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Report on

Test of Models DO, DO-1, DO-2, and DO-3

Radio Direction Finder Equipments

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

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Prepared by: John H. Gough, Associate Radio Engineer

Reviewed by: T. McL. Davis, Radio Engineer (Chief of Section)

A. Hoyt Taylor, Physicist, Supt. Radio Division

Approved by: H. R. Greenlee, Captain, U.S.N., Director

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Appendices

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AUTHORIZATION FOR TEST

1. The tests herein reported were authorized by ref.(a). Other pertinent data are listed as references (b) to (o) inclusive.

Reference: (a) BuEng let.S67/69(3-6-W8) of 8 March 1934.
(b) Specifications RE 13A 473A (DO)
(c) Specifications RE 13A 474A (DO-1, DO-2, DO-3)
(d) Specifications RE 13A 481B (telephone jacks)
(e) Specifications RE 10A 263H (name plates)
(f) Specifications 17 I 12 (electrical indicating instruments)
(g) Specifications RE 13A 346S (vacuum tubes)
(h) Specifications RE 13A 317F (ceramic insulating materials)
(i) Specifications 17 I 14 (phenolic insulating materials)
(j) Specifications RE 13A 488B (foil-paper capacitors)
(k) RCA Victor Company, Inc. IB-23262 (DO)
(l) RCA Victor Company, Inc. IB-23263 (DO-1)
(m) RCA Victor Company, Inc. IB-23264(DO-2)
(n) RCA Victor Company, Inc. IB-23265(DO-3)
(o) Contract NOs-31569 dated 24 May 1932.

OBJECT OF TEST

2. The object of the test was to determine first, compliance with the requirements of specifications, refs. (b) to (o), inclusive; second, the presence of desirable features over and above the specific requirements of the specifications; and third, any objectionable features in these equipments which should either be corrected or avoided in future equipments.

ABSTRACT OF TEST

3. The Models DO, DO-1, and DO-3 Radio Direction Finder Equipments were set up in the Laboratory and given a general inspection of mechanical construction and wiring. The electrical tests conducted on these equipments for compliance with specifications, as set forth in refs. (b) and (c) above, are given below in the order in which they appear in ref.(c):

(a) General direction finder performance.
(b) Loop sensitivity, CW and MCW.
(c) Maximum noise level, CW and MCW operation.
(d) Selectivity, optimum and reduced gain, CW and MCW.
(e) Image selectivity.
(f) Antenna and loop coupling.
(g) Overall voltage gain to noise ratios.
(h) Variation of overall gain with reduction in input field strength.
(i) Frequency stability with variation of line voltage.
(j) Resonant overload.
(k) Audio frequency response of audio system, CRV-46031 and CRV-46031A Receivers.
(l) Frequency overlap between bands, CRV-46031 and CRV-46031A Receivers.
(m) Shock test.

(n) Frequency stability vs. change in input signal intensity.
(o) Frequency stability vs. change in volume control settings.
(p) Time constant test.
(q) Range and linearity of manual volume control.
(r) Trans- rectification.
(s) Manual volume control characteristics - constant input.
(t) Balancer and sense sensitivities.
(u) Balancer detuning.
(v) Ratio of quadrature to in-phase voltages for standard output.

4. Additional tests not specifically covered by either of specifications, refs. (b) and (c), and which were made not only because of the value of the information derived therefrom but because some of the tests contributed toward the satisfactory determination of the results of other tests covered by the reference specifications, are as follows:

(aa) Determination of correct position of loop in screened booth for minimum error.
(bb) Measurement of true loop circuit inductances and capacitances.
(cc) Measurement of constants for the calculation of effective heights of the CRV-69003 and CRV-69004 Loops.
(dd) Determination of loop circuit radio frequency resistances.
(ee) Determination of loop circuit "Q's".
(ff) Measurement or calculation of loop circuit selectivities.
(gg) Overload characteristic of audio system of CRV-46031 and CRV-46031A Receivers.
(hh) Harmonic analysis of 1,000 cycle output signal from CRV-46031 and CRV-46031A Receivers.
(ii) Regulation of CRV-20011 and CRV-20011A Power Units.
(jj) Radio frequency attenuation characteristics of CRV-20011 and CRV-20011A Power Unit Filters.
(kk) Harmonic analysis of a.c. ripple on d.c. output of the CRV-20011A Power Unit.

Conclusions

(a) The Models DO, DO-1, and DO-3 Equipments (the Model DO-2 Equipment was not furnished to the Laboratory for test) are, in general, ruggedly constructed, present a pleasing appearance, and the workmanship is, in general, of very high quality. The materials employed are generally of excellent quality. The coil construction is commendable, all coils being thoroughly protected against all forms of corrosive action by a thick coating of a wax compound. With few exceptions, the component parts are accessible for inspection and servicing. The band selector switches and the toggle switches are a source of trouble and are, therefore, untrustworthy.

(b) In general, these equipments when operated in the service with reasonable care, can be expected to yield results which will exceed all previous models of direction finder equipments.

(c) The minima are almost always exactly opposite and are not shifted by tuning or changing the sensitivity control setting. Perfect balance is obtainable at all but the highest frequencies. The failure to obtain perfect balance at and near the upper limit of the frequency ranges of these equipments is due to coupling between the active balance circuit with the supposedly inactive sense circuit at these frequencies.

(d) The sense feature is workable but weak at most frequencies and failed completely at some frequencies due to the lack of a means for compensating the sense resistance for each band to suit the characteristics of the antenna.

(e) While the loop sensitivities do not comply with the specification limits, these sensitivities are adequate at all frequencies to give excellent bilateral operation of these equipments.

(f) The efficiency of the transmission line operated equipment (Model DO-3) is considered favorable and is such that remote loop tuning can be considered practicable. It is probable that the small loss that must be necessarily expected from transmission line coupling may be more than compensated for by the more favorably located position of the loop.

(g) The effectiveness of the CRV-46031 and CRV-46031A Receivers as direction finder receivers is limited owing to slow and cumbersome tuning controls provided with these receivers.

(h) The balancer mechanism is ingenious and its performancc is commendable.

(i) The power unit furnished with the Model DO equipment is inadequately filtered to permit good direction finder performance from this equipment when operated on a line.

Recommendations

It is recommended:

(a) That adequate filters be provided within the CRV-46031 Receiver for filtering the +B and heater circuits for battery operation or that the design of the CRV-20011 Power Unit used with this Receiver as for the Model DO Equipment be completely redesigned to provide a lower maximum receiver noise level. The effectiveness of the filters in the redesigned power unit should be equivalent to those in the CRV-20011A Power Unit.

(b) That the chassis-cabinet fit for each of the four types of equipments covered by these specifications be considerably improved for future and similar equipments. The button type guides should be eliminated and continuous guides be substituted therefor.

(c) That the knurled head screws for securing the panels of the receiver chassis of the four types of equipments to their respective cabinets be redesigned to permit handling without tools, and that greater clearance be provided between these thumb screws and the top or bottom of the panel of the CRV-46031 Receiver.

(d) That the cabinets for the CRV-46031 and CRV-46031A Receivers be provided with some means for trimming the antenna loop circuits without removing the receiver chassis from the cabinet.

(e) That attempt be made to protect the fine copper wire used for the pig tail connectors on the variometers from the effects of the corrosive action of humid salt atmospheres. (Silver plating might be helpful) and that the pig tail connectors be so mounted, mechanically, as to avoid any tendency toward self interference throughout the range of rotation of the variometer.

(f) That the holes provided in the loop circuit coil shield in the radio frequency and oscillator coil shields for making trimmer condenser adjustments be better aligned with the adjusting screws in the trimming condensers.

(g) That the soldering lug terminals on the range switch for the output meter on either type of receiver be better protected against corrosion.

(h) That the telephone jacks employed in either type of receiver be redesigned to comply with specifications, ref.(d).

(i) That the interference between the intermediate frequency oscillator tube shield of either type of receiver and the dial lamp bracket mounted directly in front of it be eliminated in future receivers.

(j) That rubber insulated stranded copper wire without cotton braid insulation be employed for all circuits operating at radio frequency potentials.

(k) That at least #8-32 screws be used for securing the cable clamp to the front panel of either the CRV-20011 or CRV-20011A Power Units.

(l) That the mounting of the load resistor of the CRV-20011A Power Unit be changed to provide greater clearance between the +B terminal lug of the resistor and the rectifier tube mounting, and that the plate leads to the rectifier tube be arranged so as to clear the sharp edges of the shock mounting frames supporting the tube sockets.

(m) That greater clearance be provided between the high tension fuse and the receiver chassis for each type of receiver and that the power plug panel be increased in size so as to provide greater clearance between the high tension lead terminal of the receiver power cable and the supporting pillar nearest this terminal.

(n) That the engraved letters and figures on the small mica dielectric condensers in the receiver units be filled with white wax; that Navy type numbers appear on all component parts, without exception, in all the units comprising each equipment.

(o) That the displacement of bilateral minima of each type of equipment be improved to comply with specification requirements through the reduction of stray non-directional pick-up

(p) That the cabinets of the CRV-46031 and CRV-46031A Receivers be reenforced to prevent any possibility of bowing of the top or bottom.

(q) That to assure absolute protection against moisture as particularly applied to the CRV-46031 Receiver, the cables provided should be rubber clad so as to avoid any possibility of moisture entering the cable fitting at the rear of the receiver cabinet by virtue of the wick effect.

(r) That the brass strips holding the rubber gaskets in place on the cover of the CRV-46031 Receiver cabinet be drilled and tapped for the securing screws, and that the screws be made to come flush with the gasket retaining strips so as to avoid any danger of injury to an operator's hand or arm.

(s) That space be provided on the calibration chart attached to the front panel of either type of receiver for recording the antenna tuning control calibrations.

(t) That a name plate be provided for the output meter on either type of receiver, and for the voltmeter on the CRV-46031 receiver; that a name plate or panel engraving be provided to indicate the association of the range switch with the output meter; that the labelling of the sensitivity control be changed to read "SENSITIVITY" instead of "VOLUME", and that a calibrated scale or panel engraving be provided to permit accurate determination of the setting of the sensitivity control for either type of receiver.

(u) That the use of the type of band selector switches employed in either type of receiver be avoided in future equipments.

(v) That the friction device provided for the balancer control used in either type of receiver be redesigned to eliminate any possibility of a slipping or jerking action of the control and that a larger control knob, similar to that used for the sensitivity control, be employed in place of that furnished for the balancer control.

(w) That the screw fit cans for the intermediate frequency transformers be provided with some means for loosening them with special tools or otherwise, as similar cans have been known to stick under service conditions. These tools should be furnished with each equipment.

(x) That the use of rivets for securing the tube sockets and tube shields to the chassis of either type of receiver and the small molded mica dielectric condensers to the small mounting panels be avoided in future equipments, and that screws and nuts be used in lieu of the rivets.

(y) That mounting brackets be provided for the cabinets of the CRV-20011 and CRV-20011A Power Units and so designed that they may be secured either to the top or bottom edge of the receiver cabinet upon installation.

(z) That consideration be given in the case of the condenser, transformer, and choke design to the elimination of all terminals on the case. Laboratory tests have shown that even though the capacitors, transformers, and chokes may be well sealed against the effects of moisture, there is frequently creepage particularly between the terminals. This is usually behind the insulating strip upon which the terminals are mounted and will be particularly true with the units furnished in the subject receivers and power units, owing to the fact that the terminals are mounted to the terminal panels with open eyelets. Moreover, this can always be expected so long as the various parts used do not possess the same thermal expansion quality. It is, therefore, recommended that consideration be given to a requirement that all paper dielectric capacitors, transformers, and chokes be required to have the terminals brought out of the potted assembly, in as high grade rubber covered leads of sufficient length to connect to the circuits external to the unit. It is known that bunched terminal leads from a potted assembly have the possibility of a leak between such leads where the potting compound does not reach. This could be overcome by bringing the leads out separately and, if necessary, providing an elastic packing under pressure around the terminals.

(aa) That in the interest of increasing the rapidity with which the antenna and receiver tuning may be accomplished it is suggested that future designs of receivers similar to subject receivers employ tuning controls similar to the main tuning controls of the Models RAA and RAB receivers. If the present type tuning control is retained for future equipments it should be accompanied with a provision for coarse tuning adjustment.

(bb) That the main tuning dial for the antenna and receiver tuning controls for either type of receiver be graduated on a 0 to 10 basis so as to avoid any chance of ambiguity between the reading of the main dial and the vernier dial of either control for any setting. Specifications, par.4-20, refs. (b) and (c) should be reworded so as to avoid confliction with the specifications of par.7-5 of the same references in connection with the markings of the balancer dial for either type of receiver.

(cc) That the specifications for par.4-34 (par.4-40 of ref.(b)) be changed to require that the output transformer be designed to match a 600 ohm load instead of a 20,000 ohm load.

(dd) That the terminals on the balancer coil assembly of either type of receiver be identified with markings corresponding to the markings on the balancer coil leads.

(ee) That specification requirements of par.4-38 (par.4-39 of ref.(b)) and of par.4-39 (par.4-40 of ref.(b)) be revised to approve the type of output meter and markings of the range switch furnished with each type of receiver. For observations near minimum a more sensitive instrument than that required by specification is preferable. A 60 microwatt zero level instrument would permit noise adjustment to zero level. This gives a maximum usefulness for null observations.

(ff) That the clamping dogs provided on each of the CRV-69003 and CRV-69004 Loops be backed with phosphor bronze springs so as to cause them to swing clear of the retaining slots in the Loop Pedestal when loosened.

(gg) That the CRV-69005 and CRV-69005B Loop Pedestals be redesigned so as to include a pocket or other means to retain the spray proof cap when not in use. While an aluminum cap has been furnished with these subject pedestals and renders the pedestals spray tight, there is danger of the cap becoming lost unless some provision within the pedestal assembly is made for stowage.

(hh) That at least #8-32 screws be used for securing the cover plate of the collector ring brush assembly to the Loop Pedestal.

(ii) That a larger loop similar to the CRV-69003 loop but having a diameter equal to the diameter of the CRV-69004 loop be furnished with all types of equipments as a means for improving the loop circuit sensitivities on future and similar equipments.

(jj) That the maximum noise level in the Model DO Equipment for line operation be considerably reduced by improving the design of the CRV-20011 Power Unit so as to provide filtering characteristics equivalent to the CRV-20011A Power Unit.

(kk) That the specifications of par.6-5 of ref.(c) and par.6-4 of ref.(b) for "merit factor" be revised for receivers having 600 ohm outputs; **this** revision to take into consideration the ouput impedance and a standard noise level of 60 microwatts.

(ll) That the loop circuit for the Model DO-3 equipment be redesigned to provide more adequate trimming tolerances to compensate for variations in transmission line construction.

(mm) That the maximum attenuation of the manual volume control for all equipments adjusted for CW reception be set at 100 decibels at any frequency within the range of any equipment.

(nn) That the specifications of par.6-33 of refs. (b) and (c) be revised to require that the output transformer of either type of receiver match a 600 ohm load.

(oo) That more uniform balancer sensitivity be provided particularly at the high frequency end of all equipments to assure specification compliance.

(pp) That an adjustable sense resistor be provided for each band of each type of equipment to permit the required compensation for antenna size to be permanently made at the time of installation.

(qq) That it be required that the spare parts boxes for each type of equipment include a small quantity of all kinds of "hook-up" wire used in these equipments.

DESCRIPTION OF MATERIAL UNDER TEST

5. The material under test consisted of one of each of the Models DO, DO-1, and DO-3 Radio Direction Finder Equipments, each complete in itself. With this material it was possible to make complete tests to determine the operating characteristics of the Models DO, DO-1, DO-2, and DO-3 Radio Direction Finder equipments.

6. These equipments were manufactured by the RCA Victor Company, Inc., of Camden, New Jersey. Each equipment covers a frequency range of from 100 to 1500 kilocycles. The Model DO Equipment is 115 volt, d.c. operated, while the others operate from a 115 volt, 60 cycle, single phase line. A round loop assembly is used with the Models DO and DO-1 Equipments, whereas a square loop assembly is used with the Models DO-2 and DO-3 Equipments. In the latter case, the operation of the loop for the DO-3 Equipment is by remote control, electrical connection between the loop and receiver being accomplished by means of coupling transformers and a transmission line. In all other respects, the four types of equipments are identical.

7. The Model DO-3 Equipment, Serial #33, was delivered to the Laboratory on 28 February 1934 and was followed by the Model DO-1 Equipment, Serial #45, on 11 May 1934, and by the Model DO Equipment, Serial #42, on 7 June 1934. Tests were begun on 1 April 1934 and continued until 1 August 1934 when full time was spent on the Class IA, IIA, and Class IV equipments. Work was again resumed on 3 December 1934 and continued to date.

METHOD OF TEST

8. Table 1, appended hereto, contains a list of the measuring instruments used in making the tests outlined above. Table 2 gives a tabulation of the application of the instruments listed on Table 1 to each individual test. The letters designating the several tests correspond each for each with those given under pars. 3 and 4 above.

9. Except as specifically noted in the description of the tests about to be described, these tests apply equally as well to any one type of Equipment as to the others. The tests were conducted so as to avoid duplication of effort as much as possible. For example, the sensitivities of the a.c. operated Equipments were determined by actual measurement for one type of Equipment, and by calculation for the other types of equipment. The calculated sensitivities were determined by simply applying a correction factor to the measured sensitivities, these correction factors being of such values as to account for the difference between the loop circuit "Q" of the measured equipment and the loop circuit "Q" of the particular equipment under consideration. Inasmuch as the a.c. operated equipments are identical except for their loop circuits, the procedure followed and described above is sound.

10. Prior to the beginning of each test, the line or battery voltages were checked to ascertain if they were normal. In the case of the a.c. operated Equipments, the control of the line voltage was by means of a General Radio Variac. A rheostat was used for controlling the voltage for the d.c. operated equipment. The tubes used were those furnished with each Equipment.

