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DATE 23 January 1942

SUBJECT

Test of Model N-S27C Radio Receiver

Made by the Hallicrafters Company

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Report on

Test of Model N-S27C Radio Receiver
Made by the Hallicrafters Company

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AUTHORIZATION OF TEST

1. The tests to be reported were authorized by reference (a). Other references are listed below.

References:
(a) BuEng. ltr. C-S67/46 (7-28-R8) July 30, 1938.
(b) Hallicrafters Company Descriptive Specification, October 17, 1940.
(c) BuEng. Specifications RE 13A 554A.
(d) BuEng. Specifications RE 13A 555B.
(e) BuEng. Specifications RE 13A 557D.
(f) Hallicrafters ltr. to NRL, October 18, 1940.
(g) Radio - Contract No. N173s4056, November 25, 1940.
(h) General Specifications for Inspection of Material, Navy Department, September 1, 1934.
(i) Hallicrafters Co. Instruction Book for Model N-S27C Radio Receiving Equipment

OBJECT OF TEST

2. The object of the tests was to determine the structural and performance characteristics of the Receiver with respect to the Manufacturer's descriptive specifications, reference (b).

3. A further object was the determination of desirable improvements which would increase the suitability of the Receiver for Naval service.

ABSTRACT OF TEST

4. The Receiver was subjected to a general inspection of construction and wiring. The following electrical tests were made:

(a) Sensitivity and search for dead spots
(b) Selectivity
(c) Fidelity
(d) Input and output impedance
(e) Automatic volume control characteristics
(f) Audio output harmonic distortion
(g) Image signal rejection
(h) Intermediate-frequency signal rejection
(i) Oscillator frequency stability against changes in line voltage
(j) Oscillator frequency stability against changes in ambient humidity
(k) Oscillator frequency stability against changes in ambient temperature
(l) Oscillator frequency drift during warm-up and manipulation of controls
(m) Oscillator frequency shift on replacing oscillator tubes
(n) Input-level "S" meter calibration
(o) Radio-Frequency gain control characteristics
(p) Audio-Frequency gain control characteristics
(q) Temperature rise
(r) Vibration Test

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(s) Shock test
(t) Rocking test
(u) Radiation at oscillator frequency
(v) Tuning control backlash
(w) Calibration and Reset accuracy
(x) Power requirements
(y) Check for use of iron in structure
(z) Time required for tuning
(aa) Depth of modulation characteristic
(bb) Resonant overload
(cc) Frequency-modulation limiter characteristic
(dd) Frequency-modulation discriminator characteristic
(ee) Reserve gain
(ff) Overload selectivity
(gg) Cross modulation selectivity
(hh) Maximum power output

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CONCLUSIONS

(a) The Model N-S27C Receiver meets the stipulations of the Manufacturer's descriptive specifications, reference (b), with certain exception

(b) In general, the construction of the Receiver is sturdy and the accessibility of components good. Generally good materials and design are evident throughout with exception of the type of hook-up wire used and of the lack of sufficiently thick silver facing on contacts used in switches and rotary condensers. No provision is made for securing the Receiver to a table. Withdrawal of the chassis from the cabinet requires the removal of screws from the bottom of the cabinet.

(c) The oscillator frequency is affected by changes in ambient temperature and humidity, although this instability is relatively unimportant if a local frequency reference, such as a transmitter or a crystal frequency indicator is available. The bandwidth of the intermediate-frequency channel at the 6 db attenuation level is much too small to assure reliable reception without adjustments to compensate for first oscillator frequency instabilities arising from various causes and probable drift in transmitter frequencies. This feature appears to be of consequence in searching service also because it restricts the speed at which the tuning may be varied without danger of passing over a signal unnoticed. For communication service, this relatively narrow acceptance bandwidth appears to be of little consequence if the receiver is to be attended and if the attendant has at his disposal suitable frequency standards for tuning adjustments as required. The selectivity curve bandwidth ratio between 60 db and 6 db levels is considered poor as compared to existing Navy receivers.

(d) The operation of the Receiver is simple, tuning being accomplished with a single control. The Receiver is therefore suitable for searching or other applications in which rapid shifts in tuning are desirable.

(e) The Receiver cannot be accurately preset to a given frequency by its own calibration, as no crystal calibrator is included. However, it would be satisfactory in communication service when the frequency to be received is identical with the local transmitter frequency, permitting the Receiver frequency to be adjusted to the latter. An external calibrating device would be essential to preset the Receiver with precision to frequencies other than those of local transmitters.

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RECOMMENDATIONS

Deficiencies in design, construction and performance of the Receiver are cited throughout the report and are summarized in paragraph 163. Recommendations for their correction are listed below under headings "A" and "B". Under "A" will be found recommendations of deficiencies to effect compliance with the Manufacturer's descriptive specifications, reference (b). The modifications and corrections recommended under "B" together with the recommendations under "A" are considered necessary if the Receiver is to comply with existing Navy general specification, only a few items of which, however, are covered in reference (b).

A. In order that the Receiver be brought into compliance with the Manufacturer's descriptive specifications, reference (b), it is recommended that:

(a) The design of the audio output circuits be altered to provide maximum output into a 600 ohm load at the phone jack and also at one pair of terminals at the rear of the chassis. Ref. paragraph 149.

(b) That the preselector circuits be modified to provide at least 60 db image rejection at all operating frequencies. Ref. paragraph 92.

(c) That the electrical design be modified to reduce total distortion to 5% under all operating conditions likely to be encountered. Ref. paragraph 95.

B. That the Receiver may comply with structural specifications generally applicable to radio receiving equipment for Naval service, it is additionally recommended:

(a) That hook-up wire will be used which will pass Navy specifications relative to moisture, spray and heat resistance. In particular, that rubber (or equivalent homogeneous) covering be incorporated as a part of the insulation on all wiring carrying direct currents or radio-frequency voltages of any amounts. Ref. par. 105, 124.

(b) That solid silver contact surfaces be provided at all locations where radio-frequency currents must be conducted across sliding or rotating contacts. This refers particularly to band switches and tuning condenser rotor contacts. All wafer switches should be replaced by switches having solid silver contacts similar to the newly developed Oak or Yaxley Mallory switches which have solid silver contacts and would be preferable to those employed in the subject Receiver. Ref. par. 109, 110, 111.

(c) That the arbitrary logging scale markings on the main tuning dial be printed in a different color or otherwise distinguished to avoid the confusing identification with the legend "megacycles" applying apparently to the entire dial. Ref. par. 155.

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(d) That handles be provided on the front panel to facilitate withdrawal of the chassis from the cabinet. Ref. par. 118.

(e) That the chassis and cabinet design be altered to permit ready removal of the chassis from the cabinet after loosening captive screws on the front panel. Rails or similar means should be provided to allow the chassis to slide freely to a partially removed position at which it may be secured for servicing or to permit the chassis to be withdrawn completely from the cabinet when necessary for more extensive repair. In practice, the Receiver will be permanently mounted through shock proof mounts as recommended in the following paragraph. Ref. par. 86, 118.

(f) That means be provided for securing the cabinet of the Receiver to a table through the medium of suitable shock mounts, such as four Lord mounts each rated at 20 pounds. The chassis should not be secured to the bottom of the cabinet. Ref. par. 86, 116, 118.

(g) That provision be made for locking the tuning control in any desired position. While it is recognized that there is no need for this improvement in searching operations, it is believed desirable from the point of view of possible use of the Receiver for communications purposes in which a fixed tuning adjustment must be maintained without disturbance due to accidental contact with the tuning control knob or its crank. Ref. par. 137.

(h) That the springs on the main tuning drive clutch and on the two-section gears in the tuning drive be made of non-corrosive material or be so treated that they will not corrode or rust. Ref. par. 134.

(i) That a clip designed to receive a protective gap across the antenna input circuit be mounted in the Receiver. It would then be readily possible to install such a gap if this proves desirable when working near powerful transmitters. Ref. par. 107.

(j) That the glass window over the main tuning indicator dial be more firmly secured in place so as to prevent rattling during vibration. Ref. par. 113.

(k) That the main tuning control knob be provided with a crank to facilitate rapid changes in tuning. Ref. par. 136.

(l) That a wax impregnation treatment be applied, where practicable, to radio-frequency and intermediate-frequency coils as well as to the fixed resistors, fixed condensers and terminal strips. Ref. par. 98.

(m) That the main tuning and logging dials be constructed of a heavier material having less brittleness and a smaller tendency to warp. Ref. par. 134.

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(n) That consideration be given to the procurement of spare parts packed in a suitable box for each of the subject Receivers purchased under future contracts. Ref. par. 160.

(o) That the long shaft coupled to the antenna trimmer condenser be equipped with additional bearings in order to provide greater sturdiness. Ref. par.112.

(p) That lock washers of the split ring or similar type be provided in order to assure unimpaired locking action after several disassemblies and reassemblies. Ref. par. 122.

(q) That insulation of suitably high grade be used in the construction of all radio-frequency tuning condensers. Ref. par. 124.

(r) That all joints in the wiring be cleaned after soldering. Ref. par. 125.

(s) That all components be suitably marked to designate their location in the circuit. Ref. par. 126.

(t) That non-ferrous materials (or iron suitably protected against corrosion and rust) be used for the plate supporting the bearing at one end of the antenna trimmer condenser shaft and for all hardware in the phone jack frame. Ref. par. 131.

(u) That a diode noise limiter of the series type be employed in place of the shunt type as used in the subject Receiver. Ref. par. 148.

(v) That an input level meter calibrated with respect to some standard signal, such as five microvolts, be used in place of the meter used in the Receivers tested which indicate in terms of "S" units. Ref. par. 150.

(w) That an instruction book of suitable scope be furnished with future models of the subject Receiver. Ref. par. 158.

C. The following recommendation does not imply any design deficiency but is intended to suggest a change in antenna terminal arrangements to permit the use of concentric lines and fixtures, achieving uniformity in installation with modern Naval radio receiving equipment. It is recommended:

(a) That an unbalanced antenna input terminal be provided at the rear of the Receiver and equipped with Navy type --49120 concentric jacks, drawing #RA 49F 215. These jacks would permit use of Navy type --49122 or --49123 concentric patch cords (drawing #RA 62F 218) connecting the Receiver through a Navy type --62019 or --62020 receiver junction box (drawing #RA 62F 219) to the receiving antenna plugboard (drawing #RA 49F 219, 220, 221, 222 or 223). Where direct connection to the

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antenna is desired, a type 49152 binding post adapter (dwg. #RA 49AA 225) could be employed; this adapter would be also convenient in connecting the receiver direct to a single wire feeder from an antenna for test purposes or in locations where concentric line feeders are not used. Ref. par. 88, 153.

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MATERIAL UNDER TEST

5. The material under test consisted of three radio receivers, Model N-S27C, serial numbers 1, 2 and 3.

6. The Model N-S27C Radio Receivers were manufactured and supplied by the Hallicrafters Company, Inc., Chicago, Illinois, under contract, reference (g). They were delivered to the Naval Research Laboratory for test on September 3, 1941.

METHOD OF TESTS.

7. The following instruments were used for electrical tests:

(a) Signal generator, General Radio Company, Model 804B, Serial No. 206.

(b) Standard Signal Generators, Ferris Instrument Corporation:
Type 16C, Serial No. 44.
Type 18B, Serial No. 65.

(c) Standard Signal Generator, Measurements Corporation, Type 65B, Serial No. 108.

(d) Experimental Radio Receiver, R.C.A. Manufacturing Company. Model XRAQ.

(e) Radio Receiver, National Company, Model RAS, Serial No. X79.

(f) Vacuum-Tube Voltmeters, General Radio Company, Type 726A, Serial No. 628. Type 726A, Serial No. 1397.

(g) Wattmeter, Weston Electrical Instrument Corporation, Model 310, Serial No. 7803.

(h) Ammeter, Weston Electrical Instrument Corporation, Model 370, Serial No. 2791.

(i) Voltmeter, Weston Electrical Instrument Corporation, Model 433, Serial No. 29594.

(j) Electronic Voltmeters, Ballantine Laboratories, Inc. Type 300, Serial Nos. 14, 194 and 195.

(k) Foot-Candle meter, Westinghouse Electric and Manufacturing Company, No. 8804.

(l) Wave analyzer, General Radio Company, Type 736A, Serial No. 289.

(m) Power output meters, General Radio Company:
Type 483F, Serial No. 650
Type 483F, Serial No. 649
Type 583A, Serial No. 64
Type 583F, Serial No. 16

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(n) Output meters, Naval Research Laboratory
No. 19A, Serial No. 6343
No. 22A, Serial No. 106
Serial No. 2508

(o) Beat Frequency Oscillator, General Radio Company, Type 713B, Serial No. 766.

(p) Harmonic Generator, Locked Oscillator Type, Naval Research Laboratory, Serial No. 105.

(q) Mercury thermometers.

(r) Temperature Control Room, Shop, Naval Research Laboratory.

(s) Vibration Table, Transmitter Building, Naval Research Laboratory.

(t) Super Frequency Heterodyne Caliorator, Naval Research Laboratory, No. 2.

(u) Cathode-Ray Oscillograph, Allen B. DuMont Laboratories, Inc., Type 208, Serial No. 292.

8. After unpacking and inspecting the Model N-S27C Receivers, serial numbers 1, 2 and 3, they were subjected to preliminary overall electrical tests which indicated that they were all in operating condition. It was noted that the antenna input terminals of Receiver serial number 2 had been damaged, apparently by a blow from the direction of the top of the Receiver which bent the aluminum plate on which the three terminals were mounted and also cracked the insulation of the two antenna binding posts. Otherwise, all three Receivers appeared to be in good mechanical condition.

9. During all tests, unless otherwise noted, the line voltage to the Receiver was maintained at 115 volts, 60 cycles.

10. Sensitivity to amplitude modulated signals was measured with the aid of a General Radio Type 804B Signal Generator, which was found to have less frequency modulation than the Ferris Type 18B Generator. For this test the Receiver was operated with audio gain at maximum, AVC off, noise limiter off, and the tone control at 9. At each frequency, the antenna compensator was varied for maximum output, and the R-F gain control varied for standard noise output. Signal to noise ratios of 5:1 (6 mw : 1.2 mw) were measured across 600 ohms resistance in the 500 ohm termination, with the aid of a vacuum tube voltmeter. The input to the receiver was fed to one antenna post and ground, with the other antenna post grounded, through a General Radio Type 774X1 insertion unit and 10:1 attenuator. Since this combination gave an effective signal generator output impedance of 75 ohms, no dummy antenna was used. The input signal was modulated 30% at 1,000 cycles. Measurements were made throughout the range of the receiver, at 10 Mc intervals. A check of these measurements was made with the Ferris Type 18B Signal Generator, using a 68 ohm non-inductive resistor as a dummy antenna. Readings could not be taken at frequencies higher than 155 Mcs, due to the limited range of this signal generator.

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11. Selectivity measurements were taken of both the I-F amplifier of the Receiver, and the overall selectivity. For the I-F selectivity, input was fed to the converter grid, and readings were taken of the input off resonance necessary to give the same output as readings at resonance. Input was modulated 30% at 1,000 cycles. The receiver was kept in AM operation, with noise limiter and AVC off. For overall selectivity, the receiver was set up as for standard MCW sensitivity, and the signal generator set up with the aid of the heterodyne frequency calibrator to give frequencies above and below resonance. At each frequency, the input was adjusted to give standard output, and that value of input noted. Readings were taken at the ends and the middle of the receiver frequency range, with increments for each curve being 100 kilocycles plus and minus the resonant frequency.

12. Fidelity characteristics were taken through the entire receiver to the audio, through the intermediate-frequency amplifier to the audio, and through the audio alone. For the overall fidelity, the receiver was first set up for a convenient output across 600 ohms in the 500 ohm termination, with 50 microvolts input modulated at 30%. Readings of output voltage were then taken for different frequencies, with the tone control at 0, 5, and 9. The same set of readings was taken with the output this time fed through the intermediate-frequency amplifier and into the audio amplifier. The characteristics were repeated with the input first through the AM detector into the audio, and again with the input in series with the FM detector. All measurements were taken below the point of overload for either the R-F or A-F stages of the receiver.

13. Input impedance was measured by setting up the receiver for standard output (standard sensitivity) and recording the value of input voltage. A resistor, non-inductive, of the same order of magnitude as the input impedance of the receiver, was then placed in series with the receiver, and the input to the receiver from the signal generator at the frequency under test was varied until the same output was obtained. Assuming the impedance of the input to be a pure resistance, the impedance of the input was calculated from the above data. This measurement was repeated at suitable intervals throughout the range of the receiver.

14. Output impedances from the receiver were measured at the three output terminals - the phone jack, the 500 ohm termination, and the 5,000 ohm termination. The test was made with a General Radio power output meter with variable impedance. For each measurement the impedance was varied for maximum output, and the impedance noted at that point. Measurements were made with 30% modulation at 1,000 cycles. The test was conducted at low and high power output levels.

15. Automatic volume control characteristics were taken at 150 MCS with the audio gain reduced to prevent the audio amplifier from overloading. With AVC on, the receiver was adjusted with the R-F gain control at the same position as for standard sensitivity. Readings were taken of both signal plus noise and carrier noise alone, for different values of input signal. The modulation used was 30% at 1,000 cycles.

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16. The audio output harmonic distortion was measured with input held constant at 100 microvolts. A wave analyzer was connected across 560 ohms in the 500 ohm output termination, and used to obtain the harmonic voltages across the output. The input for this test was fed directly to the mixer grid, at the intermediate-frequency, and distortion measured as a function of the percentage of modulation of a 400 cycle tone. The same test was repeated, but this time the audio frequency modulation was kept constant at 30%, but with the frequency varied. Another distortion measurement was made with 30% modulation at 400 cycles, but the input voltage to the intermediate-frequency amplifier varied. The last distortion measurement was made with 1,000 microvolts input to the intermediate-frequency amplifier, modulated 30% at 400 cycles, maintaining a constant power output of two watts into load resistances of various sizes in the 500 ohm termination, by varying the R-F gain.

17. For image signal rejection determinations, the Receiver was set up as for standard MCW AM sensitivity, and the output noted. The signal generator frequency was then shifted to 32 MCS lower than the receiver frequency, and the input adjusted to give standard output from the Receiver. This value of input divided by the sensitivity input and expressed in decibels was recorded as the image rejection ratio. Readings were taken at 20 MC intervals throughout the range.

18. Measurements of intermediate-frequency signal rejection were taken with the Receiver set as for standard MCW AM sensitivity. A low frequency signal generator, at 16 MC was then substituted for the ultra-high frequency signal generator, and the input to the Receiver varied until the standard output was obtained. For this test, both signal generators were modulated 30% at 1,000 cycles. The input from the low frequency generator, divided by the input from the high frequency generator, for standard output conditions, expressed in decibels, is the intermediate-frequency signal rejection, for measurements with the low frequency signal generator, a 68 ohm non-inductive resistor was used as a dummy antenna. Readings were taken at 10 MC increments throughout the band.

19. Variation of oscillator frequency with line voltage was measured at 200 MC with the aid of a heterodyne frequency calibrator, loosely coupled to the oscillator of the Receiver. At each measurement the heterodyne frequency oscillator was tuned to zero beat with the output from the Receiver oscillator, and the frequency of the signal noted. Checks were made at frequency intervals, of the calibration of the heterodyne frequency calibrator, with the aid of a standard crystal. The line voltage was shifted in small increments, and after the Receiver had stabilized, readings were taken of the oscillator frequency. Changes in line voltage were made both above and below the 115 volts standard line voltage used for all other measurements. The same measurement was made with variation of line frequency and fixed line voltage.

20. Oscillator frequency stability against changes in ambient humidity was determined as follows: the Receiver was set up in the temperature-humidity control room at the Naval Research Laboratory, and the oscillator output loosely coupled to the heterodyne frequency calibrator and monitored. While the ambient humidity was undergoing change, frequent checks were made of the Receiver oscillator frequency by tuning to zero

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beat with the heterodyne frequency calibrator. The signal was monitored continually to notice any sudden changes in oscillator frequency that may have been due to moisture. Checks were also made of the Receiver gain during the test.

21. Temperature tests were made in the temperature control room of the Laboratory shop in order to determine changes in Receiver gain and oscillator frequency in the presence of varying ambient temperatures. A modulated signal was applied to the Receiver through a flexible concentric cable from an ultra-high frequency signal generator. The output from the Receiver was measured by an output meter and monitored by headphones. An auxiliary Receiver was used to pick up the beat note between the oscillator in the Receiver under test and the heterodyne oscillator of a heterodyne calibrator made in this Laboratory. The heterodyne calibrator frequency was adjusted to zero beat against the Receiver oscillator for each frequency drift reading. The heterodyne calibrator was also checked against its standard crystal oscillator before each reading. The Receiver oscillator drift was calculated from the heterodyne calibrator dial readings by use of the slope of the calibrator frequency calibration curve.

22. The oscillator frequency drift during warm-up, and change with variations of controls were checked as follows: the Receiver was set up as for standard sensitivity at a desired frequency, and the heterodyne calibrator, loosely coupled to the oscillator, used to receive the oscillator signal. Readings were taken of the oscillator frequency during warm-up, by obtaining a zero beat with the oscillator of the heterodyne frequency calibrator. After this test had been completed, the controls of the Receiver were varied and note was made of the shift in frequency of the oscillator with variation of the controls.

23. The oscillator frequency shift on replacing oscillator tubes was determined in the following way: After the Receiver had been warmed up for a considerable length of time, readings were taken of the oscillator frequency. The original oscillator tube was then replaced by another tube of the same type, and readings taken of the oscillator frequency at suitable intervals after replacing the oscillator tube. This was repeated with several other tubes. During these measurements, no other controls were varied.

24. In order to calibrate the 'S' meter, the signal generator was connected directly to the Receiver. With the R-F gain switch full on, and with AVC on, the input to the Receiver was varied and note made of the values of input which caused the 'S' meter to read at one of the calibrated points.

25. Radio-frequency gain control characteristics were measured by first setting up the Receiver as for standard sensitivity. Readings were then taken of the input necessary to give standard output with different settings of the R-F gain control. The results were expressed in terms of decibels attenuation from the input necessary to give standard output at maximum position of the gain control.

26. Audio-frequency gain control characteristics were measured by first setting up the receiver as for standard AM sensitivity, and then increasing the R-F gain control to a point just below the overload of the

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audio amplifier. Readings were then taken of the output for different settings of the gain control. With the output at maximum gain taken as standard, the attenuation of the control was expressed in decibels.

27. The temperature rise of the interior of the Receiver was measured by first setting up the Receiver with both R-F and A-F gain controls full on, with AVC and noise limiter off, and with a 500 ohm load on the 500 ohm termination at the back of the Receiver. Thermometers were then strapped on to the filament and high voltage transformers, and another suspended in the space near the high frequency section of the Receiver. Readings were taken of the temperature on each of these thermometers at suitable intervals, and compared with a thermometer measuring the ambient temperature outside of the cabinet. The test was continued until it was evident that an equilibrium had been reached.

28. Vibration tests were carried out on the shake table belonging to the radio transmitter section of this Laboratory. As furnished by the manufacturer, the Receiver could not be secured to a table. In order to mount it for vibration testing, the four rubber mounting feet furnished by the manufacturer were removed from the cabinet and for them were substituted four Lord shock mounts, each being rated at 25 pounds. These shock mounts were secured by machine screws to a stiff plywood board which in turn was bolted to the vibration table. A modulated signal from an ultra-high frequency signal generator was applied to the Receiver through a concentric cable. The output from the Receiver was observed by an output meter and monitored by headphones. In conducting the test, attention was given to changes in the signal generator frequency dial setting for maximum output from the Receiver and to the input required from the generator for a standard output over the available range of vibration frequencies, and for some time at each of the observed critical mechanical frequencies.

29. Shock tests were carried out on the shake table of the radio transmitter section of this Laboratory using the pneumatic ram developed in that section for imparting very strong horizontal blows to the steel table top on which the Receiver was mounted as described in paragraph 27. Before and after each impact of the ram, signal generator readings were made for standard Receiver output, as in the vibration test.

30. Rocking tests were carried out with the aid of the equipment described in paragraph 27. The Receiver was rocked through angles up to plus or minus 45 degrees from the vertical while signal generator readings were made for standard Receiver output as in the vibration test.

31. The radiation voltage from the Receiver oscillator appearing at the antenna terminals was measured by substitution. A Receiver that covered the same range as the oscillator of the Hallicrafter Receiver under test was coupled through a 5 mmfd capacitor to the Receiver under test. Both Receivers were loaded with 68 ohms to represent a dummy antenna. The Receiver used for measurement was tuned to the oscillator frequency and the output noted by means of a carrier meter. The signal generator was then substituted for the Receiver under test, and the output adjusted at the same frequency until the same reading was observed on the carrier meter. This reading of signal generator output voltage was recorded as the oscillator voltage appearing at the antenna terminals. The controls of the Receiver

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were also varied to determine any interdependence of oscillator output voltage with control position. This test was repeated at suitable frequency intervals throughout the band.

32. Backlash was measured by first setting up the Receiver to a given input frequency from the standard signal generator, and noting the reading of the linearly calibrated scale on the Receiver at the position of maximum audio output, as the signal is approached first in a clockwise, then counterclockwise direction. The input signal was modulated 30% at 1,000 cycles. The difference between the readings so obtained, is the backlash. This test was repeated with another observer in an attempt to minimize personal error of observation.

33. Calibration accuracy was measured by first allowing the Receiver to stabilize after about four hours of operation. The Receiver was then set to each of the frequencies at which the check was to be made, and the output loosely coupled into a heterodyne frequency calibrator which had also warmed up. Checks were made of the calibration of the heterodyne frequency oscillator at each frequency of test, by means of the standard 5 MC crystal incorporated therein. Reset accuracy was determined by setting the Receiver to a given frequency and noting the oscillator frequency at each setting. Allowance had to be made for the fact that the oscillator was 16 MC below the Receiver frequency. Two observers were used for this test to minimize personal errors of observation.

34. The power requirements of the Receiver were measured with a wattmeter in the A-C supply, and noted with each change of switch or control positions that affected the power consumed by the Receiver. The power factor was measured at the same time, by comparing the results obtained with a wattmeter, against the results obtained by the use of ammeters and voltmeters. Ripple voltage appearing at the high voltage terminal at the output from the power supply, after the filter, was measured by means of a vacuum tube voltmeter through a 10 mfd condenser.

35. A check was made throughout the assembly of the Receiver, using magnets, in order to ascertain if iron or ferric alloys had been used in places where it was not necessary for electrical purposes, as required in applicable Naval specifications.

36. A check was made of the length of time necessary to tune to a given signal of 50 microvolts strength, with a knowledge of the frequency of the desired signal. This was done by setting a standard signal generator with 30% modulation at 1,000 CPS and 50 microvolts output to the Receiver, with the generator frequency somewhere in the band, and noting the time required for tuning to the signal.

37. Depth of modulation characteristics were taken to determine the linearity of the audio detector for different levels of modulation. The input for this test was fed to the I-F amplifier to avoid errors due to frequency modulation resulting from the use of the U-H-F signal generator. With 12,000 microvolts input to the converter grid, the R-F gain was adjusted for 1 volt output across 600 ohms in the 500 ohm output terminal, with 20% modulation. The AVC and noise limiter were rendered inoperative for this test. The tone control was at 9. After this initial adjustment,

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readings were taken of output for different percentages of modulation of the signal input. Readings were taken with: (1) AVC off, noise limiter off; (2) AVC off, noise limiter on; and (3) AVC on, noise limiter off.

38. Resonant overload characteristics were taken with the same set up as for the AVC characteristics, paragraph 15, but with the AVC off. The Receiver was first adjusted for standard sensitivity at the frequency of test, and readings taken of increased values of input and resulting signal plus noise output and carrier noise output. For this test, the standard modulation of 30% at 1,000 CPS was used.

39. The characteristics of the limiter of the frequency-modulation part of the Receiver were measured by feeding to the second I-F amplifier control grid a signal at the intermediate frequency, modulated 30% at 1,000 CPS, and measuring the output across the load in the limiter circuit, with a vacuum tube voltmeter, the Receiver being set for F-M operation. Readings were taken of the drop across the load resistor for increased values of the input signal.

40. Frequency-modulation discriminator characteristics were measured in the I-F amplifier by applying a signal at the intermediate frequency, amplitude modulated 30% at 400 cycles, and with the Receiver set as for F-M operation, reading the voltage at the output terminals, for variations of the signal generator input frequency above and below that of the center of the I-F band pass region.

41. The reserve gain was determined after setting up the Receiver for standard A-M sensitivity, with the tubes as furnished by the manufacturer. The R-F gain control was advanced to maximum, and readings taken of the noise output at that point. This value of noise output divided by standard noise and expressed in decibels, is the reserve gain.

42. The magnitude of the intermediate frequency of the Receiver was checked as follows: The center of the pass band of the intermediate frequency amplifier was determined by first setting up a signal generator with input to the converter grid of the Receiver, and with 1,000 CPS modulation at 30%, the signal generator frequency was varied till maximum audio output voltage was obtained. At this point, the output of the signal generator was fed to a Receiver at 16 MC, and the beat between the signal generator output and a standard frequency at 16 MCS, as obtained from a harmonic generator operating from the Laboratory's standard frequency supply, measured by beating against the audio output from a beat frequency oscillator.

43. Overload selectivity tests were conducted with the aid of a test transmitter which was installed with its antenna on the same horizontal plane with a vertical dipole used as receiving antenna for the N-S27-C Receiver. The antennas were separated about 65 feet. In this test a "desired" modulated signal was introduced into the Receiver from a local signal generator. The effect of an unmodulated signal from a test transmitter, operating at suitable power levels, in reducing the desired signal output was observed.

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44. Cross-modulation selectivity tests were carried out with the set-up described in paragraph 43. The local desired signal was adjusted to give a standard output; its modulation was then removed and a modulation undesired signal received from the model XTBT transmitter operating at full power. The frequency separation between desired and undesired signals was determined under the condition of standard output from the desired modulation.

