenna insulators were not supplied.

82. Par. 3-17. The test meter, meter holder, cable, and plug were not furnished with the equipment.

83. Par. 3-18. The receiver case is not completely sprayproof on account of ventilation holes. The entrance of spray at these points, however, is not serious, as no vital parts are exposed. The waterproof slip cover was not provided with the equipment.

84. Par. 3-19. All controls are satisfactory in this respect, except as mentioned in Par. 74.

85. Par. 3-20. Remote control switches were not furnished for test.

86. Par. 3-21. The tuning dials are marked on a 0-100 basis.

87. Par. 3-22. Previous experience indicates that the friction and pressure contacts used should be satisfactory in use over a long period of time.

88. Par. 3-23. The arrangement of parts and construction permits easy servicing.

89. Par. 3-24. No protective caps were furnished for the plug receptacles of the junction box and dynamotor.

90. Par. 3-25 to 3-30 inclusive. This type of dynamotor is capable of operating satisfactorily for long periods of time. Its smooth running shows that the balance of the moving parts is good. Constructional details were not checked.

91. Par. 3-31. The dynamotor is of the totally enclosed type.

92. Par. 3-32. Jack receptacles are as specified.

93. Par. 3-33. Spaces specified are sufficient for removing single and dual coil sets, and all plugs.

94. Par. 3-36. Tuning condensers and trimmers for same are of the air dielectric type.

95. Par. 3-37. Total weight of all parts supplied for operation of one receiver, including a single frequency coil set and a complete set of tubes, but not including remote controls for tuning, antenna-loop switch, or dual coil set, is 30 pounds 15 ounces.

96. Par. 3-38. All units are quickly replaceable, as required. The catches are capable of being safety-wired.

97. Par. 3-39. No tool is provided for the trimming condensers.

98. Par. 4-5(b). With a separate heterodyne oscillator for CW reception the CW selectivity depends on the audio frequency characteristics of the receiver. Therefore the MCW selectivity should be a satisfactory index of the CW selectivity.

99. Par. 5-1. Control is as specified when only one receiver is connected at the junction box. When two receivers are connected, for operation from the same dynamotor, turning one off does not of course stop the dynamotor and thus current continues to flow through several resistors in this receiver. This is discussed in detail in Par. 150.

100. Par. 5-3. The 224 - 350 kilocycle and 350 - 545 kilocycle bands are combined in a dual ganged coil set, as specified in reference (c). No single ganged coil sets are furnished for these two bands.

101. Par. 5-5. Tuning is by means of the same single control in each case.

102. Par. 5-7. This is accomplished by the three-position switch, which also contains the "Off" position.

103. Par. 5-8. The same control knob adjusts the receiver sensitivity when the above switch is in the "Manual" position, and the audio level when the switch is in the "Auto" position.

104. Par. 5-9. Adjustment for CW or MCW is by a toggle switch as specified.

105. Par. 5-10. Only the two additional adjustments specified are required. However, the antenna trimming condenser is of the mica dielectric type, with which it is difficult to hold an accurate capacitance setting under flight conditions. In addition, when the temperature is varied the capacitance change is sufficient to throw the antenna out of alignment and reduce the receiver sensitivity.

106. Par. 5-11. The antenna-loop switch is as specified, but no remote control was supplied.

107. Par. 5-12. Temperature tests were made on the equipment, the results of which appear at various places under more specific paragraphs of this report. This Laboratory is not equipped to conduct the required humidity tests.

108. Par. 6-1. Operation is unsatisfactory with the crystal frequency indicator.

109. Par. 6-2. The receiver operated satisfactorily with all types of antennae on aircraft during flight tests.

110. Par. 6-3. The frequency range 224 - 13,575 kilocycles is covered by 10 overlapping bands.

111. Par. 6-4. There is a separate gang of plug-in coils for each band of paragraph 110, except for 224 - 350 kilocycles and 350 - 545 kilocycles, which are combined in a dual gang. In addition a single gang is supplied for 5200 - 7700 kilocycles, replacing that for 5400 - 8100 kilocycles as required in the original contract.

112. Par. 6-5. The interchangeability of coil sets is shown in Table 21. The frequency overlap between bands is not less than two per cent.

113. Par. 6-6. Tuning is provided in the first grid circuit.

114. Par. 6-7. The equipment will operate satisfactorily with any vacuum tubes within the limits set by Navy standard specifications for the types used.

115. Par. 6-8. A heterodyne oscillator is used for reception of CW signals, and its coupling to the detector circuit is satisfactory.

116. Par. 6-9. No adjustment of the antenna trimmer is necessary when changing coils provided the same antenna is used.

117. Par. 6-10. A high grade phenolic composition is used for coil forms, but the lower frequency universal-wound coils are supported on wooden dowels. Glass insulation is used in the variable tuning condensers. Air dielectric trimming condensers are used with the tuning condensers.

118. Par. 6-11. A jack is provided on the front panel of the receiver unit for the input from an interior communication system.

119. Par. 6-12. The output is intended for the use of low impedance phones only, as specified by Addendum No. 1 to reference (b).

120. Par. 6-13. All D.C. and substantially all radio frequency potentials are removed from the telephone cords.

121. Par. 6-14. (1) The results of MCW sensitivity measurements are given in Table 1. When allowance is made for experimental errors, the sensitivity is slightly outside the specification limits at one point in the 224 - 350 kilocycle band. Variation of MCW sensitivity in any one band does not exceed 2/1.

(2) The results of CW sensitivity measurements are given in Table 2, and are within the specification limits. Variation of CW sensitivity in any one band does not exceed 4/1.

122. Par. 6-15. The sensitivity with loop reception is given in Tables 3 and 4. In general, this is much greater than required by the specifications, but the ratio to the antenna sensitivity approaches the designated limit at the higher frequencies.

123. Par. 6-16. (1) The MCW selectivity is shown in Table 5. After allowance is made for experimental errors, the requirements are not met in the two lowest and two highest frequency bands. There is also a tendency for the high frequency ends of several bands to be outside the limits. This is true especially of the 5400 - 8100 kilocycle or 5200 - 7700 kilocycle band. The selectivity at reduced gain settings is discussed in Par. 131.

(2) Since the circuits are the same for CW reception, except that the oscillator is used, the MCW selectivity may be taken as an index of the CW selectivity. See also Par. 98.

124. Par. 6-17. The table of selectivity given in the specifications is reproduced in Table 5 for comparison purposes.

125. Par. 6-18. The audio fidelity is given in Table 7 and Plate 1. With a carrier of 450 kilocycles, the side band cutting causes distortion as shown by the rapid decrease above 1000 cycles. The results with the 4200 or 8000 kilocycle carrier may be taken as giving the true audio fidelity curve. It is seen that the attenuation greatly exceeds the specification limit at 3000 cycles, while at 50 cycles the requirement is very nearly met.

126. Par. 6-19. Overload curves are given in Plate 2 from the data of Table 8. While a maximum output of about 500 milliwatts is reached, distortion of the wave-form begins to be visible, as viewed on the oscillograph, at about 250 milliwatts. This is also shown by the tendency of the curves to become slightly flattened at this point. The 600-ohm output only was used, in accordance with Addendum No. 1 to reference (b).

127. Par. 6-20. The noise ratio is given in Table 6. This exceeds the specified limit in the five lowest frequency bands by a small amount. Flight tests indicate that the noise level is satisfactory.

128. Par. 6-21. Laboratory and flight tests indicate that the microphonic tendencies are negligible.

129. Par. 6-22. Paragraph 5(e) of Appendix B discusses noise level in flight. The noise was not considered excessive since the major portion of the noise in the receiver was attributable to ignition disturbances.

130. Par. 6-23. The attenuation produced by the manual sensitivity control is satisfactory, as shown in Table 9.

131. Par. 6-24. (a) Receiver blocking does not occur at any operative position of the manual or automatic sensitivity control. No appreciable change of the frequency of the oscillator was observed. At 450 kilocycles the MCW selectivity remained practically constant as the sensitivity control setting was decreased, but at 7600 kilocycles the selectivity was decreased, as shown in Table 10. With MCW operation a very noticeable shift in tuning was caused by reducing the sensitivity control from maximum to minimum, as shown by the last column of Table 9.

(b) Under normal conditions, the sensitivity control, both manual and automatic, was not noisy. When making a temperature run, as +35°C. was reached, it was found that the manual control gave a series of loud clicks in the telephones as each new contact was made. This effect disappeared after the receiver had become cool again.

132. Par. 6-25. The antenna binding post is grounded when the switch is thrown to the "Loop" position.

133. Par. 6-26. As reported in Appendix B, the operation on a loop antenna was satisfactory.

134. Par. 6-27. No shift in bearings was noted with variations of tuning or sensitivity control.

135. Par. 6-28. Minima may be obtained as specified. However, on frequencies above 1500 kilocycles, the indicated direction is not nescessarily correct, but will depend upon altitude, distance and terrain.

136. Par. 6-29. An input of 0.5 volt was applied to the receiver at the same frequency to which it was tuned. On the "Manual" setting the receiver immediately became operative when this signal was removed; on "Auto" it became operative after an interval of approximately one second. A further discussion relative to break-in operations will be found in Par. 5(d) of Appendix B.

137. Par. 6-30. Cycles per division are sufficiently evenly spaced.

138. Par. 6-31. The number of kilocycles per division of the tuning dial for each band (excluding the extreme ends) is given in Table 19. This is somewhat over the specification limit at the higher frequencies, but is compensated for by the greater overlap obtained.

139. Par. 6-32. Operation of the remote tuning control is satisfactory.

140. Par. 6-33. Continuous operation is possible without damage as specified. However, dynamotor No. 2 became noisy after only a few hours of operation due to faulty brush contact.

141. Par. 6-34. The range of the automatic sensitivity control was measured as described under this paragraph of the specifications - that is, with an initial output of 10 milliwatts with the level control set at maximum. The level control was reduced until the output was one milliwatt and the run repeated in each case. The results are shown in Table 11 and Plates 3 to 5 inclusive. The requirement of a 3 to 1 voltage ratio in output for a 1000 to 1 increase of input is met in MCW operation. For CW this ratio is exceeded at the higher frequencies, becoming 5.6 at 13,575 kilocycles. An extra curve is shown on Plate 4. The curve labeled "MCW" is obtained with the initial conditions described above. For the dotted curve, "MCW - Increased Input," the initial input is increased by a ratio of 2.5, but the same initial output maintained by reducing the level control. This flatter curve shows better regulation and at the same time represents more nearly the working condition in service.

142. Par. 6-35. A comparison of the "Manual" and "Auto" sensitivity values in Tables 1, 2, 3, and 4 shows that the change in output between the two is such as to pass unnoticed by the ear.

143. Par. 6-36. With the maximum setting of the manual sensitivity control, the receiver operates satisfactorily and without oscillation other than in the heterodyne oscillator circuit, over the entire frequency range and with the primary power source varying between 12 and 16 volts.

144. Par. 6-37. The frequency drift of the heterodyne oscillator at constant ambient temperature is given in Table 14 and Plates 6 and 7. At 325 kilocycles the requirement for the first ten minutes of operation is not met, but at 6200 kilocycles this is well within the limit. The succeeding run of 50 minutes at 325 kilocycles is satisfactory, with a frequency change of only 241 cycles, but at 6200 kilocycles the limit is slightly exceeded, the frequency change being .023 per cent. The frequency change of the oscillator for variation of the D.C. power source from 12 to 16 volts is shown in Table 12. This is well within the specification limits.

145. Par. 6-38. The frequency variation of the heterodyne oscillator with change in ambient temperature is shown in Tables 15 to 18 inclusive, and Plates 8 and 9. Runs were taken with both decreasing and increasing temperature, to eliminate the lag of the actual receiver temperature behind that indicated by the thermometer. For purposes of calculation the slopes of the two curves were averaged. The average frequency change was as follows:

325 kilocycles - .38% for 20°C.
6200 kilocycles - .08% for 20°C.

Both of these values are greater than allowed by the specifications. A constant supply voltage of 14 volts was maintained during this test, and the receiver was warmed up before starting.

