FR-1202

10 October 1935

NRL Report No. R-1202
Bu.Eng.Problem R1-4

NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report on

Test of U.S. Coast Guard Type CGR-31 Intermediate Frequency Receiver

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WASHINGTON DC

Number of Pages: Text - 40 Tables - 12 Plates - 47

Authorization: Bu.Eng.let.S67/46(7-29-W8) of 30 July 1935.

Dates of Tests: 11 August to 27 September 1935.

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Distribution:
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CONCLUSIONS

(a) The Type CGR-31 receiving equipment is in its present form unsuitable for satisfactory operation in the Naval Service.

(b) In the important features in mechanical construction, when viewed in the light of present day knowledge of Navy receiver design, the receiver is without merit. The design of the ganged variable tuning condenser is poor, for the separate tuning condensers are housed in a common die case aluminum housing which showed evidence of "growing action" -- a characteristic common with this type of housing -- which resulted in a non-uniformity of the spacing between the rotor and stator plates; the longitudinal tie members for the stator plates are secured to hard rubber insulating strips which are not satisfactory for the degree of precision expected for ganged tuning condensers. No provision is made for adjusting the spacing between the rotor and stator plates. The steel drive shaft possesses magnetic properties and was inadequately plated to withstand the wiping action of the wiper contacts; the wiper contacts were without sufficient tension and were improperly designed for the service for which they were intended. The three point suspension mounting, together with the lack of provision for balancing the adjustment of the separate condensers, does not provide permanent adjustment of the condenser setting under conditions of severe vibrations. The so-called anti-capacity switches employed for band switching have been known to give trouble while in service, and are so mounted that visual inspection of them is not possible without the removal of the coil systems. The link and bar mechanism for operating the anti-capacity switches in tandem from a single control is unsatisfactory owing to the strain it places in its extreme positions upon the anti-capacity switches themselves, and to the uncertainty involved in determining the correct position for any setting of the switches by "feel". The universal use of phenolic insulation is not satisfactory for all circuits. The type of wire insulation used is of poor quality, some of the wires having under the outer cotton braid coating a composition insulating material which became hard and brittle due to aging. The construction of the r.f. coils, paper dielectric by-pass condensers, r.f. transformers, trimmer condensers and a.f. transformers is such that they will not be trouble free and may fail entirely when the receiver is operated in humid, salt atmospheres. The battery cable, sensitivity control and regeneration control failed while in service.

(c) The electrical performance characteristics of this receiver are decidedly inferior to similar characteristics of the approved model of the Class IA receiving equipment. It covers a much narrower frequency range, and its operation is limited to battery power supplies. Sensitivity and selectivity are much poorer and of course resonant overload output is at a much lower level. No AVC is provided and audio tuning is limited to a fixed frequency of approximately 800 cycles. The frequency stability of the oscillator under conditions of changes in control settings is extremely poor.

RECOMMENDATIONS

(a) The Type CGR-31 receiver is not recommended for Naval Service without major modifications. Such modifications as would be necessary would mean a complete redesign of the receiver.

MATERIAL UNDER TEST

4. The material under test consisted of one type CGR-31 Intermediate Frequency Receiver, Serial #120, and manufactured for the U.S. Coast Guard by the RCA Victor Company, Inc., of Camden, New Jersey, under contract number TCG-12974 (U.S. Coast Guard) dated 10 July 1931.

5. The equipment was delivered on 11 August 1935 to the Naval Research Laboratory from the New York Navy Yard. A battery cable was included with the receiver, but no battery box or tubes were furnished.

METHOD OF TEST

6. The tubes used for the tests about to be described were those selected from Laboratory stock and having characteristics which were within the Naval specifications for the particular types of tubes employed.

7. Periodic measurements of battery voltages were made to assure, at all times, normal operation of the receiver under test. Measuring equipments employing vacuum tubes were allowed a "warming up" period before being used to assure consistency of their calibrations and reasonable stability in operation.

8. The following equipment was employed in the tests for sensitivity, selectivity, maximum noise, main tuning dial calibration, accuracy of resettability, temperature test, and manual volume control characteristics.

(a) General Radio, Type LC-1, Ser. No. 18, Standard Signal Generator.
(b) General Radio, Type 418, Dummy Antenna.
(c) General Radio, Type 483C, Ser. No. 107, Output Meter.

9. In addition to the equipment listed in paragraph 8 above, two General Radio, Type 359B, Variable Ratio Transformers and one Type CRV-53002 Band Pass Filter were employed for making the tests for resonant overload.

10. In the test involving only the characteristics of the audio system of the receiver under test, the following measuring equipment was employed.

(a) General Radio, Type 513B, Ser. No. 44, Beat Frequency Audio Oscillator.
(b) General Radio, Type 546A, Ser. No. 119, Microvolter.
(c) General Radio, Type 483C, Ser. No. 107, Output Meter.
(d) General Radio, Type 583A, Ser. No. 16, Output Meter.
(e) General Radio, Type 636, Ser. No. 102, Wave Analyzer.
(f) Audio amplifier - built at the Laboratory.

11. A General Radio Type 617A, Ser. No. 30, interpolation audio oscillator was employed, in addition to the equipment listed in paragraph 8 above for the tests of frequency stability.

12. The equipment employed for the tests for audio frequency cross talk and radio frequency interference and reaction for multiplex operation of the receiver under test was essentially the same as that listed under

paragraph 8 above except that a General Radio Type LC-A, Ser. No. 8, Standard Signal Generator was used as the signal source, while a Laboratory-built receiver was used as the listening receiver.

13. Time Constants. The equipment employed for the measurement of time constants consisted of a General Radio Type 377B, Ser. No. 136, Audio Frequency Oscillator; a General Electric Type HC-10-A1, Ser.No. 712478 cathode ray oscillograph which was modified to use a RCA Type 905 tube, and used in conjunction with a circular time sweep circuit designed and built at the Laboratory. The audio signal was applied to the receiver through an electronic keying device also made at the Laboratory. RF signals were supplied from a General Radio Type LC-1, Serial No. 18, Standard Signal Generator.

14. Sensitivity. Measurements of sensitivity were made in accordance with paragraph 7-7 of reference (b) at five frequency settings of each band, each setting being the geometric mean between the two adjacent settings, and the two extreme settings being at the overlap frequencies of the band. The radio frequency signals were applied to the receiver input through a standard dummy antenna while the outputs were measured with a 20,000 ohm output meter. STANDARD NOISE was taken at 50 microwatts, while STANDARD OUTPUT was taken at 6 milliwatts across the 20,000 ohm load offered by the output meter.

15. Selectivity. Measurements of selectivity were made in accordance with paragraph 7-8 of reference (b) at the two overlap frequencies and geometric mean frequency of these two frequencies for each band of the receiver. The receiver was adjusted first for OPTIMUM GAIN and STANDARD OSCILLATIONS and then for ONE-TENTH OPTIMUM GAIN, with all other controls unchanged, at each frequency setting at which selectivity measurements were made. In measuring selectivity, a band-pass filter was used between the output of the receiver and the output meter and was coupled to them through impedance matching transformers, since the filter was designed for 200 ohm circuits and the output impedance of the receiver and that of the output meter was each 20,000 ohms. The band-pass filter was used only for frequencies above 100 kc.

16. Maximum Noise Level. With the sensitivity control set at maximum and with zero r.f. input, MAXIMUM NOISE LEVEL was measured in accordance with paragraph 7-9 of reference (b) at the same frequency settings for each band as for sensitivity measurements.

17. Resonant Overload. Using the band pass filter and the impedance matching transformers as described in paragraph 15 above between the receiver output and the output meter, resonant overload measurements were made at the overlap frequencies of each band in accordance with paragraph 7-10 of reference (b). The output readings were corrected for the attenuation due to the losses of the band-pass filter and its associated impedance matching transformers. All measurements were made at STANDARD OUTPUT FREQUENCY, namely 1000 cycles.

18. Overload Selectivity. Owing to the lack of adequate measuring equipment, this test was omitted.

19. Capacity of Panel Operated Vernier. A General Radio, Type 383B, Ser. No. 60, Capacity Meter was used for measuring the capacity of

at 1100 kcs. to the input of the Laboratory receiver such as to produce a MAXIMUM OUTPUT SIGNAL from the latter receiver. Conversely, the change in the output of the Laboratory receiver above the initial noise level was noted, when an input signal was applied at 550 kcs. to the type CGR-31 receiver such as to produce a MAXIMUM OUTPUT SIGNAL from that receiver.

25. Temperature Test. The Type CGR-31 receiver was placed in a temperature control chamber and adjusted for STANDARD CONDITIONS at 550 kc. The signal source was from a standard signal generator and was applied to the receiver through a standard dummy antenna. The receiver was operated through a complete temperature cycle starting at room temperatured, cooled to 0°C, heated to 44.5°C and then recooled to room temperature. Sufficient time was allowed to elapse to permit the receiver to assume the same constant temperature to which the temperature control chamber was adjusted for each step in the temperature cycle. Sensitivity measurements were made at each step both before and after reset of the signal generator to regain STANDARD OUTPUT FREQUENCY. In this manner, the change in receiver frequency was noted. No means is provided in the temperature control chamber for regulating the humidity.

26. Salt Water Immersion Test. The test was omitted inasmuch as no test samples were available.

27. Main Tuning Dial Calibration and Frequency Overlap. The main tuning dial was calibrated at the five settings at which sensitivies were measured for each band. The tunable frequencies of each end of each band were also recorded and from this data the percents of overlap between bands were calculated.

28. Accuracy of Resettability. The accuracy of resettability of each receiver solely from the calibration data previously obtained was determined at the overlap frequencies of each band of the receiver by noting the change in OUTPUT SIGNAL before and after reset for the same microvolts of input signal.

29. Output Impedance Characteristics. This characteristic was determined by measuring with a wave analyzer used as a vacuum tube voltmeter the output voltage obtained across different load resistances. These data were converted to terms of milliwatts of output and a curve of milliwatts output was plotted against load resistance. From inspection of this curve the optimum impedance for maximum output may readily be determined.

30. Frequency Stability. The frequency stability of the receiver was determined by measuring the beat note frequency before and after each test listed below, with a General Radio interpolation oscillator and noting the change in the frequency of the beat note. In cases where the change in the beat note frequency exceeded the range of audibility, the frequency of the standard signal generator was changed until the original beat note frequency was obtained and the reading of the frequency dial of the standard signal generator noted. Before each test the receiver was adjusted exactly as for the sensitivity tests. These tests were conducted at the overlap frequencies of each band.

(a) Effect of varying the regeneration control from OPTIMUM to STANDARD OSCILLATIONS.

(b) Effect of varying the panel operated vernier from one end of the dial to the other.

(c) Effect of vibration.

(d) Effect of changing the input from 1 or 2 microvolts to such values as to produce MAXIMUM OUTPUT under conditions of STANDARD OSCILLATIONS and OPTIMUM GAIN. This is not strictly in accordance with the specifications in that a higher input was used than that specified because with the specified initial input, the output signal was inaudible above the noise level.

(e) Effect of reducing the sensitivity control from MAXIMUM down to such a value that the output signal becomes just audible under conditions of STANDARD OSCILLATIONS and with an impressed signal of such value as to produce MAXIMUM OUTPUT at full gain.

(f) Effect of cutting the audio filter in or out with the receiver adjusted for STANDARD conditions.

31. Audio Frequency Characteristics. Audio frequency measurements were made in accordance with standard practice. The output signal from a General Radio beat frequency audio oscillator was applied across a dummy resistance network, to simulate the plate impedance of the detector tube, and connected to the input of the first audio transformer. The signal from the audio oscillator was first amplified through a Laboratory amplifier. The input to the resistance network was measured on a General Radio microvolter except where the range of the latter was exceeded, in which case, the input voltage was measured with a 20,000 ohm voltmeter. The magnitude of the input signal when once adjusted for a given test remained fixed throughout the test (except for the test for overload), while the change in output for changes in input signal frequency was measured with a General Radio wave analyzer used as a vacuum tube voltmeter. The following characteristics were measured.

(a) AF characteristics of audio amplifier alone, at outputs adjusted to 6 and 125 millivolt levels at 1000 cycles.

(b) AF characteristics of audio amplifier with tuned filter at outputs adjusted to 6 and 125 milliwatt levels at 1000 cycles.

(c) Overload characteristic of audio amplifier alone at 1000 cycles.

32. Sensitivity Control Characteristics. The following tests for sensitivity control characteristics were made at the overlap frequencies of each band. Prior to each test, the receiver was adjusted exactly as for sensitivity measurements.

(a) Range and linearity determined by increasing the microvolts input required to produce STANDARD OUTPUT at different set-

tings of the sensitivity control. The setting of the sensitivity control for STANDARD OUTPUT was taken as the reference level.

(b) Noise vs. output signal plus noise was determined by adjusting the CW input and receiver controls for STANDARD CONDITIONS as for sensitivity, and then measuring the output signal plus noise volts, and noise volts with no input signal for various increasing settings of the sensitivity control up to maximum and decreasing settings of the sensitivity control until the noise level became too small to measure. The CW input signal remained constant for this test. The gain setting for STANDARD OUTPUT was taken as the reference level.

(c) Measurements similar to (b) were recorded for CW inputs of 1,000 and 250,000 microvolts except that noise level data were not taken.

33. Transrectification. Transrectification was determined by measuring the change in plate current of each radio frequency tube for a change in CW input from 0 to 500,000 microvolts with the receiver adjusted for STANDARD OSCILLATIONS and MINIMUM gain. Sensitive Research Instrument Corporation D.C. microammeters, Model S, Ser. Nos. 2342 and 2343, were used in this test for measuring the change in plate current. Measurements for transrectification were made at the overlap frequencies of each band.

DATA RECORDED DURING TEST

34. Complete data was recorded on all tests conducted and this information, together with the corresponding data for the approved model of the Class IA receiving equipment, is contained in Tables 1 to 12 inclusive and Plates 1 to 31A inclusive appended hereto.

PROBABLE ERRORS IN RESULTS

35. All tests were carefully conducted using every precaution to assure reasonable accuracy in the calibrations of the measuring equipments employed so as to assure reliable and consistent results.

36. Estimates of the overall accuracies of the results of the measurements made in the tests reported upon herein are given below.

Group A

Test No.	Nature of Test	Estimated Overall Accuracy
(a)	Sensitivity	± 10%
(b)	Selectivity (sensitivity off resonance	± 10%
	(frequency setting	± 0.1%
(c)	Maximum noise level	± 10%
(d)	Resonant overload	± 10%
(e)	Radio frequency intercoupling multiplex operation	± 10%
(f)	Audio frequency cross talk	± 20%

Test No.	Nature of Test	Estimated Overall Accuracy
(g)	Main tuning dial calibration and frequency overlap	± 2%
(h)	Manual volume control characteristics	± 10%
(i)	Transrectification	± 10%

Group B

Test No.	Nature of Test	Estimated Overall Accuracy
(a)	Measurement of capacity of trimmer condenser	± 5% d.b.
(b)	Measurement of battery voltages	± 3%

Group C

Test No.	Nature of Test	Estimated Overall Accuracy
(a)	AF characteristics of a.f. amplifiers	± 0.5 d.b.
(b)	AF characteristics of tuned filter (calculated)	± 1 d.b.
(c)	Overload characteristic of a.f. amplifiers	± 10%
(d)	Output impedance characteristics	± 10%

Group D

Nature of Test	Estimated Overall Accuracy
Frequency stability under conditions of changes in settings of sensitivity control, regeneration control, input signal intensity, and settings of trimmer condenser.	± 5%

37. The accuracy of the measurements of Group A tests depends upon the accuracy of the standard signal generator, the accuracy of the output meter, and the precision with which the receiver may be adjusted for STANDARD CONDITIONS. The accuracy within which the standard signal generator may be set to a given frequency is better than 1%, while the accuracy of the calibration of the slide wire is within ±5%. The output meter employed has an accuracy of ± 2% as demonstrated by a previous calibration. The precision with which the receiver may be adjusted to STANDARD CONDITIONS depends primarily upon the noise condition and the stability of the receiver when subjected to control manipulations. The results of these tests show that STANDARD CONDITIONS cannot be obtained with a degree of precision of more than ± 3% because of the difficulty in adjusting the noise level exactly to STANDARD and because of the frequency drift encountered when adjusting the regeneration control from OPTIMUM to STANDARD OSCILLATIONS making it necessary to reset the main tuning control to regain STANDARD OUTPUT FREQUENCY. This discussion applies particularly to tests (a), (c), (d), (e), (f), (g) and (h) of this group. For selectivity measurements (test (b)) in addition to the above discussion, it should be pointed out that the accuracy of the frequency adjustment of the standard signal generator, for the several percentages off resonant frequency at which measurements were made, is better than ± 0.1%. This

is because the frequency increments are determined from a fixed arbitrary setting of the frequency dial of the standard signal generator. They represent differences in frequencies higher or lower than the resonant frequency and are calculated in terms of percentages of the resonant frequency and therefore do not depend upon the calibration of the frequency dial of the standard signal generator. The accuracy stated herein assumes that at all times the adjustment of the frequency dial of the standard signal generator is made in the same direction of rotation. Test (c) involving transrectification depends only upon the accuracy of the plate microammeters. Since the plate current of either of the two r.f. tubes was not appreciable, barely registering on the most sensitive scale of the microammeters, the change in plate current being only slight, if any; transrectification cannot be more accurate than ± 10%.

38. The accuracy of the measurements listed as tests (a) and (b) under Group B tests are dependent only upon the accuracies of the instruments employed in the measurement.

39. The accuracy of the measurements made under tests (a) to (d) inclusive of Group C tests, depend upon the accuracies of the audio oscillator, the wave analyzer, and the input measuring instruments employed. The frequency calibration of the audio oscillator is accurate to within 1%. The accuracy within which the input voltage was maintained at a constant value (except for test (d)) is within ± 2%. This holds true also for test (d) except in this test the input was not constant for all outputs. The wave analyzer has a rated voltage accuracy of 5% for all ranges used in these tests, and an accuracy of frequency calibration within 2%.

40. Tests listed under Group E tests involved the use of an interpolation oscillator as a means for measuring the drift in beat note frequency. This instrument is so designed as to permit an accurate determination of a frequency difference of less than 1 cycle. In such cases where it was necessary to reset the frequency control of the standard signal generator to regain the initial beat note, an additional error of ± 1% in frequency was introduced. Other unavoidable errors, such as errors in observation, errors due to inadequate precision in receiver adjustment for this kind of test bring the total overall accuracy of the measurement of frequency stability to ± 5%.

RESULTS OF TESTS

41. Descriptions of Type CGR-31 Receiver. The Type CGR-31 receiver is of the tuned radio frequency type having two radio frequency stages with an autodyne detector for CW reception. The r.f. system utilizes three tuned circuits and two type 232 vacuum tubes. a tuned circuit in the first r.f. grid circuit provides pretuning to reduce cross modulation or overloading effects in the first r.f. tube resulting from local interference. The antenna is coupled to this circuit by means of a small capacitance. Tuned impedance coupling is used between the r.f. stages and between the second r.f. and detector stages.

42. The r.f. system is designed to operate over the frequency range of 90 to 550 kcs., the range being divided into three bands, namely 90 to 165 kcs., 165 to 300 kcs., and 300 to 550 kcs. Band changing is accomplished by means of a switch operable from the front panel and which in turn oper-

ates separate anti-capacity switches for each circuit in tandem. For each band a different value of inductance is used in the tuned circuits. For the low frequency band, all three inductances in each circuit are employed. For the medium frequency band one set of the inductances is shorted. For the high frequency band two sets of inductances are shorted.

43. The detector circuit utilizes grid circuit detection, and regeneration is accomplished by inductive feed-back controled by the regeneration control operated from the front panel, by variation of the detector plate voltage. A Type 112A vacuum tube is employed as the detector. The required feedback inductances for the various frequency bands are switched simultaneously into the circuit with the same gang switch which changes the tuned circuit inductances. The detector circuit is supplied with a radio frequency filter to eliminate radio frequency from the audio and output circuits.

44. The audio system consists of two Type 112A vacuum tubes which are transformer coupled. A switch on the operating panel is arranged to connect two tuning capacitors across the transformer primaries and which provide high frequency filtering. A shielded output transformer is provided and designed for operation into high impedance head telephone receivers.

45. The receiver is designed to operate from batteries. A double range voltmeter is provided on the front panel to indicate filament and plate voltages. Sensitivity is controlled by variation of the r.f. screen grid potential. An "on-off" switch breaks both the filament and screen grid potentials.

46. Par. 1-i. In the following discussion, reference will be made to Specifications RE 13A 500A, reference (b), covering Class IA and Class IIA radio receiving equipments. However, this report will be confined to those paragraphs of reference (b) which apply particularly to the former equipment. Inasmuch as the Type CGR-31 receiving equipment and the Class IA receiving equipment have similar operating features which are not identical, owing to the wide differences in the advances made in the art of radio engineering at their respective dates of conception, make them applicable to similar types of service.

47. One of the objects of the tests made upon the subject equipment was to determine to what extent the mechanical and electrical features of this equipment complies with the requirements of reference (b) in so far as they apply to Class IA equipments. The model of the Class IA receiving equipment manufactured by the same supplier and recently approved by the Bureau of Engineering has met the specifications of reference (b) in practically all respects. Therefore, in comparing the Type CGR-31 equipment with the approved model of the Class IA equipment, the burden of proof as to the suitability of the former equipment for the same type of service for which the Class IA equipment is to be employed rests upon the Type CGR-31 equipment. This report will have two purposes; the first, to show to what extent the mechanical features of the Type CGR-31 equipment complies with reference (b), and the second, to discuss the electrical features of the Type CGR-31 equipment with those of the approved model of the Class IA equipment on a comparative basis. From such a comparison, such performance characteristics of one type of equipment which excell equivalent performance characteristics of the other type of equipment will be made evident.

48. Par. 1-2. The Type CGR-31 receiving equipment does not comply with all of the requirements of reference (b) and hence cannot be considered suitable for the same type of service intended for the approved model of the Class IA receiving equipment. Moreover, its mechanical features and some of its performance characteristics make it unsuitable and unsatisfactory for Naval Service.

49. Par. 1-3. This specification does not wholly apply to the subject equipment. The Type CGR-31 equipment is, however, complete in itself and does not depend upon other equipment for its operation, except for batteries and head telephone receivers.

50. Par. 1-4. The frequency range covered by the equipment is from 90 to 550 kcs. covered in three bands having the following frequency ranges:

Band 1 - 90 to 165 kcs.
Band 2 - 165 to 300 kcs.
Band 3 - 300 to 550 kcs.

This specification requirement in this respect is from 15 to 600 kcs.

51. Par. 1-5. This equipment is capable of and suitable for taking pure, modulated, or interrupted CW radio frequency energy from an antenna and delivering, through head telephone receivers, audio frequency signals, keyed or modulated in accordance with the impressed signals. With the "audio tuning" out, voice modulated reception at all frequencies is reasonably good.

52. Par. 1-6. The Type CGR-31 receiver is designed for operation with a standard antenna of approximately 200 mmf. effective capacity. Since the antenna is coupled to the first tuned circuit by means of a small capacitance, efficient operation on a wide variety of antenna systems may be expected. The input impedances for the three bands of this receiver are given in Table 10.

53. Par. 1-7(a). No definite limit for maximum noise level is in effect. This receiver is considered as having a low maximum noise level. The maximum noise level is not uniform in the range of any one band and is greatest for Band 1.

54. Par. 1-7(b). The sensitivity to noise ratio is considered as good, being best for Band 3.

55. Par. 1-7(c). This equipment is not considered as possessing a high degree of protection against strong local signals to permit duplex operation. Taken as an average, an increase in signal intensity of this order is sufficient to cause complete blocking of the detector.

56. Par. 1-7(d). High degree of oscillator frequency stability is not a characteristic of this equipment under all conditions.

57. Par. 1-7(e). The recovery of this equipment from the paralyzing effect of static is good.

76. Par. 3-14. Volume Control: - Manual. (Specification requirement for Class IA equipments - manual and automatic.)

77. Par. 3-15. Output Impedance. 4000 ohms at 1000 cycles for maximum output - Actual load used for tests - 20,000 ohms. (Specification requirement for Class IA equipment - 600 ohms at 1000 cycles.)

78. Par. 4-1. General Specifications for the inspection of material issued by the Navy Department - no comment.

79. Par. 4-2. Electrical Indicating Instruments. The only electrical indicating instrument provided on the operating panel is a Weston d.c. voltmeter, Model 506, having two ranges, namely 0 to 7.5 and 0 to 150 volts. The lower range reads filament voltage continuously, while the plate voltage may be read on the higher range upon depressing a push button on the front of the instrument. The meter is of the flush mounting type, has a chromium plated mounted flange and its overall dimensions and general electrical and mechanical features are in accordance with reference (e).

80. Nameplates. A nameplate is provided on the front of the operating panel, and the information contained thereon includes the name of the receiver, type number, serial number, frequency range, contract number and its date, and the name of the manufacturer. The nameplate is 2" wide x 3" long. For obvious reasons this nameplate cannot be expected to comply with Specifications RE 13A 263H, reference (i).

81. Vacuum Tubes. The tube complement employed in the Type CGR-31 receiver is of approved types as listed in reference (f), and is as follows:

2 - Type 232 - used as r.f. amplifiers.
3 - Type 112A - used as detector and AF amplifiers.

82. Ceramic Insulation. No ceramic insulation of any form is used in any part or for any purpose in the subject receiver.

83. Phenolic Insulation. The terminal panels of the AF transformers, condenser packs, detector r.f. choke, filament resistor mountings, and all miscellaneous terminal strips are of canvas-based bakelite or its equivalent. Paper-based bakelite or its equivalent is used for all r.f. coil forms, 1st r.f. and 2nd audio tube sockets and "on-off" power switch. Modeled bakelite or its equivalent is used for the 2nd r.f. detector and 1st a.f. tube sockets, main power plug, contact supports for anti-capacity switches, antenna-ground and phone output terminals power supply meter housing and housings for regeneration and sensitivity controls.

84. Par. 4-3. Receiver Cabinet. The receiver cabinet is made of 3/32" thick aluminum. It is made in two pieces, the first of which is folded to form the top, two sides and bottom, while the second, a flat piece with flanged edges, forms the back. The back is secured to the cabinet proper with round head rivets. The two ends of the first section forming the main portion of the cabinet are joined together at the midpoint of the bottom of the cabinet to form a butt joint which is secured together by means of a 1/16" thick aluminum strip which is placed over the butt joint and riveted in place. Brass blocks and angles riveted to the two sides and bottom of the

cabinet are drilled and tapped for the front panel retaining screws. The top of the cabinet is cut away to form an opening for a hinged cover. This opening extends to within 3/4" from each of the two sides of the cabinet, within 5/8" from the front of the cabinet, and 1" from the back of the cabinet. The cover encloses the entire opening and is secured throughout its length to the rear of the cabinet by means of a nickel plated brass piano hinge riveted in place. The edges of the opening in the top of the cabinet are reinforced along the two ends of the opening with 1/8" thick brass strips riveted in place and along the front edge by means of a 1/6" thick brass angle also riveted in place. This angle and the two strips are so mounted as to form stops for the cover. Further, the front angle is drilled and tapped for the retaining screws for the top edge of the operating panel. The construction of the cabinet is considered as being sufficiently rugged for the purpose for which it was intended. Provision has been made at the rear of the box for the entry of the power supply leads, antenna and ground leads, and output leads by means of a sliding cover which encloses an opening five inches square. The leads themselves do not pass through the opening, but through separate holes drilled into the sides of the box, the large hole in the rear only serving as a means for easy access to the binding posts and the male plug of the power cable at the rear of the receiver chassis.

85. Receiver Chassis. The front operating panel is of one piece aluminum 1/8" thick. The sub-panel is of shelf type construction fabricated from a one piece 3/32" thick aluminum sheet with all four edges bent down to form four sides each 2-1/4" high. All four sides are riveted together. The sub-panel is secured to the front operating panel with #10 - 32 screws and nuts. It is further secured at the front by means of two 3/32" thick aluminum brackets which are secured to the front panel with 1/4 - 20 studs and nuts, of the two handles on the front panel, and secured to the two sides of the sub-panel with rivets. These brackets extend to within 5/8" of the rear of the sub-panel and extend 3/4" below the bottom edges of the sides of the sub-panel to form runners for sliding the chassis out of its cabinet. The receiver chassis, together with all of its supporting brackets, has a sand blast finish. The front panel and chassis are considered as being ruggedly constructed.

86. Ganged Variable Condensers. The ganged variable condensers are mounted in a one piece die cast aluminum "bath tub" housing, having 3/32" thick walls, and which includes diaphragm shields for the separate condenser units. The stator plates are of aluminum stampings molded into a common hub of some material similar to "type" metal. The stator plates are also of aluminum stampings and are staked into longitudinal tie-members supported from the die cast "bath tub" housing by hard rubber insulators. Neither the die cast "bath tub" housing nor the rubber supports is considered stable for the precision required of ganged variable condensers. The "bath tub" die cast housing has a three point suspension, two of which are at the front while the third is at the rear. This housing is secured to the sub-panel and to the front panel by means of L-shaped nickel plated brass brackets. One of the mounting screws securing the condenser housing to the rear bracket fell out during the vibration tests. The main condenser shaft is of steel and is magnetic. The shaft apparently was plated, but this plating has worn through as the result of the wiping action of the brush contacts. No provision has been made for centering the rotor plates between the stator plates and these have become dangerously close to each other as the direct result of the "growing" action of the die cast housing. The wiping contacts are

poorly designed, do not have sufficient tension, and are wholly unsatisfactory for the purpose for which they are intended. The velvet vernier dial used for driving the main tuning condenser shaft does not provide sufficient lock to assure that the mechanical unbalance of the condenser will not result in a capacity variation under conditions of vibration.

87. Band Selector Switches. Band switching is accomplished by the so-called anti-capacity type of switches, there being a separate switch for each of the three circuits requiring adjustment. All three switches are mechanically coupled to a rigid brass bar which, in turn, is coupled to a control lever through a link system. The band switch has its extreme variations limited only to the extent as is contained within the anti-capacity switches themselves. These two positions are for Bands 2 and 3. The center position is indicated by alignment of the switch arm with a numeral on the front panel and the "feel" resulting by a clicker arrangement which is a part of the mechanical drive. There is a possibility for confusion as to the exact center positions as three points are indicated by "feel". The anti-capacity switches have generally been found to give unsatisfactory contact after continuous usage, although no contact difficulty was evident in this particular unit. The anti-capacity switches are so located as to make it practically impossible to make a visual inspection of them to determine their action without extensive disassembly.

88. R.F. Coil Systems. The coil system of the 1st r.f. circuit consists of three inductances wound on individual forms and connected in series. Two of these inductances used for bands 2 and 3 (medium and high frequency bands respectively) are supported from a common bracket, which in turn is secured to the receiver chassis. These two coils are mounted at right angles to each other, the one used for Band 3 being supported vertically, while the other is in a horizontal position. The coils are housed in the shielded compartment mounted on the top of the sub-panel of the receiver chassis, the This compartment houses, in addition to these coils, the 1st radio frequency tube, trimmer condensers for these coils, band switch, grid condenser, grid leak resistor, and an r.f. by-pass condenser. The trimmer condensers for these two coils are mounted on top of the vertical coil used for band 3. The third inductance coil is mounted directly beneath the r.f. compartment housing the other two inductances of this coil system, and the under side of the sub-panel of the receiver chassis. This coil is mounted in a vertical position and is provided with a cylindrical shield can of a screw fit design. A trimmer condenser for this coil is mounted on the bottom end of the coil form. Access to this trimmer condenser for adjustment is provided through a hole in the bottom of the shield cans. No holes are provided in the cover of the compartment shield for adjusting the trimmer condensers for the two coils housed within this compartment.

89. Each inductance is wound in an individual 1" diameter cylindrical form of phenolic material. The leads are soldered to terminals mounted at one end of each form. Litz wire, insulated with silk, is used for all inductances. "Universal" winding has been employed for all inductances. The inductances are wax-treated, but the terminals to which the leads are soldered have not been so coated. The insulation at the ends of the leads which are soldered to the coil terminals has been removed approximately 1/8" from the soldered connections, thus exposing the fine strands of the lead wire to corrosive action of salt humid atmospheres. All of the

coils are connected to a common terminal strip mounted on the supporting bracket for the two coils in the r.f. compartment. Unsoldering these leads permits the removal of any of the coils for replacement or repairs without disconnecting the individual leads from their terminals in the coil forms. In the low frequency band (Band 1) all three inductances are employed; for the medium frequency band (Band 2) the separately shielded coil in the cylindrical screw fit shield can is shorted out; and for the high frequency band (Band 3) the horizontal coil in the r.f. compartment is shorted out in addition to the one shorted for Band 2.

90. The coils employed in the 2nd r.f. stage, their connections for the three bands, and their construction and mechanical arrangement are identical to the 1st r.f. stage. This statement applies also to the inductance system for the detector, except that there are three additional feed-back coils, one each wound on the same form as the corresponding inductance to which it is inductively coupled. These coils have fewer turns and appear to be also of Litz wire. The winding construction for these coils is also of the "Universal" type. In changing bands, the same sequence for shorting out coils applies to the feed-back coils as to their corresponding tuned condensers.

91. Vernier Condenser. The panel operated vernier air dielectric condenser has but a single bearing and depends upon the knob located on the front of the panel for limitation of thrust motion. If the knob should become loosened or have to be replaced, it is necessary that the shield enclosing the condenser be removed to centralize the rotor plates between the stator plates. Due to the fact that there is no indication on the shaft as to the angular position of the rotor plates with respect to the stator plates, it is entirely possible that the single set screw in the knob might become sufficiently loosened as to destroy the calibration of the condenser with respect to its dial.

92. Trimmer Condensers. The trimmer condensers provided do not retain their adjustments under conditions of vibration and severe humidity. It was possible to retrim the receiver prior to test so as to provide, in some instances, as much as 10 to 1 improvement in the sensitivity of the receiver. It is believed that the construction of the trimmer condensers which employ mica dielectrics mounted on phenolic bases is largely responsible for this variation.

93. Controls. The power supply meter frame, main tuning dial, vernier condenser dial, band switch lever, "on-off" switch, telephone jack and " filter 'on-off' switch" have their exposed surfaces on the front operating panel, chromium-plated and are highly polished. This is true also of the two handles mounted on either side of the panel. This type of plating, particularly when polished, is not generally considered desirable, especially when applied to meters and dials, due to light reflections which make their reading difficult.