45. Maximum power output was measured from all three terminals on the Receiver, first by measuring the voltage across standard resistances in the output of the Receiver, and second by means of a General Radio output power meter with variable impedance. The maximum power output was measured at 1,000 cycles.

DATA RECORDED DURING TEST

46. Complete data were recorded for all tests conducted, and this information is contained in Tables 1 to 8 inclusive and Plates 1 to 30 inclusive. Photographs and a wiring diagram are contained in Plates 101 to 112 inclusive.

PROBABLE ERRORS IN RESULTS

47. Tabulated below are estimates of the probable errors in the results of the various tests. These estimates are based on the assumption that the equipment has been operated for sufficient time to permit stabilization to take place prior to test and include the advertised errors for the instruments employed. Included also are errors resulting from line-voltage fluctuation, radio-frequency leakage, frequency modulation, and errors due to resetting of instruments and Receiver controls. The latter errors were reduced to a minimum by frequent checking of line voltage, the location of the ground connections for maximum reduction of stray field influences, and care in the adjustment of all instrument and Receiver controls.

Name of Test	Estimated Overall Accuracy
Sensitivity	40%
Selectivity (Attenuation	± 1 db
Selectivity (Frequency Setting	± .05%
Oscillator Frequency Stability	± .005%
AVC and Resonant Overload Characteristics	± 5%
Audio-Frequency Fidelity	± .5 db
Audio Output Harmonic Distortion (Per cent error in per cent distortion)	± 10%
A.C. Power Consumption	± 3%

RESULTS OF TEST

48. General Description of Receiver

The Receiver employs a superheterodyne circuit having two stages of tuned, radio-frequency amplification, a heterodyne oscillator,

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a converter, two stages of intermediate-frequency amplification (at 16 Mc) common to the amplitude-modulation and frequency-modulation channels, one stage of intermediate-frequency amplification for the amplitude-modulation channel, intermediate frequency limiter amplifier for the frequency-modulation channel, second detector for amplitude-modulation and discriminator for frequency-modulation reception, one triode and one pentode stage of audio-frequency amplification, with a jack for output to head telephones and two pairs of terminals labeled 500 and 5000 ohms for driving a loud speaker or oscilloscope. A power supply system is built into the receiver chassis; it is designed to operate on a 115 volt, 60 cycle line.

49. Frequency Range

The Receiver has a rated frequency range of 130 to 210 Mc, covered in one tuning band.

50. Vacuum Tube Complement

Type	Number	Function
954	Two	R-F Amplifier
954	One	R-F Converter
955	One	R-F oscillator
6AC7	One	I-F amplifier
6AB7	One	I-F amplifier
6SK7	One	I-F amplifier (a-m only)
6AC7	One	I-F Limiter-Amplifier (f-m only)
6H6	One	a-m detector and noise limiter
6H6	One	f-m discriminator
6SC7	One	audio frequency amplifier
6V6	One	audio frequency amplifier
5X4G	One	Power Rectifier
VR-150-30	One	Voltage Regulator

51. The circuit elements, noted in order from input, are as listed below. They are also indicated in the wiring diagram given on Plate 112.

(a) Input circuit
(b) First radio-frequency circuit
(c) First radio-frequency amplifier tube
(d) Second radio-frequency circuit
(e) Second radio-frequency amplifier tube
(f) Third radio-frequency circuit
(g) First detector tube
(h) Oscillator circuit
(i) Oscillator tube
(j) First intermediate-frequency transformer and circuit
(k) First intermediate-frequency amplifier tube
(l) Second and third intermediate-frequency transformers and circuits
(m) Second intermediate frequency amplifier tube
(n) Third intermediate frequency amplifier - AM operation
(o) Third intermediate frequency amplifier tube - AM operation
(p) Third intermediate-frequency limiter amplifier - FM operation

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(q) Third intermediate-frequency limiter amplifier tube - FM operation
(r) AM detector circuits
(s) AM detector tube
(t) FM detector circuit
(u) FM detector tube
(v) Automatic volume control circuits and switch - FM and AM operation
(w) First audio amplifier circuit
(x) First audio amplifier tube
(y) Output circuit
(z) Output tube
(aa) Tone control circuit
(bb) Tuning meter circuit
(cc) FM - AM operation switch
(dd) Automatic noise limiter switch
(ee) Power supply and voltage regulator
(ff) Power rectifier and voltage regulator tubes

52. Input Circuit

The antenna input is inductively coupled to the first tuned circuit. The coupling loop is designed to match transmission line impedances of 75 to 100 ohms.

53. First Radio-Frequency Circuit

The first radio-frequency circuit consists of a coil wound on a polystyrene form. Selection of the desired signal frequency is accomplished by tuning a variable capacitor which is mounted with the other tuning capacitors, in broadcast receiver fashion, along the depth of the cabinet. The control grid of the first R-F tube has a small resistor in series with it, probably to limit the amount of regeneration and prevent oscillation in that stage.

54. First Radio-Frequency Amplifier Tube

This tube is a 954 acorn pentode having its suppressor grid and cathode tied together and grounded. The heater circuit is provided with a bypass capacitor to ground. The control grid does not receive any AVC bias. The screen grid is returned through a resistance-capacity filter to a positive tap in the power supply.

55. Second Radio-Frequency Circuit

This circuit also contains a transformer wound on a polystyrene form. The coupling to the grid of the next tube is capacitive, as well as inductive through the mutual inductance between the primary and secondary of the transformer. The input to the grid contains the tuned circuit, tuned by means of a ganged variable capacitor.

56. Second Radio-Frequency Amplifier Tube

This tube is of the same type and is connected in the same manner as the first radio-frequency amplifier tube.

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57. Third Radio-Frequency Circuit

In the third radio-frequency circuit, methods of coupling to the plate of the second radio-frequency amplifier tube and to the control grid of the first detector tube, etc., are the same as in the second radio-frequency circuit.

58. First Detector Tube

This tube is a type 954 acorn pentode with the suppressor grid connected directly to ground, and no AVC bias voltage to the grid. The cathode is connected through an inductance and a parallel combination of resistance and capacity, to ground for bias. The inductance in series with the cathode is coupled by mutual inductance to the oscillator, providing cathode injection of the oscillator voltage. The screen is returned to a positive potential in the power supply by means of a resistance, by-passed capacitatively to ground. The heater of this tube is also by-passed to ground.

59. Oscillator Circuit

The oscillator circuit consists of a tuned plate oscillator, with shunt feed. The grid is inductively coupled to the tuned plate circuit, with a grid leak in series, by-passed to ground. The plate of the tube is tapped down on the tank coil, for higher 'Q', and stability.

60. Oscillator Tube

The oscillator tube consists of a 955 acorn type triode. The plate voltage is fed through a choke and resistor, from the 'B' supply voltage, with a capacity-resistance filter to keep oscillator voltage from the plate supply. The cathode of the tube is connected directly to ground. The heaters of the tube are by-passed to ground, and further isolation of the tube is assured by a radio-frequency choke in series with the ungrounded side of the filament.

61. First Intermediate-Frequency Transformer and Circuit

The first intermediate-frequency transformer consists of an air-core transformer, with both primary and secondary tuned. A series resistor is employed for the grid to reduce the possibility of oscillation of the circuit. The control grid of the tube is connected through the degenerative resistor and tuned circuit, to a resistor delivering the AVC voltage.

62. First Intermediate-Frequency Amplifier Tube

The first intermediate frequency amplifier tube is a 6AC7 (1852). The cathode of the tube is connected through a series resistor to a potentiometer from the supply voltage to ground. This potentiometer in the cathode serves as the radio-frequency gain control. The cathode is also by-passed to ground. The suppressor of the tube is tied directly to ground at the socket. The screen is fed through a resistor from the high voltage supply, and by-passed to ground. The plate is fed through the primary of the next

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tuned circuit, through a resistance, with the other side of the primary of the transformer by-passed to ground. A small neutralizing condenser is connected from the plate of the amplifier to the 'cold' side of the input primary. It is believed that this condenser achieves the neutralization of the tube by virtue of the currents flowing through the by-pass capacitors, connected in series from the point of connection of the neutralizing capacitor to ground, and the currents flowing in the tube due to input admittances.

63. Second and Third Intermediate Frequency Transformers and Circuits

The second and third intermediate frequency transformers and circuits are similar to those just described for the first intermediate frequency transformer and circuits. In addition, however, the third transformer's secondary is capacitatively coupled to the next two stages, the AM amplifier and the FM limiter-amplifier, only one of which is used during reception.

64. Second Intermediate-Frequency Amplifier Tube

The second intermediate-frequency amplifier tube is a type 6AB7 (1853) pentode, connected in a manner similar to the first intermediate-frequency amplifier tube, including the AVC control to the control grid, and the control of the bias to the cathode by means of the potentiometer arrangement. Both cathodes of the first and second intermediate-frequency amplifiers are connected to the same tap on the potentiometer.

65. Third Intermediate-Frequency Amplifier - AM Operation

The third intermediate-frequency amplifier is capacitively coupled from the input tuned circuit. The output of the stage is fed through another transformer to the diode detector.

66. Third Intermediate-Frequency Amplifier Tube - AM Operation

The third intermediate-frequency amplifier tube is a 6SK7 pentode in a conventional amplifier circuit, with suppressor connected to the cathode, and the cathode connected to ground through a bias resistor, also by-passed. The screen of the tube is fed through a series resistor from the high voltage, and is by-passed to ground. The plate is fed through the primary of the intermediate-frequency transformer and a resistor, to the 'B' supply, with a by-pass capacitor from the 'cold' side of the primary to ground.

67. Third Intermediate-Frequency Amplifier Circuit - FM Operation

The third intermediate-frequency amplifier is fed from the secondary of the third intermediate-frequency transformer, capacity coupled. There is no cathode bias on the tube, allowing the grid to draw current, supplying an AVC voltage to be described later. The output of the tube is fed through a conventional FM transformer to the next stage.

The input to the tube is fed through a resistor of low ohmage.

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68. Third Intermediate-Frequency Amplifier Tube - FM Operation

The third intermediate-frequency amplifier tube, FM operation, is a pentode type 6AC7 (1852) with the screen fed through a series resistor from the supply voltage. In series with the screen resistor is another resistor to the last intermediate-frequency transformer primary, and thence to the plate, causing the plate to be at a lower D-C potential than the screen, and so deriving its limiting abilities. The suppressor of the tube and the cathode are grounded. In series with the grid is a grid leak whose action is such that the grid biases itself negatively when drawing current, providing another means of limiting in the tube.

69. AM Detector Circuits

The AM detector consists of a simple diode detector in a conventional circuit, feeding a shunt type of noise limiter. The AVC voltage is derived from part of the diode load. The noise limiter diode is connected across part of the detector diode load, and when operative is biased by the current flowing through the load due to the signal voltage. When instantaneous peaks, such as noise, are impressed across the secondary of the last intermediate-frequency transformer, the noise limiter tube is made conductive, causing the audio voltage due to the peak of noise to pass through the tube and a condenser to ground. The time constant of the noise limiter circuit, affecting the operation of the limiter of pulses of different width, is determined by the resistance and capacity in the plate circuit of the noise limiter diode. It has been the experience of the Laboratory that this type of noise limiter, involving a shunt action on the undesired audio voltage, is relatively ineffective, except on certain types of noise. It has been found that a series type of noise limiter, such as the Karr noise limiter circuit, has greater capabilities and effectiveness.

70. AM Detector Tube

The detector tube is a 6H6 duo-diode, with cathode grounded. The tube is self-biased by the current flowing through the load.

71. FM Detector Circuit

The FM detector circuit consists of a standard type of frequency discriminator, such as is commonly used for automatic frequency control of broadcast receivers, a transformer that is both inductively (Mutual) and capacitively coupled. The input is fed from the limiter stage preceding. The output from the detector circuit is taken through a resistor to a condenser and potentiometer arrangement, to the next stage.

72. FM Detector Tube

The FM detector tube is a type 6H6 duo-diode with plates connected across opposite ends of the secondary of the last intermediate-frequency transformer, and returned through the center tap of the transformer secondary, to the center tap of a resistance between both cathodes.

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73. Automatic Volume Control Circuits and Switch - FM and AM Operation

For AM operation the automatic volume control bias is taken off part of the resistive load of the AM detector diode, and fed through suitable resistive-capacitive networks to the control grid circuits of the first and second intermediate-frequency amplifier tubes. The automatic volume control operation is optional with AM reception. A switch connecting from the automatic volume control bias to ground provides means for grounding the automatic volume control bias, or applying it to the control grids of the tubes under control. When the Receiver is put into FM operation, automatic volume control bias is put on the same tubes under control, by taking part of the voltage appearing in the grid circuit of the limiter tube caused by the flow of current through the grid resistor. There is no optional use of this automatic control bias, it being connected at all times for FM reception.

74. First Audio Amplifier Circuit

Audio voltage for the first amplifier is taken from the AM or FM detector at will, and fed through a series capacity and potentiometer to the control grid of the amplifier tube. The output is capacity coupled to the next stage.

75. First Audio Amplifier Tube

The first audio amplifier tube consists of a type 6SC7 duo-triode, with grids and plates of each section tied together respectively, to form a single triode. The plate voltage is fed through a series resistor from a point in the high voltage supply. The tube is biased by a resistor in the cathode, by-passed with a high capacity.

76. Output Circuit

The input to the grid of the output tube is capacity coupled from the preceding stage. The output is transformer coupled to the output terminals. The phone jack provides output for the phones from the preceding triode stage, when the phone plug is inserted, and shorts the output transformer of the last stage through a resistor to ground. When the phone plug is removed, the resistor is taken off from across the secondary of the output transformer, and power output becomes available for the 500 ohm or 5,000 ohm terminal. The 5,000 ohm terminal is connected across the entire secondary of the output transformer, while the 500 ohm terminal is connected across part of the output transformer.

77. Output Tube

The output tube is a pentode, type 6V6. The plate of the tube is fed through the primary of the output transformer to the high voltage supply, and is by-passed for high frequencies, at the plate. The suppressor is tied to the cathode. Bias for the tube is derived from the cathode resistor which is by-passed to ground by a large capacity. The grid returns to ground through a resistance.

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78. Tone Control Circuit

A tone control circuit is placed in the control grid of the output pentode tube. This control consists of a series capacity and rheostat connected to ground, allowing attenuation of the higher frequencies only.

79. Tuning Meter Circuit

The tuning meter circuit consists of a tuning meter having a current range of 80-0-20 microamperes. For AM operation, the meter derives its current from the second intermediate-frequency amplifier tube plate current, shunted with 10 ohms. The variations in plate current to operate the meter are caused by the automatic volume control grid bias on the tube, which changes the plate current. The meter, therefore, is effective only with AVC. It is made to operate only with the gain at maximum position, so that the calibration of the meter scale can be relied upon to a greater degree of accuracy for comparison of signal strengths. For FM operation, the meter is grounded where it formerly was connected to the plate supply voltage. The other end of the meter then connects to a series resistance to the ungrounded cathode of the FM detector diodes. When the Receiver is tuned to the center frequency of the incoming signal, the voltage drop across the cathode of that tube to ground, or cathode to cathode, is zero, so that no current will flow from the cathode to ground through the meter. On either side of the center frequency, however, the voltage from that cathode to ground, or to the other cathode, will be proportional to the deviation of the Receiver frequency from the center frequency of the desired signal, being one value for an increase of receiver frequency, and the negative value for a decrease in frequency of the same amount, so that the meter needle will vary about a center position when tuning through a carrier, and would remain at zero when tuned to the center frequency. The swing of the needle, however, is limited by the pass band of the preceding stages.

80. FM - AM Operation Switch

To switch from FM to AM operation, the single control does the following:(1) switch output of detectors from FM detector to AM detector; (2) change insertion point of the tuning meter; and (3) change the automatic volume control bias source, from the grid circuit of the limiter tube in FM operation, to the load circuit of the diode detector.

81. Automatic Noise Limiter Switch

The automatic noise limiter switch connects the noise limiter diode to the appropriate points in the diode detector circuit.

82. Power Supply and Voltage Regulator

The power supply consists of a transformer-rectifier filter operating from a 115 V. A.C. source. The input is fused in both leads to the primary of the input transformers and has in series with each lead to ground a pi-network of capacity by-passes and r-f chokes, to reduce the feed-back of oscillator voltage to the line, and prevent disturbances from reaching the Receiver power supply. A switch is provided in series with

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one of the leads. Separate transformers are used for plate and filament supplies. One side of the receiver filament supply is grounded. The output from the rectifier passes to a socket at the back of the Receiver. With the proper type of shorting plug in the octal socket, the power supply can be made to work with either A.C. or D.C. input. For D.C. input, however, connection must be made to the socket instead of through the line cord. An external switch is placed in the center tap of the high voltage transformer to permit switching of the Receiver from send to receive by means of an external contacting device, instead of the send-receive switch on the front panel. The rectified D.C., or the D.C. from the external source, is then filtered through two pi-sections of chokes and condensers. Power for the output tube is taken from the first section. The second section feeds all the other tubes, with the exception of those elements, or tubes, fed from the voltage regulator. The voltage regulator circuit is connected across the output of the second filter section and is used to supply voltage to the plate of the oscillator tube, the screen and plate of the converter tube, and the screen of the second intermediate-frequency amplifier tube.

83. Power Rectifier and Voltage Regulator Tubes

The power rectifier tube is a 5X4G full wave rectifier with plate voltage supplied by the high voltage transformer and filament voltage supplied by a separate winding on the filament transformer. The voltage regulator tube is a VR-150.

84. Contract Requirements

The contract, reference (g), covering the Model N-S27C Receivers, stipulates that they meet the requirements outlined in the Manufacturer's descriptive specifications, reference (b), which are filed with the contract. The contract also requires that the Receivers conform to the General Specifications for Inspection of Material, reference (h). Compliance with the Manufacturer's descriptive specifications, reference (b), will now be considered; this will be followed by a discussion of the Receiver in the light of other Naval specifications, notably those of references (c), (d) and (e).

85. In the following paragraphs, the provisions of the Manufacturer's descriptive specification, reference (b), are considered consecutively. Since the paragraphs of reference (b) are not numbered, each section referred to is quoted below with comment based upon the results of test and inspection in this Laboratory.

86. "The proposed UHF receiver will be similar in general outward appearance to our present model S-27. . . . The chassis and panel are removable from the cabinet as a unit for rack mounting where such is required. The power supply is self-contained for operation from 115 volts 60 cycle A.C. The frequency range is from 130 to 210 Mc."

(a) The model S-27 receiver referred to provides amplitude and frequency modulation reception from 27.5 to 145 Mc in three ranges:

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Band 1	27.5	to	47 Mc
Band 2	46	to	82 Mc
Band 3	82	to	145 Mc

The panel of the Model N-S27C Receiver is arranged similarly to that of the Model S27 except that some simplification is achieved in the former by the elimination of band switching.

(b) The panel and chassis are conveniently arranged for rack mounting. However, the Receiver is not properly designed for securing to a table. Four rubber feet for shock protection are secured to the bottom of the receiver cabinet. No holes are provided in the bottom of the cabinet for securing it to a table top. In order to remove the receiver chassis from its cabinet, fifteen screws must be taken from bottom of the cabinet; this would, of course, necessitate removal of the Receiver box from the table and represents an unacceptable degree of inconvenience in servicing operations afloat.

(c) The power supply is integral with the Receiver and is designed for operation on voltages from 110 to 125, 60 cycles. A line filter is provided to attenuate the radio frequency output from the receiver oscillator to the line.

(d) The frequency range of the Receiver is nominally 130 to 210 Mc. The frequency range actually covered is from 125 to 214 Mc.

87. "The panel controls are as follows:

Main tuning knob
RF gain control
Antenna trimmer
AF Gain control
AM - FM switch
Tone control
Automatic noise limiter switch
AVC on-off switch
Stand-by switch
Phone jack

"In addition there are the main tuning dial and the logging dial, as well as the meter, which reads comparative signal strength in S units for AM reception and correct tuning for FM reception.

"The main tuning dial is calibrated directly in frequency, as well as having an arbitrary scale calibration, which together with the calibration of the logging dial gives 2,380 divisions for full rotation of the condenser."

(a) Panel controls are provided as listed above. Electrical function and mechanical design of these controls are discussed in paragraphs 135, 136

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(b) Clockwise rotation of the main tuning knob results in increase of frequency and decrease in the arbitrary number scale provided for logging purposes. One turn of the tuning knob gives a change in frequency of about 2 Mc, or an arbitrary logging scale change of 45 divisions. 38-1/2 turns of the tuning knob are required to cover the entire nominal frequency range of 130 to 210 Mc, corresponding to a shift from 2135 to 405 in the arbitrary logging scale divisions and a rotation of approximately 130 degrees by the ganged tuning condensers.

(c) The degree of frequency linearity of the tuning control is indicated in plate 13 in terms of the arbitrary logging scale divisions.

88. "On the rear of the chassis are antenna terminals, 500 and 5000 ohm output terminal, connections for external stand-by switch, AC socket and power socket and plug for optional external A and B supplies."

(a) Two antenna terminals and a ground terminal are provided for a two-wire line balanced radio-frequency input. The input impedance is given in table 7.

(b) The output impedance at the 500 and 5000 ohm output terminals is given in table 4. The maximum power output available from these terminals is shown in Table 5.

(c) The power input facilities are satisfactory for laboratory use. For shipboard use, it may be desirable to substitute a Navy standard power cable.

89. "Description of Circuit

"The Receiver will be of the super-type, using at least one stage of RF amplification and sufficient pre-selection to meet the performance requirements. Either one or two IF channels will be used together with a standard type of detector for AM reception and a limiter and discriminator circuit for FM reception. The audio amplifier will be terminated by a single power pentode or beam tube capable of delivering at least 2 watt of audio power. Choice of AM or FM reception is by a single switch on the front panel."

(a) A more comprehensive description of the receiver circuits is given in paragraphs 48 to 83, inclusive, and in the wiring diagram, plate 112.

90. "Electrical Performance

"Frequency Range
"130 - 210 Mc in one or more bands"

(a) The frequency range 130 - 210 Mc is covered in one band. The actual oscillator frequency range provided, as checked by a heterodyne calibrator, is 109 to 198 Mc corresponding to the actual signal frequency coverage of 125 to 214 Mc.

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91. "Sensitivity

"Two microvolts average for 6 mw audio output with a 5 to 1 ratio of signal plus noise power to noise power, using a signal modulated 30% at 1000 cycles."

(a) The results of sensitivity measurements, shown on plate 1, fulfill the specification requirement satisfactorily.

92. "Image Ratio and Spurious Responses

"For interfering signals of not more than 50,000 microvolts, image and spurious response ratio of at least 60 db.

NOTE: This response ratio will be carried up to as high a value as possible during development."

(a) The image rejection ratios at several operating frequencies are given in Table 3. The 60 db requirement is satisfied at frequencies of 170 Mc. and below, but not at higher frequencies.

(b) The intermediate-frequency rejection ratios, given in Table 2, exceed 60 db at all receiver tuning frequencies.

(c) Other spurious responses, due to the Receiver alone, were not observed.

93. "Selectivity

"Bandwidth approximately 800 kc at 80 db down with a selectivity curve having a shape so that the ratio of bandwidth at 60 db down to the bandwidth 6 db down is approximately 4."

(a) The intermediate-frequency selectivity, which dominates the weak-signal selectivity characteristics of the Receiver, is shown on plate 5. Its bandwidth at 80 db attenuation is 840 KC. The ratio of bandwidth at 60 db down to the bandwidth 6 db down is 4.0.

(b) Overload selectivity results are discussed in paragraph 139 and plotted in plate 30.

94. "Measurements made with Ferris model 18B Standard Signal Generator up to 155 Mc, using a 60 ohm non-inductive series resistor (this with internal resistance of the signal generator makes 75 ohm). From 155 to 210 Mc, measurements will be based on calculated values of second harmonic, unless another type of measuring equipment is available in the meantime."

(a) Sensitivity measurements were made over the entire frequency range of the Receiver by means of the General Radio Company u-h-f signal generator model 804B. Check measurements up to 155 Mc were made with a Ferris model 18B generator. A comparison of the results of both tests is given in plate 1.

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95. "Maximum Audio Output approximately 2 watts with not over 5% total distortion."

(a) The maximum audio output is 5 watts. Ref. table 5. The total harmonic distortion under various conditions is given on plates 20, 21 and 22. When a load of resistance R is connected to the 500 ohm output terminals and supplied with 2 watts of 400 cycle audio power, the total output harmonic distortion was found to be less than 5% when R was greater than 740 and less than 1100 ohms.

96. "Audio Fidelity will be within 6 db from 100 - 3000 cycles."

(a) When the tone control is set at 5 or 9 (or at intermediate points) it was found that the overall fidelity curve varied by less than 6 db between 100 and 3000 cycles. Ref. plates 6, 7, 8 and 9.

97. "Mechanical Construction

"The cabinet and panel will be of aluminum alloy with a durable black wrinkle finish. The chassis shields and other small metal parts and compartments will be of aluminum alloy having a sand blast and clear lacquer finish. High quality components will be used throughout."

(a) The cabinet is formed of aluminum (or aluminum alloy) stock, 3/32 inch thick and finished in fine-grain black wrinkle lacquer. No corrosion-resistant primer coat was observed on the metal beneath the lacquer. The front panel is of aluminum (or alloy), 3/16 inch thick with a coarse-grained black wrinkle finish in front and a smooth black lacquer interior finish. The chassis is of aluminum (or alloy), sand blasted and apparently finished in clear lacquer. The shielding housing of the radio-frequency section is formed of aluminum 1/16 inch thick with a smooth lacquer-finished surface. The shield partitions between radio-frequency amplifier stages appear to be of brass with nickel plating. The intermediate-frequency transformer shield cans and condenser cans are of aluminum with smooth surface and clear lacquer finish. Components of high commercial quality are used.

98. "Fixed condensers will be either of the mica type molded in low loss bakelite cases or of the paper type in hermetically sealed containers. Both types of condensers will be Cornell-Dubilier or equal. Fixed resistors will be the equal of IRC types BT or BW or Ohmite type BD."

(a) Fixed condensers are of good commercial quality in the following types:

(1) Tubular paper condensers of "dykanol" type in sealed aluminum cans projecting above the chassis and having terminals at the lower ends beneath the chassis.

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(2) Paper dielectric condenser sealed in small aluminum box with rubber sealed terminals, mounted beneath the chassis.

(3) Electrolytic condensers sealed in small aluminum boxes with rubber sealed terminals, mounted beneath the chassis. The electrolytic condensers are used for by-passing cathode resistors and work at potentials less than 50 volts.

(4) Mica dielectric condensers molded into cases of a phenolic material. The cases are waxed.

(b) Fixed resistors are of the composition type for higher resistance values and of the wire-wound type for the lower resistances. These resistors are encased in a phenolic or in a ceramic cylinder and are mounted on their leads which are soldered to terminal strips or terminals on tube sockets. The ceramic encased condensers are wax-coated. It is recommended that all such components be wax impregnated.

99. "Transformers will be potted and sealed in non-corrosive cases and will be manufactured by Kenyon Transformer Company, Chicago Transformer Company, or equal."

(a) The plate supply transformer, the filament transformer, the two filter reactors and the audio output transformer are potted and sealed in separate aluminum cans which have terminal boards of molded phenolic material. These cans are finished in smooth black lacquer. These transformers and reactors appear to be liberally designed and of good commercial quality.

100. "Insulation will be either Grade G ceramic or laminated phenolic similar to the grades XX or LE, the choice of the insulation depending on the circuit requirements.

"Sockets or molded parts will either be ceramic, Grade G, or mica filled bakelite as made by American Phenolic Company."

(a) The radio-frequency selector and oscillator coils are wound on poly-styrene cylinders. The antenna input binding posts are mounted on a high-grade phenolic plate at the rear of the preselector unit. The acorn type tubes of the preselector are mounted on grade G ceramic sockets. The sockets of the remaining vacuum tubes are of a high-grade phenolic material. Terminal strips are formed from a lower grade laminated phenolic material. A similar laminated phenolic sheet is used as insulation in the FM - AM switch. Soft rubber grommets are used liberally to bring leads through the chassis. The intermediate-frequency transformer coils are wound on grade G ceramic forms; these coils are secured with a clear cement which appeared to contain numerous air pockets.

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101. "The meter will be as manufactured by Weston or equal."

(a) The tuning meter appears to be a good quality direct-current milliammeter calibrated in S units and in decibels above S9.

102. "Variable condensers will all be of the air dielectric type or in the case of some trimmers possibly of the ceramic dielectric type. All types are to have ceramic insulation. The tuning condenser and R-F or oscillator trimmers may or may not be invar as indicated by results of development work."

(a) The stators of the air-dielectric tuning condensers in the preselector circuits are insulated and supported on soft laminated type X2B sheet material which appears to be a mica-bearing composition rubber. The stator of the oscillator tuning condenser is insulated by sheets which appear to be mycalex.

(b) The preselector tuning condenser plates appear to be of brass with a light silver plating. The preselector trimming condensers are of the cylindrical type in which the capacitance is varied by changing the position of a screw within a concentric cylinder insulated from the screw by polystyrene. Ref. par. 112.

103. "IF or RF coils will be substantially constructed on 'rolled' phenolic tubing or Grade G ceramic forms. Where RF inductors of the transmission line type are used, they will be constructed of invar if necessary or if not, of copper, brass or other suitable material."

(a) The r-f coils in the preselector circuits are of heavy, silver-plated wire wound on solid polystyrene cylinders and secured in place with a lacquer having, apparently, a polystyrene base.

(b) The i-f coils are wound on apparently high grade ceramic forms and are cemented in place with a lacquer or cement which appears to contain numerous air pockets which might occlude varying amounts of water vapor.

(c) R-F inductors of the transmission line type are not used.

104. "All metal parts not covered by the first paragraph in this section will be heavily plated for maximum corrosion resistance and best electrical performance."

(a) Refer to paragraph 97 for discussion of finishes and probable corrosion resistance.

105. "The wiring, mounting of parts and general mechanical construction will be consistent with best mechanical strength and good standards of workmanship."