146. Par. 6-39. No calibration charts were supplied with this equipment.

147. Par. 7-1. The parts listed under this paragraph in the specifications were not supplied.

148. Par. 7-3. No spare parts were furnished.

149. Since provision is made in the junction box for operating two receivers independently from the same dynamotor, additional tests were made under this condition. The supply voltage was kept at 14 volts in all cases regardless of the increased loads.

150. It is found that when both receivers are thus connected, but only one is turned on, more power is taken from the dynamotor than when only one receiver is connected and operating. This is due to the following paths for the dynamotor current in the second (off) receiver.

Terminal #78 - 1200 ohms (-side).
Terminal #80 - 7000 ohms (+side).
Terminal #81 - 110,000 ohms (+side, but only if switch of second receiver is on MCW).

These resistances are thrown in parallel with those in the first receiver, on the corresponding sides of the dynamotor, when the control switch of the first receiver is turned on in either the "Manual" or "Auto" position. All current paths are broken with both switches off, and operation is also normal when both are on, except for reduction in voltages due to the increased load.

151. When the switch of the first receiver is turned on, the heaters of only this receiver light up. But a study of the wiring diagram shows an additional current path through the windings of the relay in series with the heaters of the second receiver.

152. Table 23 shows the changes in the plate voltage supply for each condition. There is also a difference at the "A" and "B" sides of the junction box, due to a difference in the connection of terminal #79.

153. Table 24 shows the changes in the voltages applied to the automatic sensitivity control tube. Actually this is more nearly normal with both receivers turned on than with one off.

154. Table 22 shows the currents taken from battery and dynamotor. With both receivers turned on there is about a 60 per cent increase in the total current from the storage battery over the normal condition with one receiver. The dynamotor current is increased to 130 milliamperes, considerably above its rating. When one receiver is turned off, but left connected, the currents are still higher than normal, due mainly to the cause discussed in Par. 150.

155. These current and voltage changes naturally affect the operation of the receiver. Table 26 shows the effect on the sensitivity under the various conditions. Actually this is less than might have been expected, showing mainly that the receiver is not very critical as to plate voltage.

156. It should be noted that the sensitivity with automatic sensitivity control changes in a slightly different manner, giving the greatest discrepancy with both receivers connected but only one turned on. The effect on the action of the automatic sensitivity control is given in greater detail in Table 27. Three columns, (a), (b), and (c), are given to show normal operation with one receiver. When both receivers are connected and turned on, it is seen that with the maximum level setting the initial input must be increased, but slightly better regulation is obtained at the lower input ratios. When one receiver is turned off the grid and cathode voltages on the second are decreased and a still higher input is required to give the initial condition. The action in this case is quite similar to that of a single receiver as given in column (c), where the level is reduced and input increased.

157. The results of flight tests are given in the report of the Naval Air Station, which is included herewith as Appendix B.

158. A summary of the defects noted and such items as do not comply with the requirements of reference (b) are as follows:

(a) Par. 2-12. Wooden dowels are used as supports for some of the lower frequency coils.

(b) Par. 2-13. Identification markings and type numbers are not complete.

(c) Par. 2-14. Name plates and unit identifications were not supplied.

(d) Par. 2-46. The manual sensitivity control became noisy at +35°C.

(e) Par. 2-52. When two receivers are operated from the same dynamotor, interaction is quite noticeable when one receiver is tuned to one-half the frequency of the other.

(f) Par. 3-2. Items (9), (11), (16), (17), (18), (19), and (20) were not submitted for test. Only one set of vacuum tubes, item (14), was furnished.

(g) Par. 3-3. The junction box is 5/8" too high, due to the removable fuse cover which projects above the upper surface.

(h) Par. 3-4. The current rating of the dynamotor is exceeded under some conditions of operation. The unit is over the specified weight.

(i) Par. 3-5. The receiver unit exceeds the specified weight. Half divisions are not engraved on the tuning dial.

(j) Par. 3-7. The dimensions of the switch box do not conform to the specifications, due to the use of a different mounting plate. "MCW" is used as a switch marking instead of "Voice."

(k) Par. 3-9. The disk of the local tuning control is not knurled. There is a considerable change in frequency when the control is reset in the opposite direction.

(l) Par. 3-11. No remote control or linkage is provided for the antenna-loop switch.

(m) Par. 3-13. No remote control or linkage is provided for the dual coil set switch.

(n) Par. 3-15. Lengths and weights of connecting cables show minor discrepancies.

(o) Par. 3-17. The test meter, meter holder, cable, and plug were not furnished with the equipment.

(p) Par. 3-18. The waterproof slip cover was not supplied.

(q) Par. 3-24. No protective caps were furnished for the plug receptacles of the junction box and dynamotor.

(r) Par. 3-37. Total weight of equipment is 15 ounces over that specified, even without remote tuning control.

(s) Par. 3-39. No tool is provided for the trimming condensers.

(t) Par. 5-1. When two receivers are operated from the same dynamotor, turning the control switch of one off does not break all current paths in that receiver.

(u) Par. 5-10. The mica dielectric antenna trimming condenser is not entirely satisfactory.

(v) Par. 6-14. The MCW sensitivity is slightly outside the specification limits at 290 kilocycles.

(w) Par. 6-16. The MCW selectivity does not meet the requirements for the two lowest and two highest frequency bands. There is also a tendency for the high frequency ends of several bands to be outside the limits. Selectivity is decreased at reduced gain settings, as noted below under (aa).

(x) Par. 6-18. The audio fidelity curve shows the attenuation to be too great at 3000 cycles.

(y) Par. 6-19. The output begins to be noticeably distorted at 250 milliwatts.

(z) Par. 6-20. The noise ratio exceeds the specified limit at the lower frequencies.

(aa) Par. 6-24. With MCW operation the receiver tuning is shifted when the manual sensitivity control setting is decreased. At the same time the selectivity, at the higher frequencies, is reduced. With CW operation the oscillator frequency remains practically constant, so that these effects are masked, but it is apparent that the circuits are thrown somewhat out of alignment.

(bb) Par. 6-31. The number of kilocycles per division of the tuning dial is above the limit for the higher frequency bands.

(cc) Par. 6-33. Dynamotor #2 became noisy after only a few hours of operation.

(dd) Par. 6-34. For CW the regulation of the automatic sensitivity control is not sufficiently good at the higher frequencies.

(ee) Par. 6-37. The frequency drift at constant ambient temperature for the first 10 minutes of operation is too great at the lower frequencies, while that for the succeeding 50 minutes is very close to the limits at the frequencies tested.

(ff) Par. 6-38. The frequency variation of the oscillator with change in ambient temperature is greater than specified.

(gg) Par. 6-39. No calibration charts were furnished with this equipment.

(hh) Par. 7-1. The parts listed under this paragraph in the specifications were not supplied.

(ii) Par. 7-3. No spare parts were furnished.

(jj) While the operation of two receivers from one dynamotor is not specifically covered in reference (b), it should be noted that they are not completely independent when thus connected. A full discussion is given in paragraphs 149 to 156 inclusive.

CONCLUSIONS

159. The preliminary Model RU-4 receiving equipment does not meet the requirements of the specifications, reference (b), in all respects.

160. The general mechanical construction of the preliminary model is in accordance with the requirements of the specifications. Materials of high quality are used in all cases. The workmanship is excellent.

161. The electrical performance in general is satisfactory. Unsatisfactory performance was found as follows:

(a) Frequency drift of the heterodyne oscillator is excessive, especially with change of temperature.

(b) The audio fidelity is poor.

(c) The selectivity at some frequencies is not as great as required by the specifications.

162. The outlet for crystal frequency indicator power supply was incorrectly wired.

163. Minor discrepancies between actual and specified dimensions and weights were noted.

164. The dynamotor does not have ample rating to supply two receivers simultaneously.

165. The equipment will be suitable for use in Naval aircraft if the contractor corrects the major defects noted herein.

Table 1

MCW Sensitivity - Antenna Reception

NOTE: Wherever frequencies between 6000 and 8100 kcs. are used in the tables, the coil range 5400 - 8100 kcs. is understood unless otherwise specified.

All measurements were made with 14 volts applied across the input terminals of cable No. 21, unless otherwise specified.

Coil Range (Kcs.)	Frequency (Kcs.)	Microvolts Input for Standard Output		
		Manual	Auto	Spec. Limit
224 - 350	225	3.2	3.1	4.0
	290	4.7	4.5	4.0
	340	4.1	3.9	4.0
350 - 545	360	4.0	3.8	4.0
	450	4.2	4.0	4.0
	540	3.8	3.6	4.0
545 - 850	560	2.1	2.0	4.0
	700	1.9	1.8	4.0
	840	1.4	1.3	4.0
850 - 1330	860	2.4	2.3	4.0
	1090	2.7	2.5	4.0
	1300	2.1	2.0	4.0
1330 - 2040	1360	2.0	1.9	4.0
	1675	2.2	2.1	4.0
	2000	1.7	1.6	4.0
	2060	1.6	1.5	4.0
2040 - 3000	2060	2.8	2.6	4.0
	2580	2.7	2.5	4.0
	3100	2.1	1.9	7.0
3000 - 4525	3100	2.1	2.0	7.0
	3800	1.7	1.6	7.0
	4200	1.4	1.4	7.0
	4500	1.2	1.1	7.0
4000 - 6000	4000	2.2	2.1	7.0
	4200	2.5	2.4	7.0
	5100	2.3	2.1	7.0
	5900	2.1	1.9	7.0
5400 - 8100	5400	5.5	5.0	7.0
	6200	5.0	4.5	10.0
	7600	5.0	4.9	10.0
	8000	4.7	5.0	10.0

Table 1 (Continued)

Coil Range (Kcs.)	Frequency (Kcs.)	Microvolts Input for Standard Output		
		Manual	Auto	Spec. Limit
6000 - 9050	6200	10.4	9.8	10.0
	7600	10.0	10.0	10.0
	9000	11.8	13.6	40.0
9050 - 13575	9000	48.0	46.0	40.0
	10500	82.0	62.0	70.0
	12500	50.0	42.0	70.0
	13575	67.0	64.0	70.0
5200 - 7700	5400	4.6	4.4	7.0
	6200	3.7	3.1	10.0
	7600	4.5	3.8	10.0

Table 2

CW Sensitivity - Antenna Reception

Coil Range (Kcs.)	Frequency (Kcs.)	Microvolts Input for Standard Output		
		Manual	Auto	Spec. Limit
224 - 350	225	1.2	1.1	1.5
	290	1.5	1.4	1.5
	340	1.4	1.2	1.5
350 - 545	360	1.4	1.2	1.5
	450	1.0	0.9	1.5
	540	0.9	0.8	1.5
545 - 850	560	0.5	0.4	1.5
	700	0.4	0.4	1.5
	840	0.3	0.2	1.5
850 - 1330	860	1.0	0.9	1.5
	1090	0.7	0.6	1.5
	1300	0.4	0.4	1.5
1330 - 2040	1360	0.6	0.6	1.5
	1675	0.5	0.5	1.5
	2000	0.3	0.3	1.5
	2060	0.3	0.3	1.5
2040 - 3000	2060	0.7	0.6	1.5
	2580	0.5	0.4	1.5
	3100	0.3	0.3	3.0
3000 - 4525	3100	0.5	0.4	3.0
	3800	0.3	0.2	3.0
	4200	0.2	0.2	3.0
	4500	0.2	0.2	3.0
4000 - 6000	4000	0.5	0.5	3.0
	4200	0.5	0.5	3.0
	5100	0.3	0.3	3.0
	5900	0.2	0.2	3.0
5400 - 8100	5400	1.2	1.1	3.0
	6200	1.0	0.7	4.0
	7600	1.2	1.2	4.0
	8000	0.9	1.0	4.0
6000 - 9050	6200	3.5	3.3	4.0
	7600	2.5	2.4	4.0
	9000	2.5	2.6	20.0

Table 2 (Continued)

Coil Range (Kcs.)	Frequency (Kcs.)	Microvolts Input for Standard Output		
		Manual	Auto	Spec. Limit
9050 - 13575	9000	9.7	9.5	20.0
	10500	11.3	9.4	35.0
	12500	8.5	8.0	35.0
	13575	7.3	6.5	35.0
5200 - 7700	5400	1.3	1.2	3.0
	6200	0.8	0.6	4.0
	7600	1.2	1.3	4.0

Table 3

MCW Sensitivity - Loop Reception

Coil Range (Kcs.)	Frequency (Kcs.)	Microvolts Input for Standard Output		Ratio of Loop to Antenna Reception*	
		Manual	Auto	Manual	Auto
224 - 350	290	1.5	1.3	3.1	3.5
	340	1.5	1.3	2.7	3.0
350 - 545	360	1.6	1.4	2.5	2.7
	450	2.6	2.2	1.6	1.8
	540	3.0	2.3	1.3	1.6
545 - 850	560	0.8	0.7	2.6	2.9
	700	1.2	0.9	1.6	2.0
	840	1.1	0.9	1.3	1.4
850 - 1330	860	1.5	1.2	1.6	1.9
	1090	2.4	1.9	1.1	1.3
	1300	2.6	2.0	0.8	1.0
1330 - 2040	1360	2.1	1.9	1.0	1.0
	1675	3.0	1.9	0.7	1.1

* Specification limit: 0.75 for 300 to 1500 kcs.