94. Par. 4-5 and 4-6. The use of iron or steel, except where specifically required for electromagnetic purposes, has been kept to a minimum. As previously mentioned, aluminum has been used for the front operating panel, receiver chassis, and its associated mounting brackets and cabinet. The material used for the battery box, however, is not known, but probably is aluminum. Aluminum has also been employed in the shield box for the panel

operated vernier condenser, mounting brackets for the ganged tuning condenser, and for the casings of a few of the paper-dielectric capacitors. Miscellaneous stand-off spacers or coil supporting brackets are of nickel-plated brass. The r.f. compartment shield cans are of copper with the outside surfaces nickel-plated, while the inside surfaces are bright finished. The "wipers" mounted inside of the upper halves of these shields are of phosphor bronze. The cylindrical coil shield cans of the screw fit design, mounted on the underside of the chassis, and housing the low frequency r.f. coils, are of copper and nickel-plated inside and out. The plating on these cans, as well as the r.f. compartment shield cans, is very good, and shows no evidence of corrosion after such service as this equipment has had. Nickel-plated phosphor bronze lock washers of the "shakeproof" type and nickel-plated brass washers have been employed throughout. Steel has been used for the cases of the audio transformers, paper dielectric condenser packs, and a few of the smaller paper dielectric condensers. Steel clamps have also been used for securing the laced wiring in place. This is an objectionable feature, for brass would have served equally as well. The main shaft of the ganged tuning condenser is also of steel. All steel used in the construction of this receiver has magnetic properties; all steel parts are cadmium-plated.

95. The r.f. coils are wax-treated, but the soldered connections to the terminals on the coil forms are exposed. The Litz strands from the coil windings are in most cases exposed near the soldered joints and are therefore subject to the corrosive action of humid salt atmospheres, which may result in the failure of the equipment.

96. The construction of the paper dielectric by-pass condensers does not comply with reference (d) in that they are not entirely metal-clad. The openings in the cases through which the terminals pass are insulated with fibre rings which leave large openings around the terminals. Moisture may easily collect around these terminals and ultimately penetrate into the interior structure of the condenser and result in its failure due to electrolytic action on the condenser coil.

97. The terminals on the panels of the audio transformers and condenser jacks are secured to their respective panels with open eyelets. The ends of the leads which pass through these eyelets and eventually soldered to the terminals are tinned but are without a protective rubber coating. The fine wire strands of the leads are, therefore, subject to the corrosive action of salt humid atmospheres which may lead to a broken connection. Moreover, under severe humidity conditions, moisture will collect between the terminals and cause creepage of current from one terminal or possibly winding to another, resulting either in a complete breakdown of the unit or render the receiver inoperative. Also, even though the transformer or condenser units themselves may be potted, moisture can still enter through the eyelets and collect underneath the terminal panel, and eventually enter the windings through the leads from "wick" effect. The net result is that in humid, salt atmospheres the soldered connection between the leads and the transformer windings or between the leads and the foil of the condensers may become corroded and destroyed.

98. Par. 4-7. Complete data for the temperature test are given in Table 12.

99. Par. 4-8. All parts are suitably designed to carry the

108. Par. 4-17. No electrolytic capacitors are used.

109. Par. 4-18. Trimming condensers are of the mica dielectric type mounted on phenolic panels. This is not in agreement with the requirements of these specifications.

110. Par. 4-19. These specifications were not met. Only phenolic or hard rubber insulating materials were employed in any circuit.

111. Par. 4-20. No calibrated vernier dial is employed on any of the controls of the subject receiver.

112. Par. 4-21. All wiring is distinctly color coded, supposedly to facilitate testing and locating faults. However, no wiring diagram is furnished in the instruction book, reference (c), and therefore no comments can be made relative to the consistency of the color coding or its adherence to any particular color code. One of the figures in the instruction book showing the location of the r.f. coils and other associated parts within the separately shielded r.f. compartments is made to show the color coding of the leads which must be disconnected when removing a coil system for replacement or repair.

113. Par. 4-22. All wires employed in any circuit are of stranded soft annealed copper of suitable cross-section to provide ample and safe carrying capacity and/or mechanical strength in compliance with these specifications.

114. Par. 4-23. All wire used is covered with a cotton braid which appears to be treated with varnish. Some leads, however, appear to have either black or white composition insulation under the cotton braid. This insulation has become solidified and brittle due to aging. The wiring job is only fair. Two connections required resoldering prior to tests owing to the poor contacts made by the original soldered connections.

115. Par. 4-24. This specification does not apply to this equipment.

116. Par. 4-25. No comment can be given.

117. Par. 4-26. to 4-28 inclusive. Wire samples were not made available for test. Therefore, no comment other than that which has already been given above can be made relative to the quality of the wire employed in this receiver.

118. Par. 5-1. The Type CGR-31 receiver is of "unit" construction.

119. Par. 5-2. The receiver chassis is housed in an individual cabinet. Auxiliary to the receiver unit is a battery box described in the instruction book, reference (c), but not supplied with the receiver furnished for test.

120. Par. 5-3. This specification does not wholly apply to the Type CGR-31 receiver. The controls mounted on the front panel are, however, symmetrically arranged.

121. Par. 5-4. The Type CGR-31 receiver is designed only for battery operation.

122. Par. 5-5. The dimensions and weight of the receiver are as follows:

Height - 10-1/2" (table to top of cabinet)
Length - 17-1/8" (including all projections)
Depth - 10-5/8" (back of panel including all rear projections but excluding controls)
Depth - 11-1/2" (back of panel including all rear projections and controls)
Weight - 35.5 pounds.

The weight of the receiver and its dimensions are well within their respective limits, as stipulated in these specifications.

123. Par. 5-6. This specification does not apply to the subject equipment.

124. Par. 5-7. While no power unit such as is defined by these specifications is either required or furnished, the equipment is supplied with a battery box by the manufacturer. The dimensions and weight of the box as given in the instruction book, reference (c), are as follows:

Height - 3-1/4"
Length - 9-3/16"
Depth - 6-3/16"
Weight - 5 pounds

125. Par. 5-8. The design and construction of the Type CGR-31 receiver is such that its cabinet may be secured to an operating table and the chassis with all integral parts capable of removal from the cabinet for servicing or other purposes without disturbing the cabinet.

126. Par. 5-9, 5-10. A five-conductor shielded cable, five feet in length, and provided with a female plug at one end (Jones plug) for connection to the receiver is furnished with the receiver. The other end of the cable has lug terminals whereby connections are made to the proper terminals of the battery box. All leads are color coded. The weight is 1 pound. The construction of this power supply cable appears to be unsatisfactory because when received at the Laboratory repairs to three breaks in the same number of conductors had already been made. The length of the cable does not fulfill the requirement of this specification, namely, that it shall be of such length as to "permit withdrawal of the receiver chassis from its cabinet for testing and the replacement of vacuum tubes with a lead length, when so withdrawn, of not less than six feet".

127. Par. 5-11. The receiver cabinet and front panel are finished on the outside with a black wrinkle finish, while the interiors are coated with a black lacquer. No information is available regarding the finish of the exterior or interior of the battery box, although it may be assumed that the finishes are similar to those of the receiver cabinet.

128. Par. 5-12. The top of the receiver cabinet is provided with a hinged cover to permit the rapid insertion or replacement of tubes. It also facilitates the connection of the power supply cable as well as the output and antenna and ground connections.

129. Par. 5-13. Two polished chromium-plated handles, arranged one at each side of the front operating panel, provide a means for removing the receiver chassis from its cabinet without putting strain on any of the control knobs or dials. The bright plating on the handles is not considered particularly desirable.

130. Par. 5-14. Number 8-32 oval head, nickel-plated, screws secure the front operating panel to the cabinet. Such screws are not considered satisfactory inasmuch as they require a screw driver for their removal and may easily become lost, as evidenced by the fact that several of these retaining screws were missing from the receiver unit supplied to the Laboratory for test.

131. Par. 5-15. The controls on the receiver are similar in design and are symmetrically arranged on the front operating panel.

132. Par. 5-16. Suitable words or phrases descriptive of the purpose of a particular control are engraved on the front panel and adjacent to each control. Attention is invited to the fact, however, that no graduated scale is provided for the regeneration control or sensitivity control. The lack of such scales makes it difficult for an operator to accurately reset the receiver to any predetermined calibration. Exception is taken to the labeling of the sensitivity control. This control should be labeled "SENSITIVITY" instead of "VOLUME".

133. Par. 5-17. All engraved markings on the front operating panel are permanent and easily readable at a distance of 24 inches under normal operating conditions.

134. Par. 5-18. Specifications do not apply to this receiver for reasons pointed out in the foregoing.

135. Par. 5-19. The vacuum tubes employed in the Type CGR-31 receiver are as follows:

2 Type 232 used as r.f. amplifiers
3 Type 112A used as detector and a.f. amplifiers.

The number of tubes employed comply with these specifications. However, the type numbers are not in agreement with those specified by these specifications. No comparison of the tube complement can rightfully be made with those used in the approved model of the Class IA equipment which complies with these specifications, other than to note the advance made in the art since the conception of the Type CGR-31 receiver.

136. Par. 5-20 to 5-22 inclusive. The band changing switches do not comply with these specifications. Band changing is accomplished through the use of the so-called anti-capacity switches operated in tandem by means of a link and bar system controlled from a lever mounted on the front operating panel. These switches have been described in an earlier part of this report. The anti-capacity switches have generally been found to give unsatisfactory contact after continuous usage. However, no contact difficulty was evident on this particular unit. For a complete discussion of the action of the positioning devices provided on the band switches and in the construction of the movable contacts used in tuning condenser assembly,

refer to paragraphs 86 and 87.

137. Par. 5-23. The main tuning dial is provided with a scale of 0 to 150 with the 150 equal divisions engraved around the lower half of its circumference and with three scales, corresponding to the three positions of the band changing switch around the upper half of its circumference. These latter three scales are calibrated at the following intervening frequencies:

Scale No. 1 - clockwise, 106 and 143 kcs.
Scale No. 2 - clockwise, 245 and 275 kcs.
Scale No. 3 - clockwise, 355, 375, 425 and 500 kcs.

The scale for the vernier condenser is graduated on a 10-0-10 basis with 10 equal divisions on either side of zero. The regeneration or sensitivity controls are, as previously mentioned, without graduated scales or other markings to indicate their settings. The two scales described above are both out of agreement with the requirements of these specifications.

138. Par. 5-24. The rotation of the main tuning dial is such that a counterclockwise rotation causes the graduations of the 0-150 scale to increase, numerically, with increase in frequency, while a clockwise rotation causes the calibration of the three auxiliary scales to increase numerically with increase in frequency. All other controls rotate clockwise for an increase in the final effect.

139. Par. 5-25. The main tuning dial and vernier condenser dial are chromium-plated and highly polished and both are difficult to read owing to light reflections. The requirements of these specifications are therefore not met.

140. Par. 5-26. The main tuning is accomplished by vernier control by means of a "National Velvet Vernier" dial. The drive is a standard unit, the scale and outer ring containing the fiducial marks being special.

141. Par. 5-27. The main tuning control has a ratio of approximately 5 to 1 instead of 6 to 1 as quoted in the instruction book, reference (c). This ratio is considerably less than the minimum of 20 to 1 as required by these specifications.

142. Par. 5-28, 5-29. The main tuning vernier is friction-driven instead of gear-driven as required by these specifications. However, the control is easy running, free from appreciable back-lash and torque-lash, and, as indicated by the results of these tests, is capable of being reset in any direction to any predetermined point within the limits of these specifications. The design of this vernier dial appears to be satisfactory in so far as its freedom from back-lash and its ease in operation is concerned, as demonstrated by its present action after such usage as it may have had in actual service.

153. Par. 5-30. A panel operated vernier of the air dielectric type is provided in the oscillator circuit, being connected so as to trim the oscillator coils. No panel operated air dielectric vernier controls are used for the two r.f. stages contrary to the requirements of these specifications.

144. Par. 5-31, 5-32. The position of the panel operated air dielectric condenser is such that but one adjustment for each frequency band is necessary for optimum receiver performance. No mechanical verniers are associated with this device.

145. Par. 5-33. The vernier condenser is calibrated with a "zero center" instead of zero left, as required by these specifications.

146. Par. 5-34. This specification does not apply to the subject equipment.

147. Par. 5-35. The number of friction and pressure contacts have been kept within reasonable limits. The cylindrical coil shield cans of the screw type design as well as the separate r.f. compartment cans are of copper which are nickel-plated on the outside. The plating on all cans appears to be very good, there being no evidence of corrosion. The threaded ends of the cylindrical coil shield cans show no evidence of wear or corrosion in the threads. These cans are easily unscrewed from their retaining bases without the use of special tools. The phosphor bronze wiping contacts riveted inside of the covers of the separate r.f. compartment shields have good tension and make positive contact with their mates which are permanently secured to the receiver chassis.

148. Par. 5-36. With the exception of the parts contained within the separately shielded r.f. compartments, all parts are readily accessible for replacement or repair. The component parts within the r.f. compartments are, in most cases, accessible only after the removal of the coil systems. Each of these coil systems may be removed by taking out two screws which secure the coil mounting brackets to the receiver chassis and unsoldering several leads from the common terminal strip to which all of the coil leads are soldered. The leads which must be unsoldered are not the leads connecting these terminals to the terminals on the individual coil forms, but those external leads connecting the coils to their associated circuits. However, the leads which must be unsoldered are all color coded and their connections are fully covered in the instruction book, reference (c).

149. Par. 5-37. No "Oscillation Test" devices are provided, as required by these specifications, on the front panel of the receiver to permit an operator to ascertain when the receiver is in condition for CW reception.

150. Par. 5-38. The calibration of the main tuning condenser is shown on Plate 1 for the Type CGR-31 receiver and on Plate 1A for the approved model of the Class IA receiving equipment.

151. Par. 5-39. The Type CGR-31 receiver is provided with an output transformer described in the instruction book, reference (c), as shielded. However, the schematic diagram shown on Plate 30 does not indicate that shielding is provided between the primary and secondary windings of this transformer. The secondary winding **one side at ground** potential and connects to an open circuit telephone jack mounted on the front panel and also to a pair of binding posts mounted at the rear of the receiver chassis. The telephone jack is of Yaxley manufacture, is of the short type, and does not comply with the specifications of reference (h).

152. Par. 5-40 to 5-43 inclusive. No auxiliary "control unit" is provided with the Type CGR-31 receiving equipment.

153. Par. 5-44. A 2-1/2" d.c. voltmeter having two ranges, namely 0 to 7.5 volts and 0 to 150 volts, is provided on the front operating panel of the receiver. The lower range indicates filament voltage, while the higher range indicates maximum plate voltage when a push-button located at the base and on the front of the meter is depressed. This instrument complies with specifications, reference (e), but not with these specifications which require that the instrument be of the a.c.-d.c. type.

154. Par. 5-45 to 5-47 inclusive. The Type CGR-31 receiver does not comply with these specifications in that no output level indicator is provided as an integral part of the receiver.

155. Par. 5-49. An "on-off" double pole single throw "Midget" jack switch of Yaxley manufacture is provided in the front operating panel. When in the "off" position, this switch interrupts the high potential side of the filament supply and the r.f. amplifier screen grid potential. The plate potential to all tubes and the C bias potentials to the a.f. amplifier tubes are applied at all times, although with the switch in the "off" position, no current is drawn from these sources.

156. Par. 5-49 to 51 inclusive. These specifications do not apply to the subject equipment.

157. Par. 5-52. Antenna and ground binding post type of terminals are provided at the rear of the receiver chassis. They are mounted on a molded insulating block, apparently of Ebby manufacture, which in turn is mounted on top and at the rear of the receiver chassis, with the ends of the terminals projecting through holes provided for them in the sub-base of the chassis. The terminal mounting for the phone output terminals is of similar construction.

158. Par. 6-1. Sensitivity. The variation in sensitivity over the frequency range of each band of the Type CGR-31 receiver is shown on Plate 2. Two sets of curves are shown, one set being measured with the original sensitivity control operating in the receiver, and the other with this control replaced by one of Clarostat manufacture and having an overall resistance equal to the rated overall resistance of the original control. It developed during tests that the overall resistance of the original sensitivity control had decreased from its rated value of 10,000 ohms to 5600 ohms. It is not known how much this resistance had decreased at the time the sensitivities were measured with this control. It is known, however, that when the resistance had become 5600 ohms, the sensitivity of the receiver was poorer by several orders, at all frequencies, that it was when the upper curves shown on Plate 2 were measured. The improvement realized in the average sensitivity of each band with the new sensitivity control is indicated by the following approximate ratios.

Band 1 - 1.5 to 1
Band 2 - 3 to 1
Band 3 - 2 to 1

All sensitivity measurements were made with the panel operated vernier

condenser set at zero, as indicated on its dial. Attention is invited to the fact that prior to tests it was necessary to retrim the r.f. circuit to obtain maximum receiver sensitivity. As much as 10 to 1 improvement in receiver sensitivity was realized in some instances. These circuits were retrimmed in accordance with the instructions given in reference (c).

159. Plate 3A shows the variation in sensitivity over the frequency range of the several bands of the approved model of the Class IA receiver. Only bands 4, 5 and 6 are of interest when comparing these sensitivities with those of the Type CGR-31 receiver at corresponding frequencies. It will be noted that the sensitivities shown on Plate 3A comply with the requirements of this specification. It will be further noted, when comparing curves shown in Plate 2 with the corresponding curves on Plate 3A, that the average sensitivity of each band of the Type CGR-31 receiver is poorer than the average sensitivity of the corresponding band of the approved model of the Class IA receiver. The extent to which the average sensitivity of each band of the Type CGR-31 receiver is poorer than for the Class IA receiver is indicated by the following ratios:

Band No. CGR-31	Band No. Class IA	With Original Sensitivity Control	With Replacement Sensitivity Control
1	4	9 to 1	6 to 1
2	5	17 to 1	4.5 to 1
3	6	8 to 1	4 to 1

Obviously, then, the sensitivity of the type CGR-31 receiver is considerably outside the limits of this specification.

160. Par. 6-2. Selectivity. Selectivity curves measured for the Type CGR-31 receiver operating at OPTIMUM GAIN are shown on Plates 5, 7 and 9 for Bands 1, 2 and 3, respectively. The nearest corresponding curves, in so far as frequency agreement is concerned for the approved model of the Class IA receiver, are shown on Plates 8A, 9A and 10A for Bands 4, 5 and 6, respectively, of that receiver. These curves show selectivities with this receiver operating at OPTIMUM GAIN.

161. Attention is invited to the abscissa scales on Plates 5, 7 and 9, which are 5% per full division instead of 2% as required by Par. 8-3, reference (b), and as employed on Plates 8A, 9A and 10A. Owing to the broadness of the selectivity curves of the Type CGR-31 receiver, it was necessary to increase the range of the abscissa scales for Plates 5, 7 and 9 to adequately picture the selectivities at the several frequencies at which they were measured. In general, the selectivity of the Type CGR-31 receiver at any frequency is considerably poorer than that for the corresponding frequency of the approved model of the Class IA receiver. Also, the selectivities are considerably outside the limits of these specifications for inputs greater than two orders above resonant inputs, whereas they are well within these limits for all inputs for the approved model of the Class IA receiver.

162. Par. 6-3. Maximum Noise Level. The noise level with full gain does not vary more than 12 decibels (total) throughout the working range of any band of the Type CGR-31 receiver. Curves showing

the variation in maximum noise level for the receiver are measured with the original sensitivity control in the circuit as shown on Plate 3. Similar curves are shown on Plate 4 but with the replacement sensitivity control employed. The data illustrated by these curves were obtained at the same time as the corresponding sensitivity data shown on Plate 2. The comments relative to the change in the resistance of the original sensitivity control and the occurrence of that change given under paragraph 158 above apply also to the curves shown on Plate 3. It will be noted upon examination of corresponding curves on these two plates that the average maximum noise level was increased approximately 17.5 times for Band 1, 26.7 times for Band 2, and 23.5 times for Band 3 when the replacement sensitivity control was used.

163. Corresponding curves shown on Plate 4A for the approved model of the Class IA receiver and for Bands 4, 5 and 6 which cover approximately the same frequency range as do the three bands of the subject receiver, show the maximum noise level at any frequency considerably greater than shown on Plate 4 for the same frequency. This is to be expected since the gain of this receiver is greater at any frequency than for that of the subject receiver at any corresponding frequency and the maximum noise level is proportional to the gain. Maximum noise level is only a relative quantity and its magnitude is not important as long as useful receiver sensitivity is not destroyed by it. Obviously, since these quantities are so radically different between the Type CGR-31 and the approved model of the Class IA receiver, comparison of the maximum noise of the two receivers can be made only on a relative basis.

164. Par. 6-4. Resonant Overload. Resonant overload characteristics measured at the overlap frequencies of each band of the Type CGR-31 receiver are shown on Plates 11, 12 and 13. Resonant overload at these frequencies, and as defined by Par. 2-11 of reference (b), is tabulated in Table 3. Owing to the types of tubes employed, the resonant overload output at any frequency is considerably less than the 300 milliwatt minimum as required by these specifications. The resonant overload curves shown as solid curves on Plates 11, 12 and 13 were measured with the original sensitivity control operating in the receiver. Similar curves shown as dash-line curves are estimated characteristics determined from the sensitivities required for STANDARD OUTPUT at these frequencies when using the replacement sensitivity control. The dash-line curve shown on Plate 11 for 90 kc. was measured, however, to check the assumption that the shape of the resonant overload characteristic would not be affected by the new sensitivity control. It will be noted from Table 3 that the outputs at resonant overload are approximately the same for either sensitivity control.

165. Resonant overload characteristic curves are shown on Plates 12A and 13A for Bands 4 and 6 of the approved model of the Class IA receiver. These curves show resonant overload characteristics for the nearest corresponding frequencies at which similar characteristics were measured for the Type CGR-31 receiver. The outputs at resonant overload at the overlap frequencies of Bands 4 and 5 on the approved model of the Class IA receiver are tabulated in Table 3, and it will be noted that these values are all within the specification limits.

166. Comparing the results from this test for the two types of receivers, it will be noted that resonant overload at any frequency at

which comparison can be made occurs for approximately the same input signal intensity for both types of receivers when the replacement sensitivity control is employed in the Type CGR-31 receiver. The outputs for these inputs are, of course, limited by the type of tubes used in the two receivers. The input level, at which complete detector blocking occurs, is better than one order greater than that required for resonant overload for either type of receiver.

167. Par. 6-5. In view of the lack of adequate equipment for overload selectivity tests, these tests were omitted for the Type CGR-31 receiver.

168. Par. 6-6. The Type CGR-31 receiver is of the tuned radio frequency type.

169. Par. 6-7. The subject receiver is provided with three tuned circuits between the antenna and detector, the first one of which precedes the first vacuum tube.

170. Par. 6-8. CW reception is accomplished by the autodyne method.

171. Par. 6-9. Tuning is accomplished by one main tuning control. The main tuning control has for its purpose the changing of the resonant frequency of all tuned circuits simultaneously over the range of the coil system.

172. Par. 6-10. The panel operated trimmer condenser may be permanently set at zero for optimum sensitivity at any frequency. The total capacity variation of this condenser is 14.27 mmf. with a minimum capacity of 2.38 mmf. However, when adjusting this condenser from -10 to +10 on its dial, the change in capacity is only 11.89 mmf. The maximum range in capacity is 3.85% of the maximum range of the main tuning capacitor.

173. Par. 6-11. Interaction and Loading - Multiplex Operation. The input impedances of the antenna circuit of the three bands of the Type CGR-31 receiver are given in Table 10. The input impedances are sufficiently high as to permit the operation of this receiver on the same antenna with a similar receiver without serious reduction in its normal efficiency.

174. In a test for interaction, the subject receiver and a Laboratory receiver were operated adjacent to each other from their own respective battery supplies. An input signal from a standard signal generator was applied to both receiver inputs, connected in parallel, through a standard dummy antenna. Both receivers were tuned to 550 kc. and both adjusted for STANDARD CONDITIONS. There was no change produced in the output of the Laboratory receiver from its initial value when the CGR-31 receiver was connected in parallel with it, thus showing that the oscillator of the latter receiver does not feed a signal back into the antenna.

175. Par. 6-12. Power Consumption. The Type CGR-31 receiver is designed to operate from a total "B" battery supply of 135 volts and an "A" battery supply of 6 volts. The current drain from these sources are as follows:

Total filament current - 0.770 amps. at 5.95 volts
Total plate current - 11.6 milliamps. at 135 volts
Total screen current - 1.8 milliamps. at 68 volts

These values are within the limits of this specification.

176. Par. 6-12. "C" Battery. A 6-volt "C" battery is required to supply bias to the a.f. amplifier tubes. This specification prohibits the use of such a battery.

177. Par. 6-14. Power Supply. Plate potentials are obtained from the maximum "B" supply voltage, while an intermediate tap is required for the screen potentials of the r.f. tubes.

178. Par. 6-15, 6-16. These specifications do not apply to the subject receiver.

179. Par. 6-17. Regenerative Action. The regeneration control furnished with the subject receiver was defective to such an extent that it was impossible to obtain smooth control of regenerative action. The Clarostat regeneration control substituted for the original control, and having the same overall resistance as the original one, effected a smooth and noiseless control of regeneration. It also permitted the entering and leaving of the oscillating condition at any specific frequency without clicks or squeals at points embracing less than 2% of the complete range of the regeneration control and measured on the control.

180. Par. 6-18. Time Constants. The time required for the receiver to return to normal sensitivity after an impact of 5.0 volts was found to be .01 second. This complies with the specifications, reference (b).

181. Par. 6-19. Radio Frequency Harmonic Interference - Multiplex Operation. For this test the Type CGR-31 receiver was operated adjacent to the Laboratory receiver. Both receivers were operated from the same "B" supply, but from their own respective "A" supplies owing to the fact that the ground connections to these supplies were at opposite polarities. The results of this test are tabulated in Table 11. The data given in this table is self-explanatory and no further comment need be given other than the statement of the fact that this receiver is not free from radio frequency harmonic interaction. Similar data is given in Table 11 for the approved models of the Class IA and IIA receivers. It is evident from this data that the latter receivers are practically free from this sort of interaction.

182. Par. 6-20. Audio Cross Talk. With the Type CGR-31 receiver operating adjacent to the Laboratory receiver, their inputs connected in parallel across a standard dummy antenna, both operating from their own respective battery supply and both operating with STANDARD OSCILLATIONS, at OPTIMUM GAIN, there was no evidence of any audio cross talk when the former receiver was tuned to 550 kcs. and the latter tuned to 1100 kcs., and an input signal applied to one receiver of such value as to produce a maximum output signal from the other.

183. Par. 6-21. Humidity Test. Owing to the lack of adequate facilities for making humidity tests, this test was omitted for the subject receiver.

184. Par. 6-22, 6-23. Immersion Test on Component Parts. No sample component parts were submitted for these tests. It is believed, however, that the component parts used in the subject receivers, particularly the a.f. transformers, r.f. chokes, and paper dielectric condensers would not, owing to their construction, withstand such severe tests as prescribed by these specifications.

185. Par. 6-24. Frequency Overlap. The frequency overlaps between bands of the Type CGR-31 receiver and of the approved model of the Class IA receiver are as indicated in Table 1. Both receivers comply with this specification.

186. Par. 6-25. Accuracy of Resettability. The subject receiver more than complies with the requirements of this specification, although not by such a wide margin as does the approved model of the Class IA receiver as demonstrated by the data given in Table 2.

187. Par. 6-26, 6-27. These specifications do not apply to the subject equipment.

188. Par. 6-28. Output Impedance. The output circuit of the Type CGR-31 receiver is designed for operation into a pair of 22,000 ohms (at 1,000 cycles) telephone receivers. The optimum output load for maximum output is 4000 ohms, as shown by the curve on Plate 28. The specification requirement is 600 ohms at 1,000 cycles. Plate 31A shows a curve similar to that on Plate 28 for the approved model of the Class IA receiver.

189. Par. 6-29. Isolation of DC Potential and Balance of Output Transformer. This specification is not entirely met by the output transformer in the Type CGR-31 receiver. The output transformer has two windings, the primary of which isolates all d.c. potentials from the telephone cords. It is claimed in the instruction book that the two windings are shielded from one another, but no indication is given in the schematic diagram, Plate 30, that such is the case. Moreover, the secondary is not balanced and one side is permanently connected to ground.

190. Par. 6-30. The Type CGR-31 receiver is not considered as being generally capable of rendering continuous service without serious deterioration or damage to integral parts under conditions of humid salt atmospheres. The battery cable is not satisfactory, as demonstrated by the repairs which had been made in it during its use in service. The sensitivity control and regeneration control also failed after such service as they may have had. The wiper contacts in the variable ganged tuning condenser are of poor design. Under these conditions, creepage between terminals and the damaging effects of corrosion may be expected for all a.f. transformers, r.f. inductances, and paper dielectric condensers. The type of band switches employed have been known to give trouble in service.

191. Par. 6-31. This specification does not apply to the subject equipment.

192. Par. 6-32 to 6-37 inclusive. Frequency Stability. Tables 4 to 8 inclusive contain data obtained from tests made in accordance with these specifications for the Type CGR-31 receiver. Comparative data are also given in Tables 4 to 7 inclusive for the approved model of the Class IA receiver. Comments on the results of these tests are as follows:

(a) Table 4. The variation in the frequency of the oscillator as the result of changing the regeneration control from OPTIMUM to STANDARD oscillations with the receiver adjusted for STANDARD OUTPUT prior to the test is well within the limits of these specifications. The stability of the oscillator of the subject receiver at any frequency is better than for the Class IA receiver at the corresponding frequency.

(b) Table 5. The change in the frequency of the oscillator of the Type CGR-31 receiver as the result of changing the setting of the panel operated trimmer condenser exceeds the specification limits by several times.

(c) Table 6. The comments given under "A" above apply for the frequency stability of the subject receiver under conditions of change in intput signal intensity.

(d) Table 7. The change in frequency of the oscillator with changes in the setting of the sensitivity control exceeds the limits of these specifications by several times.

(e) Table 8. Cutting the audio filter in or out affects the oscillator frequency but slightly.

(f) Under conditions of vibration at the rate of 2,000 cycles per minute the main tuning dial shifts from its original setting for this test by several degrees so that the applied input signal is completely lost.

193. Par. 6-38 to 6-43, inclusive. Audio Filter. No band-pass filter is provided with the Type CGR-31 receiver. However, a switch is provided on the front panel of the receiver and is arranged to connect two tuning capacitors one across the primary of each of the two a.f. transformers to provide high frequency filtering. The attenuation in the overall audio frequency response of the amplifier contributed by this tuning filter is shown on Plates 26 and 27 for 6 and 125 milliwatt levels respectively.

194. Plate 24 shows the audio frequency characteristics of the audio system with the "audio tuning" in and out with the input adjusted for a 6 MW ouput at 1,000 cycles. The algebraic difference between these two curves is the curve shown on Plate 26. Similarly, Plate 25 shows the audio frequency characteristics of the audio system with the "audio tuning" in and out with the input adjusted for 125 MW output at 1,000 cycles. The algebraic difference between these two curves is the curve shown on Plate 27.

195. Attention is invited to the fact that the voltage gain of the audio amplifier without "audio tuning" at 1,000 cycles is not the same for the two similar curves shown on Plates 24 and 25, being 775 for a 6 MW output level and 108 for the 125 MW output level. There is a dissimilarity between the two curves shown for the audio amplifier above. Also, the curve at 6 MW output with audio tuning in is sharper than the one for 125 MW output. An examination of Plate 23 will clarify these discrepancies, for it will be noted that the 125 MW level is well past the knee of the overload curve of the audio system. Therefore, the voltage gain at 1,000 cycles will not be as great for a 125 MW level as for a 6 MW level. For all other frequencies where the output is greater than 50 milliwatts, the overload characteristic will determine the relative attenuation of the a.f. characteristic of the audio system, at those frequencies, with respect to the gain at 1000 cycles since this frequency is taken as the reference frequency. Audio frequency characteristics of the audio amplifier of the approved model of the Class IA receiver with and without the low pass filter and variable audio attenuators are shown on Plate 28A for an output level of 6 MW at 1,000 cycles without any filters. The attenuation characteristic of the low pass filter is shown on Plate 29A. Overload characteristics of the amplifier with and without AVC are shown on Plate 24A. These curves are included in this report for comparative purposes.

196. Par. 6-44 to 6-52, inclusive. These specifications do not apply to the subject receiver, since the receiver is not provided with variable frequency audio filters.

197. Par. 6-53. Manual Volume Control. A manually operated volume control, referred to throughout this report as the sensitivity control, was furnished with the Type CGR-31 receiver and is operable from the front panel. As previously mentioned, this control failed during tests and was replaced by one of Clarostat manufacture. However, the following tests were made using the original sensitivity control, and the comments made relative to the succeeding paragraphs apply to that control.

198. Par. 6-54. Curves showing the range and linearity of the sensitivity control as measured at the overlap frequencies of the three bands of the Type CGR-31 receiver are shown on Plates 17, 18, and 19. Other important data are given in Table 9. For the curves shown, zero level represents STANDARD OUTPUT. Except at 550 kcs., the attenuation provided in the overall gain of the receiver by the sensitivity control is less than the required 100 decibels for an applied CW input of 500,000 microvolts. At those frequencies where the range of the sensitivity control fails to comply with these specifications, it will be noted that the sensitivity control has been retarded only about half of its full range for the maximum attenuation attainable for 500,000 microwatts input. For inputs equal to 100,000 times the sensitivity of the receiver, at any given frequency, there is sufficient range of the sensitivity control to provide 100 decibels of attenuation in the receiver gain at that frequency. To directly comply with the requirements of these specifications, the sensitivity of the receiver should not be less than 3 microvolts at any frequency. The range and linearity of the sensitivity control of the approved model of the Class IA receiver is shown on Plates 18A and 19A for Bands 4 and 6 of that receiver. Other data are given on Table 9.

199. Par. 6-55. Transrectification. For the Type CGR-31 receiver there was no detectable change in the plate current of any radio frequency amplifier tube at any frequency when the CW input was increased from 0 to 500,000 microvolts and with the receiver operating with STANDARD OSCILLATIONS and MINIMUM GAIN.

200. Par. 6-56. Selectivity at Reduced Gain. With the gain of the receiver adjusted to reduce the receiver gain to one-tenth of its optimum value, the selectivity of the receiver at any frequency is essentially the same as for optimum gain conditions at the same frequency. The comments given in Par. 160, however, relative to specification compliance in this regard still apply. Selectivity curves measured at reduced gain are shown on Plates 6, 8 and 10 for Bands 1, 2 and 3 respectively. Corresponding curves for the approved model of the Class IA receiver are not available. Suffice it to say that the selectivity of this receiver at any frequency is the same at reduced gain as for optimum gain.