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(a) The wiring is neatly arranged, but not entirely in accordance with Naval standards with respect to the type of insulation used. In general, the components are firmly secured and well placed from the electrical design standpoint. The arrangement of small resistors and condensers is not as systematic or as well distributed as might be desired from the purely mechanical point of view; however, it is recognized that the requirement for short leads in high-frequency circuits often prevents use of the layout mechanically most desirable. The mechanical strength of the chassis and mounted components appeared to be good and to display satisfactory workmanship. (This concludes direct comment on the Manufacturer's Descriptive Specifications.)

106. The following paragraphs describe further test results and offer a discussion of them based on specifications for radio receivers for Naval shipboard use, notably the specifications references (c), (d) and (e).

107. The Model N-S27C Receiver is, in many respects, well designed and sturdily built. Some exceptions to this general statement of excellence are noted in paragraph 163. The Receiver provides satisfactory reception of voice or keyed tone modulated signals at any frequency in the range 130 to 210 megacycles, which is covered in a single band with a single tuning control. The operation of the Receiver either in searching or in tuning approximately to a specified frequency is thus quite simple and may be accomplished by relatively inexperienced personnel with very little specialized instruction. It may be desirable to provide protection of the Receiver against high voltages arising at its antenna terminals due to local operation of high power transmitters by the inclusion of a protective gap across the antenna input terminals.

108. No precision calibration means are provided with the Receiver. However, the main tuning dial is calibrated in megacycles and may be preset to a desired frequency with an accuracy of the order of ± 0.3 Mc (or ± 0.2% at 150 megacycles).

109. The probability of a long life of trouble-free operation is prejudiced by the use of lightly silver-plated spring contacts on the main tuning condensers. These contacts show signs of wear and may be expected to operate erratically after an appreciable portion of the surface has lost its silver plate, resulting in noise and possible intermittent failure of the oscillator. It would be preferable to employ more massive silver contacting members, avoiding the use of thin silver plating.

110. The FM-AM switch is of the single-wafer, rotary, self-positioning and self-cleaning type having lightly silver plated contacts. It is expected that these contacts may develop erratic operation due to wear during use in the Naval service under conditions of high saline humidity. Suitable solid silver contacts are recommended instead of silver plating.

111. Contact to ground from the rotor shaft of the antenna trimming condenser is made by two silver-plated flat spring members bearing on the silver-plated shaft. These contacts are also likely to become erratic due to abrasion of the silver plating and solid silver or silver-faced contact members are consequently recommended.

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112. The tuning condensers (one in the antenna circuit, two in the radio-frequency amplifier and one in the heterodyne oscillator circuit) are similar in structure to a design commonly used in entertainment receivers. Each condenser has two stator and three rotor plates with the exception of the antenna circuit condenser which has two stator and two rotor plates. The rotor plates are pressed and apparently soldered into slots in the shaft. The spacing of these plates is about double that ordinarily employed in commercial receivers, being approximately 0.05 inch in the Model N-S27C Receiver. The thickness of the plates is about 0.020 inch. The exterior plates of each rotor section are serrated to allow trimming of the capacitance at several positions of the condenser during the alignment process. The antenna and r-f amplifier tuning condensers are grouped together between two end partitions, apparently of brass (with nickel plating) 0.072 inch thick; each pair of condensers is separated by a nickel-plated brass partition 0.040 inch thick. The longitudinal frame of this assembly is composed of two pairs of nickel-plated brass rods, one pair being 1/4 inch square and located at either side of the assembly near the tops of the end plates, the other pair being rectangular in section with dimentions 1/16 by 23/64 inch and located at the bottom of the assembly on either side. These rods are pressed into notches in the end partitions and the shield partitions. The structure of the oscillator condenser is similar; it is assembled separately with heavier nickel-plated brass end plates 0.120 inch thick. The shafting of the oscillator condenser is supported at each end by ball bearings. The material of which the balls were made was not ascertained; it is recommended that stainless steel balls be provided in order to minimize the effects of corrosion.

The wiping contacts used for grounding the condenser rotors to their respective frames appear to be of phosphor bronze with a thin layer of electro-deposited silver. These contacts are 0.009 inch thick and are bent in the form of a flat U shaped spring 9/16 by 9/16 inch and soldered along the base of the U into a shallow channel in a silver plated brass block screwed to the interstage shield (in the case of the antenna and radio-frequency amplifier tuning condensers) or soldered directly to the end plates (of the oscillator tuning condenser). The free ends of the U shaped springs have semi-circular cut-out sections which are sprung in to annular grooves machined into the condenser shaft. One such contact is built into the antenna tuning condenser, one into each of the radio-frequency amplifier tuning condensers and two in the oscillator tuning condenser (one at each end of the rotor shaft). Refer to paragraph 102 for details on tuning condenser insulation and radio-frequency trimmer construction. The antenna trimmer consists of a rotor having 3 small plates which mesh with an extension of the stator plates of the antenna tuning condenser. The position of this rotor is controlled from the front of panel by a shaft about eleven inches long connected through a porcelain-insulated coupling to a short shaft mounted on a bearing and driving the condenser through 1 to 1 ratio gears, one of which is of a molded phenolic material and the other of nickel plated brass. The long shaft is not sufficiently well supported and it is recommended that additional bearings be provided to correct this condition.

113. The Receiver (serial no. 3) was subjected to vibration testing on the shake table of the Transmitter Section of this Laboratory. During this test a modulated signal at 150 Mc was applied to the Receiver and the

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output observed both aurally and by an output meter. No mechanical damage or impairment of electrical operation was noted during or after vibration tests which were carried on continuously for one hour. A strong resonant vibration of the receiver cabinet was noted at mechanical vibration frequencies of about 14 per second but no damage resulted during 10 minutes at this frequency from the comparatively large amplitudes encountered at resonance. At a minor resonant frequency near 12 vibrations per second, it was noted that the glass window of the main tuning dial rattled violently. It is recommended that the dial windows be more thoroughly secured to the panel. Very little vibration modulation or microphonic output was noted at any time. The modulation was removed from the test signal for this observation. The vibration frequency ranged from 0 to 30 vibrations per second during this test. The amplitude of the vibration table top in a direction normal to its surface (this is the principal mode of vibration) was not measured, but it is understood that this may reach 1/8 inch at certain table resonance frequencies.

114. The Receiver operated satisfactorily and without damage while rocking through an angle of $\pm$ 45° with the vertical. This test was conducted on the shake table just before the vibration test.

115. The Receiver was subjected to a shock test as described in paragraph 29. During this test the gain of the Receiver decreased nearly 5 db after three impacts but showed no tendency to decrease on further shocks. The tuning of the Receiver did not shift appreciably during the test. The decrease in gain during the first two shocks may have been due to a slight disturbance of a trimming control, but subsequent checks on the Receiver disclosed no mechanical or electrical faults attributable to the shocks.

116. The receiver cabinet is supported on four rubber feet which serve as mechanical shock absorbers but do not permit securing the Receiver to a table. It is recommended that the cabinet be designed to be secured to a table through four shock mounts such as the Lord 20 or 25 pound type.

117. The Receiver is capable of passing through a hatch 25 inches by 36 inches with considerable clearance. Its overall dimensions are:

Height (measured from table top)	9-7/16 inches
Depth	17-7/8
Width	19-1/8

The volume is 1.65 cubic feet.
The weight of the Receiver is 66 pounds.

118. In order to withdraw the chassis from the cabinet, it is necessary to remove six screws from the front panel, two of them being secured with nuts, and also 15 screws from the bottom of the cabinet. It is recommended that in future models for shipboard use the chassis be arranged to slide from the cabinet on rails after loosening captive screws from the panel front and that the screws securing the chassis to the bottom of the cabinet.be eliminated. It is also recommended that handles be furnished on the front panel to facilitate withdrawal of the chassis from the cabinet without the necessity of putting any undue stress on any of the control knobs.

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119. The Receiver is provided with an output jack, primarily for headphone use. This jack is of conventional commercial design but is not of Navy approved type. The springs appear to be of non-ferrous material; however, the front-of-panel nut and washer and part of the frame is of magnetic material, apparently cadmium-plated iron. This jack is connected in the output circuit of the first audio-frequency amplifier tube and consequently is fairly well adapted for pulse outputs since no output transformer is involved.

120. Ventilation is provided by six inwardly-projecting louvers in the bottom of the cabinet and by 78 holes of rectangular section in the back and sides of the cabinet. In addition, the lower portion of the rear of the cabinet is open to give access to the terminals projecting from the rear apron of the chassis.

121. The power transformer and filament transformer are air cooled and operated satisfactorily in ambient temperatures as high as 50° C. The equilibrium temperatures of these components measured by thermometers secured to the tops of the transformers were 52° C. in each case after 5 hours' operation in an ambient temperature of 28° C. The temperature at a point within the cabinet was 50° C. under the same conditions, indicating only about 2° C. temperature rise of the transformers above their immediate surroundings.

122. Lock washers of the internal tooth type are largely used in the receiver. They provide good locking action if not used repeatedly. Use is recommended of lock washers of the split-ring or other type providing good locking action and good contact to the metal after several disassemblies and reassemblies.

123. Satisfactory protection is afforded operating personnel against contacts with circuits at potentials above ground in excess of 150 volts.

124. The insulation used in the Receiver is, in general, of good grade. Ref. par. 100, 102. The use of type X2B composition rubber insulation for supporting the stators of the antenna and r-f amplifier tuning condensers is of doubtful merit. Use of higher grade insulation, such as mycalex, is recommended at these points. The insulation of the wiring is of various types. Some of the wiring appears to be similar to ordinary Lenz hook-up wire. Some composition rubber insulated wire with a fabric cover is used. In consideration of the conditions respecting exposure to moisture, spray and high ambient temperatures, which are likely to be encountered in Naval shipboard conditions, it is recommended that rubber or similar material be used as a portion of the insulation on all wiring in the Receiver.

125. In general, the wiring is neatly arranged and carefully soldered to the terminals. A somewhat excessive amount of solder is apparent in some locations. In most locations, the wiring has been thoroughly secured to the terminals before soldering, so that the solder is not required to provide mechanical support. Soldered joints have not been cleaned or lacquered and soldering flux (apparently rosin) has been left on the joints, although there is no evidence of the use of corrosive soldering flux.

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126. The components are not labeled to designate their location in the circuits. All fixed resistors are enclosed in ceramic or phenolic sleeves except two wire wound 10 watt resistors which are coated with a vitreous material. The fixed resistors and phenolic-encased fixed condensers are color coded to indicate the magnitude of their resistance or capacitance. The resistors encased in vitreous material are provided with metallic bands on which are imprinted the resistance values. Suitable name plates are attached to the cases of the filament and plate transformers and of the filter reactors. A name plate of Navy standard design is screwed to the front of the panel.

127. No pilot lamp is provided to indicate receiver readiness for operation. However, the same purpose is served by two panel lamps, one of which is located behind the main tuning dial and one behind the logging dial. These panel lamps are rated at 6 volts and are supplied from the filament transformer. The lamps are Mazda type 44 of the single prong bayonet style. The bayonet sockets are mounted by light aluminum brackets to the cover of the radio-frequency section and to the frame of the gear system, respectively.

128. Most components and all vacuum tubes are readily accessible for replacement or servicing. However, withdrawal of the chassis from the cabinet is rendered inconvenient by the securing of the chassis to the bottom of the cabinet, making it necessary first to remove the Receiver from the table and to take out 21 screws before the chassis can be slid from the cabinet. Ref. par. 86.

129. Many of the smaller components are interchangeable with similar components of other equipments, since they are of standard commercial design. As a consequence of the special nature of this equipment, however, other components, notably in the r-f and i-f circuits are not interchangeable with components in other types of receivers.

130. Wood is not used in the construction of the Receiver.

131. Iron is used sparingly where not essential for electromagnetic purposes. However, the plate supporting the bearing for one end of the long antenna trimmer condenser shaft is of magnetic material, probably nickel-plated iron. Some of the hardware of the toggle switch and phone jack frame are of iron.

132. So far as has been ascertained, standard threads have been furnished on all bolts, studs, screws, etc., used in the Receiver. With exceptions such as those noted in paragraphs 119 and 131, the bolts, screws, and washers appear to be of nickel plated brass. However, the set screws used in control knobs and flexible couplings are of steel, the former apparently nickel-plated, the latter cadmium-plated.

133. All vacuum tube sockets are of the single-unit type and appear to be satisfactory in design and choice of materials. These sockets are not separately shock mounted. Ref. par. 100.

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134. The tuning controls operate through positive gearing of the split-gear type. Ten nickel-plated brass gears are used. The four larger gears (3 inches diameter and 0.067 inch total thickness) and one small gear (3/4 inch diameter by 0.067 inch thick) are of the double section type with a spring take-up between sections to reduce backlash. The other gears of the five pairs are in one piece, two being 1 inch diameter by 1/4 inch thick, two 13/32 inch diameter by 0.20 inch thick, and one 1 inch diameter by 0.20 inch thick. These gears are mounted within a frame consisting of two nickel-plated brass plates 3-3/4 by 7-1/2 inches and about 1/16 inch thick mounted 7/8 inch apart parallel with the front panel and about 1-1/4 inch behind it. Some of the set screws and nuts of this assembly are of ferrous material and show signs of rust. All of these gears operate together to form a mechanical vernier tuning assembly which includes the two illuminated dials, one of which (the main tuning dial) is placed in the gear train in a position where it rotates about 350 degrees while the tuning condenser moves from its minimum to its maximum capacitance position. The other dial (the fine logging dial) is at a point in the train which causes it to turn 23 complete revolutions during the same change. These dials are made of a rather brittle material having the general appearance of celluloid and being about 0.018 inch thick. These dials showed a tendency to warp and the logging dial broke when it was attempted to bend it back so that it would not rub the inertia wheel during its revolution. It is recommended that these dials be made of a somewhat heavier material having less tendency to warp and a smaller degree of brittleness. Further details on the tuning system are given in paragraph 87. It is recommended that the tuning drive clutch spring as well as all split gear springs be made of a non-corrosive metal or be suitably coated to resist corrosion. The amount of backlash in the main tuning dial is given in Table 1. The backlash is considered satisfactorily small.

135. The small r-f gain, antenna trimmer, a-f gain, a-m/f-m and tone control knobs are provided with a bevel skirt on which the graduations or suitable markings are inscribed. The knobs are 1-1/8 inch in diameter and project about 1 inch from the panel. The skirts are 1-1/2 inch in diameter and are beveled at an angle of about 40 degrees with the panel. Ref. par. 87.

136. The tuning control knob is in the form of a wheel 2-5/16 inches in outside diameter and secured to its axle by 3 flat spokes. This knob and the smaller control knobs are formed from a hard phenolic material. For rapid tuning over the frequency range, as in searching operations, it would be convenient to incorporate a crank handle with the tuning control knob.

137. No locking devices are provided on the tuning control or the other controls. It is recommended that a lock be provided to prevent motion of the tuning control due to accidental contact during communication use at a fixed frequency.

138. The weak-signal selectivity of the Receiver is shown in plates 2, 3, 4 and 5. Plate 5, the selectivity measured with a signal near the intermediate frequency (16 Mc), is to be regarded as more reliable than the overall selectivity results shown in plates 2, 3 and 4 because of the difficulties involved in using ultra-high-frequency signal generators.

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139. Overload selectivity characteristics were obtained by the method described in paragraph 43. An overload selectivity curve is given on plate 30. Interfering signals (unmodulated) of 1.4 volts (at Receiver antenna terminals) at 144.5 Mc cause a 6 db decrease in a moderately strong (less than 30 microvolts) modulated desired signal output when the frequency difference between desired and interfering signals is about 1.9% or 2.7 megacycles. In addition to the principal overload characteristic of the receiver, obtained when the transmitter (which was used as the source of interfering signal) was tuned to frequencies near that of the desired modulated signal, other overload regions were observed when the interfering signal frequency was 108.5, 112.7, 118.4, 130.1, 137.1, 153.1, 162.7, and 173.6 megacycles. These additional overload characteristics are caused (with possible exception of the 112.6 Mc response which is close to the receiver image frequency) by voltages at frequencies which are multiples of the test transmitter master oscillator frequency when one of these multiples happens to coincide with the frequency to which the Receiver is tuned (144 Mc in the case illustrated by plate 30). For example, when the transmitter output is at 108.5 Mc, the master oscillator frequency is 108.5/12 = 9.05 Mc, the 16th multiple of which lies near 144.5 Mc to which the receiver is tuned. Similarly for the other responses: 112.7 x 23/18 = 144.1, 118.4 x 22/18 = 144.5; 130.1 x 20/18 = 144.5; 137.1 x 19/18 = 144.6; 153.1 x 17/18 = 144.6; 162.7 x 16/18 = 144.6; 173.6 x 15/18 = 144.6 Mc. Although these results are limited in application to the particular transmitter used in these tests, they may be considered typical of interferences to be expected from locally operating transmitters of the frequency multiplying type.

140. A voltage, of amount indicated in table 8, is present at the antenna terminals of the Receiver arisingfrom the heterodyne oscillator. It is possible that the resulting radiation from the receiving antenna may cause interference with local ultra-high-frequency services. The outputs at frequencies of 200 Mc and higher could not be measured because of the limitation in amount of voltage available from the standard signal generator used for calibration purposes. At these two frequencies, it was merely established that the voltage was greater than 20,000 microvolts.

141. The power supply is mounted within the receiver cabinet. The power requirements of the Receiver are indicated in table 6. Ref. par. 86.

142. The main tuning dial is calibrated in megacycles with markings at two megacycle intervals. A logging dial, affording finer calibration logging, is provided in conjunction with the arbitrary counting scale on the main tuning dial. The accuracy of calibration of the Receiver is indicated in plate 12. The relationship between readings of the logging dial and of the frequency dial is given in plate 13. Ref. par. 87. The direct reading dials make unnecessary the use of calibration charts unless the maximum calibration and reset accuracy available with the logging scales are required.

143. The frequency stability of the oscillator was determined under the conditions referred to below.

(a) The variation of oscillator frequency during warm-up from a cold start is given in plates 28 and 29.

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(b) The influence of humidity changes on oscillator frequency is shown in plates 26 and 27.

(c) The effect of ambient temperature changes on the oscillator frequency is given in plates 24 and 25.

(d) The variation of oscillator frequency with line voltage is shown in plate 23.

(e) When the oscillator tuoe is exchanged, the frequency of the oscillator may shift by as much as 55 kilocycles according to results of tube interchange tests in which the oscillator was given time to reach frequency equilibrium.

144. The sensitivity of the Receiver was measured at several frequencies by each of two signal generators. The results are assemoled on plate 1.

145. The fidelity was measured in several ways. The overall fidelity was measured with a modulated signal from an ultra-high-frequency signal generator which had a considerable amount of frequency modulation. Ref. plate 6. The fidelity was also measured with a modulated intermediate-frequency signal applied to the converter tube grid from a signal generator of the modulated amplifier type having a very small amount of frequency modulation. Ref. plate 7. Finally the fidelity of the audio amplifier itself was measured under "F-M" and "A-M" audio input conditions. Ref. plates 8 and 9.

146. The audio harmonic output of the Receiver was measured by means of a wave analyzer and the results are shown as a function of intermediate-frequency input voltage in plate 20, of modulation depth in plate 21 and as a function of load resistance in plate 22.

147. The automatic volume control characteristic of the Receiver was measured as described in paragraph 26 with results plotted in plate 15. The resonant overload characteristic is shown in plate 14.

148. The noise limiter was fairly effective in reducing the interfering effects of noise peaks of high intensity and short duration. Tests in this Laboratory on other equipment indicate that the shunt type of diode limiter used in the subject receiver is not so effective as the series or Karr type of diode limiter.

149. The maximum output powers available from the Receiver are shown in table 5. The harmonic content of the audio output when the power was maintained at 2 watts is shown in plate 22 for various load resistances. The output impedance deviates somewhat from the nominal values as indicated in table 4. An output impedance of 600 ohms for loudspeaker or phone reception is recommended in order to conform with current Naval receiver practice.

150. The Receiver is provided with an input meter indicating the approximate signal level in terms of "S" units or db above the S9 level. Ref. par. 79. This meter was calibrated in terms of 150 Kc signal input

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voltage. Ref. plate 17. The meter is so located that it may be easily replaced. It is not of a Navy standard pattern. The meter graduations are legible at a distance of 2 feet in an illumination of 1 foot-candle. Calibration with respect to a standard input reference level of 1 microvolt on a db basis, identifying it as an "input meter", would be in keeping with Naval practice.

151. The shielding of the Receiver appears to be adequate both externally and internally. The case and other external parts are at ground potential during operation.

152. The monitor operation of the Receiver was fairly satisfactory. Clear voice signals were received from the Model XTBT transmitter operating at full power into its antenna spaced 66 feet from the doublet receiving antenna; however, some crackling noise was heard during these monitor tests; the origin of this noise was possibly in imperfect contacts within the transmitter.

153. No transmission lines or antenna were supplied with the Receiver. It is recommended that the Receiver antenna input terminals be fitted for concentric line rather than two wire line feed. Standard Navy concentric jack fittings could be applied to attain a greater degree of standardization with other shipboard equipments.

154. Two electrolytic condensers are used in the Receiver for cathode by-pass purposes. These condensers operate at potentials less than 50 volts.

155. All front of panel markings and dial graudations appear to be permanent and of such size as to be readily readable at a distance of 2 feet under normal operating conditions with illumination as low as one foot-candle. The arbitrary scale calibration of the main tuning dial might be misinterpreted as a frequency scale because of the legend "Megacycles" applied to the entire dial.

156. Vacuum tubes used in the Receiver are listed in paragraph 50. The number of tubes and the number of tube types are believed to constitute a reasonable minimum considering the special requirements in design of ultra-high-frequency receivers. Among the tubes used in the Receiver, the following are on the Navy Standard Tube List (corrected to September 17, 1941) under the following classifications:

(a) Active List

Preferred types	954
	955
	6AB7
	6H6
	6SK7
	VR-150-30

(b) Inactive List

Replacement only	6AC7

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Vacuum tubes type 6SC7, 6V6 and 5X4G are not on the Navy Standard Tube List, although type 6V6 GT is on the active list of preferred types.

157. Two fuses (Littlefuse type 3AG) are provided in the a-c power circuit. They are mounted within easily accessible molded phenolic receptacles in the rear apron of the chassis and are readily replaceable without removing the chassis from the cabinet. One end of the fuse cartridge fits into a metal spring socket mounted on a screw by which it may be secured in the receptacle containing a socket for the other end of the fuse. The outside end of the screw is fitted with a molded phenolic cap with a slot to permit use of a screw driver in removing or replacing the fuse.

158. An instruction book, reference (i), has been furnished with each Receiver. This book does not cover all points usually included in instructions furnished with Naval equipment. It is recommended that consideration be given to requiring that the Manufacturer furnish drawings and instruction books in conformity with paragraphs 15-1 and 15-2 of BuShips specification RE 13A 571C.

159. No spare parts were furnished with the Receiver. It is recommended that consideration be given to the procurement of spare parts to be furnished in accordance with paragraphs 14-1 to 14-4, inclusive, of Bureau of Ships specifications RE 13A 571C, in so far as these paragraphs may apply to the subject Receiver.

160. In order to serve as a basis for final computation of spare parts requirements, the following list of suggested spares has been compiled using paragraphs 14-1 to 14-4 of specification RE 13A 571C as a guide.

Quantity of Spares per Receiver	Symbol Designations (ref. plate 112)	Description
8	C_3 C_4 C_5 C_8 C_9 C_{11} C_{13} C_{37} C_{59} C_{60} C_{61} C_{62} C_{63} C_{70} C_{72}	Receiver type mica fixed Capacitor 300 mmf ± 20%
1	C_6 C_{10}	Ceramic Fixed Capacitor 5 to 6.5 mmf
5	C_{14} C_{21} C_{28} C_{48} C_{51} C_{52} C_{64} C_{65} C_{66} C_{67}	Receiver type mica fixed Capacitor .01 mfd ± 20%
1	C_{17} C_{25}	Receiver type mica fixed Capacitor .004 mfd. ± 10%
1	C_{18} C_{26}	Variable Ceramic Capacitor 2 - 6 mmf (Centralab)

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Quantity of Spares per Receiver	Symbol Designations (ref. plate 112)	Description
1	C_{19} C_{24}	Receiver type mica fixed Capacitor .006 mfd ± 20%
4	C_{20} C_{27} C_{32} C_{33} C_{34} C_{43} C_{44}	Receiver type mica fixed Capacitor .002 mfd ± 20%
5	C_{21} C_{28} C_{48} C_{51} C_{52} C_{64} C_{65} C_{66} C_{67}	Receiver type mica fixed Capacitor .01 mfd ± 20%
2	C_{31} C_{38} C_{46}	Receiver type mica fixed Capacitor 50 mmf ± 20%
1	C_{40} C_{73}	Receiver type mica fixed Capacitor 25 mmf ± 20%
1	C_{45} C_{47}	Receiver type mica fixed Capacitor 500 mmf ± 20%
1	C_{49}	Electrolytic capacitor 40 mfd 100 volts
1	C_{50}	Electrolytic capacitor 20 mfd 100 volts
3	C_{54} C_{55} C_{56} C_{57} C_{58}	Paper capacitor (oil filled) 4 mfd 600 volts
1	C_{53}	Receiver type mica fixed Capacitor .003 mfd ± 20%
2	C_{68} C_{69} C_{71}	Ceramic type fixed Capacitor 100 mmf ± 10%
1	C_{7} C_{12}	Radio Frequency Trimmer Condenser (Special design by Hallicrafters)
5	C_{15} C_{16} C_{22} C_{23} C_{29} C_{30} C_{35} C_{41} C_{42}	Intermediate Frequency air Trimmer Condenser
1	C_{39}	Paper Capacitor .05 mfd 400 volts
1	R_{16}	R-F gain control potentiometer 10,000 ohms (Hallicrafters #25-058)

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Quantity of Spares per Receiver	Symbol Designations (ref. plate 112)	Description
1	R_{48} R_{52}	Volume control and Volume control Potentiometer (Hallicrafters #25-059) 1 megohm
1	R_{55}	Tuning meter adjustment Potentiometer 1500 ohms (Hallicrafters #25-060)
1	R_1	Fixed Resistor 2.2 ohms ± 10% 1/2 watt
2	R_2 R_5 R_{44}	Fixed Resistor 250 ohms ± 10% 1/2 watt
5	R_3 R_4 R_6 R_7 R_9 R_{10} R_{23} R_{29} R_{30}	Fixed Resistor 1000 ohms ± 20% 1/2 watt
1	R_8	Fixed Resistor 12,000 ohms ± 10% 2 watts
4	R_{12} R_{13} R_{19} R_{20} R_{33} R_{37} R_{45} R_{46}	Fixed Resistor 100,000 ohms ± 20% 1/2 watt
1	R_{15}	Fixed Resistor 100,000 ohms ± 10% 1 watt
1	R_{17}	Fixed Resistor 40,000 ohms ± 10% 1/2 watt
2	R_{18} R_{24} R_{60}	Fixed Resistor 300 ohms ± 10% 1/2 watt
1	R_{21} R_{39}	Fixed Resistor 35 ohms ± 20% 1/2 watt
1	R_{22}	Fixed Resistor 150 ohms ± 20% 1/2 watt
1	R_{25}	Fixed Resistor 10 ohms ± 10% 1/2 watt
2	R_{26} R_{36} R_{51}	Fixed Resistor 500,000 ohms ± 20% 1/2 watt
1	R_{27}	Fixed Resistor 600 ohms ± 10% 1/2 watt
1	R_{28}	Fixed Resistor 7500 ohms ± 10% 10 watts
1	R_{31} R_{38}	Fixed Resistor 50,000 ohms ± 20% 1/2 watt

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Quantity of Spares per Receiver	Symbol Designations (ref. plate 112)	Description
1	R_{32}	Fixed Resistor 1 megohm ± 20% 1/2 watt
2	R_{34} R_{35} R_{41} R_{50}	Fixed Resistor 250,000 ohms ± 20% 1/2 watt
1	R_{40}	Fixed Resistor 3900 ohms ± 10% 2 watts
1	R_{42}	Fixed Resistor 3300 ohms ± 10% 1 watt
1	R_{43}	Fixed Resistor 330,000 ohms ± 10% 1/2 watt
1	R_{47}	Fixed Resistor 200,000 ohms ± 20% 1/2 watt
1	R_{49}	Fixed Resistor 3000 ohms ± 20% 1/2 watt
1	R_{53}	Fixed Resistor 390 ohms ± 10% 1 watt
1	R_{54}	Fixed Resistor 4700 ohms ± 20% 2 watts
1	R_{56}	Fixed Resistor 3200 ohms ± 10% 10 watts
1	R_{57}	Fixed Resistor 20,000 ohms ± 10% 1/2 watt
1	R_{58}	Fixed Resistor 4000 ohms ± 10% 1/2 watt
1	R_{59}	Fixed Resistor 5000 ohms ± 10% 1/2 watt
1	R_{60}	Fixed Resistor 300 ohms ± 10% 1/2 watt
1	R_{61}	Fixed Resistor 150,000 ohms ± 20% 1/2 watt
1	T_{10}	Output Transformer, Hallicrafters #7329
2	S_1 S_2 S_5 S_6	Toggle Switch
1	S_4	Wafer switch
1	S_3	Meter switch (mounted on back of gain control R16)
2	---	Acorn Tube Sockets (Hammarlund #UHS 900)
5	---	Octal Sockets (Amphenol #MIP8T)
2	F_1 F_2	Cartridge Fuse 3 amp. 250 volt (Littlefuse Lab. type 3AG)

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Quantity of Spares per Receiver	Symbol Designations (ref. plate 112)	Description
Complete Set	Vacuum Tubes	As listed in Paragraph 50
1		Molded phenolic or similar insulated Screwdriver for alignment
1	I_1 I_2	Panel lamp 6.3 Volt Mazda #44

Spare parts boxes are recommended in accordance with Navy Department specifications 42-B-9.