11. General Direction Finder Performance. Each of the Models DO and DO-3 Equipments were installed in the penthouse of the Laboratory. Their respective loops were installed on the concrete roof of the penthouse, a few feet apart, and sufficiently isolated from local antennas and circuits as to be more favorably placed than in most Naval installations. A single antenna about 70 feet long and sloping about 30° to the horizontal was made available and was connected to one or the other receiver as required for test. The Model DO Equipment was operated from a 115 volt d.c. line fed from a generator.Each equipment was tested individually on local signals to note quality of minima inherent accuracy, balancing ability, and quality of sense indication.

12. Loop Sensitivity. This is the most important consideration as regards receiving range. Sensitivity was measured by applying a CW or 30% modulated CW signal, as the case may be, to the center of the loop. This was accomplished by means of a 100 to 1 voltage attenuator, the larger section of which was 50 ohms and placed in series with the high side of the Standard Signal Generator output cord, and the smaller section being 0.5 ohm, was inserted between the grounded mid-connection of the loop and one side of the loop winding. The applied signal was fed across the 0.5 ohm section of this attenuator. The purpose of the attenuator was two-fold, the first being to reduce the error in the loop circuit "Q" due to an added resistance in the loop to a minimum, and the second to increase the accuracy of the signal generator slide wire readings. Had the output leads of the Standard Signal Generator been directly inserted in the loop center, the error introduced in the loop circuit "Q" by the variation in the slide wire resistance would have been as much as 25% under some conditions, whereas, with the method adopted, this error did not exceed 1-1/2% under any condition. Moreover, without this external attenuator, the attenuator of the Standard Signal Generator would necessarily, owing to the magnitudes of the absolute microvolt inputs required to produce standard output over the frequency range of the equipment under test, have to be operated at its lowest step. The accuracy of the slide wire readings would be limited, under this condition, to two significant figures, the second of which would be only an estimate.

13. The test procedure was to set the Standard Signal Generator to a given frequency and to adjust the output for a sufficiently large CW signal to permit easy location of the signal with the receiver under test. The receiver was then tuned for a 1,000 cycle beat note at resonance. The Standard Signal Generator was shut off and the sensitivity control of the receiver adjusted for a Standard Noise Level of 0.2 volt. The Standard Signal Generator was again turned on and the output adjusted until the receiver output was

Standard, or six milliwatts. After rechecking the noise level and receiver tuning for a Standard Output Signal, the receiver was considered as properly adjusted, and the slide wire reading noted. This procedure was repeated for 30% modulated CW signals, except that where the noise level at full gain was less than Standard, maximum gain setting was used.

14. In making these tests, the loop was placed inside of the screened booth in a location predetermined for minimum detrimental coupling effects with the screened booth and oriented for minimum noise pick-up. This is true of all of the tests made within the screened booth. Sensitivities on CW and MCW were measured for five frequencies of each band of the CRV-46031 and CRV-46031A Receivers, using the CRV-69003 Loop directly connected to whichever Receiver was under test at the moment. When the CRV-46031 receiver was employed, sensitivity measurements were made for both line and battery operation. (Line operation was from a generator as a source of power.) These data, obtained as described above, gave actual CW and MCW sensitivity measurements for the Models DO and DO-1 equipments. Sensitivities for the Model DO-2 equipment, employing the CRV-69004 Loop direct connected to the CRV-46031A Receiver, and the sensitivities for the Model DO-3 Equipment employing the same type of receiver and loop but remotely connected to each other via coupling transformers and a 35-foot transmission line, were calculated by applying correction factors to the Model DO-1 sensitivities to account for the differences between the loop circuit "Q" in the Model DO-1 equipment and the corresponding loop circuit "Q" of the other Equipments whose sensitivities were calculated. Preliminary sensitivity measurements made on the Model DO-3 Equipment prior to receipt of the transmission line and using a pair of single parallel conductors for a transmission line substantiated the results of these calculations. The slide wire readings for all sensitivity measurements were corrected for errors due to the external attenuator and in parallel with the slide wire resistance.

15. Maximum Noise Level. Measurements of maximum noise level were made for each of the CRV-46031 and CRV-46031A Receivers, each employing the CRV-69003 loop, at the same frequency settings of each band and with the same control settings except for the sensitivity control for the sensitivity measurements described under par. 12 above. The sensitivity control was set at maximum and the noise level measured with the Standard Signal Generator turned off. It was found that with either type of receiver adjusted for MCW reception, the maximum noise level did not exceed Standard Noise level except with the CRV-46031 Receiver when operated from a line.

16. Selectivity. Selectivity measurements were made at three points in each band of the CRV-46031 and CRV-46031A Receivers each employing the CRV-69003 loop direct connected. The receiver under test was adjusted at resonance as for sensitivity and likewise the signal from the Standard Signal Generator was applied at the center of the loop as described in pars. 12 and 13. Measurements were made at optimum and reduced gain. MCW signals were used for all selec-

tivity measurements for both of the a.c. and d.c. operated equipments. The procedure followed in all instances was to measure the microvolts input required to produce Standard Output at definite percentages off resonance (plus or minus). This procedure was carried out to the limit of the Standard Signal Generator. The selectivity measurements thus obtained apply directly to the Models DO and DO-1 equipments. However, inasmuch as the selectivities of these two equipments are so sharp and so nearly identical, and also inasmuch as the loop circuit selectivities are only a small part to the overall selectivities, it was not deemed worthwhile to make similar measurements on the Models DO-2 and DO-3 equipments. For all practical purposes and intents, the selectivities of the latter two equipments may be considered as being equal to those of the Model DO-1 equipment. Similar measurements were made on the Model DO-1 equipment adjusted for CW reception at optimum gain.

17. Image Selectivity. Measurements of image selectivity were taken at five points in each of the medium and high frequency bands of the Models DO and DO-1 Equipments. The method employed was essentially the same as for the selectivity measurements described under par.16 above except that the Standard Signal Generator was tuned to the image frequency of the particular resonant frequency at which the receiver was tuned (or, receiver frequency plus 2 times intermediate frequency amplifier frequency), and the microvolts input to the loop center required to produce Standard Output at resonance and at the image frequency were measured. These measurements were made for both CW and MCW input signals. The ratio of the microvolts input at the image frequency to the microvolts input at the resonant frequency is a measure of the image selectivity. Image selectivities were not measured for the low frequency bands of either Equipment because they were beyond the range of the Standard Signal Generator. The image selectivities of the Models DO-2 and DO-3 equipments may be assumed to be the same as for those measured except as slightly affected by the loop and loop coupling circuits.

18. Antenna and Loop Coupling. Employing the same test set up and with all receiver controls adjusted as for sensitivity, the receiver was tuned to a given frequency. The output cord from the Standard Signal Generator with the external attenuator removed was then connected to a Standard Balanced Antenna connected to the antenna and ground posts of the receiver. (See note below.) The frequency of the applied signal to the Standard Dummy Antenna was then adjusted to ± 10% off the frequency to which the receiver was previously tuned. The microvolts input required to produce Standard Output was then observed with the Balancer set full "on" in either direction. This test was conducted on both of the Models DO and DO-1 equipments and obviously the results of these tests as applied to the Model DO-1 equipment will apply equally as well to the Models DO-2 and DO-3 equipments since the factors which influence the reduction in the coupling between the loop and the antenna of any of these three equipments are the same. These tests were conducted for five points in each band of the Equipment under test, using a CW input.

19. Note: The Standard Balance Antenna employed was the General Radio type 418 having the following electrical characteristics: Inductance - 20 microhenries; capacity - 200 micro-microfarads; resistance - 25 ohms and an effective height assumed to be two meters in accordance with the definition given under par.8-8 of refs. (b) and (c).

20. Overall Voltage Gain to Noise Ratios. The overall voltage gain to voltage noise level ratios for each Equipment were calculated from the sensitivities obtained as described in pars. 12 to 14 for CW reception and for standard noise level. In brief, this ratio at any of the five points in each band considered is equal to the ratio of the Standard Output to the corresponding input in volts, divided by Standard Noise level in volts multiplied by 10^6. These ratios are referred to as "merit factors".

21. Overall Gain and Linearity. The variation of the overall voltage gain of the CRV-46031 and CRV-46031A Receivers (with CRV-69003 loop) under conditions of CW reception at optimum gain for a reduction in the applied input signal to the center loop was determined. The magnitude of the applied CW input was reduced from the value required to produce Standard Output down to a level where the output signal became inaudible above the noise. In the above tests and at each of the frequencies at which the tests were made, the receiver was adjusted exactly as for sensitivity tests described in pars. 12 to 14 above.

22. Frequency Stability with Line Voltage Variation. Maintenance of the frequency stability of the Models DO-1, DO-2, and DO-3 equipments for a change in the line voltage ± 5% above or below normal was determined by measuring the beat note frequency before and after each voltage change and noting the change in beat note frequency relative to the beat note frequency at normal line voltage. This data was obtained only on the Model DO-1 Equipment. However, the results are representative of those to be expected from the Models DO-2 and DO-3 Equipments under similar conditions. A similar test was conducted on the Model DO Equipment operating from a 115 volt battery supply.

23. Resonant Overload. All controls of the receiver of the Models DO and DO-1 equipments under test were adjusted exactly as for sensitivity measurements except that applied signal to the center of the loop from the Standard Signal Generator was increased in progressive increments from zero up to the maximum obtainable from the Standard Signal Generator. At each of these increments the receiver output voltage was noted. This test was conducted at 900 kilocycles for each of these two equipments and for CW and MCW applied signals. From the data obtained from the Model DO-1 equipment, resonant overload characteristics were calculated for the Models DO-2 and DO-3 equipments by applying correction factors as described in par.14.

24. Audio Frequency Response - Audio System. The frequency response characteristic of the audio system of the CRV-46031 and CRV-46031A Receivers was measured by applying an audio signal from a General Radio Beat Frequency Audio Oscillator to the grid of the detector through a voltage divider network and measuring the output

voltage from the amplifier under test with a General Radio Wave Analyzer shunted across a 600 ohm load. The input voltage was maintained at a constant value while the audio frequency signal was varied from 60 to 10,000 cycles in several steps and the output voltage from the amplifier at each frequency measured.

25. Frequency Overlap. Frequency overlap between bands of each of the CRV-46031 and CRV-46031A receivers was determined by measuring the tunable frequency at the end of each band and calculating the percent of overlap. The test set up employed and the procedure followed were the same as for Loop sensitivity measurements described in pars.12 to 14.

26. Shock Test. Inasmuch as the proper equipment was not available for subjecting the Equipments covered by this report to a vibration test, the two Equipments actually tested were subjected to what might be considered as a shock test. This test consisted of striking the top and the sides of the receiver cabinet with hard blows with the hands. In each case the receiver under test was adjusted for Standard Output and for Standard Output Signal Frequency with the CW signal applied to the loop center. The beat note frequency was measured before and after each blow and the change in beat note frequency caused by these blows was noted. This test was conducted in the middle of each band of each of the Models DO and DO-1 equipments. Since the effect was so slight it may be assumed that the test results apply equally as well to the Model DO-2 and DO-3 Equipments and no tests were made on the latter.

27. Frequency Stability with Changes in Input Signal Intensity and Volume Control Settings. These tests were conducted in a manner similar to that described in par.22, except the change in beat note frequency was noted first when the input signal was changed for 1/2 microvolt per meter to such a value as to produce Maximum Output under conditions of CW reception and optimum gain; and second, under similar conditions of reception except that the sensitivity control was adjusted for full gain, and with the applied input signal adjusted to produce Maximum Output at full gain, the change in beat note frequency was noted for a reduction in the manual volume control down to a value where the output signal became barely audible. This test was conducted at the middle of each band of each of the Models DO and DO-1 equipments. Results of these tests on the Model DO-1 equipment apply to all of the a.c. operated equipments.

28. Time Constants. This test was made using the CRV-46031A receiver a.c. operated from its associated CRV-20011A power unit. The results of the tests apply for all practical purposes and intents to all of the subject equipments. The test procedure followed was as described below.

(a) An electron oscillograph was set up with a 30 cycle time sweep and modulator apparatus and connected across the receiver output load.

(b) The grid of the first radio frequency amplifier tube of the receiver was energized, at resonance, by a signal from a standard signal generator applied to the grid of this tube through a potentiometer.

(c) The receiver output was made to modulate the circle on the oscillograph. An increase in the instantaneous output voltage of the receiver produces an increase in the instantaneous radius of the circle so that a 990 cycle receiver output signal produces a stationary pattern showing 33 cycles in the circular pattern.

(d) An electronic key delivering voltage impulses at the note 15 or 30 per second was used in parallel with the standard signal generator input. Each pulse is about .011 millisecond in duration and approximately 2 volts in amplitude as applied across the receiver input potentiometer. The electronic key was synchronized with a 30 cycle signal from an audio oscillator which energizes the circular time sweep mentioned under (a) above, either on the fundamental or on half frequency.

(e) A buffer amplifier was used between the audio oscillator and the electronic key to prevent feed-back from the electronic key and thus cause direct modulation of the circle.

29. Range and Linearity of Manual Volume Control. The range and linearity of the manual volume control for each of the Models DO and DO-1 equipments was determined by measuring the microvolts input in the loop center required to produce standard output at various settings throughout the range of the volume control. Tests were made for both CW and MCW input signals and all tests were made at 900 kilocycles. The test set up employed was the same as for loop sensitivity as described under pars. 12 to 14.

30. Trans-rectification. The procedure of this test conducted on the Models DO and DO-1 equipments was to apply a pure CW input signal of 50,000 microvolts per meter to the loop at receiver resonance as for loop sensitivities with the receiver adjusted for minimum gain, and noting the change in the total plate current of the radio frequency tubes with and without the applied signal. This test was applied at 200, 500, and 1500 kilocycles for each equipment under test. Inasmuch as no detectable change in plate current was observed, it was not deemed necessary to examine each tube separately. It is worthwhile to mention at this point that had it been necessary to examine each tube separately it would have been extremely difficult to do so owing to the inaccessibility of the radio frequency tube sockets without removal of the gang tuning condensers. In making this test, the total plate current was balanced out so that the microammeter used for this test indicated only a change in the total plate current.

31. Manual Volume Control Characteristics. Using a test set up similar to that described in par.29, the variation in the output signal plus noise voltage for a constant applied radio frequency input signal with variation in the settings of the volume control throughout its range was observed for each of the Models DO and DO-1 equipments. The inherent receiver noise voltages at these same settings of the volume control but with the Standard Signal Generator turned off, were also observed.

32. Sense and Balancer Sensitivities. The test set-up used for these tests was similar to that described for loop sensitivities. For sense conditions the "Sense-Balance" switch was thrown to the sense position and the balancer control set "hard over" in the direction producing the maximum effect. A CW (or MCW signal) from the Standard Signal Generator was applied to the loop center and the receiver tuned to a given frequency. The CW (or MCW signal) was then applied to the antenna of the receiver under test through a Standard Dummy Antenna previously described and without the external attenuator as used with the loop. The antenna tuning control was then tuned for best sensitivity and the Standard Signal Generator output and receiver controls adjusted to produce Standard Output from the receiver under conditions of Standard Noise for CW reception and at maximum gain for MCW reception(only where, as in most cases, the maximum noise does not exceed Standard Noise level). These measurements were made at five points within the range of each band of each of the Models DO and DO-1 equipments under test. In the former case, duplicate measurements were made with the Equipment operating from batteries as well as from a line. The results of these tests made on the Model DO-1 equipment apply equally as well to the Models DO-2 and DO-3 equipments.

33. Balancer sensitivities were made in a manner similar to that described for the sense sensitivities except the sense balance switch was thrown to the balance condition and that the balancer control was varied from plus to minus 50 settings. After adjusting the balancer control for a given setting, the microvolts input to the Standard Balance Antenna required to produce Standard Output at each 10th division of the balancer scale and at the settings for null conditions were observed. These tests were conducted for CW and MCW input signals for five points in each band of each of the Models DO and DO-1 equipments. The last statement in the preceding paragraph relative to the tests made on the Model DO-1 equipment and the application of the results of the tests to the Models DO-2 and DO-3 Equipments apply to the test just described.

34. Balancer Detuning. The effect of the Balancer on the tuning of the receiver was made using the same test set-up as described for loop sensitivities in pars. 12 to 14 above and measuring the microvolts input required at the loop center to produce Standard Output when the balancer control was adjusted from +50 through zero to -50 settings. For this test an MCW signal was applied. This test applies directly to the Model DO and DO-1 equipments and indirectly to the Models DO-2 and DO-3 equipments. Tests were made at five points in each band for each equipment actually under test.

35. Quadrature to In-phase Ratios of Standard Output. For each Equipment covered by this report and for each of five frequencies of each band of each Equipment, the ratio of the microvolts per meter input to the loop center for both CW and MCW reception to the microvolts per meter input impressed across the Standard Balance Antenna at +50 and -50 settings of the Balancer control for corresponding CW and MCW applied signals were calculated from the results of data obtained from tests described in pars. 12 to 14, 32 and 33.

36. A preliminary test was conducted prior to final tests for specification compliance of these equipments to determine the advisability of placing the loop and loop pedestal inside of the screened booth. The procedure of this test was to measure the change in the radio frequency resistance and inductance by means of a General Radio type 516C Radio Frequency Bridge. A signal of 1000 kilocycles was applied to the input of the Bridge and a Silver-Marshal receiver was used to indicate null. Only 1/2 of the loop winding was used since one side of the bridge is at ground potential. This portion of the loop was tuned to 1000 kilocycles with the General Radio Precision Condenser Type 222. The change in the radio frequency resistance of the loop and in the precision condenser settings which indirectly indicates the change in loop inductance was noted for various positions of the loop relative to the screened booth.

