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REPORT NO. R-1030

DATE 1 March 1934

SUBJECT

Test of Models RAA and RAB Receiving Equipments

(R.F. and I.F. Amplifier and Detector Circuits of the Model RAB)

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NAVY DEPARTMENT
BUREAU OF ENGINEERING



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NAVAL RESEARCH LABORATORY

BELLEVUE, D. C.

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Report No. R-1030
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NAVY DEPARTMENT
BUREAU OF ENGINEERING

Report on
TEST OF MODELS RAA AND RAB
RECEIVING EQUIPMENTS

(This report is submitted in three sections,
this section dealing with the test of the
radio frequency and intermediate frequency
amplifier and detector circuits of the
Model RAB.)

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

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Reported by: Warren B. Burgess, Associate Radio Engineer
Approved by: H. R. Greenlee, Captain, U.S.N., Director
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I AUTHORIZATION

1.1 The tests as reported upon herein were authorized by Bureau of Engineering letter S67/46/L5(12-22-W8) of 26 December 1933.

II OBJECT

2.1 This problem requires that exhaustive tests and examination of the Model RAA and Model RAB receiving equipments be made to provide the required data necessary for the preparation of revised specifications covering such equipments.

III DESCRIPTION OF EQUIPMENT

3.1 The receivers tested were manufactured by the RCA Victor Company of Camden, New Jersey, on Contract 22837. The Model RAA consists of the following:

- 1 - CRV 4550 Radio Frequency Tuner Serial #115
- 1 - CRV 4551 Intermediate and Audio Amplifier Serial #115
- 1 - CRV 4554 Power Unit Serial #157

The Model RAB consists of the following:

- 1 - CRV 4552 Radio Frequency Tuner Serial #74
- 1 - CRV 4553 Intermediate and Audio Frequency Amplifier Serial #74
- 1 - CRV 4554 Power Unit Serial #203

3.2 The audio system as reported upon and covered by the data, shown on Plates 200 to 217 inclusive, was not the one included in either of the receiver models, but was made up of the following parts purchased from the same company and under the same specifications as apply in the receiver contract, on Naval Research Laboratory Contract N-173 S-1893.

- 1 Type CRV 30019 input transformer, 35.7-1 ratio
- 1 Type CRV 53001 low pass filter
- 1 Band pass filter either (Type CRV 53002 for the RAA or
(Type CRV 53010 for the RAB.
- 1 Type CRV 4555 audio chassis

3.3 The voltage supply to the assembled audio system was as indicated in the instruction books supplied with the RAA and RAB equipments. The standard power unit was used for voltage supply in all cases where wave form and harmonic analysis data was taken. A Laboratory power pack was employed in other tests due to there being but one complete standard model of each type of equipment available, these being required almost continuously for other tests which were made simultaneously with the audio tests.

3.4 Both receivers are of the superheterodyne type. The RAA covers the range of 10 to 1000 and the RAB 1000 to 30000 kcs. These equipments are AC operated from a 60 cycle 110 volt power supply and have an output impedance suitable for use with from one to four pairs of 600 ohm telephone receivers connected in parallel.

3.5 The Model RAA employs an antenna coupling capacitor to the first of two loosely coupled tuned circuits which are followed by a single type 38035 R.F. amplifier tube. The R.F. amplifier tube has a tuned plate circuit which is inductively coupled to the tuned grid of the first detector. The first detector as well as the second function as plate detectors for weak signals while for stronger signals they function with both grid and plate rectification due to the presence of grid leak and stopping condensers as well as cathode bias resistors. Both the first and the second oscillators are type 38027 tubes. Their oscillator circuits are inductively coupled to the detector cathode bias lead. The coupling transformers from the first detector to first I.F., from first to second I.F., and from second I.F. to second detector have tuned primary and tuned secondaries which are slightly less than critically coupled, inductively. The second detector feeds into a low pass filter cutting off at around 4,000 cycles and a band pass filter may be cut in at will giving appreciable attenuation below 750 and above 1250 cycles. The audio amplifier consists of a resistance coupled stage employing a type 38024 tube followed by 38027 output stage feeding into a 600 ohm output transformer. An automatic volume control is provided which may be cut in at will. This consists of a high ratio step up transformer the primary of which, for AVC action, is cut in parallel with the output transformer. The secondary is center tapped and feeds to two 38027 vacuum tubes connected as biased rectifiers. As the receiver audio output voltage is applied to the rectifier anodes (plate-grid), this anode resistance decreases. This resistance is reflected through the high ratio transformer resulting in a lowering of the effective impedance load in the receiver output stage plate circuit, thus limiting the output voltage. The degree of limitation is controlled by a variable cathode bias on the rectifier tubes, thus providing an audio output level that can be controlled by the bias voltage.

3.6 The Model RAB receiver input couples to the antenna through a variable coupling capacitor which is used to compensate for various antenna constants, thus providing the ability to obtain resonance in the first tuned input circuit. There are two capacitively coupled tuned circuits preceding the first R.F. tube, which is a type 38058 pentode. This tube's grid is connected through a 1.0 megohm leak to a fixed 1.5 volt negative bias and is coupled to its grid circuit through a 250 uufd capacitor. The plate of the first R.F. tube connects to a mid tap of the inductance forming a part of the tuned grid circuit of the second R.F. stage. The tuned grid circuit of this stage, as well as that of the first and that of the first detector also, employs a fixed series capacitor in addition to the customary variable. The capacitance of this fixed capacitor varies from about double to triple that for the maximum of the variable depending upon the frequency band. The grid coupling capacitor for both of the R.F. amplifier grids is connected between the fixed and the variable capacitors. The grid of the second R.F.

tube obtains its bias voltage through a 1.0 megohm leak which is connected to a potentiometer volume control. The bias voltage variation obtainable from this volume control is from -1.5 to -75 volts. The plate of the second R.F. tube connects to the detector tuned grid at a mid point on the inductance similar to the preceding stage. The grid of the detector, however, is connected directly to the plate of the second R.F. tube through a coupling capacitor and to ground or -B through a 1.0 megohm leak. The detector functions as a plate rectifier for weak signals due to a cathode bias resistor but for sufficiently strong signals to draw grid current, both grid and plate rectification occur. Both the first and the second oscillators are type 38064 tubes. These oscillators couple to their respective detectors inductively through couplings provided in their cathode circuits. The oscillator filaments are heated by direct current supplied from the rectified B supply potential divider. The plate circuit of the first detector is tuned to the I.F. and coupled through a low impedance line to the tuned grid circuit of the first I.F. tube (type 38035). The coupling transformers between the first I.F., second I.F., (type 38035) and the detector (type 38024) are similar and consist of separately tuned grid and tuned plate circuits, capacitively coupled. Both of the I.F. grids obtain their bias voltages from the same volume control voltage regulating potentiometer as does the second R.F. tube mentioned previously. The second detector differs from the first in that it is a straight cathode biased plate rectifier. The plate circuit of this detector is provided with an R.F. filter in addition to the transformer primary which feeds the low pass filter as mentioned in connection with the Model RAA audio system previously described. The audio system is similar to that described for the Model RAA except for the characteristics of the band pass filter system which passes from 700 to 1300 cycles with slight attenuation and with appreciable attenuation below 600 and above 1600 cycles.

3.7 The type CRV-4554 power supply unit which is adaptable to either the Model RAA or the RAB has been designed to operate from a 60 cycle 110 volt line drawing approximately 235 watts. The power supply circuit consists essentially of an R.F. filter in the 110 volt supply line to the electrostatically shielded power transformer, two type 38180 rectifier tubes, a two stage filter, a voltage regulator tube and the voltage divider system. The two type 38180 rectifier tubes are operated in parallel and the type 38274 regulator tube is employed to stabilize the 90 volt B supply which feeds the oscillator plates and improves frequency regulation.

3.8 In view of the detailed description given in the instruction books supplied with each type of equipment, only a brief description has been given herein. If further detail is desired, the reader is referred to RCA-Victor Company's instruction books as issued with Contract NOs 22837 dated 30 June 1931, #IB-23206 applying to the Model RAA and #IB-23207 to the Model RAB.

IV TESTS

(a) Outline of Tests.

4.a.1 For purposes of measurement, the Model RAB receiver was set up in a screen booth to exclude local interferences. A shielded power lead of minimum length was used. Power was supplied by a local generator.

4.a.2 It was necessary to set up the receiver units without their cases to facilitate access to points of measurement. This is not believed to have affected performance, as the component parts are very thoroughly shielded. The instruction book indicates that operation should be normal without the cases.

4.a.3 These tests have been made on the receiver as delivered to the Laboratory, without adjustment of trimmers, except that the second oscillator, Band A, was readjusted for frequency, as it was found in error by 4 kilocycles in 600. The equipment is supposedly an average sample from the production line.

4.a.4 Radio frequency inputs were provided by Model LC-1 standard signal generators. For Band A-2 observations, the frequencies were matched with the harmonics of the temperature controlled crystal calibrator in the Model LF frequency measuring equipment. Radio frequency outputs were measured in one test by means of a sensitive vacuum tube voltmeter, 0.01 to 2 volts. Only relative readings were taken with this instrument, as it has a finite input impedance and increases the losses of the circuits to which it is connected. Changes in plate currents of detectors were measured by the insertion, at points of low radio frequency potential, of portable meters of high sensitivity, the normal current being balanced out by suitable batteries and resistors, only the current increments being read. Audio frequency outputs were measured on 600 ohm output meters of the rectifier type. Audio frequency beat frequencies were measured by comparison with the output of a General Radio type 513-B beat frequency oscillator.

4.a.5 The following definitions are the basis on which test procedure was built. They differ somewhat from standard practice.

Sensitivity is the number of microvolts of C.W. radio frequency energy, pure or 30% modulated at 1,000 cycles, impressed on the antenna circuit through 300 ohms non-inductive resistance, at resonance, to produce standard output (5 milliwatts, noise plus signal) at standard output frequency (1,000 cycles) with optimum gain.

Selectivity is the number of times the resonant input signal necessary to produce standard change in average plate current of the second detector.

Gain between two points in the receiver is the ratio of the voltage due to signal at the point farther from the antenna to that at the point nearer to the antenna. It is measured by connecting a low impedance signal generator successively at the points in question, noting the inputs required to give standard radio frequency output, and taking the ratio of these inputs.

Optimum Gain of the receiver is the highest gain which may be used without exceeding standard output noise level (0.42 milliwatts, 0.5 volts at 600 ohms).

Image frequency sensitivity for any given resonant frequency setting of the receiver is the sensitivity measured in the usual way, for a frequency equal to the resonant frequency plus twice the corresponding intermediate frequency.

Overload is the condition of excessive signal voltage at any given stage, causing a decrease in the gain of such stage.

Preselector includes the antenna circuit and all tuned circuits preceding the first tube.

First radio frequency stage includes from the first radio frequency grid to the second radio frequency grid.

Second radio frequency stage includes from the second radio frequency grid to the first detector grid.

Detector stage includes from the first detector grid to the first intermediate frequency grid.

First intermediate frequency stage includes from the first intermediate frequency grid to the second intermediate frequency grid.

Second intermediate frequency stage includes from the second intermediate

4.a.6 The exhaustive tests requested by the Bureau have been interpreted to require all the ordinary tests of sensitivity, selectivity, image frequency sensitivity, overload, audio frequency characteristics, radiation, etc. In addition, careful examination of stage by stage gains and selectivities were considered necessary in order that duplex overloading effects might be deduced. Direct measurement of duplex overload conditions having been previously attempted and found impractical because of lack of suitable equipment, no such attempt has been made on the subject receiver. This report does not cover the audio frequency amplifier, as this has been covered elsewhere. Where audio frequency outputs were measured, the "broad" condition was used. It has been found impossible to complete the tests of this receiver in the time allotted. The work completed is reported herewith.

(b) Method of Conducting Tests.

4.b.1 An attempt has been made to make tests on a more accurate basis than in previous cases. This has led to a number of changes in procedure, the reasons for which will be discussed under V below.

4.b.2 For radio frequency input tests, a standard signal generator (LC-1 #18) was equipped with a special low loss, low capacity shielded lead about three feet long, which length was necessary to reach the input posts

and all radio frequency stage inputs. For "antenna" inputs, a 300 ohm non-inductive resistor was used, as specified. The construction of this receiver, unlike the Model RAA, does not permit easy access to tube grids for measurement purposes. In order to connect the signal generator cable to successive grids without removing important components of the shielding, it was necessary to drill holes in the back plate of the radio frequency catacomb to permit insertion of an insulated probe to the grid connections of the various tubes. This unavoidably placed the low impedance output of the generator in parallel with the relatively high impedance of a tuned circuit in each case. To avoid disturbance of the normal grid bias (maintained by a one megohm resistor in each radio frequency stage) a mica capacitor of 0.00025 mfd was used in series with the high potential generator lead. It was not always practicable to return the low potential lead to the appropriate bias point, so it was returned to ground in each case.

Input tests to the intermediate frequency stages were made by a second signal generator (LC-1 #13) through a 0.5 mfd capacitor in the high potential lead. No grid leaks are involved in these biases. For these tests, it was found possible, by careful handling of a second probe, to contact the grids as required, through ventilating holes already existing in the intermediate frequency amplifier cover. This was simple in the lower frequency bands, but will be more difficult in the higher bands, when the intermediate frequency amplifier slides under the audio frequency amplifier assembly. This second generator was set to frequency in each run by adjusting it to zero beat with the intermediate frequency produced by combination of the radio frequency input and the first oscillator. This eliminated any error due to the frequency calibration of the second generator.

4.b.3 The change in second detector plate current was measured by the use of a meter in this circuit. No jack is provided for this purpose, as is done in the Model RAA receiver, so it was necessary to open the circuit connections and bring out leads. An attempt to measure this current below the radio frequency by-pass capacitor was abandoned, because the smallest of line voltage surges kept the meter in motion such as to prevent reasonably accurate measurements. It was found necessary to insert the meter at the low potential end of the 250,000 ohm plate resistor to minimize these variations. This is the point at which a jack has been connected in the Model RAA equipment. A portable meter (6 microamperes full scale) was used in this circuit, the initial plate current balanced out by local battery and suitable resistors. Later, a portable galvanometer was substituted, to eliminate the effects of pivot friction and provide increased deflections. This meter was calibrated as a microammeter and proved to be a substantial improvement. A short circuiting key was used for meter protection. As a further refinement, it was found necessary to substitute batteries to provide the screen and plate potentials for this tube. This provided a considerable increase in measurement accuracy. Under such conditions, possibly the meter could be connected below the by-pass capacitor successfully, but such a test has not been made. This substitution of batteries was made only for sensitivity and selectivity tests, a return to power pack supply being made for studies of overloads, drifts, etc., in order that conditions might be normal.