Table 4

CW Sensitivity - Loop Reception

Coil Range (Kcs.)	Frequency (Kcs.)	Microvolts Input for Standard Output		Ratio of Loop to Antenna Reception*	
		Manual	Auto	Manual	Auto
224 - 350	290	0.6	0.5	2.5	2.8
	340	0.8	0.6	1.8	2.0
350 - 545	360	0.4	0.3	3.5	4.0
	450	0.6	0.5	1.7	1.8
	540	0.8	0.6	1.1	1.3
545 - 850	560	0.2	0.2	2.5	2.0
	700	0.3	0.2	1.3	2.0
	840	0.3	0.2	1.0	1.0
850 - 1330	860	0.9	0.8	1.1	1.1
	1090	0.7	0.5	1.0	1.2
	1300	0.6	0.5	0.7	0.8
1330 - 2040	1360	0.5	0.5	1.2	1.2
	1675	0.7	0.4	0.7	1.3

* Specification limit: 0.75 for 300 to 1500 kcs.

Table 5

MCW Selectivity

Coil Range (Kcs.)	Freq. (Kcs.)	Kilocycles displacement for the following percentages of resonance sensitivity. 10% Measured –	10% Measured +	10% Spec. Limit	5% Measured –	5% Measured +	5% Spec. Limit	1% Measured –	1% Measured +	1% Spec. Limit
224-350	225	4.9	3.9	3.8	7.3	5.0	4.9	13.2	8.3	8.7
	290	4.8	4.7	4.2	6.3	6.2	6.0	10.8	11.0	9.6
	340	5.7	5.7		7.6	7.5		13.5	13.2	
350-545	360	5.1	5.4	4.6	6.9	7.1	6.5	12.9	12.3	10.6
	450	6.4	7.3		8.7	9.7		15.5	16.7	
	540	8.4	10.0		11.3	13.2		20.3	23.3	
545-850	560	6.8	7.4	7.2	9.1	9.0	9.1	16.9	16.0	16.7
	700	7.2	8.5	9	9.5	10.9	11	17.7	19.4	21
	840	8.2	10.6	10	11.3	13.8	13	21.0	24.3	24
850-1330	860	9.9	10.1		13.5	13.3		25.7	23.2	
	1090	11.2	12.7	12	15.7	17.2	16	28.0	29.6	28
	1300	13.8	15.5		18.6	20.2		34.2	36.1	
1330-2040	1360	11.0	13.0		15.1	16.9		29.5	28.9	
	1675	12.2	15.3	15	16.3	19.8	20	30.7	34.6	36
	2000	14.0	18.8	17	19.1	24.1	22	36.4	42.2	40
	2060	14.6	19.0		19.7	24.6		37.8	43.2	
2040-3000	2060	13.5	15.0		18.7	20.1		35.3	34.3	
	2580	15.1	18.1	18	21.2	24.0	23	38.6	41.5	42
	3100	16.6	22.0	19	23.3	28.2	24	45.3	51.1	43
3000-4525	3100	13.9	18.9	19	19.2	25.0	24	38.2	43.7	43
	3800	16.1	23.8	24	23.1	31.2	29	45.7	54.5	56
	4200	17.0	25.4	25	25.4	33.3	32	49.9	58.9	60
	4500	18.6	25.4		27.0	34.5		52.9	62.9	
4000-6000	4000	16.3	23.5		23.5	30.5		49.6	53.4	
	4200	17.9	24.7	25	25.6	32.8	32	50.6	56.4	60
	5100	21.1	28.3	30	30.4	38.4	39	59.4	69.7	71
	5900	26.1	34.1		38.1	45.2		74.8	84.2	
5400-8100	5400	23.4	30.0		30.2	39.1		60.8	68.3	
	6200	24.8	35.0	35	35.9	44.6	46	68.2	75.1	82
	7600	36.9	50.4	37	53.3	66.7	54	97.7	121.0	99
	8000	41.8	64.8		58.9	79.2		112.4	139.3	
6000-9050	6200	30.0	38.7	35	41.3	48.9	46	78.4	81.7	82
	7600	39.8	57.7	37	55.9	74.1	54	103.9	114.0	99
	9000	65.0	69.5	45	85.7	88.4	59	145.4	158.4	112

Table 5 (Continued)

Coil Range (Kcs.)	Freq. (Kcs.)	10% Measured −	10% Measured +	10% Spec. Limit	5% Measured −	5% Measured +	5% Spec. Limit	1% Measured −	1% Measured +	1% Spec. Limit
		Kilocycles displacement for the following percentages of resonance sensitivity.								
9050-13575	9000	43.6	59.2	45	61.7	74.8	59	113.2	127.4	112
	10500	73.0	81.4	53	97.3	99.9	63	174.2	174.2	126
	12500	65.4	78.6	73	81.6	124.8	86	180.6	193.8	176
	13575	93.4	115.9	83	131.1	143.8	97	232	255	200
5200-7700	5400	25.5	30.4		34.8	39.8		65.5	69.2	
	6200	27.2	34.2	35	37.5	44.2	46	71.7	78.1	82
	7600	50.7	53.3	37	65.5	70.2	54	117.8	131.2	99

Table 6

Noise Ratio

Coil Range (Kcs.)	Frequency (Kcs.)	Noise Ratio	
		Power	Voltage*
224 - 350	225	.20	.45
	290	.050	.22
	340	.045	.21
350 - 545	360	.085	.29
	450	.035	.19
	540	.030	.17
545 - 850	560	.120	.35
	700	.080	.28
	840	.095	.31
850 - 1330	860	.065	.26
	1090	.037	.19
	1300	.038	.20
1330 - 2040	1360	.055	.23
	1675	.028	.17
	2000	.030	.17
	2060	.030	.17
2040 - 3000	2060	.020	.14
	2580	.012	.11
	3100	.013	.11
3000 - 4525	3100	.017	.13
	3800	.017	.13
	4200	.020	.14
	4500	.023	.15
4000 - 6000	4000	.016	.13
	4200	.012	.11
	5100	.010	.10
	5900	.010	.10
5400 - 8100	5400	.003	.05
	6200	.003	.05
	7600	.003	.05
	8000	.003	.05
6000 - 9050	6200	.002	.04
	7600	.001	.03
	9000	.002	.04
9050 - 13575	9000	<.001	<.03
	10500	<.001	<.03
	12500	<.001	<.03
	13575	<.001	<.03

Table 6 (Continued)

Coil Range (Kcs.)	Frequency (Kcs.)	Noise Ratio	
		Power	Voltage*
5200 - 7700	5400	.005	.07
	6200	.006	.08
	7600	.015	.12

* Specification limit: 0.20.

Table 7

Audio Fidelity

Modulation Frequency (Cycles)	Per Cent of Maximum Output Voltage		
	Carrier 450 Kcs.	Carrier 4200 Kcs.	Carrier 8000 Kcs.
50	76	71	71
70	92	87	89
100	91	87	86
200	97	92	92
300	99	94	94
400	100	98	98
500	100	99	99
700	100	100	100
1000	94	100	98
1500	76	96	92
2000	62	86	78
3000	33	62	54
5000	9	22	18
7000	-	10	7

* Specification limit: at least 75% for 50 to 3000 cycles.

Table 8

Overload - MCW

340 Kcs. Input µV.	340 Kcs. Output MW	3100 Kcs. Input µV.	3100 Kcs. Output MW	13,575 Kcs. Input µV.	13,575 Kcs. Output MW
1	0.07	0.5	0.07	10	0.03
2	0.6	0.7	0.32	20	0.22
3	2.5	1.0	0.71	30	0.89
4	7.1	1.5	3.1	50	3.9
5	15.5	2	8.8	70	11.4
7	50	3	31.5	100	29.0
10	130	4	71	150	68
16	270	5	140	200	124
20	280	7	250	300	210
30	360	10	245	500	315
50	395	15	415	700	440
70	400	20	440	1000	465
100	390	50	500	2000	500
200	335	70	500	5000	410
400	127	100	435	7000	265
450	14.7	200	163	10000	115
480	2.2	250	75	15000	0.55
530	0.3	300	1.9	20000	0.11
600	0.15	400	0.3		

Table 9

Operation of Manual Sensitivity Control

Freq. (Kcs.)	Reception	Microvolts Input for Standard Output: Sensitivity Control Max.	Microvolts Input for Standard Output: Sensitivity Control Zero	Attenuation Ratio	Frequency Shift for Full Range - Kcs.
450	CW	1.0	310,000	.0000032	-
	MCW	4.2	>500,000	<.000008	+ 2.4
7600	CW	1.2	>500,000	<.000002	-
	MCW	5.0	>500,000	<.00001	+26.8

Table 10

Effect of Manual Sensitivity Control on Selectivity - 7600 Kcs.

Sensitivity Control Setting - Per Cent of Maximum	10% of Resonant Frequency Kcs. Displacement		1% of Resonant Frequency Kcs. Displacement	
	-	+	-	+
100	36.9	50.4	97.7	121.0
50	55.8	58.4	134.0	147.3
20	62.4	63.4		

Table 11

Automatic Sensitivity Control

	MCW			CW		
		Output MW			Output MW	
Freq. Kcs.	Input µV.	Max. Level	Reduced Level	Input µV.	Max. Level	Reduced Level
340	3.9	10.0	1.0	1.2	10.0	1.0
	39	26.0	3.4	12	100	11.6
	390	28.0	3.7	120	88	10.5
	3900	31.5*	4.0	1200	90*	10.3
	39000	34	4.4	12000	95	10.8
	390000	46	5.5	120000	102	11.4
3100	2.1	10.0	1.0	0.35	10.0	1.0
	21	39.5	5.0	3.5	185	12.8
	210	41.5	5.2	35	230	15.0
	2100	42.5*	5.3	350	245*	15.5
	21000	47	6.0	3500	245	16.1
	210000	54	7.0	35000	270	16.8
13575	64	10.0	1.0	6.5	10.0	1.0
	640	37.5	4.8	65	255	22.5
	6400	37.5	4.9	650	305	25.0
	64000	42.0*	5.3	6500	315*	27.5
				65000	350	32.0

* Specification limit: 90 MW (= output voltage ratio of 3 to 1).

Table 12

Variation of D.C. Supply Voltage

Frequency (Kcs.)	Change in Oscillator Frequency: 14 to 16 Volts, Cycles	14 to 16 Volts, Per Cent	14 to 12 Volts, Cycles	14 to 12 Volts, Per Cent
450	- 45	- .010	+ 60	+ .013
8000	-252	- .003	+464	+ .006

Specification limit: 0.02 per cent or 250 cycles, for 12 to 16 volts.

Table 13

Frequency Stability - MCW

6200 Kcs.

Time* (Minutes)	Output MW	Change in Output (Per Cent)
0	10.0	0
10	10.0	0
20	10.0	0
30	10.0	0
40	9.9	1.0
50	9.7	3.0

* Receiver warmed up before start of test.

Table 14

Frequency Stability - CW

Constant Ambient Temperature: 23°C.