37. Measurement of True Inductance and Distributed Capacity of Loop and Associated Coupling Circuits. The CRV-69003 loop, CRV-69003 loop pedestal and 108" coupling cable were set up in the normal relation with one another. CW signals from a Standard Signal Generator were applied to the loop center (the external attenuator was omitted for this test). A General Radio Type 222 Precision Variable Condenser was connected across the receiver terminals of the coupling cables. A slide-back vacuum tube voltmeter was bridged across this latter connection and its purpose in this test was to serve as a resonance indicator. The circuit under test was then tuned to resonance at several frequencies and the dial readings of the Precision Condenser recorded for each frequency. From the calibration curves of the Precision Condenser the capacity for each dial setting was determined. From this data a curve was plotted with wavelength squared as ordinates and capacity as abscissae. As is indicated on Plate 4 and under the "RESULTS OF TESTS" section of this report, the true inductance of the loop circuit, including the leads down to the terminals which connect to the receiver may be determined from this curve by calculation. Moreover, the true total distributed capacitance of this circuit can also be determined from this curve.

38. Similar measurements were made on the CRV-69004 Loop, CRV-69005B Loop Pedestal and 108" coupling cable as well as for the CRV-69004 Loop and CRV-69005 Loop Pedestal employed in conjunction with the coupling transformers and 35 foot transmission line as used with the Model DO-3 Equipment.

39. The distributed capacitances of the 108" coupling cable and the leads in the CRV-69005B Loop Pedestal were measured separately on a General Radio Type 650A Impedance Bridge. From this data, together with the total distributed capacitances, as determined under pars.38 and 39 above, the true distributed capacitances of the CRV-69003 and CRV-69004 Loops may be calculated. This procedure does not apply to the loop circuit equipment as applied to the Model DO-3 Equipment owing to the complications introduced by the coupling transformers.

40. Measurement of True Inductances of Loop Load Coils. The measurement of the total load coil inductance of each band of the CRV-46031 or CRV-46031A Receiver was accomplished with a General Radio Type 650A Impedance Bridge. Measurements were made at 1000 cycles with the Bridge connected across the loop terminals on the receiver chassis. The loop tuning condenser was shorted. While there are no actual load coils employed in the loop circuits of the receiver for the high frequency band, there will, nevertheless, be some inductance contributed by the wiring. From the data obtained, the inductance of each load coil may be determined as follows for each band:

$$\text{Stray inductance in each side of loop for high frequency band} = \frac{\text{Measured Inductance}}{2}$$

$$\text{Medium frequency band} = \frac{\text{Measured Induc.} - \text{Measured Induc. for H.F. Band}}{2}$$

$$\text{Low frequency band} = \frac{\text{Measured Induc.} - \text{Measured Induc. for M.F. Band}}{2}$$

41. The effective heights of the CRV-69003 and CRV-69004 loop were calculated from the physical dimensions and the number of turns, for each loop for 100 and 1500 kilocycles.

42. Loop Circuit Radio Frequency Resistances. The loop circuit radio frequency resistance for the Models DO, DO-1, and DO-2 Equipments were determined by direct resistance measurement on a General Radio Type 516C Radio Frequency Bridge. The radio frequency signals (CW) for the several frequencies at which measurements were made were applied to the bridge input terminals from a Standard Signal Generator. A high gain receiver was used as a null indicator and was connected across the "detector" terminals. The unknown terminal of the bridge was connected to the center of the loop under test and with a small fixed condenser in series with high side of this connection.

43. The procedure followed in making the above measurement was as follows:

(a) A decade resistance box was connected across the series resistor terminals of the bridge while the external series fixed condenser was connected across the unknown terminals. The purpose of the decade resistance box was to provide sufficient range to the resistance arm of the bridge to compensate for the resistance of the series condenser.

(b) The bridge was adjusted for balance at a given frequency in accordance with the General Radio Instruction Book.

(c) The unknown terminals were then connected from the grounded midpoint of the loop to one side of the loop, with the fixed condenser in series with the high side of this connection.

(d) The loop tuning condenser in the receiver was tuned for resonance at the same frequency as for (b) above, and the Bridge again balanced by adjustment of the decade resistance on the Bridge. No other control of the Bridge was altered. The difference between the original adjustment and the final adjustment of the decade resistance in the Bridge is the radio frequency resistance of the circuit under test at the test frequency. No power was applied to the receiver for this test.

(e) This procedure was repeated for each of five frequencies within each band of each of the above named Equipments.

44. The procedure followed in determining the radio frequency resistance of the loop circuit of the Model DO-3 Equipment was distinctly different than for the other Equipments owing to the difficulty encountered in attempting to measure them with the Radio Frequency Bridge. For this Equipment, the radio frequency resistances for each band were calculated for the loop circuit "Q's" measured in accordance with the procedure outlined in the following paragraph.

45. Determination of Loop Circuit "Q's". The loop circuit "Q" for each of five frequencies of each band of the Models DO, DO-1, and DO-2 Equipments were calculated from the corresponding measured radio frequency resistances determined from the Radio Frequency Bridge measurements described under par.44.

46. The loop circuit "Q" for five frequencies of each band of the Model DO-3 Equipment were determined as follows:

(a) A 25,000 ohm load resistor was placed from the plate of the first radio frequency tube to the low side of the receiver circuit. The antenna and ground terminals of a high gain receiver were connected in parallel with this resistor. The purpose of the resistor was to effectively reduce the tube gain of the 1st radio frequency tube.

(b) For any given frequency, the microvolts input to the loop center required to produce a given output from the auxiliary receiver, with both receivers tuned for resonance, was measured. The application of the CW signal from the Standard Signal Generator to the loop center was the same as for loop sensitivities described under pars. 12 to 14 above.

(c) The microvolts input required to produce the same output from the auxiliary receiver, and when the CW signal from the Standard Signal Generator was applied to the grid of the 1st Radio Frequency tube, was also measured at the same frequency as for (b) above. For this test, the external attenuator was omitted from the Standard Signal Generator output lead.

(d) The ratio of the microvolts input measured under the conditions described under subparagraph (c) to the microvolts input measured under the conditions described in subparagraph (b) is the true loop circuit "Q" at the frequency at which these measurements were made.

(e) This procedure was repeated for each of five frequencies within each band of the Model DO-3 Equipment. The calculation of the loop circuit "Q", for each frequency concerned, was corrected for error introduced by the insertion of the 1/2 ohm in the loop center and for the error in the Standard Signal Generator slide wire calibration due to the external attenuator.

47. Measurement or Calculation of Loop Circuit Selectivities. The loop circuit selectivities of the Models DO, DO-1, and DO-2 Equipments were calculated for three points in each band of each equipment, from their respective loop circuit "Q's", determined and described in the preceding paragraphs, and the Universal Resonance Curve from Terman's "Radio Engineering". With the aid of this curve and knowing the circuit "Q" at the resonant frequency, it is possible to calculate the times resonant input required for any percent off resonance, to produce the same final result as for resonance.

48. The loop circuit selectivities of the Model DO-3 Equipment for CW signals were measured using an auxiliary receiver bridged across a plate loading resistor on the 1st radio frequency tube, as described under par. 46. Energy was applied to the loop by induction from a coupling coil fed by the Standard Signal Generator. A fixed coupling between the coupling coil and the loop was maintained throughout this test. The microvolts input to the coupling coil required to produce a given output from the auxiliary receiver with both receivers tuned to resonance at a given frequency was noted. Similarly, the microvolts input required to produce the same output from the auxiliary receiver was noted with both receivers tuned to resonance, and with the signal from the Standard Signal Generator applied to the grid of the 1st radio frequency tube. This procedure was repeated except that the DO-3 receiver settings were not altered and with the Standard Signal Generator frequency increased in definite increments above and below the receiver resonant frequency and the magnitudes of microvolts input to the loop coupling coil and to the grid of the 1st radio frequency tube required to produce the same output from the auxiliary receiver tuned for each increment of the Standard Signal Generator frequency.

49. The above procedure was repeated for five points in each band of the Model DO-3 Equipment and from the data recorded, the loop circuit selectivity for each point considered in each band, may be calculated. These calculations assume a constant coefficient of coupling between the loop and loop coupling coil, and further assumes that the change of the reflected resistance in the loop due to the loop coupling coil, with frequency, remains reasonably constant within the limits of the frequency range explored for each selectivity measurement. The selectivity at any point within a band and at any percent off resonance, within the limits of actual measurements, was calculated using the following formula:

Times Resonant Input at "X" % off Resonant Frequency =

$$\frac{\text{Microvolts input to loop coupling coil at "X" \% off resonant frequency}}{\text{Microvolts input to grid of 1st RF tube at "X" \% off resonant frequency}}$$

$$\frac{\text{Microvolts input to loop coupling coil at resonant frequency}}{\text{Microvolts input to grid of 1st radio frequency tube at resonant frequency}}$$

50. Overload Characteristic of Audio System of Either the CRV-46031 or CRV-46031A Receivers was measured by applying a 1000 cycle signal from a General Radio Type 513B beat frequency audio oscillator to the grid of the second detector tube through a voltage divider network. The output voltage across the 600 ohm load of the audio amplifier was measured with a General Radio Type 636A Wave Analyzer used as a vacuum tube voltmeter. The input audio signal was increased in several steps from zero up to such values as produced overloading of the audio amplifier and the output voltage measured for each step.

51. Using the same test set-up as for the overload characteristics, the 1000 cycle audio signal input was adjusted for a 6 milliwatt output from the audio amplifier under test. The harmonic content of the output signal was analyzed with the Wave Analyzer for outputs varying from standard down to 1 milliwatt.

52. The Regulation of the CRV-20011 and the CRV-20011A power units for changes in line voltage was measured with a Weston Set Analyzer applied to the heater and plate voltage terminals within each unit for each change in line voltage.

53. The Attenuation Characteristics of the Radio Frequency Filter of the CRV-20011 Power Unit were measured as follows:

(a) A radio frequency signal from a Standard Signal Generator was applied across the line terminals of the power unit and of sufficient magnitude to produce a given output from an auxiliary receiver connected across the plate output terminals of the power unit.

(b) A signal of the same radio frequency was applied to the antenna and ground terminals of the auxiliary receiver and its magnitude adjusted for the same receiver output as obtained under subparagraph (a). The ratio of the microvolts input for these conditions is a measure of the attenuation due to the filter at that frequency.

(c) The procedures outlined under subparagraphs (a) and (b) were repeated for several frequencies within a frequency range of 100 to 1500 kilocycles.

54. The Attenuation Characteristic of the Radio Frequency Filter of the CRV-20011A Power Unit was determined using the same procedure as described under par.53, except that only that portion of the filter from the line terminals to the plate winding of the shielded transformer was considered for this test, inasmuch as only this section of the entire unit can be considered as a true radio frequency filter.

55. A harmonic analysis of the high voltage supply of the CRV-20011A Power Unit was determined using a General Radio Type 636A Wave Analyzer. Measurements were made at the input and output connections to the audio filter in the plate supply circuit.

DATA RECORDED DURING TEST

56. Complete data was recorded on all tests conducted and this information is contained in Tables 1 to 16 and Plates 1 to 105, appended hereto.

PROBABLE ERRORS IN RESULTS

57. Prior to the tests, the equipment under test and all measuring instruments incorporating tubes or other devices which are dependent upon constant temperature for stability were allowed to operate for a sufficient length of time to permit stabilization to take place. The line voltage for the a.c. operated equipments was controlled with a General Radio "Variac".

58. Periodic calibration of the wave analyzer and the audio frequency oscillator, employed in connection with some of the tests, was made to assure consistent and reliable results.

59. All tests were carefully conducted so as to maintain minimum errors in observations and in the manipulation of the controls of the equipment under test or by the measuring equipment.

60. Tables 1 and 2 show the measuring instruments used and their application to these tests.

61. Actual tests were made on the Models DO and DO-1 equipments. Except for the variations in the loop circuit constants, it has been assumed that the receivers for the Models DO-2 and DO-3 equipments are sufficiently identical to that of the Model DO-1 equipment as to render duplication of tests, made on the latter equipment, for the former equipments unnecessary. Where the results of a given test for overall performance depended upon loop circuit constants, the results obtained for that test on the DO-1 equipment were corrected so as to apply to the Models DO-2 and DO-3 equipments. The logic of this procedure has been demonstrated to be both sound and practical by actual tests made on the available equipment.

62. The measurement of loop circuit constants was made for each equipment and the results for one equipment are independent of the corresponding results of any other equipment.

63. For the purpose of discussing the probable errors in tests, the tests may rightfully be classified under the headings given below. The estimates are based on actual measured results and when considering these estimates, it should be borne in mind that in the overall accuracy the error of one instrument in one direction oftentimes cancels the error of some other instrument employed in the same test and vice

versa so that the net result is several times more accurate than the rated accuracy of either one of the instruments taken separately.

(a) Radio frequency measurements employing a Standard Signal Generator, a 1000 cycle audio oscillator of the fork type, and output meters, either voltmeter or microwattmeter. Under this category fall the following tests:

Name of Test	Estimated Overall Accuracy as Applying to Models DO and DO-1
1. Sensitivity (Loop, balance, and sense)	± 10%
2. Selectivity (Sensitivity off resonance)	± 10%
(Frequency setting)	± 0.1%
3. Image selectivity (Sensitivity off resonance)	± 10%
(Frequency setting)	± 0.1%
4. Maximum noise level in voltage	± 10%
5. Antenna and loop coupling	± 10%
6. Overall voltage gain	± 10%
7. Variation of overall gain with reduction of output signal intensity	± 10%
8. Resonant Overload	± 10%
9. Calibration and frequency overlap	± 1%
10. Manual volume control characteristics	± 10%
11. Trans-rectification	± 1%
12. Balancer detuning	± 1%
13. Ratio of quadrature to in-phase voltages	± 5%

The accuracies of the above tests 4, 5, 10, 11, 12, and 13 apply equally as well to the Models DO-2 and DO-3 equipments. The errors introduced in the calibration of the Standard Signal Generator slide wire by the external attenuator is less than 2-1/2%. All slide wire readings were corrected for these errors. The accuracy of the antenna sensitivities for balance or sense conditions as given above, apply also to the Models DO-2 and DO-3 equipments.

(b) Audio frequency measurements employing a beat frequency audio oscillator, input and output voltmeter, and a wave analyzer. The accuracy of these measurements is ± 1.0 db.

(c) Frequency stability measurements employing a beat frequency audio oscillator, output meters, and a standard signal generator.

Name of Test	Accuracy of Measurement Applies to all Equipments
1. Frequency stability vs changes in line frequency	± .5%
2. Frequency stability vs changes in input signal intensity	± .5%
3. Frequency stability vs changes in volume control setting	± .5%
4. Frequency stability under conditions of shock	± 25%

(d) Time constant measurements are accurate to within 0.0005 second.

(e) Loop circuit radio frequency resistance and "Q" tests, employing the use of a radio frequency bridge, standard signal generator, auxiliary receiver, and output meters, or as for the case of the Model DO-3 equipment, a standard signal generator, auxiliary receiver and output meters.

Name of Test	Accuracy of Test Applies to all Equipments
1. Loop circuit radio frequency resistance	0.1 ohm
2. Loop circuit "Q"	1%

(f) Loop circuit constants, employing a standard signal generator, precision type of variable condenser, slide back tube voltmeters, and 1000 cycle impedance bridge.

Name of Test	Accuracy of Test Applies to all Equipments
1. True inductance of loop and associated loads	± 10%
2. True distributed capacitance of leads in coupling cables or loop pedestal at 1000 cycles	± 3%
3. Inductance of loop load coils	± 3%

(g) Loop circuit selectivities as calculated from the loop circuit "Q's" of Models DO, DO-1, and DO-2 equipments are accurate to ± 10% for times resonant inputs and ± 5.0% for percent off resonance. The measured loop circuit selectivities of the Model DO-3 equipment have "times resonant inputs" accurate to ± 10% and "percents off resonance" accurate to 0.1%.

(h) The radio frequency attenuation and characteristics of the CRV-20011 and CRV-20011A power units are accurate to within 10%.

(i) The regulation of the CRV-20011 and CRV-20011A power units are accurate to within the limits of the Weston set analyzer employed in making these tests. The harmonic analysis of the radio frequency filter of the CRV-20011A power unit is likewise limited in accuracy to the accuracy of the wave analyzer.

RESULTS OF TESTS

64. Electrically, with but a few exceptions as noted below, the Models DO, DO-1, DO-2, and DO-3 equipments are identical.

(a) The Model DO equipment is d.c. operated while the other three equipments are a.c. operated.

(b) The heaters of the tubes in the CRV-46031 receiver used with the Model DO equipment are connected in series while in the CRV-46031A receiver used with the other three equipments, they are connected in parallel.

(c) The CRV-69003 loop (round) is employed with the Models DO and DO-1 equipments and in each case is directly connected to the receiver. The CRV-69004 loop (square) is employed with the Models DO-2 and DO-3 equipments. However, it is directly connected to the receiver for the Model DO-2 equipment and remotely connected to the receiver for the other equipment through suitable coupling transformers and a 35-foot transmission line.

(d) The CRV-20011 and CRV-20011A power units are respectively d.c. and a.c. operated. Both have identical radio frequency and audio frequency filtering systems. The former employs voltage dropping resistors to reduce the supply voltage down to the correct value for the heater circuit. The latter employs a power transformer and rectifier tube for supplying the heater and rectifier d.c. potentials.