161. An octal socket is provided at the rear of the chassis. This socket may be used to receive leads from a d.c. power source to replace the internal rectifier power supply. For normal a.c. operation, using the receiver power supply, it is necessary to insert a jumper plug in this d.c. operation socket. When it is desired to operate the Receiver on an external d.c. supply, this jumper plug is removed and a similar plug, carrying the d.c. leads, is inserted in its place.

162. It is possible to put the Receiver in a standby condition from a remote position by connecting the remote switch or relay contacts through a cable to two prong plug which is inserted into the corresponding socket on the rear apron of the receiver chassis. This socket connects the external contacts across the standby switch (marked "Send-Rec") in the Receiver.

163. Summary of Defects which might adversely affect satisfactory operation in Naval Shipboard service:

(a) Ref. par. 124. The wire insulation may not prove satisfactory from the points of view of moisture absorption, aging and power factor. The woven fabric insulation used on some of the wiring in the Receiver is less impervious to moisture than rubber or other homogeneous covering which is preferred for use in Naval equipment.

(b) Ref. par. 116. No facilities are provided for securing the Receiver to a table.

(c) Ref. par. 118. The cabinet and chassis are not designed for ready removal of the chassis for servicing or replacement operations. No handles are provided for this purpose and the shock mounts are not suitable for securing to a table.

(d) Ref. par. 137. No means are provided for locking the tuning control at a desired position.

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(e) Ref. par. 155. There is a possibility that the logging scale on the main tuning control may be mistaken by uninitiated personnel for a frequency scale since the entire scale is indiscriminately labeled "Frequency in Megacycles".

(f) Ref. par. 113. The glass window over the main tuning dial was not firmly secured.

(g) Ref. par. 98. Wax impregnation treatment was not applied to all fixed resistors, fixed condensers and terminal strips.

(h) Ref. par. 134. The material used in the main tuning and logging dials was somewhat brittle and subject to warping.

(i) Ref. par. 112. The long antenna trimmer condenser shaft is inadequately supported and may be subject to excessive vibration and possibly to breakage of the coupling fixture.

(j) Ref. par. 122. The internal tooth lock washers liberally employed in the Receiver are subject to decrease in usefulness after repeated disassembly and reassembly.

(k) Ref. par. 105. The thin silver plating used at r-f moving contacts and in switch contacts is subject to wear and subsequent erratic operation.

(l) Ref. par. 125. Soldered joints have not been cleaned and lacquered.

(m) Ref. par. 126. No components are marked to indicate their position in the circuit.

(n) Ref. par. 131. A small amount of ferrous material is used in the Receiver where not essential for electromagnetic purposes.

(o) Ref. par. 150. The input meter indicates in terms of units not familiar to Naval personnel.

(p) Ref. par. 158. The instruction book furnished by the Manufacturer does not give sufficient data on the characteristics of the Receiver.

(q) Ref. par. 88. The Receiver antenna input terminals are arranged for a two-wire balanced line input instead of the concentric line unbalanced type used in Naval equipment.

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CONCLUSIONS

164. The Model N-S27C Receiver meets the stipulations of the Manufacturer's descriptive specifications, reference (b), with certain exceptions.

165. In general, the construction of the Receiver is sturdy and the accessibility of components good. Generally good materials and design are evident throughout with exception of the type of hook-up wire used and of the lack of sufficiently thick silver facing on contacts used in switches and rotary condensers. No provision is made for securing the Receiver to a table. Withdrawal of the chassis from the cabinet requires the removal of screws from the bottom of the cabinet.

166. The oscillator frequency is affected by changes in ambient temperature and humidity, although this instability is relatively unimportant if a local frequency reference, such as a transmitter or a crystal frequency indicator is available. The bandwidth of the intermediate-frequency channel at the 6 db attenuation level is much too small to assure reliable reception without adjustments to compensate for first oscillator frequency instabilities arising from various causes and probable drift in transmitter frequencies. This feature appears to be of consequence in searching service also because it restricts the speed at which the tuning may be varied without danger of passing over a signal unnoticed. For communication service, this relatively narrow acceptance bandwidth appears to be of little consequence if the receiver is to be attended and if the attendant has at his disposal suitable frequency standards for tuning adjustments as required. The selectivity curve bandwidth ratio between 60 db and 6 db levels is considered poor as compared to existing Navy receivers.

167. The operation of the Receiver is simple, tuning being accomplished with a single control. The Receiver is therefore suitable for searching or other applicationsin which rapid shifts in tuning are desirable.

168. The Receiver cannot be accurately preset to a given frequency by its own calibration, as no crystal calibrator is included. However, it would be satisfactory in communication service when the frequency to be received is identical with the local transmitter frequency, permitting the Receiver frequency to be adjusted to the latter. An external calibrating device would be essential to preset the Receiver with precision to frequencies other than those of local transmitters.

[redacted]

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[redacted]

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TABLE 1

Backlash in Tuning Condenser Drive

Receiver Tuning Frequency	Backlash in Logging Dial Divisions	Backlash in Kc
130 Mc	1.2	40
150	1.2	55
200	1.4	51

TABLE 2

Intermediate Frequency Signal Rejection

Receiver Resonant Frequency Mc.	Microvolts Input at Intermediate Frequency to Produce Standard Output	DB Rejection
130	65,000	96
140	110,000	102
150	130,000	107
160	120,000	103
170	70,000	98
180	60,000	91
190	16,700	84
200	27,000	84
210	520,000	111

TABLE 3

Image Rejection Ratio

Receiver Resonant Frequency in Mc.	Image Frequency in Mc.	Image Input For Standard Output	DB Rejection Ratio
130	98	5400	75
150	118	5800	77
170	138	1000	62
190	158	220	45
210	178	480	48

[redacted]

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TABLE 4

Output Impedances

Output Terminal	Matching Impedance
Phone Jack	> 20,000 ~
5000 ohm Terminal	> 20,000 ~
500 ohm Terminal	2,500 ~

TABLE 5

Maximum Power Output

Tap	Termination	Power Output
Phone Jack	600 ~	1.1 milliwatts
500 ~ Terminals	600 ~	5.0 watts
5000 ~ Terminals	6000 ~	5.0 watts

TABLE 6

Power Requirement

Send - Receive Switch Position	RF Gain Switch Position	60 Cycle Power Input	Power Factor
Receive	On	100 watts	77%
Receive	Off	95	76
Send	Off	57	70

[redacted]

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TABLE 7

Input Impedance

Frequency	Input Impedance
130 Mc	76 ohms
150	50
170	28
180	70
200	60
210	39

TABLE 8

R-F Output from Oscillator

Measured at Receiver Antenna Terminals

Receiver Tuned to	Oscillator Frequency	Oscillator Voltage at Antenna Terminals
130 Mc.	114 Mc.	1610 microvolts
140	124	3300
150	134	4800
160	144	7300
170	154	14000
180	164	11500
190	174	19500
200	184	Greater than 20000
210	194	Greater than 20000

[redacted]

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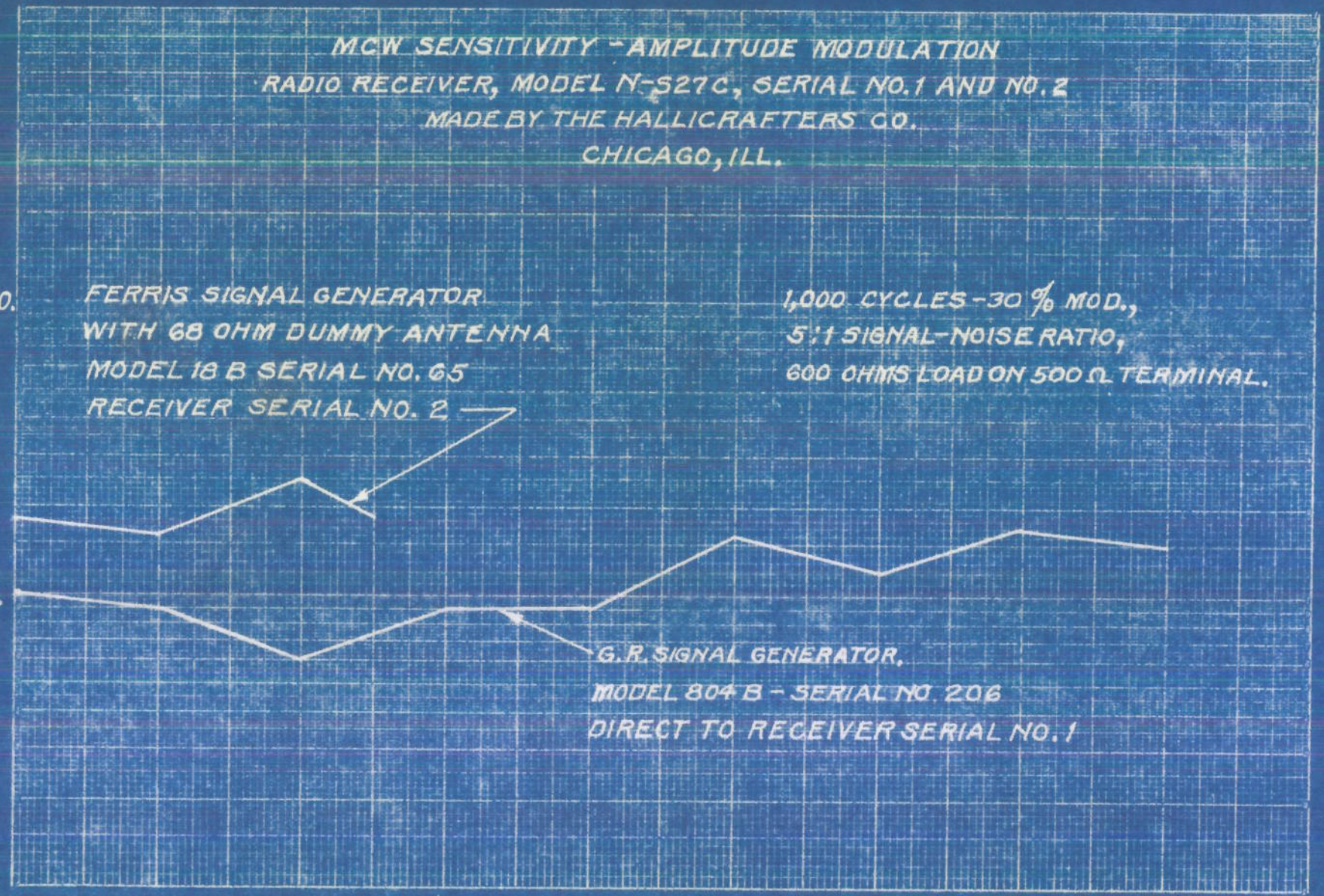
MCW SENSITIVITY - AMPLITUDE MODULATION

RADIO RECEIVER, MODEL N-S27C, SERIAL NO. 1 AND NO. 2

MADE BY THE HALLICRAFTERS CO.

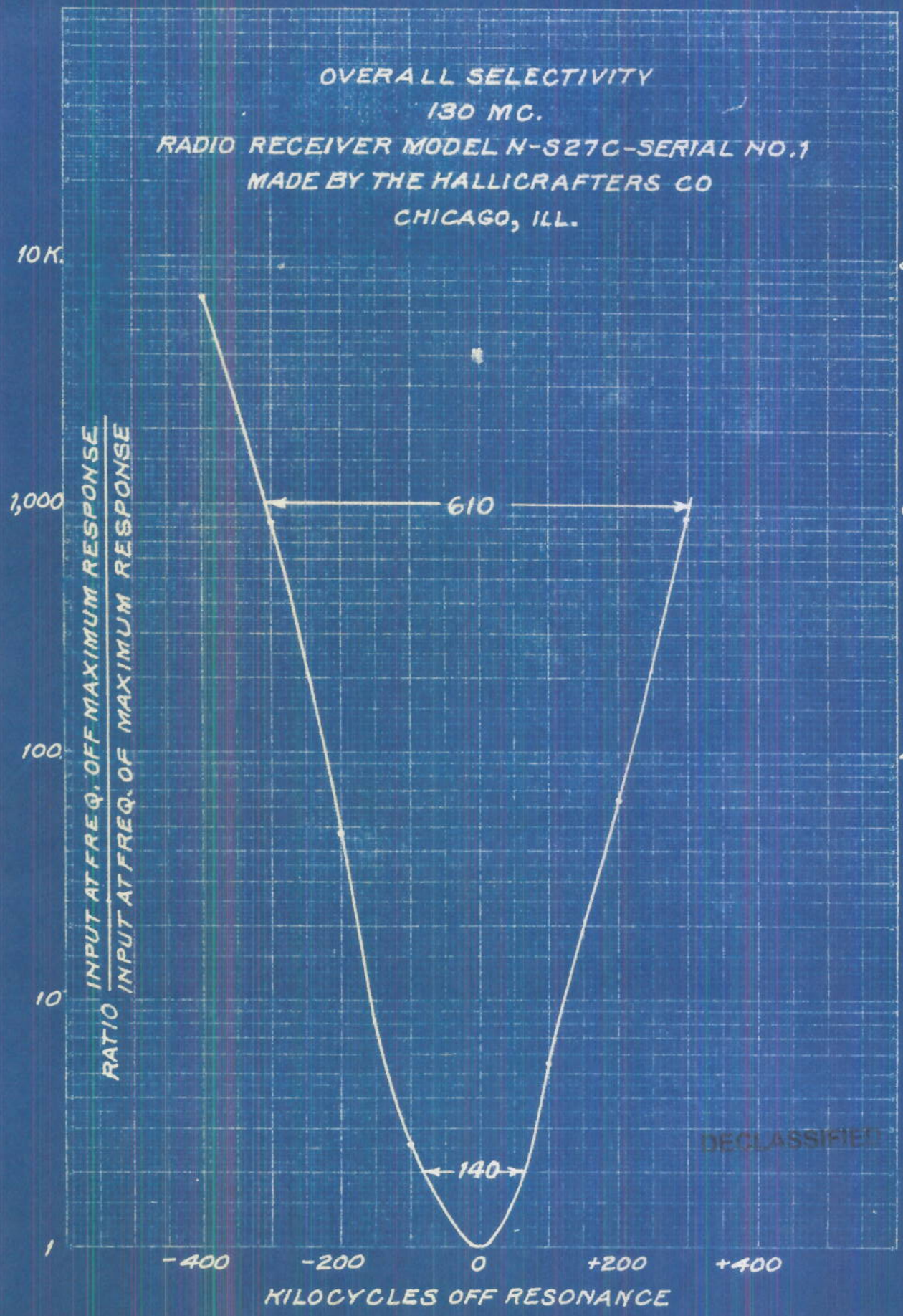
CHICAGO, ILL.



SENSITIVITY μV. (1.9 V. OUTPUT)

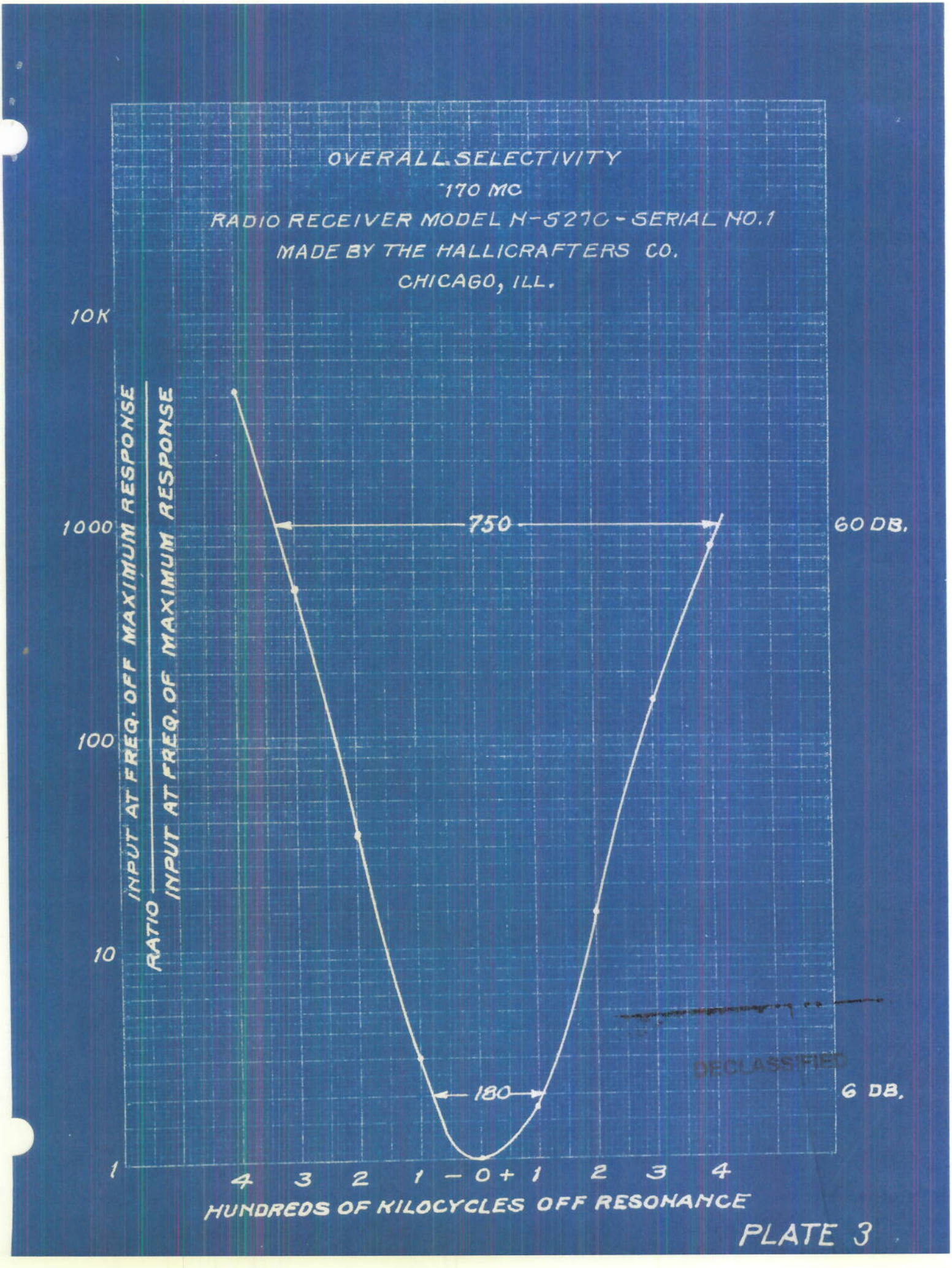
DECREASING SENSITIVITY

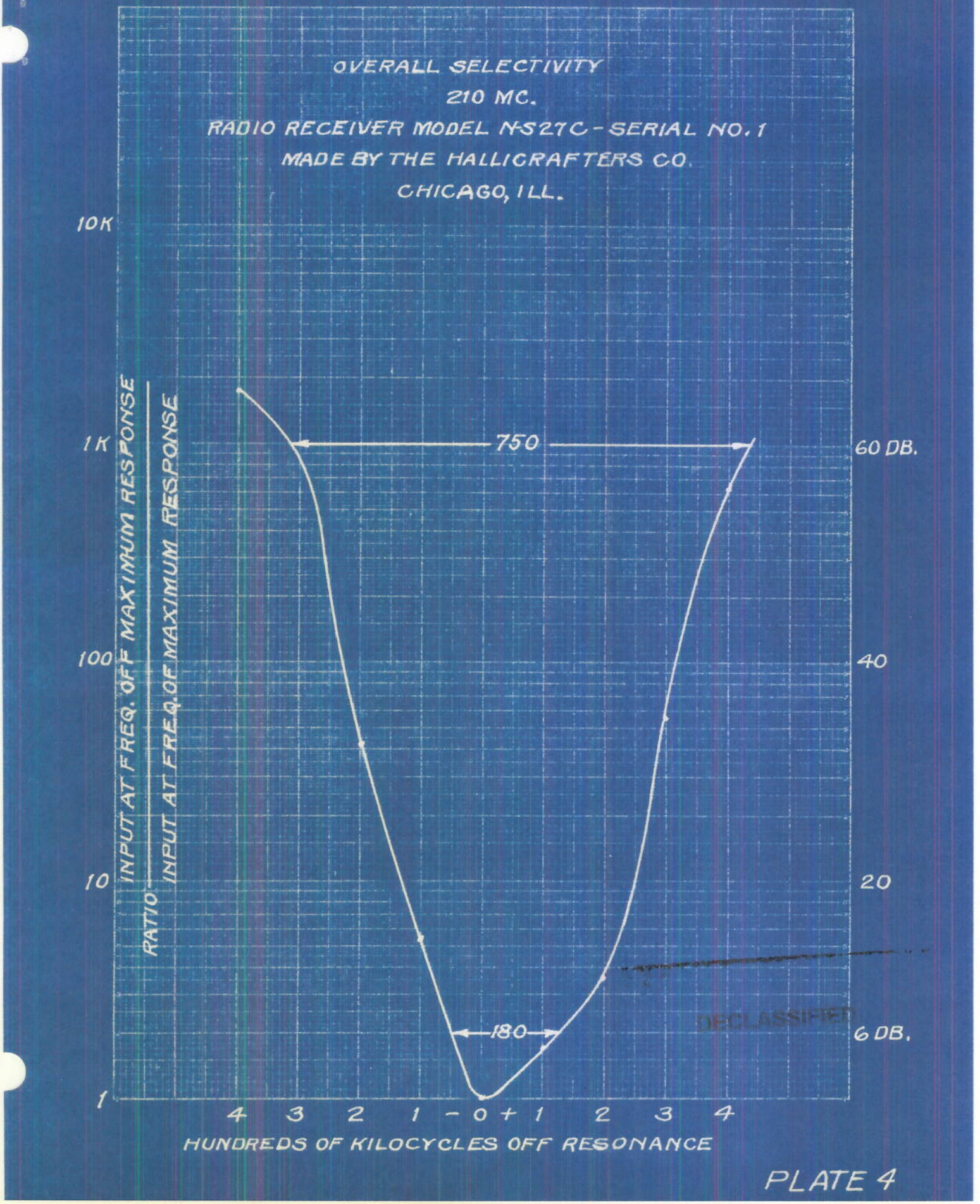
PLATE 1



DECLASSIFIED

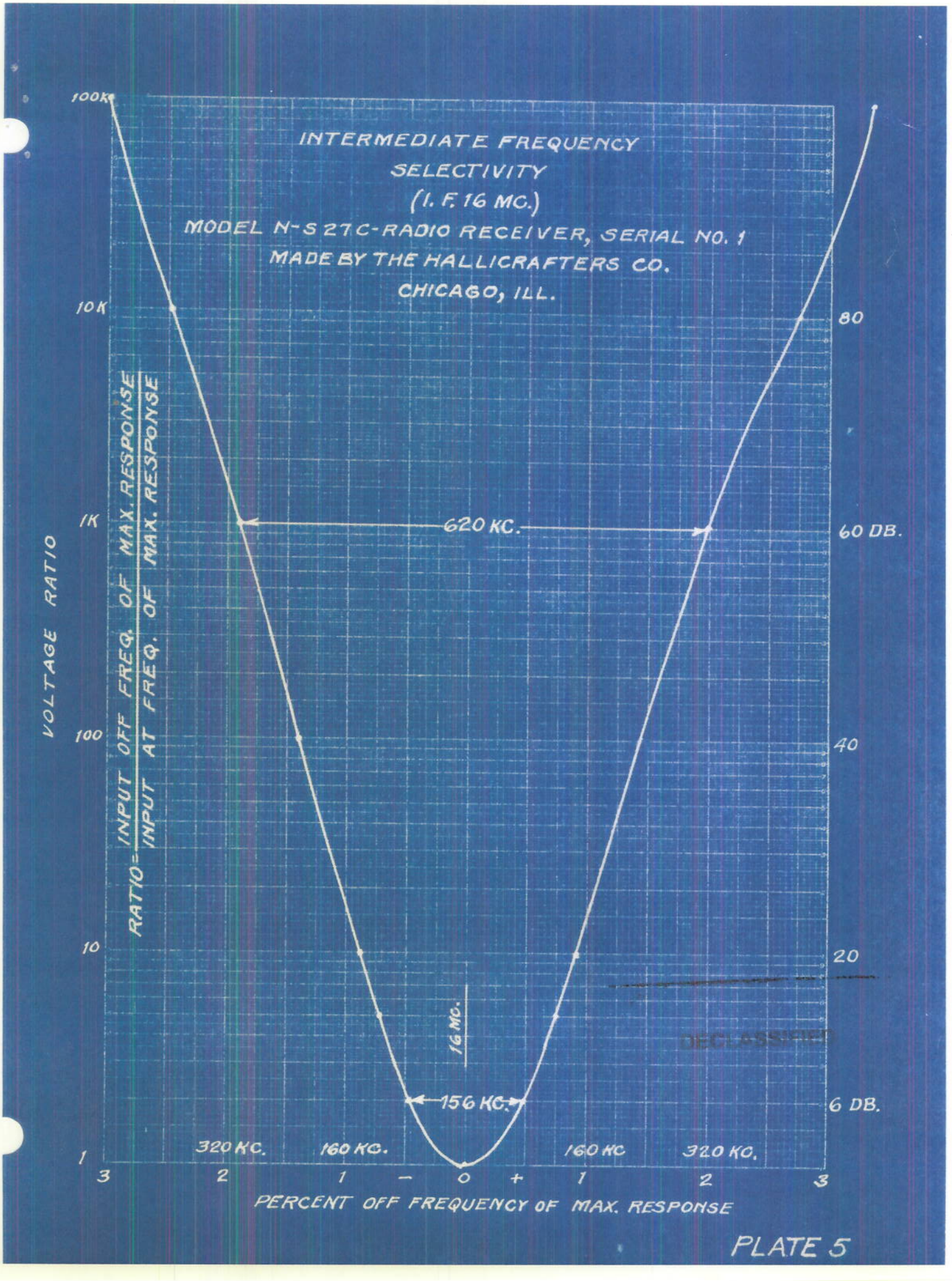
PLATE 2

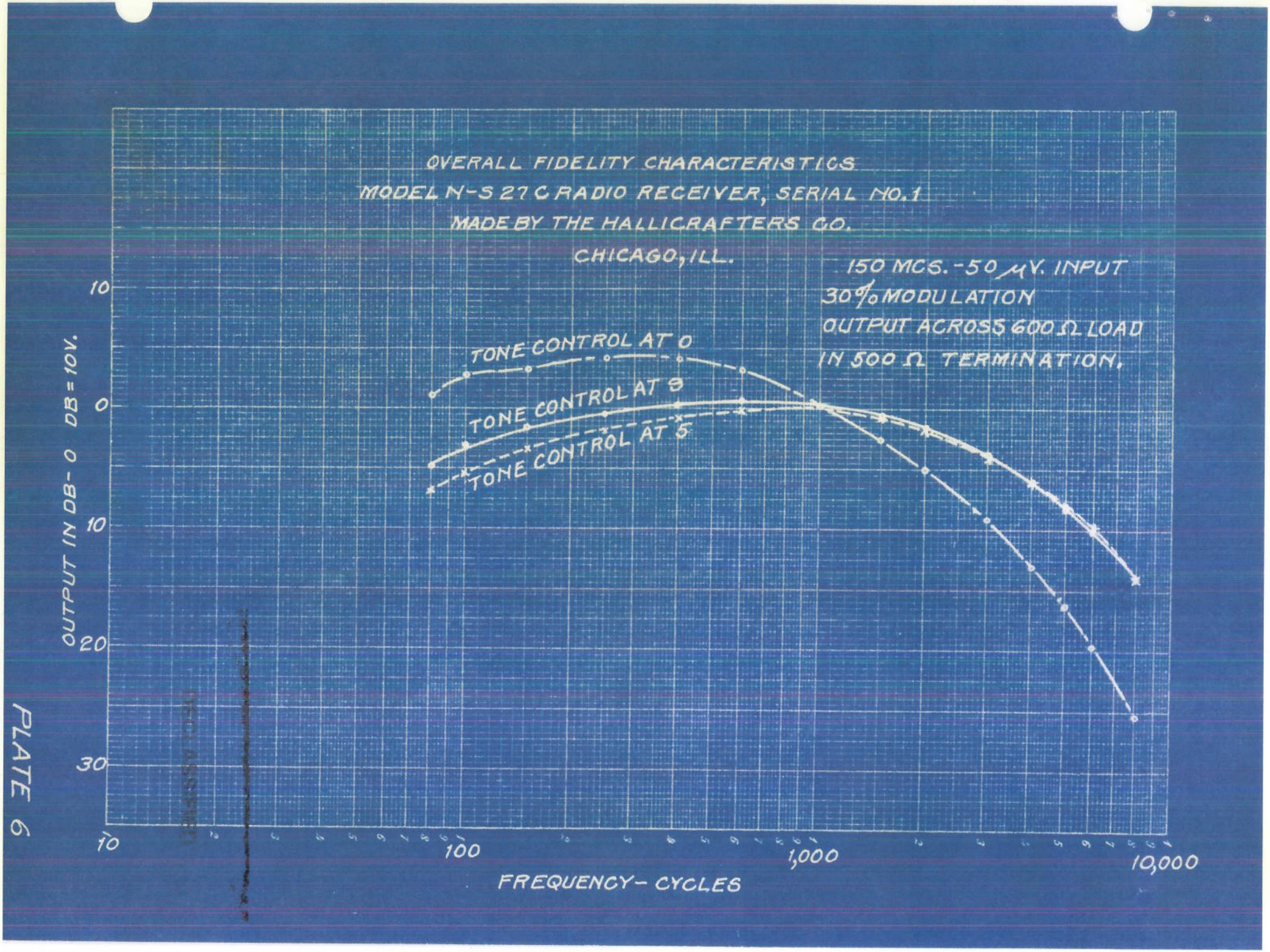

OVERALL SELECTIVITY
170 MC
RADIO RECEIVER MODEL H-527C - SERIAL NO. 1
MADE BY THE HALLICRAFTERS CO.
CHICAGO, ILL.
10K
1000
100
10
1
RATIO INPUT AT FREQ. OFF MAXIMUM RESPONSE / INPUT AT FREQ. OF MAXIMUM RESPONSE
750
60 DB.
180
6 DB.
4 3 2 1 — 0 + 1 2 3 4
HUNDREDS OF KILOCYCLES OFF RESONANCE
DECLASSIFIED
PLATE 3