4.b.4 The vacuum tubes used were tested and found to be average tubes.

4.b.5 Since it was evident that complete tests over the whole range of the receiver would not be possible in the limited time and since there is considerable difficulty in accurately measuring inputs at the higher frequencies, it was believed that the Bureau's interests would be best served by getting complete information on one or more of the lower frequency bands, adding such information about the higher ranges as time might permit.

4.b.6 A check showed the limiting frequencies of the bands, as specified by the manufacturer, to allow reasonable overlaps and to be the proper end frequencies for the bands to permit comparisons from band to band on overlapping frequencies. Each band was laid off in geometric progression to assign five suitably spaced frequencies for sensitivity tests, the first, third, and fifth being chosen for selectivities also.

4.b.7 After completion of the first band (A-1), there having been some difficulty with frequency drift of the signal generators with temperature and battery voltages, all selectivity test frequencies were shifted to the nearest 30 kilocycle harmonic, to provide for convenient checks of the resonant frequencies by means of the Model LF crystal calibrator. This made a distinct improvement in the precision of measurement, particularly on selectivity runs interrupted over night. It was found best to keep the receiver warm all night and give the signal generators an hour to become stable in the morning.

4.b.8 The test of Model RAA equipment having been started before that of the RAB and a basically more accurate method of determination of signal levels in selectivity tests having been worked out, it was considered that this method would best fit the tests on the subject equipment. Tests to establish the facts in the matter included the effect of input signals on noise level and the proportions of output contributed by inherent noise, the C.W. carrier, and the modulation used.

4.b.9 Because novel features were introduced, and because greater accuracy of measurement was attained than usual, the detailed operations involved in a combined sensitivity-selectivity run are listed herewith.

Procedure:

Find signal generator setting for the resonant frequency, a harmonic of 30 kilocycles. Work out scale increments for percentages above and below this point from manufacturer's first derivative curves. Be sure second detector plate current is balanced to zero, and stable. Set generator to antenna position; tune in MCW signal; set receiver roughly to optimum gain; cut off modulation and add input from crystal harmonic; adjust generator to zero beat in head phones; cut off crystal circuit. (Note - by suitable adjustment of input levels the difference frequency of the two sources may easily be adjusted to a fraction of a cycle by

observing the beat change in noise level after the beat frequency is below the audible limit.) Record generator setting.

Retune receiver carefully to 1,000 cycle beat on the unmodulated generator output, selecting the more sensitive side of the audio frequency note, keeping the output down to a low value (to prevent frequency reaction in the oscillators) and matching the beat note to a 1,000 cycle standard. Cut off input by setting generator attenuator to zero (not by short-circuiting the receiver input - this would affect tuning and gain) and adjust "Sensitivity" control to optimum gain. Record settings of "Antenna Compensator", "Tuning Control", and "Sensitivity Control". They must not be altered until all selectivity data are complete for this frequency.

Measure the input required for standard output (CW). Switch to MCW, noting change of plate current in second detector due to second oscillator. Modulate signal generator 30% at 1,000 cycles. Reduce output to zero. Advance "Sensitivity" control to optimum gain for MCW signals and record setting. Set MCW input for standard output. Record settings. Cut off modulation and note remaining noise due to combined receiver noise and CW carrier.

Set input to zero, cut off generator modulation, rebalance detector plate current, measure input for 0.40 microamperes increase. Repeat last measurement on first radio frequency, second radio frequency, and first detector grids.

With input to first detector grid still on, couple generator #13 to first intermediate frequency grid loosely and adjust it to zero beat with existing intermediate frequency. (Should be 600 kilocycles for Bands A-1 and A-2). Reconnect #18 to antenna circuit (at zero output), connect #13 to first intermediate frequency, second intermediate frequency, and second detector grids, successively, measuring input at each for 0.4 microamperes increase of detector plate current. Disconnect generator #13 and recheck antenna input on #18. If it does not check previous reading within 2%, investigate reason. Check noise level for constancy of gain.

Reset frequency to the first plus frequency increment and repeat stage by stage tests, receiver adjustments untouched. Next take the first minus increment and continue alternating from plus to minus until completion, in order to minimize the effects of small frequency drifts. It has been found possible to break a test, doing part one day and part the next, checking very closely from day to day if the gain is maintained constant and frequency at resonance is rechecked against the crystal, the receiver being kept warm over night.

4.b.10 It is important to note that the receiver tuning used is that determined by a 1,000 cycle output note on CW signal. This tuning is determined solely by the first and second oscillator frequencies, regardless of the tracking of other tuned circuits, but is the only one which may be used for CW test. For MCW sensitivity, the same tuning was

used. However, retuning for maximum MCW response would have shown a better sensitivity, possibly affecting measurements as much as ten or even twenty percent. Because the CW condition is considered the governing and important operating condition, retuning for MCW tests was not done.

4.b.11 Bands A-1 and A-2, using the 600 kilocycle intermediate frequency, were investigated at three frequencies each by this procedure. In addition, sensitivities were taken at the two other points mentioned for each band. Because of difficulties peculiar to the new methods used, the first two runs were found unsatisfactory and they were repeated after the completion of the other four in very much reduced time.

4.b.11 In order that some selectivity and sensitivity data might be available at the higher frequencies, an attempt was made to include some data on Bands D-1 and D-2. It was found impossible, above 20,000 kilocycles, to read input levels accurately, because signal generator leakages were serious and "zero" output at the signal generator showed a strong signal. This is a common occurrence at the higher frequencies. It can be avoided to some extent by careful spacing of units and experimenting for proper ground conditions. It was finally found possible to make reasonably accurate tests at 16,190 and 24,510 kilocycles on D-1, and 24,510 kilocycles on D-2. Because of lack of time overall selectivities on these frequencies had to be taken the easiest way; i.e., with modulated signals, using the audio frequency amplifier in the usual way at standard output.

4.b.12 Before it was decided to work only on the harmonics of 30 kilocycles for input, resonant overload curves were taken at 1544 kilocycles on Band A-2. Three runs were taken at different receiver sensitivities of input microvolts (CW) against power output.

4.b.13 Non-resonant overload data were taken with the receiver tuned to 1560 kilocycles, Band A-2, for the purpose of studying overloads in the radio frequency tuner. In this case, outputs were measured as microamperes change in the second detector plate current and data were taken on the change in the combined plate currents of the radio frequency stages and first detector. It would be difficult to separately measure the plate currents of these three tubes. This particular input frequency, 1560 kilocycles plus 1.30 percent, was chosen because there appeared to be an overload effect at this point; i.e., a relatively sharp noise minimum as the frequency of a strong carrier (about 0.1 volt) was varied.

4.b.14 Another resonant overload test was made at 2460 kilocycles, Band A-2, to locate the reason for overload effects repeatedly noticed whenever high inputs were used because of reduced gain or non-resonant conditions. Output was measured in terms of the second detector plate current.

4.b.15 A test was made of the sensitivity of the second detector, (MCW) in terms of microvolts input and plate current change, up to the 0.5 volt limit of the signal generator.

A similar test was made in the CW condition, it being necessary to apply the input to the second intermediate frequency grid, to avoid interference with the coupling of the second oscillator to the detector, with a measurement of the second intermediate frequency stage gain. These CW data are not presented here as it is hoped they may be better correlated with receiver conditions and presented later.

4.b.16 A test was made of beat frequency drift, for Band D-1, on the 24,000 kilocycle harmonic of a 300 kilocycle crystal calibrator, with temperature control (Model LF). Using two successive retunings, together with a receiver tuning control calibration, the second oscillator vernier and a calibrated beat frequency oscillator, the drift was observed for over two hours from a "cold start" at room temperature.

4.b.17 An additional test was made at the conclusion of the above run with the receiver warm, varying the line voltage and observing beat frequency drifts, both immediate values and after a short elapsed time.

V RESULTS OF TESTS

5.1 The test at 1,000 kilocycles, MCW, to analyse the noise and signal content of receiver output, resulted as follows:

Input Microvolts	Gain	Modulated Input		Unmodulated Input		No Input	
		#	*	#	*	#	*
1.15	Optimum	5.0	0.071	3.7	0.063	0.42	0.014
2.92	"	110	0.138	27.0	0.123	0.42	0.015
10.00	Reduced	5.0	0.096	1.0	0.080	0.0	0.0
100	Further reduced	5.0	0.121	0.0	0.118	0.0	0.0

Input Microvolts	Receiver Noise		Output due to carrier		Output due to Modulation	
	#	*	#	*	#	*
1.15	0.42	0.014	3.3	0.049	1.3	0.008
2.92	0.42	0.015	26.6	0.108	83.0	0.015

Milliwatts audio frequency output.

* Microamperes increase in second detector plate current, from no-signal condition.

5.2 In Plate 101 are shown the sensitivities, as far as tests have gone, of this receiver. The use of log-log paper permits showing the entire frequency range on one sheet, with all the bands shown at their relative widths. Bands A-1 and A-2 have been completely measured. Accompanying Sensitivity-Control settings were about 80 for CW and about 90 for MCW tests, to give optimum gain. The four bands B-1, B-2, C-1, and C-2, have not been tested. Two points in D-1, and one in D-2 are shown. Dotted lines indicate the uncertain position of the connecting lines. At 16,190 kilocycles, D-1, sensitivity was set at 94 for CW, and 100 for MCW, the latter giving but 24 microwatts noise. At 24,510 kilocycles, D-1 and D-2, full sensitivity was used, and the gain was still well below optimum.

5.3 Plate 102 gives overall selectivity by the test procedure outlined in detail under 4.b.9 for 1,000, 1244, and 1544 kilocycles, Band A-1.

5.4 Plate 103 covers, in similar fashion, 1560, 1950, and 2460 kilocycles, Band A-2.

5.5 Plate 104 shows selectivity for 16,190, and 24,510 kilocycles, Band D-1, taken as previously mentioned with modulated input.

5.6 Plate 105 shows, similarly, a curve for 24,510 kilocycles, Band D-2. These two plates will receive special comment under VI.

5.7 Plates 106 to 111, inclusive, summarize a large number of observations on individual stage gains, Bands A-1 and A-2. They are self-explanatory in form. Attention is invited to the abscissae, which are in terms of percent detuning from the resonant frequency. Since the intermediate frequency stage curves are shown in terms of radio frequency percent detuning, it has been thought wise to indicate the equivalent percent detuning in terms of the 600 kilocycles intermediate frequency. Since the first oscillator is maintained 600 kilocycles above the signal frequency, for a given receiver tuning, an increase of signal frequency decreases the intermediate frequency.

5.8 Plate 106, in curve A, shows the typical variation of second detector sensitivity, MCW, at about 600 kilocycles. Curve B shows substantially zero variation when no coupling exists to the tuned circuit of the inoperative second oscillator.

5.9 Plates 112 and 113 present overall resonant overload data, CW inputs, for optimum gain and two reduced gain settings selected to give sensitivities of 100 and 100,000 microvolts, respectively. The first two are substantially identical, except for horizontal displacement. The third indicates a serious overload condition, repeatedly experienced, the maximum output being but 45 milliwatts. Some difficulty was experienced in isolating the cause for this condition, owing to the limited output (0.5 volt) of the Model LC-1 standard signal generator.

5.10 Plate 114 shows non-resonant overload curves, receiver tuned to 1560 kilocycles, Band A-2, with CW inputs at the antenna, and first and second radio frequency grids, plotted against increase of second detector plate current. Curves are also shown of the accompanying change in the total plate current of the first three tubes, separation of the three components having proven impracticable.

5.1 Plate 115 summarizes a test to further study the overloads shown in Plate 114, under somewhat different conditions. With inputs at 2460 kilocycles, Band A-2, CW inputs are plotted against voltage outputs by vacuum tube voltmeter for the preselector and first radio frequency stages, second radio frequency and first detector, and first detector alone, together with a curve of grid current caused by excessive inputs on the first radio frequency grid. Sensitivity was increased to get sufficient gain from the second radio frequency stage but avoiding grid current in this tube. While outputs are in volts, it is important to note that the finite input resistance of this grid detection voltmeter materially alters stage gains, so that outputs are proportional to, but are not the actual gains. The detector curve was obtained by multiplying the second radio frequency stage inputs by the measured gain of this stage, which may safely be assumed to be practically constant, since it operated at sufficient grid bias to prevent the flow of grid current.

5.12 Plate 116 presents input microvolts, MCW, versus increase in second detector plate current, up to the 0.5 volt input available. The points shown are actual observations, while the straight line represents true square law response calculated to pass through the point at 100,000 microvolts input. This curve would have greater value if the inputs could have been carried further.

5.13 Plate 117 indicates the rate of drift of output beat note, with a constant crystal harmonic input frequency, against time from a room temperature start. It is interesting to note the relative smoothness of the curve, it having been somewhat difficult, not only to keep track of the beat note during the early rapid drift, using receiver tuning, oscillator vernier, and a variable pitch standard, but also to reconcile the variations of all three in properly evaluating the data.

5.14 Plate 118 shows the effect of increasing the line voltage on the warm receiver from below 90 to 125 volts on output beat frequency at 24,510 kilocycles, Band D-1. One or both oscillators started at 95 volts and a rapid variation of note ensued, a radical change appearing at 100 volts, after which, as the voltage was increased by five volt steps, the immediate output frequency assumed the value shown by the upper limits of the shaded area and after about two minutes assumed the value shown by the lower limit. These limits are only relative and may be varied radically by slight changes in procedure. For instance, the 120 volt observation showed 250 cycles after two minutes, but dropped to zero beat in three.

5.15 Miscellaneous use and cursory inspection of the instruction book for the Model RAB equipment discloses an unusually complete book. However, in the schematic wiring diagram, drawing P-701165, the caption "CW OSC. COILS, A₄ to D₄" has been erroneously placed to point out the radio frequency filter coils 42 and 43, in the plate circuit of the second detector. The arrow should point to coil 39, somewhat to the right.