201. Par. 6-57. Sensitivity Control Characteristics. The sensitivity control of the Type CGR-31 receiver operates in such a manner as to provide linear relationship well within 12 decibels between its angular rotation and the audio output for any constant input up to such a value as to produce maximum output at all but the high frequency ends of each band. At these frequencies and for an input of 250,000 microvolts there is sufficient leakage within the r.f. circuits and not affected by the sensitivity control as to cause a flattening off of the attenuation curves for the lower half of the range of the sensitivity control. Sensitivity control characteristics are shown on Plates 20, 21 and 22. For the curves zero level represents STANDARD OUTPUT. Similar characteristics of the sensitivity control of the approved model of the Class IA receiver are shown on Plates 21A and 22A for Bands 4 and 6 of this receiver for purposes of comparison.

202. Par. 6-58. The sensitivity control of the Type CGR-31 receiver operates in such a manner as to provide a continuous variation in the output for any constant value of input.

203. Par. 6-59. The sensitivity control operates in a manner that the noise level is substantially reduced in direct proportion to the CW signal. This relationship is shown on Plates 14, 15 and 16. Similar curves are shown on Plates 15A and 16A for Bands 4 and 6 of the approved model of the Class IA receiver.

204. Par. 6-60. The sensitivity control operates in a smooth and quiet manner at all frequencies.

205. Par. 6-61. This specification does not apply since no automatic volume control is furnished with this receiver.

206. Par. 6-62. The sensitivity control furnished with this receiver is not of wire wound construction, but has a special carbon type element fused to a vitreous enameled base.

207. Par. 6-64 to 6-69, inclusive. Since the subject receiver is not provided with an automatic volume control, these specifications cannot be applied to this receiver.

208. A summary of the defects noted and such items as do not comply with the requirements of reference (b) which make this equipment inferior to the approved model of the Class IA equipment is as follows:

(a) Par. 1-4. The frequency range is from 90 to 550 kcs. instead of 15 to 600 kcs.

(b) Par. 1-7. The receiver is not considered as possessing a high degree of protection against strong local signals.

(c) Par. 1-10. The receiver is unsuitable for a.c. operation.

(d) Par. 3-1. The maximum undistorted output is only 50 milliwatts instead of 300 milliwatts as prescribed by these specifications.

(e) Par. 3-13. No variable audio tuning is provided. A fixed audio tuning is provided, however, which provides only high frequency filtering, and is in effect a low pass filter.

(f) Par. 3-14. No automatic volume control is provided.

(g) Par. 3-15. The optimum load for maximum output is 4000 ohms instead of 22,000 ohms, as indicated in reference (c), and 600 ohms, as required by reference (b).

(h) Par. 4-3. The die cast aluminum "bath tub" housing for the ganged variable condenser is unsatisfactory in that it is known to "grow". The hard rubber insulators used for supporting the longitudinal tie members for the stator plates are not considered sufficiently stable for the precision required for ganged variable condensers. The suspension provided, and its associated mounting structure, is not sufficiently rugged to withstand severe vibrations. No provision has been made for centering the rotor plates between the stator plates. In the subject receiver, the rotor plates have become dangerously close to the stator plates due to the "growing" action of the die-cast aluminum housing. The wiping contacts are poorly designed, have insufficient tension, and are wholly unsatisfactory for the purpose for which they are intended. The velvet vernier dial used for tuning the main tuning shaft does not provide sufficient lock to assure that the mechanical unbalance of the condenser will not result in a capacity variation under conditions of vibration. The main condenser shaft is of steel and is magnetic. The shaft apparently was plated, but this plating has worn through as the result of the wiping action of the brush contacts.

(i) The anti-capacity switches employed for band switching, while not giving any contact trouble in the receiver under test, have been known to fail in service and are therefore not wholly satisfactory for use in Naval receivers. The mechanical drive associated with these switches is poorly designed for two reasons: The first is that its extreme variations are limited only to the extent

as is contained within the anti-capacity switches themselves, and the second is that there is a possibility for confusion as to the exact center position, as three points are indicated by "feel". The anti-capacity switches are so mounted as to make it practically impossible to make a visual inspection of them to determine their action without extensive disassembly.

(j) All of the r.f. coils are wound with silk insulated Litz wire. The soldered terminal connections are not coated with wax as are the coils, and are therefore subject to corrosion under severe humidity conditions, due to the fact that the fine strands of wire in the coil leads are uninsulated approximately 1/8" from the terminals.

(k) The panel operated vernier air dielectric condenser has but a single bearing and depends upon the knob located on the front of the panel for limitation of thrust motion. If the knob should become loosened or have to be replaced, it is necessary that the shield enclosing the condenser be removed to centralize the rotor plates between the stator plates. Due to the fact that there is no indication on the shaft as to the angular position of the rotor plates with respect to the stator plates, it is entirely possible that the single set screw in the knob might become sufficiently loosened as to destroy the calibration of the condenser with respect to its dial.

(l) The trimmer condensers are of the mica dielectric type mounted on phenolic bases. This type of condenser is not satisfactory because it does not maintain a permanent capacity adjustment under conditions of vibration or severe humidity. No provision has been made in the top of the r.f. compartment shields for adjusting the trimmer condensers within these compartments.

(m) The use of polished chromium-plated surfaces on meter frames, tuning dials and other controls is not satisfactory, particularly as applied to meters and tuning dials due to light reflections which make their reading difficult.

(n) Par. 4-5, 4-6. The use of magnetic steel for the main shaft of the ganged variable tuning condenser and for the wiring clamps is unsatisfactory even though plated. In the former instance, the plating has been worn off and is subject to rusting.

(o) The construction of the paper dielectric condensers does not comply with reference (d) in that they are not entirely metal-clad. The terminal construction on these condensers as well as on the audio transformers is such as not to provide sufficient protection against surface creepage and damage to internal leads or windings from corrosion resulting from the operation of this equipment in humid salt atmosphere. Under such conditions of operation, failure of any or all of these parts may be reasonably expected.

(p) Par. 4-10. The battery cable, as received at the Laboratory, had failed at some time during such usage as it may have had because three of the conductors had been repaired. The regeneration control and sensitivity control, both of which are Electrad Tonatrols, were found to be defective after such service as they may have had.

(q) Par. 4-18. The trimmer condensers employed are not of the air dielectric type as required by these specifications.

(r) Par. 4-19. Ceramic insulation or its equivalent has not been employed as directed by the specifications.

(s) Par. 4-20. No calibrated vernier dial is employed for the main tuning control as required by the specification.

(t) Par. 4-23. The wiring job is only fair. Poor contact was found in the case of a few soldered connections prior to tests. The wire used for some of the leads employs a composition insulating material under a cotton braid outer coating. This composition insulating material has become solidified and brittle due to aging. The use of cotton braid covered leads for r.f. circuits is unsatisfactory, even though they be varnish impregnated. It has never been satisfactorily demonstrated that treated cotton braid insulation is as good as rubber insulation for use in such circuits.

(u) Par. 5-10. The length of the five-conductor shielded battery cable does not comply with the specifications.

(v) Par. 5-13. The use of a polished plating on the handles on the front operating panel is not considered desirable.

(w) Par. 5-14. The number 8-32 oval head chromium-plated screws used for securing the front operating panel to the cabinet are not satisfactory because they require the use of a screw driver for their removal and also because they do not remain with the panel when loosened so as to obviate their loss.

(x) Par. 5-16. No graduated scales are provided for the regeneration or sensitivity controls. The lack of such scales makes it difficult for an operator to reset the controls to any predetermined calibration. Exception is taken to the labeling of the sensitivity control, which should be labeled "SENSITIVITY" instead of "VOLUME".

(y) Par. 5-19. The receiver is extremely microphonic due to the type of tubes employed. An attempt has been made to remedy this defect by using "Benjamin" cushioned sockets, which are not sufficiently effective to eliminate microphonics under any degree of chassis vibration.

Par. 5-20 to 5-22, inclusive. The type of switches used for band changing does not comply with these specifications.

(z) Par. 5-23. The marking of the main tuning dial does not comply with this specification. The dial is divided into 150 equal divisions marked 0 to 150 from left to right, around the lower half of its circumference. The upper half of its circumference is provided with three scales corresponding with the three positions of the band changing switch and is calibrated at two or more intervening frequencies for each band. The scale of the panel operated vernier condenser is marked on a 10-0-10 basis instead of a 0 to 10 basis as required by the specifications.

(aa) Par. 5-24. The rotation of the main tuning dial is such that a counterclockwise rotation causes the graduations to increase numerically, with increase in the final effect, while a clockwise rotation causes the calibration of the three auxiliary scales to increase numerically with increase in frequency. The dial therefore does not comply with the specification, since the 1 to 150 scale is the more important scale from the standpoint of receiver calibration for complete coverage of its frequency range.

(bb) Par. 5-25. Owing to the polished chromium-plated surfaces on the main tuning control dial, or on the dial of the vernier condenser, these dials are difficult to read with any point source of lighting other than at a perpendicular to the dials because of light reflections.

(cc) Par. 5-27. The main tuning control has a vernier ratio of approximately 5 to 1 instead of 6 to 1, as quoted in reference (c). This ratio is not in compliance with the specifications.

(dd) Par. 5-28, 5-29. The vernier of the main tuning control is not gear-driven, as required by this specification.

(ee) Par. 5-33. The panel operated trimmer condenser is provided with a "zero center" scale instead of "zero left" scale, as is prescribed in this specification.

(ff) Par. 5-36. The component parts in the separately shielded r.f. compartments are accessible for replacement or repair only after the removal of the coil systems. This is not considered as a serious defect, however, since the coil systems are easily removable.

(gg) Par.5-37. No "oscillation test" devices are employed, as required by these specifications.

(hh) Par.5-39. The receiver is provided with an output transformer claimed in reference (c) to be shielded. However, no indication is given in the schematic diagram, Plate 30, that this shielding is electrostatic, and it can only be assumed, therefore, that the shielding is only of magnetic nature. The open circuit telephone jack mounted on the front operating panel and to which the secondary winding of the transformer is mounted is of Yaxley manufacture. It is of the "short type", is not interchangeable with the Navy standard telephone jack, and hence does not comply with reference (h).

(ii) Par.5-44. The 2-1/2-inch flush mounted voltmeter is not of the AC-DC type, as required by this specification.

(jj) Par.5-45 to 5-47, inclusive. No output level indicating instrument is furnished with this receiver, as required in these specifications.

(kk) Par.5-49. Plate potential is applied at all times. This is not desirable from the standpoint of safety.

(ll) Par.6-1. The sensitivity of any frequency is poorer than that required by this specification. The average sensitivity for any band, when using the replacement sensitivity control which offered a very appreciable improvement in receiver sensitivity over that obtained with the original sensitivity control, was on the average 4.5 to 1 poorer than the average sensitivity for corresponding bands of the approved model of the Class IA receiver. Also, in order to obtain optimum receiver sensitivity, it was necessary to retrim the r.f. circuits prior to tests.

(mm) Par.6-2. The selectivity at any frequency is considerably outside of the limits of this specification and is poorer than that of the approved model of the Class IA receiver.

(nn) Par.6-4. At all frequencies complete detector blocking occurs within approximately one and a half order greater than that required for resonant overload. Because of the type of tubes employed, resonant overload obviously occurs at a much lower level than the specified minimum value as set forth in this specification.

(oo) Par.6-12. A "C" battery is required to supply bias to the a.f. amplifier tubes in violation with this specification.

(pp) Par.6-17. The original regeneration control was defective to the extent that its operation was noisy and it was impossible to obtain smooth control of regenerative action.

(qq) Par.6-19. The Type CGR-31 receiver does not comply with this specification, as clearly shown in Table 11.

(rr) Par.6-22, 6-23. The construction of the paper dielectric by-pass condensers, r.f. chokes, and a.f. transformers is such that it is reasonable to assume that they would not withstand tests as severe as these specifications prescribe. This assumption is based upon past experience with component parts of similar construction.

(ss) Par.6-28. The optimum load impedance for maximum output is 4000 ohms instead of 22,000 ohms, as stated in reference (c). This specification requirement is 600 ohms for Class IA receiver.

(tt) Par.6-29. The secondary winding of the output transformer is not electro-magnetically balanced. One side of this winding is permanently connected to ground potential.

(uu) Par.6-30. The receiver is not considered as being capable of rendering continuous service without serious deterioration or damage to most of the integral parts when operated under conditions of humid, salt atmosphere.

(vv) Par.6-32 to 6-37. The specification limits for the frequency stability of the oscillator are exceeded under the following conditions:

(a) Change in setting of panel operated trimmer condenser from minus 10 to plus 10 settings.

(b) Change in sensitivity control from maximum down to such point when the signal becomes just audible, under conditions of standard oscillations and an impressed signal of such value as to produce maximum output at full gain.

(c) Vibration, due to the type of tuning drive employed which does not provide sufficient lock to maintain a fixed adjustment under conditions of vibration.

(ww) Par.6-38 to 6-52, inclusive. "Audio tuning" provides only high frequency attenuation, resulting in a somewhat peaked audio frequency characteristic. These specifications require a permanently connected band-pass filter and a variable frequency audio attenuator capable of being adjusted to accept any frequency from 450 to 1300 c.p.s. this attenuator to be so arranged that it may be cut in or out of the circuit at will.

(xx) Par.6-53. The sensitivity control failed during test.

(yy) Par.6-62. The sensitivity control is not of wire wound construction as required in this specification.

(zz) Par.6-63,6-64. No automatic volume control is provided in this receiver.

CONCLUSIONS

209. The Type CGR-31 receiving equipment is, in its present form, unsuitable for satisfactory operation in the Naval Service.

210. In the important features in mechanical construction, when viewed in the light of present-day knowledge of Navy receiver design, the receiver is without merit. The design of the ganged variable tuning condenser is poor, for the separate tuning condensers are housed in a common die cast aluminum housing which showed evidence of "growing action" -- a characteristic common with this type of housing -- which resulted in a non-uniformity of the spacing between the rotor and stator plates; the longitudinal tie members for the stator plates are secured to hard rubber insulating strips which are not satisfactory for the degree of precision expected for ganged tuning condensers. No provision is made for adjusting the spacing between the rotor and stator plates. The steel drive shaft possesses magnetic properties and was inadequately plated to withstand the wiping action of the wiper contacts; the wiper contacts were without sufficient tension and were improperly designed for the service for which they were intended. The three-point suspension mounting, together with the lack of provision for balancing the rotors of the separate condensers, does not provide permanent adjustment of the condenser setting under conditions of severe vibrations. The so-called anti-capacity switches employed for band switching have been known to give trouble while in service, and are so mounted that visual inspection of them is not possible without the removal of the coil systems. The link and bar mechanism for operating the anti-capacity switches in tandem from a single control is unsatisfactory owing to the strain it places in its extreme positions upon the anti-capacity switches themselves, and to the uncertainty involved in determining the correct position for any setting of the switches by "feel". The universal use of phenolic insulation is not satisfactory for all circuits. The type of wire insulation used is of poor quality, some of the wires having under the outer cotton braid coating a composition insulating material which became hard and brittle due to aging. The construction of the r.f. coils, paper dielectric by-pass condensers, r.f. transformers, trimmer condensers, and a.f. transformers is such that they will not be trouble-free and may fail entirely when the receiver is operated in humid, salt atmospheres. The battery cable, sensitivity control, and regeneraion control failed while in service.

211. The electrical performance characteristics of this receiver are decidedly inferior to similar characteristics of the approved model of the Class IA receiving equipment. It covers a much narrower frequency range, and its operation is limited to battery power supplies. Sensitivity and selectivity are much poorer and, of course, resonant overload output is at a much lower level. No AVC is provided and audio tuning is limited to a fixed frequency of approximately 800 cycles. The frequency stability of the oscillator under conditions of changes in control settings is extremely poor.

TABLE 1.

Frequency Overlap - Type CGR-31 Receiver.

Band	Freq.Range Kcs.	Overlap Bands	Overlap Freq. Kcs.	% Overlap
1	85.7 to 169.8			4.77*
		1 and 2	165	6.84
2	158.5 to 320.0			
		2 and 3	300	13.00
3	281.0 to 573.0			4.18**

* Percent Overlap from 85.7 to 90 kcs.
** Percent Overlap from 550 to 573 kcs.

Frequency Overlap - Class IA Receiver.

Band	Freq.Range Kcs.	Overlap Bands	Overlap Freq.Kcs.	% Overlap
4	75.50 to 159.50			2.58*
		4 and 5	153	7.40
5	148.00 to 319.50			
		5 and 6	307	6.90
6	298.20 to 627.00			4.50**

*Percent Overlap from 75.50 to 77.50 kcs.
**Percent Overlap from 600 to 627 kcs.

TABLE 2.

Accuracy of Resettability.

Type CGR-31 Receiver			Class IA Receiver		
Band	Freq. Kcs.	Change in Output upon reset - decibels*	Band	Freq. Kcs.	Change in Output upon reset - decibe
1	90	0.59	4	77.5	0.12
1	165	0.83	4	153.0	0.22
2	165	0.90	5	153.0	0.00
2	300	4.30	5	307.0	0.00
3	300	2.10	6	307.0	0.46
3	550	4.10	6	600.0	1.77

*Specification Limit - 20 decibels.

TABLE 3.

Resonant Overload, Type CGR-31 Receiver
With Original Sensitivity Control.

Band	Freq. Kcs.	Microvolts Input for Resonant Overload	Output at Resonant Overload milliwatts*
1	90	125.0	59.2
1	165	18.0	28.6
2	165	140.0	51.2
2	300	39.0	34.8
3	300	65.0	39.5
3	550	16.0	60.5

Resonant Overload, Type CGR-31 Receiver
With Replacement Sensitivity Control.

Band	Freq. Kcs.	Microvolts Input for Resonant Overload	Output at Resonant Overload milliwatts*
1	90	33.0	30.8
1	165	20.0	28.6
2	165	45.0	58.5
2	300	16.5	34.8
3	300	32.0	39.5
3	550	16.0	60.5

Resonant Overload, Class IA Receiver

Band	Freq. Kcs.	Microvolts Input for Resonant Overload	Output at Resonant Overload milliwatts*
4	77.5	35.0	375
4	153.0	15.0	375
6	307.0	30.0	312
6	600.0	17.0	375

*Specification Limit - 300 milliwatts

TABLE 4.

Frequency Stability vs. Change in Regeneration from Optimum to Standard Oscillations.

Type CGR-31 Receiver			Class IA Receiver		
Band	Freq. Kcs.	Change in Oscillator Freq. - Cycles*	Band	Freq. Kcs.	Change in Oscillator Freq. - Cycles*
1	90	+ 5.0	4	153	115.5
1	165	+27.0	5	307	182.0
2	165	+13.0	6	600	248.0
2	300	+51.0			
3	300	+ 9.0			
3	550	+54.0			

*Specification Limit - 100 cycles.

TABLE 5.

Frequency Stability vs. Change in Trimmer Capacitor Setting.

Type CGR-31 Receiver					Class IA Receiver			
		Change in Oscillator Freq*					Maximum Change in Oscillator Freq.*	
Band	Freq. Kcs.	-10 Setting	0 Setting	+10 Setting	Band	Freq. Kcs.	Ant.Trim.	R.F.Trim.
1	90	493 cycles	0	778 cycles	3	77.5	2 cycles	4 cycles
1	165	972 "	0	4500 "	4	153.0	1 "	1 "
2	165	800 "	0	1515 "	5	307.0	0%	0.0015%
2	300	1.16%	0	3%	6	600.0	0.00017%	0.00432%
3	300	0.495%	0	0.313%				
3	550	1.27%	0	3.27%				

*Specification Limits - 90 to 200 kcs. - 100 cycles
200 to 550 kcs. - 0.05%

TABLE 6.

Frequency Stability vs. Change in Input Signal Intensity.

Type CGR-31 Receiver			Class IA Receiver		
Band	Freq. Kcs.	Change in Oscillator Freq.-Cycles*	Band	Freq. Kcs.	Change in Oscillator Freq.-Cycles*
1	90	15.5	3	77.5	1.0
1	165	36.4	4	153.0	1.5
2	165	14.0	5	307.0	0.0
2	300	69.0	6	600.0	3.0
3	300	66.0			
3	550	45.0			

*Specifications Limit - 100 cycles.

TABLE 7.

Frequency Stability vs. Change in Sensitivity Control Setting.

Type CGR-31 Receiver			Class IA Receiver		
Band	Freq. Kcs.	Change in Oscillator Frequency *	Band	Freq. Kcs.	Change in Oscillator Frequency *
1	90	223 cycles	3	77.5	9.5 cycles
1	165	852 "	4	153.0	6.0 "
2	165	240 "	5	307.0	0.00766%
2	300	0.352%	6	600.0	0.0208%
3	300	0.085%			
3	550	0.020%			

*Specification Limits - 77.5 to 200 kcs. - 100 cycles
200 to 600 kcs. - 0.05%

TABLE 8.

Frequency Stability With Audio Filter "Off and On" - Type CGR-31 Receiver.

Band	Kcs.	Change in Oscillator Frequency - Cycles
1	90	0
1	165	1.0
2	165	0.5
2	300	1.0
3	300	1.5
3	550	5.0

TABLE 9.

Range of Original Sensitivity Control
Type CGR-31 Receiver.

Band	Freq.Kcs.	Microvolts Input Range	Sensitivity Control Range - Degrees	Attenuation Range - Decibels*
1	90	37.8 to 500,000	300 to 158	0 to -82.4
1	165	7.3 to 500,000	300 to 135	+0.98 to -95.7
2	165	55.0 to 500,000	300 to 155	0 to -79.2
2	300	19.7 to 500,000	300 to 140	0 to -88.1
3	300	33.9 to 500,000	300 to 148	0 to -83.4
3	550	5.2 to 500,000	300 to 90	0 to -99.7
		Range of Sensitivity Control - Class IA Receiver		
4	77.5	3.3 to 500,000	257 to 70	0 to -103.92
4	153.0	1.22 to 500,000	245 to 37	0 to -112.27
6	307.0	2.68 to 500,000	254 to 69	0 to -105.44
6	600.0	1.37 to 500,000	248 to 69	0 to -111.25

*Specification Limit - 100 decibels.

TABLE 10.

Input Impedance - Type CGR-31 Receiver.

Band	Freq.Kcs.	Input Impedance - Ohms
1	90	35,000
1	165	20,000
2	165	25,000
2	300	17,000
3	300	12,000
3	550	6,700

TABLE 11.

Multiplex Operation - Type CGR-31 and Laboratory Receivers.

(a) Interfering Receiver				(b) Receiver Listened On				Increase in Output of (b) Due to (a)
Receiver	Freq.Kc.	Regeneration	Gain	Receiver	Freq.Kc.	Regeneration	Gain	
CGR-31	550	Standard	Optimum	Lab.	550	Standard	Maximum	0.20 volt
"	550	Maximum	"	"	550	"	"	2.75 volts
"	550	Standard	"	"	1100	"	"	0.15 volt
"	550	Maximum	"	"	1100	"	"	1.80 volts
"	550	Standard	"	"	1650	"	"	Not Measurable
"	550	Maximum	"	"	1650	"	"	Not Measurable

Multiplex Operation - Class IA and IIA Receivers.

IA	600	Standard	Optimum	IIA	600	Standard	Optimum	Not Measurable
"	600	"	"	"	600	"	Maximum	Not Measurable
"	600	Maximum	"	"	600	"	Optimum	0.10 MW above noise
"	600	"	"	"	600	"	Maximum	17.2 " " "
IIA	300	Standard	"	IA	600	"	Optimum	0
"	300	Maximum	"	"	600	"	"	0
"	300	"	Maximum	"	600	Maximum	Maximum	0

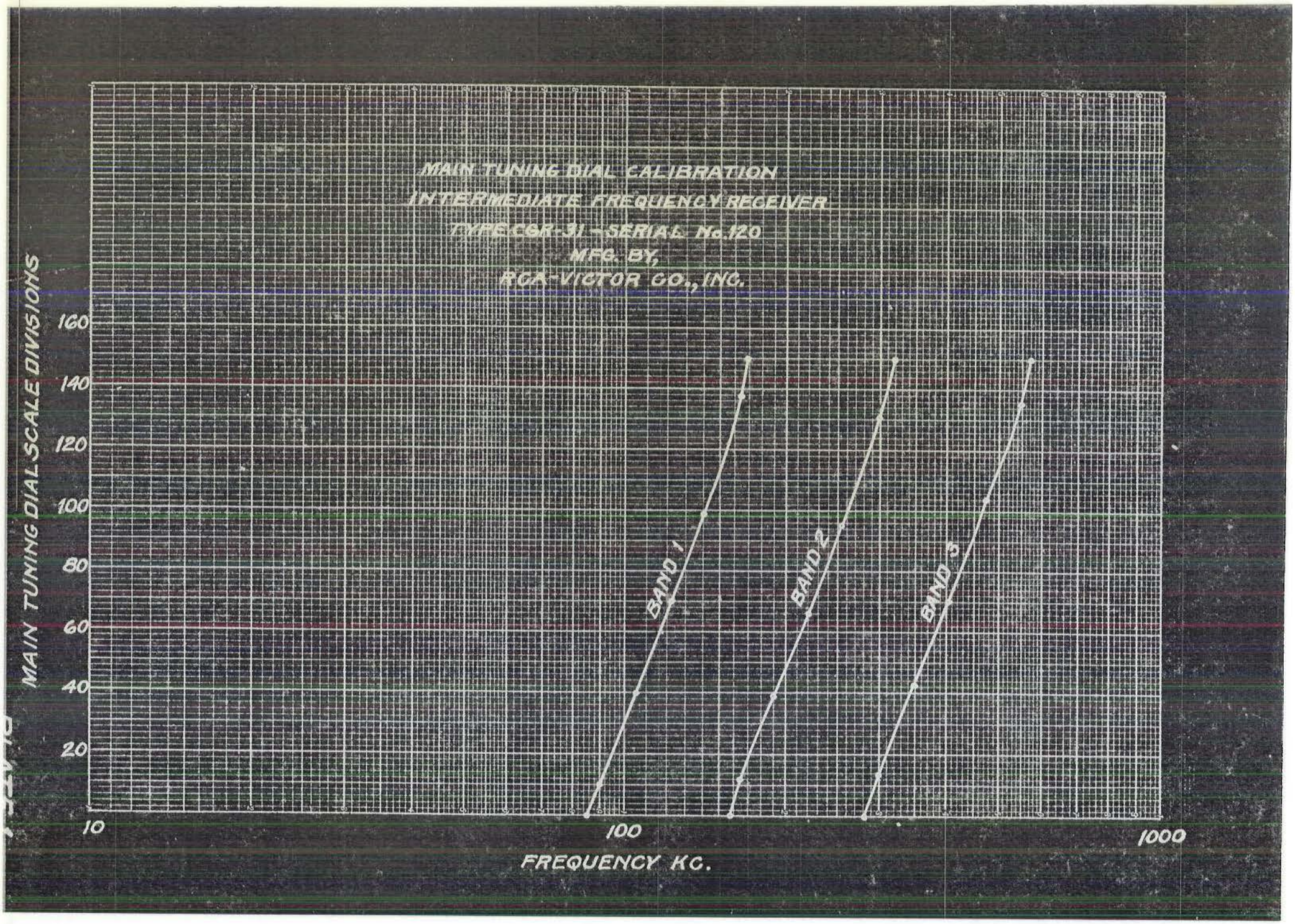
The procedure was repeated with the Class IA receiver as (a) tuned to 600 kc. and the Class IIA as (b) tuned to the first harmonic, or 1200 kc. No response could be detected from the Class IIA due to the Class IA under any of the conditions specified.

The procedure of the preceding paragraph was repeated, leaving the Class IA receiver at 600 kc. and tuning the Class IIA to the higher harmonics: 1800, 2400, 3000 and 3600 kc. In no case was any response detected from the Class IIA due to the Class IA.

TABLE 12.

Temperature Test - Type CGR-31 Receiver.

Temp. °C	Microvolts Input Before Reset	After Reset	Change in Freq.-Cycles	Comments
28.2	5.7	-	0	Initial measurement at room temperature.
0	41.8	6.2	+3205	Measurement made after 2-hour operation of receiver at 0°C.
44.5	131	5.8	-4862	Measurement made after all night run to allow receiver and temperature control cabinet to arrive at a constant temperature.
29	20	5.2	+2.325	Final measurement at room temperature after 6-hour lapse of time to allow receiver to cool to room temperature.


MAIN TUNING DIAL CALIBRATION
INTERMEDIATE FREQUENCY RECEIVER
TYPE COR-31 — SERIAL No. 120
MFG. BY,
RCA-VICTOR CO., INC.
MAIN TUNING DIAL SCALE DIVISIONS
160
140
120
100
80
60
40
20
BAND 1
BAND 2
BAND 3
10
100
1000
FREQUENCY KC.

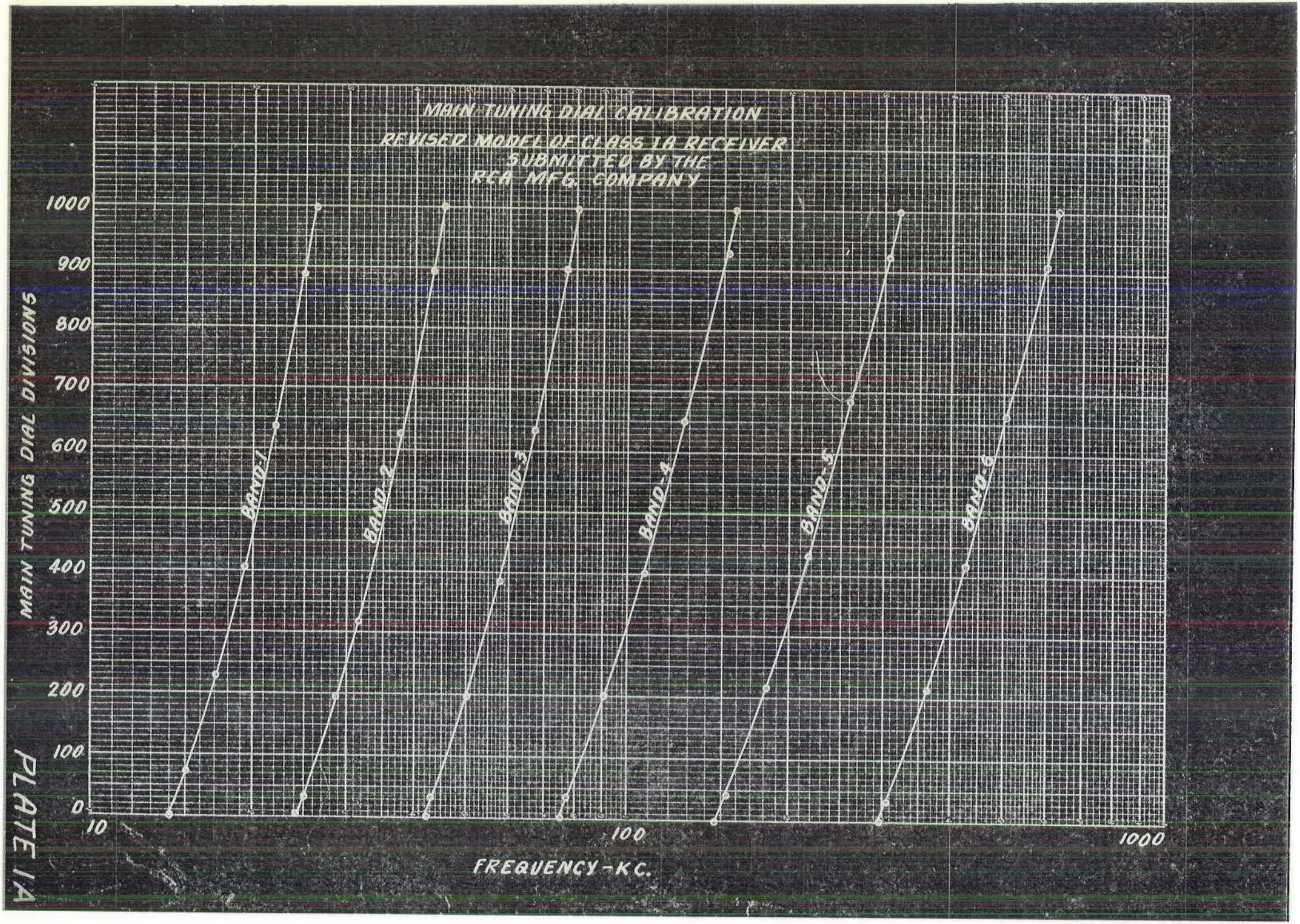

MAIN TUNING DIAL CALIBRATION
REVISED MODEL OF CLASS 1A RECEIVER
SUBMITTED BY THE
REA MFG. COMPANY
MAIN TUNING DIAL DIVISIONS
1000
900
800
700
600
500
400
300
200
100
0
10
100
1000
FREQUENCY - K.C.
BAND-1
BAND-2
BAND-3
BAND-4
BAND-5
BAND-6