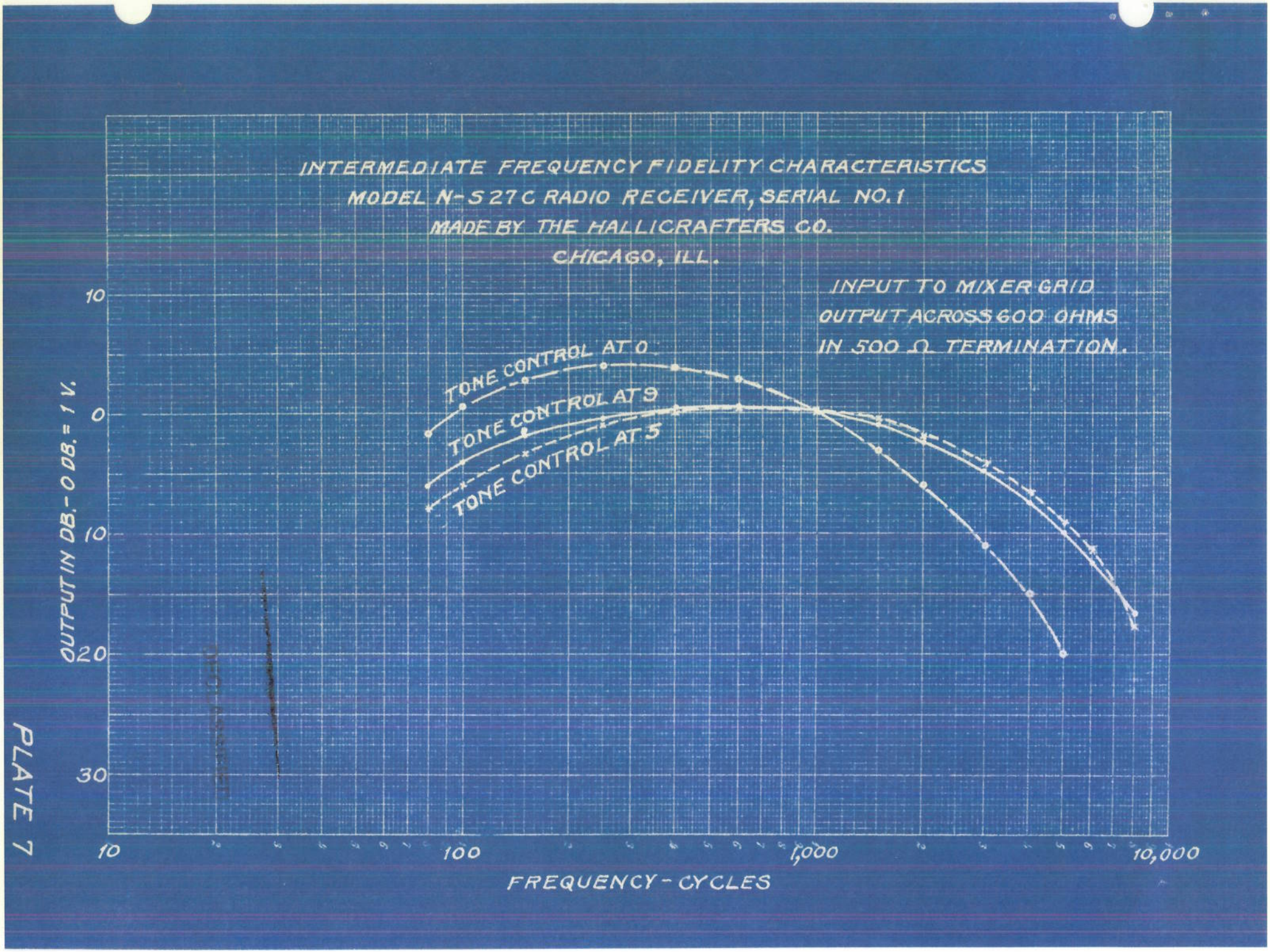


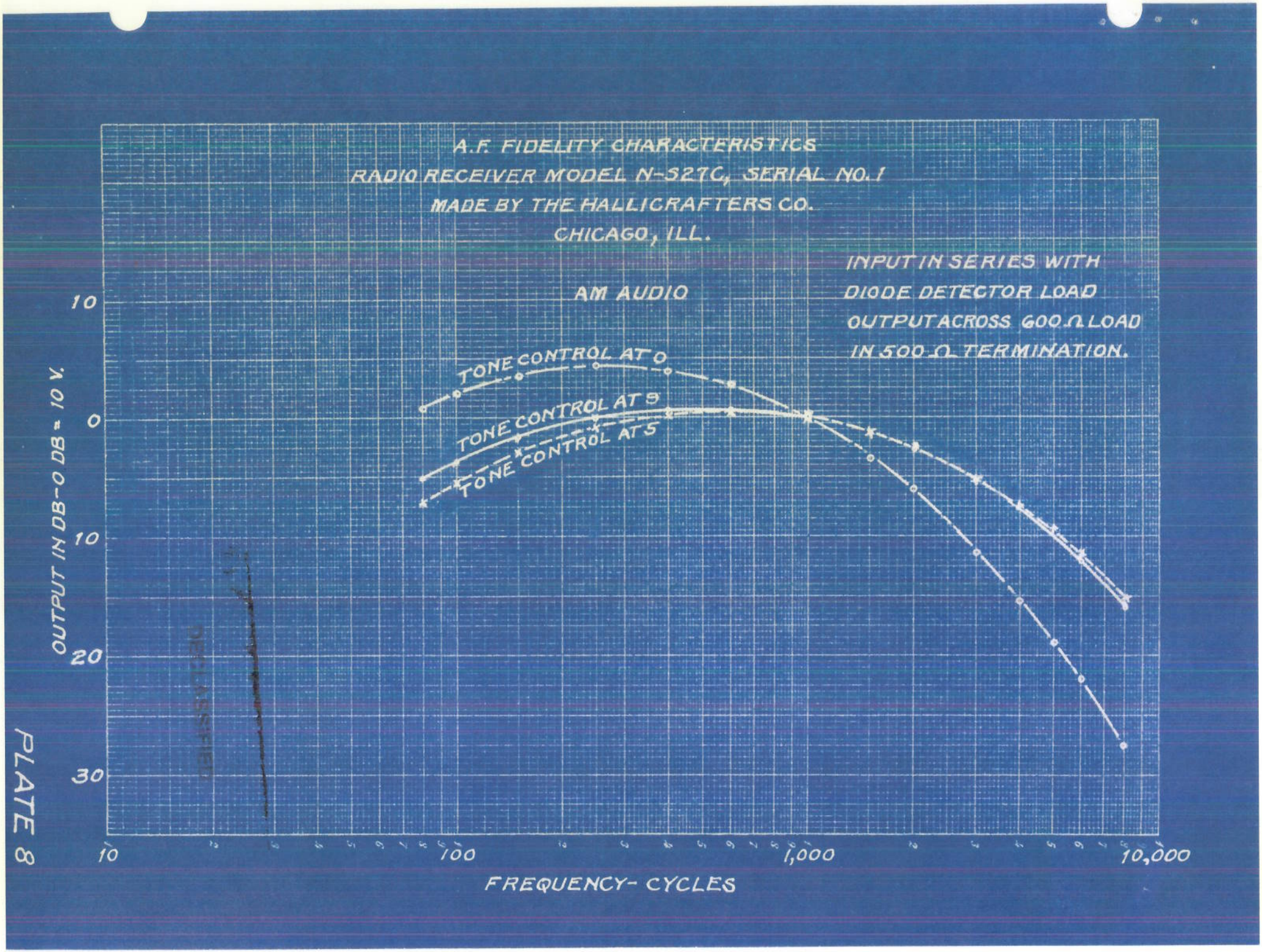
DECLASSIFIED

PLATE 4

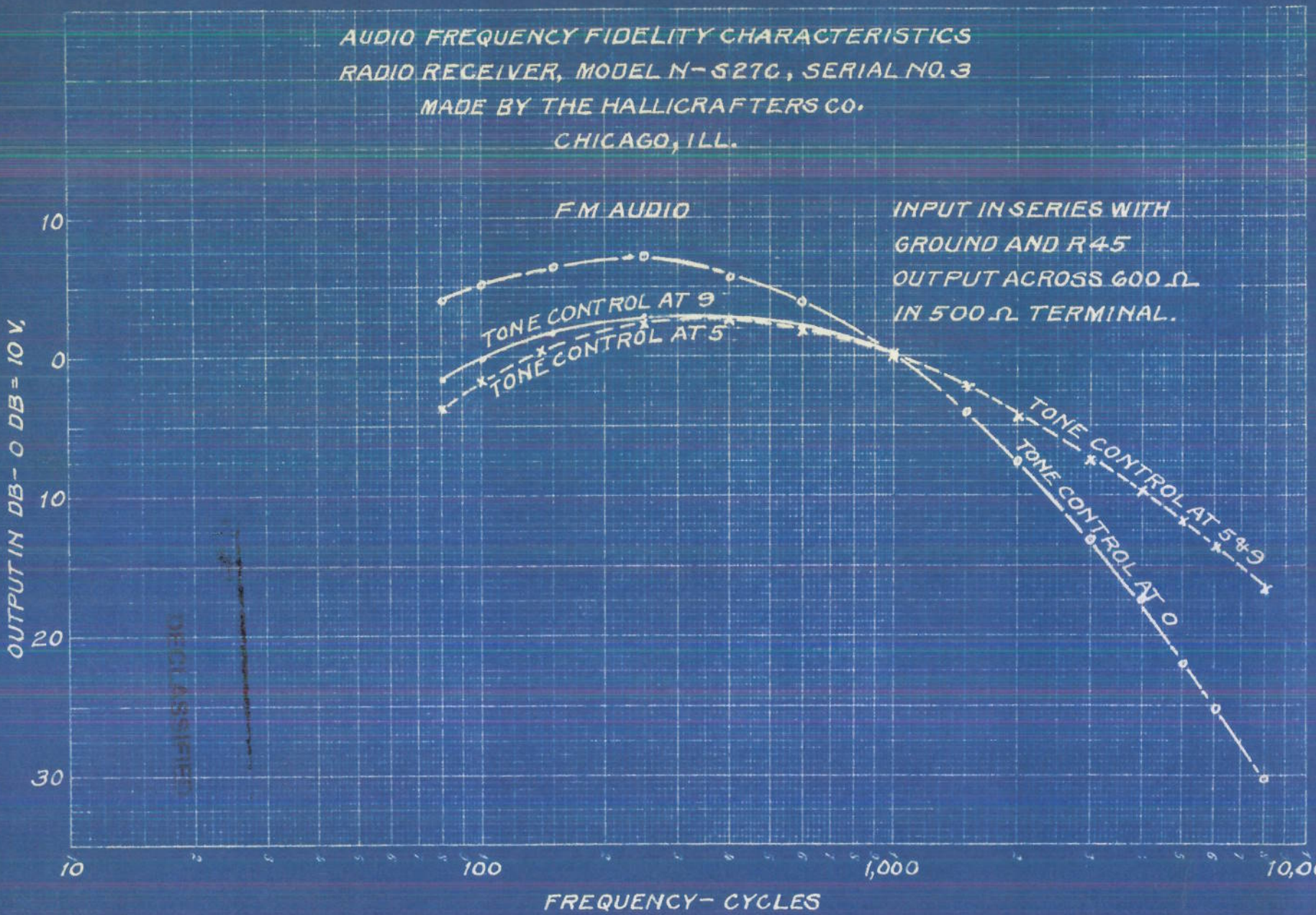

INTERMEDIATE FREQUENCY
SELECTIVITY
(I. F. 16 MC.)
MODEL N-S 27C-RADIO RECEIVER, SERIAL NO. 1
MADE BY THE HALLICRAFTERS CO.
CHICAGO, ILL.
VOLTAGE RATIO
RATIO = INPUT OFF FREQ. OF MAX. RESPONSE / INPUT AT FREQ. OF MAX. RESPONSE
100K
10K
1K
100
10
1
80
60 DB.
40
20
6 DB.
620 KC.
156 KC.
16 MC.
320 KC.
160 KC.
160 KC
320 KC.
3
2
1
–
0
+
1
2
3
PERCENT OFF FREQUENCY OF MAX. RESPONSE
DECLASSIFIED
PLATE 5


OVERALL FIDELITY CHARACTERISTICS
MODEL N-S 27 C RADIO RECEIVER, SERIAL NO. 1
MADE BY THE HALLICRAFTERS CO.
CHICAGO, ILL.
150 MCS. - 50 μV. INPUT
30% MODULATION
OUTPUT ACROSS 600 Ω LOAD
IN 500 Ω TERMINATION.
TONE CONTROL AT 0
TONE CONTROL AT 9
TONE CONTROL AT 5
OUTPUT IN DB - 0 DB = 10V.
10
0
10
20
30
10
100
1,000
10,000
FREQUENCY - CYCLES
PLATE 6


INTERMEDIATE FREQUENCY FIDELITY CHARACTERISTICS
MODEL N-S 27 C RADIO RECEIVER, SERIAL NO. 1
MADE BY THE HALLICRAFTERS CO.
CHICAGO, ILL.
INPUT TO MIXER GRID
OUTPUT ACROSS 600 OHMS
IN 500 Ω TERMINATION.
TONE CONTROL AT 0
TONE CONTROL AT 9
TONE CONTROL AT 5
OUTPUT IN DB. - 0 DB. = 1 V.
10
0
10
20
30
10
100
1,000
10,000
FREQUENCY - CYCLES
PLATE 7

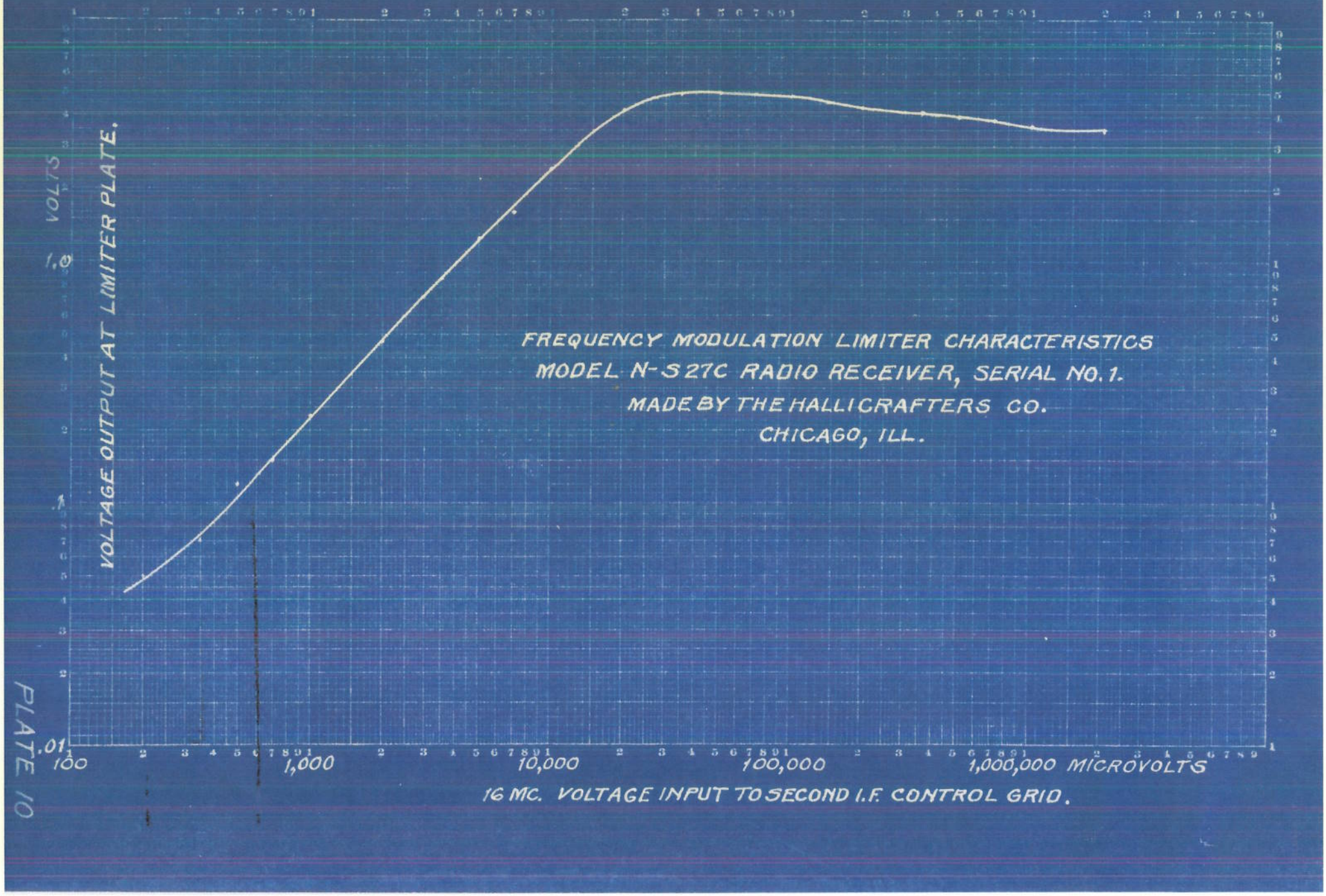

A.F. FIDELITY CHARACTERISTICS
RADIO RECEIVER MODEL N-52TC, SERIAL NO. 1
MADE BY THE HALLICRAFTERS CO.
CHICAGO, ILL.
AM AUDIO
INPUT IN SERIES WITH
DIODE DETECTOR LOAD
OUTPUT ACROSS 600 Ω LOAD
IN 500 Ω TERMINATION.
TONE CONTROL AT 0
TONE CONTROL AT 5
TONE CONTROL AT 5
OUTPUT IN DB-0 DB = 10 V.
10
0
10
20
30
10
100
1,000
10,000
FREQUENCY- CYCLES
DECLASSIFIED
PLATE 8

AUDIO FREQUENCY FIDELITY CHARACTERISTICS
RADIO RECEIVER, MODEL N-S27C, SERIAL NO. 3
MADE BY THE HALLICRAFTERS CO.
CHICAGO, ILL.



DECLASSIFIED

PLATE 9

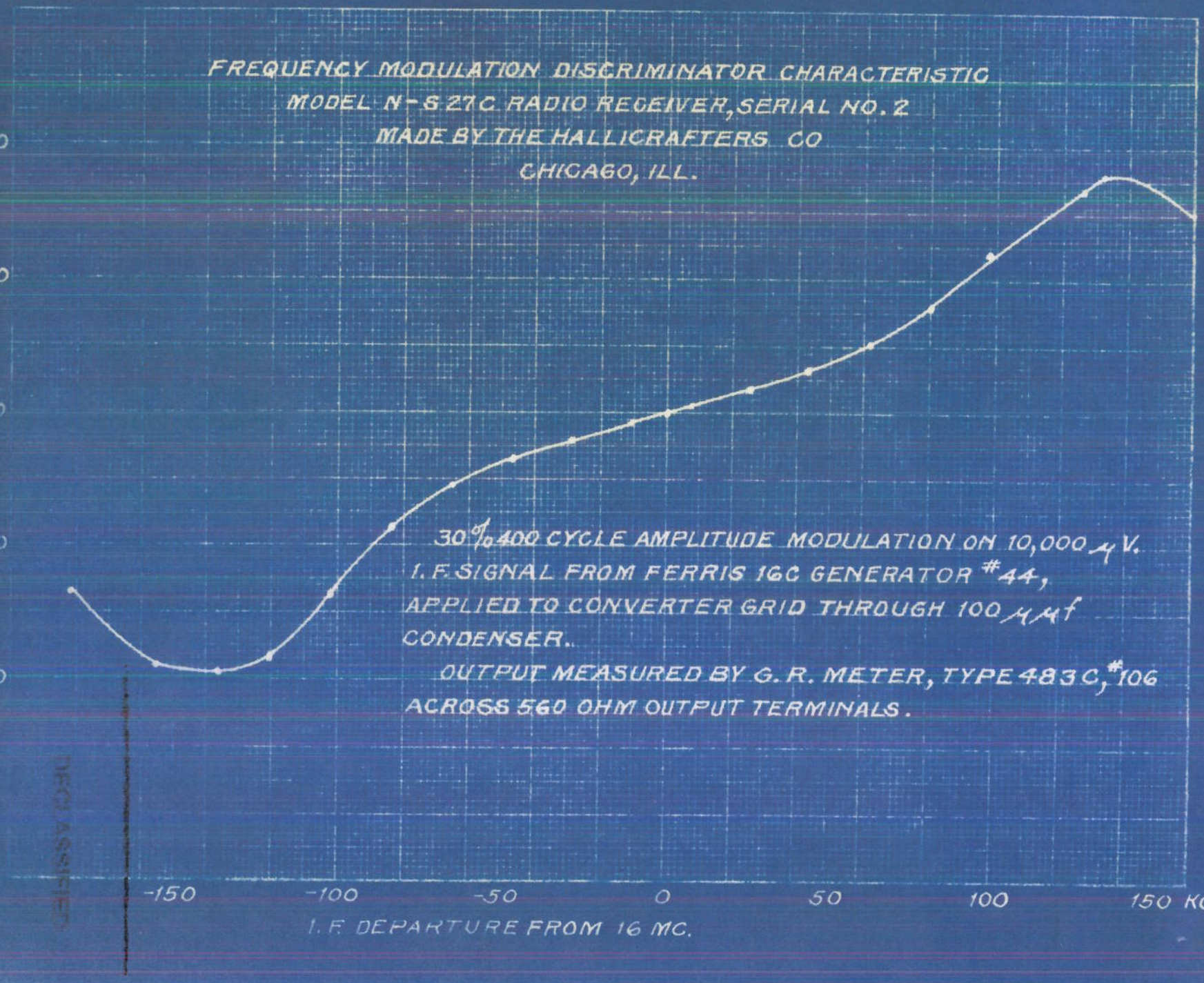

VOLTAGE OUTPUT AT LIMITER PLATE.
1.0 VOLTS
.1
.01
100
1,000
10,000
100,000
1,000,000 MICROVOLTS
FREQUENCY MODULATION LIMITER CHARACTERISTICS
MODEL N-S27C RADIO RECEIVER, SERIAL NO. 1.
MADE BY THE HALLICRAFTERS CO.
CHICAGO, ILL.
16 MC. VOLTAGE INPUT TO SECOND I.F. CONTROL GRID.
PLATE 10

FREQUENCY MODULATION DISCRIMINATOR CHARACTERISTIC

MODEL N-S 27C RADIO RECEIVER, SERIAL NO. 2

MADE BY THE HALLICRAFTERS CO

CHICAGO, ILL.



30% 400 CYCLE AMPLITUDE MODULATION ON 10,000 μV. I. F. SIGNAL FROM FERRIS 16C GENERATOR #44, APPLIED TO CONVERTER GRID THROUGH 100 μμf CONDENSER.

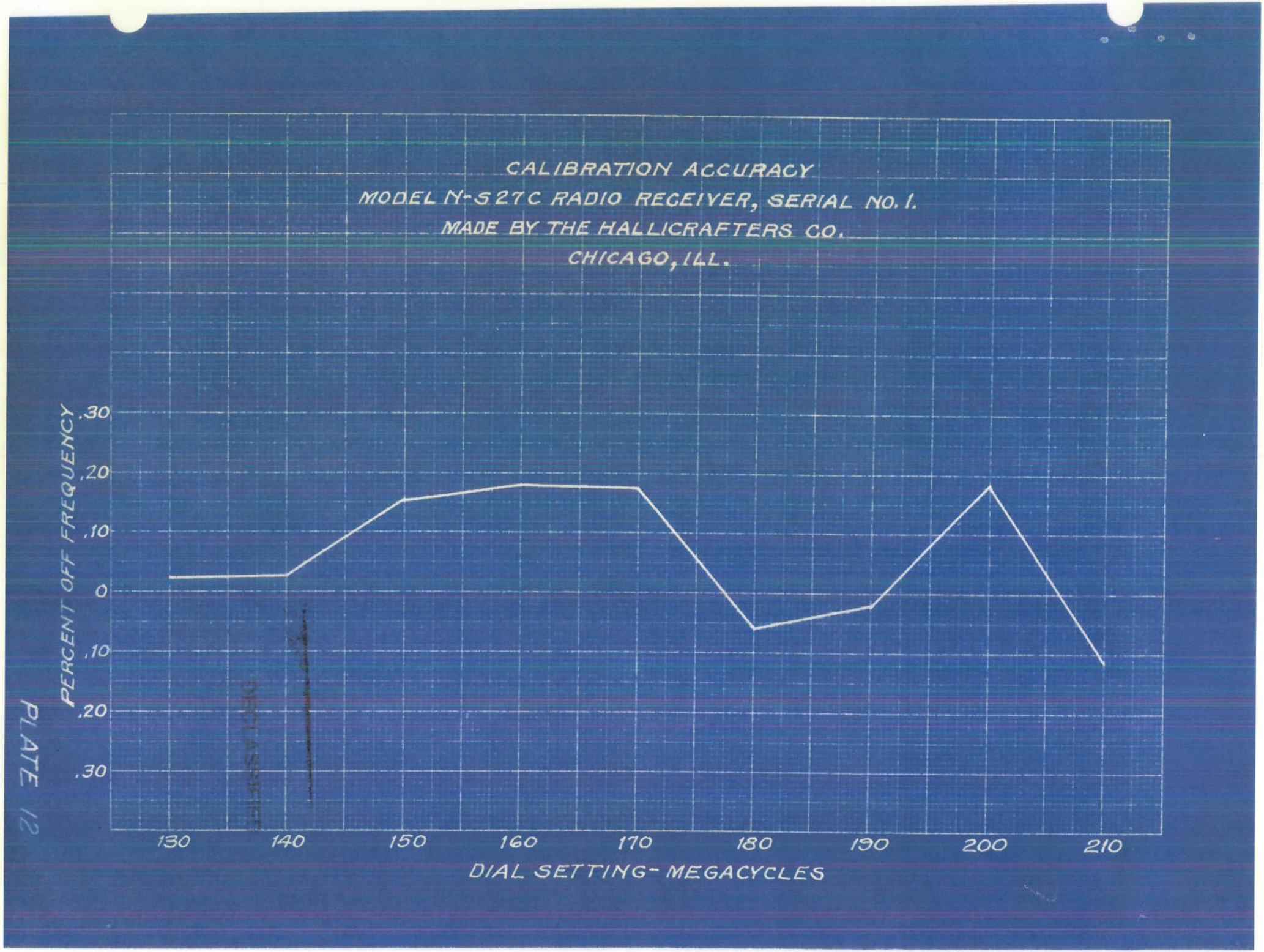
OUTPUT MEASURED BY G. R. METER, TYPE 483C, #106 ACROSS 560 OHM OUTPUT TERMINALS.