5.16 No image frequency response could be found with 0.5 volt input in Band A-1. Further study should be made with higher inputs.

VI CONCLUSIONS

6.1 Table 1 (see 5.1 above) shows a 2100 percent increase in output for only 150 percent increase in input volts. Also, it is evident that as receiver noise is decreased, because of reduced gain, the modulation furnishes an increasing percentage of the output.

Table 2, calculated from Table 1, shows that at optimum gain and standard output, MCW, cutting off the modulation reduces the output only 1.3 milliwatts, or 26 percent. At a higher input, cutting off the modulation caused a decrease of 75.4 percent. The power output is, therefore, a poor indication of the amount of modulated energy at the output of the detector circuit.

The standard noise level, 0.42 milliwatt, increases considerably under the heterodyning influence of a resonant carrier. However, a non-resonant carrier has a much smaller effect and one well off resonance would not increase the noise level appreciably. Near resonance, the heterodyning effect will predominate, while well off resonance, the modulation effect will reach a maximum of 4.58 milliwatts. It follows, then, that such a type of measurement does not give a true ratio between the off-resonance and the on-resonance gains of the receiver. Since the on-resonance output is 5.0 milliwatts, representing 1.3 milliwatts due to the modulation, it may be considered that the proper selectivity measurement by this system would require an off-resonance input such that a change of 1.3 milliwatts would be caused in the output by switching modulation on or off. This would be laborious and slow. Instead, the usual procedure would measure the input required for $5.0 - 0.42 = 4.58$ m.w. of modulation effect, which would result in an off-resonance ordinate for the selectivity curve which would be high by a factor $4.58/1.30 = 3.53$. For any receiver test where a different ratio of signal to noise exists in the output, it is clear that this ratio would change. All selectivities measured by such a system are in error and the error applies in such a direction as to show a greater selectivity than is justified.

In contrast to this, if Plate 116 is consulted, it will be found that the increase of plate current in the second detector is proportional to the square of the input microvolts, (all selectivities and stage gain data were taken at 0.4 microamperes change.) The curve shows that the

CW voltage applied to the second detector grid may be accurately measured by a plate meter. The increase in receiver noise due to heterodyning by the carrier, therefore, is of no consequence in the test method used and the method is basically correct for obtaining selectivities. (See Report on Model RAA Receiver for further discussion.)

6.2 Plate 101 presents the sensitivities so far taken on this equipment. It should be remembered that no attempt has been made to retrim the receiver, measurements on a production line model being the aim. The second oscillator for Band A was readjusted and the same treatment for Band D is similarly advisable. The error for Band A was about 4 kilocycles or 0.67 percent.

The methods developed have been proven to give results which are quite reasonably reproducible, when the receiver settings remain undisturbed and the signal generator may be reset by precise methods. It is felt that the observational errors are, in general, small compared with the instrumental errors. Model LC-1 signal generators, at low outputs, are rated at 10 percent accuracy up to 1500 kilocycles and 20 percent up to 30,000 kilocycles at the output jack, after all corrections have been made. These instruments are among the finest of their kind. Accuracy of output meters averages about 10 percent. It is probable, therefore, that the sensitivities for Bands A-1 and A-2 are accurate to within 20 percent and for Band D-1, perhaps 30 percent, while the single frequency tested in Band D-2 is possibly 50 percent in error. This was a hurried observation and will be repeated if opportunity offers. At these higher frequencies, it is usually necessary to use at least a two foot shielded output cable from the signal generator to the receiver in order that there may be a minimum of leakage. This cable must have a minimum of both inductance and capacitance to minimize transmission errors. These two requirements are somewhat contradictory and very little information is available regarding the errors to be expected. It is necessary that considerable testing be done before the situation will be clear with respect to input voltages at the higher frequencies. Matching of impedances to permit use of true transmission line effects is very difficult in this case. The error due to leaving a tuned circuit in shunt to the signal generator output has been proven negligible at 2500 kilocycles and below.

The accuracy mentioned above does not include the discrepancy previously disclosed under 4.b, due to taking MCW sensitivities with the tuning set for a 1,000 cycle CW beat note, not on the setting for maximum overall gain. This difference is not likely to exceed 20 percent. Retuning for MCW would have lowered the MCW points on Plate 101.

6.3 The above discussion relative to selectivity measurements has a bearing at this point. It was pointed out that 5.0 milliwatt outputs on MCW test at optimum gain drop but 1.3 milliwatts when modulation is shut off. This is a representative condition for Bands A-1 and A-2, observations having been made for each sensitivity point. While the output meter indicated 5.0 milliwatts of noise and 1,000 cycle note, it should be pointed out that the ear would hear but little musical note because most of the

energy is in noise. The ordinary variability of the noise level noticeably affects the accuracy of output readings for the same reason. Most receivers in the past have been tested on the basis of 0.5 volt noise (20,000 ohm output) at optimum gain with 10 volts or 5.0 milliwatts standard output, signal plus noise. If the subject receiver had been tested on the same noise wattage basis, the gain would have been reduced to one-third and all microvolt inputs shown on Plate 101 would have been shown at about three times their present values. Such increased values would be more accurate for comparison with the sensitivities of previously tested receivers.

The 0.5 volt noise level was originally fixed as the smallest output which could be read on available output meters. This is no longer a valid limit, as a lower noise level may easily be read.

6.4 Plate 102 shows but little variation in selectivity over Band A-1. These data were very carefully taken and the ordinates are believed more accurate than previously quoted sensitivities, as a more accurate method was employed. 15 percent is considered a fair estimate of accuracy, although repetition has been made to 10 percent.

It has been pointed out in 6.1 above, that modulated signal methods of overall measurement are faulty and that the curves of Plate 102 may be expected to flatter the receiver somewhat less. In spite of this, selectivities are in fair agreement with the available curves previously taken on similar equipment, the new curves appearing somewhat broader.

The normal improvement in selectivity with lower L/C ratios appears to be largely neutralized by the superheterodyne characteristic of decreasing radio frequency to intermediate frequency ratio, at the lower end of the band.

All three curves show a slight error in tracking of the circuits, since the greatest gain is slightly to one side of the resonant frequency determined by oscillator frequencies only. This error is most pronounced at 1244 kilocycles.

The 1244 kilocycle curve presents an interesting departure from the ordinary shape. A discrepancy having been noticed, a large number of points were taken to obtain full information. With the second oscillator shut off, for selectivity measurements, it was observed that a beat note could be heard at about 1.1 percent below the resonant frequency, at the input level required for selectivity measurement at that point, about 2,000 microvolts. This is 1230 kilocycles, as nearly as the signal generator can be read. Since there was but one oscillator operating in the receiver, such a beat note must be caused by the beating of undesired frequencies. The first oscillator should be 1244 plus 600 or 1844 kilocycles. If, now, the second harmonic of 1230 beats with the oscillator, the difference is 616, increasing with increase of 1230, while the difference between 1844 and 1230 is 614, decreasing with increase of 1230.

Zero beat will occur between these two intermediate frequencies at about this point and accounts for the beat note observed. Less than 1 percent of second harmonic in the signal frequency would be adequate.

The receiver output curve on Plate 102 shows clearly the dip in noise level due to the combination of signals, with one side of the beat more pronounced than the other.

After this test, a check was made on the three test frequencies of Band A-2. While no detailed data are presented here, sweeping across the frequency range with 0.5 volt CW input, receiver set for MCW, produced a total of 29 separate beat notes for three receiver settings. Most of these beats were quite weak. All of them are undesirable. In addition, a number of successive maxima and minima of noise, unaccompanied by beats, were observed.

Imperfections in the contacts of the signal generator slide wire constitute insufficient modulation to be audible under usual circumstances. However, when the inputs approach 50,000 microvolts, off resonance, the scratching due to these modulations causes noise outputs approaching saturation of the audio frequency amplifier. They may be considered to shock excite the receiver, or that they give rise to damped oscillations of assorted frequencies, to some of which the receiver responds. At about 170,000 microvolts, the scratching ceases, probably because of reduced gain due to overload. This was observed, for instance, at plus 1.6 percent, 1244 kilocycles and at minus 1.75 percent, 1,000 kilocycles. All frequencies show actual or incipient overload at the curve limits shown.

The overloads observed off resonance were, in some cases, such as to permit obtaining only half, or less, of the standard output, after which the output decreased as input continued to increase.

The manufacturer's curves of overall selectivity were made with 50 microvolts resonant input and the ordinates reach 1,000 times resonant input. The curve here included for 1544 kilocycles shows incipient overload at 1,000 times with a resonant input of only 2 microvolts. It is possible that the overload conditions existed in taking the manufacturer's data, but were not evident because a modulated input was used. It has been found in the tests here reported, that overloads are less noticeable on MCW signals and that on CW, the effect is as though the first oscillator were pulled part way into synchronism. This would lower the intermediate frequency.

These conditions will be further discussed in connection with overload tests.

6.5 Plate 103, with its data on the selectivities of Band A-2, may be considered to be covered by the remarks on Plate 102. 2460 kilocycles overloads more easily than the other frequencies.

6.6 Plate 104 shows selectivities for the end frequencies of Band D-1, taken by a discredited method, but of accuracy probably similar to that of previous curves from other sources. It is hoped that ordinates are accurate to 50 percent. The curves agree reasonably with the manufacturer's sample curves.

6.7 The remarks of the previous paragraph apply, in general, to Plate 105. These bands need further study.

6.8 Plate 106 presents an individual stage gain analysis for 1,000 kilocycles, Band A-1. It shows clearly the imperfect tracking of the pre-selector circuit and of the first oscillator, since both intermediate frequency band pass stages are somewhat off center. The second radio frequency stage has a much lower gain than the first because of its higher grid bias due to reduced gain. (The first radio frequency stage has a fixed 1.5 volt bias.) It having been noted during the tests that the second detector sensitivity varied somewhat with frequency, Curves A and B have been added. It is evident that the variation in A is due to absorption in the inactive but coupled second oscillator circuit, which is peaked 1 kilocycle above the rated intermediate frequency. Curve B, with the coupling coil short-circuited, is practically flat and shows greater sensitivity. This condition affects only unmodulated reception, as the second oscillator, when active, furnishes negative resistance, thus reducing the losses of the grid circuit of the second detector. All stage gain curves are based on the use of Curve A, which is for normal conditions.

The intermediate frequency stages show an excellent band pass characteristic about 10 kilocycles wide, and are well matched. It is interesting to note how accurately the curves of Plates 106-111 repeat the detail differences in shape of these two stages. The width, as plotted, varies as the radio frequency to intermediate frequency ratio varies.

6.9 Plate 107, covering the middle frequency of Band A-1, is very similar. However, the preselector gain curve shows little drop on the lower frequency side as far as the data could be taken. It is evident that the preselector is of no value to the receiver with respect to duplex operation up to minus 1.5 percent. It is useful to prevent image interference, which would come on the plus side.

6.10 Plate 108 shows a still worse broadening in the preselector characteristic. (Compare with Plates 109, 110, 111.) Dash extensions to the preselector and first radio frequency curves indicate the effect of overload. This plate presents the poorest data of the report. In view of the haste required, the runs were not repeated, as it is believed the curves are reasonably accurate. A comparison with Plates 106 and 107 indicates the improvement in accuracy with more experience in this particular type of measurement.

6.11 Plates 109, 110, and 111 give a stage analysis of Band A-2. Only at the lowest frequency does the preselector show a near-resonant peak, as in Band A-1. At the higher frequencies, the double humped

curve indicates excessively close coupling in the double tuned circuit and a complete lack of preselection on the low frequency side. The pre-selector, then, is a protection only on the high frequency side, which is the side on which image response would occur. It is regrettable that the signal generators have not sufficient output to carry the curves farther from resonance, or to investigate overloading on the first radio frequency tube, which has only a 1.5 volt bias.

6.12 In obtaining the stage gain data of Plates 106-111, inclusive, it was observed that overloads occurred at from 0.75 to 2.0 percent on either side of resonance. The effect of the overload was to show a maximum second detector plate change of less than normal (0.4 microampere) which decreased as input was increased. A similar effect was observed at about 200,000 microvolts input to the antenna circuit with greatly reduced gain, during a comparison of the outputs of two signal generators.

Plates 112 and 113 present data taken in the search for the cause of the overload. Only when the gain was reduced as in Plate 113 did the condition appear. It was first believed the cause lay in the 1.5 volt bias on the first radio frequency tube and that grid current at this point was destroying the gain.

6.13 In Plate 114, the gain of the preselector is shown as the horizontal distance from Curve A to Curve B and the first radio frequency stage from B to C. As far as the signal generator permitted carrying the curves, no important change occurs in these gains. However, the curvature indicates a loss of gain in some stage at the higher levels. Curves D and E indicate a change in combined plate current for the first three tubes, but the data could not be carried far enough to complete the study and the plate currents are difficult to measure separately. It will be noted that these non-resonant overload curves were taken at 1560 kilocycles plus 1.30 percent. This particular frequency was chosen because at this point, as the input frequency was varied on the tests of Plate 109, there occurred a sharply defined minimum in the output noise with a strong input (about 150,000 microvolts.) This was believed due to overload, but the data taken did not definitely disclose the reason.

6.14 Plate 115 summarizes a test which approached the root of the overload difficulties. It is seen that the preselector and first radio frequency stage show a fair degree of linearity, even when grid current reaches one microampere. This current apparently starts at about 100,000 microvolts input, corresponding (see Plate 111) to about 400,000 microvolts on the first radio frequency grid, which has a fixed bias of 1.5 volts. The curve for the combined second radio frequency and first detector stages shows the overload characteristic under investigation. Since the second radio frequency stage is similar to the first, except that its grid is more negatively biased whenever the gain is less than maximum and since in this case a bias was used such that no grid current could be detected, it is reasonable to assume the stage to have a constant gain. This gain was measured and the first detector curve computed.