65. The CRV-46031 or CRV-46031A receivers have, with the exception noted above, identical circuits. The following statements therefore apply equally as well to one as to the other. The receiver covers a frequency range of 100 to 1500 kilocycles in three bands; namely, low frequency, medium frequency, and high frequency. The frequency ranges of these bands are, respectively, 100 to 250 kilocycles, 225 to 610 kilocycles, and 550 to 1500 kilocycles. The receiver employs the usual superheterodyne circuit in order to provide high voltage gain with maximum stability. One stage of tuned radio frequency amplification precedes the first detector and provides two tuned circuits for the suppression of image frequency response. A separate radio frequency oscillator tube is employed in an electron coupled oscillator circuit for reasons of frequency stability. Adequate selectivity is provided by two stages of high gain intermediate frequency amplification at 81.5 kilocycles. A separate intermediate frequency oscillator tube employed in an electron coupled oscillator circuit provides means for CW reception. This coupling is well shielded and by-passed so that practically all coupling is obtained through the coupling capacitor to the grid of the second detector tube. One stage of audio amplification with low power output and with a permanently connected low pass filter connected between the second detector and 1st audio tube is employed.

66. A band selector switch operated from the front panel makes all necessary circuit connections, including those for the loop circuit, in one operation for each band.

67. Type CRV-38039 tubes are used in the radio frequency, intermediate frequency, and first detector stages, while Type CRV-38036 tubes are used for the two electron coupled oscillator circuits. Type CRV-38037 vacuum tubes are used in the second detector and output stages.

68. The CRV-20011 and CRV-20011A power units employ identical inductance, capacity filters for filtering radio frequency and audio frequency disturbance. The chokes used in both types of filters have iron cores. Both sides of the line are fused and above ground potential. For further information, refer to refs. (k) to (n) inclusive.

69. In the following paragraphs, reference is made to Specifications RE 13A 473A, ref.(b), which covers the Model DO Radio Direction Finding Equipment and to Specifications RE 13A 474A, ref.(c), which cover the Models DO-1, DO-2, and DO-3 Radio Direction Finding Equipments. Unless specifically stated otherwise in any particular paragraph, it will be assumed that these equipments comply with the requirements of that paragraph. Unless otherwise noted, the indicated paragraphs refer to both ref.(b) and ref.(c).

70. In the discussion of pars.2-1 to 2-16 inclusive and 3-1 to 3-9 inclusive of ref.(b) as well as of pars. 2-1 to 2-16 inclusive and 3-1 to 3-11 of ref.(c) repetition in the discussion of the subject directly or indirectly related to these paragraphs and discussed under pars.4-1 to 4-40 inclusive; and 5-1 to 5-32 inclusive of ref.(b) and under pars. 4-1 to 4-49 inclusive, and 5-1 to 5-37 inclusive of ref.(c) will be avoided in so far as it is possible.

71. Par.1-1. Inasmuch as the Models DO, DO-1, DO-2, and DO-3 Radio Direction Finding Equipments have not complied with all of the governing specifications, they cannot be considered entirely suitable and satisfactory for Naval use.

72. Par.1-2 to 1-4 inclusive. All four types of equipments covered by this report comply with the requirements of these paragraphs. The CRV-46031 Receiver is a part of the Model DO equipment and the CRV-46031A Receiver is a part of the Models DO-1, DO-2, and DO-3 equipments. Both receivers cover a frequency range of 100 to 1500 kilocycles in three bands. Reference to column two of Tables 7 and 8 will show the actual measured limiting frequencies of each band of these two types of receivers.

73. Par.1-5. The Model DO Radio Direction Finding Equipment is supplied with a line filter and except as will be noted later in the report may be operated either from a 115 volt d.c. line or from a 115 volt battery supply. No mention of this line filter is made in ref.(b). The only requirement of ref.(b) is that this equipment be operated from batteries. The specification for par.6-10 requires that separate heater and plate batteries be employed. The Models DO-1, DO-2, and DO-3 radio direction finding equipmentsare each entirely operated from a 115 volt, 60 cycle, single phase a.c. line. Each equipment is furnished with a separate rectifier power unit for supplying low voltage a.c. to the heaters and pure d.c. potential to the plates and screens. Suitable power and receiver cables in compliance with specification refs.(b)

and (c) are furnished with each equipment. It should be noted, however, that the receiver cable for the Model DO-3 Equipment failed in service due to a broken plate supply conductor. Two breaks occurred, well away from the ends.

74. Par.1-6. The component units comprising each type of direction finding equipment are as follows:

Model DO Equipment

Type No.	Description
CRV-46031	Receiver complete with one set of vacuum tubes
CRV-20011	Power unit
CRV-69003	Round loop assembly
CRV-69005	Loop pedestal assembly
108 inch	Loop receiver cable with fittings

Model DO-1 Equipment

CRV-46031A	Receiver complete with one set of vacuum tubes
CRV-20011A	Rectifier power unit
CRV-69003	Round loop assembly
CRV-69005	Loop pedestal assembly
108 inch	Loop receiver cable with fittings

Model DO-2 Equipment

CRV-46031A	Receiver complete with one set of vacuum tubes
CRV-20011A	Rectifier power unit
CRV-69004	Square loop assembly
CRV-69005	Loop pedestal assembly
108 inch	Loop receiver cable with fittings

Model DO-3 Equipment

CRV-46031A	Receiver complete with one set of vacuum tubes
CRV-20011A	Rectifier power unit
CRV-69004	Square loop assembly
CRV-69005B	Loop pedestal assembly
CRV-69005C	Remote control pedestal
CRV-47047	Loop output transformer
CRV-47048	Receiver input transformer
16 inch	Loop output transformer cable
16 inch	Input transformer receiver cable

75. Par.2-1. General specifications for the inspection of the material by the Navy Department - no comment.

76. Par.2-2. Electrical Indicating Instruments.

(a) The electrical indicating instruments employed are as follows:

Output meter, Weston Model 506, Type S-19453, Navy Type No. CY-22152, used on the CRV-46031 and CRV-46031A Receivers.

Voltmeter, 0 - 7.5; 0 - 150 volts d.c., Weston Model 506, Type S-18957, Navy Type No. CY-22117 used on the CRV-46031 Receiver only.

Both meters are of the 2-7/16" diameter flush mounting type. The output meter is used to measure the receiver power output in decibels above or below 6 mw. The voltmeter indicates, normally, heater voltage and high potential "B" voltage when a small push button at the bottom of the instrument is depressed. Both instruments are furnished with anti-glare glass and both comply with Specifications 17-I-12, ref.(f).

(b) The master nameplate and unit nameplates of each type of equipment comply with Specifications RE 10AA 263H, ref.(e). The former nameplate is mounted on the top of the receiver cabinet.

(c) Vacuum Tubes. The same tube complement is employed in each of the CRV-46031 and CRV-46031A Receivers. This is as follows:

4 Navy Type CRV-38039
2 Navy Type CRV-38037
2 Navy Type CRV-38036

The CRV-20011A rectifier power unit employs one Navy Type CRV-38180 full wave high vacuum type rectifier tube. No regulating tubes or other devices for this purpose are used. Approval is listed in Specifications RE 13A 346S, ref.(g), for all of the above tubes.

(d) Ceramics. Isolantite is used for all adjustable trimmer condenser insulation and a glazed ceramic material is used for the stand-off insulators for the tuning condensers in both of the CRV-46031 and CRV-46031A Receivers. The value of the application of high quality insulating material for the tuning condenser stand-off insulators is questionable, owing to the fact that the condenser shafts are insulated from ground by only a phenolic material. The use of the ceramic material is probably for mechanical, rather than electrical reasons.

(e) Phenolic Insulation. In the CRV-46031 and CRV-46031A Receivers, phenolic insulation is used as follows: Canvas base bakelite (or material of similar quality) is used for the antenna and receiver tuning vernier dials, for the large and medium sized spur gears of the balance mechanism and the spur gear on the band switch mechanism. Paper base bakelite material (or material of similar quality) is used for the antenna and loop terminal strips, main power terminal and fuse panel, balancer coil assembly, tube sockets, balance shield insulators, all small supporting panels for miscellaneous small fixed mica-dielectric by-pass condensers and resistors, contact supporting blocks on anti-capacity band selector switches, stator plate mountings on tuning condensers, tuning condenser and variometer shaft insulators which support the drive bands, terminal panels on the interstage transformer, output transformer, and CRV-48393 capacitor pack, housing for the CRV-47041 radio frequency choke assembly, the universal couplings for variometers, and range switch for output meter, and all coil forms except loop load coils, intermediate frequency transformers, and intermediate frequency oscillator coil. The coils or transformers to which exception is taken are wound on solid treated maple forms. Molded bakelite or material of similar quality is used for the variometer forms, toggle switches, small mica-dielectric by-pass condensers, and panel meters. Paper base bakelite or material of similar quality is used for the tube sockets, terminal block, resistor mountings, transformers, filter reactors, and condenser blocks in the CRV-20011 and CRV-20011A Power Units. It is also used for the terminal panels and slip ring spacers in the Loop Pedestals CRV-69005 and CRV-69005B and for the insulating spacers or the CRV-69003 and CRV-69004 Loop Assemblies.

77. Par.2-3 to 2-5 inclusive. The cabinets' front panels and the controls thereon (including a description of the mechanics of the controls) and dial calibration of the CRV-46031 and CRV-46031A Receivers are covered under pars.4-1 to 4-40 inclusive of refs. (b) and (c). Such items of these two receivers which have not been discussed under these latter paragraphs will be considered as follows. These statements apply to both the CRV-46031 or CRV-46031A Receivers.

(a) The cabinet is considered as being sturdy although the panel to cabinet fit should be improved considerably for future and similar equipments. It is finished on the outside with the Navy standard black wrinkle finish while the interior has a sand blast clear lacquered finish.

(b) The front panel is constructed from 3/16" thick flat aluminum sheet stock, finished on the outside with the Navy standard black wrinkle finish and on the inside with a sand blast clear lacquered finish. Knurled head thumb screws, arranged four at the top and four at the bottom of the panel and finished with Black Japan are provided for securing the panel to the cabinet. These thumb screws are designed so as to remain with the panel when loosened so as to obviate their loss.

(c) The main chassis frame of the receiver is of three piece construction secured together and to the front panel with screws and nuts; and having a sand blast clear lacquered finish. The top is of one piece construction being made from 7/32" thick aluminum and having the front edge turned down 3/8" and the rear edge turned down 1-3/4". The former band serves as a bearing surface against the front panel, while the latter serves to support the main power jack and fuse panel. Each of the two sides of the chassis frame are of similar construction, being made from 5/64" thick aluminum and having the top, front, and bottom edges bent 3/8" inward. These bent edges serve respectively to secure the side to the top of the chassis assembly, to secure the side to the front panel, and to provide a flange to slide under the button guides at the base of the receiver cabinet. These two sides have a finish identical with the top of the receiver chassis. The sides are further supported to the top with 1/2" wide x 3/32" thick nickel plated brass reenforcing strips.

(d) Two additional shields constructed from 5/32" thick aluminum and finished the same as the receiver chassis are provided and are supported to the front panel and top section of the receiver chassis. One of these shields is placed underneath the main chassis frame and serves to shield the variometers. The other, placed directly over the latter and on top of the main chassis frame, serves to shield the balancer coil assembly and antenna circuits.

(e) The construction of the main receiver chassis and associated auxiliary shields for each type of receiver is considered as being rugged and well designed.

(f) The ganged tuning condensers of the receiver are standard Cardwell units and no further comments relative to their construction are felt necessary. Each variable tuning condenser is supported from a 14-1/2" long x 3-3/8" wide x 1/4" thick aluminum panel by three glazed ceramic pillars, each 1-13/16" long and 1/2" in diameter. Tapped holes are provided in the ends of each pillar to retain the condenser mounting screws. The aluminum panel provides a means for ganging the three separate tuning condensers as a separate sub assembly. The aluminum panel is mounted on four nickel plated brass pillars 1" long and 3/8" in diameter which support the condenser sub panel to the front panel. The four brass pillars are screwed to the front panel with #10 - 32 countersunk head, brass, black Japanned finished machine screws, which pass through the pillars and into the condenser sub panel. Two nickel plated brass hex nuts, placed between the panel and the brass pillar and a similar nut placed on the opposite side of the sub panel are provided for each mounting screw. Lock washers are provided for the nuts on the condenser side of the sub panel. The rotor of each variable condenser except for the loop tuning condenser is coupled to a shaft extension by means of a phenolic drum-like insulating coupling. Each coupling insulator except that for the loop tuning condenser is provided with a brass hub on each side. One hub is pinned to the end of the condenser shaft while the other is pinned to the shaft extension. The opposite end of the extension shaft,which is of brass and nickel plated, fits into a bronze bearing mounted in the condenser assembly sub panel. The coupling insulator for the loop tuning condenser has but one hub since no extension shaft is employed with this condenser. The insulating hubs are provided with nickel plated brass pins which retain the flat drive bands. Two such bands are used and each connects to two insulating couplings in such a manner that the direction of rotation of all tuning condensers is the same. The antenna and receiver tuning controls are mounted directly on the condenser assembly sub panel and the latter control is directly connected to the extension shaft of the oscillator tuning condenser. This control operates all three tuning condensers in tandem through the drive bands.

(g) The tuning control drive system for the sense variometers in the receiver is similar to that described above for the tuning condensers except that drive bands are used to control only the low frequency and medium frequency variometers, the high frequency variometer being direct connected to the medium frequency variometer by means of a universal coupling which insulates the two shafts from each other. The windings on the variometers do not appear to be well protected against corrosive action of humid salt atmosphere. The wire used for the windings is insulated with silk. The rotor and stator frames are of molded bakelite and their respective windings are held in place with a white cement. Past experience with similar variometers in other equipments have not proven this construction to be faulty. There is self interference of the pig-tail connection for the rotor shaft of each variometer. This interference, together with the fact that the pig-tail connection is insulated only with a cotton sleeve, may lead to trouble due either to the connection becoming broken as a result of this interference or becoming open-circuited as the direct result of corrosion.

(h) The band selector switches are operated in tandem by a single control mounted on the front panel of the receiver. The band selector switches are of the anti-capacity type and are described under par.4-19 of refs. (b) and (c). The main control knob is attached to a 8" long, nickel plated, brass shaft, supported near each end by a nickel plated brass angle secured to the under side of the main chassis frame. At the opposite end of the shaft from the knob is a fabric based phenolic pinion gear riveted to a nickel plated brass bushing, which, in turn, is pinned to the drive shaft. Two pin stops fastened to the front shaft mounting bracket limit the rotation of the control knob to 180°. The pinion gear meshes with a rack attached to a 3/8" wide x 1/8" thick x 17" long nickel plated brass beam which actuates the anti-capacity switches in tandem. The longitudinal movement of the beam is guided by idler pulleys supported by individual brackets mounted on the under side of the main receiver chassis. Toggle bearings are mounted on the beam for control of the switch levers of the anti-capacity switches.

(i) The tube socket connections and plate coupling resistors and capacitors of the intermediate frequency oscillator are protected with two shield boxes fabricated from copper and nickel plated. All of the seams of these shields are soldered. The shield boxes are secured to the underside of the receiver chassis with screws which screw into tapped holes in the mounting angle in these shield boxes.

(j) The balancer coil drive mechanism is a most unique design. A small nickel plated brass pinion gear attached to the opposite end of the control knob shaft from the control knob drives a fabric based phenolic spur gear of such dimension and construction that the ratio between itself and the pinion gear is 20 to 1. The control knob driving the pinion gear is operable from the front panel. Two pin stops mounted 180° apart in the aforementioned spur gear and a pin in the pinion gear limit the rotation of the spur gear to 180°. The shafts of the pinion and spur gears rotate in separate bearings supported by a flat nickel plated brass strip which in turn is mounted to the front panel by two oval head brass #6-32 machine screws, the shanks of which are nickel plated,while the heads are black oxidized. Nickel plated hex nuts and lock washers are used to secure the screws in place. Nickel plated tubular brass spacers are used to separate the mounting bracket from the front panel. The end of the large spur gear shaft operates a link system which in turn rotates the balancer coil through two spur gears having a 2 to 1 ratio. The link system consists of two nickel plate brass strips joined together with a nickel plated brass pin. The free end of one link is secured to the shaft of the large spur gear directly driven by the control knob by means of a set screw. The free end of the other section of the link system is riveted to a fabric phenolic spur gear which is the larger of the two spur gears mentioned above and mounted in the balancer coil carriage. The other of these two spur gears is of nickel plated brass material and is mounted directly to the balancer coil and pinned in place. The action of the link and gear mechanism just described is to cause the balancer coil to rotate 180° and during this period of rotation to move longitudinally so as to provide clearance between the coupling coil shield support and the balancer coil, and also to provide a means whereby the coupling between the balancer coil and its coupling coil may be maximum for the extreme settings of the balancer control. The longitudinal motion of the balancer control is governed by a carriage on which are mounted four grooved wheels, two at the top and two at the bottom. A solid nickel plated brass strip serves as a guide for the bottom wheels while two nickel plated phosphor bronze strips serve to guide the top wheels and at the same time provides tension for the entire balancer coil carriage. These guides are supported to the front panel and the mounting bracket for the main drive spur gear. The balancer coil mechanism, although unusual and somewhat complex mechanically, functions very creditably generally.

(k) The band selector switches, load coils and trimmer capacitors of the loop circuit are a separate sub assembly. All units are mounted on a sub base separate from the receiver chassis. The entire assembly may be easily removed from the receiver after taking out four mounting screws, unsoldering two leads and disconnecting the switch lever of a single anti-capacity switch from the main band selector switch control. The load coils are well constructed, being of the honey-comb type of winding, wound treated wooden mandrels, and thoroughly coated with wax. These coils are considered as being well protected against all forms of corrosive action. The sub-base of the assembly is secured to the main chassis frame with four #6-32 screws. The loop terminal assembly is a part of this unit. A separate copper shield, nickel plated on the outside, and copper lacquered on the inside encloses the entire loop circuit assembly. This assembly is well designed from the standpoint of both production and operation.