PLATE 1A

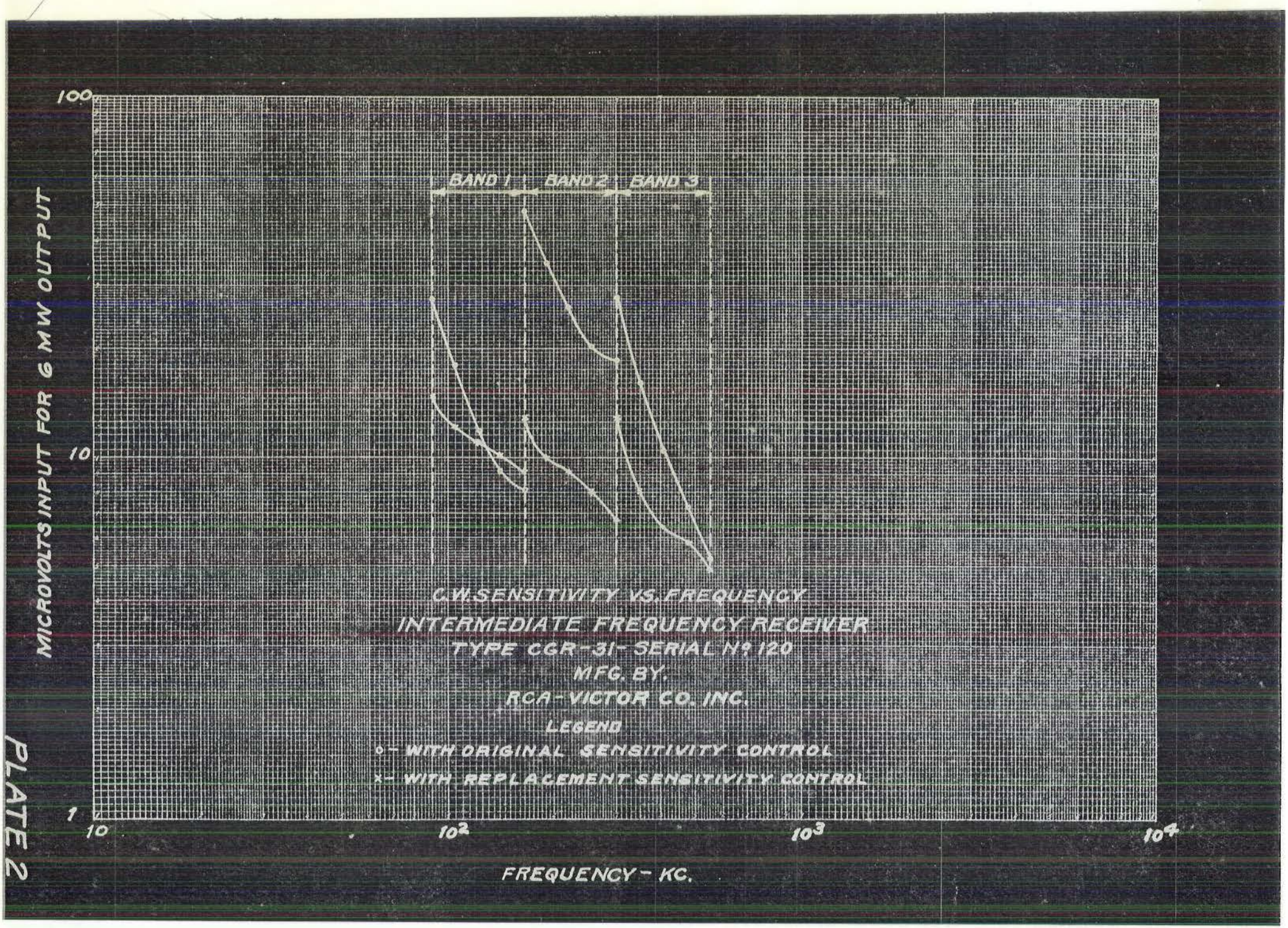
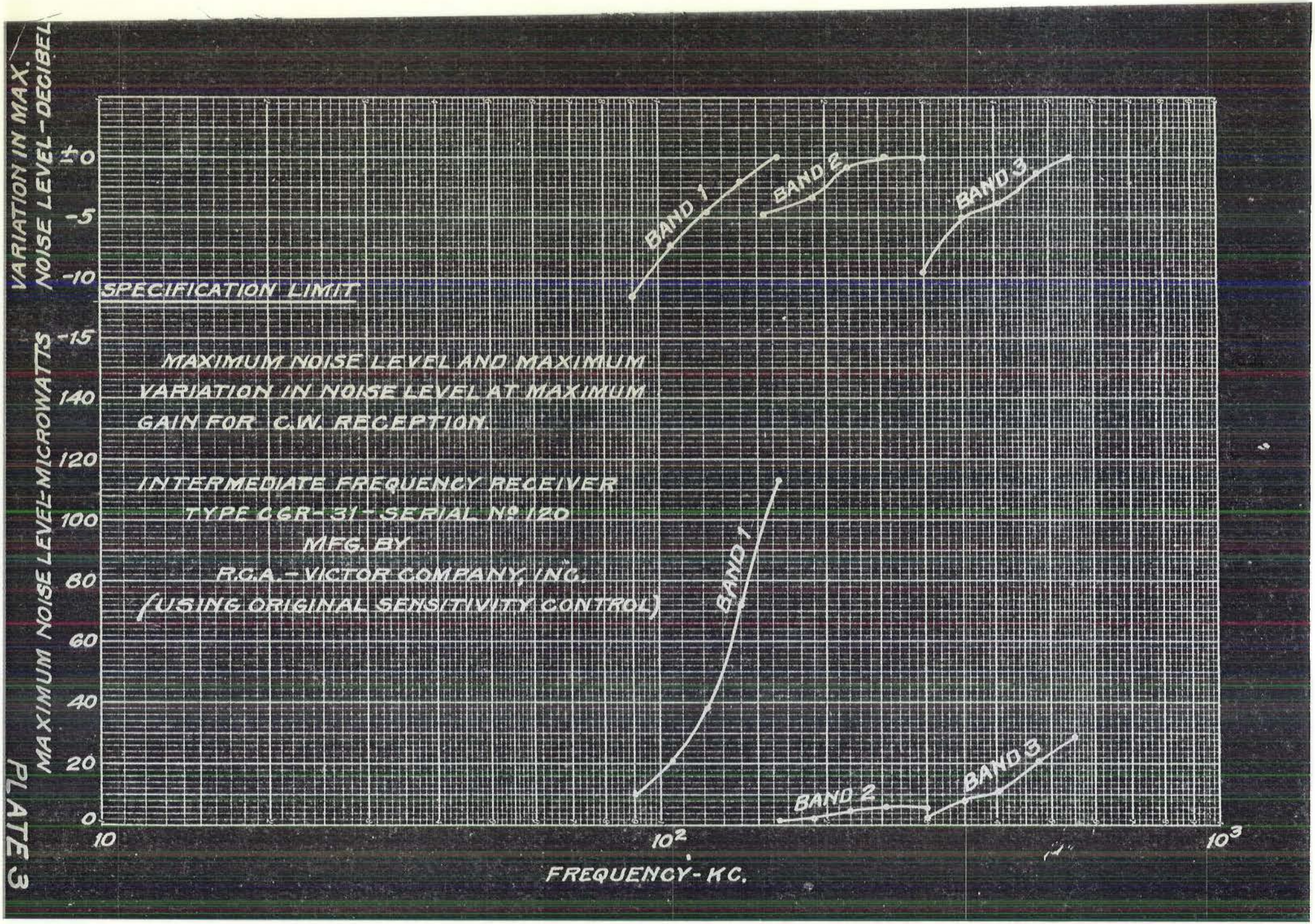
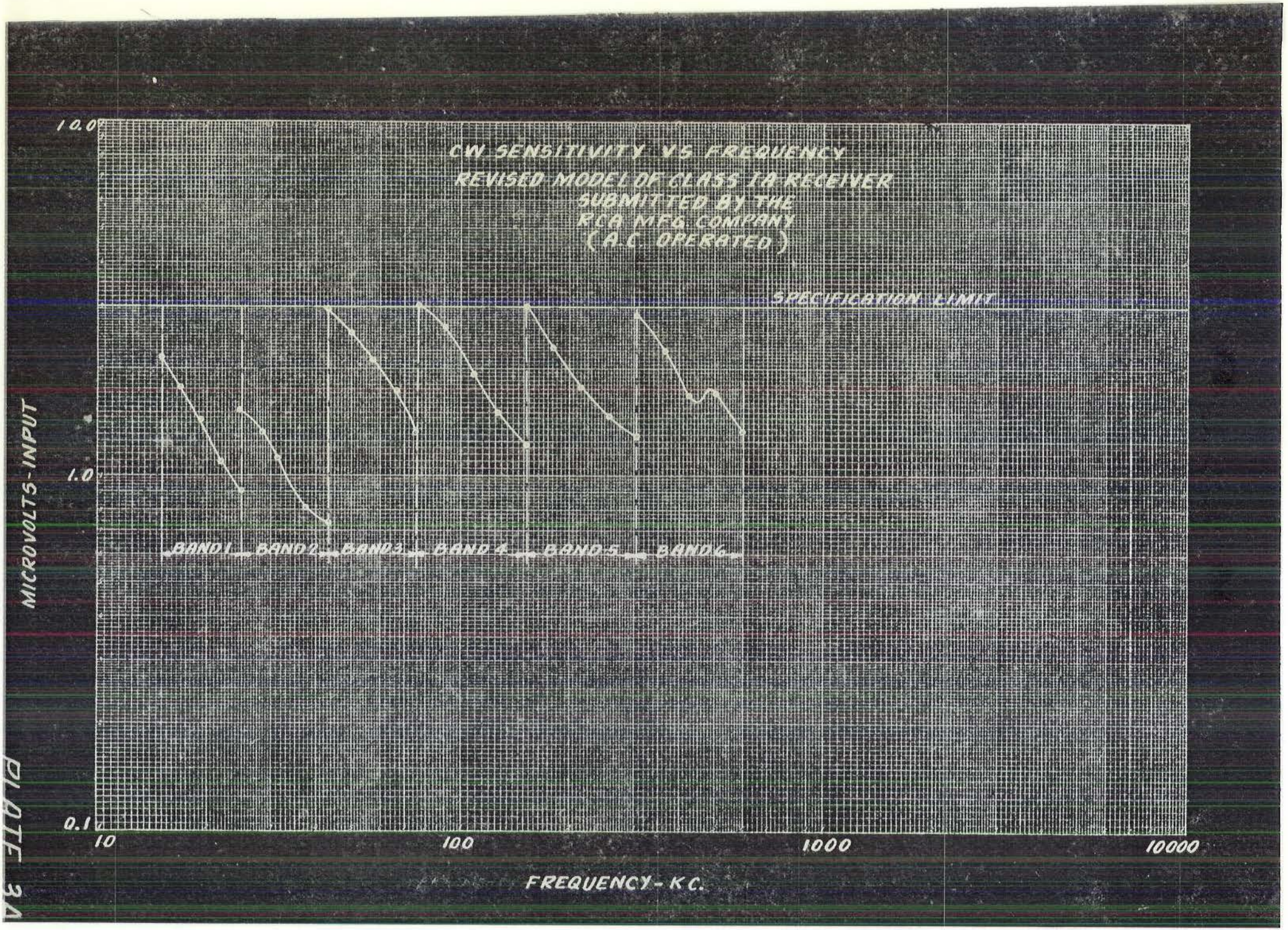

100
10
1
MICROVOLTS INPUT FOR 6 MW OUTPUT
BAND 1
BAND 2
BAND 3
C.W. SENSITIVITY VS. FREQUENCY
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31- SERIAL No. 120
MFG. BY.
RCA-VICTOR CO. INC.
LEGEND
o- WITH ORIGINAL SENSITIVITY CONTROL
x- WITH REPLACEMENT SENSITIVITY CONTROL
10
10^2
10^3
10^4
FREQUENCY - KC.

PLATE 2


VARIATION IN MAX. NOISE LEVEL - DECIBEL
MAXIMUM NOISE LEVEL-MICROWATTS
+0
-5
-10
-15
140
120
100
80
60
40
20
0
SPECIFICATION LIMIT
MAXIMUM NOISE LEVEL AND MAXIMUM VARIATION IN NOISE LEVEL AT MAXIMUM GAIN FOR C.W. RECEPTION.
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31 - SERIAL Nº 120
MFG. BY
R.C.A. - VICTOR COMPANY, INC.
(USING ORIGINAL SENSITIVITY CONTROL)
BAND 1
BAND 2
BAND 3
BAND 1
BAND 2
BAND 3
10
10^2
10^3
FREQUENCY - KC.
PLATE 3


C.W. SENSITIVITY VS. FREQUENCY
REVISED MODEL OF CLASS 1A RECEIVER
SUBMITTED BY THE
R.C.A. M.F.G. COMPANY
(A.C. OPERATED)
SPECIFICATION LIMIT
BAND 1
BAND 2
BAND 3
BAND 4
BAND 5
BAND 6
10.0
1.0
0.1
MICROVOLTS-INPUT
10
100
1000
10000
FREQUENCY - K.C.
PLATE 3A

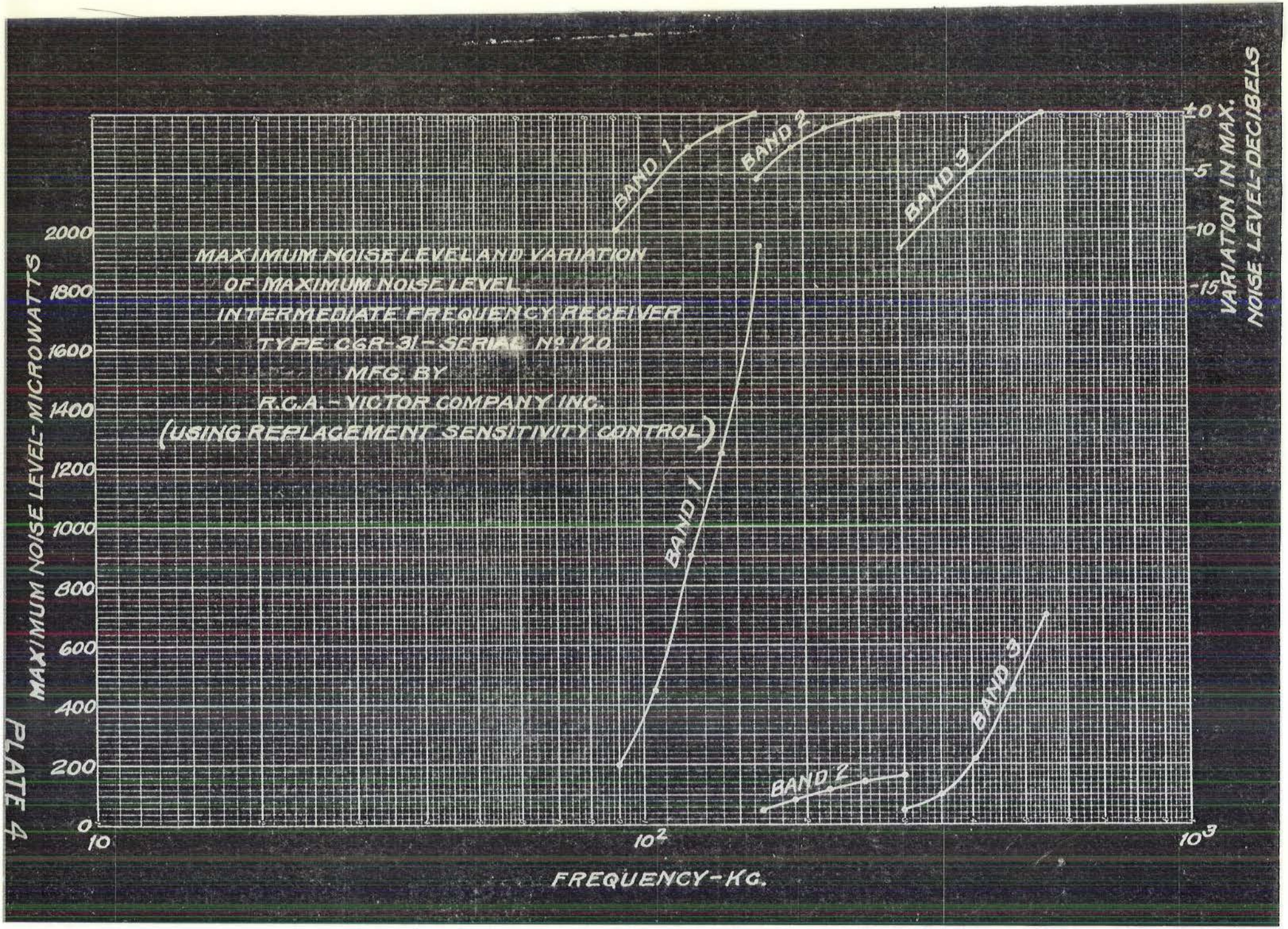
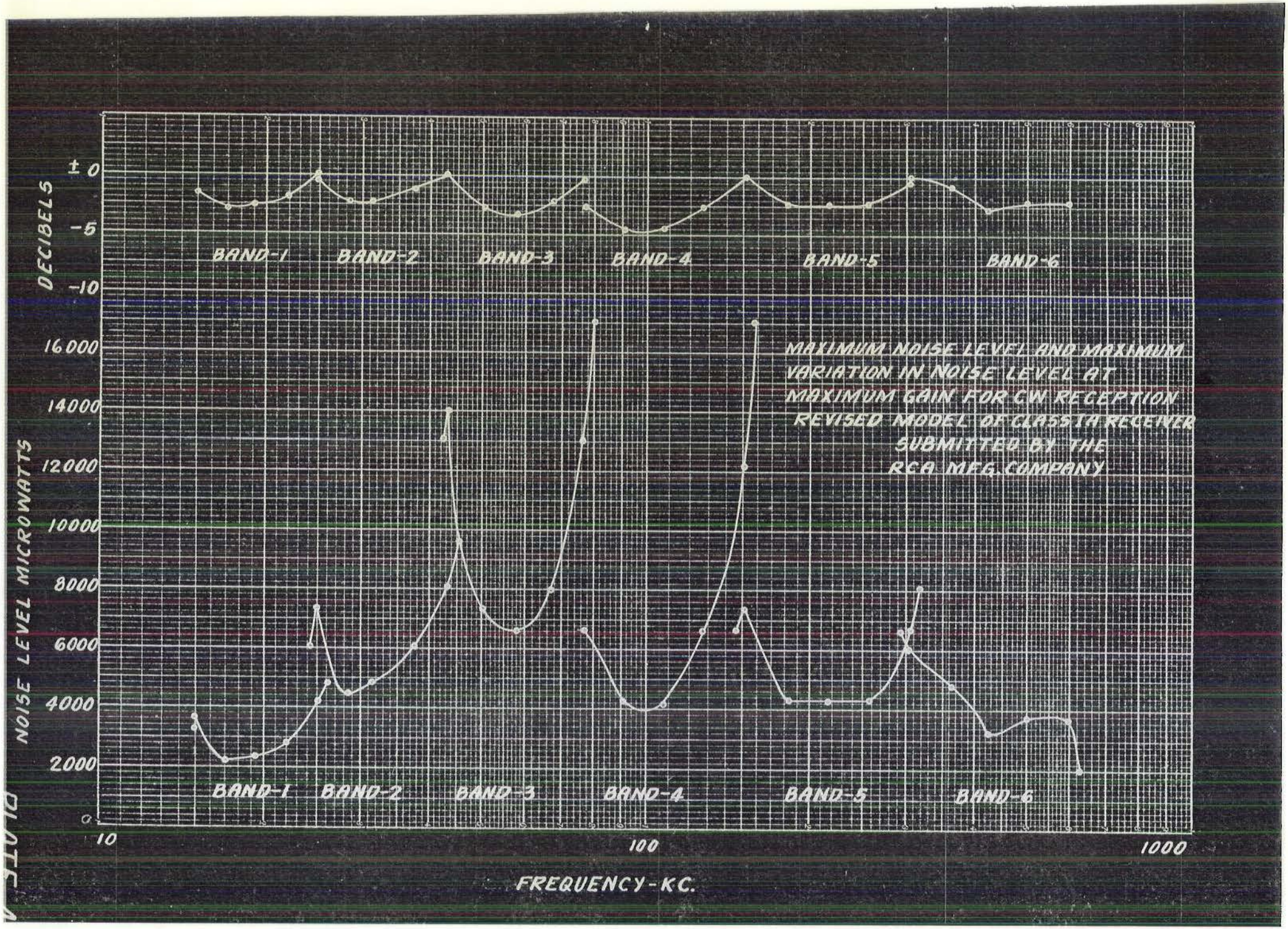
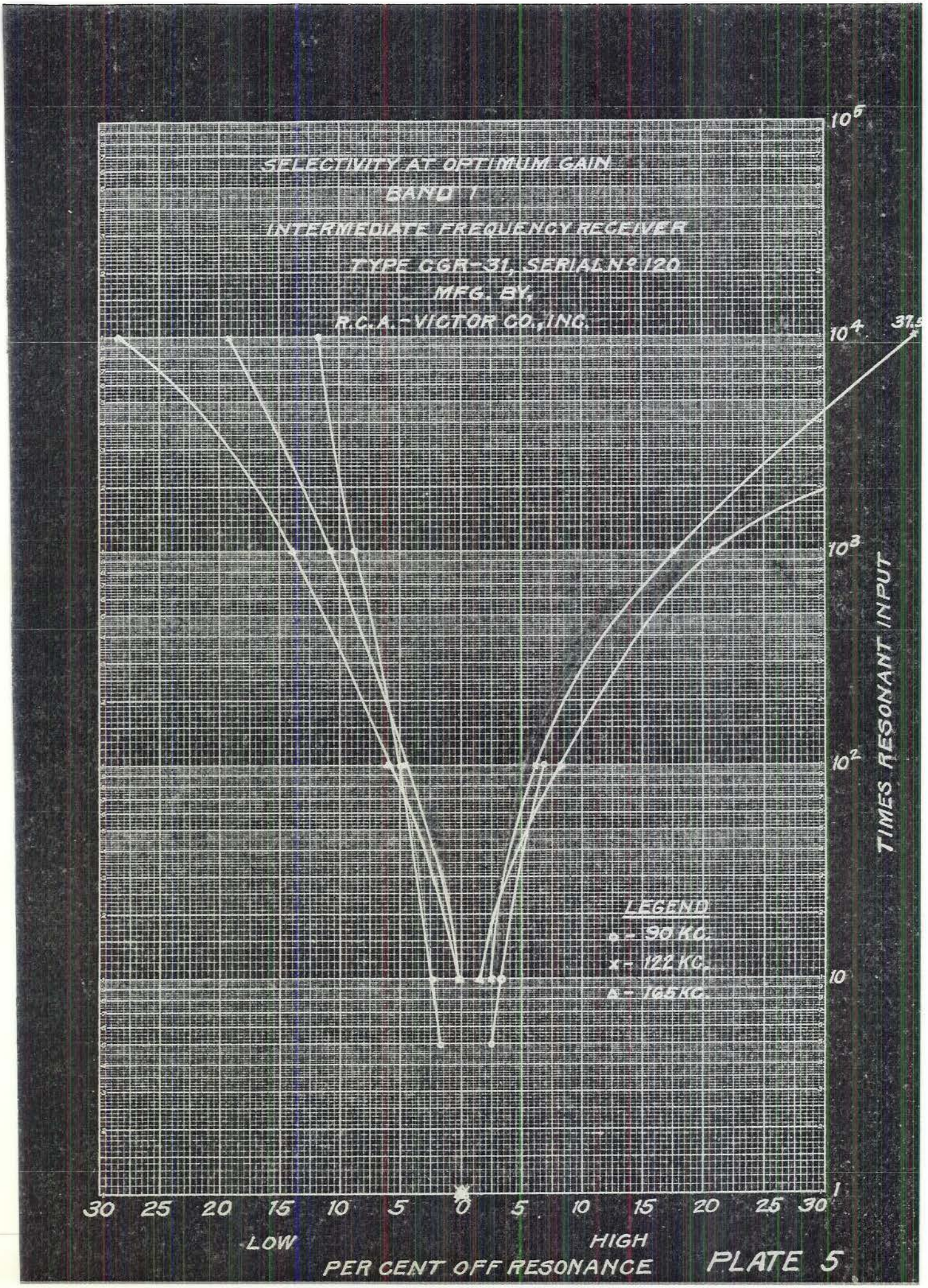
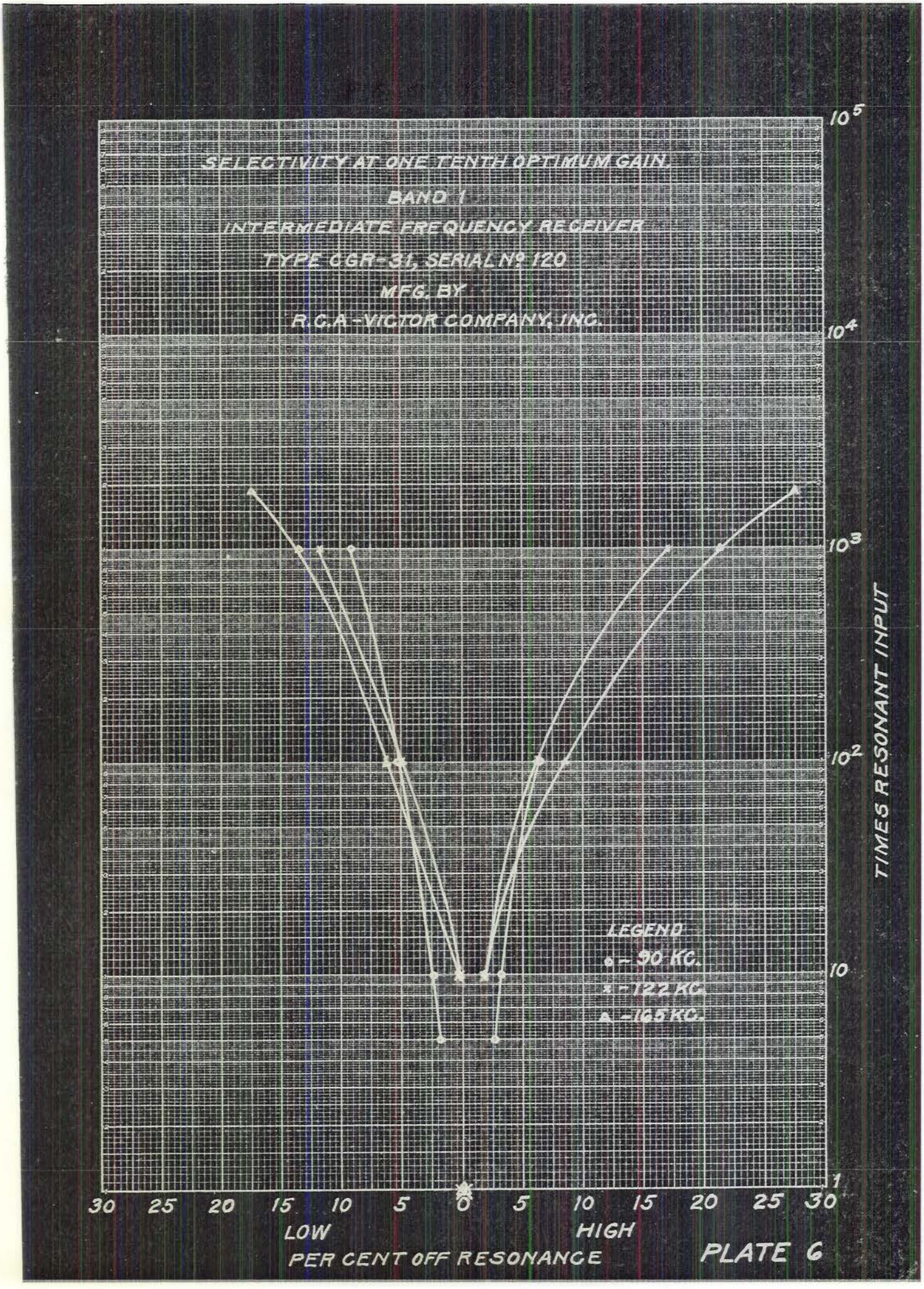
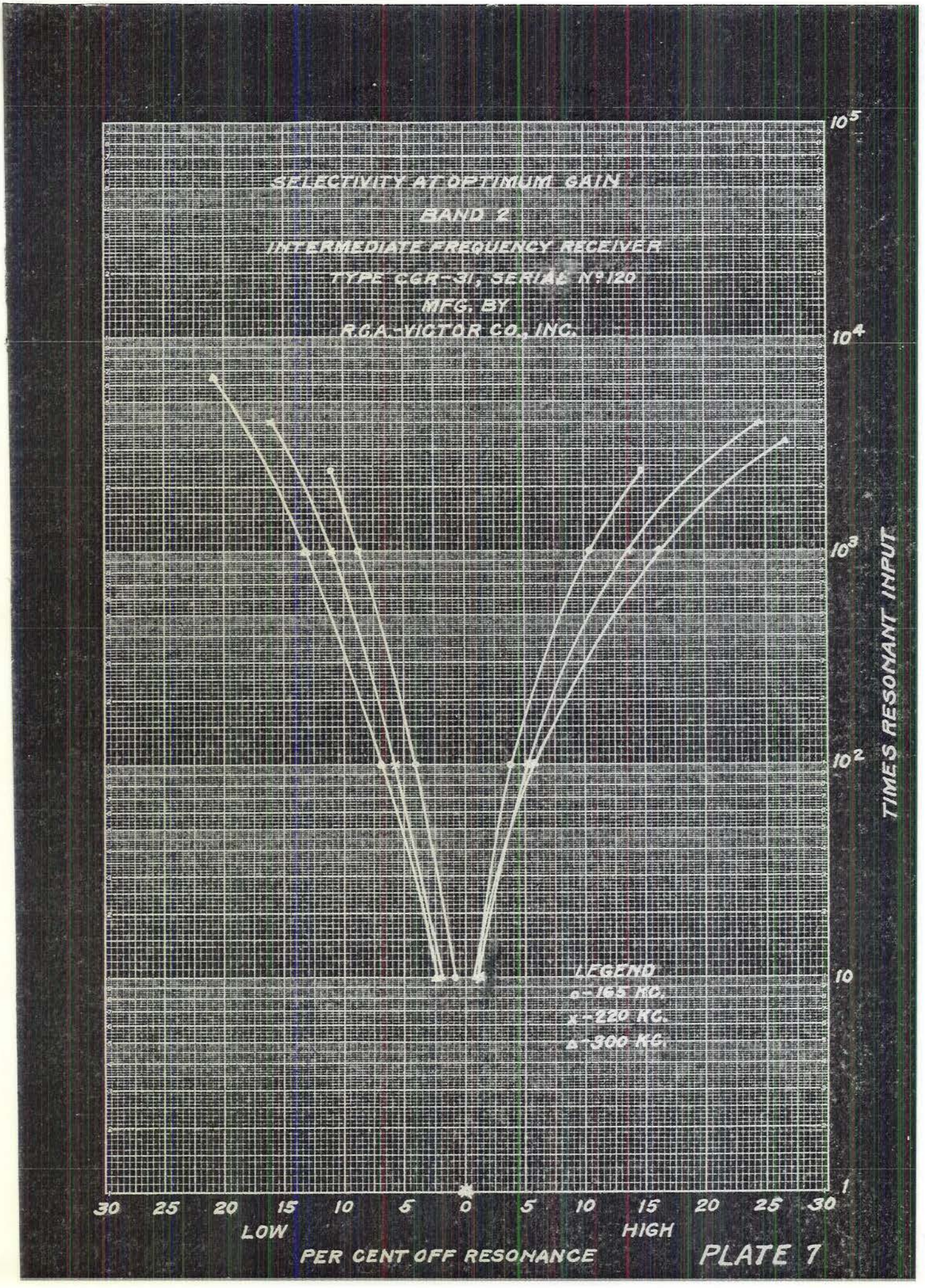

MAXIMUM NOISE LEVEL AND VARIATION
OF MAXIMUM NOISE LEVEL
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31 - SERIAL Nº 120
MFG. BY
R.C.A. - VICTOR COMPANY INC.
(USING REPLACEMENT SENSITIVITY CONTROL)
BAND 1
BAND 2
BAND 3
BAND 1
BAND 2
BAND 3
MAXIMUM NOISE LEVEL - MICROWATTS
VARIATION IN MAX. NOISE LEVEL - DECIBELS
FREQUENCY - KC.
0
200
400
600
800
1000
1200
1400
1600
1800
2000
+0
-5
-10
-15
10
10^2
10^3

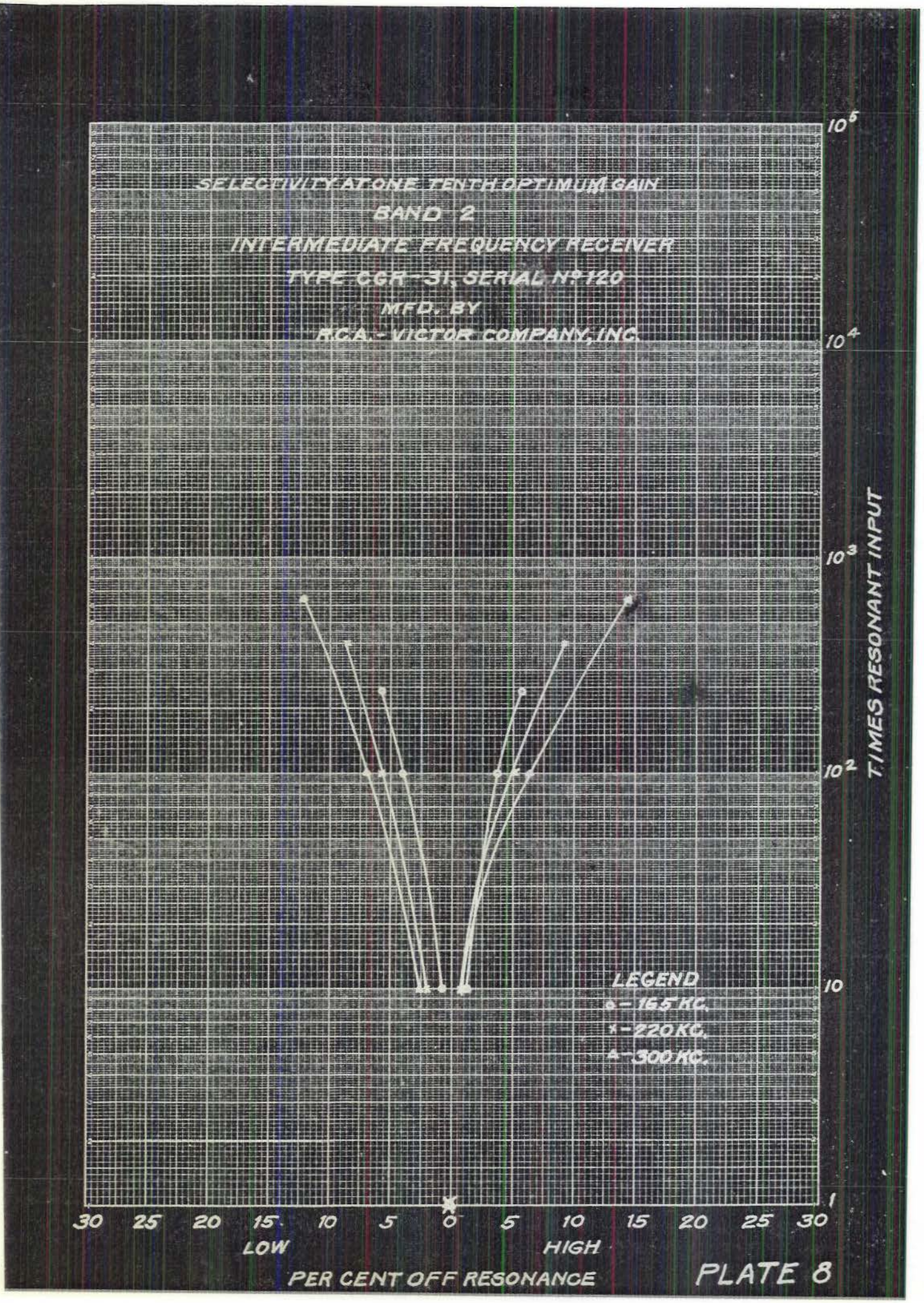
PLATE 4

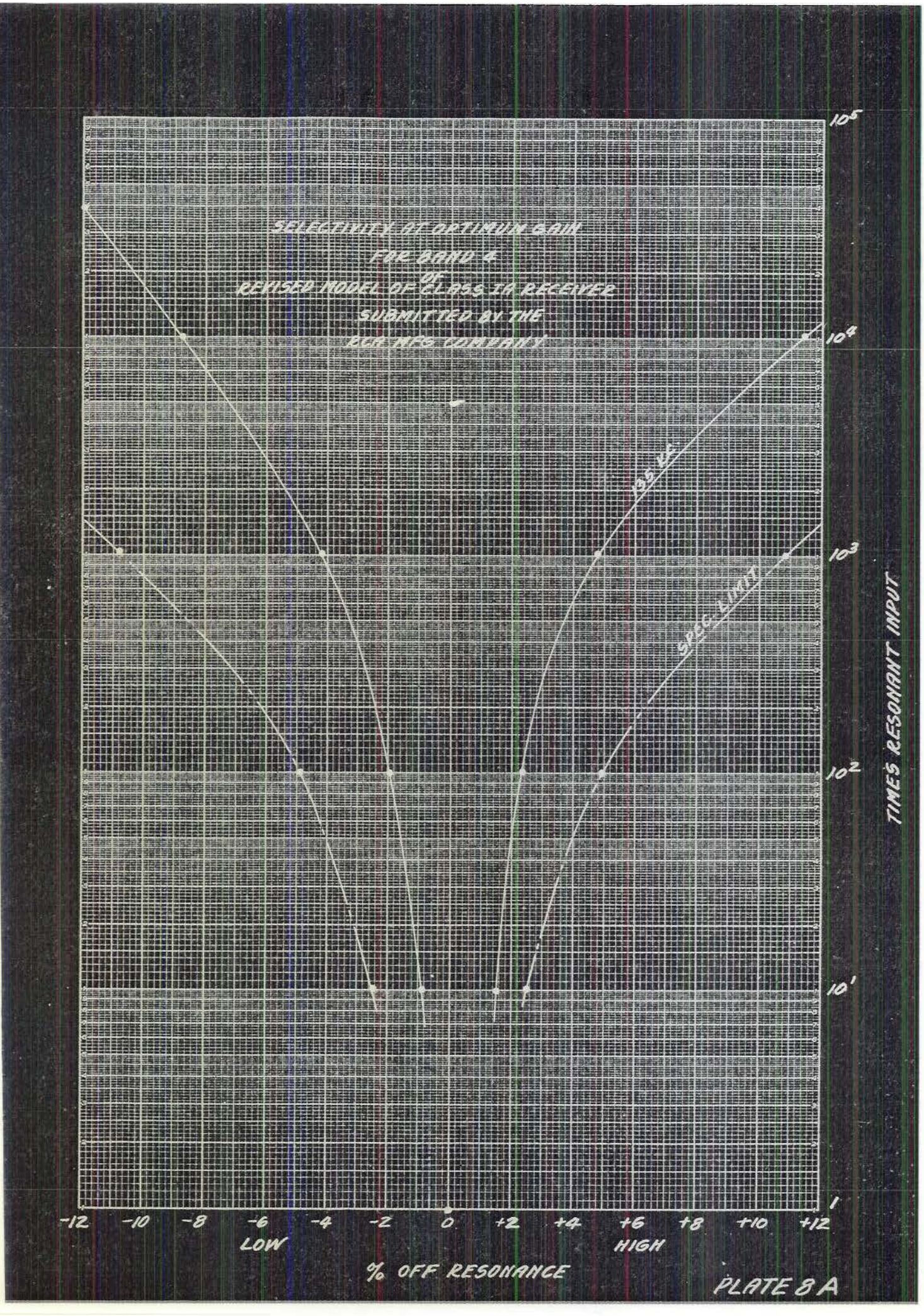

± 0
-5
-10
DECIBELS
BAND-1
BAND-2
BAND-3
BAND-4
BAND-5
BAND-6
16000
14000
12000
10000
8000
6000
4000
2000
0
NOISE LEVEL MICROWATTS
MAXIMUM NOISE LEVEL AND MAXIMUM VARIATION IN NOISE LEVEL AT MAXIMUM GAIN FOR CW RECEPTION REVISED MODEL OF CLASS 1A RECEIVER SUBMITTED BY THE RCA MFG. COMPANY
BAND-1
BAND-2
BAND-3
BAND-4
BAND-5
BAND-6
10
100
1000
FREQUENCY-KC.