Time* (Minutes)	Change in Oscillator Frequency** 325 Kcs. Cycles	Per Cent	6200 Kcs. Cycles	Per Cent
0	0	0	0	0
0.5	-3052	-0.94	-211	-.003
1	-3120	-0.96	-559	-.009
1.5	-3161	-0.97	-741	-.012
2	-3200	-0.98	-855	-.014
3	-3256	-1.00	-997	-.016
4	-3297	-1.01	-1065	-.017
5	-3335	-1.02	-1148	-.018
6	-3357	-1.03	-1200	-.019
7	-3372	-1.04	-1227	-.020
8	-3388	-1.04	-1242	-.020
9	-3393	-1.04	-1255	-.020
10	-3399	-1.05	-1286	-.021
11	-3407	-1.05	-1319	-.021
12	-3411	-1.05	-1345	-.022
14	-3426	-1.05	-1389	-.022
16	-3434	-1.06	-1426	-.023
18	-3443	-1.06	-1470	-.024
20	-3451	-1.06	-1519	-.024
22	-3462	-1.06	-1573	-.025
24	-3471	-1.07	-1634	-.026
26	-3481	-1.07	-1705	-.027
28	-3490	-1.07	-1767	-.028
30	-3499	-1.08	-1837	-.030
32	-3510	-1.08	-1903	-.031
34	-3517	-1.08	-1972	-.032
36	-3527	-1.09	-2036	-.033
38	-3541	-1.09	-2096	-.034
40	-3552	-1.09	-2154	-.035
42	-3562	-1.10	-2216	-.036
44	-3572	-1.10	-2273	-.037
46	-3580	-1.10	-2335	-.038
48	-3589	-1.10	-2394	-.039
50	-3597	-1.11	-2451	-.040
52	-3608	-1.11	-2509	-.041
54	-3617	-1.11	-2571	-.041
56	-3625	-1.12	-2621	-.042
58	-3632	-1.12	-2665	-.043
60	-3640	-1.12	-2710	-.044
65	-3659	-1.13	-2822	-.045
70			-2934	-.047

* From cold start.

** Specification limits: 0 to 10 min.: 0.05% or 250 cycles.
10 to 60 min.: 0.02% or 250 cycles.

Table 15

Effect of Variation of Ambient Temperature

325 Kcs. - Decreasing Temperature.

Time (Minutes)	Temperature Degrees C.	Change in Oscillator Frequency Cycles	Per Cent
0	+23.9	+98	+.030
2	+23.4	+73	+.022
4	+21.3	+40	+.012
6	+19.0	+28	+.009
8	+17.1	+18	+.006
10	+15.3	+10	+.003
12	+13.8	0	0
15	+11.7	+ 6	+.002
20	+ 8.9	+37	+.011
25	+ 6.3	+81	+.025
30	+ 4.3	+143	+.044
35	+ 2.5	+209	+.064
40	+ 1.0	+285	+.088
45	- 0.3	+365	+.112
50	- 1.4	+423	+.130
55	- 3.0	+507	+.156
60	- 4.3	+580	+.179
65	- 5.3	+659	+.20
70	- 6.4	+735	+.23
75	- 7.3	+787	+.24
80	- 8.1	+841	+.26
85	- 9.1	+925	+.29
90	- 9.8	+977	+.30
95	-10.5	+1024	+.32
100	-11.1	+1070	+.33
105	-11.5	+1116	+.34
110	-12.1	+1160	+.36
115	-12.8	+1201	+.37
120	-13.2	+1244	+.38
125	-13.6	+1287	+.40
130	-14.1	+1330	+.41
135	-14.5	+1416	+.43
140	-14.9	+1465	+.45
145	-15.2	+1501	+.46
150	-15.5	+1532	+.47
155	-15.8	+1558	+.48
160	-16.1	+1583	+.49
165	-16.4	+1611	+.50
170	-16.7	+1633	+.50
180	-17.2	+1682	+.52
190	-17.7	+1723	+.53
200	-18.3	+1762	+.54
210	-18.8	+1800	+.55
240	-20.0	+1925	+.59

Table 16

Effect of Variation of Ambient Temperature

325 Kcs. - Increasing Temperature.

Time (Minutes)	Temperature Degrees C.	Change in Oscillator Frequency Cycles	Per Cent
0	-20.2	+1925	+.59
5	-18.8	+1941	+.60
10	-16.3	+1960	+.60
15	-15.3	+1960	+.60
20	-14.3	+1946	+.60
25	-13.4	+1926	+.59
30	-12.0	+1899	+.58
35	-11.0	+1864	+.57
40	-10.0	+1823	+.56
45	- 9.0	+1792	+.55
50	- 8.0	+1751	+.54
55	- 6.7	+1703	+.52
60	- 5.6	+1661	+.51
65	- 4.5	+1609	+.49
70	- 2.6	+1561	+.48
75	- 1.3	+1501	+.46
80	+ 0.2	+1438	+.44
85	+ 2.0	+1372	+.42
90	+ 3.8	+1304	+.40
95	+ 5.7	+1225	+.38
100	+ 7.8	+1169	+.36
105	+ 9.6	+1063	+.33
110	+11.4	+ 974	+.30
115	+13.2	+ 894	+.28
120	+15.2	+ 835	+.26
125	+16.9	+ 757	+.23
130	+18.7	+ 655	+.20
135	+20.3	+ 557	+.171
140	+22.2	+ 485	+.149
145	+23.8	+ 372	+.115
150	+25.5	+ 261	+.080
155	+27.0	+ 157	+.048
160	+29.8	0	0

Table 17

Effect of Variation of Ambient Temperature

6200 Kcs. - Decreasing Temperature.

Time (Minutes)	Temperature Degrees C.	Change in Oscillator Frequency Cycles	Per Cent
0	+16.2	0	0
5	+11.4	+294	+.005
10	+ 7.7	+375	+.006
15	+ 4.5	+459	+.007
20	+ 2.0	+561	+.009
25	- 0.4	+731	+.012
30	- 2.3	+922	+.015
35	- 3.8	+1105	+.018
40	- 5.3	+1331	+.021
45	- 6.2	+1535	+.025
50	- 7.5	+1778	+.029
55	- 8.5	+2055	+.033
60	- 9.4	+2340	+.038
65	-10.2	+2616	+.042
70	-11.1	+2881	+.046
75	-12.0	+3128	+.050
80	-12.7	+3368	+.054
85	-13.3	+3604	+.058
90	-13.8	+3707	+.060
95	-14.4	+3897	+.063
100	-15.0	+4088	+.066
105	-15.4	+4255	+.069
110	-15.9	+4404	+.071
115	-16.3	+4542	+.073
120	-16.7	+4689	+.076
125	-17.1	+4808	+.078
130	-17.5	+4921	+.079
135	-17.8	+5035	+.081
140	-18.1	+5131	+.083
145	-18.4	+5219	+.084
150	-18.6	+5305	+.085
155	-18.9	+5372	+.087
160	-19.1	+5456	+.088
165	-19.5	+5515	+.089
170	-19.8	+5556	+.090
175	-20.1	+5610	+.090
180	-20.3	+5654	+.091

Table 18

Effect of Variation of Ambient Temperature

6200 Kcs. - Increasing Temperature.

Time (Minutes)	Temperature Degrees C.	Change in Oscillator Frequency Cycles	Change in Oscillator Frequency Per Cent
0	-24.6	+7253	+.117
5	-23.5	+7257	+.117
10	-21.5	+7277	+.117
15	-20.0	+7249	+.117
20	-18.9	+7169	+.116
25	-17.9	+7063	+.114
30	-17.1	+6951	+.112
35	-15.2	+6790	+.110
40	-13.1	+6621	+.107
45	-11.4	+6353	+.103
50	- 9.8	+6120	+.099
55	- 8.0	+5871	+.095
60	- 6.4	+5608	+.090
65	- 4.9	+5337	+.086
70	- 3.2	+5041	+.081
75	- 1.9	+4735	+.076
80	+ 0.3	+4445	+.072
85	+ 3.0	+4189	+.067
90	+ 4.2	+3800	+.061
95	+ 5.7	+3433	+.055
100	+ 7.5	+3082	+.050
105	+ 9.5	+2747	+.044
110	+11.2	+2389	+.039
115	+13.0	+2043	+.033
120	+14.7	+1679	+.027
125	+16.1	+1313	+.021
130	+18.3	+ 980	+.016
135	+19.5	+ 542	+.009
140	+21.7	0	0

Table 19

Tuning Characteristics

Coil Range (Kcs.)	Kilocycles per Division on Dial As Measured	Spec. Limit
224 - 350	1.4	8
350 - 545	2.1	8
545 - 850	3.6	8
850 - 1330	5.5	8
1330 - 2040	8.6	8
2040 - 3000	13	16
3000 - 4525	18	16
4000 - 6000	23	16
6000 - 9050	34	30
{ 9050 - 12000	51	40
{12000 - 13575	52	45
5400 - 8100	31	16 - 30
5200 - 7700	29	16 - 30

Table 20

Resettability

Freq. (Kcs.)	Tuning Control	Per Cent Change in Frequency after Reset From Lower Scale Reading	From Higher Scale Reading*
450	Local	.086**	.013
	Remote	.040	.015
8000	Local	.070	.007
	Remote	.015	.024

* This was the direction of the original setting.
** Reduction in audio output from 10.0 to 9.2 MW, or 8%.

Table 21

Interchangeability of Coils, Serial #1 and #2, in Receiver Serial #1.

Coil Range (Kcs.)	Freq. (Kcs.)	Coil #1 Receiver Tuning	Coil #1 Sensitivity MCW	Coil #1 Sensitivity CW	Coil #2 Receiver Tuning	Coil #2 Sensitivity MCW	Coil #2 Sensitivity CW
545 - 850	560	10.8	2.12	0.51	10.5	1.80	0.54
	840	88.3	1.39	0.33	87.9	1.35	0.35
5400 - 8100	5400	10.4	5.4	1.33	10.1	5.9	1.40
	7600	84.2	5.1	1.35	83.7	4.9	1.24

Table 22

Current Taken by Receivers.

	Battery Current Amp.*	Dynamotor Current M.A.**
One Receiver Connected at the Junction Box		
On A side	4.9	75
On B side	5.0	76
Two Receivers Connected at the Junction Box		
Only A side "on"	6.1	113
Only B side "on"	6.1	112
Both "on"	7.9	130

* Starting current for one receiver: 9 amp.
** Dynamotor rating: 100 m.a.

Table 23

Voltage Output of Dynamotor-Positive Side.

One Receiver Connected at the Junction Box	Voltage to Ground from Terminal in Junction Box No. 79	No. 80	Socket at which Measured
On A side	234	262	A
	262	262	B
On B side	267	259	A
	259	259	B
Two Receivers Connected at the Junction Box			
Only A side "on"	234	256	A
	256	256	B
Only B side "on"	269	254	A
	254	254	B
Both "on"	214	229	A
	229	229	B

Table 24

Voltage on Automatic Sensitivity Control Tube Measured Across the Tapped Resistor on Receiver No. 1, which is Connected at B Side of Junction Box.

Only Receiver No. 1 Connected at the Junction Box	Receiver No. 1 Switch	Voltage across Resistor Grid Tap	Cathode Tap
No. 1 "on"	Manual	87	78
	Auto	82*	75*
No. 1 "off"	Off	0	0
Both No. 1 and No. 2 Connected at the Junction Box			
No. 1 "on"; No. 2 "off"	Manual	64	58
	Auto	63	57
No. 1 "on"; No. 2 "on"	Manual	74	68
	Auto	74	67
No. 1 "off"; No. 2 "on"	Off	65	57

* Unreliable because of instability, due to the receiver being out of the cabinet.

Table 25

Interaction of Two Receivers when Operated from the same Dynamotor Unit.

Input Conditions	Frequency of Receiver Tuning - Kcs. No. 1	No. 2	Results
Without antennae	3100	3100	Neither oscillator heard on other receiver.
Without antennae	6200	6200	Oscillator of one receiver faintly heard on other.
Antenna on No. 1 only	3100	3100	No. 2 oscillator heard on No. 1.
Antenna on No. 1 only	6200	6200	No. 2 oscillator heard on No. 1.
Antenna on No. 2 only	3100	3100	No. 1 oscillator heard on No. 2.
Antenna on No. 2 only	6200	6200	No. 1 oscillator heard on No. 2.
Without antennae	3100	6200	No. 2 oscillator heard on No. 1.* No. 1 oscillator not heard on No. 2.
Antenna on No. 1 only	3100	6200	No. 2 oscillator heard on No. 1. No. 1 oscillator not heard on No. 2.
Antenna on No. 2 only	3100	6200	No. 2 oscillator heard on No. 1.* No. 1 oscillator heard on No. 2.