(l) The radio frequency coils and oscillator coils for each of the three bands of the receiver, together with their corresponding trimmer capacitors, circuit and band selection anti-capacity switches, are, like the loop circuit coils, switches, etc., mounted on a sub-panel as a separate and distinct assembly from the rest of the receiver chassis. Similarly, as for the loop circuit assembly discussed above, a separate shield of similar construction completely encloses the unit assembly. The radio frequency and oscillator coils for the low frequency and medium frequency bands are of the honey-comb type wound on a phenolic insulating tube and are thoroughly protected against moisture with a heavy coating of wax. The radio frequency and oscillator coils for the high frequency band are layer wound on phenolic tubes and similarly protected with a heavy coating of wax. The radio frequency and oscillator coil and band switch assembly may be removed as a unit by taking out four mounting screws, unsoldering six leads and disconnecting the anti-capacity switch levers from the main band selector switch drive assembly. Comments relative to the units of this assembly are the same as those applying to the loop circuit assembly described in the previous paragraph.

(m) The intermediate frequency amplifier transformers are each mounted in separate screw-top shield cans and are mounted in the under side of the main receiver chassis. Each transformer assembly includes its own trimmer condensers and coil windings. The transformer windings are of the honey-comb type and are wound on wooden mandrels and are thoroughly protected against the corrosive action of humid salt atmosphere.

(n) The paper dielectric condensers are housed in steel cases and are provided with fiber terminal panels. This type of insulation is unsatisfactory in that it is known to be moisture absorbing and hence does not comply with specifications, ref.(j). The connections to the terminals have been made through eyelets which secure the terminals to the panels. This practice is unsatisfactory inasmuch as moisture can enter the condenser through these open eyelets.

(o) The range switch for the output meter is provided with a switch arm which is positive in its action and provides self-wiping characteristics. Corrosion has appeared, however, on the soldering lug terminals.

(p) The telephone jacks are not in agreement with the specifications of ref.(d); jacks of the short-type have been employed.

(q) The dial lamp bracket mounted directly in front of the intermediate frequency oscillator tube shield is difficult to remove owing to interference between it and the tube shield.

(r) The panel thumb screw retaining block at the top of the cabinet and provided for the second thumb screw from the front left hand side of the panel, interferes with the tube shields in such a way as to make it difficult to insert the chassis into the cabinet without damaging one or more of the tube shields which are in line with this retaining block.

(s) The soldered joints are well made and the wiring is unusually neat. Except for a few bus wire connections and pig-tail connections, rubber and treated cotton braid insulated wire has been employed for all circuit connections. The use of this type of wire for radio frequency circuits is not considered good inasmuch as the effectiveness of the treatment of the cotton braid insulation is questionable. Rubber insulated wire without cotton braid would be preferable.

78. The CRV-20011 and CRV-20011A Power Units are very similar mechanically. The important features of these units,not included under pars. 4-40 to 4-49 inclusive, will be considered at this time. Unless specific exceptions are taken for one or the other units, the following statements apply to either unit.

(a) The front panel is constructed from a 3/16" thick "eraydo" alloy plate and finished on the outside with the Navy standard black wrinkle finish and on the inside with a sand blast clear lacquered finish. Eight thumb screws, similar to those used on the CRV-46031 Receiver panel are arranged four at the top and four at the bottom of the panel.

Eight 7/8" diameter ventilating holes are arranged four each near the top and bottom of the panel. These holes are spaced 1-3/4" apart and are 1-1/8" below the top or above the bottom edges of the cabinet. They are centrally located with respect to the ends of the panel. A wire screen covering the ventilating holes, is provided for shielding purposes, and is held in place with a clamp riveted to the front panel.

(b) The main sub-panel of the chassis frame is made from 3/32" thick "eraydo" alloy sheet. The front and rear edges are turned down 3/8" while the two side edges are turned down 2". The front edge is secured to the front panel with screws and nuts. This sub-base panel is further supported to the front panel with two side plates which are riveted to either side of the sub-base panel and secured to the front panel with screws and nuts. The sub-base panel and supporting side plates have a sand blast, clear lacquered finish on the surface. The main sub-base panel for the CRV-20011A Power Unit has bowed inward, probably as the result of the unit's having been dropped.

(c) The transformers, chokes and by-pass condensers are all potted in cadmium plated steel cases. The terminal board insulation for the CRV-48239 by-pass condenser is of fiber and hence does not comply with specifications, ref.(j): moreover, this condenser is not entirely metal clad as required by ref.(j). The connections of the internal leads to the terminals of these component units are brought through the open eyelets securing the terminals to their respective terminals. This feature is objectionable because moisture may enter these eyelets and in turn corrode the leads passing through them.

(d) The cable clamp screws are susceptable to breakage, being only #6-32.

(e) The +B terminal of the load resistor is too close to the tube socket mounting in the CRV-20011A Power Unit for safe operation. The plate leads to the rectifier tube lay against the sharp edges of the shock mounting frame supporting the tube socket and hence the insulation may become impaired in time, causing a breakdown to ground.

(f) The arrangement of the component parts are such that all are accessible. The line terminals and fuse clips are protected and shielded with an "eraydo" alloy casting which is held in place with two thumb screws.

(g) All soldered joints have been well made. All wiring is neatly arranged and, except for the twisted input circuit leads, are laced together.

(h) Inasmuch as the important mechanical features of the loops, loop pedestals, and remote control pedestal are discussed elsewhere in this report, no further comments on these units are necessary at this time.

79. Par.2-6. All equipments comply with these specifications.

80. Par.2-7. Test facilities available are limited to room temperatures and above.

81. Par.2-8. The +B and high side of the heater circuits are each fused in the CRV-46031 and CRV-46031A Receivers. In the heater circuit the fuse is so placed as to also protect the dial and azimuth lamps. "Little fuses" are used and are mounted on the power jack panel at the rear of the receiver chassis. The plate supply fuse is rated at 0.25 amperes while the heater and pilot lamp supply fuse is rated at 3.0 amperes. A 5 ampere, 125 volt "Little fuse" is placed in series with each side of the line to the CRV-20011 and CRV-20011A Power Units and prior to the first by-pass condensers. These fuses are mounted within the shielded compartment housing the power cable terminals.

82. Par.2-9. The radiating surfaces of the cabinets for the CRV-46031 and CRV-46031A Receivers and for the CRV-20011 and CRV-20011A Power Units are ample to dissipate the heat generated within their respective cabinets without additional ventilating louvers or other types of air vents.

83. Par.2-10. It is impossible within the scope of the tests made at the Laboratory to make any general statement regarding the capability of any of the four types of equipments covered by the report operating continuously without damage.

84. Par.2-11, 2-12. All equipments comply with these specifications. Refer also to par.6-18, refs. (b) and (c), for a discussion of the capability of either type of equipment operating under condition of vibration.

85. Par.2-13. Of the four types of Equipments covered by this report, all major parts and spare parts of one are interchangeable, without modification, with similar parts employed in the construction of other equipments. In all receivers, all fixed paper dielectric condensers, fixed mica dielectric condensers, band selector switches, audio transformers, balancer coils, variometers, trimmer condensers, "tear-drop" padding condensers, and tube sockets have had Navy type numbers either stamped, stenciled or engraved on unobstructed surfaces. Stamped letters and figures were used on metal clad units; engraved letters and figures were used on the fixed mica dielectric capacitors and band selector switches and stenciled letters and figures were used on the variometers, tube sockets, balancer coils and trimmer condensers. Labels on which were typed the Navy type numbers were affixed to the "tear-drop" padding condensers with clear varnish. Except for the mica dielectric condensers, engraved letters and figures were filled with wax. In the former instance, where filling was omitted, the characters are not readily discernible. All stencilling was done with white lacquer. In the power units, all transformers, reactors, condenser packs, and other fixed mica dielectric condensers were stamped with Navy type numbers. In the CRV-20011A Power Unit the rectifier tube socket was stencilled with a Navy type number. Navy type numbers as well as the value of the resistor was stamped on the end ferrules of the fixed resistors. It will be noted here that in addition to the stampings on the resistor ferrules, the corresponding figures and letters for the Navy type numbers and resis-

tance values are stencilled on the resistor mounting panels or at least near by on the chassis. This obviates replacing a damaged resistor of the wrong size and value. Such precaution has not, however, been taken with the fixed resistor in the CRV-20011A Power Unit. The methods for stamping or stencilling the several parts of the power units were the same as described for the receiver parts. In the receivers, no Navy type numbers or manufacturer's type numbers appear on the loop, intermediate frequency and oscillator tuning condensers, loop load coils, intermediate frequency transformers, radio frequency or oscillator coils, intermediate frequency oscillator coils, toggle switches, or range switches for the output meters. The fixed carbon rod resistors are identified only by color code.

86. Par.2-14. All equipments comply with these specifications.

87. Par.2-15. No comment. See par.4-2, refs. (b) and (c).

88. Par.2-16. All equipments comply with these specifications.

89. Par.3-1. Since none of the Models DO, DO-1, DO-2, or DO-3 equipments comply with all of the requirements of specifications, refs. (b) or (c), whichever applies to the particular equipment, they cannot be considered as being in strict compliance with the requirements of these paragraphs.

90. Par.3-2. Each equipment covered by this report is of the minimum (null) indicating type.

91. Par.3-3. Each equipment is capable of producing both bilateral and unilateral indications.

92. Par.3-4. A vertical antenna is employed with each equipment for use in obtaining perfect minima and also for obtaining unilateral indications. This antenna connects mechanically to a separate binding post and does not connect electrically to the loop. The Standard Dummy Balance Antenna used in the tests made on each equipment and reported upon herein, has the following characteristics:

Inductance	-	20 microhenries
Capacity	-	200 microfarads
Resistance	-	25 ohms

93. Par.3-6. All four equipments covered by this report comply with the requirements of these specifications.

94. Par.3-7, 3-8. Tests made on the Models DO and DO-3 equipments show that specifications are not entirely met owing to the fact that they show as much as 2.3° displacement as a maximum. Consult Table 14 for complete data in this regard. At about 247 kilocycles, the Model DO-3 equipment has self feed-back showing no direction. It is believed to be the 3rd harmonic, of the 2nd oscillator feeding back to the input. The Model DO equipment showed a similar feed-back condition at about 160 kilocycles which is probably the 3rd harmonic of the 2nd oscillator. The outputs at full volume for the two equipments were, respectively, +6 db and -2 db referred to zero level of 6 milliwatts. The large displacement

of the bilateral minima of the Model DO equipment at 1350 kilocycles is due largely to non-directional pick-up presumably coming in on the line.

95. Par.3-9. In the tests made on the Models DO and DO-3 equipments, it was found that unilateral indications were only fair to poor. The bilateral minima must be shifted over 15° to constitute a reliable sense indication and should be much more. The Model DO-3 equipment has too strong antenna effect owing to the attenuation in the loop transmission line. Increased sense resistance is required in each band of this type of equipment to improve the unilateral indications. Similarly, somewhat smaller sense resistance is required in each band of the Model DO equipment.

96. Par.3-10, 3-11. The Models DO-1, DO-2, and DO-3 Equipments are each designed for operation on a 115 volt, 60 cycle, single phase supply line, with a regulation of ± 5% and with the ground on either side of the supply line. Neither equipment introduces any metallic grounds on the supply line, but such grounds as might occur on the supply line from other causes will not damage the equipment or abrogate the performance. No batteries of any description are employed with either equipment. The Model DO Equipment may be operated from a standard 6 volt storage battery for heater supply and 100 volts of standard storage batteries for "B" supply. No intermediate taps of "C" batteries are required. While separate heater and "B" batteries may be employed, no battery cables have been furnished for such operation. The total "B" battery drain is 38.2 milliamperes. While there are no specific requirements regarding the degree of filtration required for such operation, it is believed that more satisfactory operation from the battery supply source would be assured if the heaters as well as the overall "B" supply were provided with filters within the receiver itself.

97. Par.4-1. (Par.4-1, 4-5 to 4-9 inclusive, ref.(b)) The cabinet of the CRV-46031 Receiver is fabricated from 1/8" thick "eraydo" alloy. All seams are thoroughly and uniformly soldered. The cabinet completely houses the receiver chassis to the extent that the front panel of the receiver chassis clears the front edge of the cabinet by 1-3/8". This dimension is sufficient to clear all projecting controls and handles on the front panel of the receiver chassis. The front edges of the top and bottom of the cabinet are reinforced with 1/8" thick x 5/16" wide flat nickel plated brass strips which are riveted to the cabinet. These reinforcing strips serve a secondary purpose acting as a stop for the front panel of the receiver chassis so as to prevent jamming the thumb screws in the panel against their retaining blocks or angles and to permit complete disengagement of the thumb screws from their retaining blocks or angles without requiring the partial removal of the chassis to accomplish this result. The reinforcing strips, however, are not sufficiently strong to prevent the top and bottom of the cabinet from bowing inward. Bowing of the top and bottom of the cabinet is less pronounced in the case of the cabinet for the CRV-46031 Receiver than for the CRV-46031A Receiver owing to the fact that the hinge for the front cover of the former cabinet offers additional reinforcing to the bottom of the cabinet. This objectionable feature should be overcome in future equipments of the same or similar design and purpose. At the top of the cabinet and directly behind the reinforcing strip are arranged 4 retaining

blocks for the thumb screws at the top of the receiver panel. The blocks are of nickel plated brass and are 3/4" long, 7/16" high, and 3/8" wide. They are each drilled and tapped for the thumb screws and are each secured to the top of the cabinet by two rivets. At the base of the cabinet and similarly arranged directly behind the reinforcing strip are four retaining angles for the thumb screws at the bottom of the receiver panel. These angles are also of nickel plated brass and are 7/8" x 7/8" x 1/2" wide by 1/8" thick. They are each similarly drilled and tapped for the thumb screws and secured to the bottom of the cabinet with two rivets as for the above mentioned retaining blocks. Also at the base of the cabinet are arranged, one at each corner, four button guides for the receiver chassis. These guides are of nickel plated brass and each is secured to the cabinet with a single rivet. These guides are unsatisfactory inasmuch as it is difficult to align the guide flanges of the receiver chassis under the two rear guide buttons. The cabinets of future equipment should be provided with a continuous guide. Such a guide could be provided without difficulty. The power and control cables, three in number; namely, the Power Cable, the Receiver Cable, and the Azimuth Lamp Cable enter the rear of the cabinet through individual water-proof fittings. These fittings are provided with packing compressing rings which when pressed against some form of packing would render the cable entries spray tight. No packing was furnished with either type of receiver. These cable entries will not be absolutely water-tight because the cables furnished are covered with a cotton braid which will permit moisture to enter the cabinet by virtue of "wick effect", and water could enter between the wires. The three cables connect to General Radio plugs arranged in a single row on a laminated phenolic insulating strip. This insulating strip is mounted inside and at the rear of the cabinet on four nickel plated brass pillars. It is secured to the cabinet by four #6-32 nickel plated brass machine screws which pass through the pillars and cabinet and are held in place with nuts and lock washers. A plain washer lies between each lock washer and the cabinet surface. Oversize clearance holes are provided for these four screws so that the terminal plugs may be properly aligned with the jacks in a similar terminal strip on the receiver chassis. It is to be noted at this point that the high voltage +B plug is too close to the supporting pillars at one end of the terminal strip to assure continuous operation of the receiver. While there is no danger from arcing, there is danger of the terminal lug coming in contact with ground should the plug fastening the terminal to the terminal strip become loosened under conditions of vibration. The terminal strip is suitably stencilled with figures to identify the purpose of each plug. Two 1-5/8" diameter holes surmounted by 1/8" thick x 5/16" high collars are provided at the left hand rear corner of the top of the cabinet for the antenna and loop connections. These connections are made to General Radio jacks on the receiver chassis from a separate assembly which fits into the two large holes mentioned above. A description of this assembly will be given elsewhere in this report. No provision is made in the top of the cabinet whereby adjustment of the loop trimmer capacitor can be made without removing the receiver chassis from the cabinet. This is not so important for any but the Model DO-3 equipment because all adjustments can be made at the factory. However, with the latter equipment, variations in the construction of the transmission line makes field adjustment of the loop trimmer capacitor imperative. All models require trimming of the receiver to the antenna used. It would be desirable therefore if these adjustments could be made with the receiver chassis in its normal position in its cabinet. The CRV-46031 receiver cabinet is provided with a spray proof metal cover to protect the receiver panel and interior of the receiver from damage due to moisture or spray when the receiver is not in use. This cover is fabricated from 1/8" thick "eraydo" alloy, has four turned up sides, and all seams are soldered. When closed, the cover fits over the front of the cabinet. The cover is hinged at the bottom of the cabinet and is provided with quickly detachable chain stops so arranged that when open it may be used as a small desk, 90° from the vertical or dropped completely down to hang below the receiver cabinet. The two chain stops are covered with a cotton braid. One end of each chain is secured to the inside of the front cover while the other end may be hung on a hook provided for this purpose on the receiver panel. Suitable rubber gaskets are provided on the inside of the cover and are secured into the cover with some form of cement and 3/4" wide x 1/8" thick nickel plated brass strips which in turn are fastened to the cover with nickel plated #6-32 brass machine screws and attendant nuts and lock washers. The arrangement of these screws is objectionable because the threaded ends of these screws protrude inside of the cover and are very apt to scratch an operator's hand or arm. It would be preferable in future equipment if the brass strips holding the rubber gaskets in place were drilled and tapped for the screws and that the screws were made to come flush with the surface of the gasket retaining strips. The cover when closed is secured in place with five clamping "dogs" arranged three on the top and one on each side of the cabinet. The construction of the cabinet for the CRV-46031A receiver is similar to that of the CRV-46031 described above except that it is not so deep nor is there any spray proof cover provided. The front of the panel of the receiver chassis of this receiver is flush with the front edges of the cabinet. Insertion of the panel is somewhat difficult because of the bowing of the top and bottom of the box, but once inserted the alignment of the securing screws is positive.

98. Par.4-2. The dimensions of the cabinet of the CRV-46031 receiver are as follows:

Height - 14" (including cover hinge and clamping "dogs".)
Width - 25-1/2" (including cover clamping dogs).
Depth - 15-3/4" (including cover clamping dogs).