NEG. ASSIGNED

PLATE II

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

DATE


CALIBRATION ACCURACY
MODEL N-S27C RADIO RECEIVER, SERIAL NO. 1.
MADE BY THE HALLICRAFTERS CO.
CHICAGO, ILL.
PERCENT OFF FREQUENCY
.30
.20
.10
0
.10
.20
.30
130
140
150
160
170
180
190
200
210
DIAL SETTING - MEGACYCLES
PLATE 12

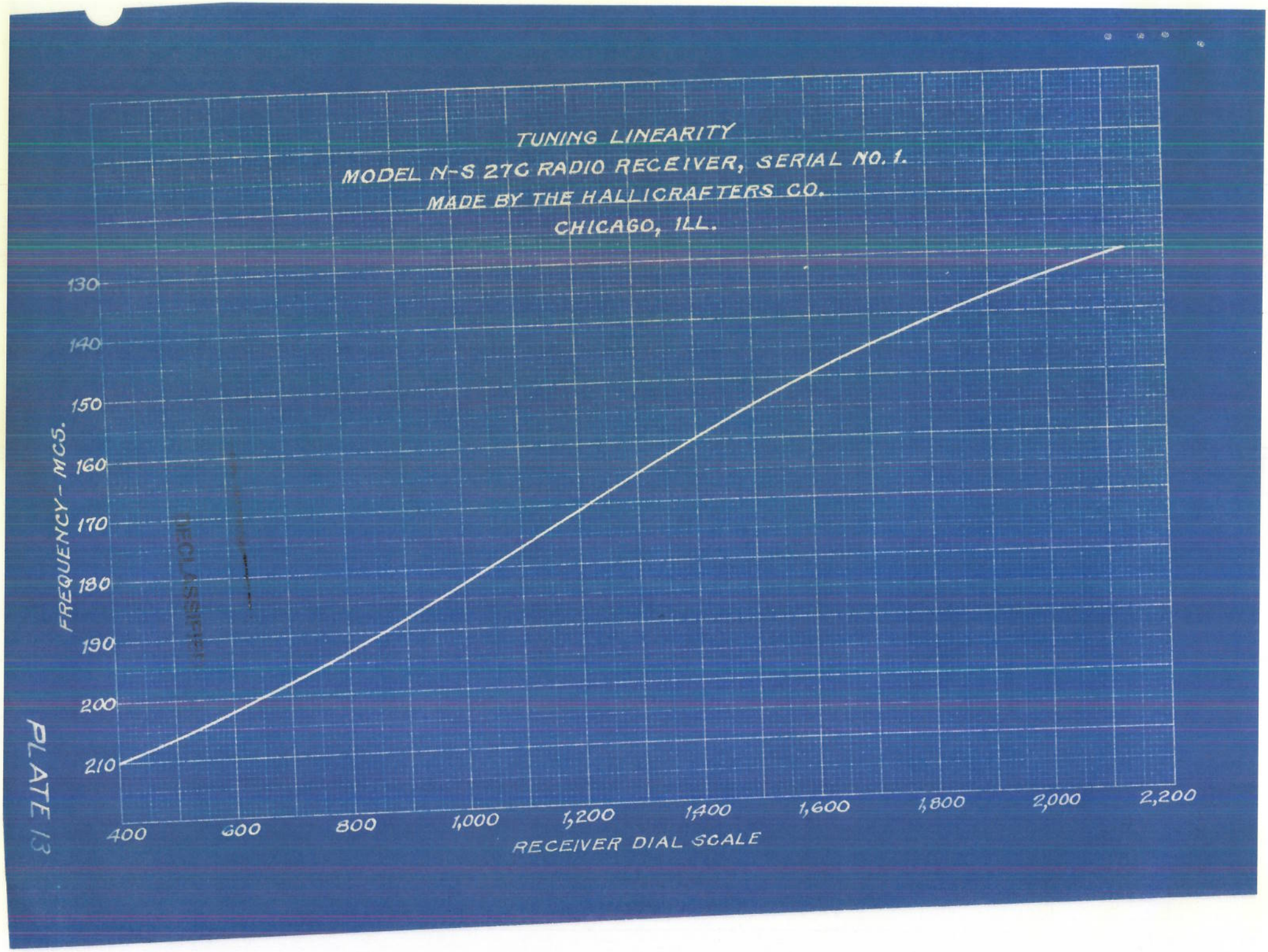

TUNING LINEARITY
MODEL N-S 27C RADIO RECEIVER, SERIAL NO. 1.
MADE BY THE HALLICRAFTERS CO.
CHICAGO, ILL.
FREQUENCY - MCS.
130
140
150
160
170
180
190
200
210
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
2,200
RECEIVER DIAL SCALE
DECLASSIFIED

PLATE 13

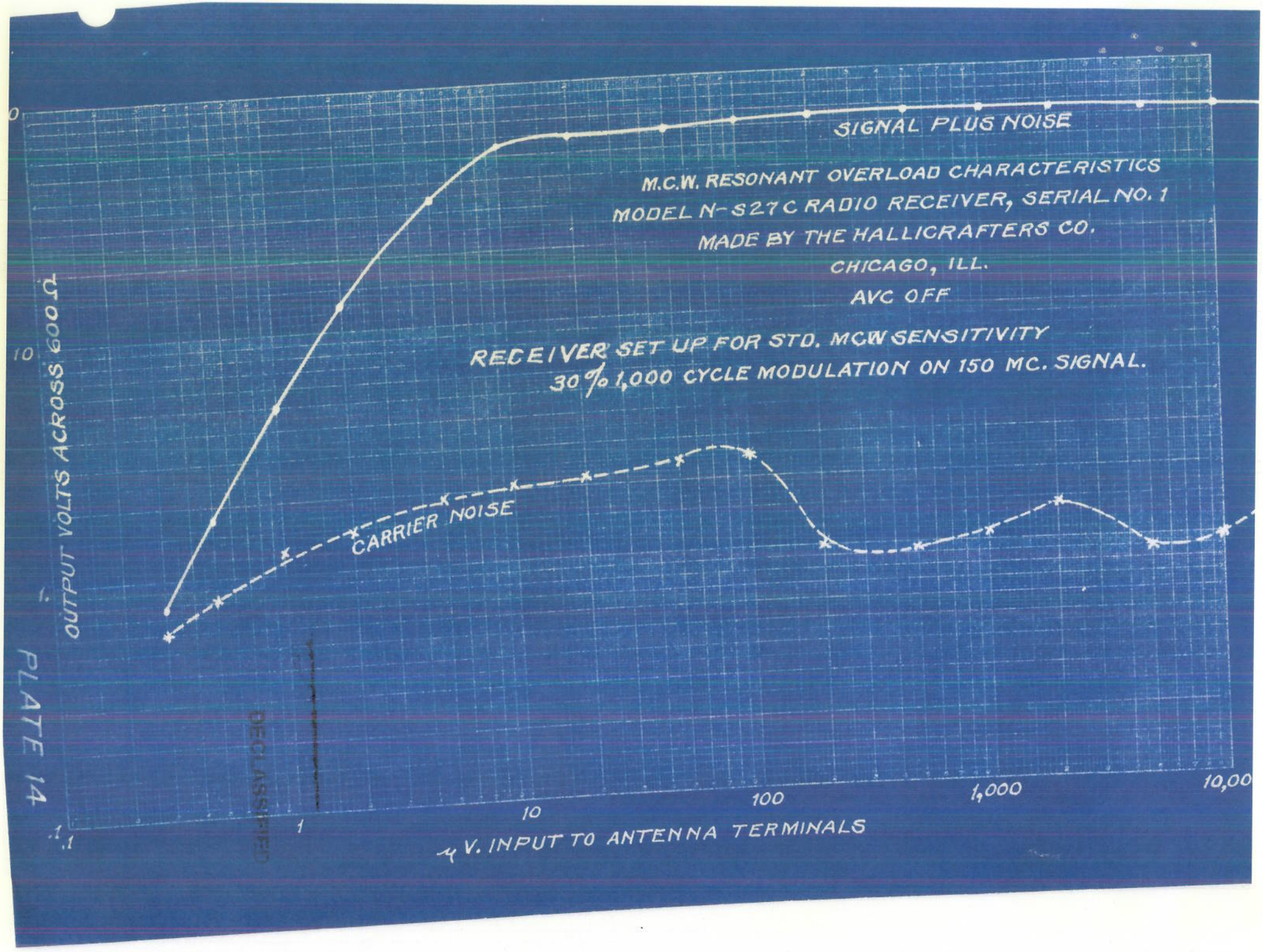


PLATE 14

DECLASSIFIED

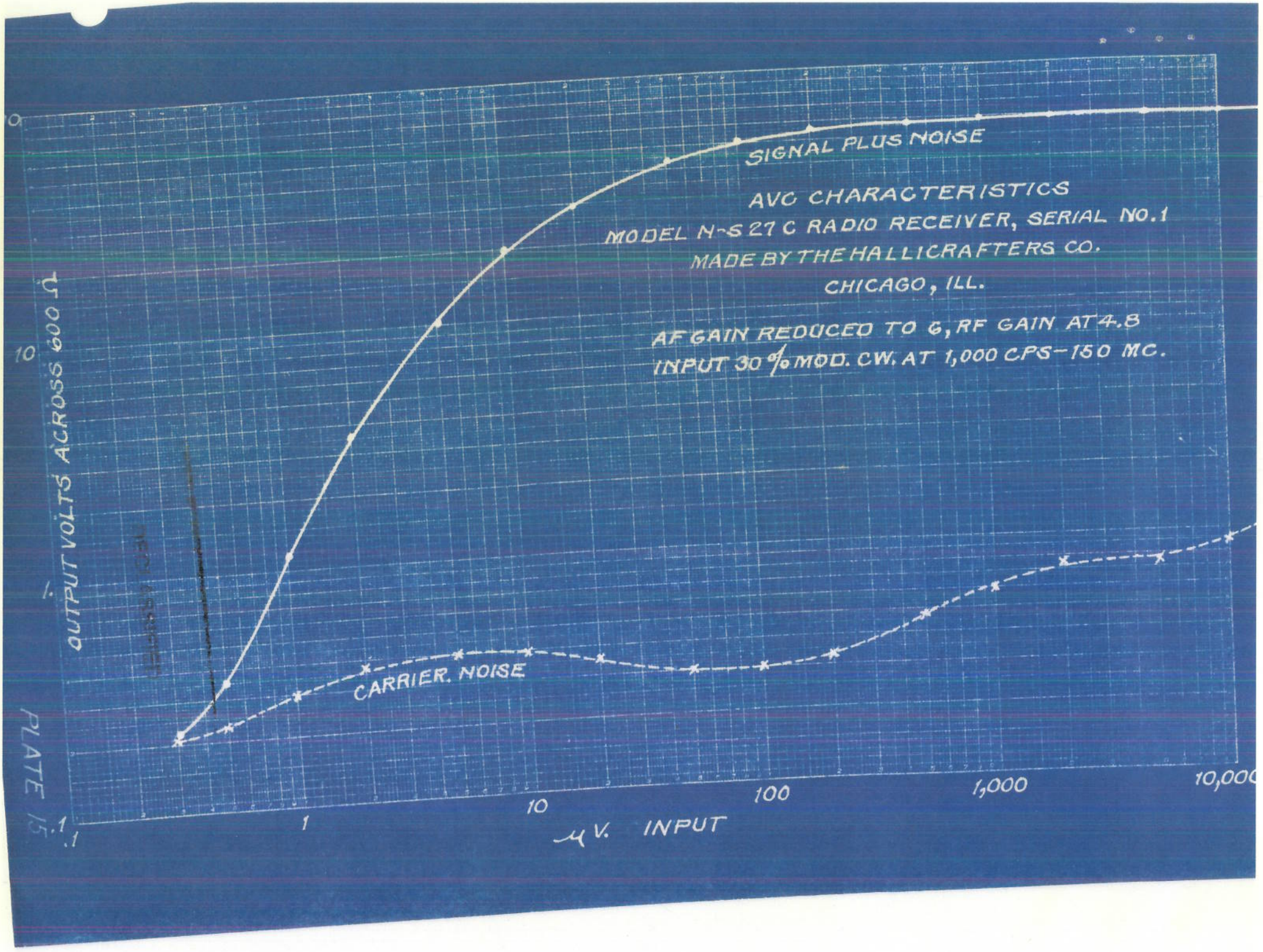

SIGNAL PLUS NOISE
AVC CHARACTERISTICS
MODEL N-S 27 C RADIO RECEIVER, SERIAL NO. 1
MADE BY THE HALLICRAFTERS CO.
CHICAGO, ILL.
AF GAIN REDUCED TO 6, RF GAIN AT 4.8
INPUT 30% MOD. CW. AT 1,000 CPS - 150 MC.
OUTPUT VOLTS ACROSS 600 Ω
CARRIER. NOISE
μV. INPUT
10
.1
1
10
100
1,000
10,000

PLATE 15

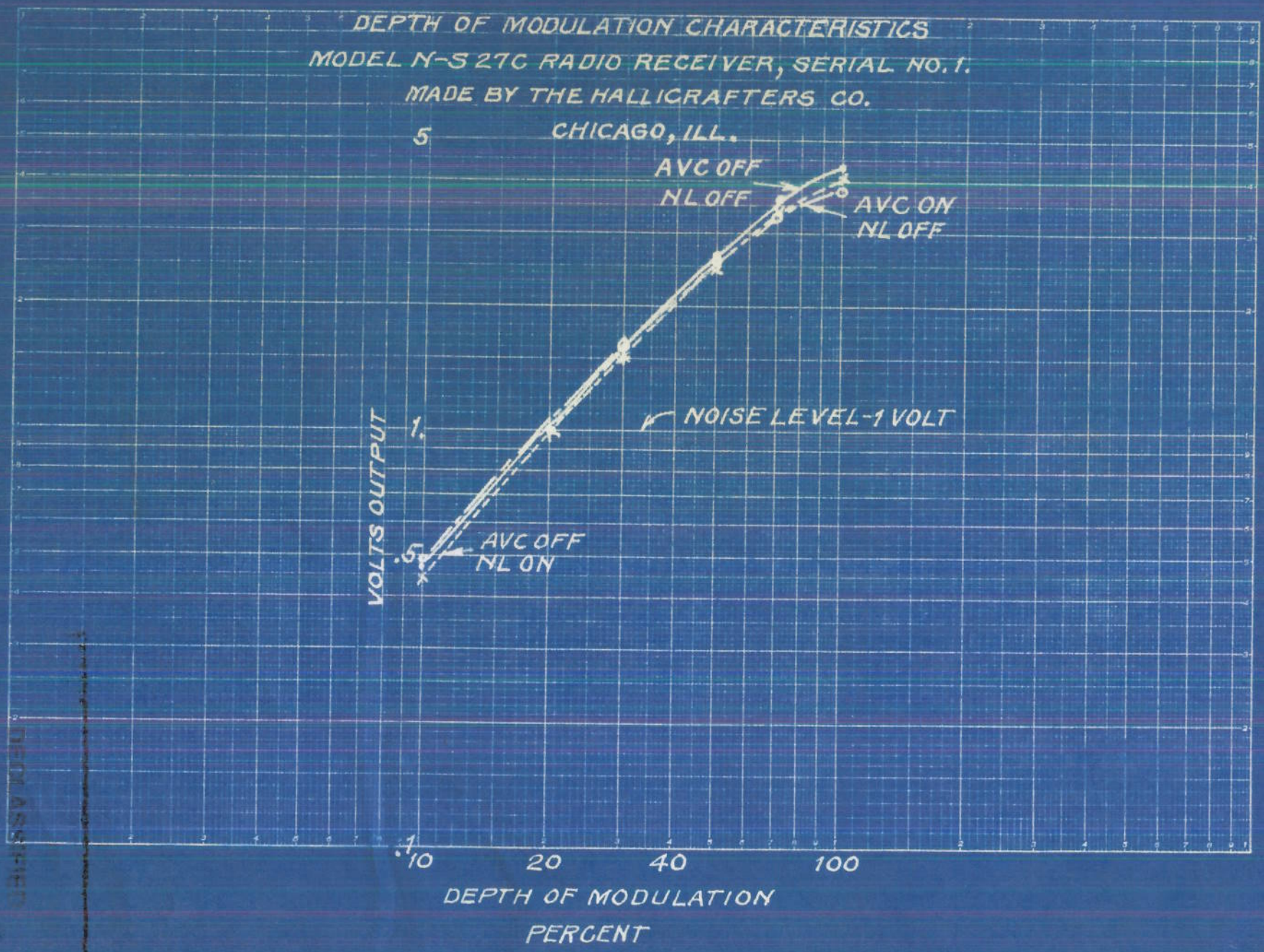
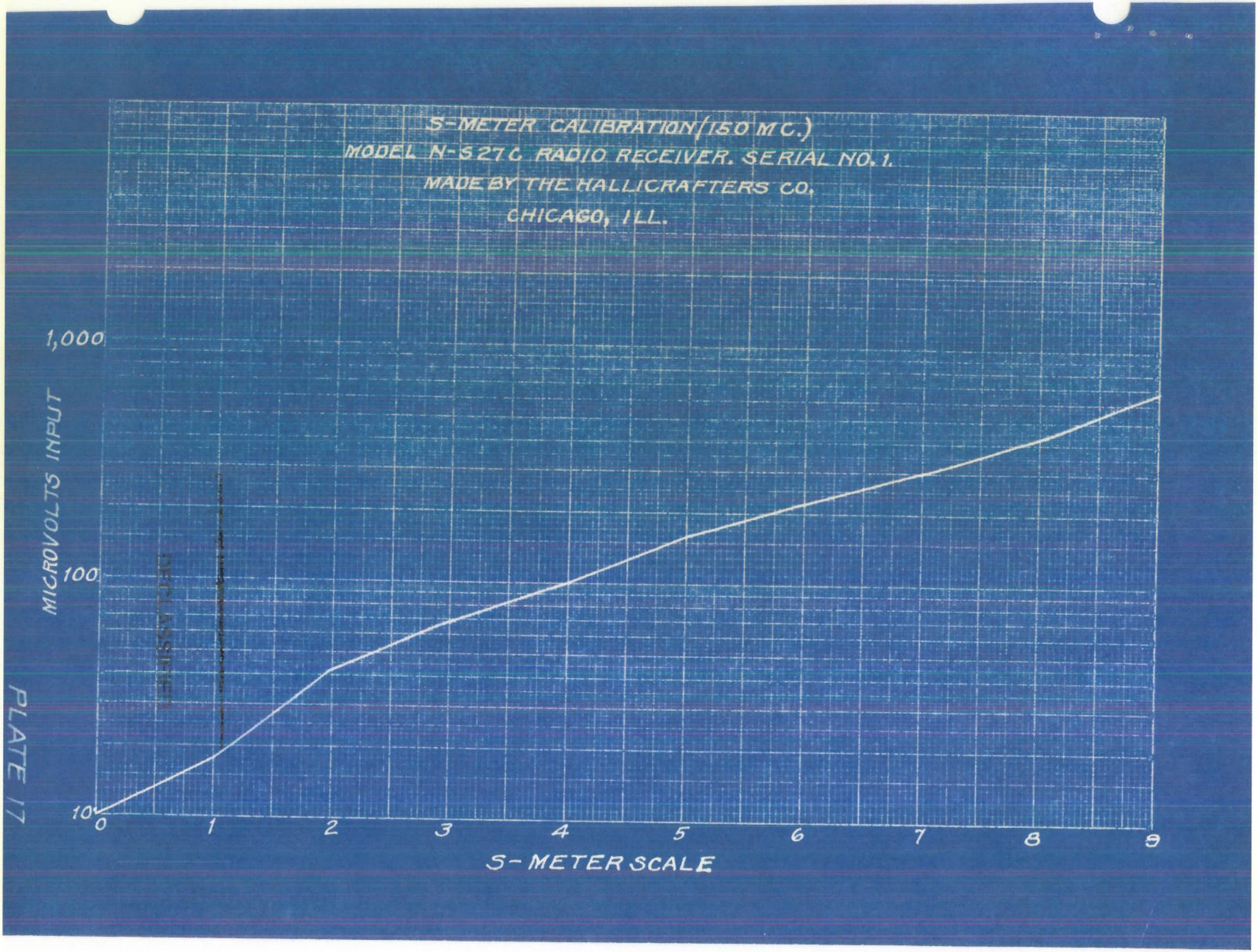

DEPTH OF MODULATION CHARACTERISTICS
MODEL N-S 27C RADIO RECEIVER, SERIAL NO. 1.
MADE BY THE HALLICRAFTERS CO.
CHICAGO, ILL.
5
1.
.5
.1
AVC OFF
NL OFF
AVC ON
NL OFF
NOISE LEVEL-1 VOLT
AVC OFF
NL ON
VOLTS OUTPUT
10
20
40
100
DEPTH OF MODULATION
PERCENT

PLATE 16


S-METER CALIBRATION (150 MC.)
MODEL N-S27C RADIO RECEIVER. SERIAL NO. 1.
MADE BY THE HALLICRAFTERS CO.
CHICAGO, ILL.
1,000
100
10
MICROVOLTS INPUT
DECLASSIFIED
0
1
2
3
4
5
6
7
8
9
S-METER SCALE
PLATE 17

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

DATE

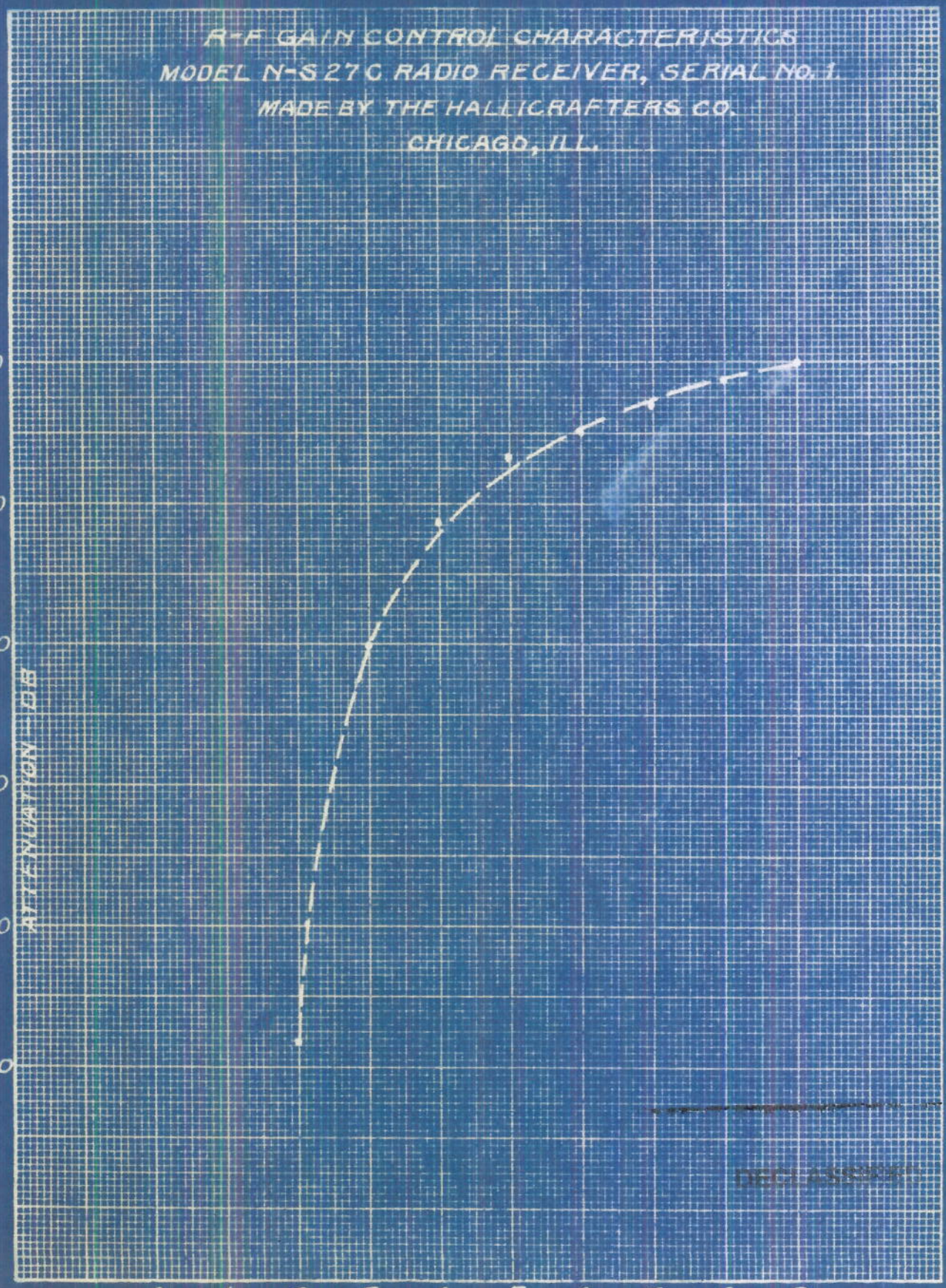


PLATE 18

DATE

AF GAIN CONTROL CHARACTERISTICS
MODEL N-S 27C RADIO RECEIVER, SERIAL NO. 1.
MADE BY THE HALLICRAFTERS CO.
CHICAGO, ILL.

OUTPUT ADJUSTED BELOW AF OVERLOAD AT MAX. AF GAIN.
1,000 C.P.S.

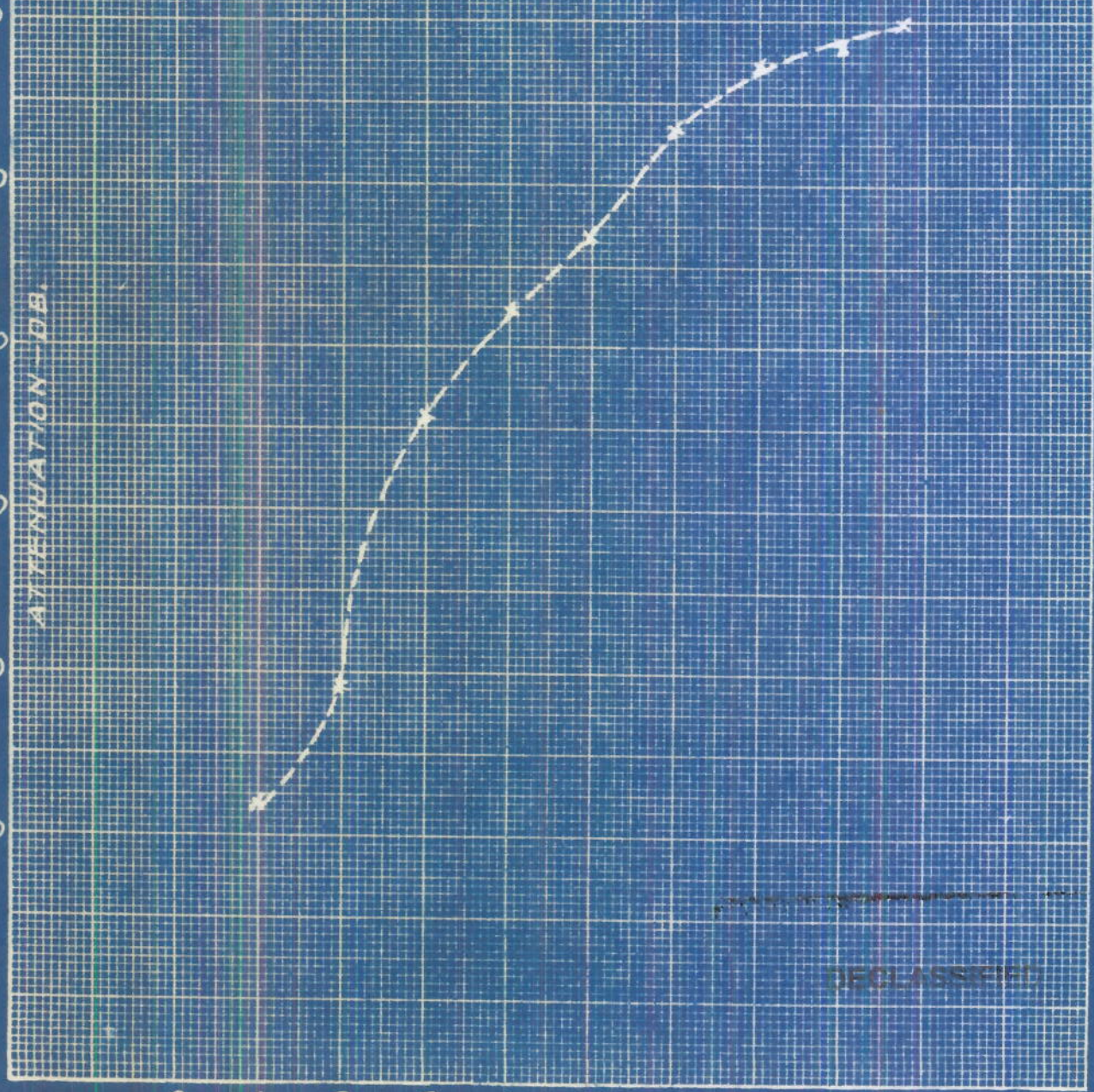


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PLATE 19

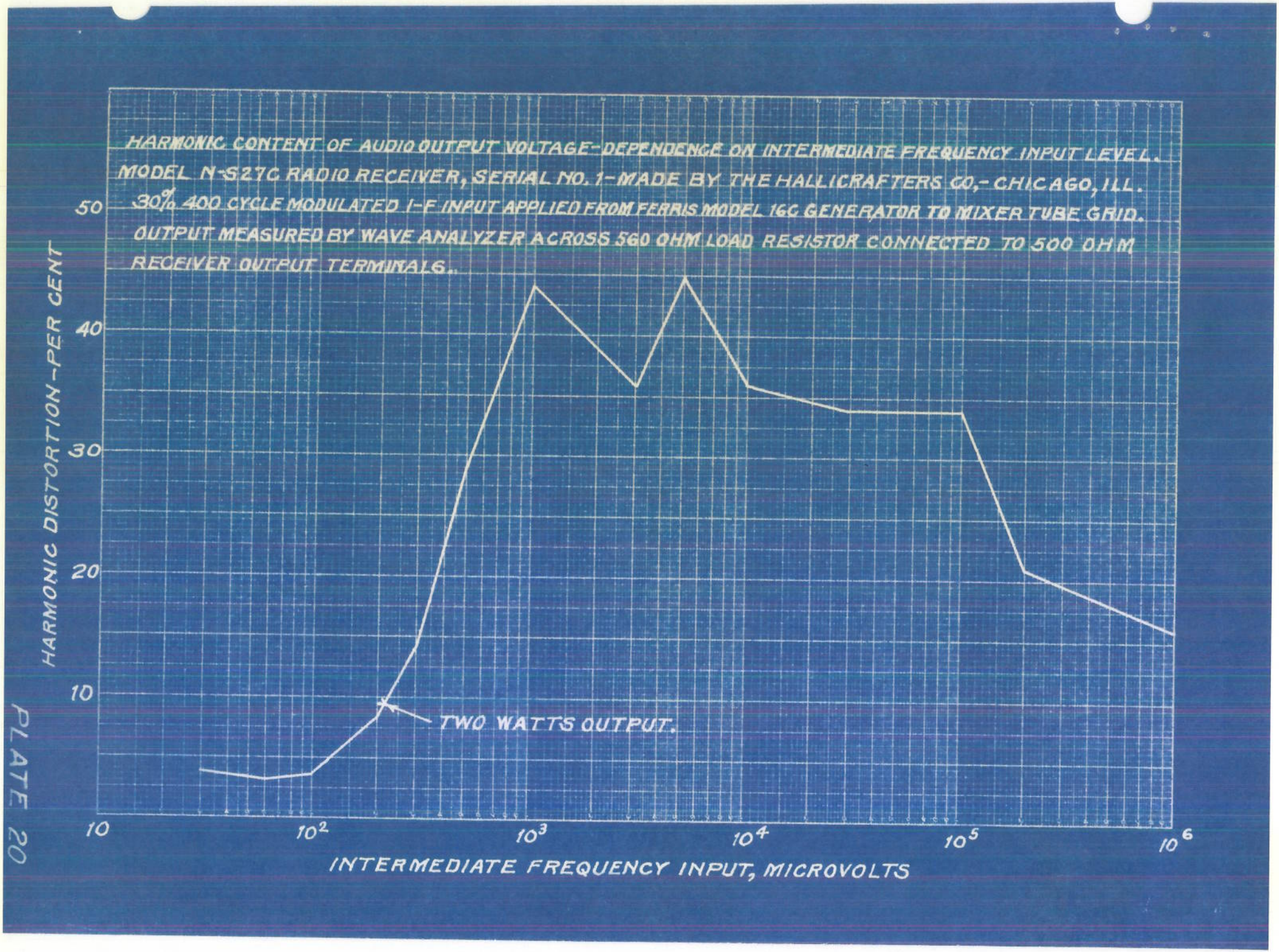
HARMONIC CONTENT OF AUDIO OUTPUT VOLTAGE-DEPENDENCE ON INTERMEDIATE FREQUENCY INPUT LEVEL.
MODEL N-S27C RADIO RECEIVER, SERIAL NO. 1-MADE BY THE HALLICRAFTERS CO,- CHICAGO, ILL.
30% 400 CYCLE MODULATED I-F INPUT APPLIED FROM FERRIS MODEL 16C GENERATOR TO MIXER TUBE GRID.
OUTPUT MEASURED BY WAVE ANALYZER ACROSS 560 OHM LOAD RESISTOR CONNECTED TO 500 OHM
RECEIVER OUTPUT TERMINALS.
HARMONIC DISTORTION-PER CENT
50
40
30
20
10
TWO WATTS OUTPUT.
10
10^2
10^3
10^4
10^5
10^6
INTERMEDIATE FREQUENCY INPUT, MICROVOLTS