This could have been directly measured, if available signal generators had higher output. It appears that the gain in this stage begins to fall off at 0.5 volt input and that its output is maximum at 5 volts input. It is unfortunate that these curves could not be carried further. In taking data for Plate 111, it was found that an overload was indicated at plus 0.82%, maximum output occurring with an input of 28,100 microvolts. Extrapolating the gain curves, a first detector grid voltage of 2.1 volts is calculated. This is close enough to 5 volts to indicate probable agreement, there being a number of variables involved. The overload point for this stage may be expected to vary with frequency, as the excitation from the first oscillator is hardly likely to be constant. It is known that the first oscillator frequency is affected by the signal level, which effect may be serious. Further study is needed.

The cathode bias of the first detector was found to be 4.1 volts with no signal. This varies with signal inputs, but the law of variation was not investigated. When signals become strong enough to draw grid current, grid detection commences and by driving the average grid potential more negative, tends to neutralize the increase of plate current due to plate detection. This is a possible reason for the saturation effect noted.

It is interesting to note that when overload occurs in the first detector-oscillator combination, that the screen voltage of the second detector is varied. This condition complicates the study of overloads. In order to measure stage gains under steady conditions, batteries were used for plate and screen supply to the second detector. These supply voltages were returned to normal for overload tests. The interaction of the screen voltages is aggravated by a common resistance in the power unit, amounting to 10,000 ohms. More tests are required for a full understanding of the overload effects in this receiver. However, data are sufficient to show that a fraction of a volt at the antenna, off resonance at optimum gain, or on resonance at reduced gain, may seriously overload the receiver. Such voltages are likely to be exceeded because of static or duplex operation. This momentary paralysis may be the reason for the reputation these receivers have earned relative to paralysis by key clicks. Detection (cross-modulation) begins in the first radio frequency stage at about 130,000 microvolts in the antenna at resonance. Key click transients in duplex operation are likely to exceed this value.

6.15 Plate 116 shows that the second detector, when not heterodyned, follows the square law very closely. This detector does not have a grid leak and stopping condenser. It operates at a no-signal bias of 4.0 volts. The second oscillator causes, in Bands A-1 and A-2, an increase of 4.5 to 5.0 microamperes in the average plate current, corresponding to about 0.8 volts excitation. Under these conditions, plate current decreases as signal increases.

6.16 Plate 117 indicates that about 25 minutes are required for the receiver to reach a constant rate of beat frequency drift from a cold start. At 24,000 kilocycles, the beat note drifted 18 kilocycles during this time and thereafter drifted about 100 cycles per minute up to two

hours from the start. During the first ten minutes, the beat note varied more than 1,000 cycles per minute. The effect is very probably due, largely, to decrease in the power unit output, because of heating. The receiver frequency dial must be increased to compensate for this drift.

6.17 Plate 118 shows the advantages of a constant line voltage. For measurement purposes, it was found possible to use one of the 5 kva machines purchased for power supply to RAA and RAB equipments. The machines give a surprisingly constant voltage and frequency, even when operated on a D.C. line with poor regulation. The test of Plate 118 served to emphasize the difficulties which were overcome by the use of the above machine. While the equipment is operable from 95 volts to 130 volts or more, it would be difficult to copy high frequency signals with rapid line voltage fluctuations and would probably be impossible, if the "sharp" audio frequency filter were to be used.

The sudden rise at 105 volts, Plate 118, is possibly due to the "striking" of the neon voltage regulator tube in the power unit. It was not possible to observe this tube during the test.

6.18 On the above well regulated generator, the receiver, with sensitivity control untouched, will hold its gain constant to 10 percent for several days.

6.19 These receivers have presented a standard of performance which is a distinct gain. They have a considerable degree of weak signal selectivity, but are very susceptible to overload under conditions of duplex operation, which is the probable reason for the complaints so far made, relative to keying interference. While no degree of excellence at the receiver can eliminate key clicks, the difficulty can be minimized by avoiding overload conditions. Keying impulses from an off-resonant transmitter may produce damped oscillations on receiver resonance of appreciable fractions of a volt under shipboard conditions.

6.20 While the instruction book infers that a better signal to noise ratio was obtained by leaving a fixed 1.5 volt bias on the first tube, it is believed that such a practice is undesirable on account of the increased likelihood of overload difficulties in duplex operation. The difference in the signal to noise ratio is probably not great, but the advantage of increased bias on the first tube, to protect against strong signals and provide more preselection, is very appreciable. If it is found that controlling four tubes makes the gain control too critical, one of the intermediate frequency stages could have a fixed bias. No tests have been made on the effects of changing the control methods. Attention is invited to the fact that on a capital ship the local noise level is likely to be so great as to swamp a small increase in receiver noise.

6.21 The receivers have a fair degree of precision in resetting to a desired frequency, if the warming-up time is not considered. At the higher frequencies, some little variation in beat note is occasioned by slight movements in the carriage shifting mechanism. This shifting mechanism is not all that might be desired with respect to quick and smooth shifts. It takes a very appreciable amount of energy to make a shift.

6.22 Aboard ship, the servicing and retrimming of these receivers will present an interesting problem. The need for and difficulty of removal from the case for any sort of service does not encourage prompt attention to faults. Tube renewals are no small undertaking. While a very reliable type of cable terminal has been adopted, it is a very slow process to connect or disconnect units. No suggestion for cable improvement is offered. The receiver construction is not well adapted to modernization to meet advances in the art.

6.23 The complexity of these receivers brings up the question of rapid construction in case of emergency. It is often found that the vandykes furnished as part of a contract are not entirely complete. If they were, it is difficult to conceive of rapid manufacture of these receivers, first, in the factory of their origin in the hands of their designers, and second, in some other factory to which plans might be sent by the Navy, but where there is no one familiar with the finished product. The difficulty of rapid manufacture might force wartime expansion with untried receivers whose principal merit would be production facilities.

6.24 The high gain of the receiver results in a tremendous maximum noise level, sufficient to overload the audio frequency amplifier. Lower test noise levels are desirable.

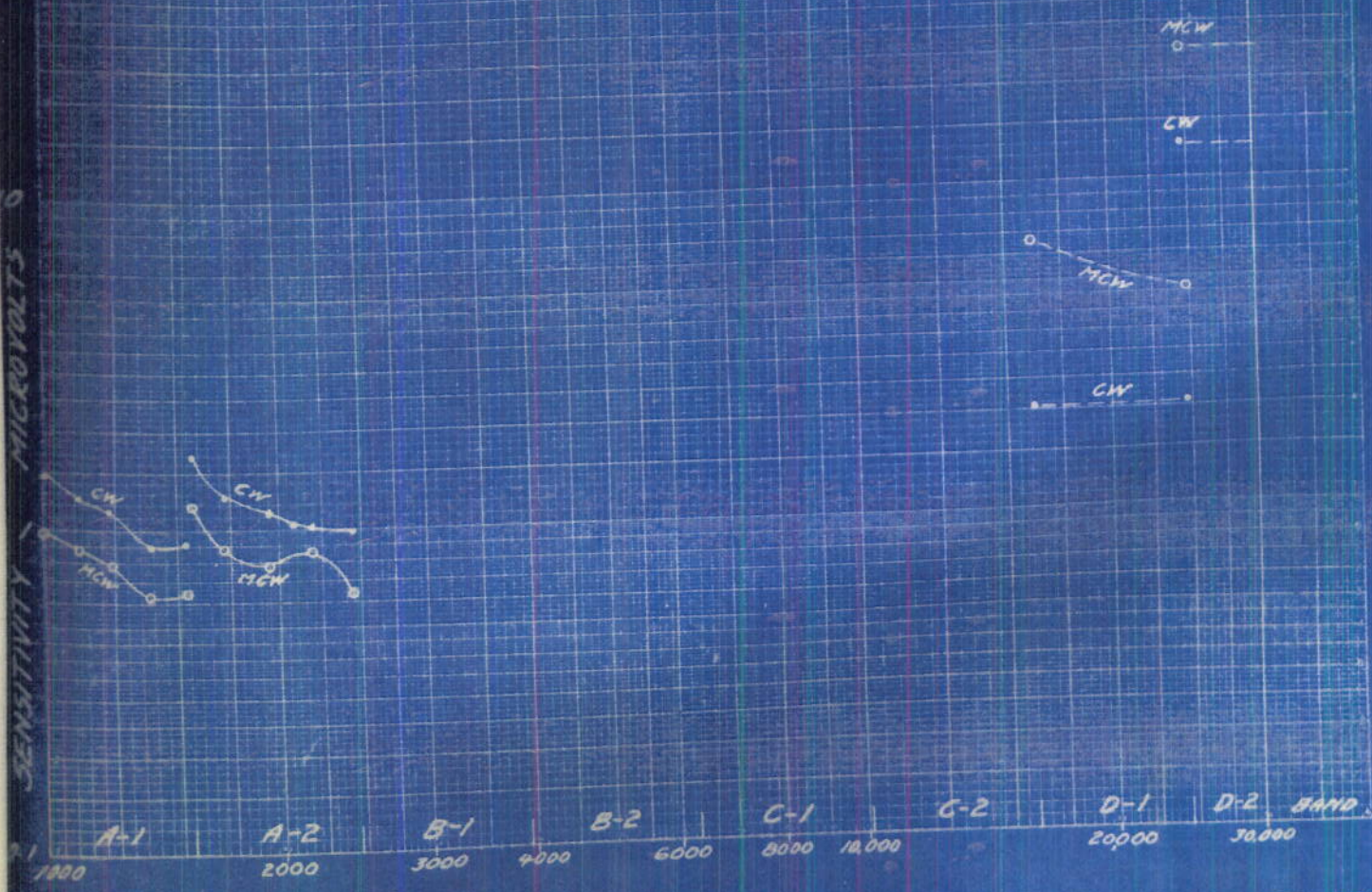
VII RECOMMENDATIONS

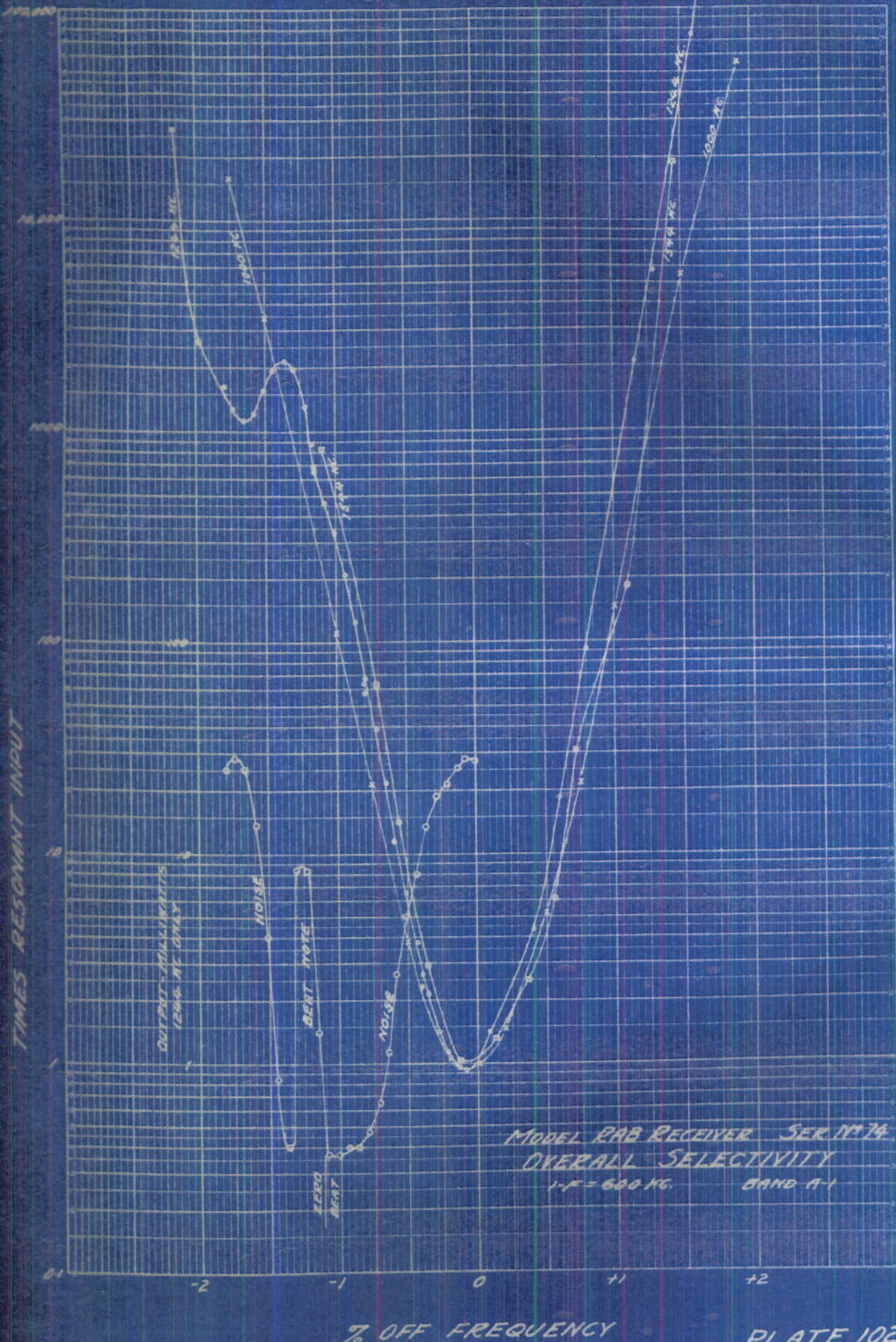
7.1 It is recommended that future purchases of receivers require a design simplified as far as practicable with a maximum possibility of modernizing the equipment when desirable and with thought in mind of the possible need for building equipment quickly in another factory in case of hostilities.

7.2 It is recommended that future test procedure be modeled after that outlined herein for most accurate results. To this end, it is desirable that the manufacturer provide, as far as possible, means of access to various tubes for radio frequency measurements, together with a jack for plate current measurement in each detector circuit.