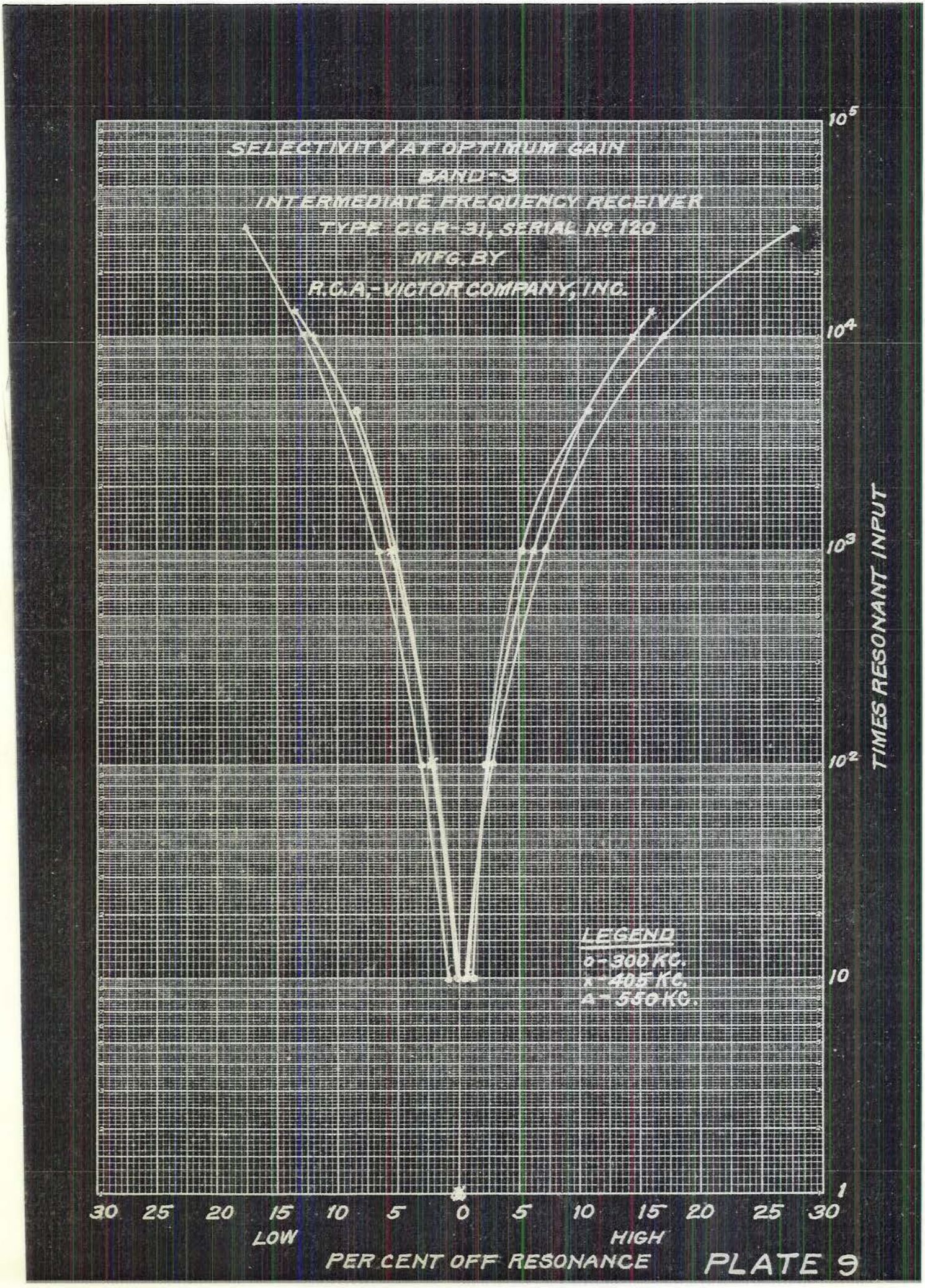

SELECTIVITY AT OPTIMUM GAIN
BAND I
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL Nº 120
MFG. BY,
R.C.A.-VICTOR CO., INC.
10^5
10^4
37.5
10^3
10^2
10
1
TIMES RESONANT INPUT
LEGEND
▲ - 90 KC.
x - 122 KC.
▲ - 165 KC.
30 25 20 15 10 5 0 5 10 15 20 25 30
LOW
HIGH
PER CENT OFF RESONANCE
PLATE 5

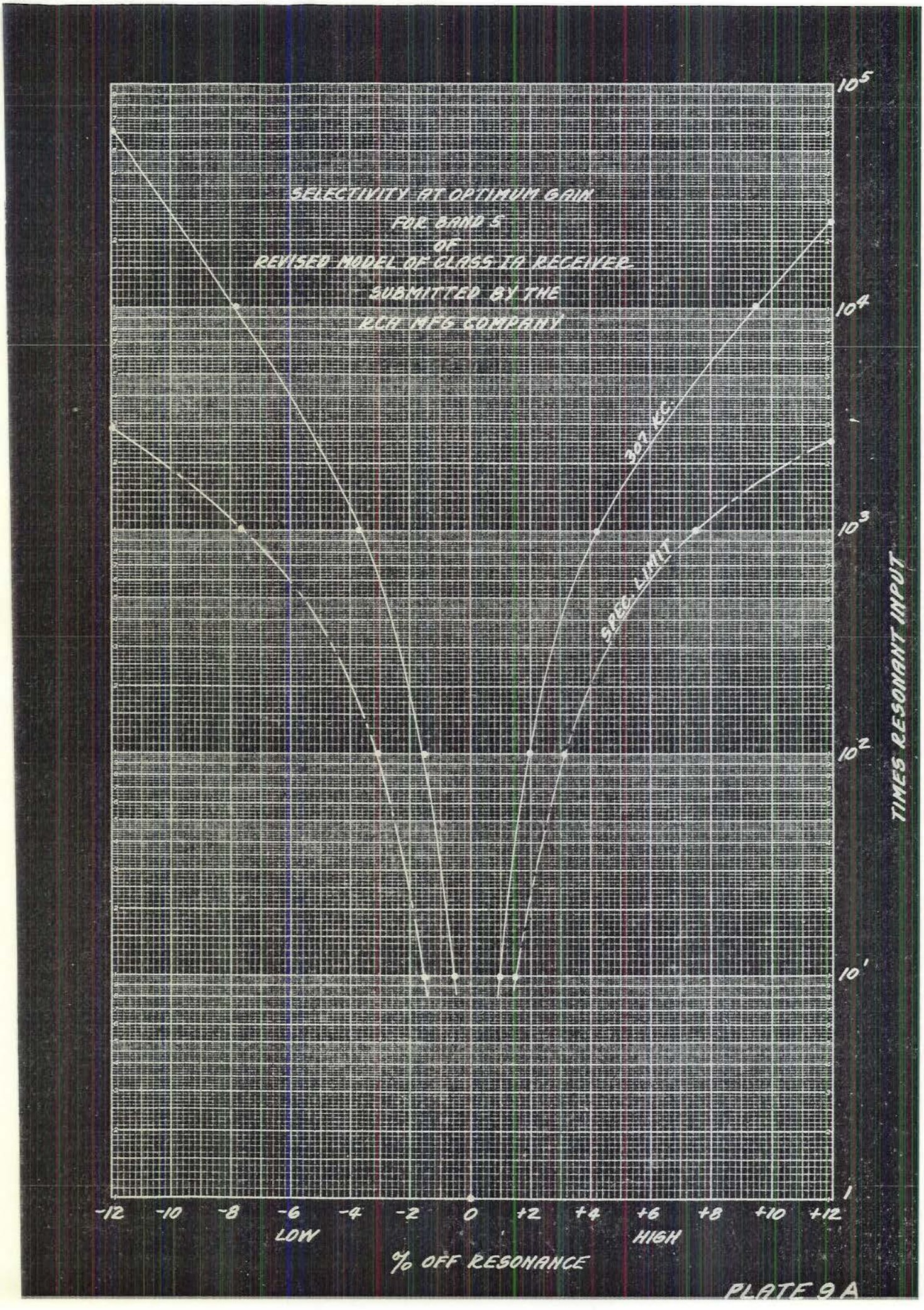

SELECTIVITY AT ONE TENTH OPTIMUM GAIN.
BAND 1
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL Nº 120
MFG. BY
R.C.A.-VICTOR COMPANY, INC.
10^5
10^4
10^3
10^2
10
1
TIMES RESONANT INPUT
LEGEND
○ - 90 KC.
× - 122 KC.
△ - 165 KC.
30 25 20 15 10 5 0 5 10 15 20 25 30
LOW
HIGH
PER CENT OFF RESONANCE
PLATE 6

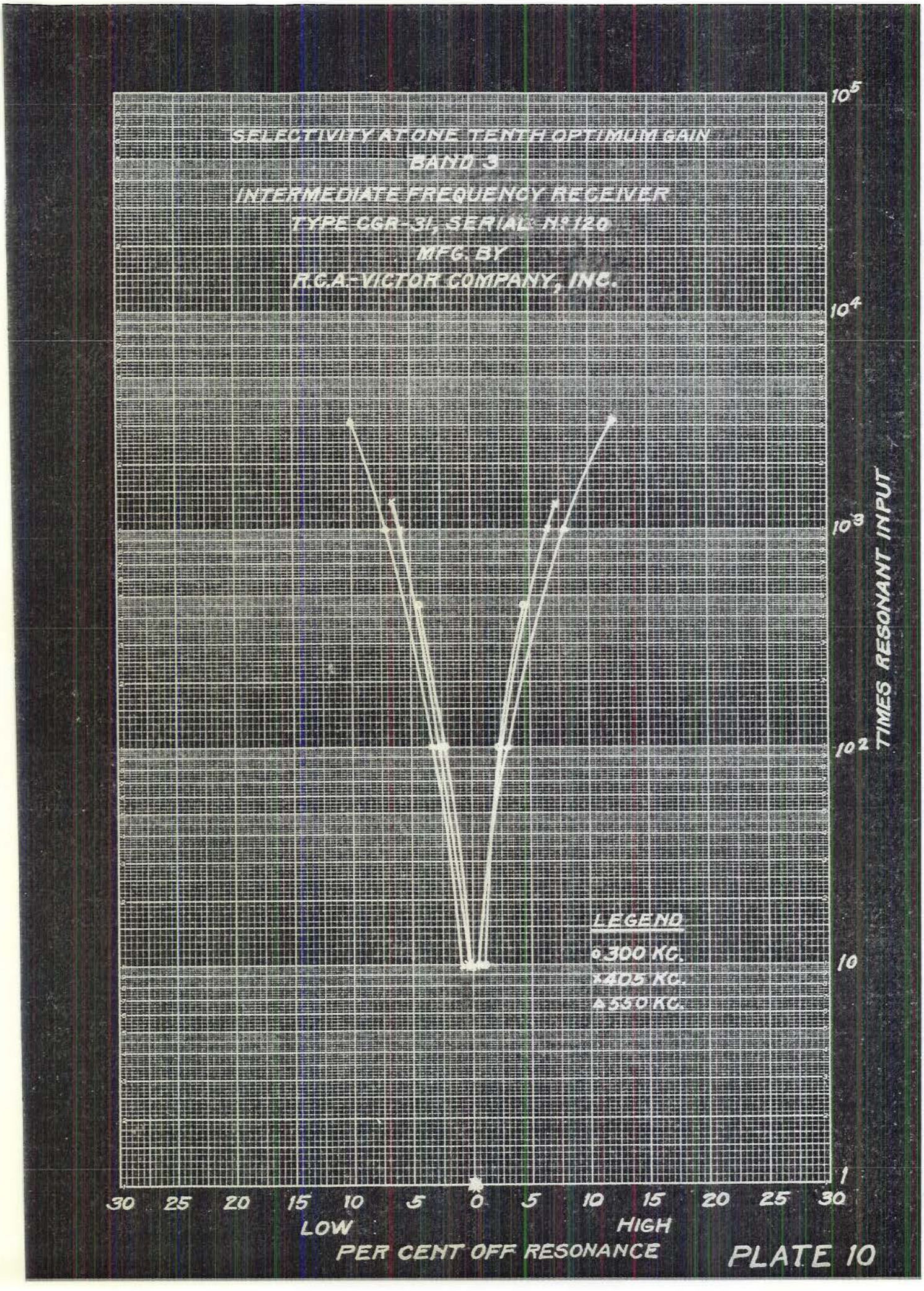

SELECTIVITY AT OPTIMUM GAIN
BAND 2
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL Nº 120
MFG. BY
R.C.A.-VICTOR CO., INC.
LEGEND
○ - 165 KC.
× - 220 KC.
△ - 300 KC.
10^5
10^4
10^3
10^2
10
1
TIMES RESONANT INPUT
30 25 20 15 10 5 0 5 10 15 20 25 30
LOW
HIGH
PER CENT OFF RESONANCE
PLATE 7

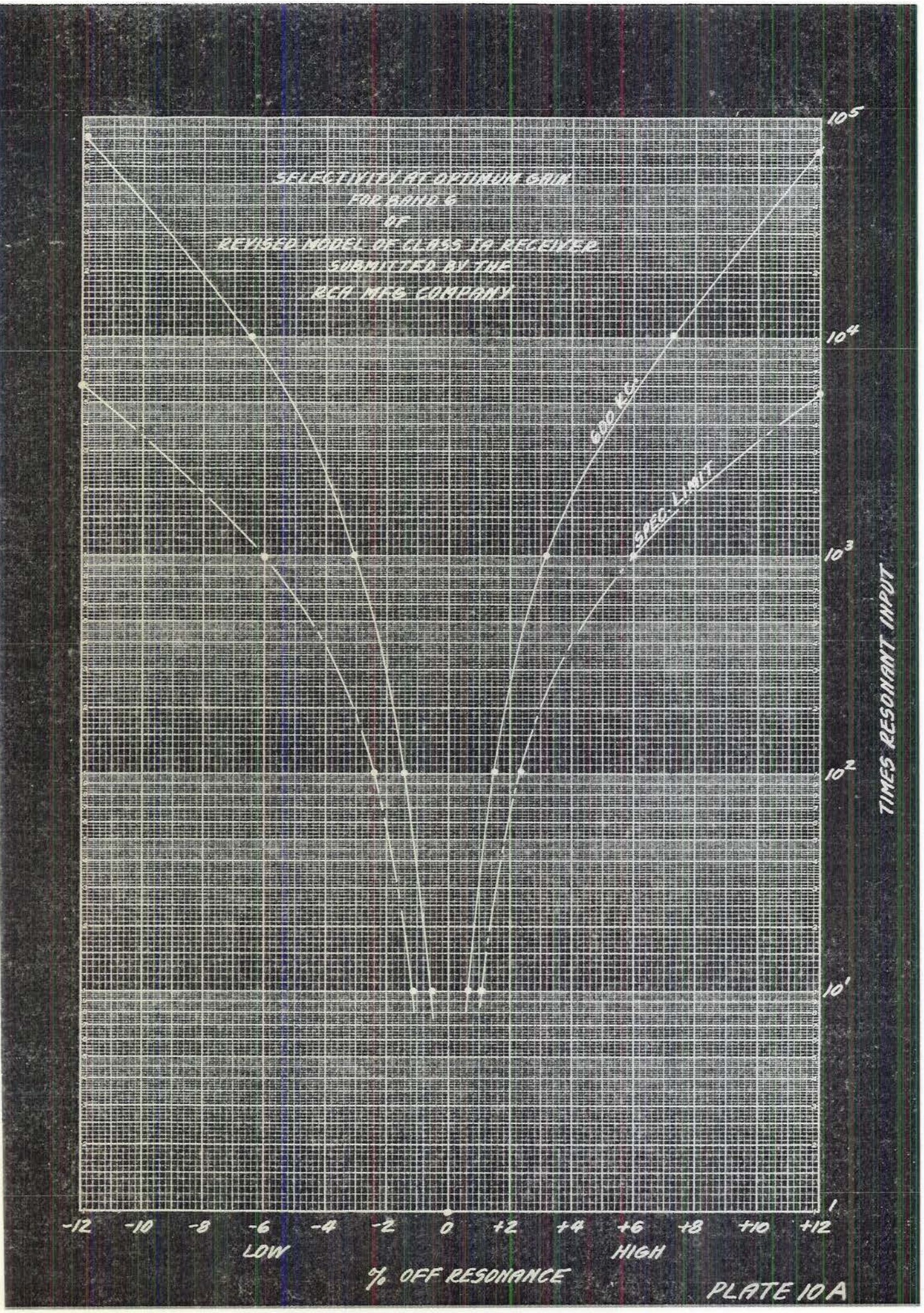

SELECTIVITY AT ONE TENTH OPTIMUM GAIN
BAND 2
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL Nº 120
MFD. BY
R.C.A.-VICTOR COMPANY, INC.
LEGEND
o - 165 KC.
x - 220 KC.
Δ - 300 KC.
10⁵
10⁴
10³
10²
10
1
TIMES RESONANT INPUT
30 25 20 15 10 5 0 5 10 15 20 25 30
LOW
HIGH
PER CENT OFF RESONANCE
PLATE 8

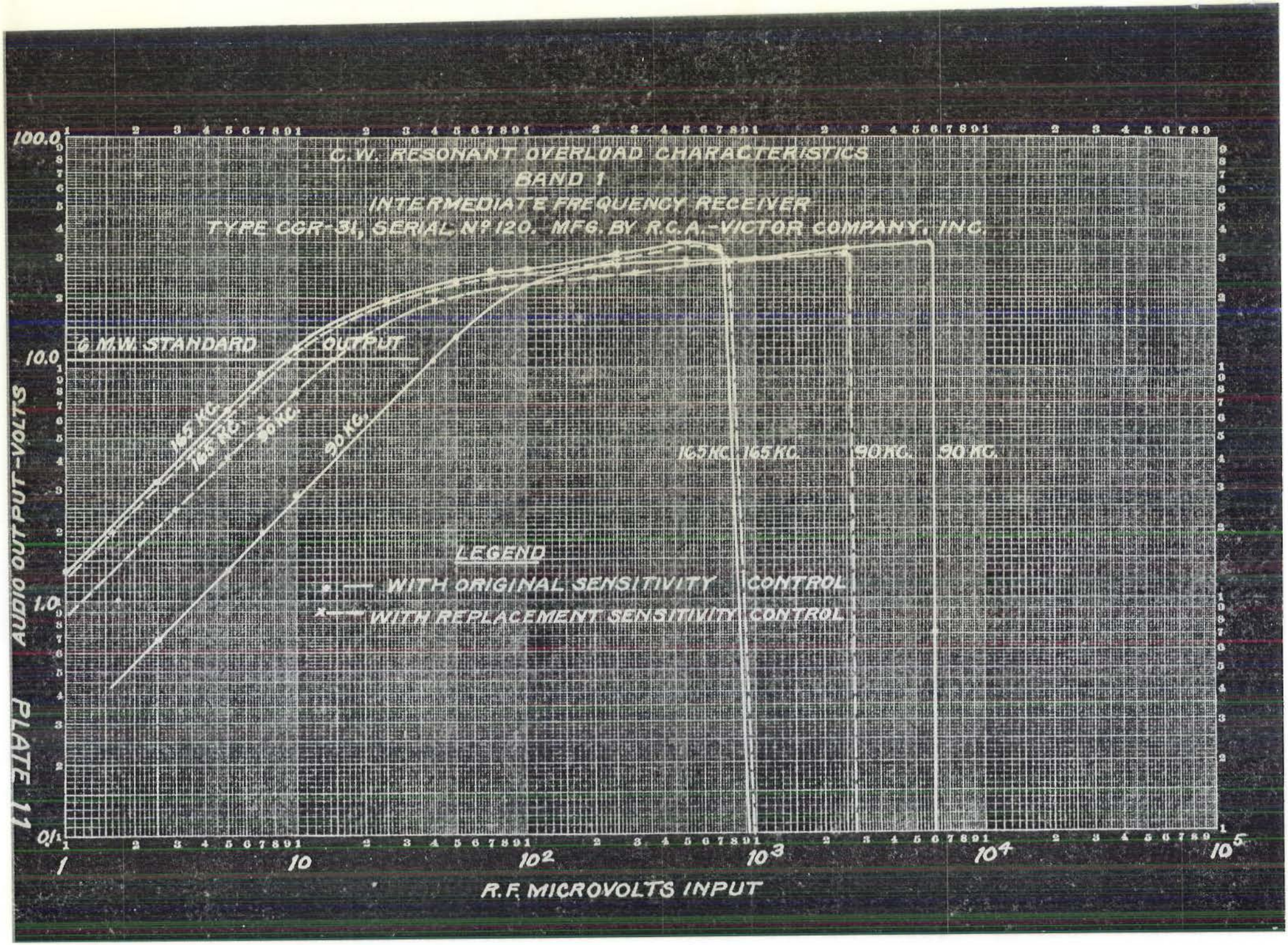

SELECTIVITY AT OPTIMUM GAIN
FOR BAND 4
OF
REVISED MODEL OF CLASS IA RECEIVER
SUBMITTED BY THE
RCA MFG COMPANY
10⁵
10⁴
10³
10²
10¹
1
15 KC
SPEC LIMIT
TIMES RESONANT INPUT
-12
-10
-8
-6
-4
-2
0
+2
+4
+6
+8
+10
+12
LOW
HIGH
% OFF RESONANCE
PLATE 8 A

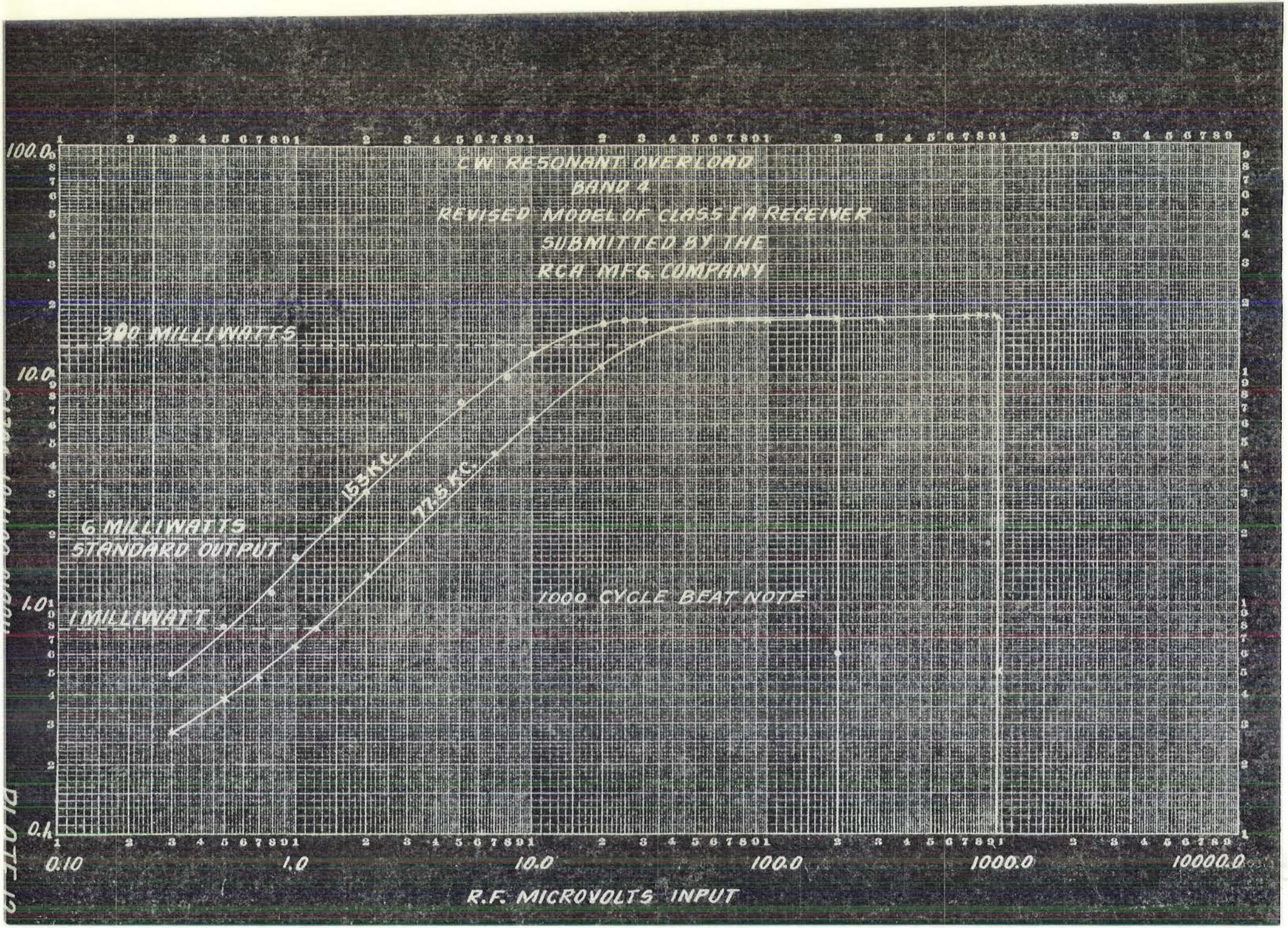

SELECTIVITY AT OPTIMUM GAIN
BAND 3
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL NO. 120
MFG. BY
R.C.A.-VICTOR COMPANY, INC.
LEGEND
o - 300 KC.
x - 405 KC.
Δ - 550 KC.
10^5
10^4
10^3
10^2
10
1
TIMES RESONANT INPUT
30 25 20 15 10 5 0 5 10 15 20 25 30
LOW
HIGH
PER CENT OFF RESONANCE
PLATE 9

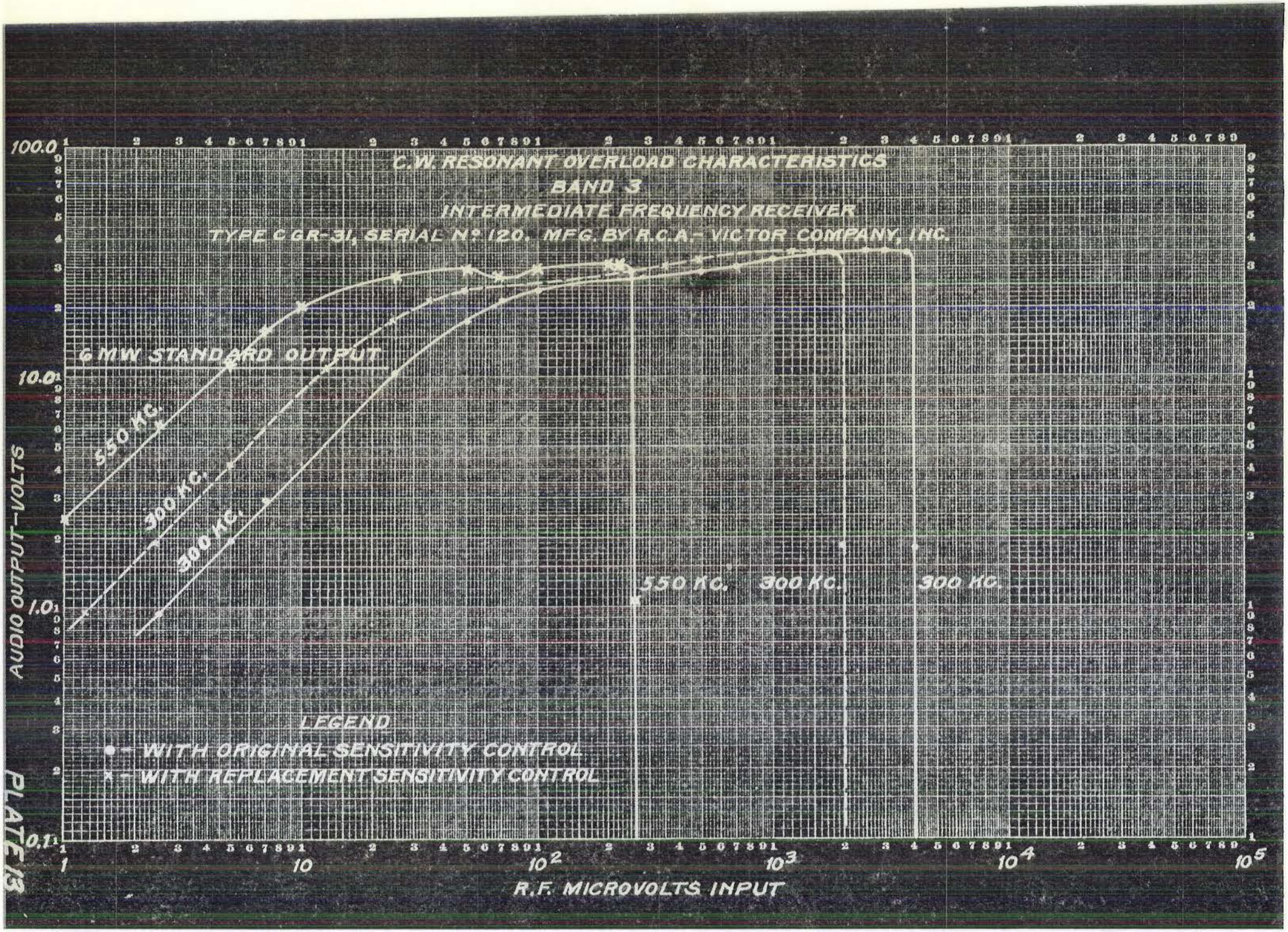

SELECTIVITY AT OPTIMUM GAIN
FOR BAND 5
OF
REVISED MODEL OF CLASS IA RECEIVER
SUBMITTED BY THE
RCA MFG COMPANY
30 KC.
SPEC. LIMIT
10^5
10^4
1
10^3
10^2
10^1
1
TIMES RESONANT INPUT
-12 -10 -8 -6 -4 -2 0 +2 +4 +6 +8 +10 +12
LOW
HIGH
% OFF RESONANCE
PLATE 9 A