The dimensions of the cabinet of the CRV-46031A Receiver are as follows:

Height - 14"
Width - 24"
Depth - 13-1/2"

On both cabinets the ground terminal projects 1-3/8" from the left side of the cabinet, the three watertight cable fittings project 1-5/8" to the rear of the cabinet, and the four Lord shock mountings project 1-3/4" below the bottom of the cabinet. The handles on the front panel of the CRV-46031A receiver project 1-3/8" from the front of the panel. Considering all of these items neither cabinet complies with the specified dimensions given in refs. (b) or (c). Neglecting these items, only the cabinet of the CRV-46031A complies with the specifications.

99. Par.4-3. Both types of receivers comply with these specifications.

100. Par.4-4. Each cabinet of the CRV-46031 and CRV-46031A Receivers is provided with four #45 Lord shock mountings, each of which is secured to the base of the cabinet with a 1/4 x 20 black Japanned brass machine screw threaded into the cabinet base. A nickel plated steel lock washer is placed under each screw head. The bases of the shock mountings are each provided with four holes for securing them to a table or bench by means of a 1/4" diameter lag screws or machine bolts. The use of wood screws or machine screws would involve the use of special screw driver owing to the lack of clearance for an ordinary screw driver. With the cabinet thus secured to a table or bench, the receiver chassis with all integral parts may be removed for servicing or other purposes without disturbing the cabinet.

101. Par.4-5 to 4-8 inclusive. (Par.13-3; 13-4 to 13-6 inclusive, ref.(b)). Both types of receivers comply with these specifications except that no provision for antenna tuning calibration is made.

102. Par.4-9. (Par.13-7, ref.(b).) The calibration charts of the CRV-46031 and CRV-46031A Receivers are protected with a clear sheet of celluloid one side of which has been sanded to reduce glare to a minimum. The sanded surface is placed next to the calibration charts. The polished surface has apparently been placed outside to prevent dirt from accumulating on the surface and thus impair the visibility, but at a sacrifice of anti-glare protection.

103. Par.4-10. Lord shock mountings #45 have been used in the construction of the CRV-46031 and CRV-46031A Receivers to minimize microphonic disturbances arising from vibration encountered on shipboard. No other shock proofing methods have been used elsewhere in either type of receiver.

104. Par.4-11. Both types of receivers comply with these specifications.

105. Par.4-12. For both types of receivers, tube insertion is accomplished only after the removal of the receiver chassis from its cabinet. This is permitted by the specifications inasmuch as the weight of the chassis of either receiver is only 51.5 lbs. (Spec.limit 75 lbs.)

106. Par.4-13. Two large handles, black Japan finished, and located one on each side of the front panel of either type of receiver permit the removal of the receiver chassis from its cabinet without putting strain on any of the control knobs or dials.

107. Par.4-14. The knurled thumb screws provided to secure the panel of either type of receiver to their respective cabinets are not considered well designed for handling without tools. This statement applies particularly to those screws arranged along the bottom edge of the CRV-46031A Receiver panel and to all of the screws of the CRV-46031 receiver, where there is insufficient clearance to obtain a satisfactory grip to loosen a tight screw. An increase in screw head radius with greater spacing of the knurled portion of the head from the panel would improve their action appreciably. They are designed, however, to remain with the panel when loosened so as to obviate their loss. No difficulty was encountered with either type of receiver from faulty engagement or disengagement of the knurled thumb screws with or from their retaining blocks or angles.

108. Par.4-15. Both types of receivers comply with these specifications.

109. Par.4-16. Except for the sensitivity control and the output meter range switch, the operating panel of each of the CRV-46031 and CRV-46031A have adjacent to each control suitable words or phrases descriptive of the purpose of the particular control. The sensitivity control is labeled "VOLUME" which should be "SENSITIVITY" to identify its purpose more precisely. The range switch for the output meter has the range of its several steps identified but there is no direct indication of its association with the output meter. While the output meter is not strictly a control, it will not be out of place here to state that there is no nameplate or other identification on the meter to indicate its purpose other than the scale markings.

110. Par.4-17. Both the CRV-46031 and CRV-46031A Receivers comply with these specifications.

111. Par.4-18. On both types of receivers, photoetched nameplates are used for the antenna tuning control, receiver tuning control, and balance control. All other control designations are engraved.

112. Par.4-19. Band switching in both of the CRV-46031 and CRV-46031A Receivers is accomplished by a single control operating several anti-capacity switches in tandem. The control is operated from the front panel and has three positions; namely, low frequency, medium frequency, and high frequency. The CRV-24006 anti-capacity switch used for band selection is the usual anti-capacity switch except that it has been improved in design by the addition of two phosphor bronze springs fastened on the outside of the two legs of the supporting frame. A wooden spool having a hub length approximately equal to the diameter of the fixed round contacts is placed between each of the two outside pairs of the fixed round contacts. These spools are fastened to their corresponding springs described above by means of rivets which pass through holes provided for them in the switch frame and at the same time spaces the spool and the auxiliary springs a definite distance apart. This distance is such that when the switch is in its neutral position the two pairs of outside fixed round contacts bear their normal relationship with respect to the moving flat spring contacts operated by the

switch key of the switch proper. The action of the auxiliary springs and their associated appendages described above is to increase the contact pressure between the outside pairs of round contacts on the moving flat spring contacts operated by the switch key when the switch is thrown to make such a contact. A secondary purpose of this auxiliary spring is to assure positive switch action. While the anti-capacity switch was improved to the extent described above, no modification in the design of the switch was made to assure an equally positive contact between the four inside fixed round contacts with the movable flat spring contacts operated by the switch key. The contact between the four inside fixed contacts and the four movable flat spring contacts have proven faulty during test and in service. The use of the anti-capacity switch for band selection should therefore be avoided in future equipment because of its unreliableness. No means is apparent for modifying the design of the present switch assembly to render it absolutely trustworthy.

113. Par.4-20. The main dials as well as the vernier dials of the antenna and receiver tuning controls of both of the CRV-46031 and CRV-46031A Receivers are marked on a 0 - 100 basis. While this is in agreement with the specification requirements, it leads to confusion in the correct reading of these control settings. A better and more practical marking would be one in which the main tuning dial, being less precise than the vernier dial, would be marked from 0 - 10 while the vernier dial would be marked from 0 - 100 as it is in its present form. Thus a setting at 2 on the main dial and a setting at 55 on the vernier would indicate a reading of 255. With the dials marked as in their present form and for corresponding settings of the two dials, the readings for the main and vernier dials would be respectively, 20 and 55. The dial indication is now either 25.5 or 255 depending upon which dial is taken as a basis of interpretation. This requirement of the specifications conflicts with the requirements of par.7-5 in regard to the marking of the balancer dial.

114. Par.4-21. In both of the CRV-46031 and CRV-46031A Receivers the values of the settings or other indications of the tuning controls, band switch, and output meter range switch increase numerically or alphabetically with increase of the final controlled effect. The pointer and vernier dial of the antenna and receiver tuning controls rotate in a clockwise direction for an increase in the final controlled effect. The sensitivity control rotates clockwise for increasing sensitivity. There is, however, no lettering or figures engraved on the panel to indicate the exact setting of the sensitivity control. The future equipment of this type should include a dial scale calibrated in degrees of rotation for the sensitivity control. The numbers on the balancer dial scale increase numerically in both the clockwise and counter clockwise direction - from a mid position for an increase in the balance effect.

115. Par.4-22. The CRV-46031 and CRV-46031A Receivers comply with these specifications.

116. Par.4-23. The receiver tuning and antenna tuning dials of both types of receivers are of the vernier controlled type only, no direct drive being employed for either control. While this is in ac-

cordance with the specification requirements, this type of control is not conducive to quick changing of receiver or antenna tuning and hence impairs the rapidity with which an operator can obtain bearings. The tuning of these receivers is slow and awkward. In the light of the success of more modern tuning controls, it is suggested that future designs of receivers for similar purposes employ tuning controls similar to the main tuning control of the Models RAA and RAB receivers. As a further improvement in the operation of the suggested tuning control, it should be one in which the one figure on the main dial referring to the vernier scale would be visible. In other words, the main dial would serve simply to count the revolutions of the vernier dial. The continued use of the present control in future equipment should be accompanied with a provision for coarse tuning adjustment.

117. Par.4-24. The tuning verniers of the antenna and receiver tuning controls of both types of receivers have 20:1 ratios.

118. Par.4-25. On both types of receivers the only auxiliary control having a vernier is the balancer. This device is vernier controlled only.

119. Par.4-26. The CRV-46031 and CRV-46031A comply with these specifications.

120. Par.4-27. Each of the vernier controls for the antenna and receiver tuning of either type of receiver is a Navy standard fine adjustment worm driven tuning control. The effectiveness of this type of control, its freedom from back-lash and torque-lash over long periods of time, and its capacity of being reset in either direction to any predetermined point within a small percent of the vernier scale has long since been demonstrated, as the result of extensive use in service in other equipments, to be excellent. These controls are equipped with spring "take-ups" to automatically adjust the controls for "spot wear" incurred by long periods of operation in one sector. Friction is provided for the balancer control of either type of receiver by means of two phosphor bronze strips (nickel plated) which serve as a track for two rollers which are a part of the carriage assembly which moves in a horizontal direction and supports the balancer coupling coil assembly. The inside surfaces of the flanges of these rollers are tapered and are in direct contact with the phosphor bronze strips. The design is such that maximum available spring pressure from the phosphor bronze strips is brought to bear against the inside surfaces of the flanges of the two stop rollers. The friction of the balancer vernier is not uniform on all receivers for in some there is too little friction and in others too much, and for still others this friction is not uniform over the range of the vernier; that is, there is a tendency to stick in some places and in other spots there is a tendency toward slipping. Owing to these difficulties already encountered with this control, not only in the Laboratory but in the field, the method adopted for providing friction to the vernier of the balancer control cannot be considered satisfactory.

121. Par.4-28. No friction driven verniers are employed in either type of receiver.

122. Par.4-29. Inasmuch as the CRV-46031 and CRV-46031A receiver are mechanically and electrically identical except for the cabinets and the filament connections, and the addition of a supply voltmeter on the CRV-46031A receiver, the parts of one receiver are interchangeable each for each with those of the other. The cabinets differ only in that one is deeper than the other and has a spray proof cover. Either receiver chassis of the two types of receivers will fit into either cabinet.

123. Par.4-30. In general, the number of friction and pressure contacts in the two types of receivers has been kept within reasonable limits. Each of the coil shield cans housing the three intermediate frequency transformers and the intermediate frequency oscillator coil is of nickel plated steel, cylindrical in shape with the open end having a screw thread which fits snugly into an aluminum base having a sand blast finish. All leads are brought out through rubber bushings in the base of the coil shields. The shield cans appear to be well plated and should be little subject to corrosion. However, should corrosion take place in the threaded joint between the two sections of the coil shield can, it would be extremely difficult to separate them in their present form. Even without the effects of corrosion, the two halves of the shield cans are very difficult to separate once they have been tightly screwed together These cans should offer no difficulty from the standpoint of noise development. The tube shield cans are fabricated from 1/32" thick sheet aluminum. All seams are riveted together and the shield assembly in turn riveted to the sub-base of the chassis. An aluminum partition is riveted in one corner of each tube shield to shield the grid lead. A dual tube shield, essentially a single tube shield with a central partition, houses the oscillator and 1st radio frequency tubes. A similar shield houses the 1st and 2nd intermediate frequency tubes. Individual shields are provided for the first detector and intermediate frequency oscillator tubes. The tube shields appear to be well constructed and should introduce no noises under conditions of severe shock or vibration, nor should there be any difficulty from corrosion. Two shield boxes fabricated from 1/32" thick sheet copper, their seams soldered, their outsides nickel plated and their interiors copper lacquered are provided, one for the loop load coils and associated trimming capacitors and band switches, and the other for the oscillator and radio frequency coils together with their associated trimming capacitors and band switches. These shield boxes are each supported at the four corners with nickel plated hexagonal brass pillars. The boxes are secured to the pillars with brass machine screws and phosphor bronze lock washers. The bottom edges of these shield boxes make a fairly good contact with the sub-base of the receiver chassis. These shield boxes are considered sufficiently good for their purpose and owing to the quality of their construction, no difficulty is anticipated from corrosion or noise. The nickel plated copper shields mounted on the radio frequency tuning condensers are well constructed, rigid, and as their surfaces as well as those of the condenser with which they make contact are well plated, no difficulty is expected from corrosion or noise generation under conditions of shock or vibration.

124. Par.4-31. The integral parts of the CRV-46031 and CRV-46031A Receivers are generally readily accessible for replacement or servicing. The exceptions to this statement are as follows:

(a) The ganged tuning condenser assembly must be removed to replace the following:

(1) Tube sockets - Radio frequency, oscillator and intermediate frequency.

(2) Intermediate frequency transformers.

(3) Volume control.

(b) All tube sockets have been riveted in place, thus making their replacement difficult. It is to be noted also that except for the detector and audio frequency tube sockets, the same rivets which secure the tube sockets also secure the corresponding tube shields to the sub base of the receiver chassis.

(c) Replacement of any of the molded mica dielectric by-pass condensers is made difficult because they are riveted in place on their small insulating panel supports.

(d) Dial lamps are difficult to replace owing to interference of the lamp socket assemblies with the tube shields.

125. Par.4-32. Refer here to Plate 1 for the calibration curve for the CRV-46031 Receiver, and to Plate 2 for a similar calibration curve for the CRV-46031A Receiver. From a practical standpoint, the requirements of this paragraph have been met.

126. Par.4-33. The telephone jacks supplied with the CRV-46031 and CRV-46031A Receivers are the short type, are connected in parallel, and are insulated from the front panel. These jacks, however, do not comply with specifications, ref.(d).

127. Par.4-34. Each type of receiver is provided with an output transformer having an electrostatically shielded primary and a balanced secondary designed to operate with a 600 ohm load. Refer to Plate 95 for a curve showing change in output for changes in load impedance. The specification requires that the output load be 20,000 ohms.

128. Par.4-35. The following comments apply to both types of receivers.

(a) The pig-tail connections on the CRV-47060, CRV-47061, and CRV-47062 variometers are unsatisfactory. These connections are of stranded copper wire with a cotton braid sleeving. This is not adequate protection against all forms of corrosion. The strands should be of tinned copper and the insulation should be of rubber. On some of the variometers the terminals on the ends of the pig-tail connections interfere with the radial movement of the pig-tail. Hence, there is danger of the connections becoming broken in service.

(b) The radio frequency circuits are wired with rubber and braid insulations. Straight rubber insulated wire for radio frequency circuits is preferred. While the present wire has been treated, the effectiveness of this treatment as a protection against humid salt atmospheres is questionable.

(c) While the leads of the balancer coil are tagged and identified by numbers, it would facilitate servicing the balancer coils if the terminals on the balancer coil assembly were similarly marked.

(d) In general the wiring is neatly arranged and all soldered connections are made in a neat and permanent manner.

129. Par.4-36. (Par.4-37, ref.(b).) Two dial lamps are mounted near the top of the front panel of each type of receiver. The dial lamps are about 9-1/4" apart and are symmetrical with the vertical center line of the front panel.

130. Par.4-37. (Par.4-38, ref.(b).) Both receivers comply with the specifications of these paragraphs.

131. Par.4-38. (Par.4-39, ref.(b).) Each receiver is provided with a rectifier type output voltmeter mounted in the upper right hand corner of the front panel of the receiver. In addition, the CRV-46031 receiver is provided with a double scale 2-1/2" flush type voltmeter (Weston Model 506, range 0 - 7.5: 0 - 150 volts) mounted midway and slightly below the horizontal center line of the front panel. This voltmeter normally indicates filament voltage at all times and plate battery voltage when a small push switch mounted on the voltmeter is depressed.

132. Par.4-39. (Par.4-40, ref.(b).) The rectifier output meter of either type of receiver is provided with a five position dial switch located adjacent to the meter and operable from the front panel of the receiver. This switch provides the following full scale readings of the output meter reading from left to right:

DIRECT - ADD 5 dbs - ADD 10 dbs - ADD 15 dbs - OFF

The above is in disagreement with but superior to the specification requirements. It is believed that the specifications should be amended. For observations nearer minimum a more sensitive instrument is preferable. A 60 microwatt zero level instrument would permit noise adjustment to zero level. This gives a maximum usefulness for zero null observations.

133. Par.4-40. The resistance of the output meter is 5500 ohms. The specifications require not less than 10,000 ohms. However, the statement given in par.4-39 applies equally well here. The resistance of this instrument does not constitute an appreciable load on the output circuit.

134. Par.4-41. The CRV-20011A Rectifier Power Unit is housed in a cabinet fabricated from 3/32" thick "eraydo" alloy. The corner seams are both soldered and reinforced with 1/2" x 1/2" x 3/32" thick "eraydo" alloy angles riveted in place. Two slots are provided in the front left hand side of the cabinet to clear the power lead ferrules in the rectifier power unit chassis. A similar slot is provided at the front right hand side of the cabinet to clear the receiver cable. This slot is insulated with two U-shaped phenolic insulators riveted together, one on each side of the slot. Across the inside of the top and bottom and indented 1/2" from the front of the cabinet are two 1/2" x 1/2" x 3/32" thick nickel plated brass angles which are not only soldered but riveted to the cabinet. These strips are each drilled and tapped with four holes to secure the thumb screws in the front panel of the rectifier power unit. The nickel plating on the two thumb screw retaining angles has been worn off from the short usage of the power unit in the Laboratory. The cabinet including the front panel and all metal parts external thereto are at ground potential.