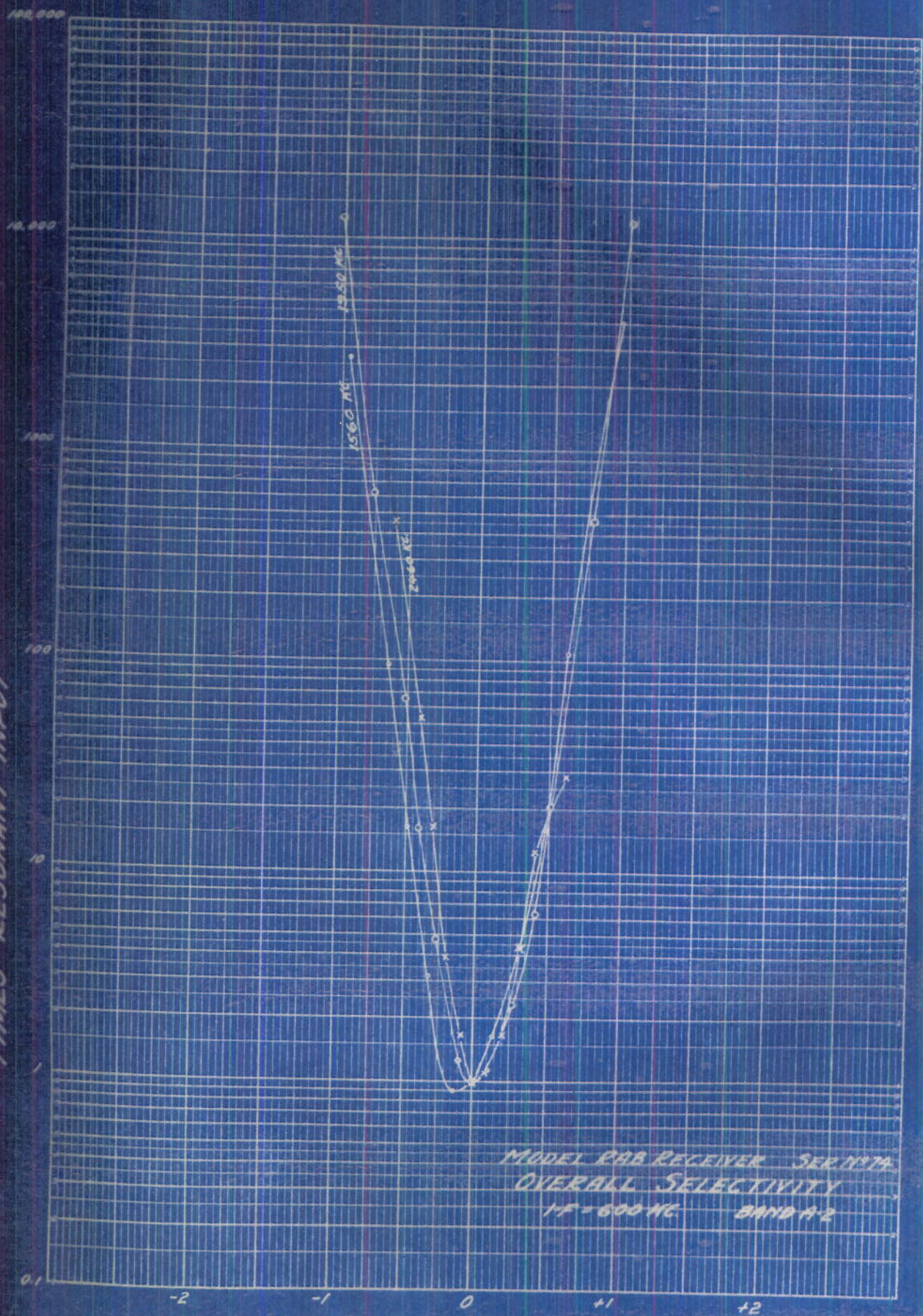
7.3 It is recommended that lower noise levels be required for test in future purchases, leaving a considerable preponderance of standard signal output over noise.

MODEL RAB RECEIVER SER. NO 74
 SENSITIVITIES-CW & MCW (30% - 1000~)
 FREQUENCY RANGE 1000-30,000 MC.
 STANDARD OUTPUT = 50 MW.