PLATE 20

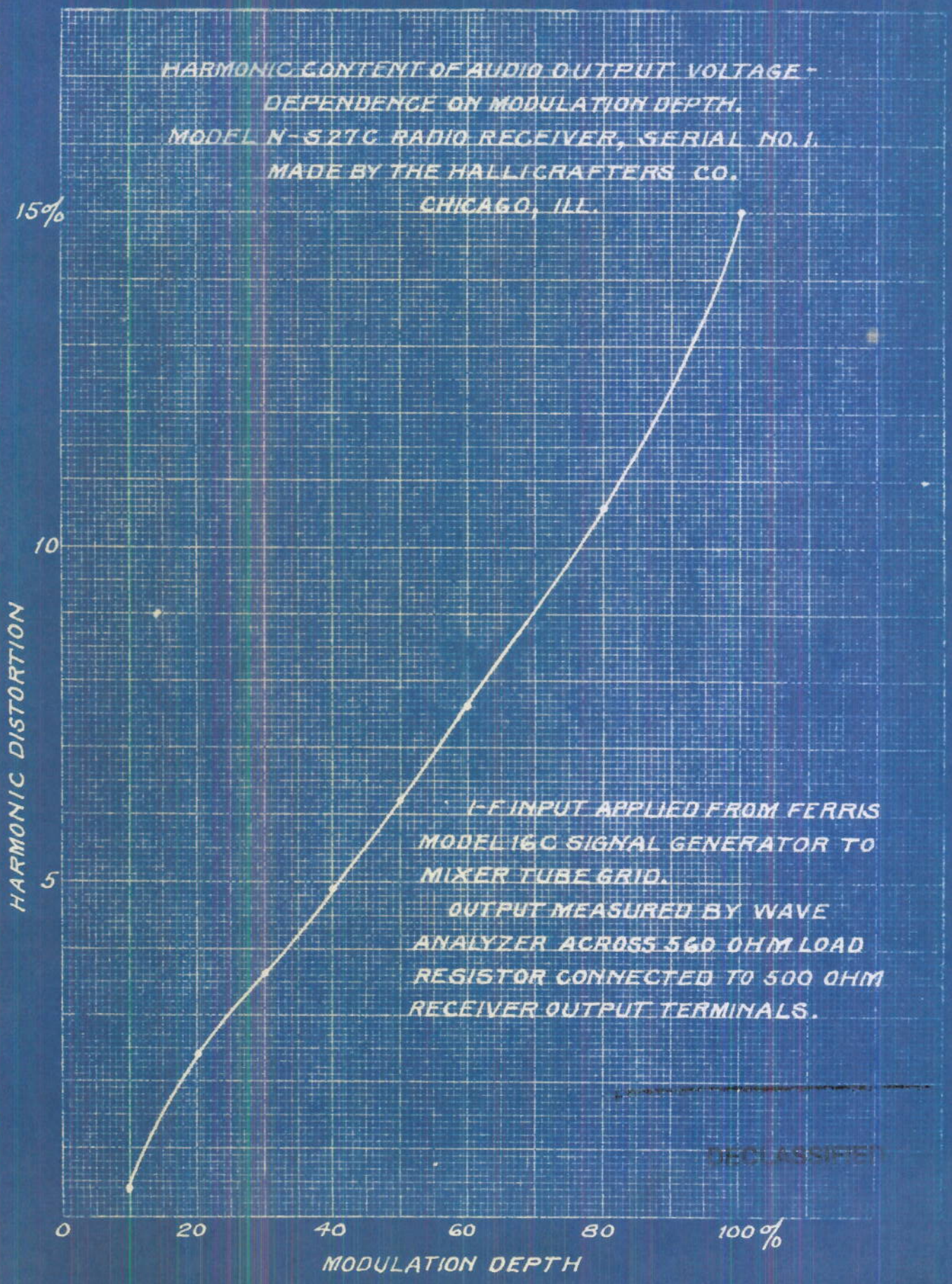
HARMONIC CONTENT OF AUDIO OUTPUT VOLTAGE - DEPENDENCE ON MODULATION DEPTH.
MODEL N-S27C RADIO RECEIVER, SERIAL NO. 1.
MADE BY THE HALLICRAFTERS CO.
CHICAGO, ILL.
15%
10
5
HARMONIC DISTORTION
I-F INPUT APPLIED FROM FERRIS MODEL 16C SIGNAL GENERATOR TO MIXER TUBE GRID.
OUTPUT MEASURED BY WAVE ANALYZER ACROSS 560 OHM LOAD RESISTOR CONNECTED TO 500 OHM RECEIVER OUTPUT TERMINALS.
0
20
40
60
80
100%
MODULATION DEPTH

PLATE 21

HARMONIC CONTENT OF AUDIO OUTPUT VOLTAGE—DEPENDENCE ON LOAD RESISTANCE.
MODEL N-S2TC RADIO RECEIVER, SERIAL NO. 1. MADE BY THE HALLICRAFTERS CO., CHICAGO, ILL.
30% 400 CYCLE MODULATED INTERMEDIATE FREQUENCY INPUT OF 1,000 MICROVOLTS TO MIXER GRID. OUTPUT MEASURED BY WAVE ANALYZER ACROSS RESISTANCE INDICATED BY ABSCISSA.
OUTPUT TAKEN FROM 500 OHM RECEIVER OUTPUT TERMINALS.

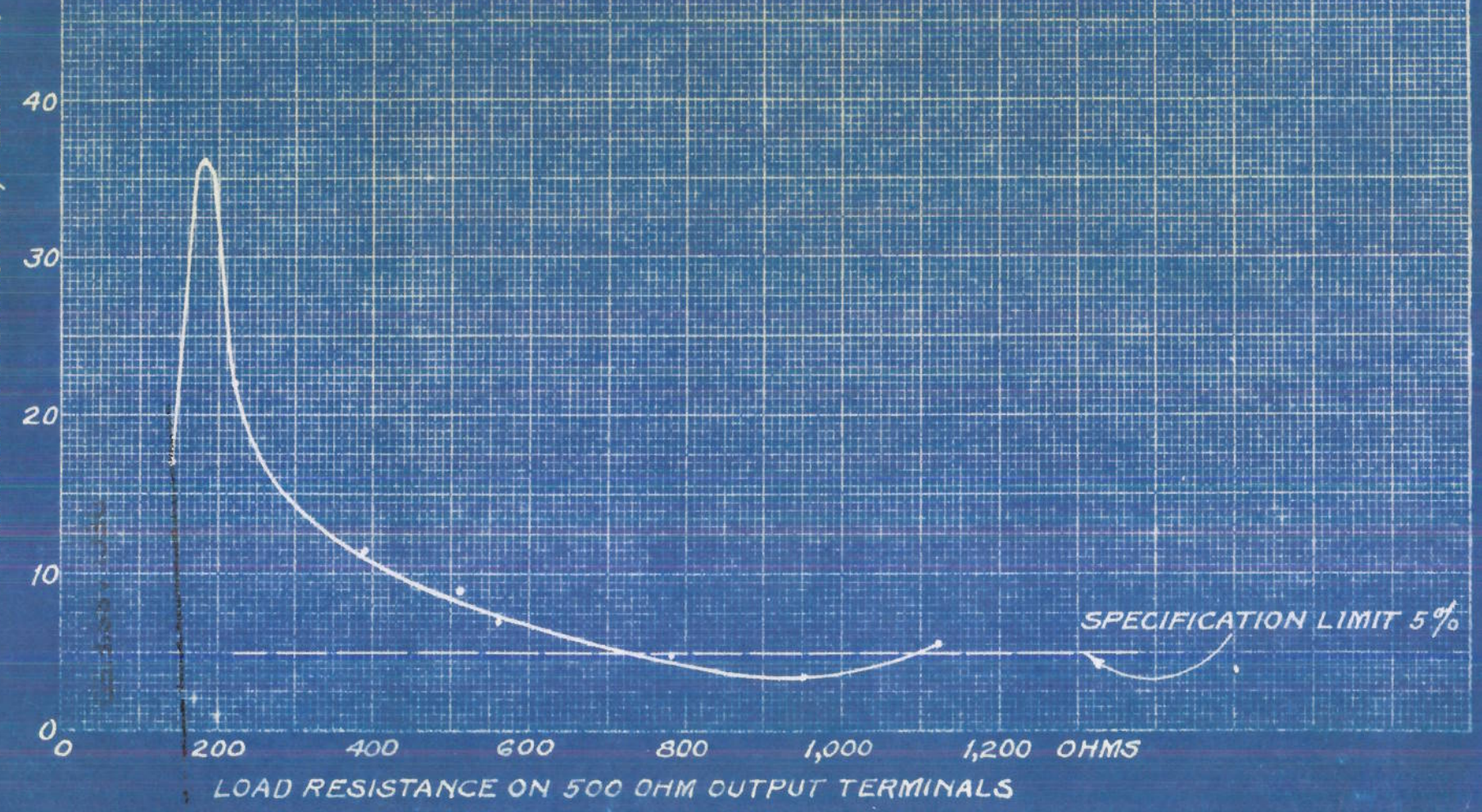

PLATE 22

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

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

DATE

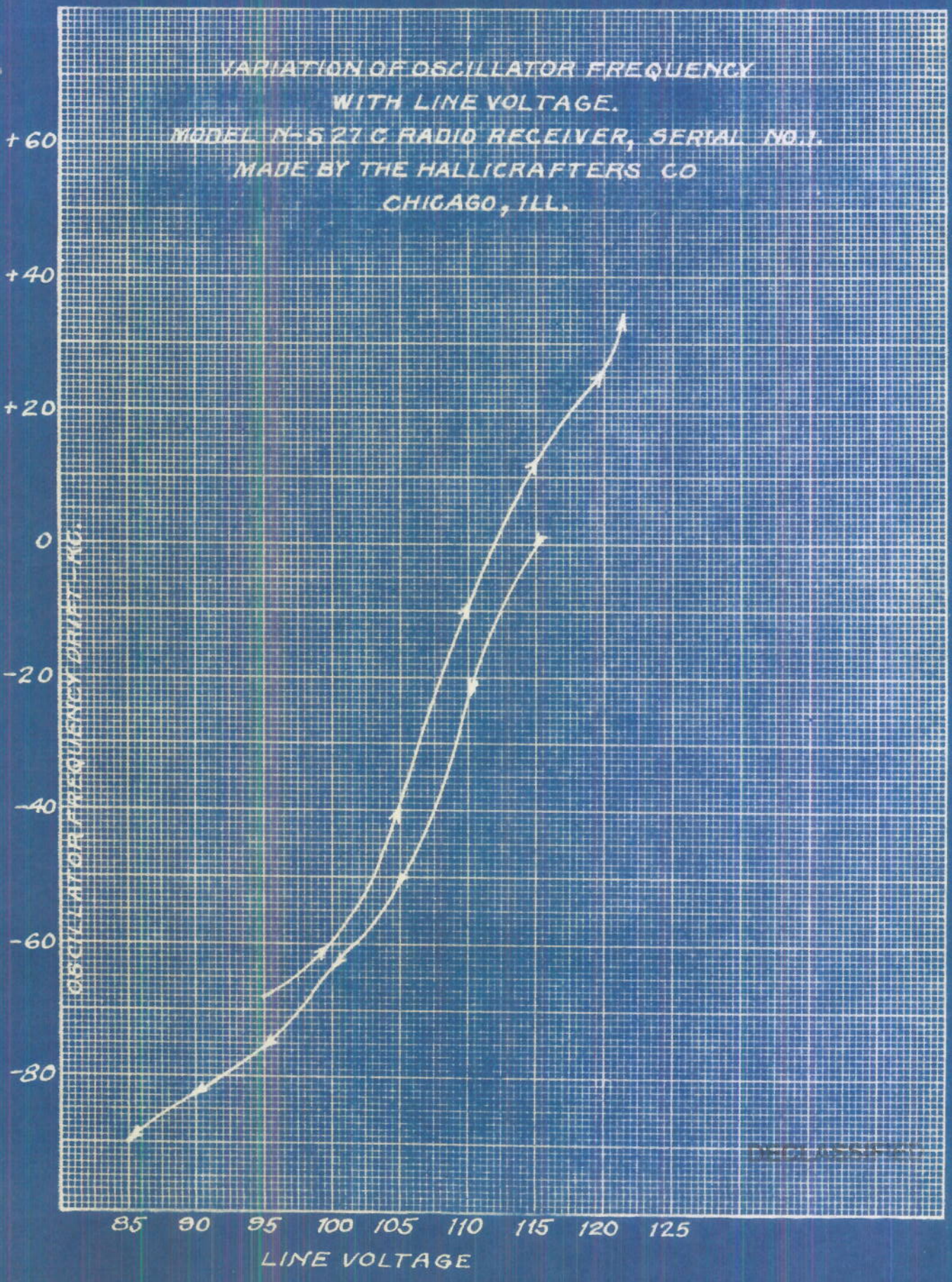

PLATE 23

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

DATE

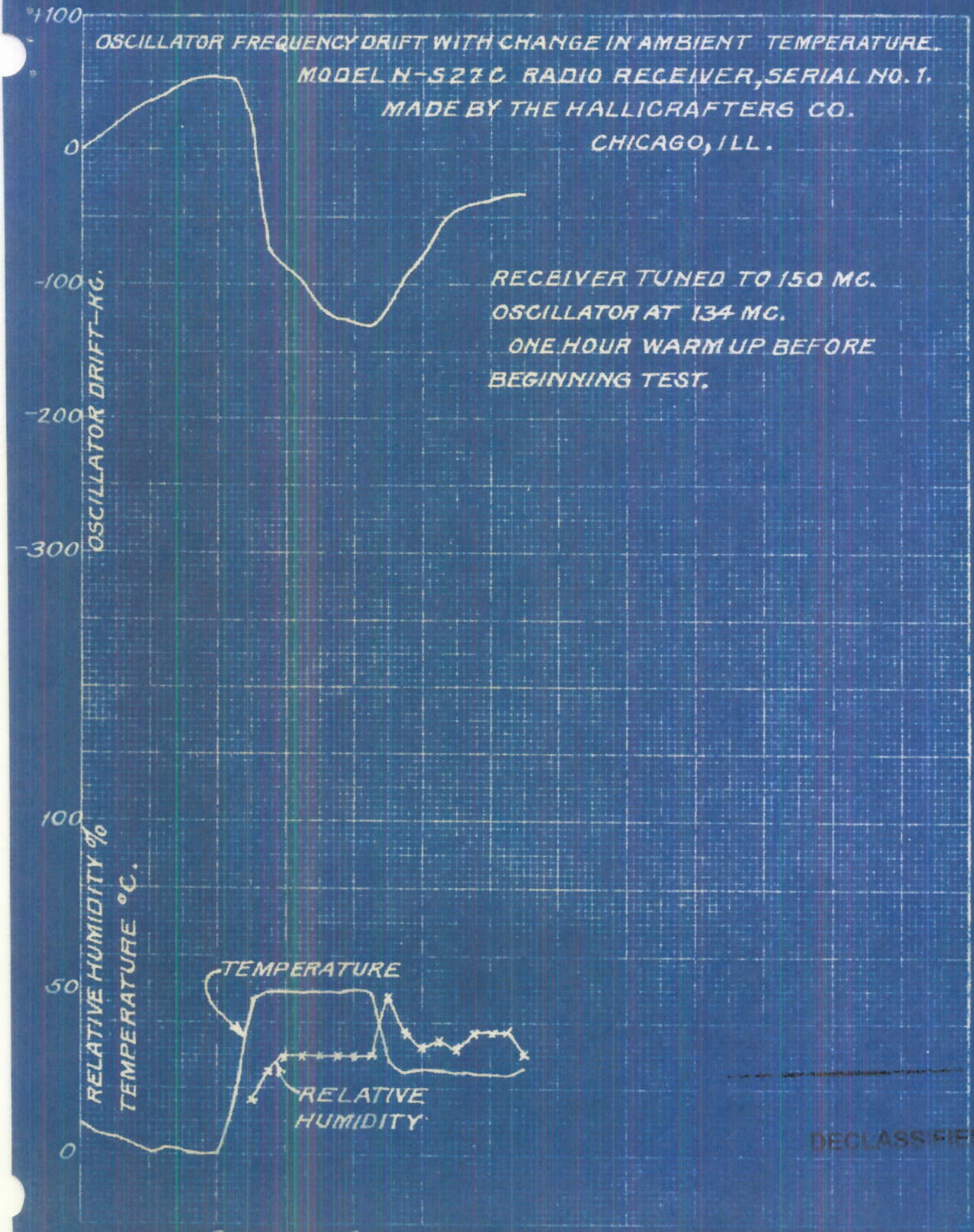

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PLATE 24

U. S. NAVAL RESEARCH LABORATORY
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OSCILLATOR FREQUENCY DRIFT WITH CHANGE IN AMBIENT TEMPERATURE.
MODEL N-S 21C RADIO RECEIVER, SERIAL NO. 1.
MADE BY THE HALLICRAFTERS CO.
CHICAGO, ILL.

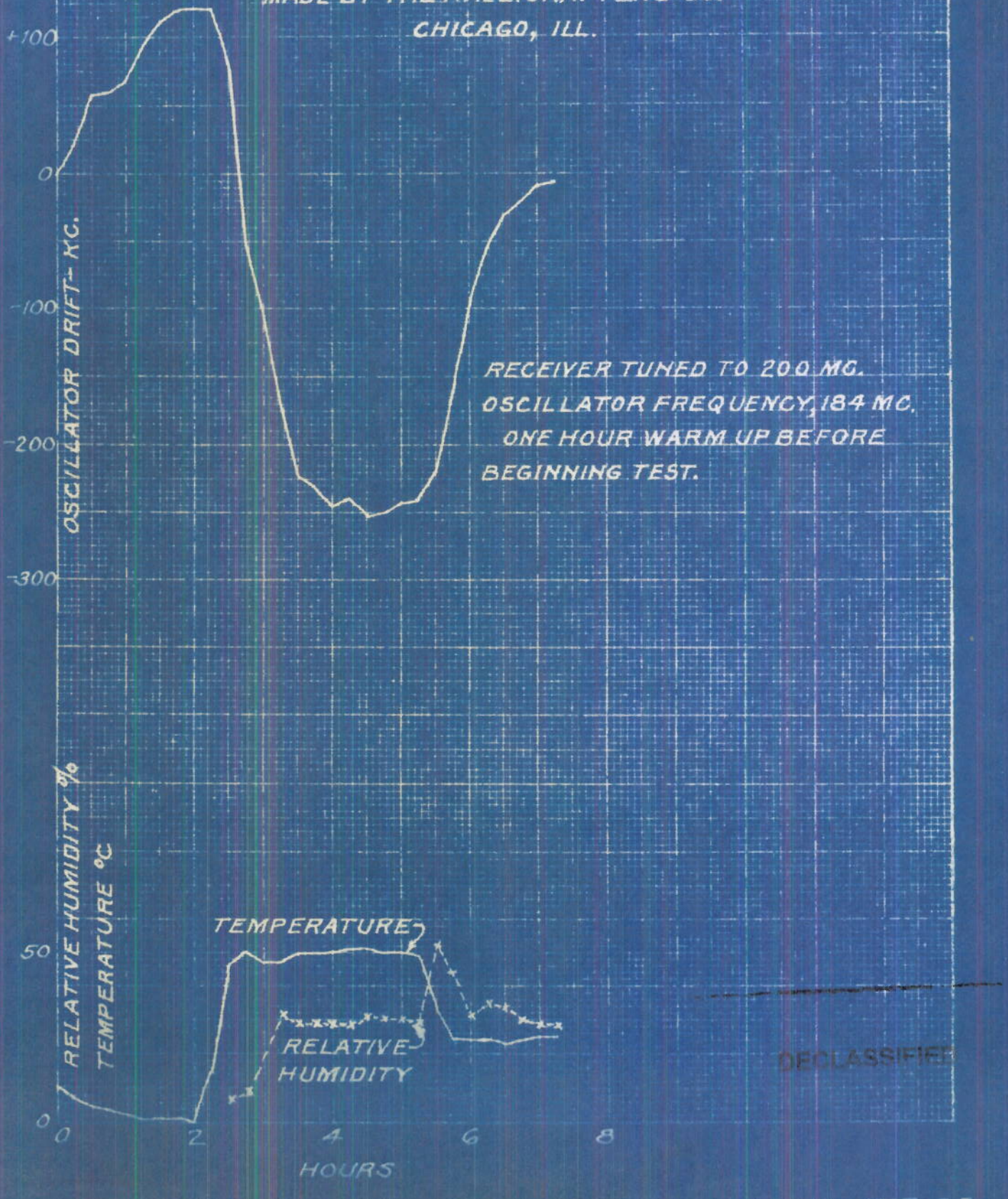

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PLATE 25

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

OSCILLATOR FREQUENCY DRIFT WITH CHANGE IN AMBIENT HUMIDITY.
MODEL N-S27C RADIO RECEIVER, SERIAL NO. 1.
MADE BY THE HALLICRAFTERS CO.
CHICAGO, ILL.

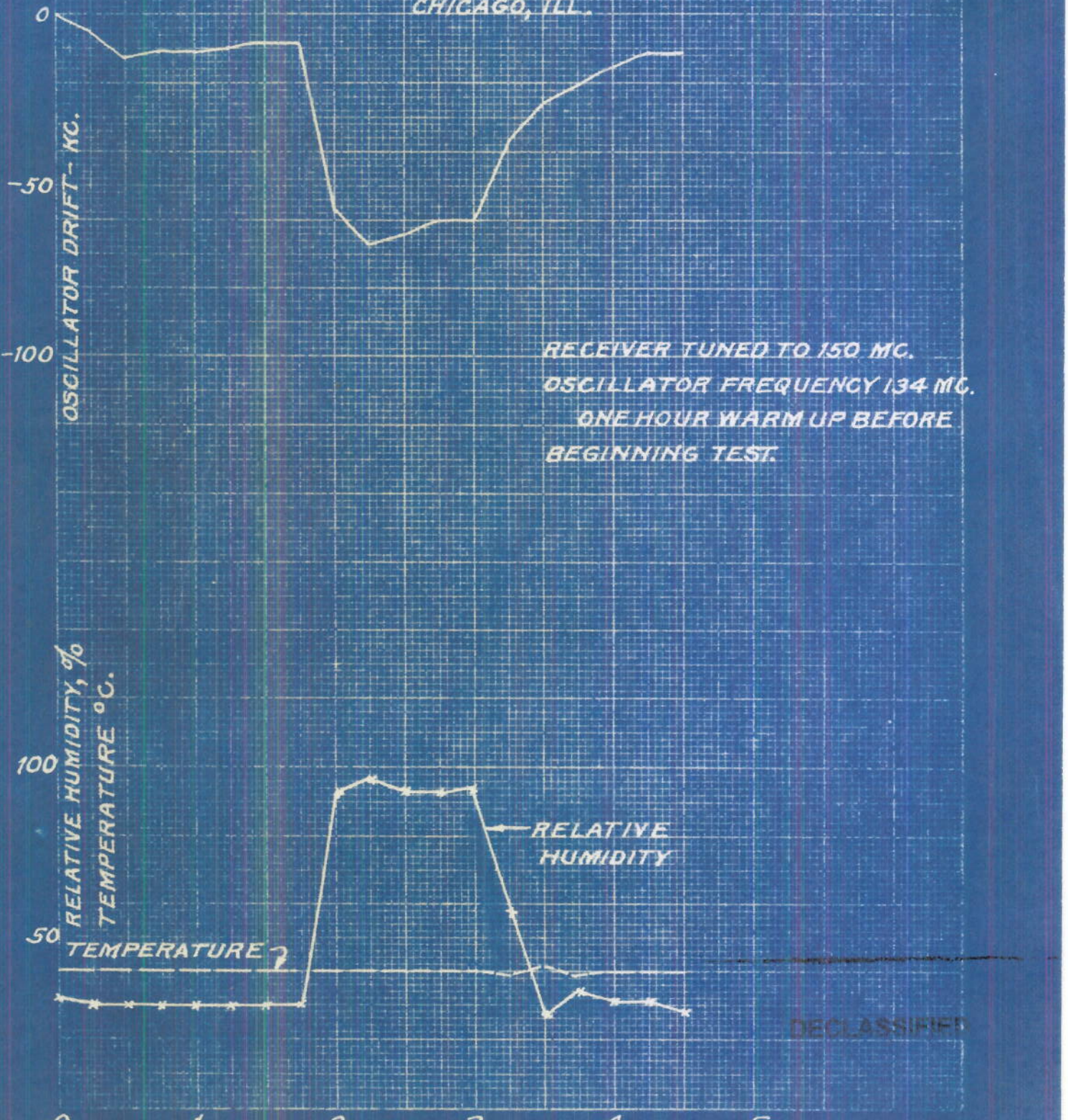

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PLATE 26

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

WARM-UP DRIFT OF OSCILLATOR
MODEL N-S27C RADIO RECEIVER, SERIAL NO. 1.
MADE BY THE HALLICRAFTERS CO
CHICAGO, ILL.

RECEIVER TUNED TO 150 MC.
OSCILLATOR FREQUENCY 134 MC.