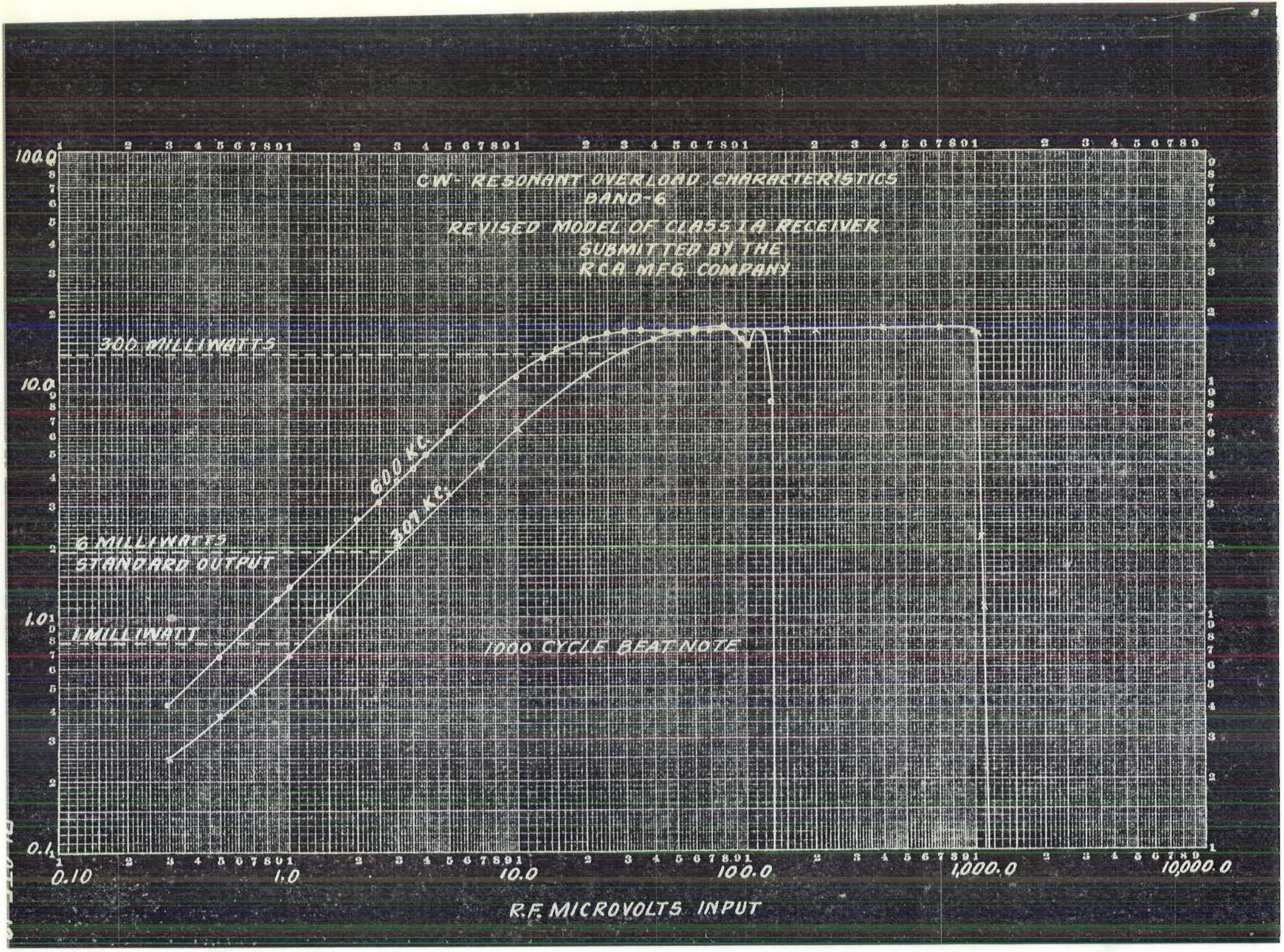

SELECTIVITY AT ONE TENTH OPTIMUM GAIN
BAND 3
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL No. 120
MFG. BY
R.C.A.-VICTOR COMPANY, INC.
10^5
10^4
10^3
10^2
10
1
TIMES RESONANT INPUT
LEGEND
○ 300 KC.
× 405 KC.
△ 530 KC.
30 25 20 15 10 5 0 5 10 15 20 25 30
LOW
HIGH
PER CENT OFF RESONANCE
PLATE 10

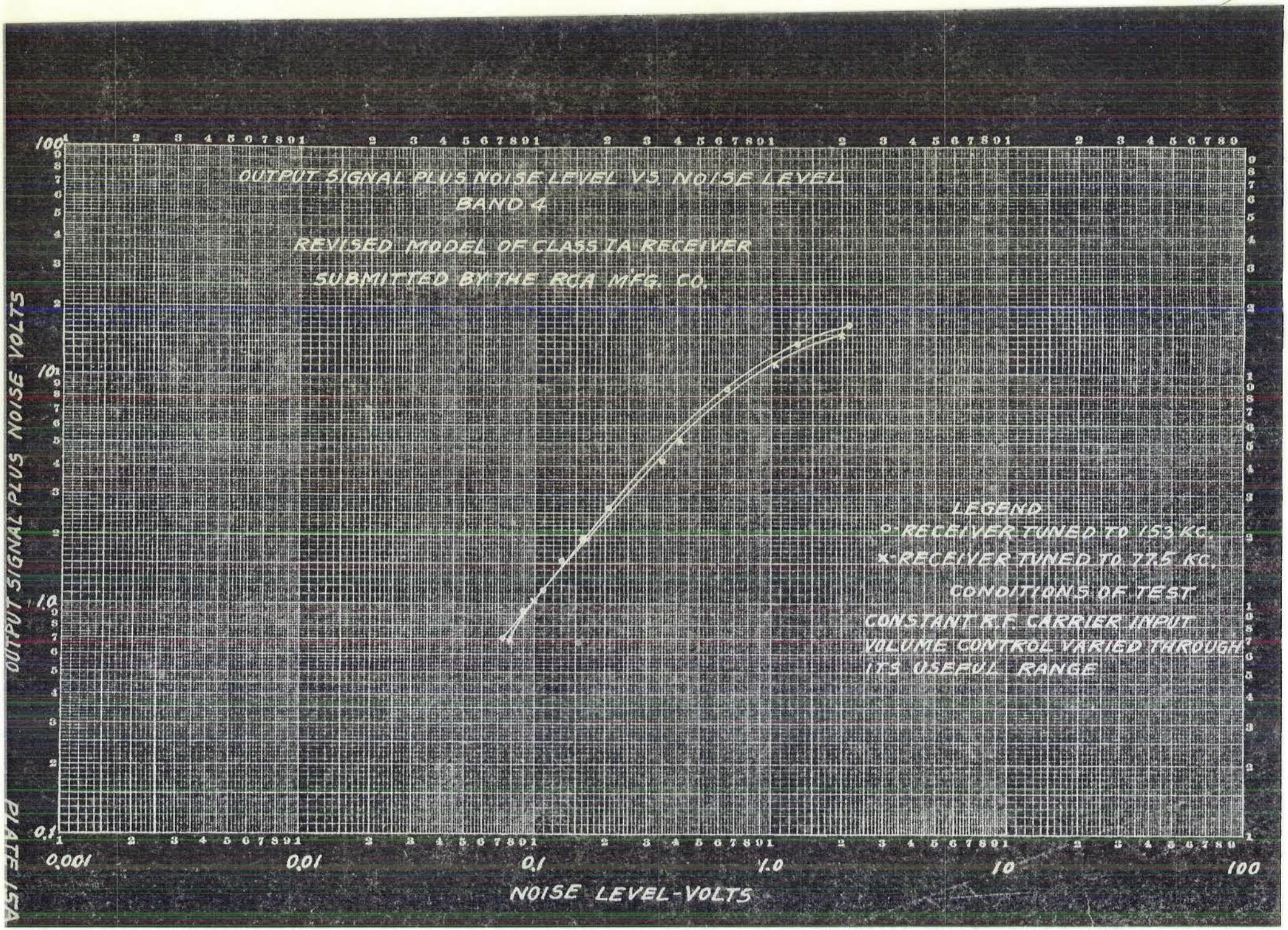

SELECTIVITY AT OPTIMUM GAIN
FOR BAND 6
OF
REVISED MODEL OF CLASS 7A RECEIVER
SUBMITTED BY THE
RCA MFG. COMPANY
GOOD R.C.
SPEC. LIMIT
10^5
10^4
10^3
10^2
10^1
1
TIMES RESONANT INPUT
-12 -10 -8 -6 -4 -2 0 +2 +4 +6 +8 +10 +12
LOW
HIGH
% OFF RESONANCE
PLATE 10A

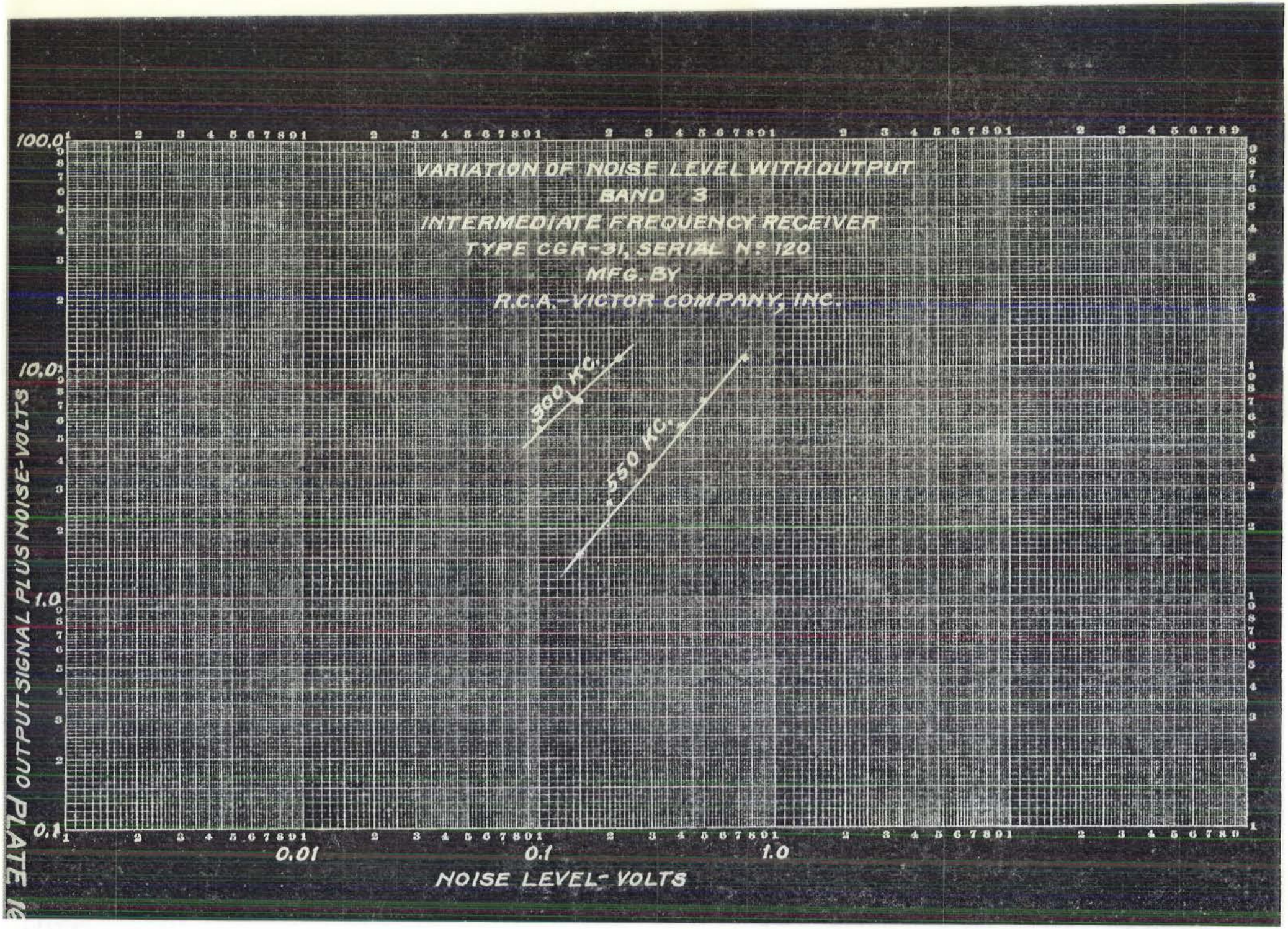

C.W. RESONANT OVERLOAD CHARACTERISTICS
BAND 1
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL Nº 120. MFG. BY R.C.A.-VICTOR COMPANY, INC.
6 M.W. STANDARD OUTPUT
16.5 KC.
165 KC.
90 KC.
90 KC.
LEGEND
• — WITH ORIGINAL SENSITIVITY CONTROL
* — WITH REPLACEMENT SENSITIVITY CONTROL
AUDIO OUTPUT-VOLTS
100.0
10.0
1.0
0.1
1
10
10²
10³
10⁴
10⁵
R.F. MICROVOLTS INPUT
PLATE 11

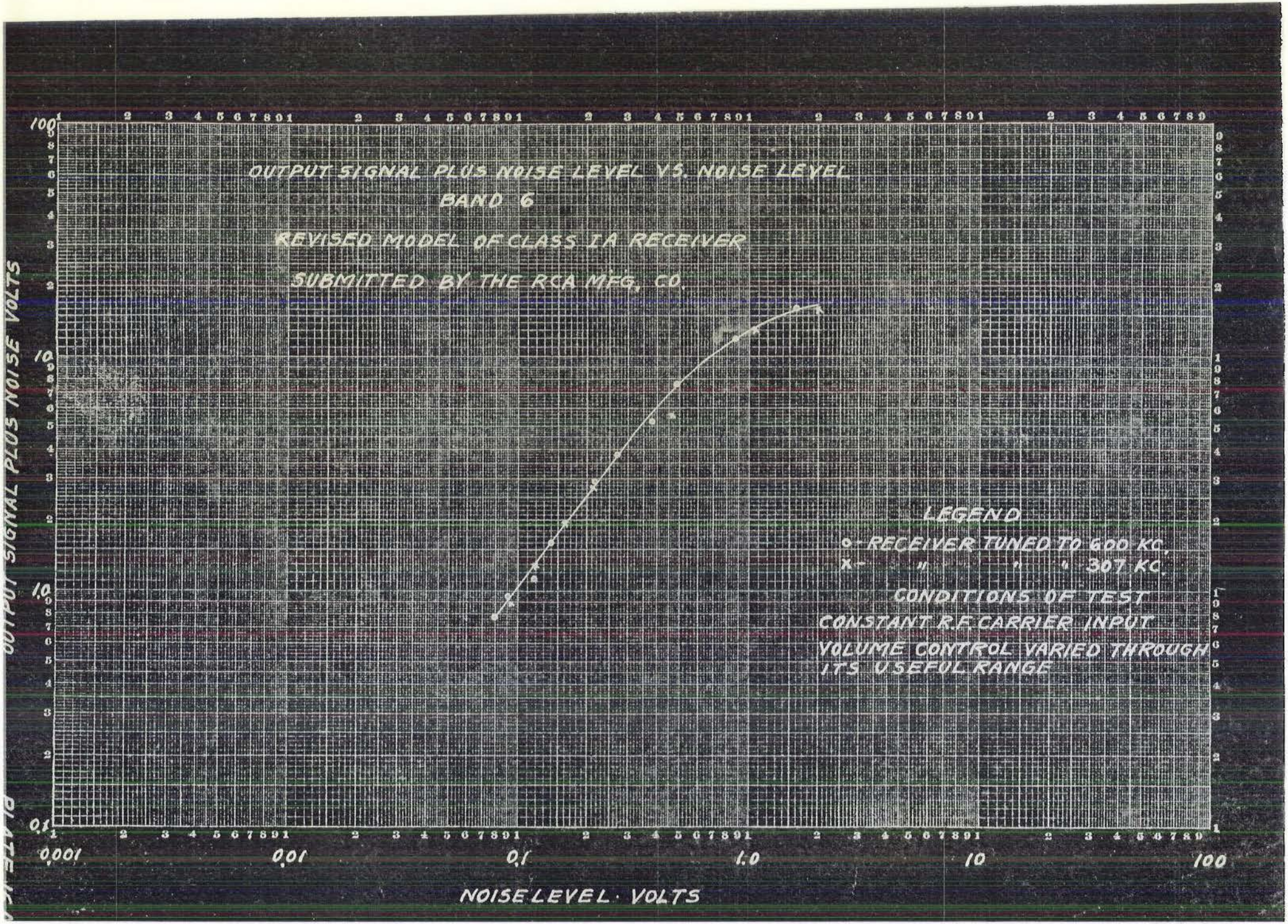

C.W. RESONANT OVERLOAD
BAND 4
REVISED MODEL OF CLASS I A RECEIVER
SUBMITTED BY THE
RCA MFG. COMPANY
300 MILLIWATTS
6 MILLIWATTS
STANDARD OUTPUT
1 MILLIWATT
1000 CYCLE BEAT NOTE
455 KC.
472.5 KC.
100.0
10.0
1.0
0.1
0.10
1.0
10.0
100.0
1000.0
10000.0
R.F. MICROVOLTS INPUT
PLOTTED

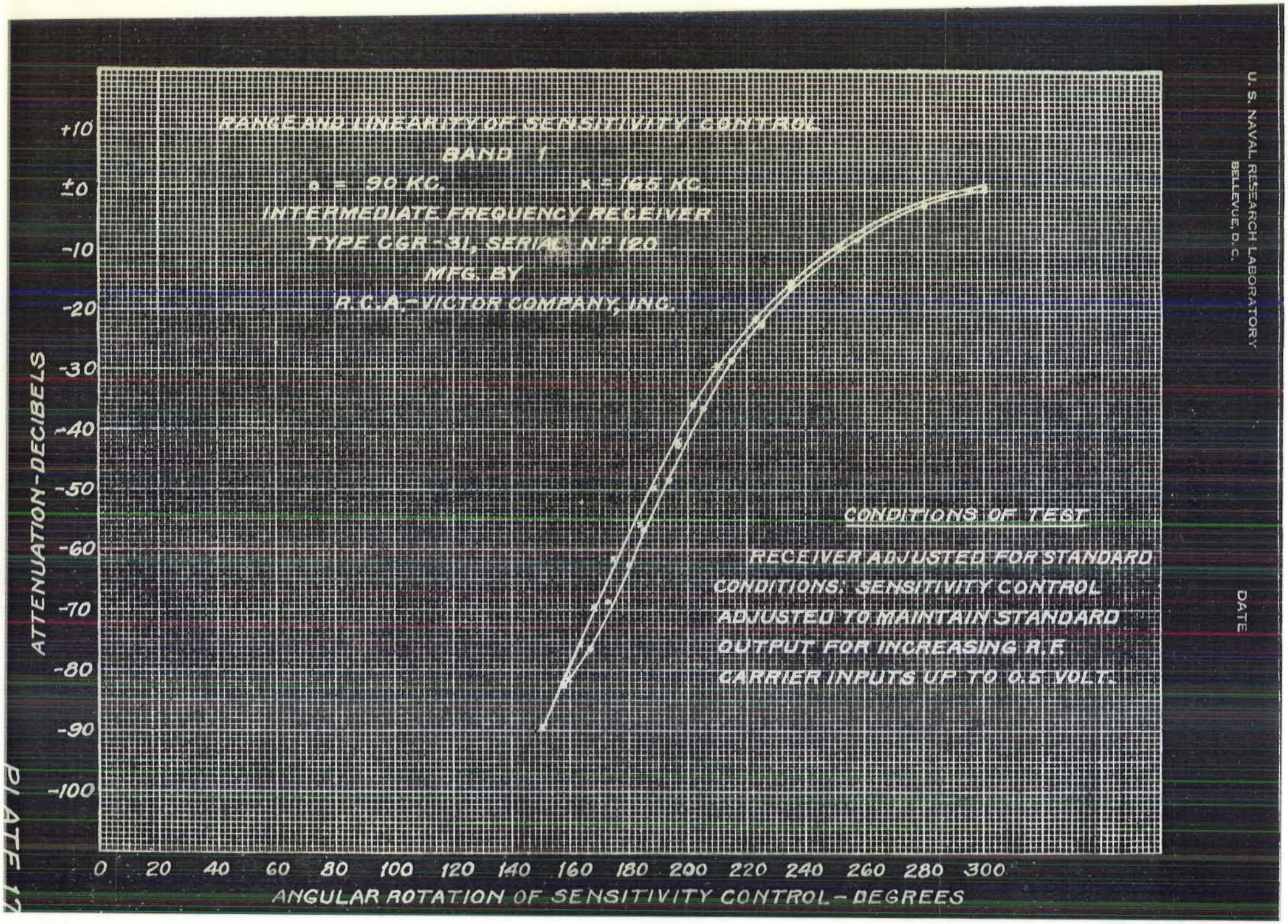

C.W. RESONANT OVERLOAD CHARACTERISTICS
BAND 3
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL No. 120. MFG. BY R.C.A.-VICTOR COMPANY, INC.
6 MW STANDARD OUTPUT
550 KC.
300 KC.
300 KC.
550 KC.
300 KC.
300 KC.
LEGEND
● - WITH ORIGINAL SENSITIVITY CONTROL
× - WITH REPLACEMENT SENSITIVITY CONTROL
AUDIO OUTPUT-VOLTS
100.0
10.0
1.0
0.1
1
10
10²
10³
10⁴
10⁵
R.F. MICROVOLTS INPUT
PLATE 13


C.W. RESONANT OVERLOAD CHARACTERISTICS
BAND-6
REVISED MODEL OF CLASS 1A RECEIVER
SUBMITTED BY THE
RCA MFG. COMPANY
100.0
10.0
1.0
0.1
300 MILLIWATTS
6 MILLIWATTS
STANDARD OUTPUT
1 MILLIWATT
600 KC.
30 KC.
1000 CYCLE BEAT NOTE
0.10
1.0
10.0
100.0
1,000.0
10,000.0
R.F. MICROVOLTS INPUT


OUTPUT SIGNAL PLUS NOISE LEVEL VS. NOISE LEVEL
BAND 4
REVISED MODEL OF CLASS IA RECEIVER
SUBMITTED BY THE RCA MFG. CO.
LEGEND
O- RECEIVER TUNED TO 1573 KC.
X- RECEIVER TUNED TO 775 KC.
CONDITIONS OF TEST
CONSTANT R.F. CARRIER INPUT
VOLUME CONTROL VARIED THROUGH
ITS USEFUL RANGE
OUTPUT SIGNAL PLUS NOISE VOLTS
NOISE LEVEL-VOLTS
0.001
0.01
0.1
1.0
10
100
PLATE 15A


VARIATION OF NOISE LEVEL WITH OUTPUT
BAND 3
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL Nº 120
MFG. BY
R.C.A.-VICTOR COMPANY, INC.
300 KC.
550 KC.
100.0
10.0
1.0
0.1
0.01
0.1
1.0
PLATE 16 OUTPUT SIGNAL PLUS NOISE-VOLTS
NOISE LEVEL-VOLTS

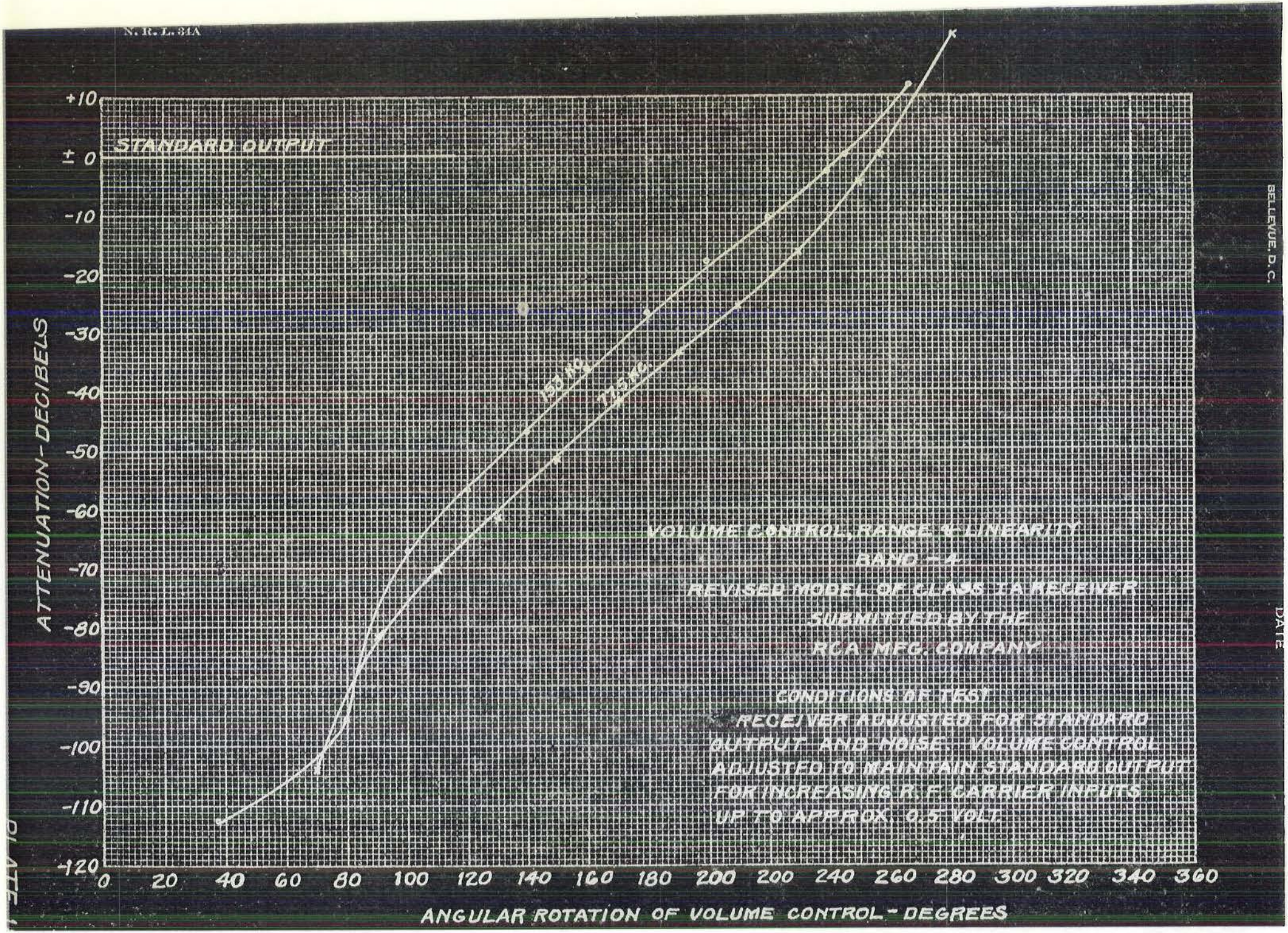

OUTPUT SIGNAL PLUS NOISE LEVEL VS. NOISE LEVEL
BAND 6
REVISED MODEL OF CLASS IA RECEIVER
SUBMITTED BY THE RCA MFG. CO.
LEGEND
o - RECEIVER TUNED TO 600 KC.
X - " " " " 307 KC.
CONDITIONS OF TEST
CONSTANT R.F. CARRIER INPUT
VOLUME CONTROL VARIED THROUGH
ITS USEFUL RANGE
OUTPUT SIGNAL PLUS NOISE VOLTS
NOISE LEVEL - VOLTS
0.001
0.01
0.1
1.0
10
100

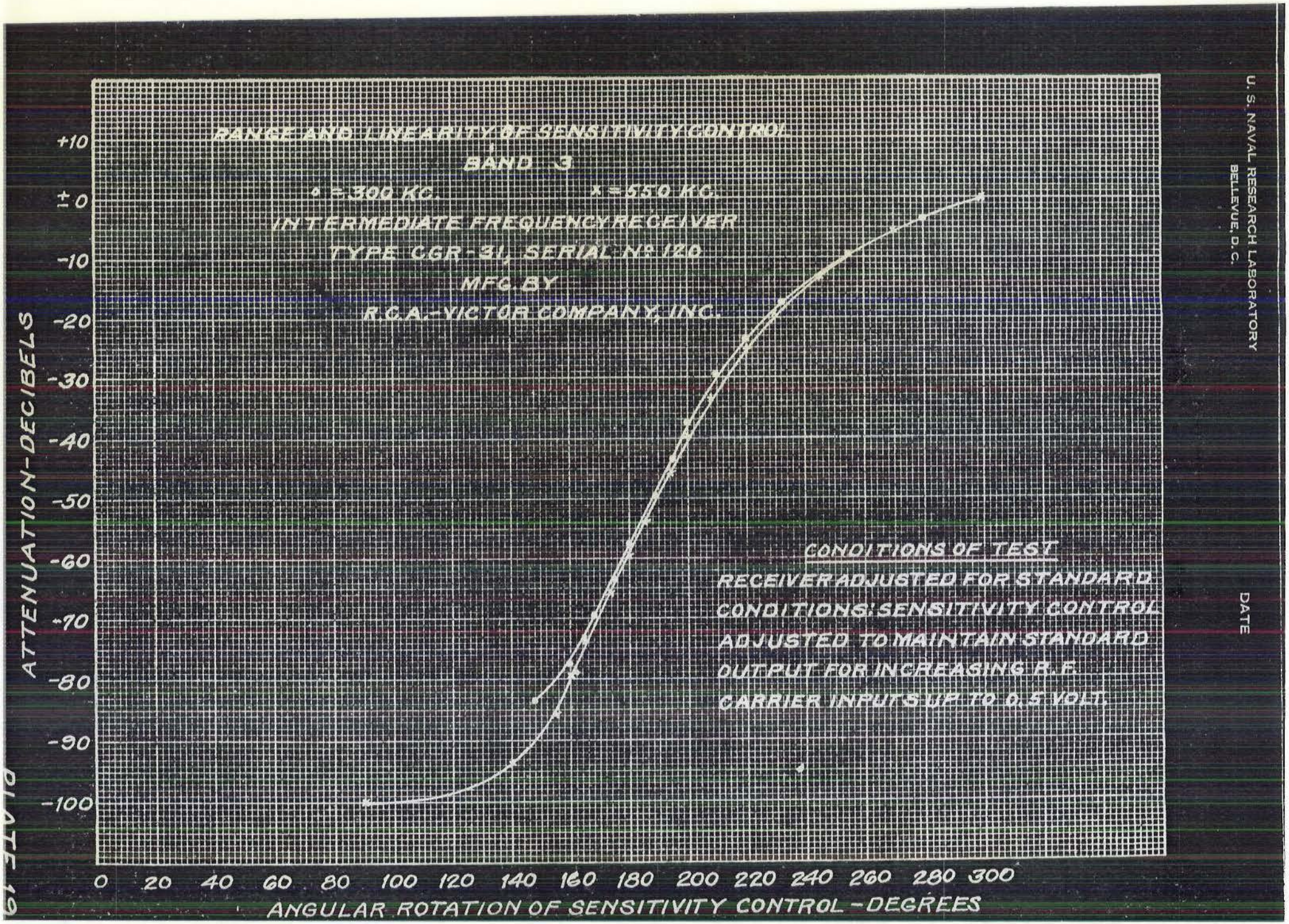

RANGE AND LINEARITY OF SENSITIVITY CONTROL
BAND 1
o = 90 KC. x = 165 KC.
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL Nº 120
MFG. BY
R.C.A.-VICTOR COMPANY, INC.
CONDITIONS OF TEST
RECEIVER ADJUSTED FOR STANDARD CONDITIONS: SENSITIVITY CONTROL ADJUSTED TO MAINTAIN STANDARD OUTPUT FOR INCREASING R.F. CARRIER INPUTS UP TO 0.5 VOLT.
+10
±0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
ATTENUATION-DECIBELS
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300
ANGULAR ROTATION OF SENSITIVITY CONTROL-DEGREES
U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.
DATE
PLATE 17

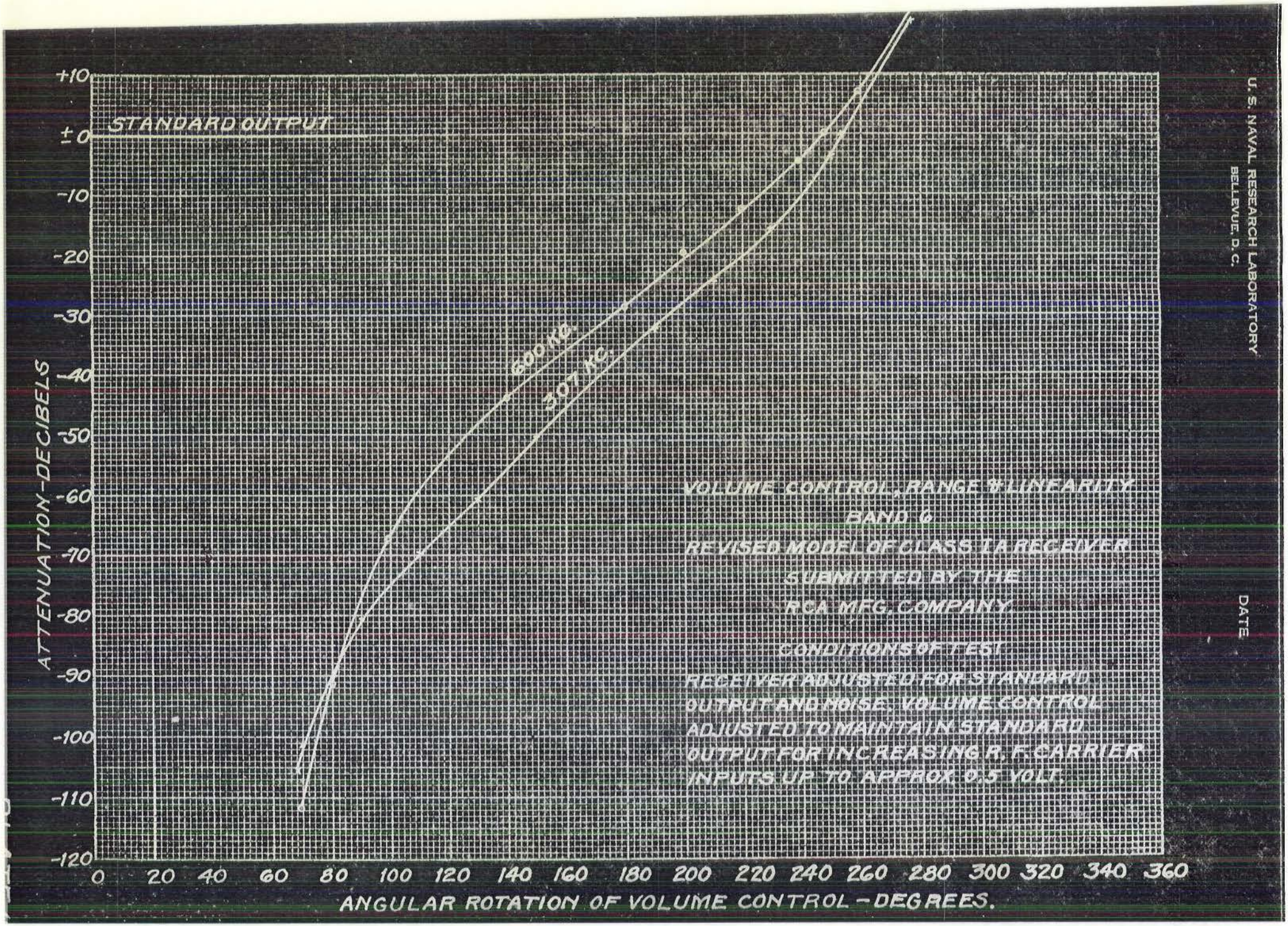
U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