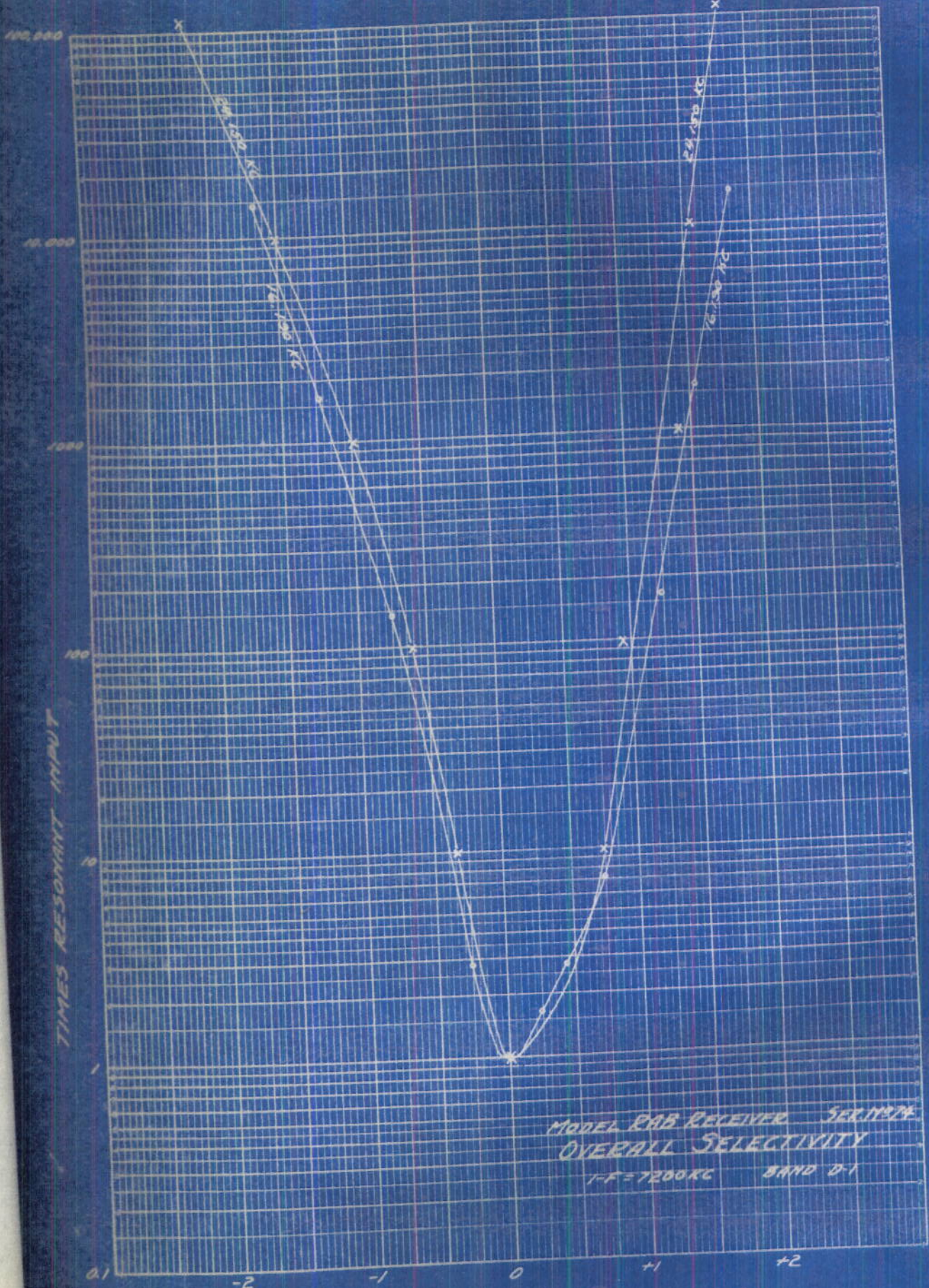
TIMES RESONANT INPUT



MODEL RAB RECEIVER SER. 117A
OVERALL SELECTIVITY
IF = 600 KC. BAND A-2

% OFF FREQUENCY

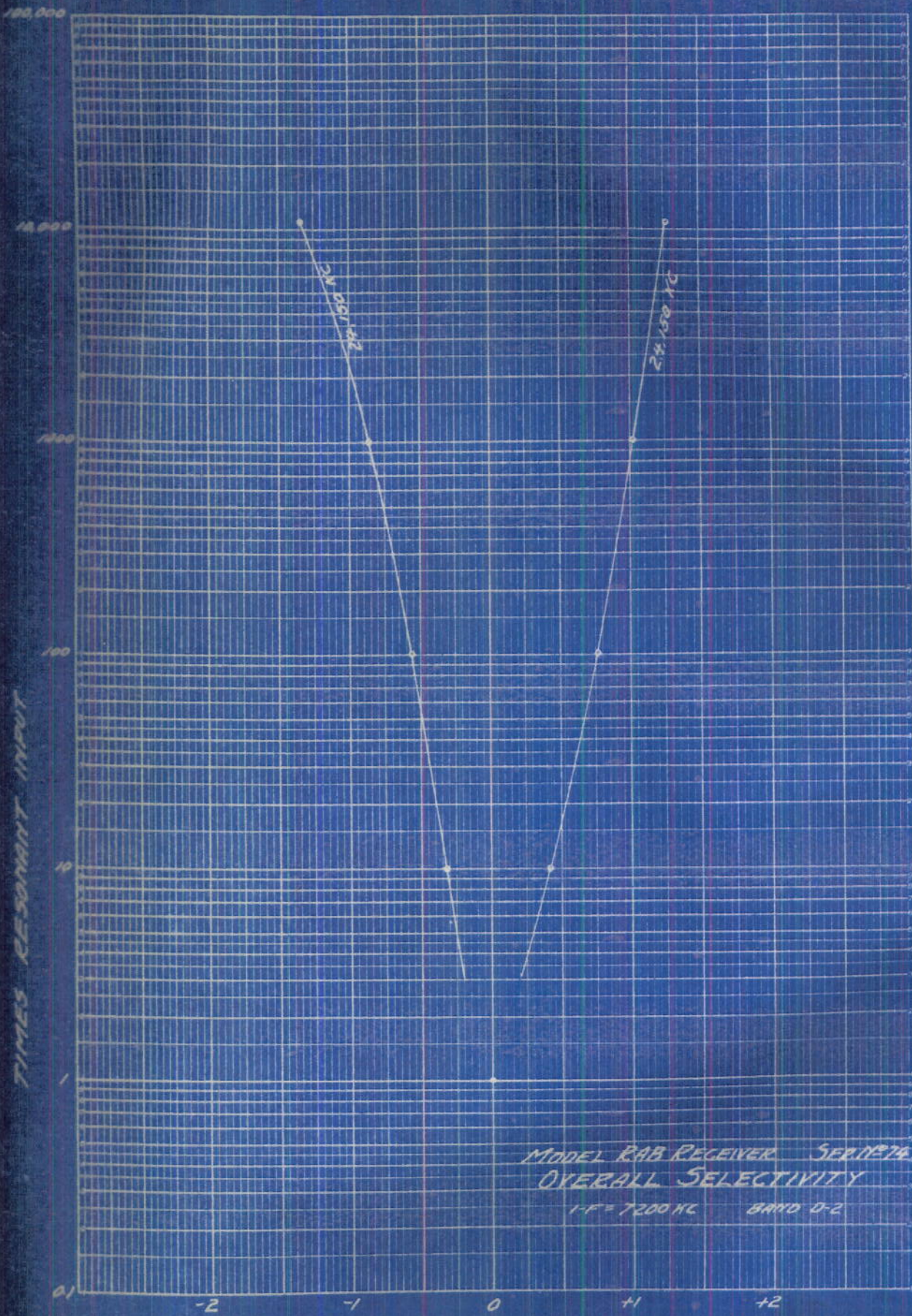
PLATE 103



MODEL RAB RECEIVER ^{SERIAL 74}
 OVERALL SELECTIVITY
 F.F. = 720 KC BAND 0-1

% OFF FREQUENCY

PLATE 104

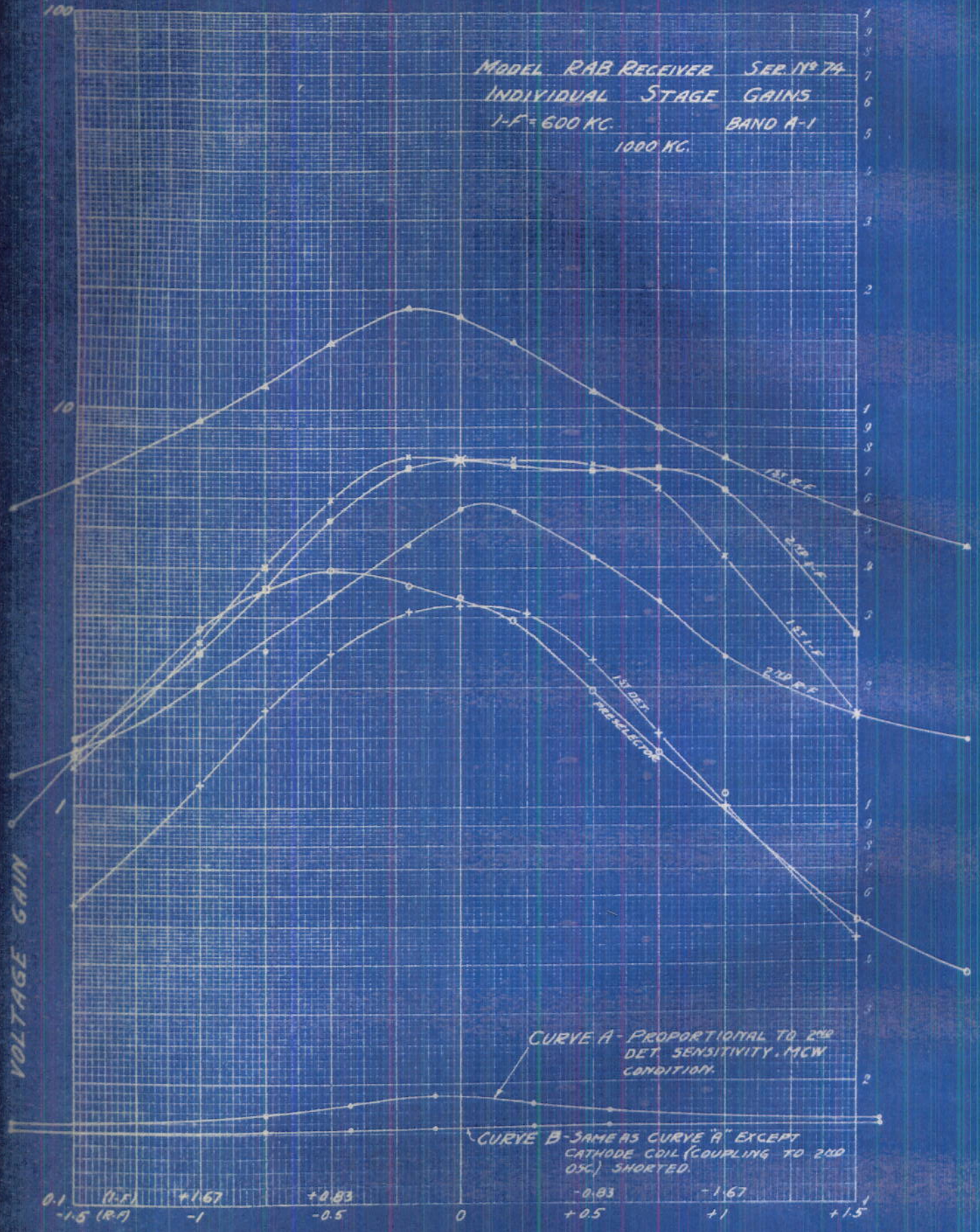


MODEL RAB RECEIVER SER. NO. 74
 OVERALL SELECTIVITY
 I-F = 7200 KC BAND 0-2

TIMES RESONANT INPUT

% OFF FREQUENCY

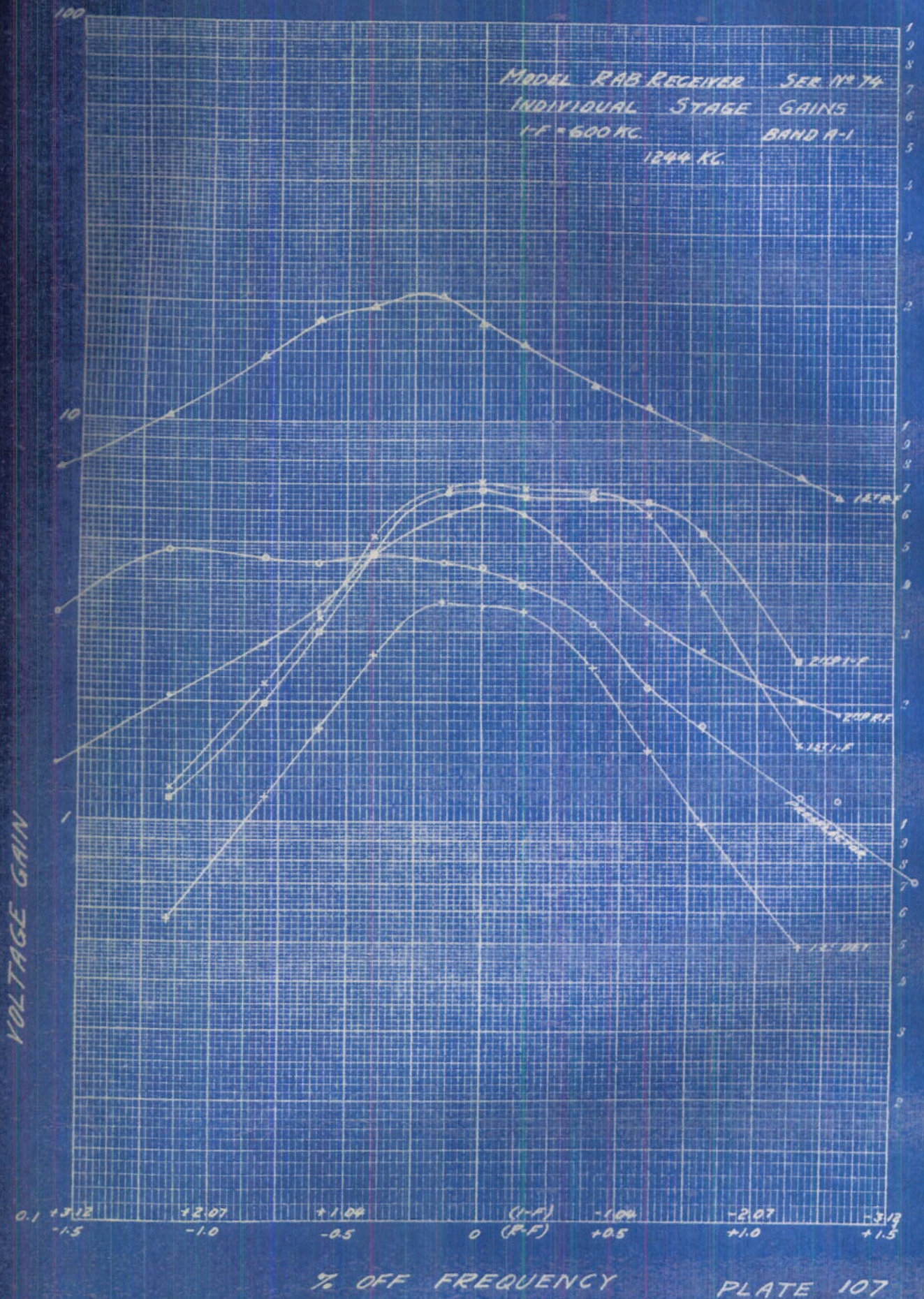
MODEL RAB RECEIVER SER. NO. 74
 INDIVIDUAL STAGE GAINS
 I-F = 600 KC. BAND A-1
 1000 KC.



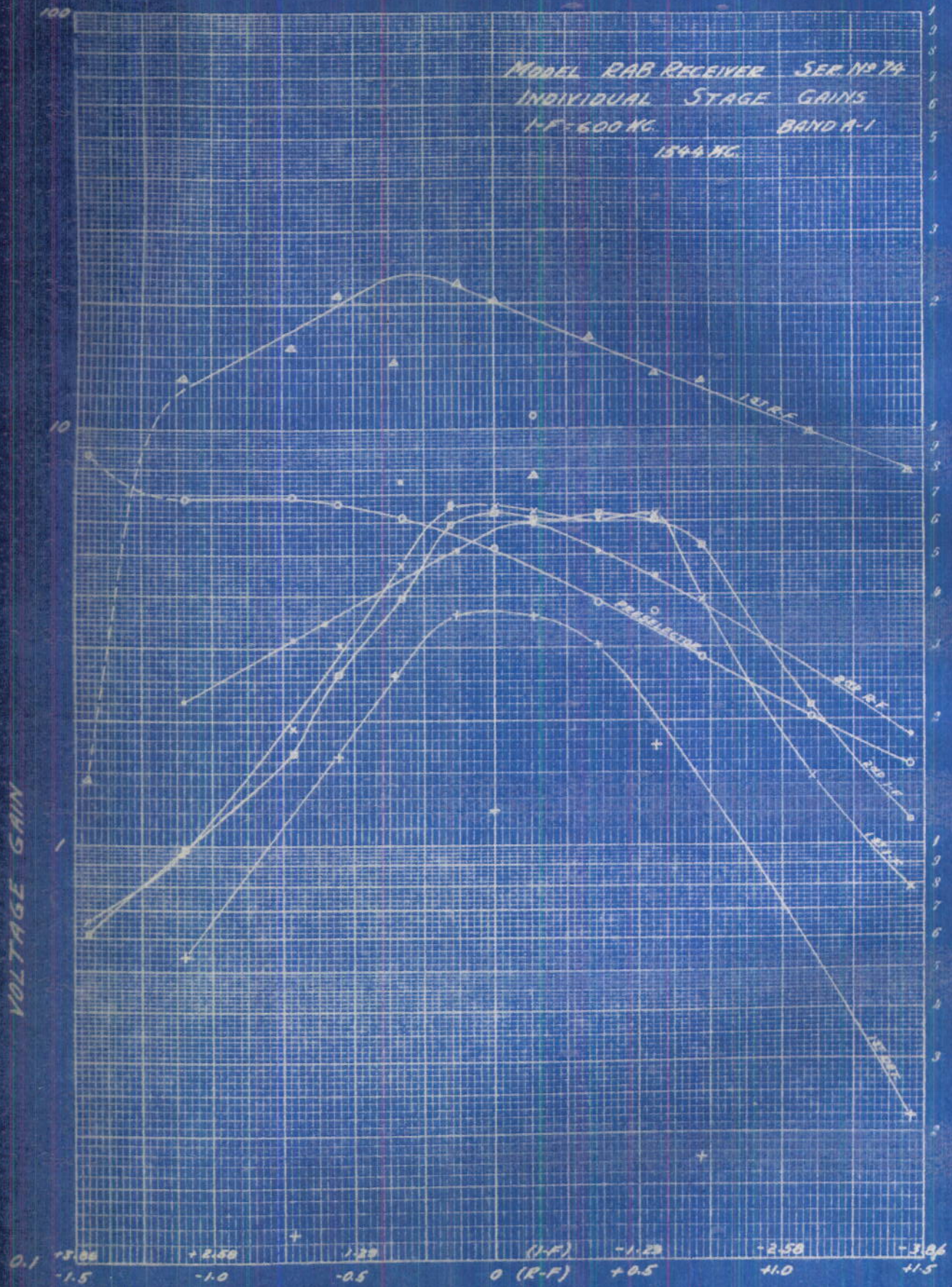
% OFF FREQUENCY

PLATE 106

MODEL RAB RECEIVER SER. N° 74
 INDIVIDUAL STAGE GAINS
 I-F = 600 KC. BAND A-1
 1244 KC.



MODEL RAB RECEIVER SER. NO 74
 INDIVIDUAL STAGE GAINS
 I-F-600 KC. BAND A-1
 1544 KC.

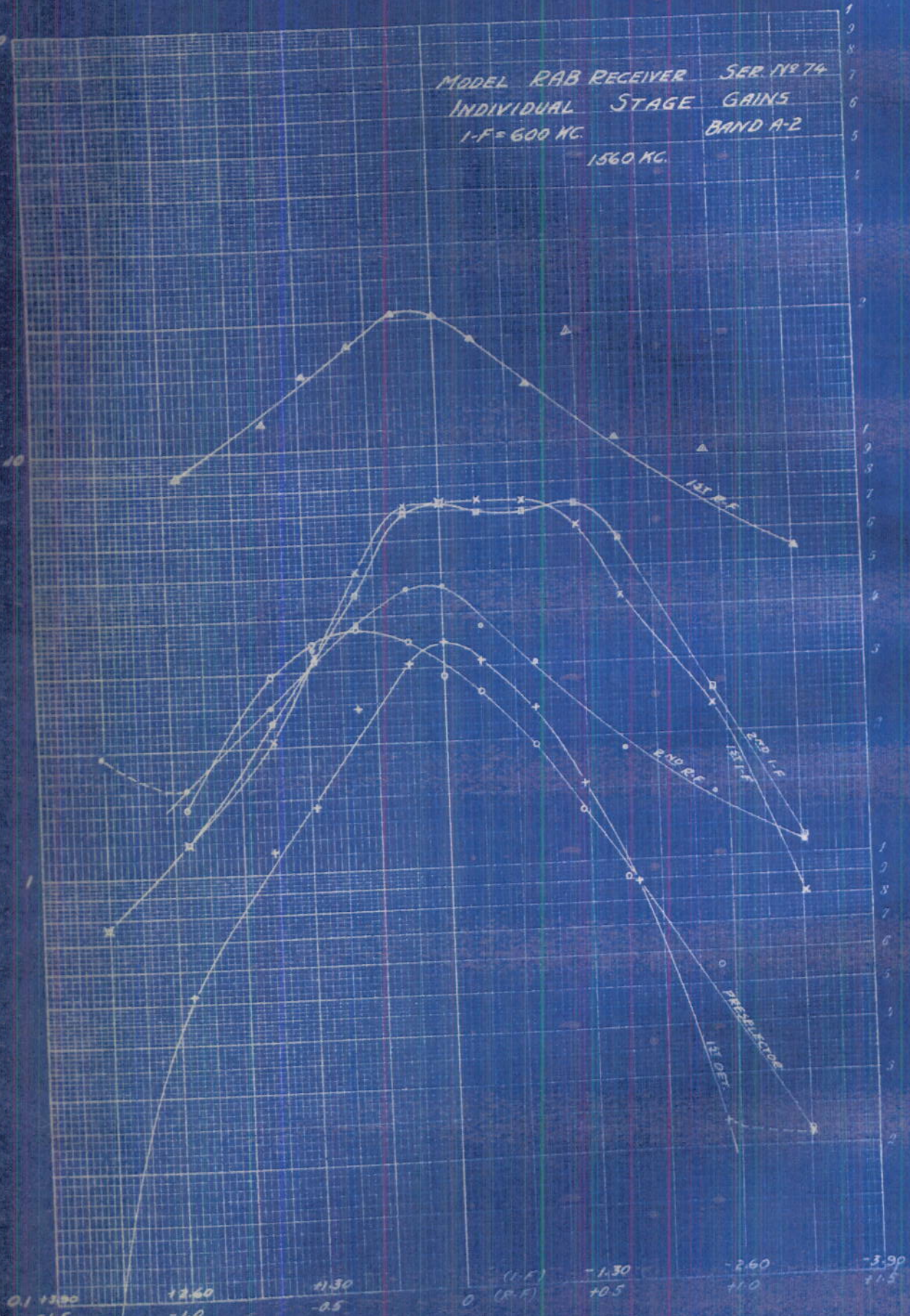


% OFF FREQUENCY

PLATE 108

MODEL RAB RECEIVER SER. 14974
 INDIVIDUAL STAGE GAINS
 I-F = 600 KC. BAND A-2
 1560 KC.