* Received with same intensity in these two cases.

Table 26

Change in Sensitivity when Two Receivers are

Operated from the Same Dynamotor Unit.

Sensitivity of receiver No. 2 at 3100 kcs.

	Microvolts Input for Standard Output			
	MCW		CW	
Only Receiver No. 2 Connected at the Junction Box	Manual	Auto	Manual	Auto
No. 2 "on"	1.8	1.7	0.32	0.30
Both No. 1 and No. 2 Connected at the Junction Box				
No. 2 "on"; No. 1 "off"	1.85	3.0	0.40	0.58
No. 2 "on"; No. 1 "on"	1.95	2.0	0.44	0.44

The sensitivity is also slightly affected by rotation of the manual sensitivity control of Receiver No. 1.

Table 27

Action of Automatic Sensitivity Control When Two Receivers are Operated from the Same Dynamotor Unit.

Input Ratio	Output in Milliwatts. Only Receiver #2 Connected (a) Max. Level	(b) Max. Level	(c) Reduced Level	#1 and #2 Connected Both at Max. Level #1 "Off"	#1 "Auto"
1	10.0	35.0	10.0	10.0	10.0
2	31.0	41.0	13.0	14.0	21.1
3	38.0	43.0	13.7	15.1	27.2
5	43.0	44.0	14.1	16.3	31.0
7	44.0	45.0	14.4	17.0	32.6
10	46.0	46.0	14.6	17.7	34.0
100	49.0	48.0	15.1	21.3	40.2
1,000	50.0	50.0	16.0	24.3	46.0
10,000	54.0	53.0	17.7	31.0	53.0
100,000	63.0	86.0	25.2	48.0	76.0
1	(1.6)	(4.0)	(4.0)	(2.7)	(2.0)

Initial input in microvolts for each column is given in parentheses.

All measurements made on receiver #2 at 3100 kilocycles - MCW.

Table 28

Weights of Units

Unit	Weight Lb.	Weight Oz.	Spec. Limit Lb.	Spec. Limit Oz.
Receiver (without tubes)	11	8		
Receiver and single frequency coil set	13	4	12	14
Receiver mounting base		10		10
Dynamotor unit	9	4	9	0
Junction box	2	0	2	0
Switch box		14		13
Remote tuning control		14		16
Remote tuning cable	1	3	1	14
Coil set, single frequency	1	12	1	12
Coil set, dual frequency	2	13		
Coil set container		8		10

Connecting Cables	Length In.	Weight Lb.	Weight Oz.	Spec. Limit In.	Spec. Limit Lb.	Spec. Limit Oz.
#133	110	1	14	108	1	12
#134	46		12	42		15
#135	60	1	0	56	1	3
# 21	50-1/2*		11	48		13

Total weight with tubes and single frequency coil set, but with no remote controls - 30 lb. 15 oz.

* To end of shield.

Table 29

Dimensions of Units

(Measured in inches)

Unit	Length	Width	Height
Receiver cabinet	15	7	6
Receiver mounting base	15-9/16	6-1/4	1-3/4
Receiver unit complete	15-9/16	7-1/4	7-3/4*
Dynamotor unit	7-3/8	4-3/8	6
Junction box	7-3/8	5-1/2	2-25/32*
Switch box	5-1/16*	3-5/8	2-3/8*
Remote tuning control	5-3/4	3	2-1/2

* Over the specification limit.

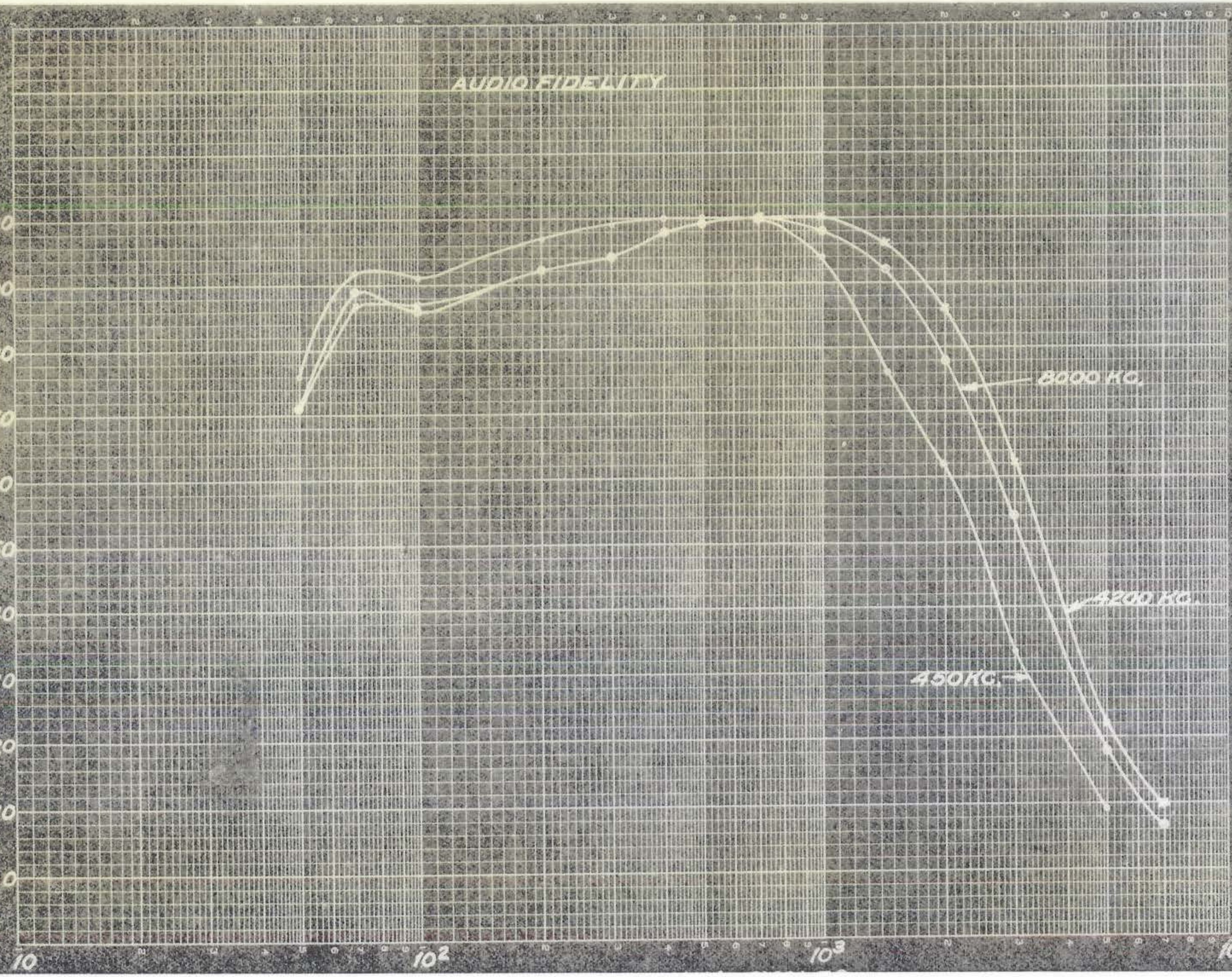

AUDIO FIDELITY
PER CENT OF MAXIMUM OUTPUT - VOLTAGE.
100
90
80
70
60
50
40
30
20
10
0
10
10²
10³
10⁴
8000 KC.
4200 KC.
450KC.