135. Par.4-42. The overall dimensions of the rectifier power unit are as follows:

Actual		Specification Limit
18-1/2 inches	Width	18 inches
8-1/4 "	Height	10 "
9-3/8 "	Depth	8 "

The dimensions of the cabinet alone are:

Width - 18 inches
Height - 8-1/4 inches
Depth - 8 inches

The dimensions of the cabinet alone comply with the specification limits, but if the projections from the cabinet due to the power lead ferrules and the handles on the front panel are considered, the overall dimensions do not comply with specifications.

136. Par.4-43. While the cabinet may be adapted for mounting beneath an operating table, either hanging or standing on a shelf, no provision has been made for securing the cabinet in place. Instead, it will be necessary to drill mounting holes in the cabinet at the time of installation.

137. Par.4-44. The Rectifier Power Unit contains all necessary appurtenances not contained within the CRV-46031A Receiver to permit the equipment (DO-1, DO-2, or DO-3) to operate in accordance with these specifications when the power unit is connected to a 115 volt, 60 cycle,

single phase a.c. supply line. An audio frequency and radio frequency filter, consisting of a dual iron cored reactor and by-pass condensers, is placed in each side of the line between the input and the power transformer primary. No regulating devices are employed.

138. Par.4-45, 4-46. The CRV-20011A Rectifier Power Unit complies with this specification.

139. Par.4-47. The cabinet is not provided with ventilating openings. The radiating surface of the cabinet is sufficient to dissipate the heat accumulated within the unit without additional ventilating louvers or holes. Ventilating holes are provided in the front panel.

140. Par.4-48, 4-49. The CRV-20011A Rectifier Power Unit complies with these specifications. While ref.(b) does not cover the CRV-20011 Power Unit which is a part of the Model DO Radio Direction Finder Equipment, the specifications of pars. 4-41 to 4-43 inclusive, and 4-45 to 4-49 inclusive apply equally well to this Rectifier Power Unit. The two power units are identical in all respects except for the omission of the CRV-30069 power transformer, CRV-38180 rectifier tube, CWC-63324 potentiometer, CWC-63085 resistor, and CEN-38002 tube socket, and the substitution therefore of a CRV-63085 resistor, a CRV-63340 resistor, and a CRV-63341 resistor, which are respectively the load, heater, and pilot lamp resistors, the latter two serving simply as voltage dropping devices. The CRV-20011 Power Unit is designed to operate either from a 115 volt d.c. line or from a 115 volt storage battery.

141. Par.5-1. The loop assembly of each type of equipment covered by this report consists of all mechanical and electrical units of the equipment not incorporated in the receiver or power unit and includes the loop with its mounting, shaft and shaft housing, collector rings, azimuth scale, hand wheel,and shielded loop receiver leads (includes coupling transformers for the Model DO-3 equipment). The separate units comprising the complete loop assembly for each type of equipment are as follows:

<u>Models DO and DO-1 Equipments</u>

CRV-69003	Round loop and mounting.
CRV-69005	Pedestal, including shaft and shaft housing, collector rings, azimuth scale, and hand wheel.
108 inch	Loop-receiver cable with fittings.

<u>Model DO-2 Equipment</u>

CRV-69004	Square loop and mounting
CRV-69005	Pedestal described above
108 inch	Loop-receiver cable with fittings

Model DO-3 Equipment

CRV-69004	Square loop and mounting
CRV-69005B	Pedestal including shaft and shaft housing, collector rings, and cable drum.
CRV-69005C	Remote control pedestal including shaft and shaft housing, azimuth scale, hand wheel, and cable drum.
CRV-47047	Loop-output transformer.
CRV-47048	Receiver-input transformer.
16 inch	Loop-output transformer cable with fittings.
16 inch	Input transformer - receiver cable with fittings.

142. Par.5-2 to 5-5 inclusive. (Par.5-3; 5-5 ref.(b). The loop and housing of the CRV-69003 loop assembly used with the Models DO and DO-1 Equipments are circular in form having a maximum diameter of 24" and a rectangular cross section whose external dimensions are 2-5/8" x 3", the larger dimension being across the rim of the loop coil housing. This is not in compliance with these specifications which require that this type of loop coil housing have a square cross section. The loop coil housing is not closed, but is separated and the two ends insulated from one another at the top with a 7/16" thick phenolic insulator. The loop housing is made in two sections, one section being in the form of a circular channel having a U-shaped cross section, the bottom of which is toward the center and the legs of which form the sides. This section is a one piece casting, cast from a light alloy metal, presumably an aluminum alloy. The outside rims of the two sides of this section appear to have been machined to form a shoulder to support the outside rim of the loop coil housing. This assumption is based on the fact that the exposed edges of the two sides are thinner than the rest of the casting. Moreover, there is no evidence of the rim's having been welded, riveted, or screwed in place. The second section of the loop coil housing is simply a flat circular split ring, the two ends of which are held together at the top of the loop housing by a 3/16" thick phenolic insulator riveted in place. The inside of the loop coil housing has been weatherproofed with a tar-like material. The loop coil housing is secured to the loop mounting by two U-shaped clamps. The loop mounting is a one piece casting, presumably an aluminum alloy and is designed to fit over the top of the CRV-69005 pedestal. It is flanged so as to extend over and below the top of the pedestal to protect the connections between the loop coil and the pedestal terminals from direct spray. The loop mounting is fitted with three clamping dogs which secure the loop assembly to the pedestal. Inside of the loop mounting is a circular phenolic insulator supporting two large type General Radio jacks to which are connected the ends of the loop winding. The loop winding consists of 8 turns of tinned, stranded, copper wire having treated cotton braid insulation and having a diameter equivalent to #16 B&S gauge. The mid point of the winding is grounded to the loop mounting. The clamping dogs and loop terminal within the loop mounting are so arranged that it is impossible to

mount the loop assembly on its pedestal in any manner except that which provides the correct connections between the two assemblies. This is a commendable feature. The loop rotates about a vertical axis and obviously the loop coil housing rotates therewith, since the coil winding is wound inside of this housing. The loop mounting is provided with a removable 3/8" diameter plug so that connections may be made to the loop **center** and brought out to a signal generator for test purposes. This method is somewhat awkward but no better method immediately suggests itself and the method used serves the purpose. The loop coil housing of the CRV-69004 loop assembly used with the Models DO-2 and DO-3 equipments is square in form, of tubular cross section and arranged for rotation about a vertical diagonal axis. The outside diameter of the tubular cross section of the four arms of the loop coil housing is 4-5/8". The diagonal dimension is 34-1/4". The specification requirement for this latter dimension is 36". The loop coil housing is divided at the top so as not to form a short circuited turn, the two ends being insulated from one another with a 7/16" thick phenolic insulating spacer. The entire coil housing except for the outlet covers at the base, two side corners and the two ends at the top is a single casting. The material used in its construction is probably an aluminum alloy. This casting is a demonstration of unusual design and the entire loop assembly is the best of its type yet received by the Laboratory. The cover plates, also cast, are bolted to the main casting with several steel cap screws. Each cover is backed with a cork gasket. The loop assembly is absolutely spray and moisture proof. The terminal connections from the loop coil are made to two General Radio plugs mounted on a phenolic insulating disc located on the loop mounting. The loop mounting is secured to the base of the loop coil housing with screws and is provided with three clamping dogs and overhanging flange similar to the CRV-69003 loop assembly described above. The loop winding is similar to that of the CRV-69003 loop mounting except that it is square in form. Connections may be made to the center of the loop from a signal generator upon removal of the cover plate at the base of the loop coil housing.

143. Par.5-6, 5-7. The CRV-69003 and CRV-69004 loop assemblies as used in conjunction with the CRV-69005 pedestal for the Models DO, DO-1, and DO-2 equipments comply with the specifications of pars. 5-6, 5-7a and 5-7b of ref.(c) and par.5-2 of ref.(b). The CRV-69004 loop assembly as used in conjunction with the CRV-69005b pedestal and CRV-69005c remote control for the Model DO-3 equipment complies with the requirements of par.5-7c of ref.(c).

144. Par.5-8. This paragraph applies only to the Model DO-3 equipment. Specification compliance is met through the use of the CRV-69005b loop pedestal and the CRV-69005c remote control pedestal. The former supports the loop structure at its top end and a control cable drum at its bottom end. It is designed for mounting directly on a deck, with the lower section containing the collector rings, outlet for a shielded interconnecting cable and control cable drum, extending below the deck. The remote control pedestal supports at the top the azimuth scale and handwheel assemblies and at its bottom end, a control cable drum identical with that on the loop pedestal. It is designed to be mounted in the same manner as the loop pedestal but in the operating room, whereas the latter may be mounted at a remote distance from the operating room.

145. Par.5-9. (Par.5-6, ref.(b).) The CRV-69005 and CRV-69005B loop pedestals comply with the requirements of these specifications.

146. Par.5-10. Attached to the lower end of the CRV-69005 loop pedestal and that end which extends into the operating room, is a 6-1/8" diameter tube which in turn supports the azimuth and handwheel assemblies. The length of this tube may be reduced by cutting off one end - such that the overall distance measured from the bottom of the deck flange to the bottom of the azimuth scale may be reduced from 5 feet to 1-1/2 feet. A similar tube is provided for the same purpose but mounted at the top end of the CRV-69005C remote control pedestal.

147. Par.5-11. The adjustment described under par.5-10 above may be accomplished with tools ordinarily available on shipboard.

148. Par.5-12 to 5-14 inclusive. (Par.5-9, 5-12, 5-13, ref.(b).) All three types of pedestal assemblies comply with these specifications. Two deck cribs each being doughnut shaped and having a wedge shape cross section are provided with each pedestal assembly to permit perpendicular alignment of the pedestal when mounted on a deck having a crown not to exceed 10%.

149. Par.5-15. (Par.5-7, ref.(b).) The CRV-69003 and CRV-69004 loop assemblies may be detached from their supporting pedestals without the use of tools. It is difficult, however, and this applies particularly to the CRV-69004 loop assembly, which is the heavier of the two, for one man to remove the loops from their pedestals owing to the fact that he cannot adequately lift the weight of the loop structure and at the same time keep one or more of the clamping dogs from falling and catching in their retaining slots in the pedestals. The removal or replacement of the loop assemblies would be greatly facilitated if the clamping dogs on the loop mountings were backed with phosphor bronze springs so as to cause them to swing clear of the retaining slots when loosened.

150. Par.5-16. (Par.5-8, ref.(b).) An aluminum cup is provided with each of the CRV-69005 and CRV-69005B Loop Pedestals and is placed over the top of the pedestal when the loop is dismounted. A coarse thread surrounds the top of the pedestal and serves as a retaining guide for a small extrusion inside of the aluminum cup. This cup fits but loosely in place. For this reason neither type of loop pedestal can be considered watertight after the loop assemblies have been removed. They are, under this condition, sprayproof. These pedestals do not, therefore, comply with the requirements of these paragraphs.

151. Par.5-17. (Par.5-4, ref.(b).) No wind velocity tests under the conditions of this specification were conducted on either type of loop assembly when mounted on either of the two types of loop pedestals. Both loop assemblies have been mounted on CRV-69005 loop pedestals on the roof of the Laboratory penthouse and have been subjected to winter gales without damaging results. Basing an opinion on the merits of their construction, it is believed that either will withstand pressure due to wind velocities up to 90 miles per hour.

152. Par.5-18. (Par.5-14, ref.(b).) The Laboratory is not in a position to state whether the shafting in the CRV-69005, CRV-69005B, or

CRV-69005C pedestals rotates on two sets of bearings without dismantling the pedestals. Suffice it to say, that the instruction books indicate that ball bearings are used and that actual operation of the pedestal assemblies shows very definitely a free rotating action of the drive shafts and a lack of any form of end-play in any of them.

153. Par.5-19. (Par.5-15, ref.(b).) The CRV-69005 loop pedestal complies with these specifications.

154. Par.5-20. (Par.5-16, ref.(b).) Lubrication of all moving mechanical parts where friction or the movement of one surface against another is involved is accomplished by means of "Alemite" grease fittings. These fittings prevent any possibility of the lubricate's flowing or creeping over the surface of the parts not intended for lubrication.

155. Par.5-21. (Par.5-17, ref.(b).) Each of the CRV-69005 and CRV-69005C pedestals is provided with an azimuth scale permanently secured to the loop shaft and with 1, 5, and 10 degree markings engraved on its periphery and with each 10 degree mark from 0 to 360 marked numerically. The scales are secured to a disc-like wheel and secured in place with screws. These screws are wired together with a wire passing through the heads of the screws to prevent their becoming loosened and hence destroying the adjustment of the azimuth scale.

156. Par.5-22. (Par.5-18, ref.(b).) The azimuth scale furnished with either the CRV-69005 or 69005C pedestals complies with these specifications. The diameter of the azimuth scale is 9-1/2".

157. Par.5-23. (Par.5-19, ref.(b).) The fiducial mark is provided for reading the azimuth scale on either the CRV-69005 or 69005C pedestals. This mark is simply a vertical line engraved on a machined surface directly above or below the azimuth scale (depending upon the installation of the pedestal, see par.5-7, a, b, and c, and par.5-8) on the pointer assembly which in turn is rigidly secured to the 6-1/8" diameter tube of the pedestal assembly. Its design precludes any form of parallax.

158. Par.5-24. Specification compliance is met. See also par. 5-23 above.

159. Par.5-25. (Par.5-20, ref.(b).) The azimuth scale of either of the CRV-69005 or CRV-69005C is provided with illumination in order to permit readings being taken in a darkened room. The illumination is accomplished by means of a small low voltage standard dial lamp, operating for the power unit and mounted directly on the pointer assembly. A metal dome fits over the dome lamp and is secured to the pointer assembly by means of a thumb screw to render it easily removable for lamp replacement purposes. A small slot cut in the dome confines the illumination from the light directly on the fiducial mark and a small area of the azimuth scale. The illumination provided is such as not to impair the darkness integrity of the ship's pilot house.

160. Par.5-26, 5-27. (Par.5-21, 5-22, ref.(b).) The handwheel provided on the CRV-69005 pedestal for directly rotating the loop and on the CRV-69005C pedestal for rotating the loop by remote control, is a standard Chevrolet steering wheel. It measures 15" in diameter and the rim is sufficiently well insulated to minimize body capacity to ground.

161. Par.5-28, 5-29. (Par.5-23,5-24, ref.(b).). The CRV-69005 and CRV-69005B pedestals comply with these specifications.

162. Par.5-30. (Par.5-25, ref.(b).) On the pointer assembly of each of the CRV-69005 and CRV-69005C pedestals is a knurled brake adjustment screw which serves to tighten or release two brake bands arranged near the top of the pedestal and on opposite sides of the drive shaft of the pedestal. The brake design is such that it cannot be applied so tightly as to prevent a slight movement of the loop when subjected to high wind pressure and hence cause damage either to the loop or pedestal assembly. When the brake is released the drive shaft is free to move without evidence of brake drag.

163. Par.5-31 to 5-33 inclusive. (Par.5-26 to 5-28 incl.,ref.(b).) All three types of pedestal assemblies and the two types of loop assemblies described herein comply with these specifications. Where now magnetic non-corrosive materials have been employed, this material is probably an aluminum alloy because it is light in weight yet strong.

164. Par.5-34 to 5-36 inclusive. (Par.5-29 to 5-31 incl.,ref.(b).) A shielded cable is provided with each of the Model DO, DO-1, and DO-2 equipments to establish inter-connection between the collector rings and the receiver. The connections are made with two #16 B&S gauge enamelled copper wires spaced 1/4" apart with several wax impregnated wood disc insulators which serve to maintain approximately equal spacing between the wires and between each wire and the flexible conduit in which they are enclosed. The flexible conduit has an inside diameter of 3/4" and is supplied by Breeze Corporations, Inc. This conduit is constructed from several inter-linking rings which provide flexibility and is covered with a wire braid. Each end of the conduit is fitted with standard ferrules and coupling nuts. The material used in the construction of the flexible conduit is an aluminum alloy, Navy Specifications 17-C-11, while the fittings are made from a similar alloy but annealed (Navy Specifications 47-A-2). The length of the cable is 108". One end of the flexible conduit is attached to the collector brush assembly by means of a standard "Breeze" bulkhead connector and nut secured to the cover plate supporting the collector brushes. To assure tight contact between the bulkhead fitting and the curved cover plate, a phenolic insulating block having one surface flat and the opposite surface milled to conform with the curvature of the cover plate, is placed with the flat surface against the bulkhead fitting. Ground connections to the flexible conduit are obtained by the bulkhead retaining nut which presses against the inside metallic surface of the cover plate. The cover plate supports two collector brushes to which the connecting lead terminals are fastened with #8-32 nickel plated round head screws, threaded into tapped holes in the brush supporting bushings, and secured in place with cadmium plated phosphor bronze lock washers under the screw heads. The collector brushes are mounted on a 1/4" x 2" x 1/8" thick phenolic insulator which in turn is fastened to the cover plate on two 5/16" diameter spacers riveted to a flat plate fastened to the cover plate. Each brush is "U" shape in form, made from nickel plated phosphor bronze and has each end slotted to form two contact brushes. Under each brush is a similar "U" shaped strip of the same material which provides rigidity to the collector brush. The collector brush is so designed as to make a good wiping contact with its cor-

responding collector ring regardless of the direction of rotation of the latter. The mounting holes in the cover plate, together with the mounting of the collector rings assures but one way of fastening the cover to the loop pedestal such that only the correct electrical connection is obtained. The screws securing the cover plate of the collector brush assembly to the pedestal should be larger than #6-32. A #10-32 screw would be preferable and provide greater strength. The other end of the flexible conduit is connected with the loop antenna jack assembly through a bulkhead fitting and nut secured to the main cover plate of the jack assemblies and directly over the loop jack assembly. Each jack assembly is simply a turned "eraydo" alloy cylinder topped with two cup shaped covers which fit over the ring surmounting the clearance hole on the top of the receiver cabinet. At the base of the cylindrical loop and antenna jack assemblies is a cylindrical phenolic insulator supporting two General Radio standard jacks, in the case of the loop jack assembly and one for the other. The top end of the antenna jack assembly is further provided with an insulating disc to support the antenna binding post. Both jack assemblies are riveted to a channel-like cover with the sides pointing downward and which serve to protect the loop and antenna connections within the receiver from moisture. A knurled thumb screw through the cover plate secures the entire assembly to the receiver cabinet through the retaining bushing provided for that purpose on the top of the cabinet. The loop cable leads are soldered to terminals fastened under the jacks in the loop jack assembly. Refer also to the description of the transmission line and coupling transformer given under pars. 13-1 to 13-6 inclusive.