VOLTAGE GAIN

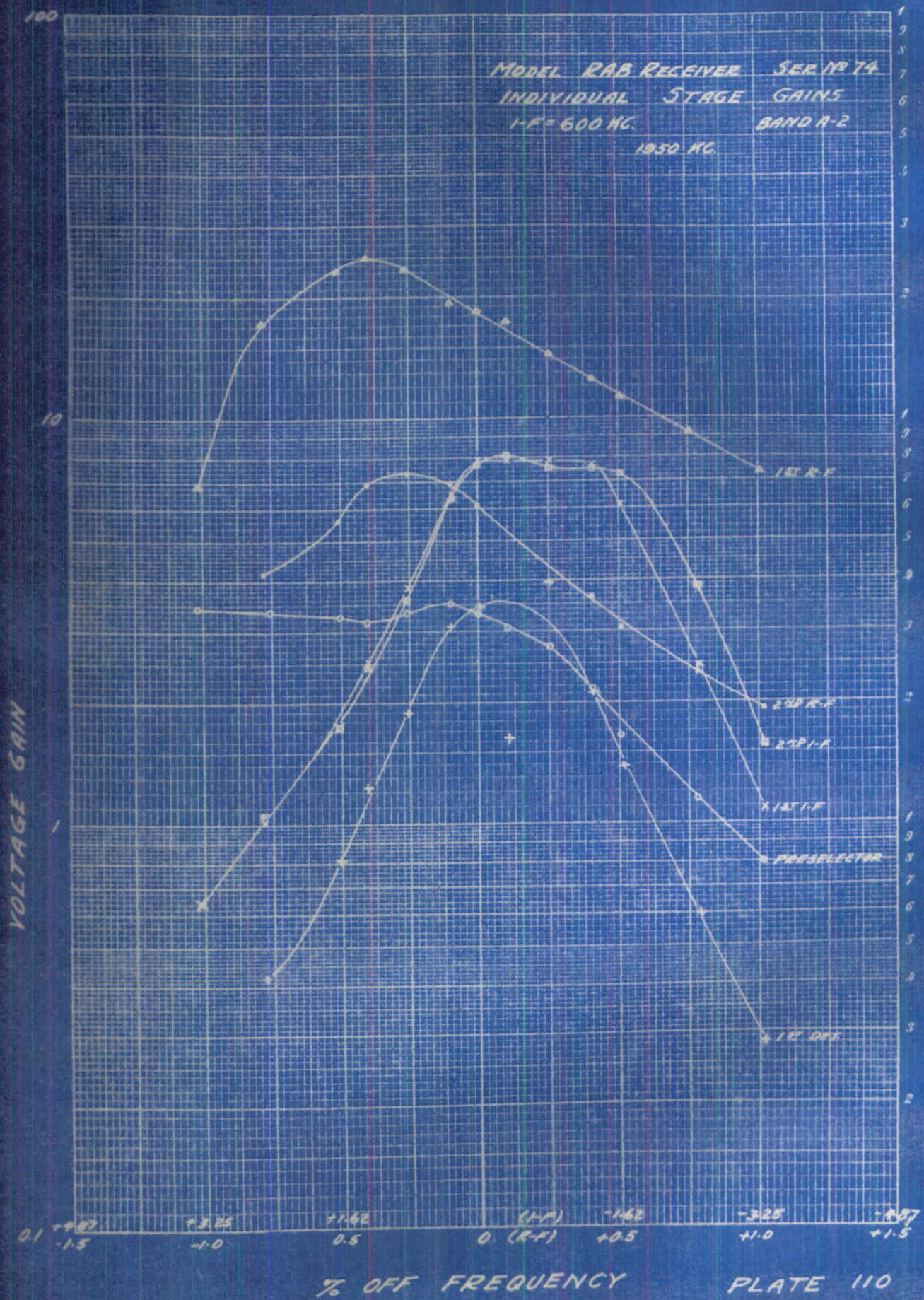


0.1 +3.00
 -1.5
 1 2.60
 -1.0
 10 1.30
 -0.5
 100 0 (I.F.)
 0 (D.F.)
 -1.30
 +0.5
 -2.60
 +1.0
 -3.90
 +1.5

% OFF FREQUENCY

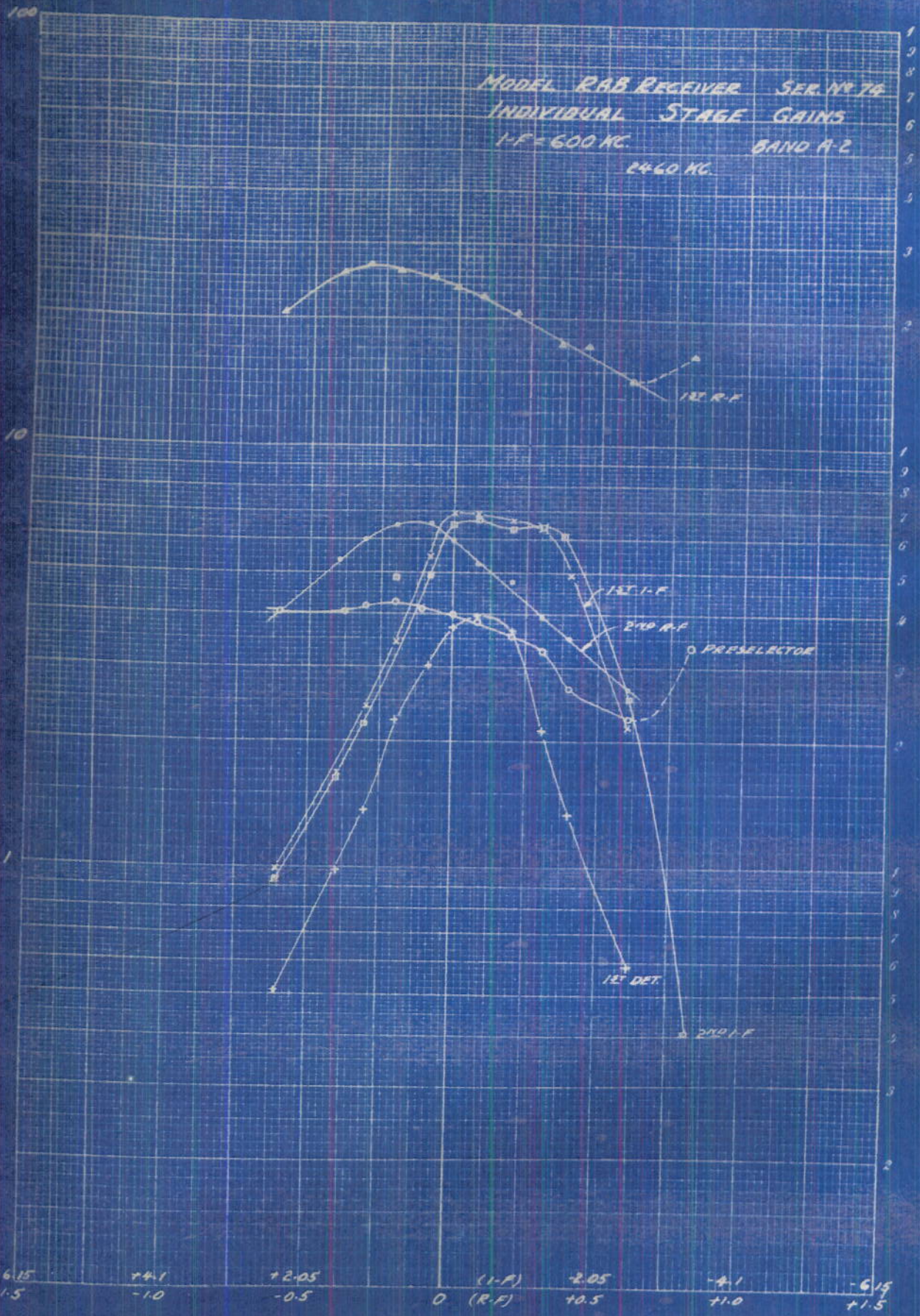
PLATE 109

MODEL RAB RECEIVER SER. NO 74
 INDIVIDUAL STAGE GAINS
 I-F = 600 KC.
 1850 KC.
 BAND A-2



MODEL RAB RECEIVER SER. NO. 76
 INDIVIDUAL STAGE GAINS
 I.F. = 600 KC. BAND A-2
 2460 KC.

VOLTAGE GAIN



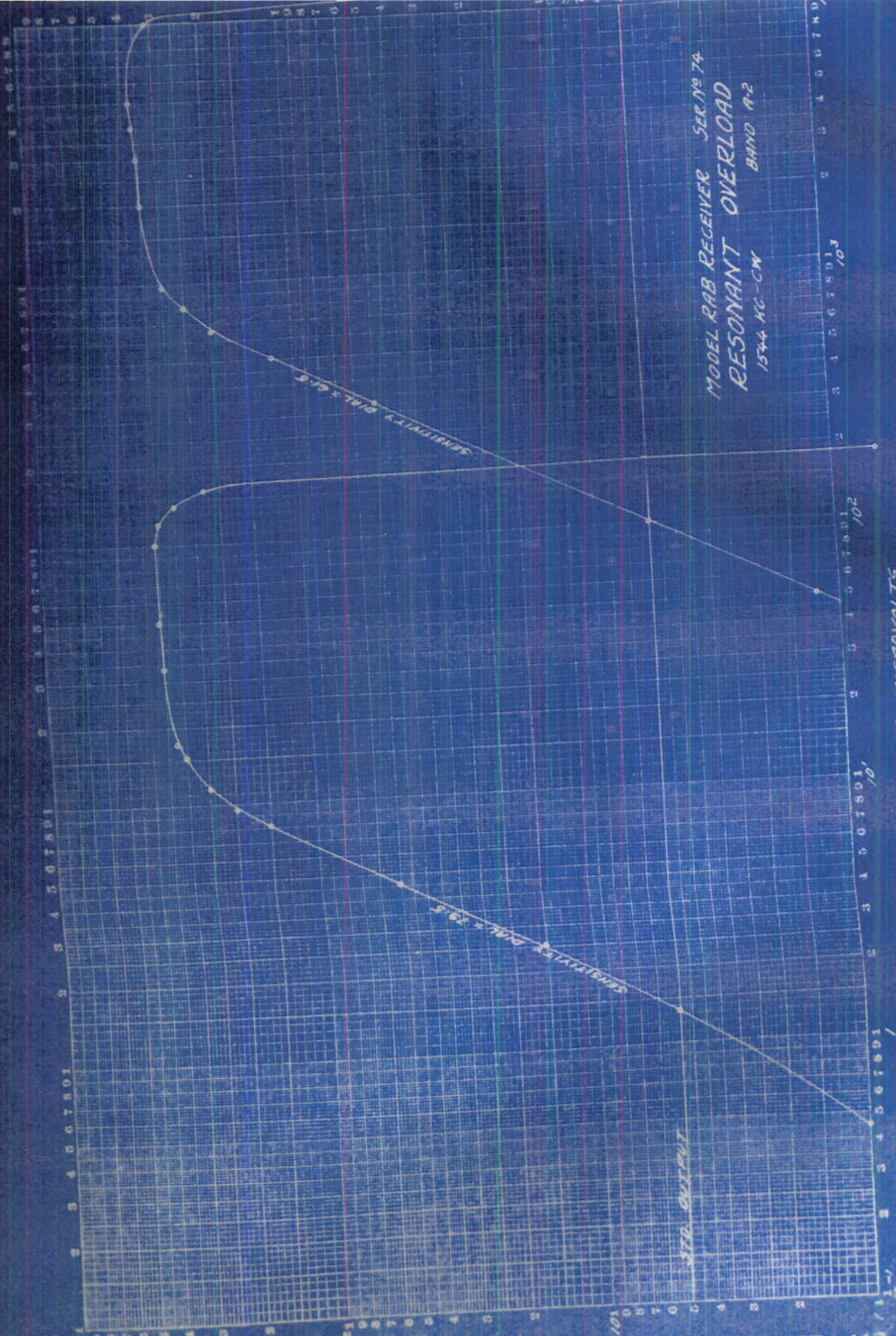
0.1	+6.15	+4.1	+2.05	0 (I.F.)	-2.05	-4.1	-6.15
	-1.5	-1.0	-0.5	0 (R.F.)	+0.5	+1.0	+1.5