PLATE 1

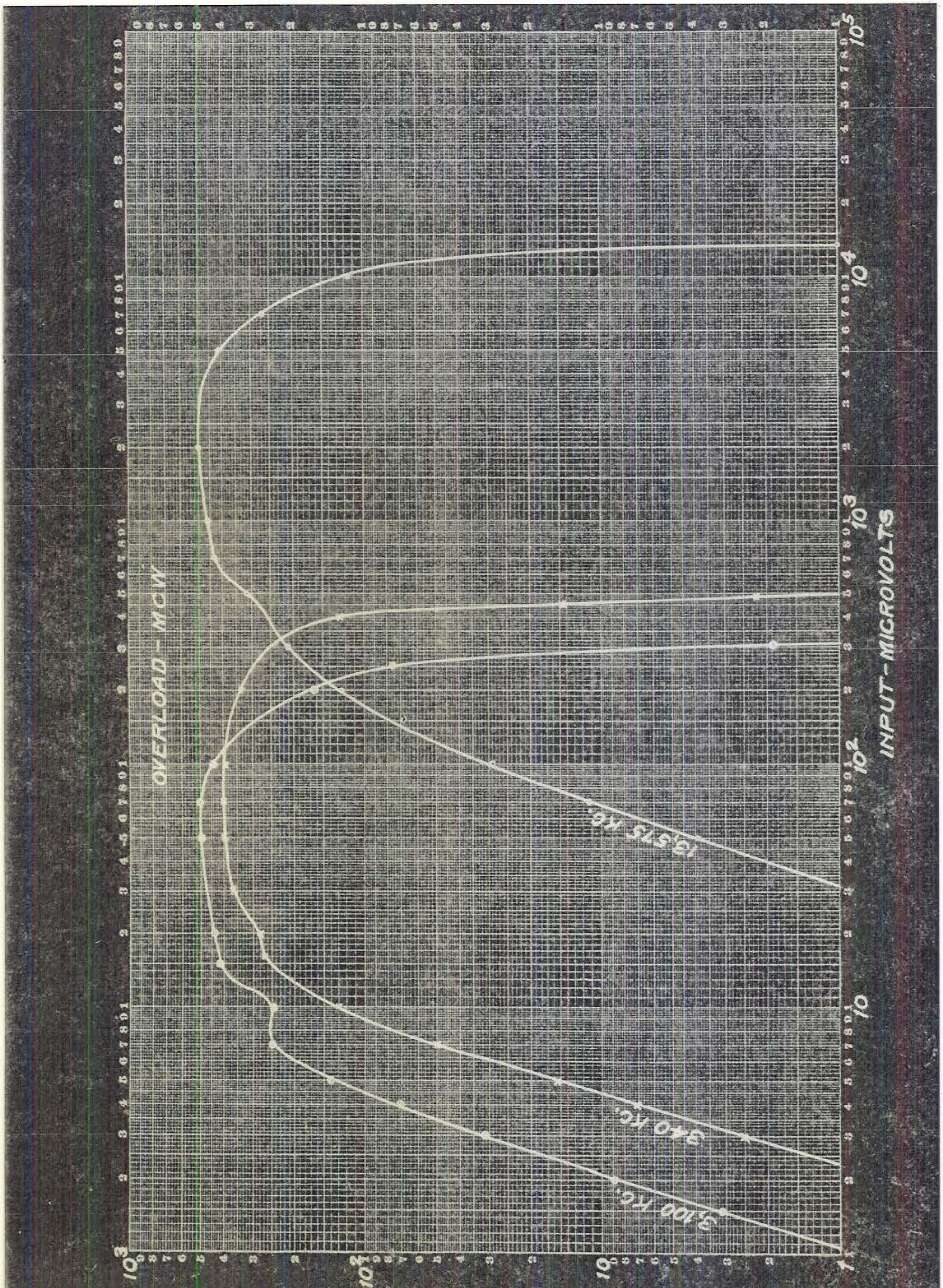

OVERLOAD - MCW
INPUT-MICROVOLTS
OUTPUT-MILLIWATTS
13,575 KC.
340 KC.
3,100 KC.
1
10
10^2
10^3
10^4
10^5

PLATE 2

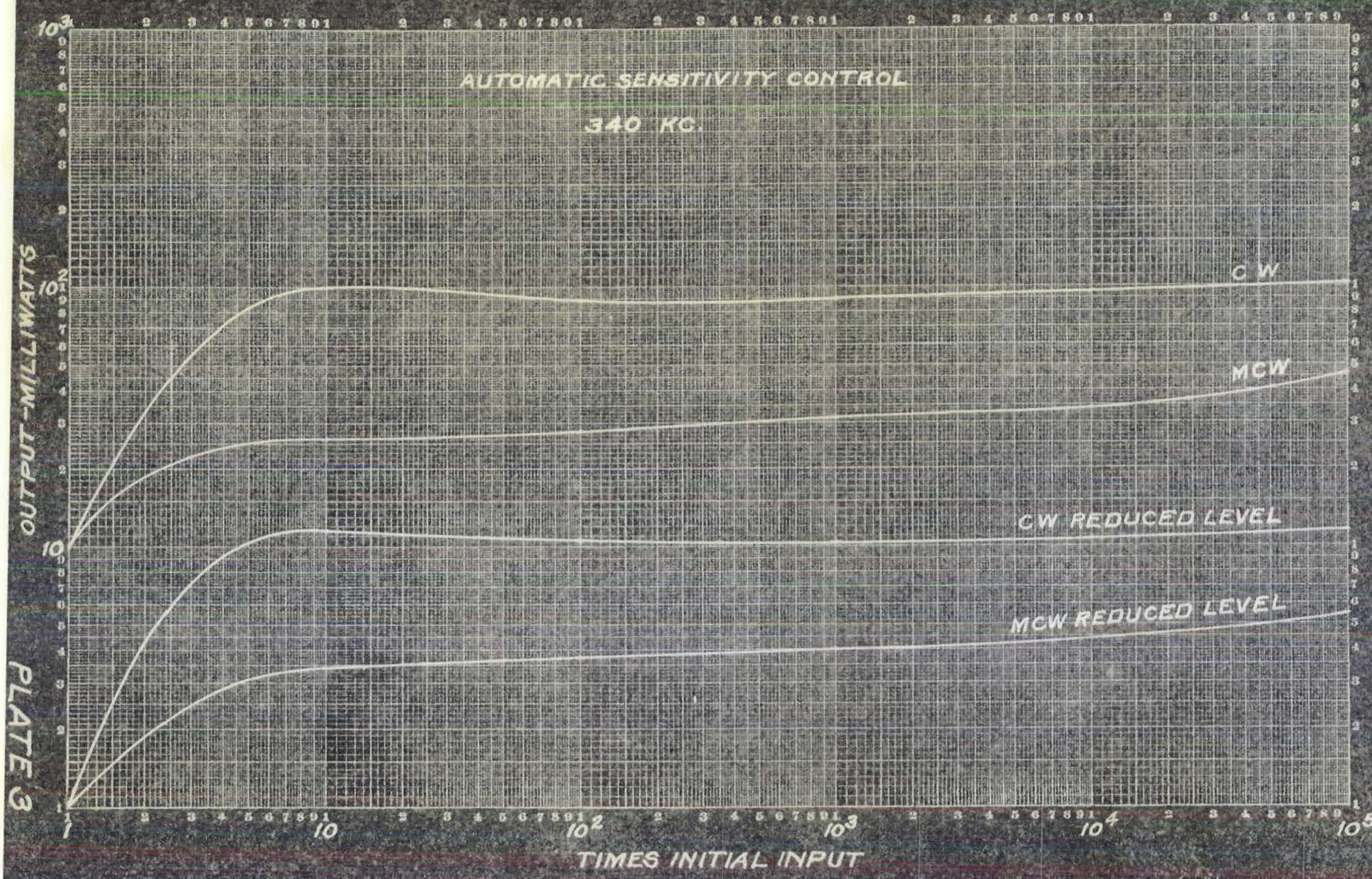

AUTOMATIC SENSITIVITY CONTROL
340 KC.
C W
MCW
CW REDUCED LEVEL
MCW REDUCED LEVEL
OUTPUT-MILLIWATTS
TIMES INITIAL INPUT

PLATE 3

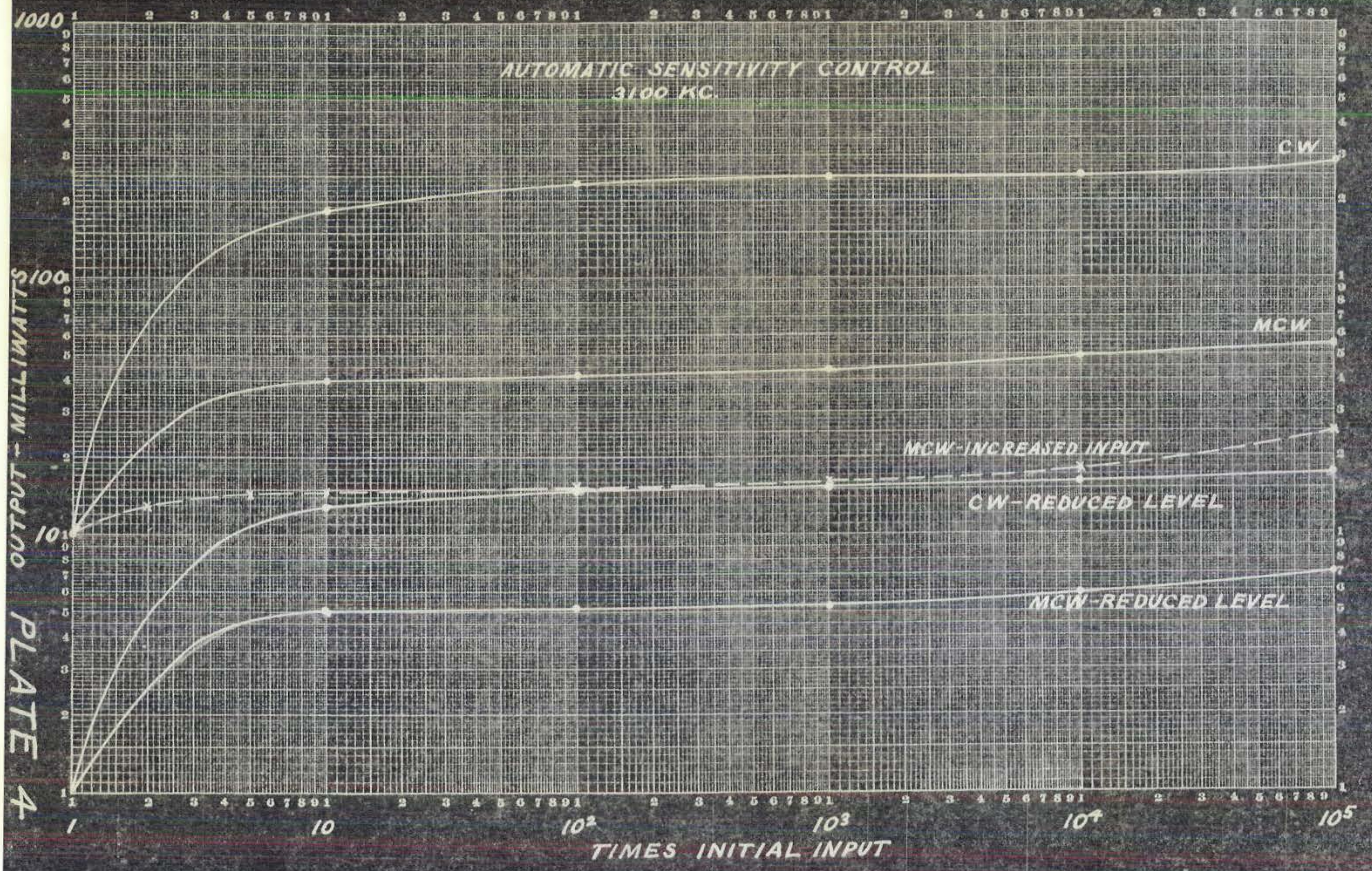

AUTOMATIC SENSITIVITY CONTROL
3100 KC.
CW
MCW
MCW-INCREASED INPUT
CW-REDUCED LEVEL
MCW-REDUCED LEVEL
OUTPUT - MILLIWATTS
1000
100
10
1
10
10^2
10^3
10^4
10^5
TIMES INITIAL INPUT

PLATE 4

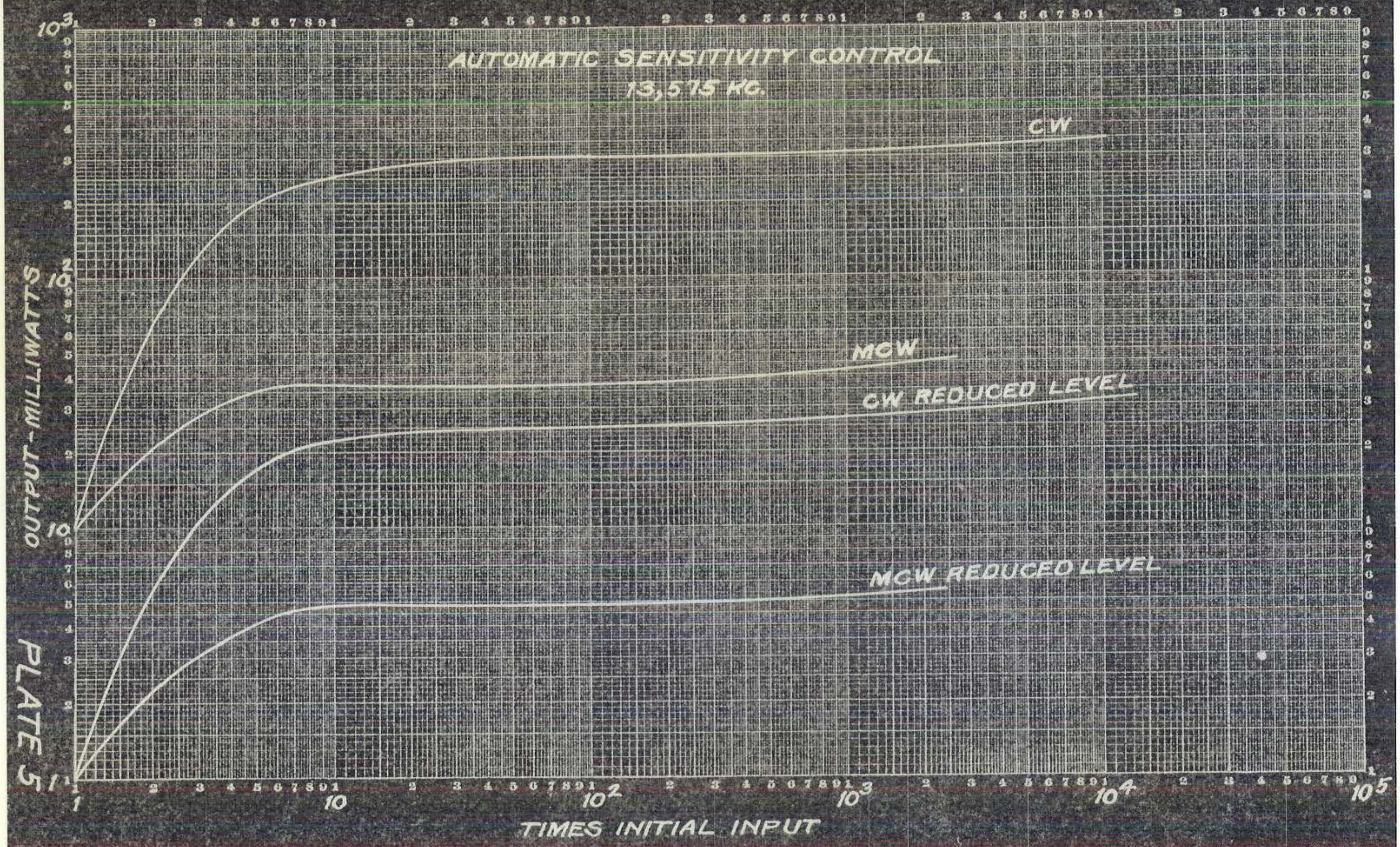

AUTOMATIC SENSITIVITY CONTROL
13,575 KC.
CW
MCW
CW REDUCED LEVEL
MCW REDUCED LEVEL
OUTPUT-MILLIWATTS
TIMES INITIAL INPUT
1
10
10²
10³
10⁴
10⁵