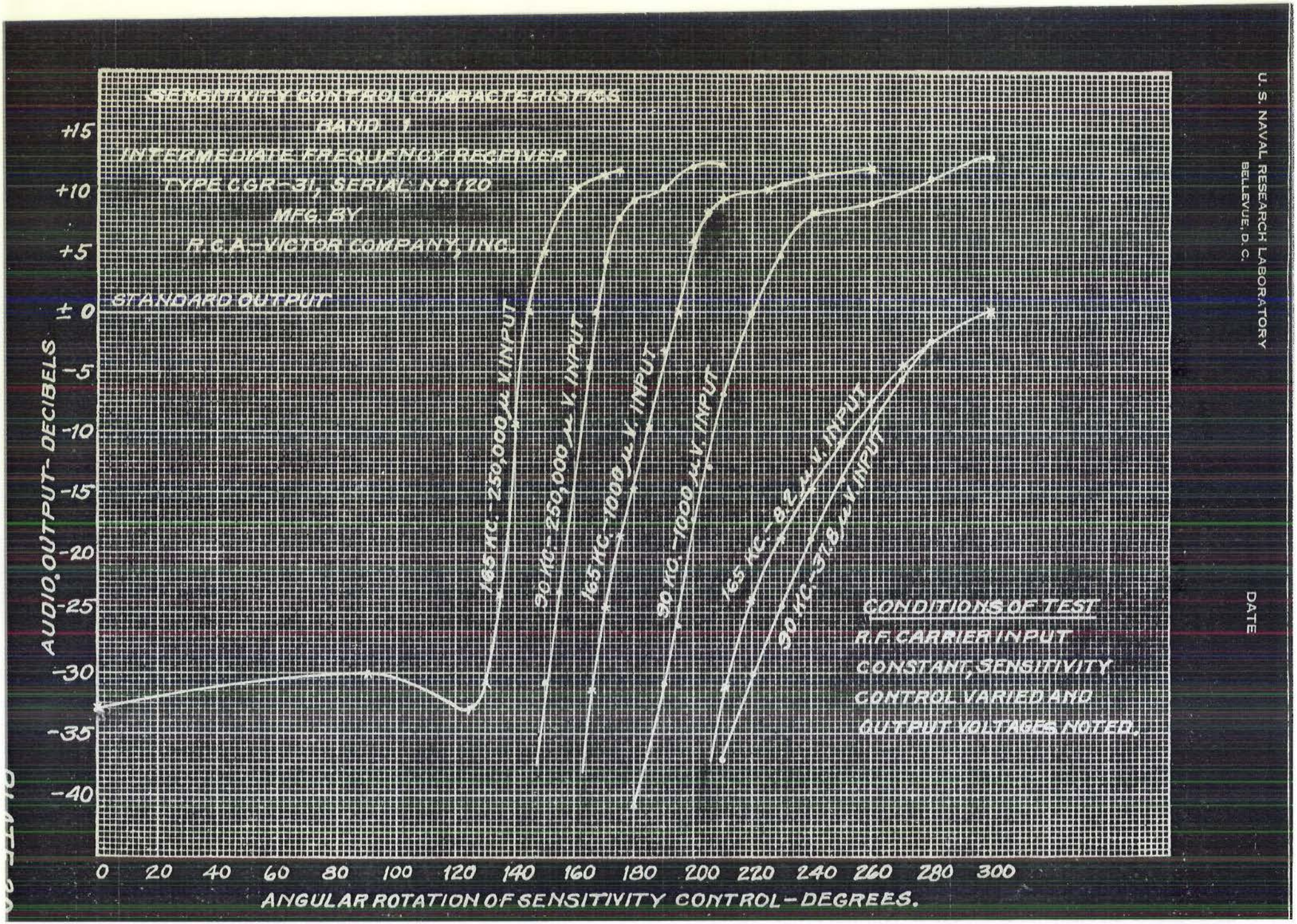
DATE

PLATE 18


N. R. L. 31A
+10
± 0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
STANDARD OUTPUT
ATTENUATION - DECIBELS
0 20 40 60 80 100 120 140 160 180 200 200 240 260 280 300 320 340 360
ANGULAR ROTATION OF VOLUME CONTROL - DEGREES
VOLUME CONTROL RANGE & LINEARITY
BAND - 4
REVISED MODEL OF CLASS 7A RECEIVER
SUBMITTED BY THE
RCA MFG. COMPANY
CONDITIONS OF TEST
RECEIVER ADJUSTED FOR STANDARD OUTPUT AND NOISE VOLUME CONTROL ADJUSTED TO MAINTAIN STANDARD OUTPUT FOR INCREASING R.F. CARRIER INPUTS UP TO APPROX. 0.5 VOLT.
BELLEVUE, D.C.
DATE


RANGE AND LINEARITY OF SENSITIVITY CONTROL
BAND 3
o = 300 KC.
x = 550 KC.
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL Nº 120
MFG. BY
R.C.A.-VICTOR COMPANY, INC.
CONDITIONS OF TEST
RECEIVER ADJUSTED FOR STANDARD CONDITIONS; SENSITIVITY CONTROL ADJUSTED TO MAINTAIN STANDARD OUTPUT FOR INCREASING R.F. CARRIER INPUTS UP TO 0.5 VOLT.
+10
± 0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
ATTENUATION-DECIBELS
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300
ANGULAR ROTATION OF SENSITIVITY CONTROL - DEGREES
U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.
DATE
OCT 19

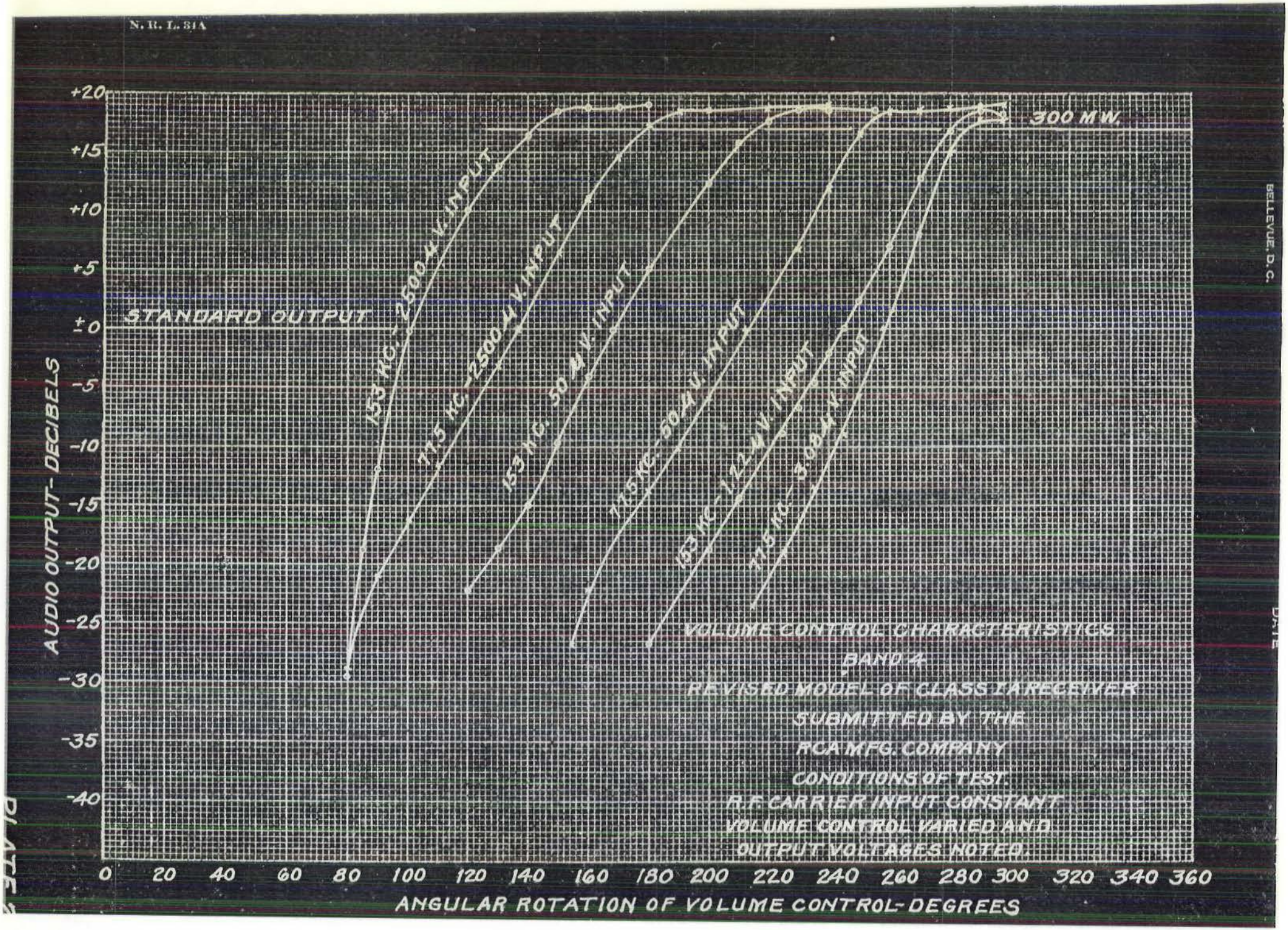

+10
± 0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
STANDARD OUTPUT
ATTENUATION-DECIBELS
600 KC
1400 KC
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360
ANGULAR ROTATION OF VOLUME CONTROL - DEGREES.
VOLUME CONTROL RANGE & LINEARITY
BAND 6
REVISED MODEL OF CLASS 1A RECEIVER
SUBMITTED BY THE
RCA MFG. COMPANY.
CONDITIONS OF TEST
RECEIVER ADJUSTED FOR STANDARD
OUTPUT AND NOISE. VOLUME CONTROL
ADJUSTED TO MAINTAIN STANDARD
OUTPUT FOR INCREASING R.F. CARRIER
INPUTS UP TO APPROX. 0.5 VOLT.
U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.
DATE


SENSITIVITY CONTROL CHARACTERISTICS
BAND 1
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL No. 120
MFG. BY
R.C.A.-VICTOR COMPANY, INC.
STANDARD OUTPUT
AUDIO OUTPUT - DECIBELS
+15
+10
+5
+0
-5
-10
-15
-20
-25
-30
-35
-40
165 KC. - 250,000 μ V. INPUT
90 KC. - 250,000 μ V. INPUT
165 KC. - 1000 μ V. INPUT
90 KC. - 1000 μ V. INPUT
165 KC. - 8.2 μ V. INPUT
90 KC. - 31.8 μ V. INPUT
CONDITIONS OF TEST
R.F. CARRIER INPUT
CONSTANT, SENSITIVITY
CONTROL VARIED AND
OUTPUT VOLTAGES NOTED.
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300
ANGULAR ROTATION OF SENSITIVITY CONTROL - DEGREES.
U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.
DATE

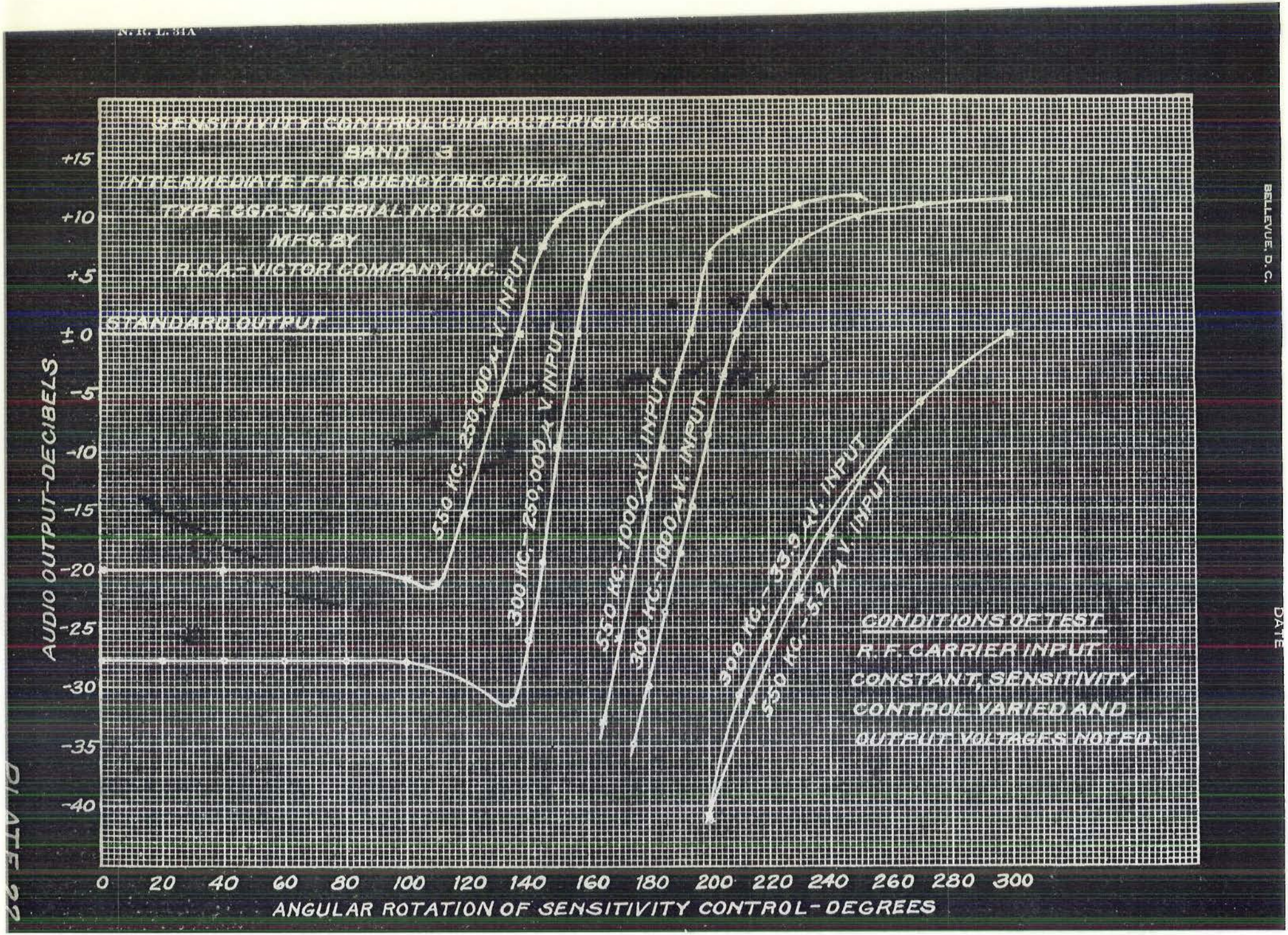
U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

PLATE 21


N. R. L. 31A
+20
+15
+10
+5
±0
-5
-10
-15
-20
-25
-30
-35
-40
AUDIO OUTPUT - DECIBELS
STANDARD OUTPUT
300 MW.
153 KC. - 2500 M.V. INPUT
715 KC. - 2500 M.V. INPUT
153 KC. - 50 M.V. INPUT
715 KC. - 50 M.V. INPUT
153 KC. - 5.0 M.V. INPUT
715 KC. - 5.0 M.V. INPUT
VOLUME CONTROL CHARACTERISTICS
BAND 4
REVISED MODEL OF CLASS 1A RECEIVER
SUBMITTED BY THE
RCA MFG. COMPANY
CONDITIONS OF TEST:
R.F. CARRIER INPUT CONSTANT
VOLUME CONTROL VARIED AND
OUTPUT VOLTAGES NOTED.
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360
ANGULAR ROTATION OF VOLUME CONTROL - DEGREES
BELLEVUE, D. C.
DATE
PLATE

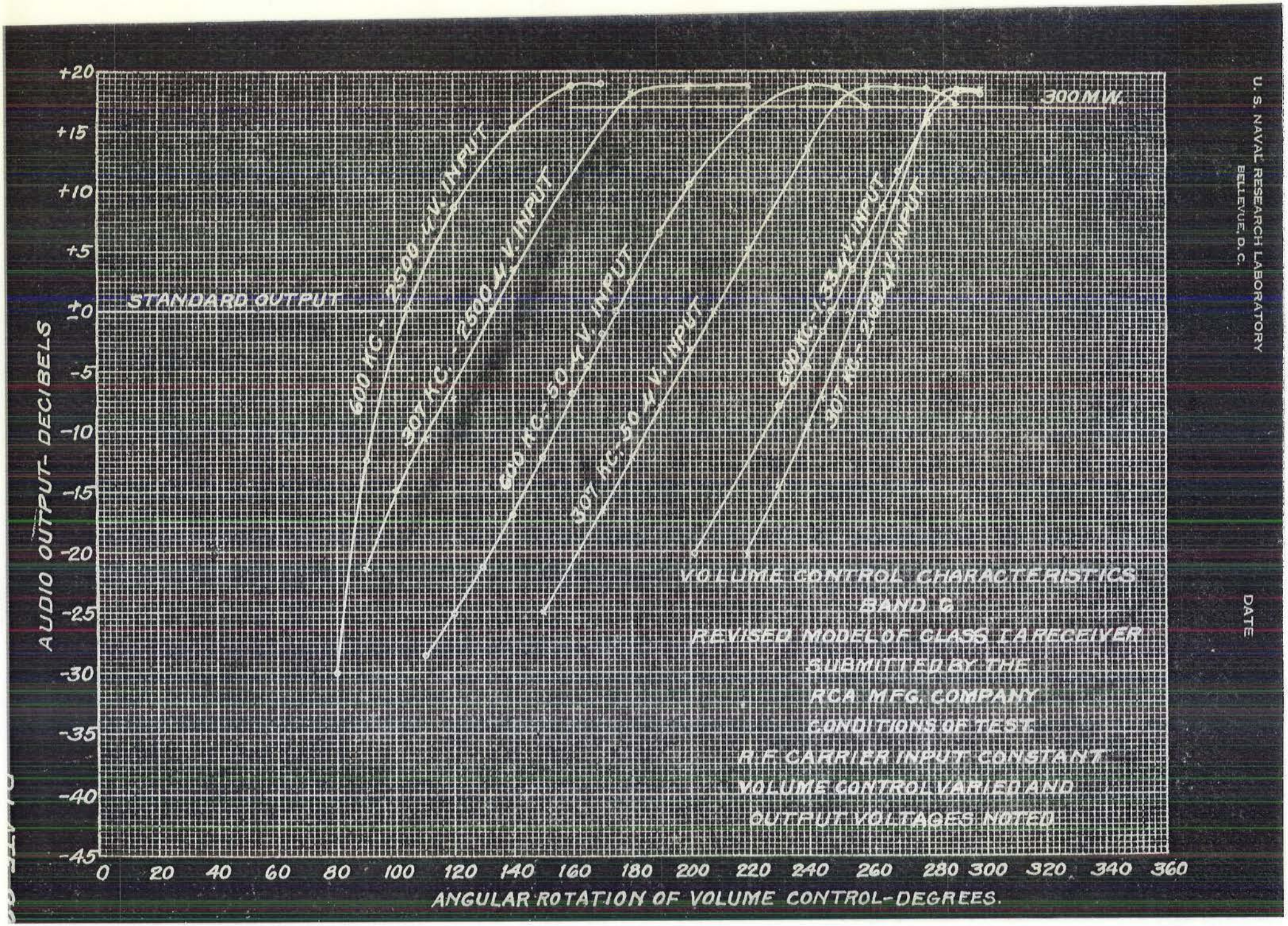
N. R. L. 31A



BELLEVUE, D. C.

DATE

DATE 22


+20
+15
+10
+5
±0
-5
-10
-15
-20
-25
-30
-35
-40
-45
AUDIO OUTPUT- DECIBELS
STANDARD OUTPUT
600 KC.- 2500 M.V. INPUT
300 KC.- 2500 M.V. INPUT
600 KC.- 50 M.V. INPUT
300 KC.- 50 M.V. INPUT
600 KC.- 15 M.V. INPUT
300 KC.- 15 M.V. INPUT
300 M.W.
VOLUME CONTROL CHARACTERISTICS
BAND C
REVISED MODEL OF CLASS I A RECEIVER
SUBMITTED BY THE
RCA MFG. COMPANY
CONDITIONS OF TEST
R.F. CARRIER INPUT CONSTANT
VOLUME CONTROL VARIED AND
OUTPUT VOLTAGES NOTED
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360
ANGULAR ROTATION OF VOLUME CONTROL-DEGREES.
U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.
DATE

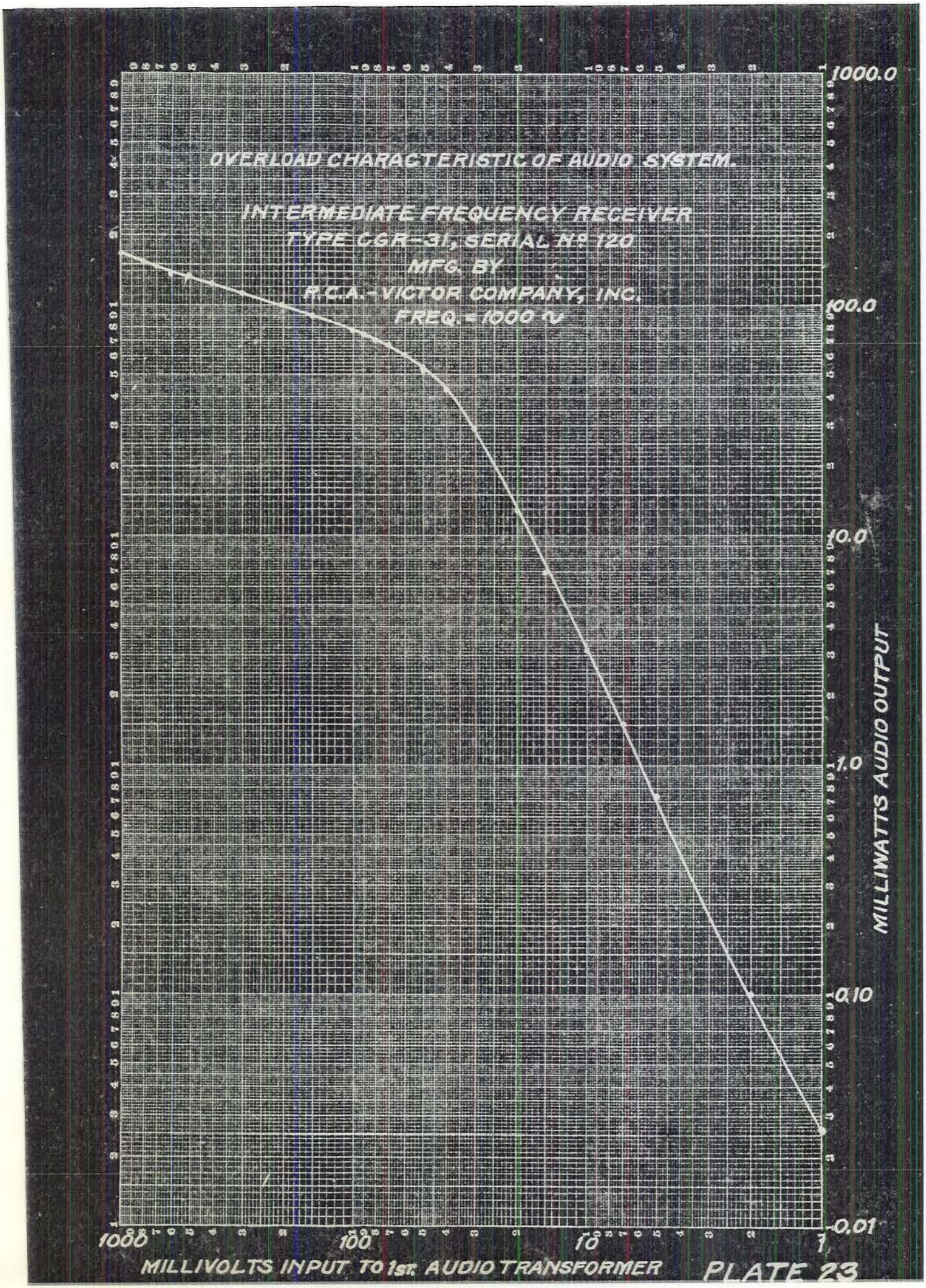
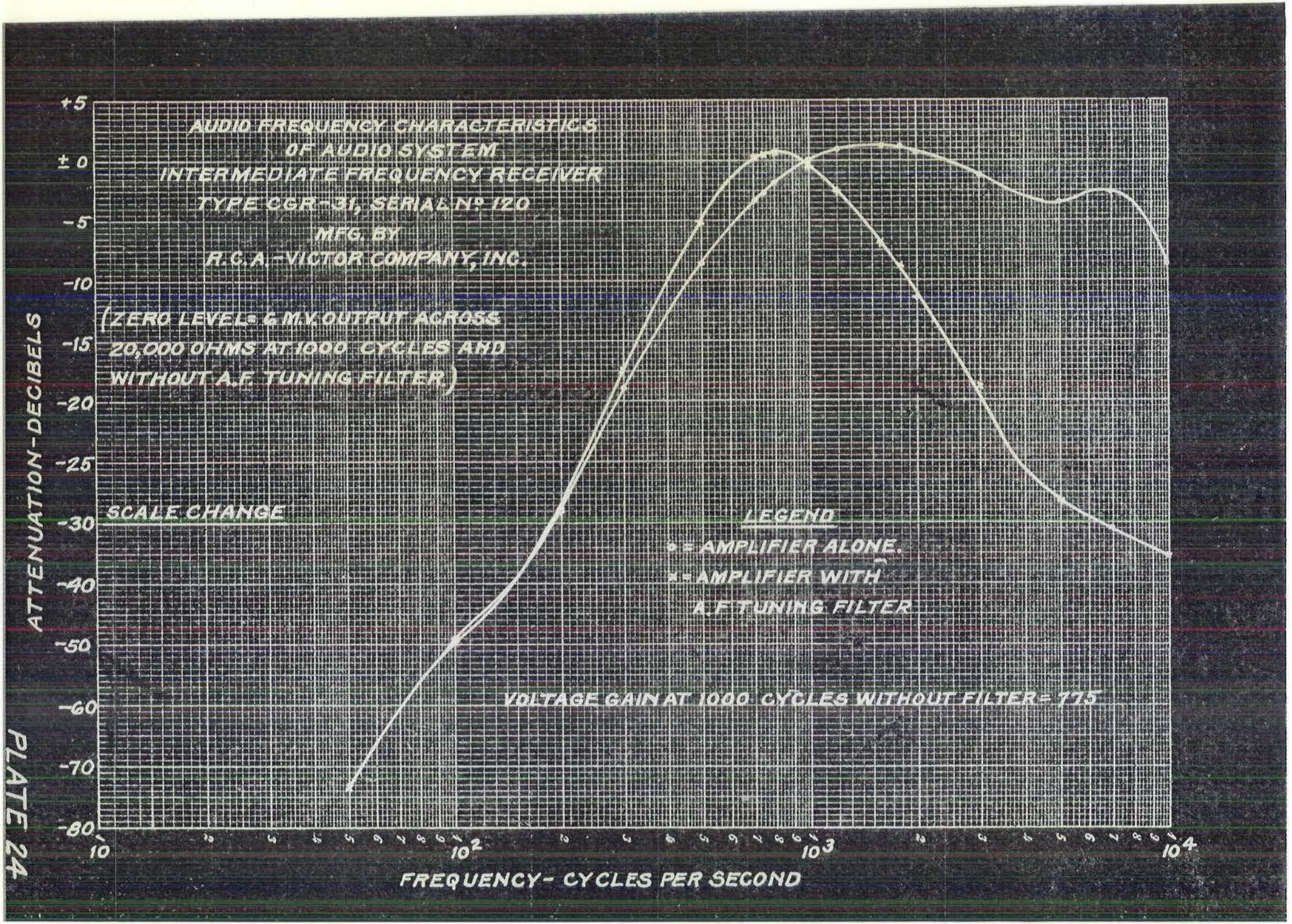

OVERLOAD CHARACTERISTIC OF AUDIO SYSTEM.
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL Nº 120
MFG. BY
R.C.A.-VICTOR COMPANY, INC.
FREQ.-1000 ~
1000.0
100.0
10.0
1.0
0.10
0.01
MILLIWATTS AUDIO OUTPUT
1000
100
10
1
MILLIVOLTS INPUT TO 1st. AUDIO TRANSFORMER

PLATE 23


AUDIO FREQUENCY CHARACTERISTICS
OF AUDIO SYSTEM
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL No. 120
MFG. BY
R.C.A.-VICTOR COMPANY, INC.
(ZERO LEVEL = 6 M.V. OUTPUT ACROSS
20,000 OHMS AT 1000 CYCLES AND
WITHOUT A.F. TUNING FILTER)
SCALE CHANGE
LEGEND
• = AMPLIFIER ALONE.
× = AMPLIFIER WITH
A.F. TUNING FILTER
VOLTAGE GAIN AT 1000 CYCLES WITHOUT FILTER = 775
+5
± 0
-5
-10
-15
-20
-25
-30
-40
-50
-60
-70
-80
ATTENUATION-DECIBELS
10
10^2
10^3
10^4
FREQUENCY - CYCLES PER SECOND
PLATE 24