% OFF FREQUENCY

PLATE III

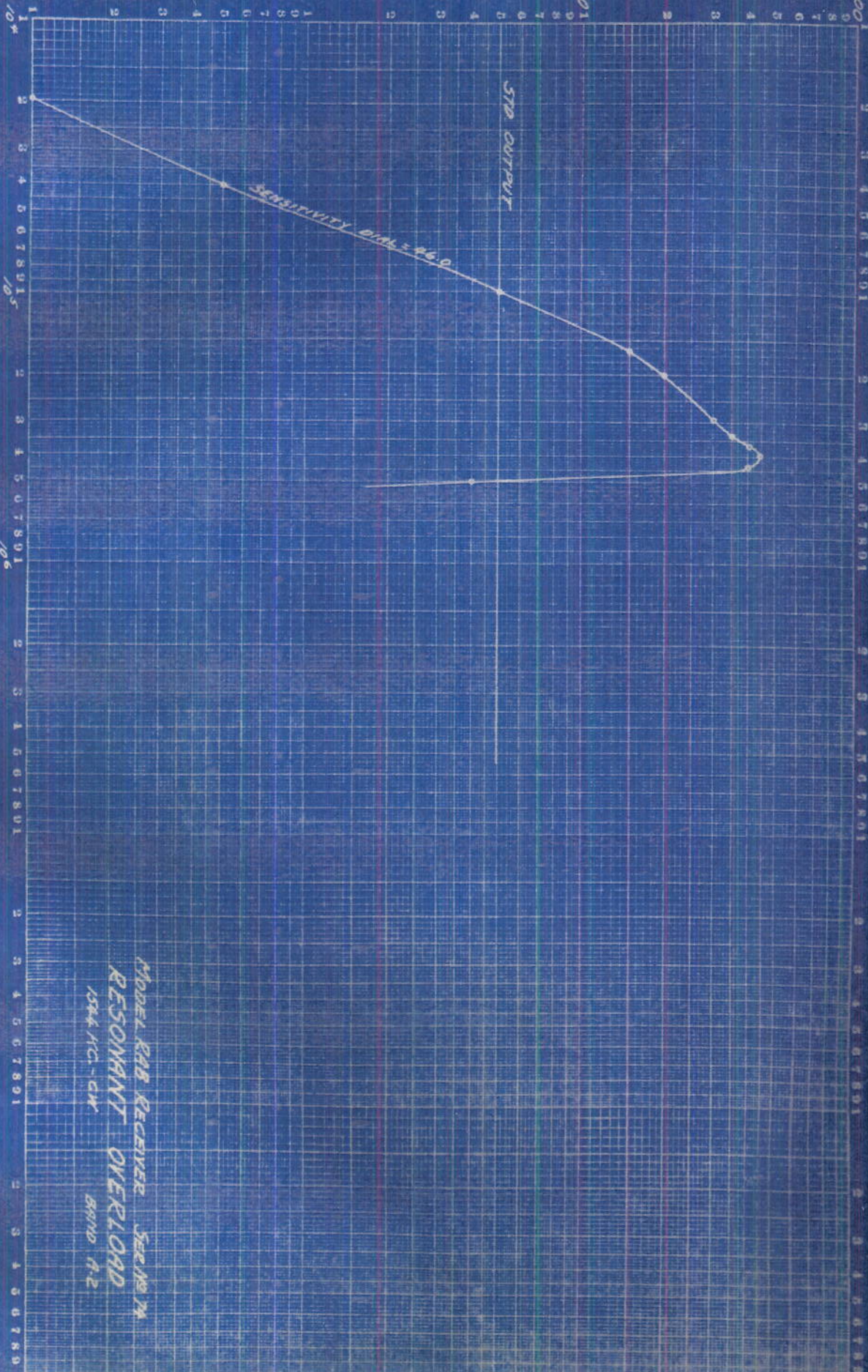
PLATE 112

OUTPUT - MILLIWATTS



ANTENNA INPUT - MICROVOLTS

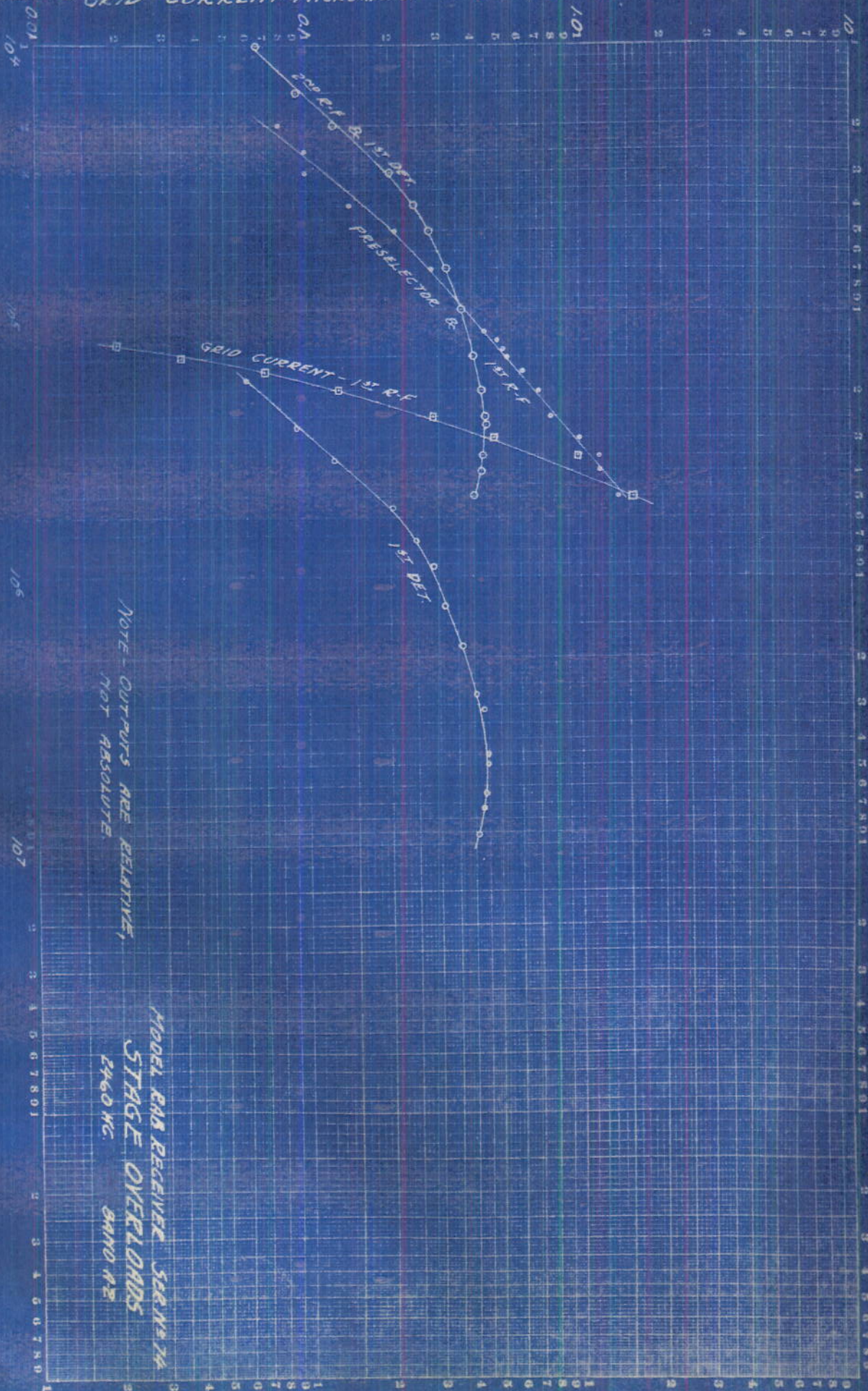
OUTPUT-MILLIWATTS



ANTENNA INPUT - MICROWATTS

MODEL RAB RECEIVER SEC. No. 7A
RESONANT OVERLOAD
1944 R.C. - CN
BRND. A-2

GRID CURRENT-MICROAMPS AND OUTPUT-VOLTS
 PLATE 115



NOTE - OUTPUTS ARE RELATIVE,
 NOT ABSOLUTE

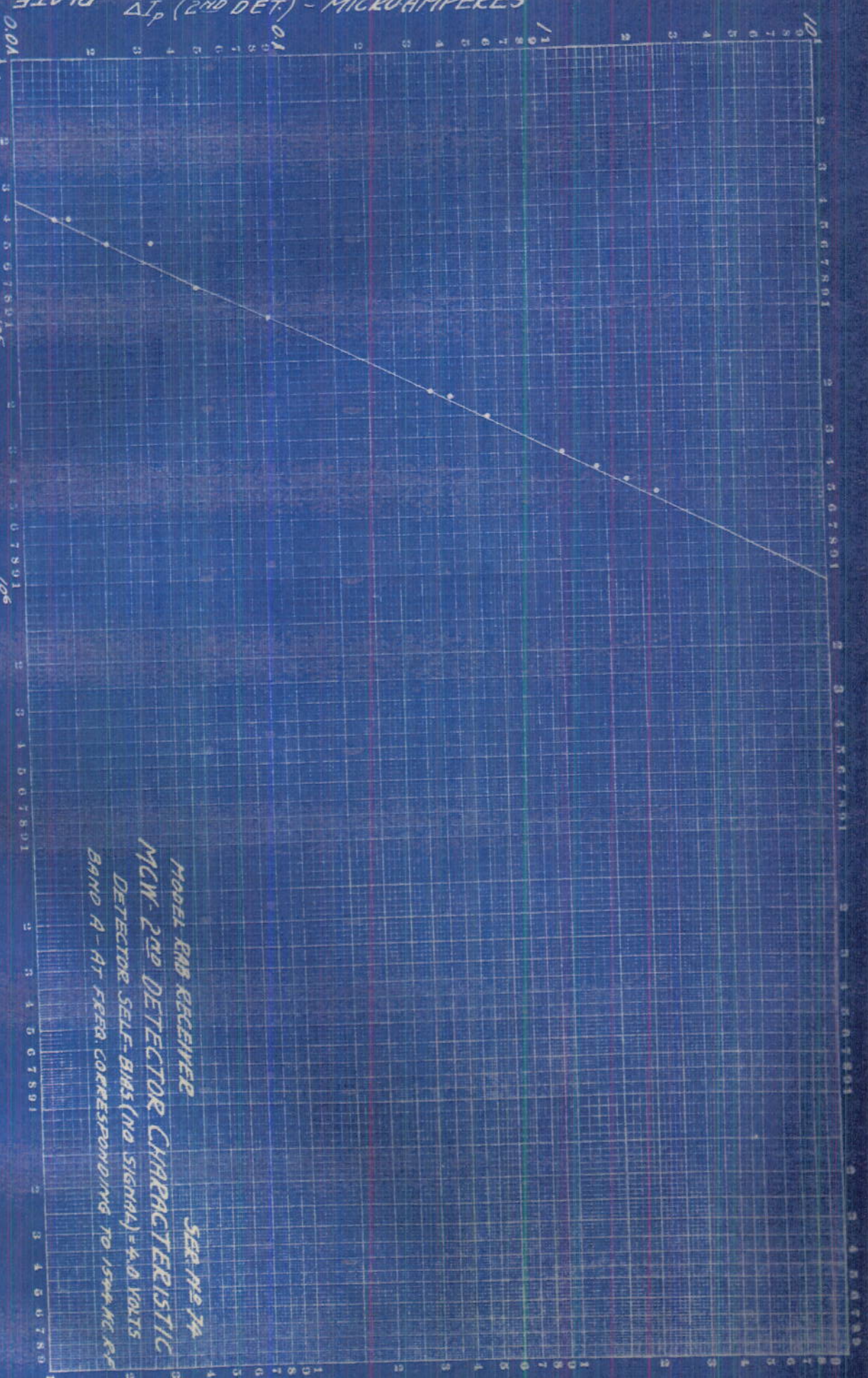
MODEL RAB RECEIVER SER. 74
 STAGE OVERLOADS
 2460 MC. BAND 42

INPUT MICROVOLTS

PLATE 116

SEMIAMPERES (2ND DET) ΔV

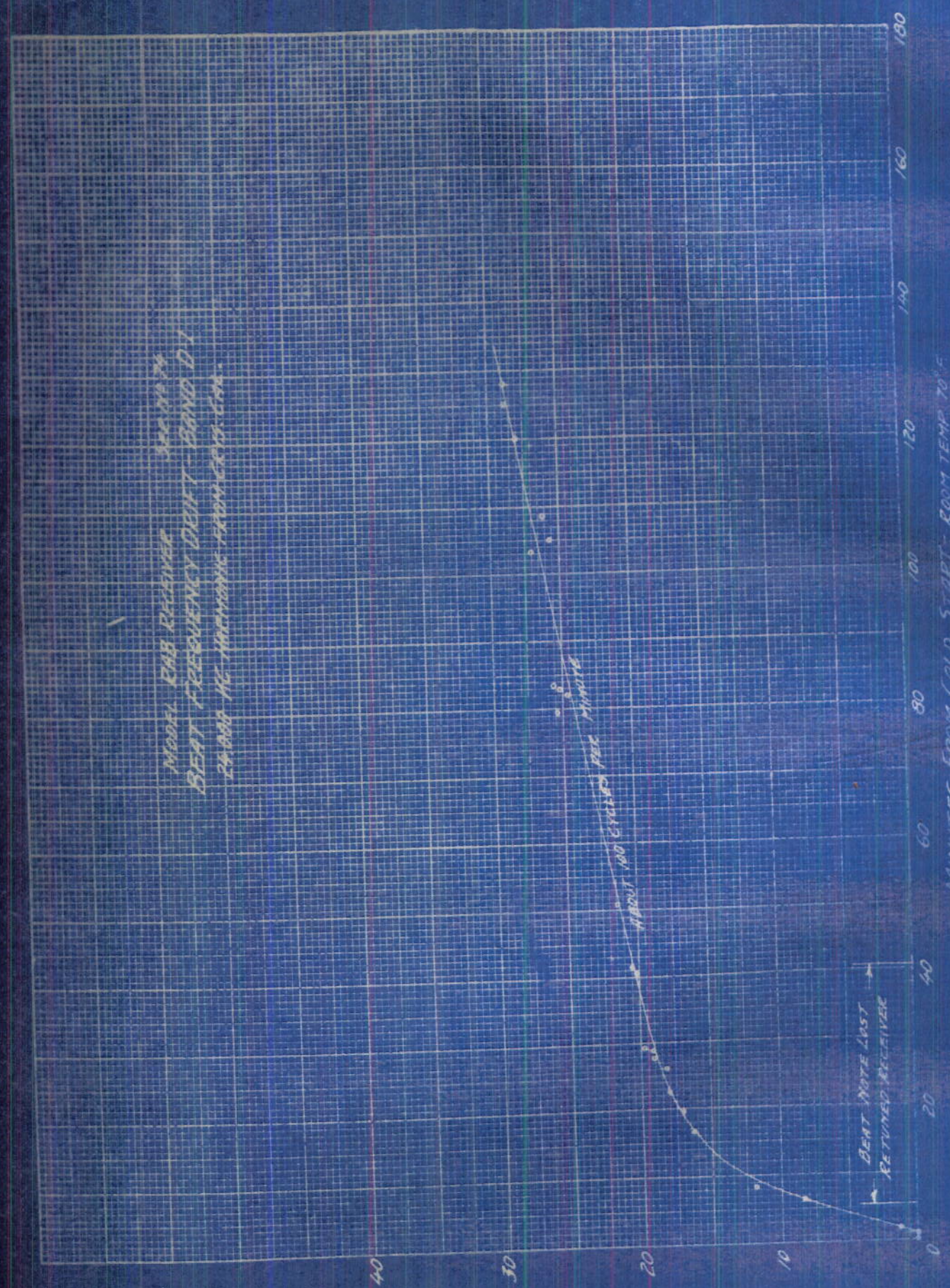
MICROVOLTS ON GRID



MODEL RAB RECEIVER
 SER. NO. 74
 MCM-220 DETECTOR CHARACTERISTIC
 DETECTOR SELF-BIAS (NO SIGNAL) = 4.0 VOLTS
 BAND A - AT FEED. CORRESPONDING TO 1500 KC FS

BEAT FREQUENCY DRIFT - MC

PLATE III



HAD TO STOP RECEIVING BEATS
 BEAT FREQUENCY DRIFT BECAME
 TOO HIGH FOR MEASUREMENT

ABOUT 100 CYCLES PER MINUTE

BEAT NOTE LOST
 RE-TUNED RECEIVER

MINUTES FROM COLD START - ROOM TEMP 70°F

MODEL KAS RECEIVER SAC No. 74
BEAT FREQUENCY VS LINE VOLTAGE
24,000 KC Band D-1