PLATE 5

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

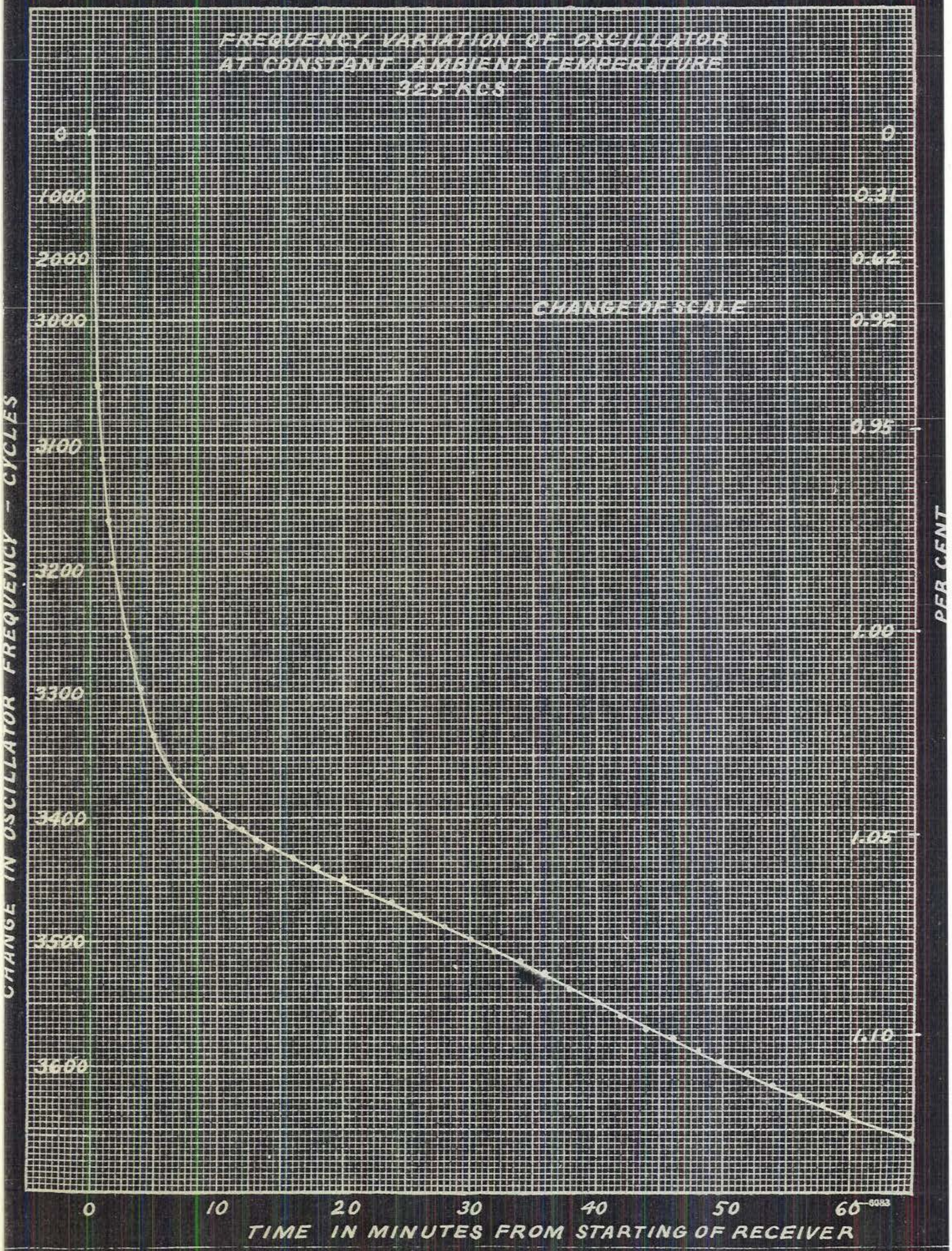


PLATE 6

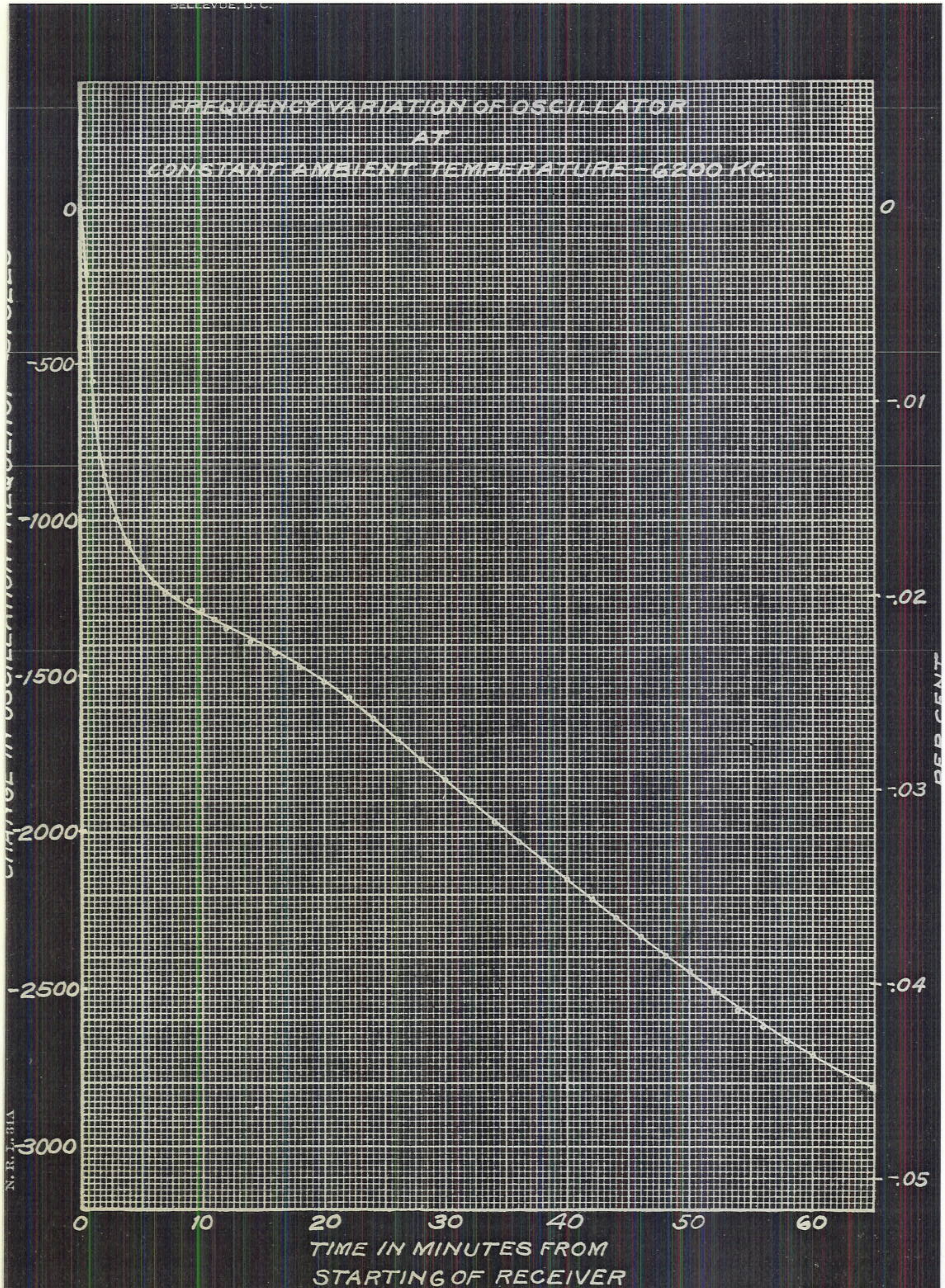
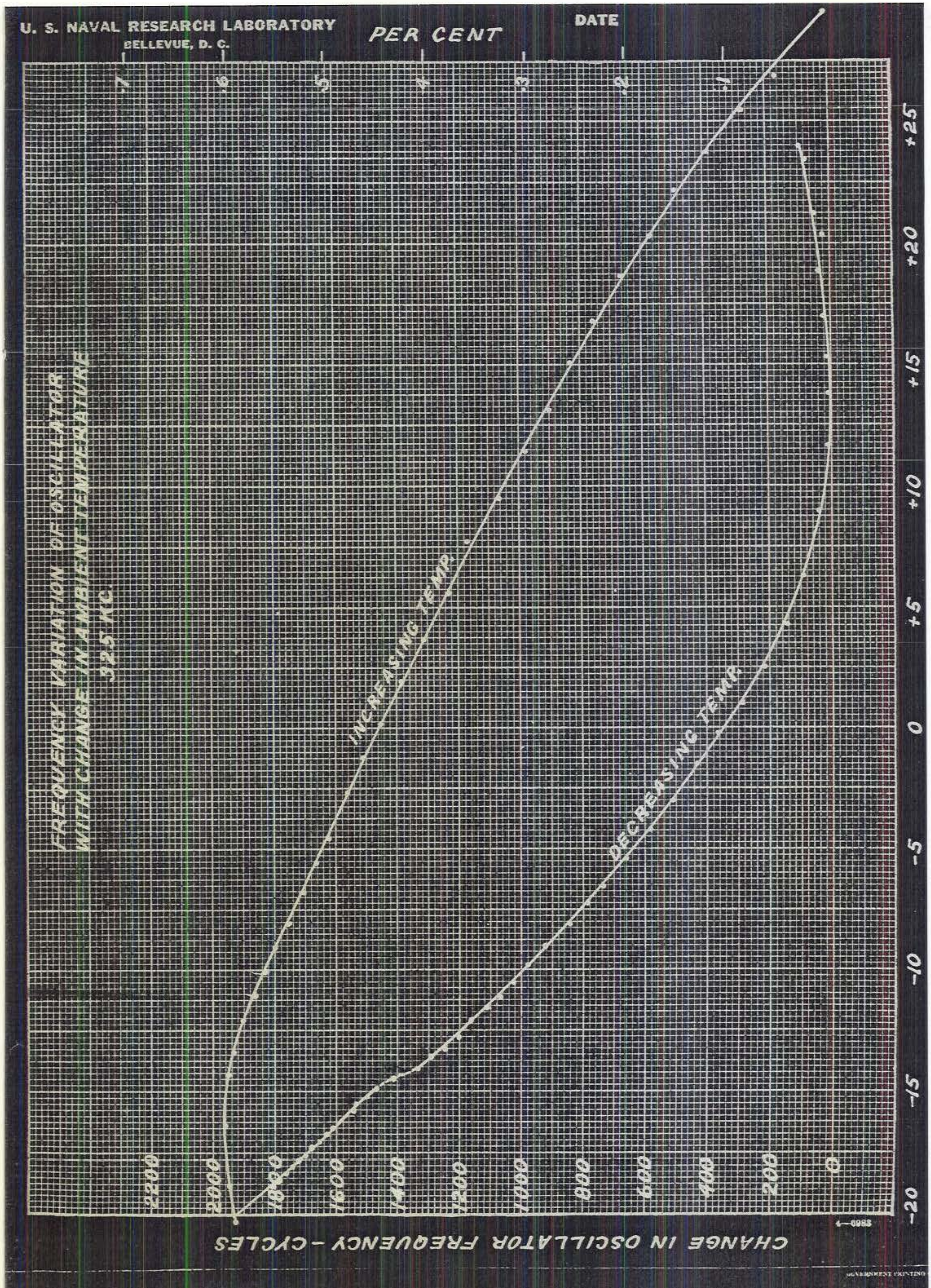

FREQUENCY VARIATION OF OSCILLATOR
AT
CONSTANT AMBIENT TEMPERATURE - 6200 KC.
0
-500
-1000
-1500
-2000
-2500
-3000
0
-.01
-.02
-.03
-.04
-.05
0
10
20
30
40
50
60
TIME IN MINUTES FROM
STARTING OF RECEIVER

PLATE 7



U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.
PER CENT
DATE
FREQUENCY VARIATION OF OSCILLATOR
WITH CHANGE IN AMBIENT TEMPERATURE
32.5 KC.
INCREASING TEMP.
DECREASING TEMP.
CHANGE IN OSCILLATOR FREQUENCY - CYCLES