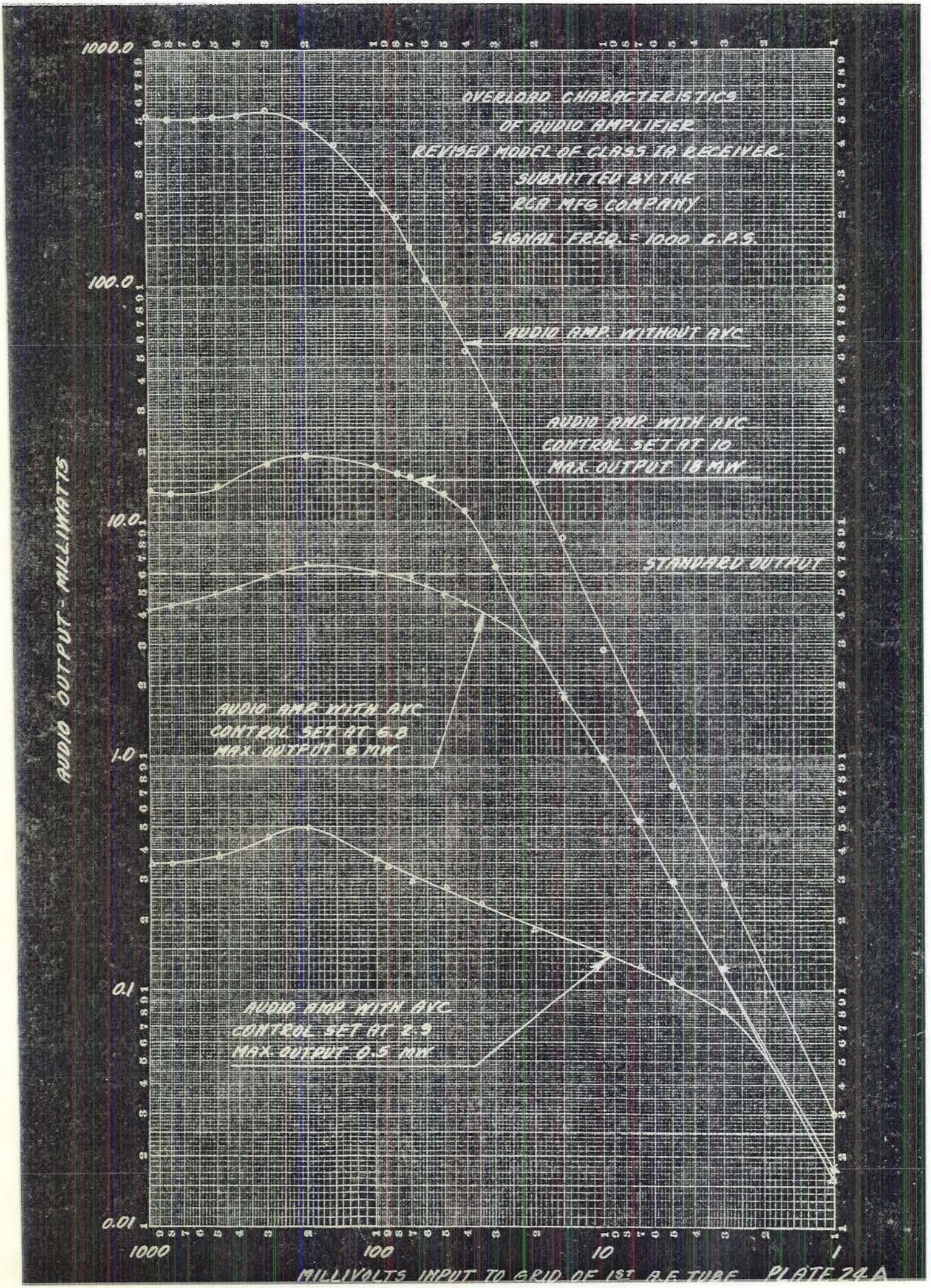
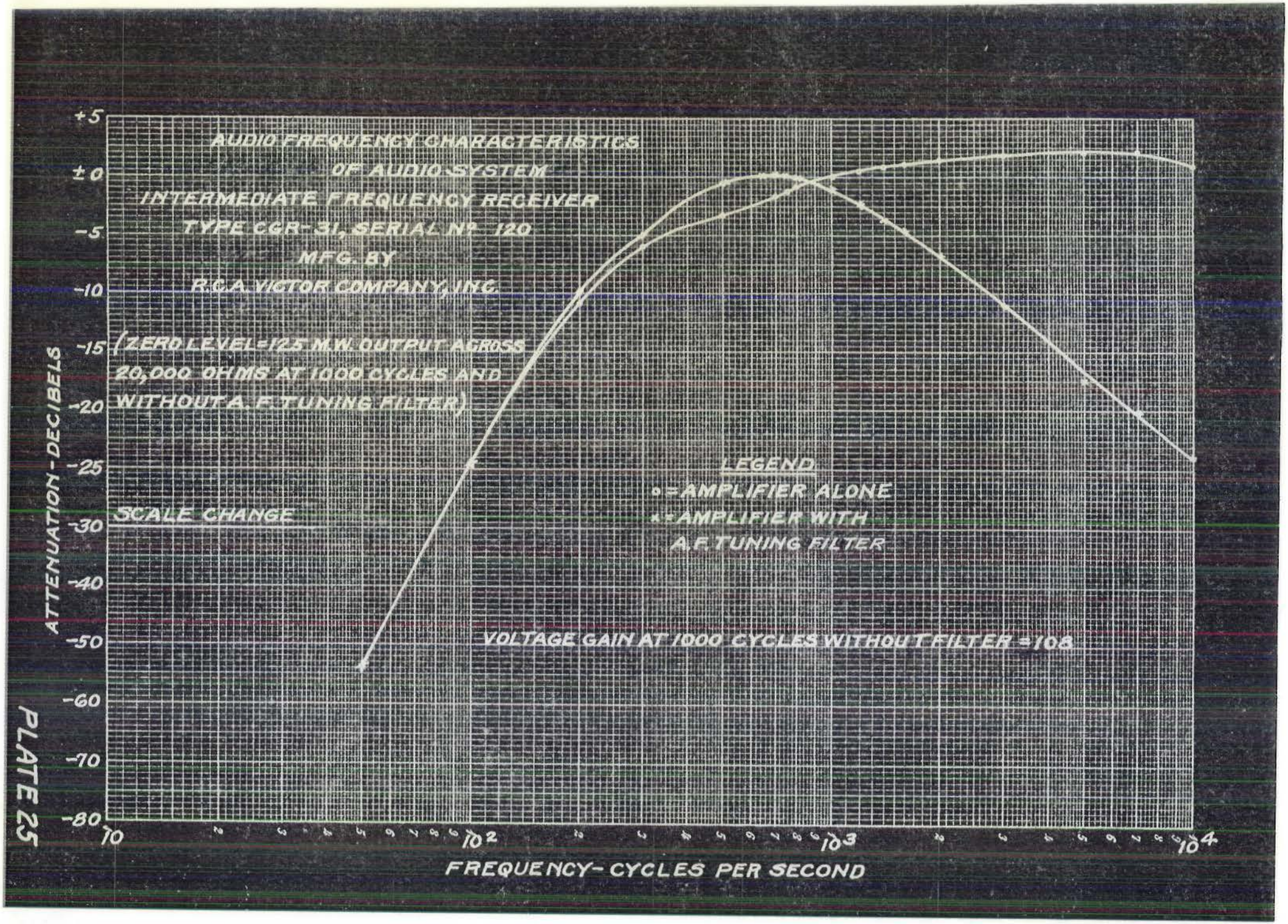
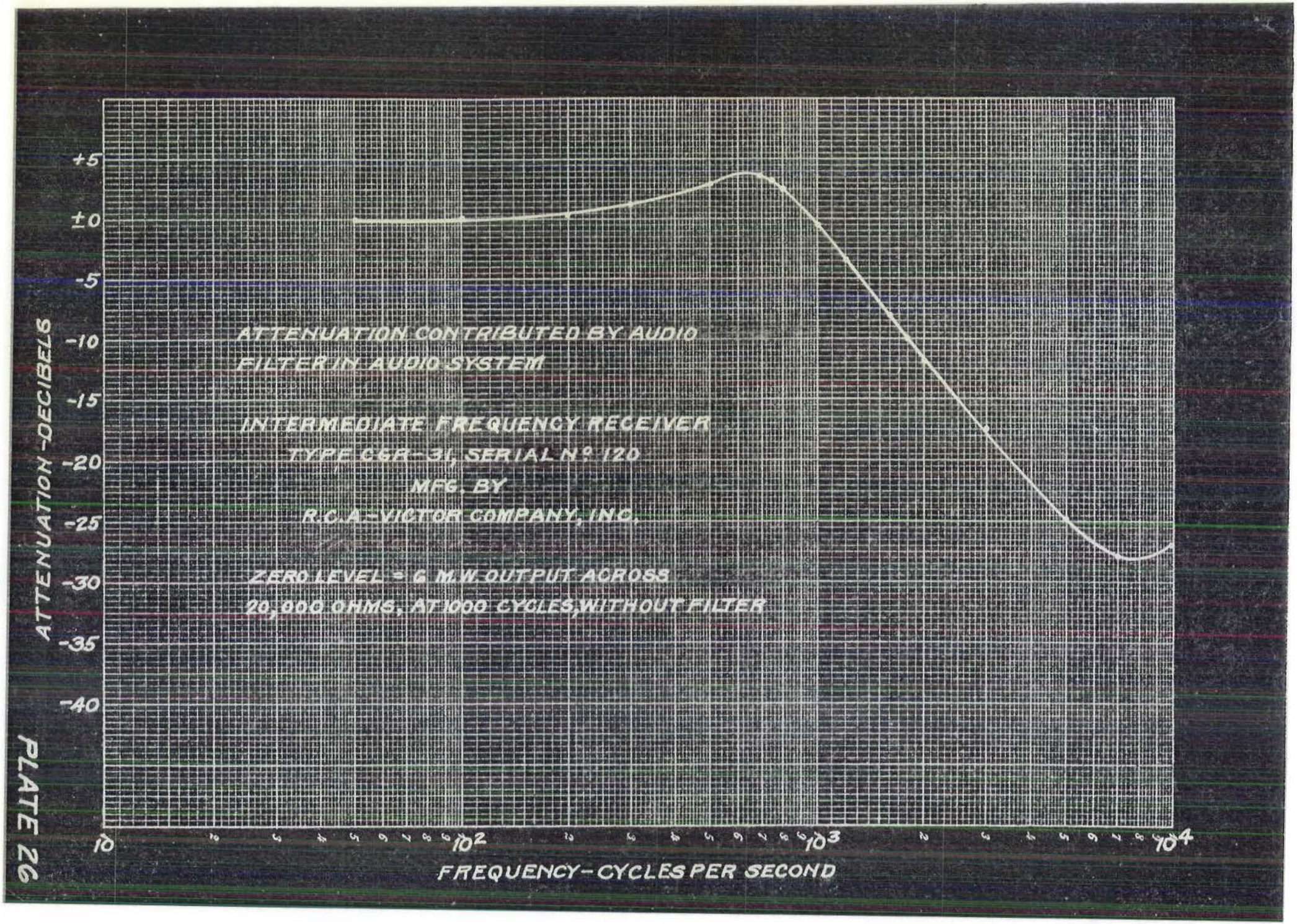
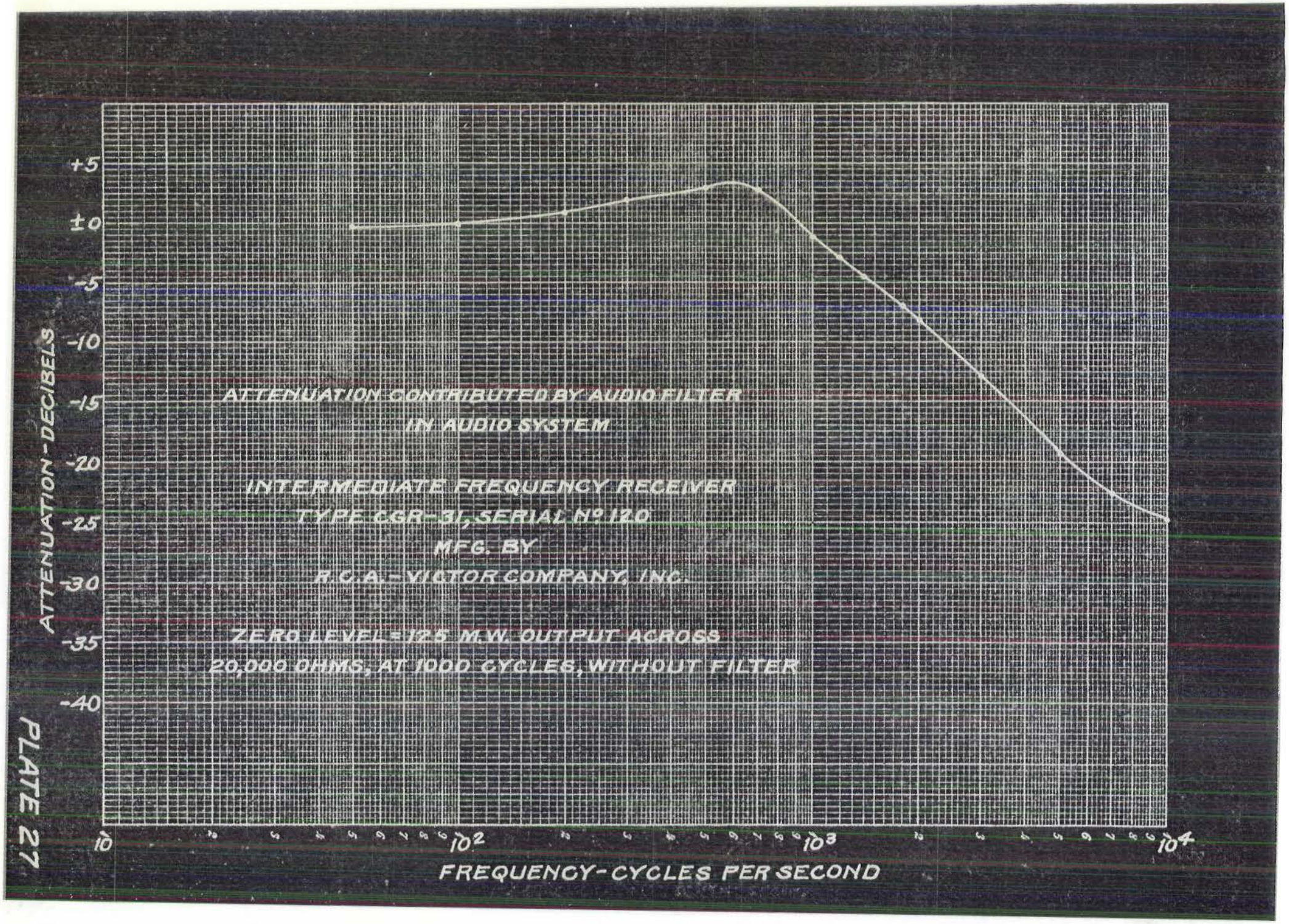

OVERLOAD CHARACTERISTICS
OF AUDIO AMPLIFIER
REVISED MODEL OF CLASS 1B RECEIVER
SUBMITTED BY THE
RCA MFG COMPANY
SIGNAL FREQ. = 1000 C.P.S.
AUDIO AMP. WITHOUT AVC
AUDIO AMP WITH AVC
CONTROL SET AT 10
MAX. OUTPUT 10 MW.
STANDARD OUTPUT
AUDIO AMP WITH AVC
CONTROL SET AT 6.0
MAX. OUTPUT 6 MW.
AUDIO AMP WITH AVC
CONTROL SET AT 2.9
MAX. OUTPUT 0.5 MW.
AUDIO OUTPUT - MILLIWATTS
1000.0
100.0
10.0
1.0
0.1
0.01
1000
100
10
1
MILLIVOLTS INPUT TO GRID OF 1ST A.F. TUBE

PLATE 24 A


AUDIO FREQUENCY CHARACTERISTICS
OF AUDIO SYSTEM
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL NO. 120
MFG. BY
R.C.A. VICTOR COMPANY, INC.
(ZERO LEVEL=12.5 M.W. OUTPUT ACROSS
20,000 OHMS AT 1000 CYCLES AND
WITHOUT A.F. TUNING FILTER)
SCALE CHANGE
LEGEND
o=AMPLIFIER ALONE
x=AMPLIFIER WITH
A.F. TUNING FILTER
VOLTAGE GAIN AT 1000 CYCLES WITHOUT FILTER =108
ATTENUATION-DECIBELS
+5
±0
-5
-10
-15
-20
-25
-30
-40
-50
-60
-70
-80
10
10²
10³
10⁴
FREQUENCY-CYCLES PER SECOND
PLATE 25


+5
±0
-5
-10
-15
-20
-25
-30
-35
-40
ATTENUATION-DECIBELS
ATTENUATION CONTRIBUTED BY AUDIO FILTER IN AUDIO SYSTEM
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL Nº 120
MFG. BY
R.C.A.-VICTOR COMPANY, INC.
ZERO LEVEL = 6 M.W. OUTPUT ACROSS
20,000 OHMS, AT 1000 CYCLES, WITHOUT FILTER
10
10²
10³
10⁴
FREQUENCY-CYCLES PER SECOND
PLATE 26


ATTENUATION - DECIBELS
+5
±0
-5
-10
-15
-20
-25
-30
-35
-40
ATTENUATION CONTRIBUTED BY AUDIO FILTER
IN AUDIO SYSTEM
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL Nº 120
MFG. BY
R.C.A.-VICTOR COMPANY, INC.
ZERO LEVEL = 12.5 M.W. OUTPUT ACROSS
20,000 OHMS, AT 1000 CYCLES, WITHOUT FILTER
10
10^2
10^3
10^4
FREQUENCY - CYCLES PER SECOND
PLATE 27

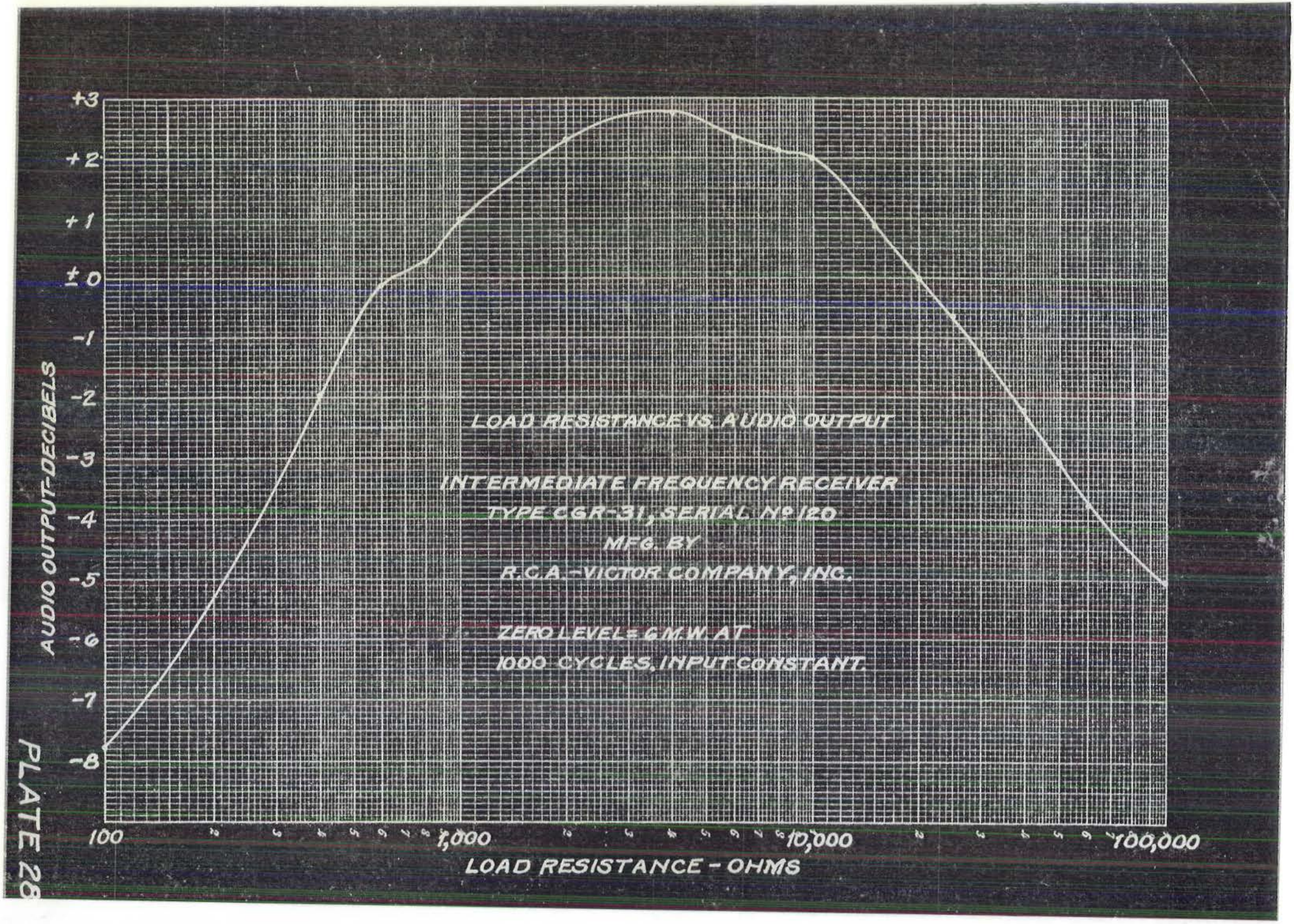
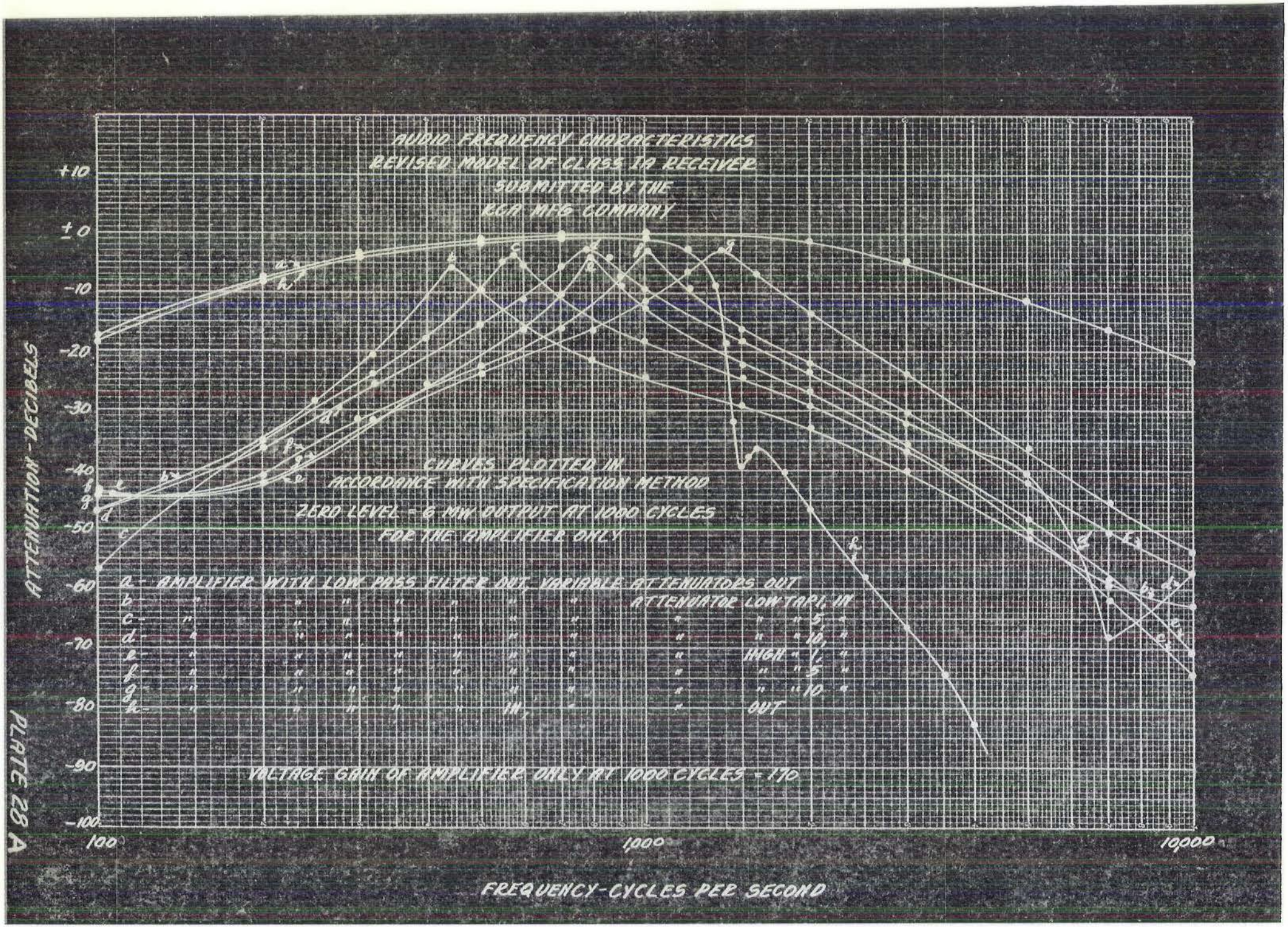
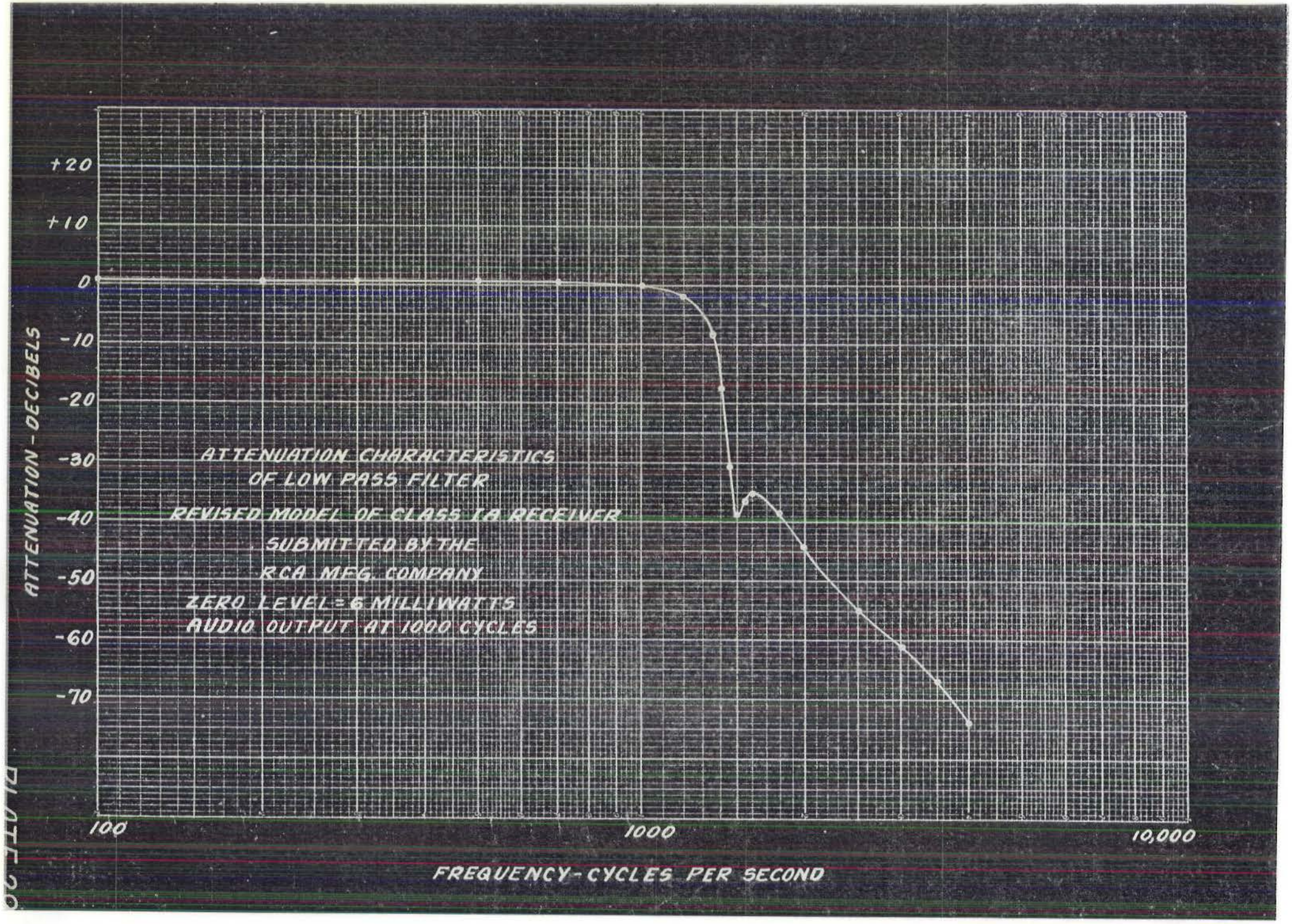

LOAD RESISTANCE VS. AUDIO OUTPUT
INTERMEDIATE FREQUENCY RECEIVER
TYPE CGR-31, SERIAL Nº 120
MFG. BY
R.C.A.-VICTOR COMPANY, INC.
ZERO LEVEL = 6 M.W. AT
1000 CYCLES, INPUT CONSTANT
+3
+2
+1
± 0
-1
-2
-3
-4
-5
-6
-7
-8
AUDIO OUTPUT-DECIBELS
100
1,000
10,000
100,000
LOAD RESISTANCE - OHMS

PLATE 28


AUDIO FREQUENCY CHARACTERISTICS
REVISED MODEL OF CLASS IA RECEIVER
SUBMITTED BY THE
RCA MFG. COMPANY
+10
± 0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
ATTENUATION - DECIBELS
CURVES PLOTTED IN
ACCORDANCE WITH SPECIFICATION METHOD
ZERO LEVEL = 6 MW OUTPUT AT 1000 CYCLES
FOR THE AMPLIFIER ONLY
a - AMPLIFIER WITH LOW PASS FILTER OUT, VARIABLE ATTENUATORS OUT
ATTENUATOR LOW TAP, IN
HIGH
OUT
VOLTAGE GAIN OF AMPLIFIER ONLY AT 1000 CYCLES = 170
100
1000
10,000
FREQUENCY - CYCLES PER SECOND
PLATE 28 A


+20
+10
0
-10
-20
-30
-40
-50
-60
-70
ATTENUATION - DECIBELS
ATTENUATION CHARACTERISTICS
OF LOW PASS FILTER
REVISED MODEL OF CLASS IA RECEIVER
SUBMITTED BY THE
RCA MFG. COMPANY
ZERO LEVEL = 6 MILLIWATTS
AUDIO OUTPUT AT 1000 CYCLES
100
1000
10,000
FREQUENCY - CYCLES PER SECOND

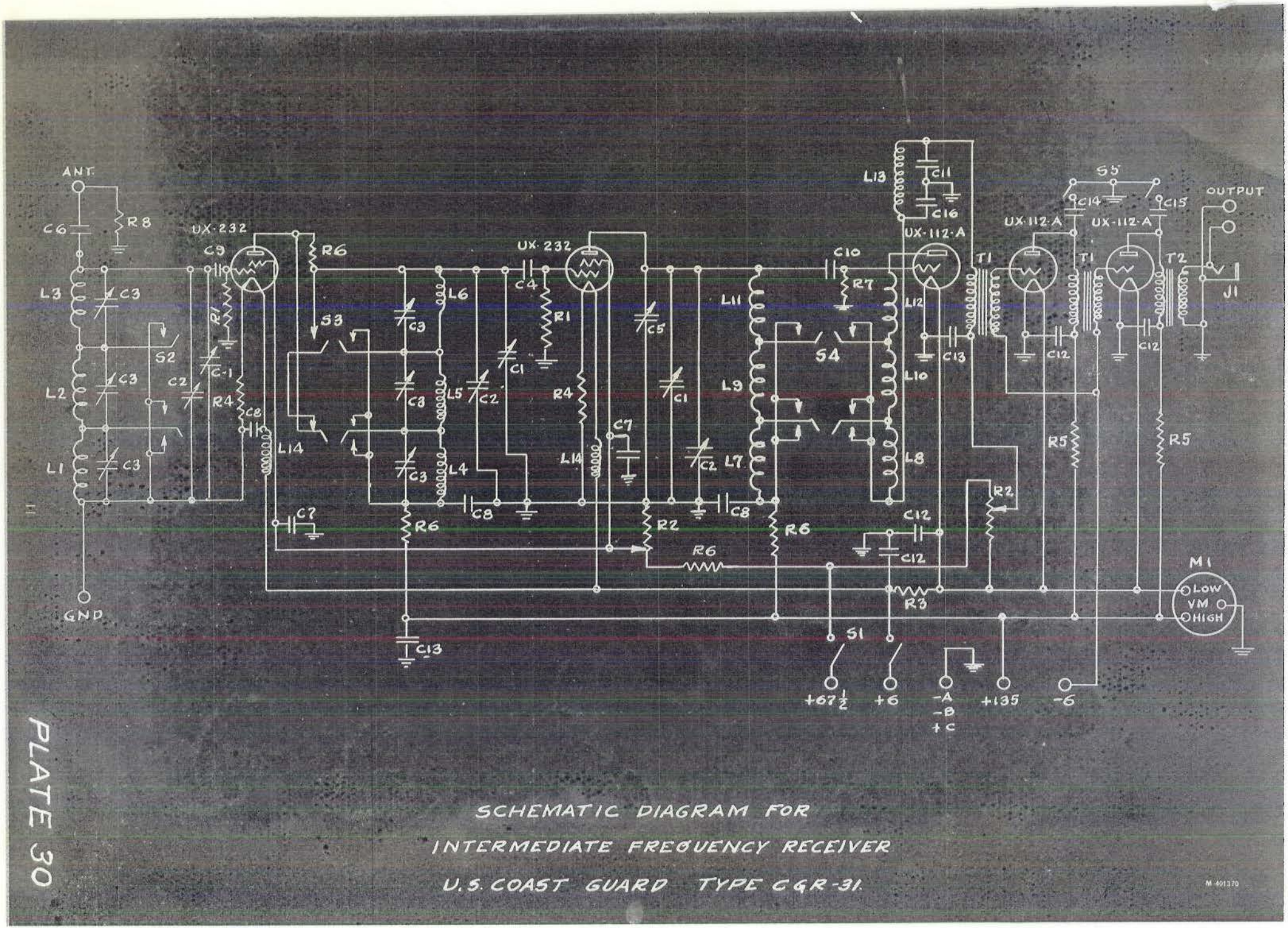
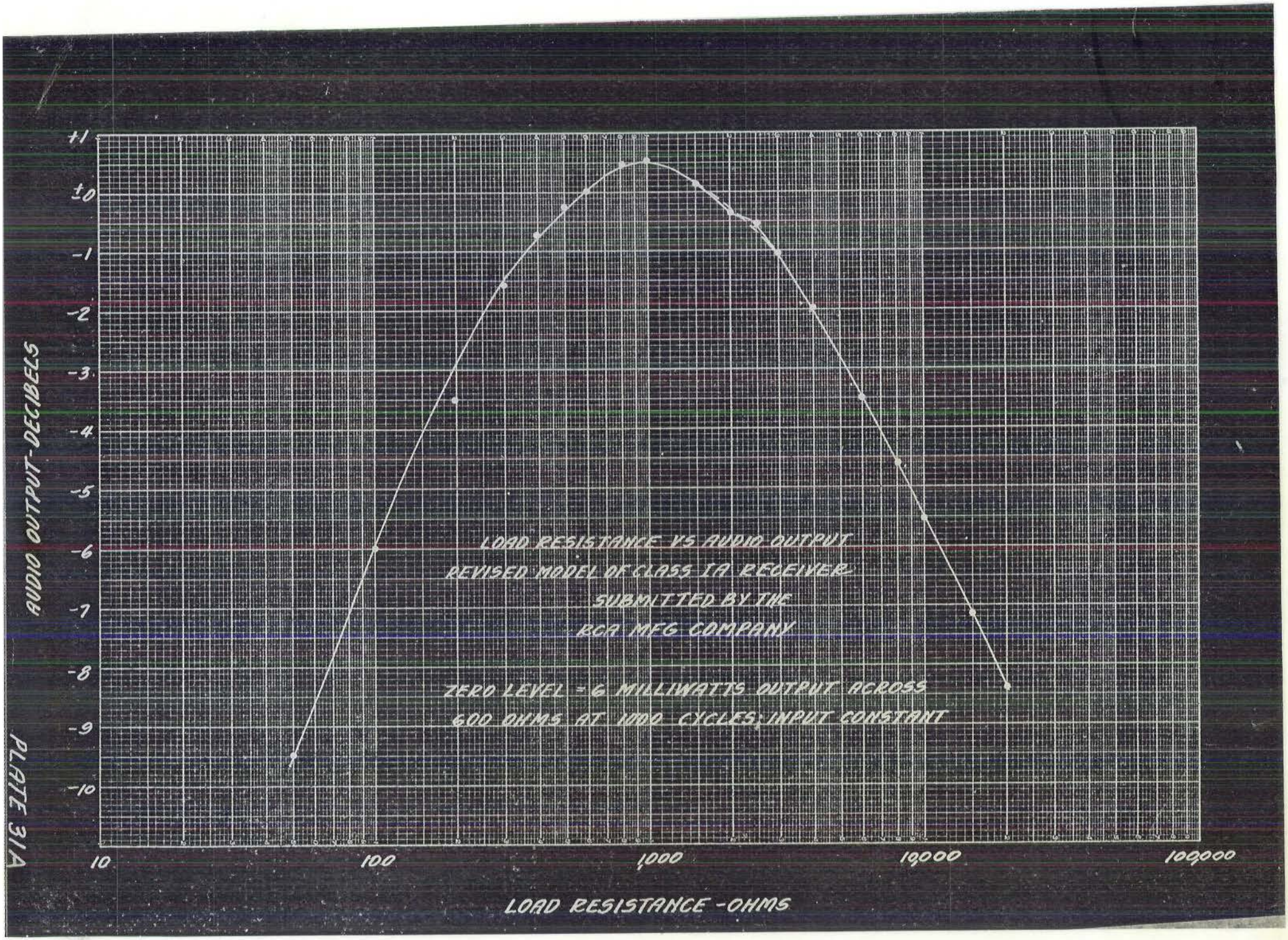


PLATE 30

SCHEMATIC DIAGRAM FOR
INTERMEDIATE FREQUENCY RECEIVER
U.S. COAST GUARD TYPE CGR-31.

M-401370


AUDIO OUTPUT-DECIBELS
+1
±0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
10
100
1,000
10,000
100,000
LOAD RESISTANCE - OHMS
LOAD RESISTANCE VS AUDIO OUTPUT
REVISED MODEL OF CLASS IA RECEIVER
SUBMITTED BY THE
RCA MFG COMPANY
ZERO LEVEL = 6 MILLIWATTS OUTPUT ACROSS
600 OHMS AT 1000 CYCLES; INPUT CONSTANT
PLATE 31A