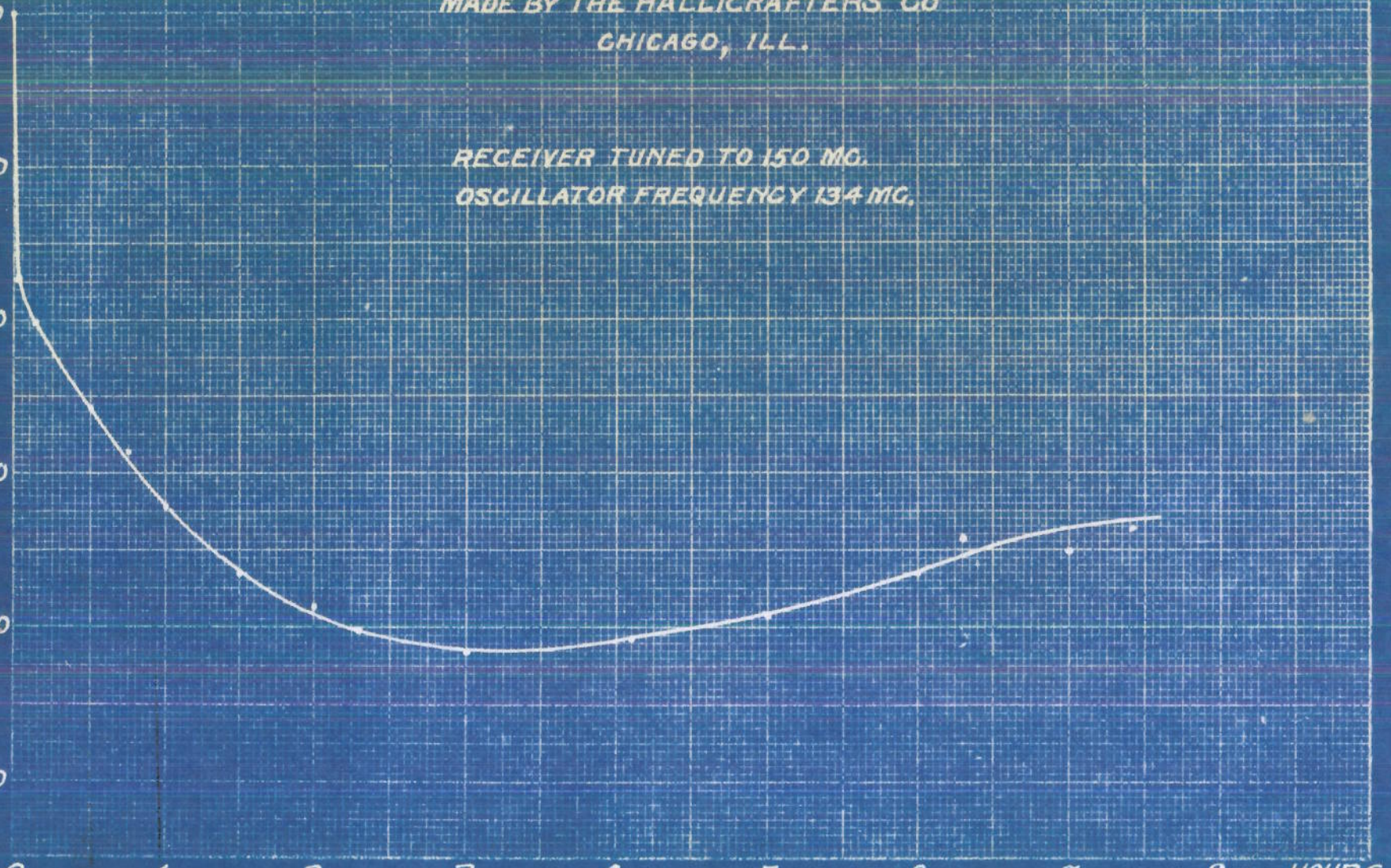
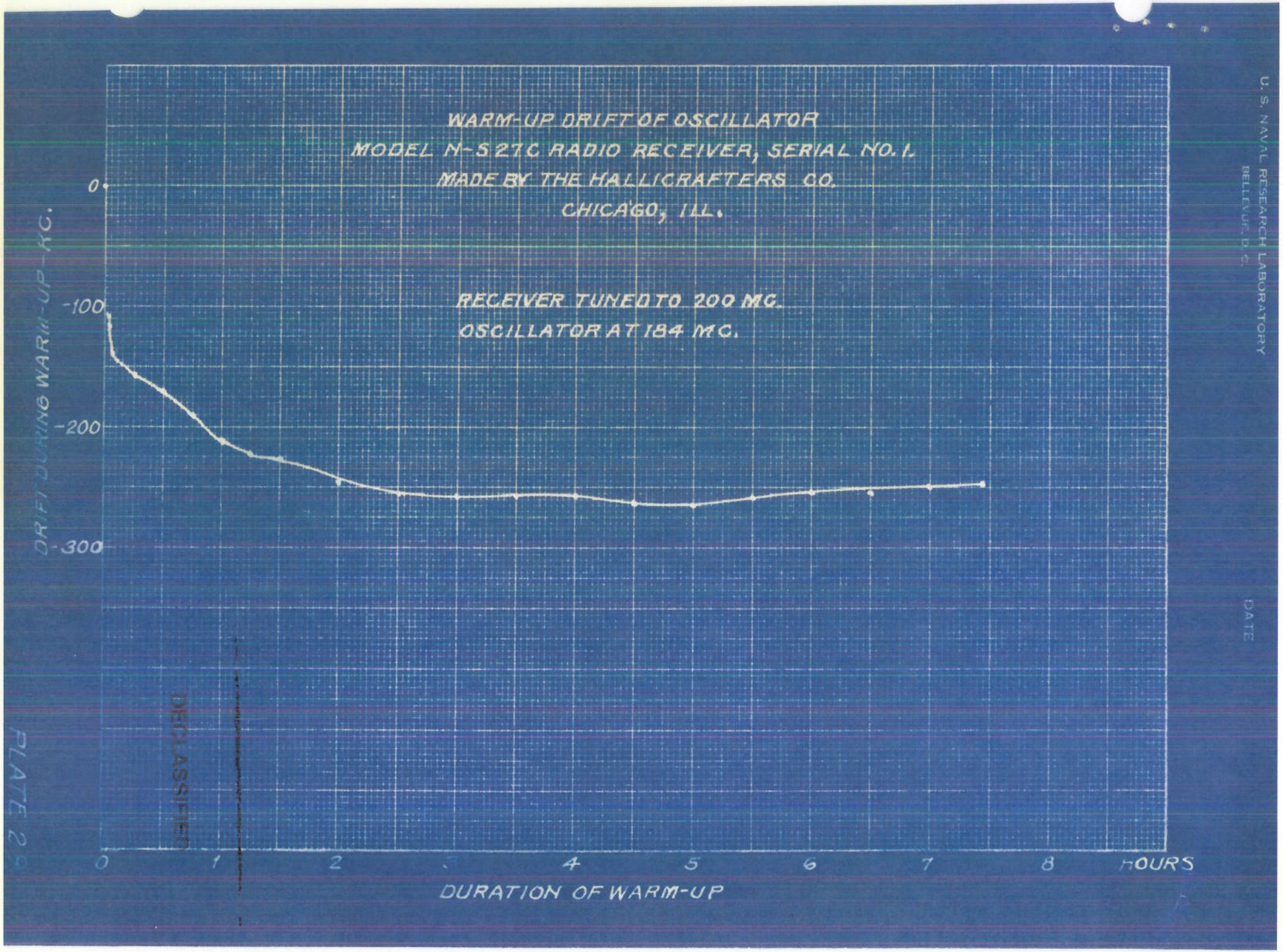


PLATE 28


WARM-UP DRIFT OF OSCILLATOR
MODEL N-S 21C RADIO RECEIVER, SERIAL NO. 1.
MADE BY THE HALLICRAFTERS CO.
CHICAGO, ILL.
RECEIVER TUNED TO 200 MC.
OSCILLATOR AT 184 MC.
DRIFT DURING WARM-UP - KC.
0
-100
-200
-300
0
1
2
3
4
5
6
7
8
HOURS
DURATION OF WARM-UP
U. S. NAVAL RESEARCH LABORATORY
DATE
PLATE 2
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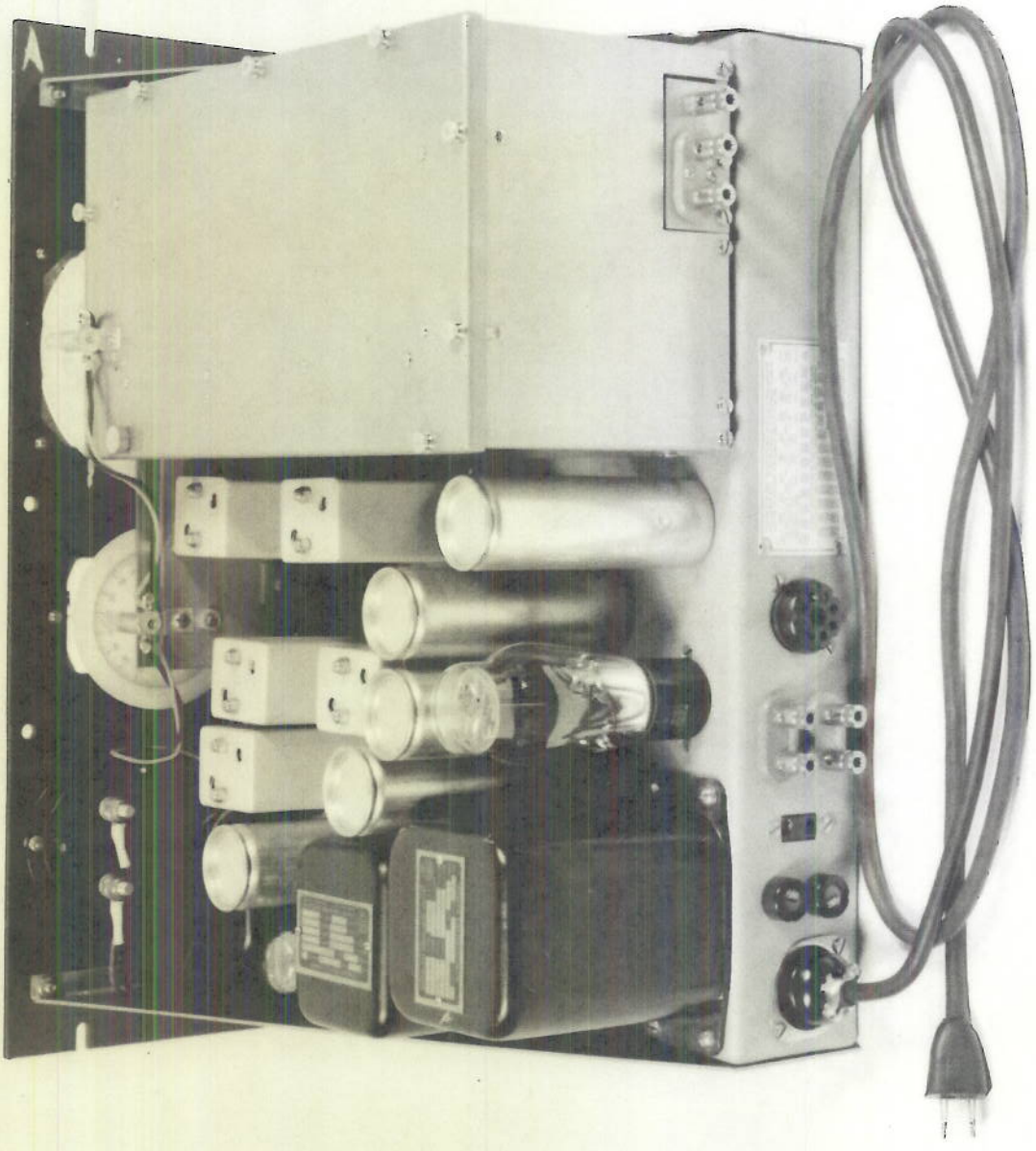

PLATE 106

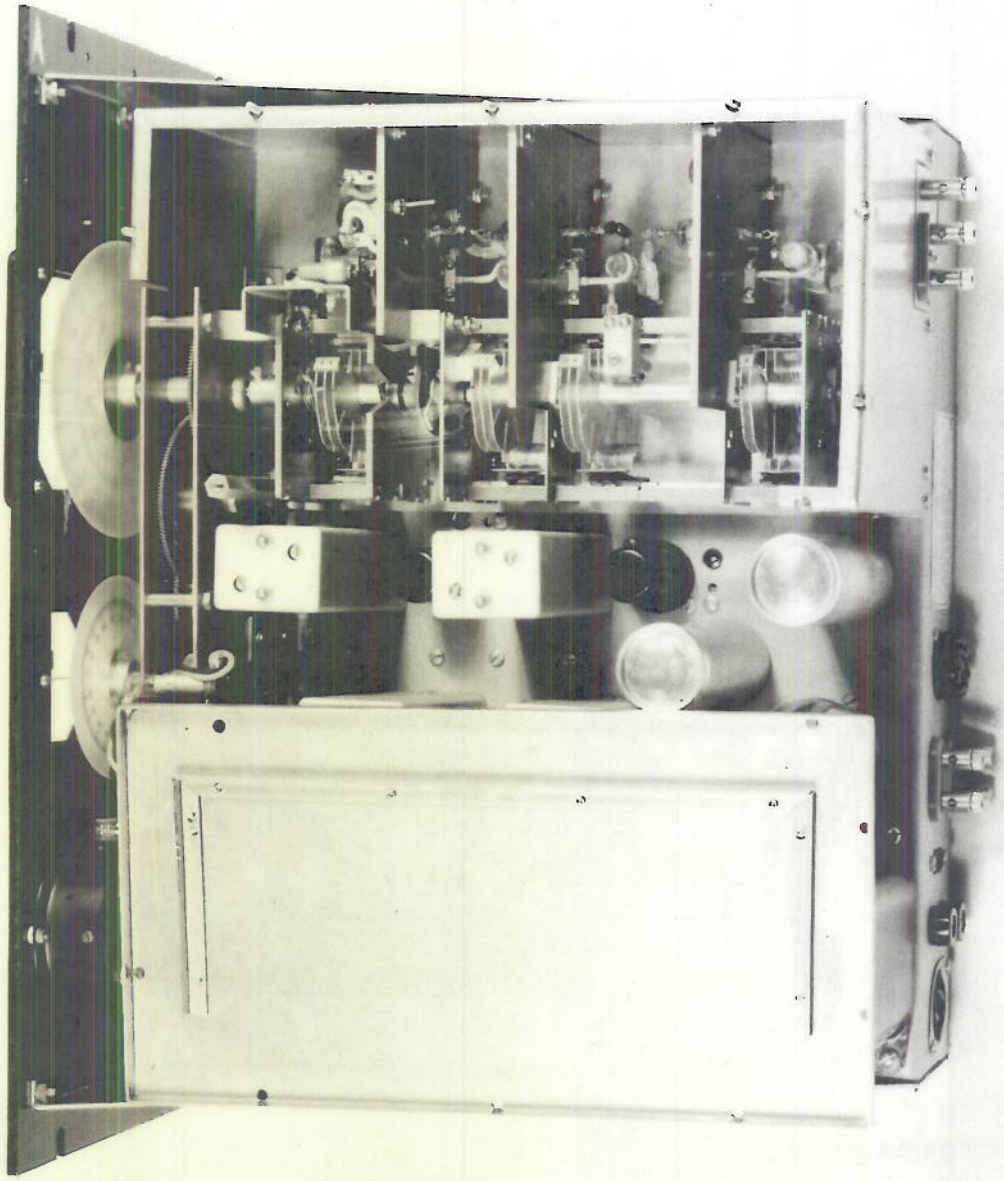

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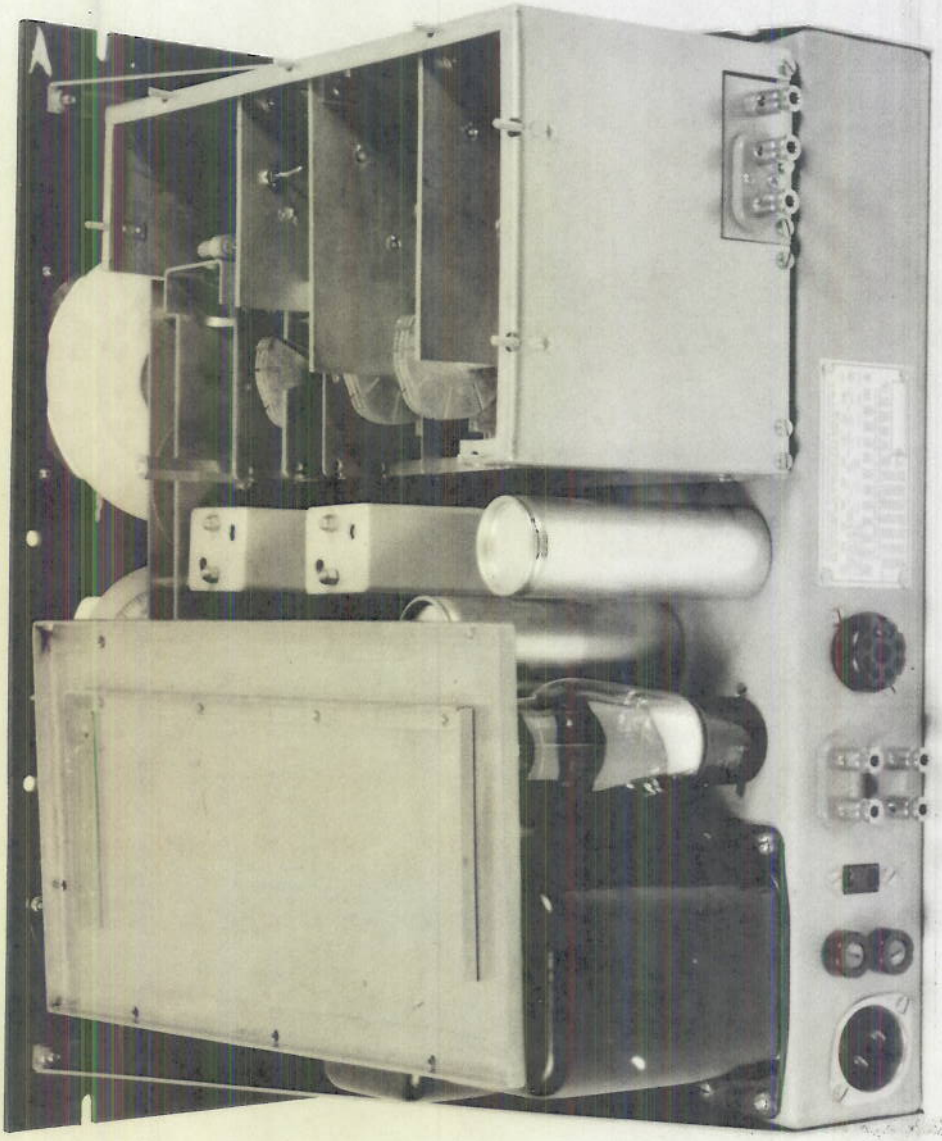
PLATE 107



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LIBRARY
NAVAL RESEARCH LABORATORY

PLATE 108

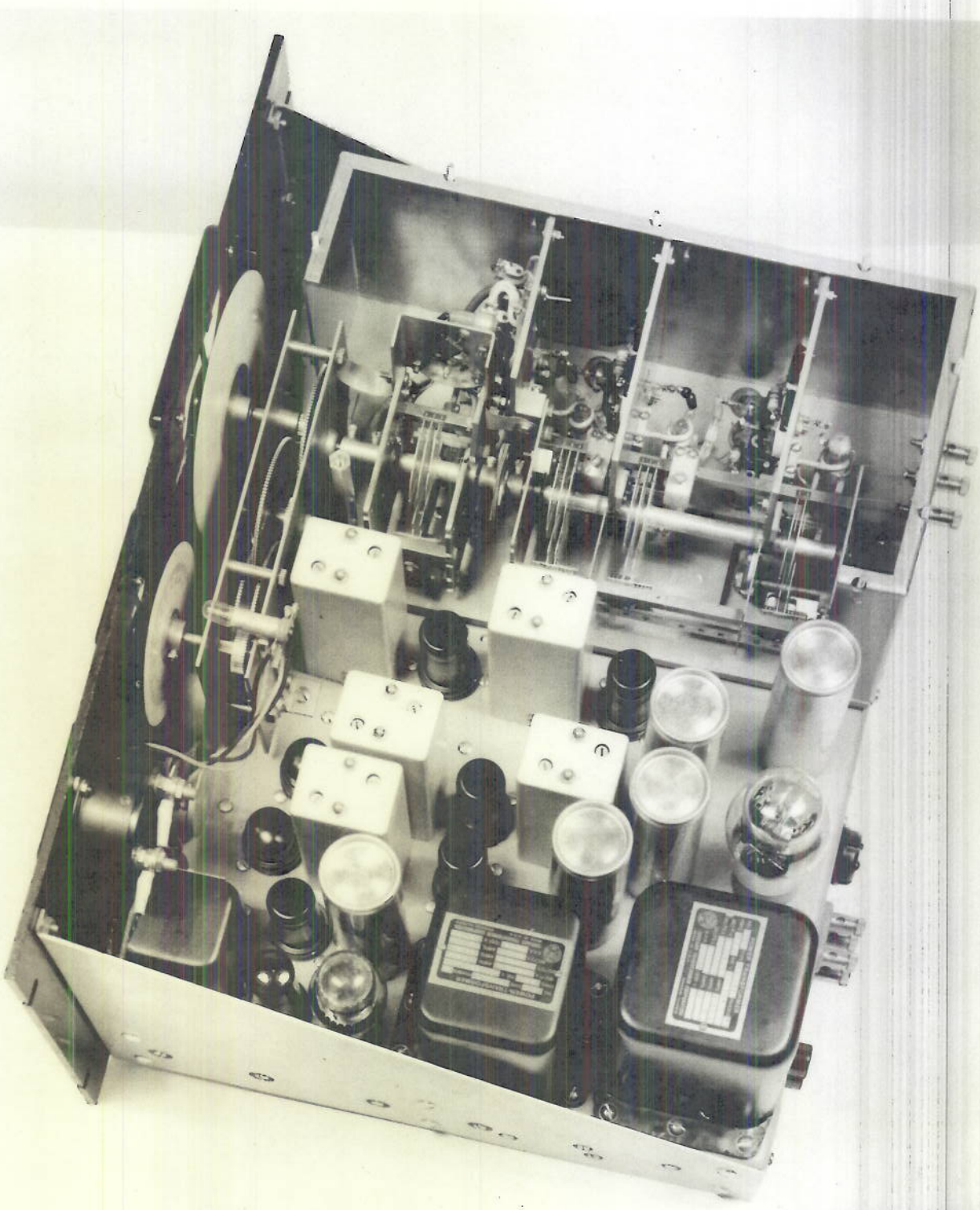

PLATE 109

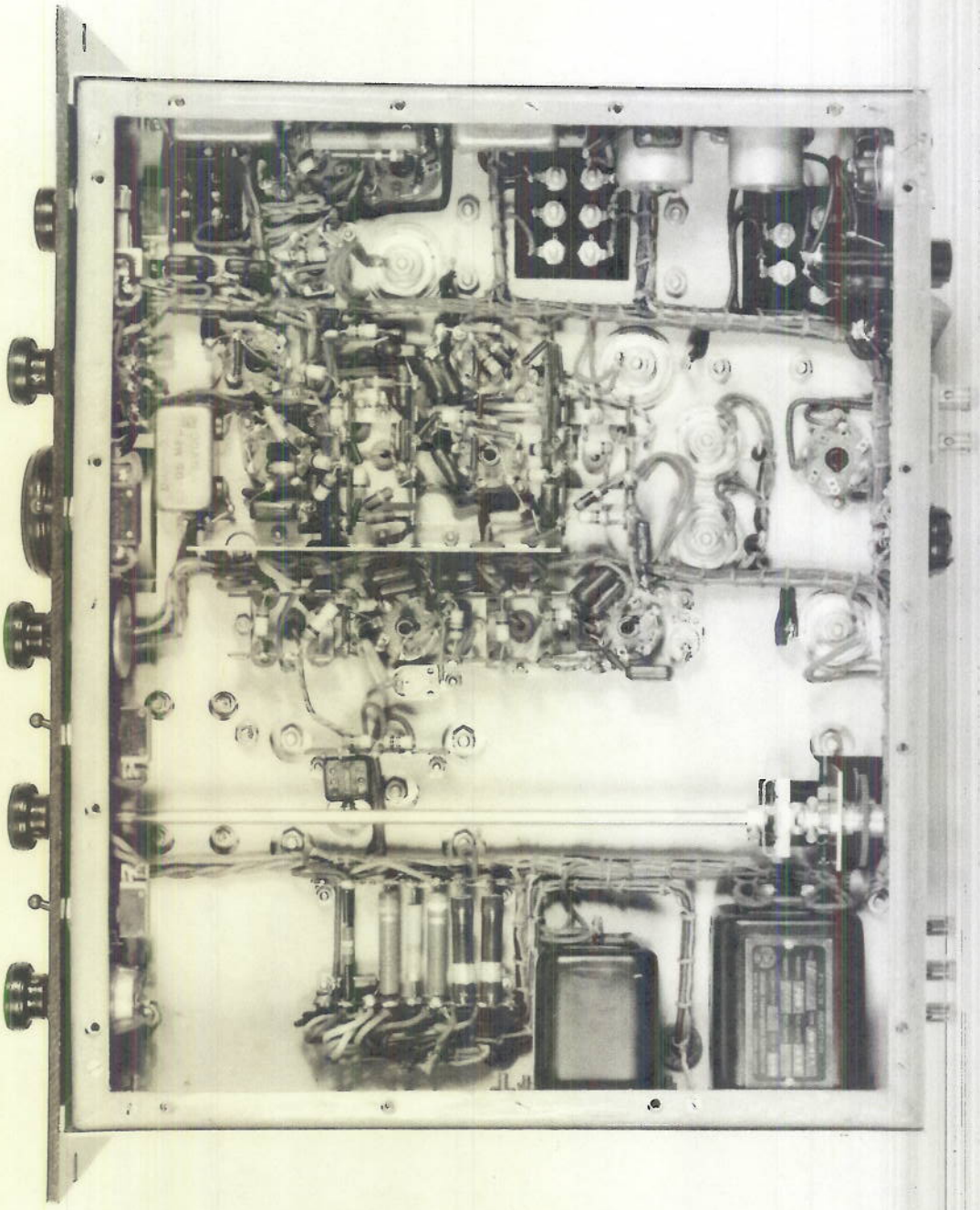

PLATE 110

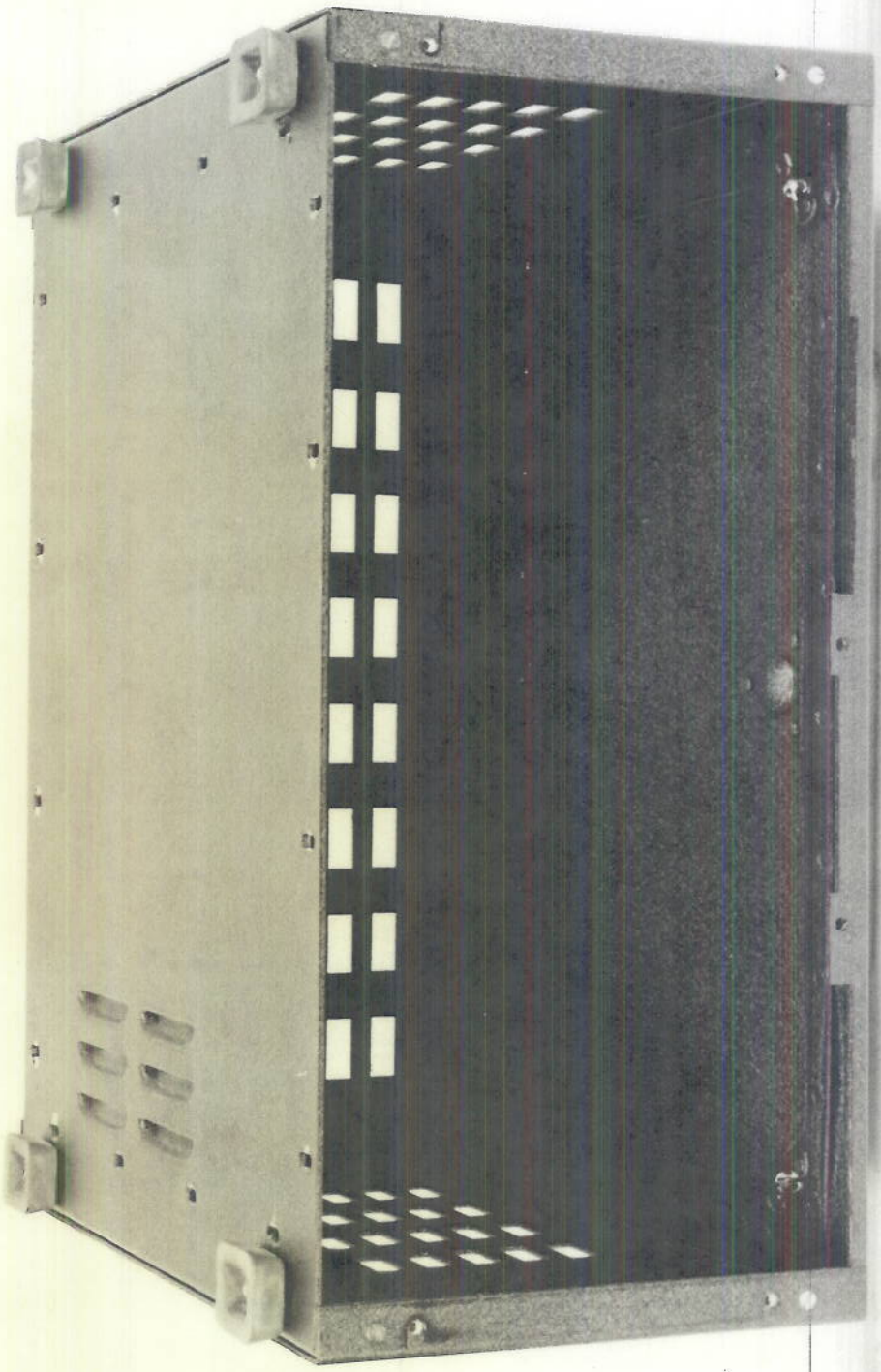

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PLATE III

SCHEMATIC DIAGRAM - ULTRA HIGH FREQUENCY FM-AM RECEIVER - TYPE N-S27C

MFD BY THE HALLICRAFTERS CO.

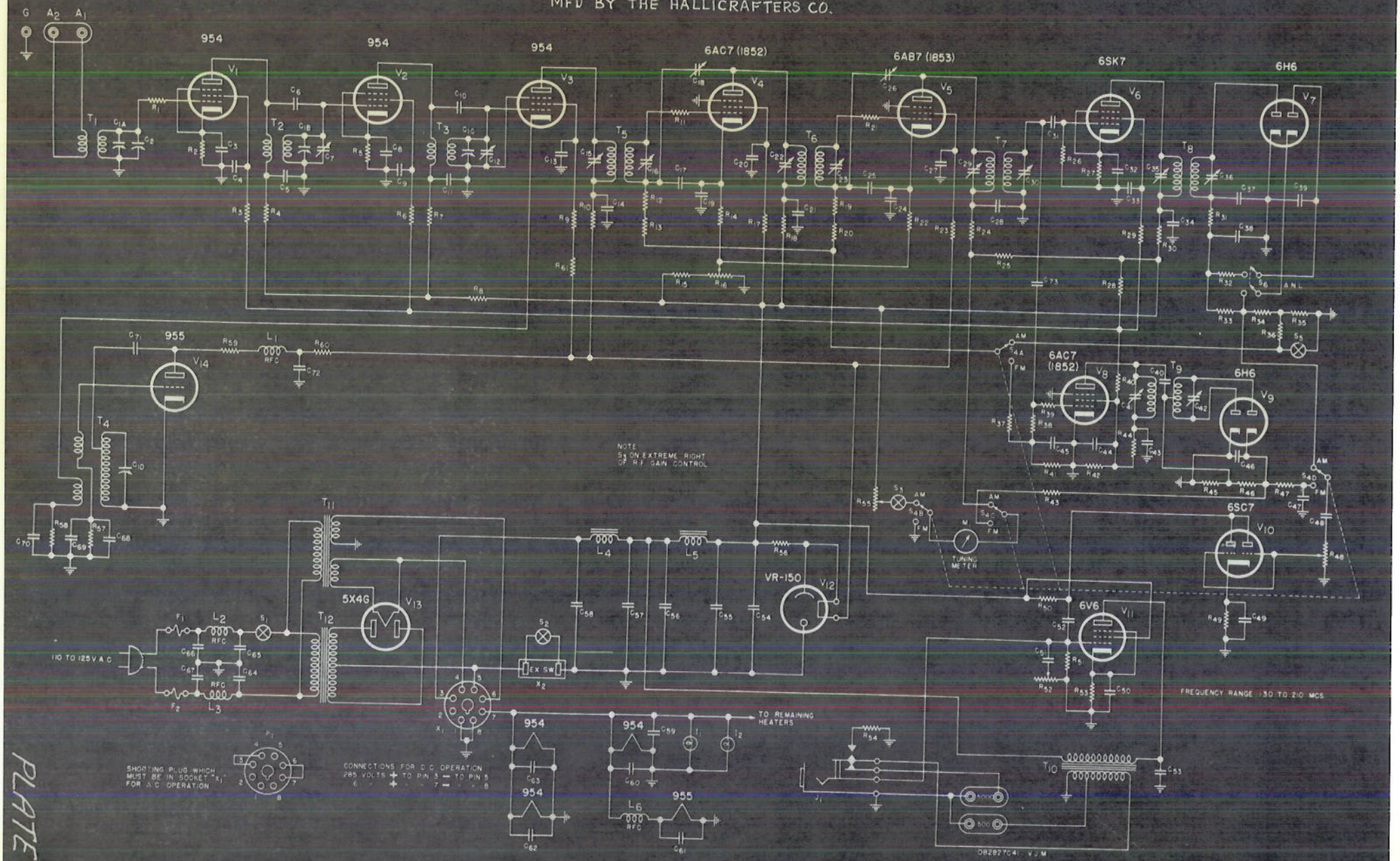

FIG. 7

PLATE 112