PLATE 8

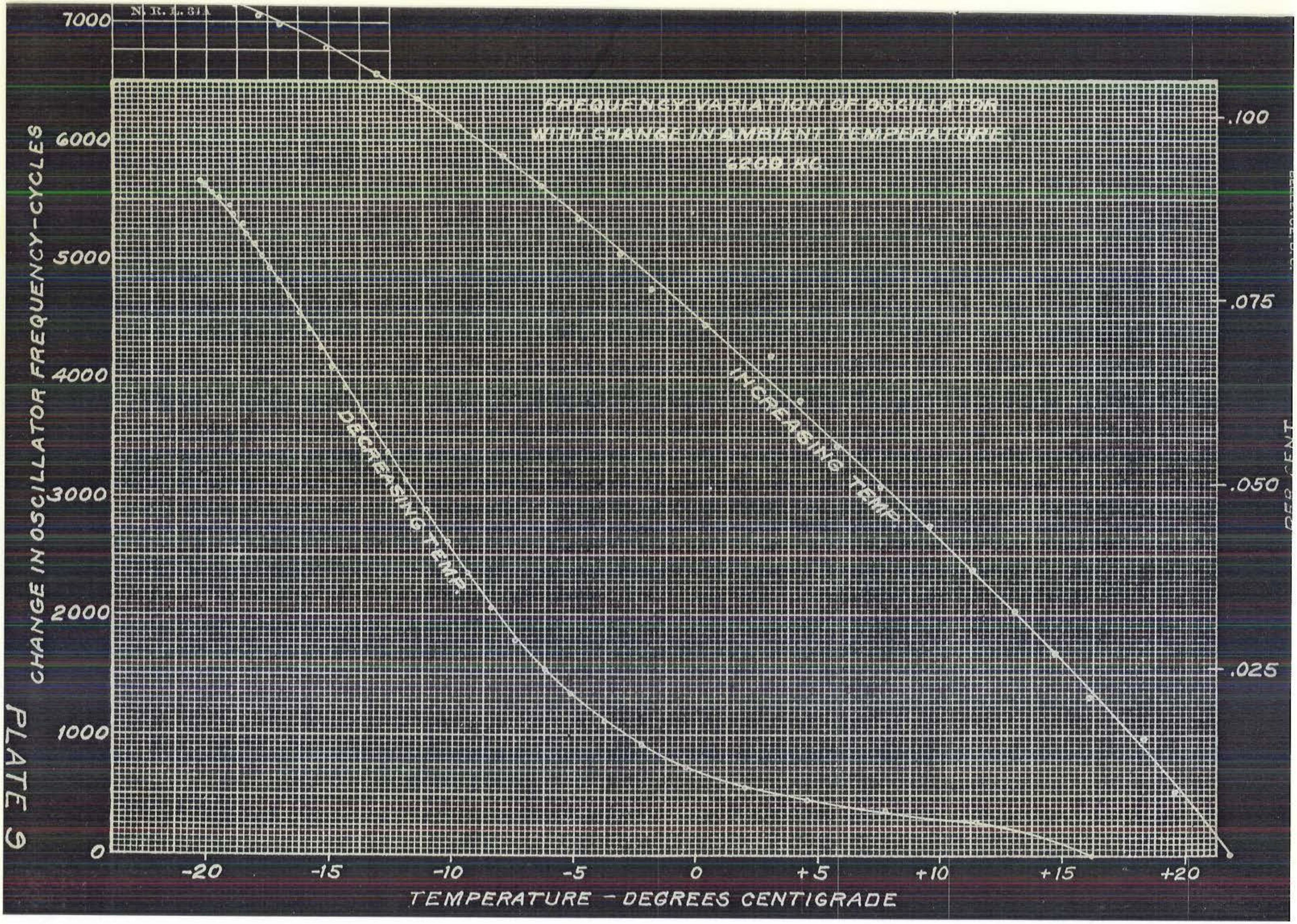

FREQUENCY VARIATION OF OSCILLATOR
WITH CHANGE IN AMBIENT TEMPERATURE
6209 KC.
INCREASING TEMP.
DECREASING TEMP.
CHANGE IN OSCILLATOR FREQUENCY-CYCLES
7000
6000
5000
4000
3000
2000
1000
0
-20
-15
-10
-5
0
+5
+10
+15
+20
TEMPERATURE - DEGREES CENTIGRADE
.100
.075
.050
.025
N. R. L. 314

PLATE 9

APPENDIX B

Refer to No.
F42-1(7)/NA6 (78)

U. S. NAVAL AIR STATION

ANACOSTIA, D.C.

April 9, 1936.

From: Commanding Officer.
To : Director, Naval Research Laboratory, Anacostia Station, D.C.

Subject: Radio - Aviation - Flight Tests of Model RU-4 Receiving Equipment.

Reference: (a) NRL letter F42-1/46, of 21 November 1935.
(b) Bu.Eng. letter, F42-1(11-8-W3) of 17 November 1934, to NRL, and NAS, Anacostia, D.C.
(c) Bu.Eng. letter NOs-42340(2-6-W3) of 19 February 1936, to INM, New York, NAS, Anacostia, and NRL, Anacostia Station.

Enclosure: (A) NAS, Anacostia, Memorandum, dated 4 February 1936, on Bu.Eng. RU-4 conference of same date.

1. Two contractor's models of the subject equipment, serial numbers 1 and 2, were received from the Naval Research Laboratory 8 November 1935, and were given ground tests at this station during the period from 21 November 1935, to 4 February 1936. The equipment was flight tested both in a Bellanca cabin transport monoplane XRE-1, No. 9838, and in an O3U-1 observation biplane, No. 8810, during an aggregate flight time of about fifteen hours.

2. No opportunity was had to flight test a dual receiver installation, especially in conjunction with a standard patrol plane radio installation.

3. In compliance with the Bureau of Engineering conference decision of 4 February 1936, one equipment (Ser. No. 1) was turned over to a representative of the contractor; the second equipment is still on hand at this station, subject to further disposition as may be directed.

4. Enclosure (A) contains the principal findings of this station, based upon the flight tests and ground examination of the subject equipment; additional verbal comments, made at the Bureau of Engineering conference of 4 February 1936, have been incorporated in enclosure (A) accompanying reference (c).

Subject: Radio - Aviation - Flight Tests of Model RU-4 Receiving Equipment.

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5. Referring to reference (a), paragraph 2, the following comments are made:

(a) Installation, adjustment, and operation are generally satisfactory, except as noted in reference (c) and enclosure (A).

(b) The receiver tunes satisfactorily with various types of aircraft antennae, and requires no readjustment of antenna alignment condenser in normal use with any given antenna (except loop).

(c) Receiver interaction was not tested in flight.

(d) The AVC action appears to be generally satisfactory, both on CW and MCW reception, except that the inherent recovery time from strong interfering signals renders the AVC position unsuitable for break-in keying. Retention of the present time constant is believed desirable for general utility, however.

(e) Flight noise levels at various frequencies varied between 0.3 and 2.5 volts, almost entirely as a result of imperfect shielding of the airplane ignition systems. The noise level inherent in the receiver was not considered excessive, either on MVC or AVC.

(f) No variations in sensitivity or output were noted as a function of direction of tuning adjustment.

(g) Operation of the receiver with the fixed wing type of direction finding loop was satisfactory, as long as the trailing antenna was reeled in. With a smaller loop, such as the "head-rest" type employed in single-seat airplanes, the loop trimming adjustment was quite critical and varied as a function of receiving frequency, as explained in paragraph 2(a) of enclosure (A).

6. With the changes required by reference (c) incorporated, this station considered the subject equipment to be suitable for its intended use in the Naval service.

K. McGinnis.

Copy to: Bu. Aero. (2)
N.A.F. (1)

U. S. NAVAL AIR STATION
ANACOSTIA, D.C.

4 February 1936.

Memorandum for Files.

Subject: BuEng. Conference 4 Feb. 1936, re RU-4 Receivers.

1. The subject conference at which the undersigned represented the Naval Air Station, Anacostia, was attended by Drs. Hull and Drake representing the contractor, Messrs. Schrenck and MacGregor of N.R.L., Lieut. Comdr. Goggins, Lieut. Cogswell, and Mr. Wright of Bu.Eng.

2. The following points were brought up or discussed by the Anacostia representative:

(a) Anacostia test data were produced showing that any given loop will match the antenna trimming only at a single frequency on any one set of coils, and that the trimming (or resonant loop constants) vary over a wide range for any coil set, and are different for each successive coil set. With low-resistance loops like the fighter head-rest type, this mis-matching frequently results in loss of 80 or 90 per cent of the sensitivity, when switching from antenna to loop, or vice versa, without re-trimming. The trimming for the "Specification loop" of 200 microhenrys and 50 mmfd matches the trimming for the specification antenna of 100 mmfd at about 700 kcs., when using the 545-850 kcs. coil unit; if used with an antenna of about 65 mmfd, trimming will be matched at around 540 kcs. The simplest way to make the antenna and loop trimming agree, if the loop constants permit, appears to be by use of the internal trimmer built into the receiver to trim the loop to the desired homing frequency, and then to make any necessary readjustment of trimming for the antenna by a small adjustable condenser inserted externally at the antenna terminal post. Anacostia should check built-in loop types, on airplane types under test, for compliance with desirable characteristics.

(b) By means of oscillograms taken at Anacostia it was shown that with one of the two 0.5 mfd. sections of the detector cathode by-pass condenser disconnected, the receiver "unblocking" time was decreased from the original value of 0.1 second to about .055 seconds, with resultant increase in break-in operating speed to about 20 words per minute. It was agreed that this speeding up of the receiver restoration was desirable, even though it involved a slight loss of response to the lower modulation frequencies below 200 cycles. The receivers should be supplied with the unused condenser section left disconnected, to permit adding a jumper at any time for the restoration of response to the low audio frequencies, as for example for a reed converter or "right-left" indicator use.

(c) The need was pointed out for a protective feature to enable rapid changing of coil units while keeping the receiver turned on. The contractor offered to do this by addition of a single bakelite guide rod, preventing coils to be inserted upside down, and offering all necessary protection. He has already done this in certain equipment for the Army.

(d) Desirability of leaving OPEN, rather than GROUNDING, the antenna for loop reception was pointed out; it was agreed, however, that this was relatively unimportant as long as the frequency did not approach antenna resonance, and that stray capacity coupling from an ungrounded antenna contact in the transfer switch would be difficult or impossible to avoid, with resultant impairment of directional bearings.

(e) Wrongly wired junction box auxiliary outlets are being corrected by contractor.

(f) Incorporation of a fixed resistor was suggested to drain static charges off the antenna, as encountered in certain rain or snow storms. In view of the conflicting and inconclusive evidence on the nature of such static encountered in flight, no further action was taken.

(g) It was agreed that addition of a heavy engraved DOT, to mark a reference point on both the antenna trimmer and volume control knobs, would be desirable for re-set and notation purposes.

(h) It was suggested that the level obtained with the A.V.C. be adjusted by shift of cut-off point rather than by attenuation in the head-set circuit, in order to retain maximum sensitivity to the weaker signals. Dr. Drake stated this might be feasible to a certain extent, but in the more sensitive condition may give rise to receiver instability, and in any event would require some research. He suggested an alternate improvement, immediately applicable, by substitution of a potentiometer type of resistor the headphones (with the slider connected to the receiver output) in place of the plain adjustable shunt resistor now used for AVC level adjustment, so that this adjustment would not affect the side tone when used in conjunction with GP class of equipment. It was agreed that this feature would be desirable, if further check showed it applicable in subject receivers.

(i) Despite wide-spread use on Manual volume control, Anacostia representative favored retention of AVC feature because of value in formation flying, etc. No elimination of AVC proposed at present.

(j) Contractor states that up to present time the 50-step Allen Bradley volume control resistor, despite its shortcomings, appears to be the most dependable type. Recent improvements have been made in it. A recently developed continuously variable type looks very promising, but has not yet proved thoroughly dependable.

(k) Anacostia representative suggested optimum receiver output impedance of 300 rather than 600 ohms be required in future specs.

(l) Agreed that supply voltage variation range of 11 to 15 volts was more representative of service conditions than present specified test range of 12 to 16 volts; should be changed in future spec.

Malcolm P. Hanson
Radio Engineer.

Encl. (A) - C.O., NAS, Anacostia, letter
F42-1(7)/NA6 (78) of 9 April 1936.