165. Par.5-37. **(Par.5-32, ref.(b).) This subject has already been covered under pars.5-2 to 5-5 inclusive.**

166. Par.6-1. Plates 15 to 24 inclusive show graphically the CW and MCW sensitivities of the Models DO, DO-1, DO-2, and DO-3 Equipments. The sensitivities are shown for five frequencies of each band of the CRV-46031 and CRV-46031A Receivers used with one or the other of these equipments and represent the microvolts per meter input at any frequency on the loop or Standard Dummy Antenna (whichever applies to a particular curve) required to produce Standard Output of 6 milliwatts across 600 ohms, with the noise level adjusted to 0.2 volt for CW operation and at maximum gain for MCW operation when the noise level at maximum gain was less than 0.2 volt and a Standard Output Signal of 1,000 cycles. The loop sensitivities may be converted from microvolts per meter to absolute microvolts by multiplying the microvolts per meter for a given frequency by the effective height of the loop at that same frequency. Curves showing the relation between effective height of the loop and frequency are shown on Plate 5 for the CRV-69003 and CRV-69004 Loops. The absolute sense and balancer sensitivities may be obtained by multiplying their respective microvolts per meter input at any frequency by a factor of two, this being the assumed effective height of the Standard Balance Antenna at all frequencies. The important features of the curves shown on Plates 15 to 24 inclusive are as follows:

(a) On CW or MCW none of the four types of Equipments covered by this report comply with these specifications. The Model DO Equipment, when operated on batteries, more nearly complies with specifications than do any of the others.

(b) The CW sensitivity of the Model DO-3 Equipment is not reduced more than 3 to 1 over the corresponding sensitivities of the Model DO-2 Equipment using the same loop, by the use of the coupling transformers and 35 foot transmission line. The greatest reduction is at the upper end of the high frequency band. This is to be expected since the coupling transformers have powdered iron cores and obviously their losses will increase with frequency. This transmission line and coupling transformers are regarded as being very efficient for the purpose for which they are intended.

(c) The CW and MCW sensitivities of the Model DO Equipment when operated on 115 volt d.c. line is very poor as compared with corresponding sensitivities of the equipment when operated on batteries. These sensitivities are inferior to the corresponding sensitivites of the Model DO-3 Equipment with its attendant attenuation due to its associated transmission line and coupling transformers. The reason for the low sensitivity is the high maximum noise level incurred by a lack of sufficient filtering in the CRV-20011 Power Unit. It has been demonstrated in the Laboratory that this power unit is not designed to adequately filter a noisy d.c. line such as may be encountered on shipboard.

(d) The loop, sense and balancer (at +50 or -50 settings) sensitivities on CW or MCW for each equipment are of the same order of magnitude. The Balancer sensitivities on CW or MCW at the neutral or null setting of the Balancer are, for each equipment, not less than 3 orders removed from corresponding loop, sense, or maximum balancer sensitivities.

Refer to tables for tabulation of the average loop sensitivities for each band of the CRV-46031 and CRV-46031A Receivers as used with the Models DO, DO-1, DO-2, and DO-3 Equipments. As indicated on Plate 5, the effective heights of the CRV-69003 and CRV-69004 Loops do not greatly differ from one another at any given frequency within the range of the equipments. However, for any given frequency within the range of 100 to 1000 kilocycles, the effective height of either loop is approximately one-half that of the loop for the Model DM Equipment at the same frequency. The loop sensitivities of the Models DO, DO-1, and DO-2, and DO-3 equipments are on the average about the same as for the Model DM Equipment. This is accomplished by increasing the overall gain of the former equipments to compensate for the reduction of the sizes of the loops associated with them as compared with the loop for the latter equipment.

To effect specification compliance as applied to loop sensitivities of either equipment would involve either an increase in the size of the loop or an increase in the overall usable receiver gain or an increase in both. In view of the high overall receiver gain already provided, it is doubtful whether any further increase is advisable because of the possibility of instability. The use of a larger loop similar to the CRV-69003 Loop but having a diameter equal to the diagonal of the CRV-69004 Loop for all types of equipments appears to be a practical solution for obtaining sensitivities more nearly in compliance with specifications. Such a loop would offer greater effective heights and would entail no greater weight or rotational area than does the now present CRV-69004 Loop. Plates 12 to 14 inclusive show maximum noise level of the Models DO, DO-1, DO-2, and DO-3 Equipments employing one or the other of the CRV-46031 and CRV-46031A Receivers adjusted for either CW or MCW reception. Curves are shown for Model DO Equipment when operating either from a line or batteries. Measurements were taken for five frequencies in each band. At all frequencies, maximum noise level occurred at the maximum setting of the volume control of either receiver. It will be noted that the maximum noise at any frequency within the range of the Models DO-1, DO-2, and DO-3 Equipments and with the CRV-46031A Receiver adjusted for CW or MCW operation is comparable with that of the Model DO Equipment, operated from batteries and adjusted for similar conditions. This is conclusive evidence of excellent filtering in the CRV-20011A Rectifier Power Unit used with the former equipments. The excessive maximum noise levels indicated on Plate 12 for the Model DO Equipment when operated from a noisy line, is equally as conclusive evidence of inadequate filtering in the CRV-20011 Power Unit (d.c.). The irregularity of the MCW noise level curves shown on Plate 12 was due to local interference entering the receiver via the line. In general, the maximum noise level of the a.c. operated equipments of the Model DO Equipment,when operated from batteries and with their respective receivers adjusted for MCW operation, does not exceed standard noise level. Tables 5 and 6 show the average maximum noise level for each band of Models DO, DO-1, DO-2, and DO-3 Equipments.

167. Par.6-2. MCW selectivities with loop excitation and optimum gain are shown on Plates 56, 57, 58, 65, 66, and 67 for the Models DO, DO-1, DO-2, and DO-3 Equipments. CW selectivities with loop excitation and optimum gain are shown on Plates 62, 63, and 64 for the Models DO-1, DO-2, and DO-3 equipments. Selectivity was measured for three frequencies; i.e., both ends and the middle of each band of each receiver under test. MCW selectivity was measured with 30% modulated CW signals. It is assumed by the Laboratory that the specified selectivity limits apply either for CW or MCW selectivity measurements inasmuch as the specifications permit either method of measurement. On this assumption, the MCW selectivity of the medium and high frequency bands of either equipment more than complies with these specifications. The MCW selectivity of the low frequency band of either equipment fails to comply with specifications at any frequency. The double "hump" occurring near resonance of the 100 kilocycles selectivity curves shown on Plates 56 and 65 is due to the side bands of the modulated signal frequency from the standard signal generator. The CW selectivity at any frequency of all bands of the Models DO-1, DO-2,

and DO-3 Equipments are well within the limits of this specification. Owing to the close similarity between the MCW selectivity curves of all four equipments it is reasonable to assume, without further measurement or demonstration, that the CW selectivity at any frequency in all bands of the Model DO Equipment also complies with this specification.

168. Par.6-3. (Par.6-2, ref.(b).) Refer to Plates 73 to 75 inclusive for curves showing the image selectivity on CW or MCW of the high and medium frequency bands of the Models DO, DO-1, DO-2, and DO-3 equipments. No curves are shown for the low frequency band of either equipment since the image selectivities for these bands were beyond the range of the Standard Signal Generator. Specification requirements are met by the low and medium frequency bands of all equipments. The upper half range of the high frequency band of all equipments fails to comply with specifications. It is the opinion of the Laboratory that the specification requirements are too exacting to expect compliance over the entire range of either equipment. The image selectivities as shown on Plates 73 to 76 inclusive are considered very good.

169. Par.6-4. (Par.6-3,ref.(b).) For either equipment, with the Balancer set full "on" in either direction and the loop tuned to a frequency 10% removed from the frequency being impressed on the balance antenna terminal (through a Standard Balance Antenna), an excitation of 250,000 microvolts per meter does not increase the output level above Standard Noise Level at any frequency. These specifications limit the minimum value of the applied excitation to 10,000 microvolts per meter.

170. Par.6-5. (Par.6-4,ref.(b).) The overall voltage gain/voltage noise level ratio of each equipment (including the loop) for CW reception; i.e., overall gain/noise x 10^6 at any setting and a measured output equal to 5 x noise level (1.0 volt signal plus noise) is less than 300, the specification minimum. Curves are shown on Plates 71 and 72. The merit figure of 300 was apparently based on receivers having 20,000 ohm output impedances. With receivers of the types furnished with these equipments and which have 600 ohm output impedances, the overall gain in voltage for the same 6 milliwatts output would be 0.173 times that for a 20,000 ohm output impedance. This would reduce the unit figure to 52.8 if taken on the same basis. It is assumed that the figure of 300 was taken from data given in previous reports on the Models DL and DM equipments which were not tested under the same procedure as the subject equipments. The merit factors of the former were computed on a maximum gain and noise level basis which in most cases gave sufficient noise to make the second detector and 60 and 120 cycle hum a negligible portion of the total noise, while in the case of the subject equipments where a 0.2 volt noise level was maintained for all measurements, the overall gain was therefore reduced below the maximum obtainable. It is considered that the subject equipments have very favorable signal to noise ratios and it is recommended that consideration be given to this discussion in the preparation of future specifications. It is recommended that a figure of 8 for an a.c. operated equipment with a direct connected loop be set as a minimum and that this figure be increased to 15 for a battery operated and similar equipment. Based upon these tests it would seem advisable that these figures be reduced

50% for transmission line operated equipments. These figures assume a 600 ohm output and a 60 microwatt standard noise level. The Model DO equipment when operated from a line has signal to noise ratios which are less than 10, whereas for the same equipment when operated from a battery, the signal to noise ratios vary from 15.8 to 37.5. The low ratios for line operation are due to inadequate filtering of the line. It is both possible and practicable to provide a line filter which will limit the maximum noise levels for line operated equipments to values at least comparable with a.c. operated equipments.

171. Par.6-6. (Par.6-5, ref.(b).) The overall voltage gain of each of the Models DO, DO-1, DO-2, and DO-3 Equipments under conditions for CW reception with optimum gain is substantially constant when measured at any output level from Standard Output down to an output equal to noise level. Refer to curves shown on Plates 77 to 80 inclusive.

172. Par.6-7 to 6-10 inclusive. (Par.6-6 to 6-9 incl., ref.(b).) Specification requirements are met by all Equipments. A discussion of the subject covered by pars. 6-8 of ref.(c) and 6-7 of ref.(b) has been given under par.4-20 of refs.(b) and (c). The tube complement of each equipment has been listed under par.2-2 of refs.(b) and (c).

173. Par.6-11. (Par.13-2,ref.(b).) All equipments except the Model DO-3 equipment comply with the requirements of these specifications. In the latter case, the loop trimmer condenser has to be adjusted for minimum capacity for best sensitivity indicating too high an LC product for the loop circuit. A reduction in the length of the transmission line and hence a reduction in the total distributed capacity of the transmission line would provide more tolerance for the adjustment of the loop trimmer condenser. Tests have shown that any increase in the distributed capacitance of the transmission line over its present value cannot be compensated for by the loop trimmer capacity. Tests have also proven that varying the minimum capacity of the loop trimmer condenser from 22.35 micromicrofarads (minimum capacity of trimmer furnished in set) down to 5.35 micromicrofarads (minimum capacity of substituted trimmer condenser) produced no change in the overall receiver gain.

174. Par.6-12. Each equipment operates in accordance with these specifications and without variation in the beat note of more than 200 cycles at any frequency within the limits of each equipment, with a line voltage variation of ± 5%. Refer to Table 9 for complete data.

175. Par.6-13. The maximum undistorted audio output of any equipment is more than 10 milliwatts. Refer to Plates 85 to 90 inclusive for overall resonant overload characteristic for CW and MCW reception.

176. Par.6-14. A low pass filter is permanently connected in circuit. The overall characteristics of the audio system show this to be ineffective below 7500 cycles. It is connected between the detector plate and the first audio transformer in each of the CRV-46031 and CRV-46031A Receivers. The overall audio frequency response of the audio amplifier of each of these two receivers is peaked at about 700 cycles per second and decidedly attenuates the lower audio frequencies.

This obviously assists very appreciably in minimizing the hum in the a.c. operated equipments. The audio frequency characteristic shown on Plate 91 complies with these specifications.

177. Par.6-15. The frequency overlap of the CRV-46031 and CRV-46031A receivers more than complies with these specifications. Refer to Tables 7 and 8 for specific data.

178. Par.6-16. CW reception is provided for in each of the CRV-46031 and CRV-46031A receivers by means of a separate heterodyne oscillator.

179. Par.6-17. These specifications do not apply to these equipments.

180. Par.6-18. At the time these tests were made no satisfactory means of operating these equipments under conditions of vibration was readily available. The receivers under test were, however, subjected to shocks applied as sudden blows with the hands to the top and the sides of the receiver. The beat note frequency was noted both before and after the application of the shocks. The change in beat note frequency at three frequencies within the range of each receiver is shown in Table 15. The apparent wide variations in beat note frequency change is due largely to the fact that with the method adopted for making this test, the application of the shock blows are inherently of non-uniform intensity. It is of interest to note that after each shock, the beat note frequency remained fixed and did not drift back to its original frequency prior to the shock. This would indicate a shift in the tuning control settings. The data shown in Table 15 indicates that these receivers do not comply with these specifications at all frequencies.

181. Par.6-19. Under conditions of CW reception with optimum gain, any change in input from 0.5 microvolts per meter to such value as to produce maximum output does not vary the frequency of the detector or heterodyne oscillator of either of the CRV-46031 or CRV-46031A receivers more than 100 cycles. Refer to Table 10.

182. Par.6-20. The variation of the beat note frequency of the CRV-46031 and CRV-46031A Receivers, under conditions of CW reception and with an impressed signal of such value as to produce maximum output with full gain, and produced by a reduction of the manual volume control is shown in Table 11. The CRV-46031A Receiver does not comply with this specification at the high frequency end of the frequency range.

183. Par.6-21. The results of the time constant test made on the CRV-46031A Receiver by applying an artificial shock excitation of approximately 2.0 volts to the grid of the first radio frequency tube are shown in Table 16. This receiver more than complies with the requirements of these specifications. Inasmuch as both the CRV-46031 and CRV-46031A Receivers are closely identical, it is reasonable to assume that the former will comply equally as well as the latter with these specifications.

184. Par.6-22. Owing to the lack of adequate facilities for making humidity tests, these tests were omitted for all equipments.

185. Par.6-24. A manually operated volume control operated from the front panel is furnished with each of the CRV-46031 and CRV-46031A Receivers. No dial scale or other means except for an arrow engraved on the control knob is provided for accurately determining the setting of the volume control.

186. Par.6-25. The range of the manual volume control of the Model DO Equipment using the CRV-46031 Receiver operated from batteries is such as to provide a maximum attenuation of 82.9 decibels in the overall gain of the receiver with an applied CW input of 50,000 microvolts per meter at receiver resonance and applied at the loop center. For an MCW input of the same magnitude the maximum attenuation is 67.3 decibels. Since the tests reported in pars. 3-7 and 3-8 of refs. (b) and (c) indicate that energy from the second oscillator feeds back to the input of the intermediate frequency stages, it may be assumed that the excitation of the second detector by this oscillator must depend somewhat upon the setting of the sensitivity control. This is a possible reason for a greater attenuation for CW signals than for MCW signals. Similarly the range of the manual volume control of the CRV-46031A Receiver used with the Models DO-1, DO-2, and DO-3 Equipments is such as to provide a maximum attenuation of only 68.2 decibels in the overall gain of the receiver with an applied CW input of 50,000 microvolts per meter at receiver resonance and applied at the loop center; and for a MCW input of the same magnitude the maximum attenuation is 56.59 decibels. Volume control range and linearity curves are shown on Plates 81 and 82. Zero levels were taken as Standard Output at maximum gain. It will be noted that the manual volume controls for the a.c. operated equipments does not comply with these specifications. The Laboratory is of the opinion that a maximum attenuation of 80 decibels for 50,000 microvolts per meter input for CW reception is insufficient for good direction finding receivers. It is believed that a minimum of 100 decibels should be demanded of future equipment. The Model DO equipment when operated from batteries complies with specifications, while the a.c. operated equipments failure to comply is due basically to the large difference in the overall gain between the former and latter equipments as illustrated on Plates 71 to 80 inclusive.

187. Par.6-26. In each of the CRV-46031 and CRV-46031A Receivers when adjusted for CW reception and with a pure CW input of 50,000 microvolts per meter applied at the loop center at receiver resonance with minimum gain, no radio frequency amplifying tube showed any detectable change in plate current.

188. Par.6-27. Except for the low frequency band in each receiver, the manual volume controls of CRV-46031 and CRV-46031A Receivers operate in compliance with these specifications. Refer to Plates 59, 60, 61, 68, 69, and 70. The selectivity curves at reduced gain for the low frequency band of either receiver when adjusted for MCW reception, fail to comply with specifications to the same extent as do those shown on Plates 56 and 65 for optimum gain conditions. In

brief, it can be stated that the manual volume control does not appreciably affect the selectivity of the receiver.

189. Par.6-28, 6-29. The manual volume controls of the two types of receivers covered by this report comply with these specifications. Refer to Plates 81 to 84 inclusive.

190. Par.6-30, 6-31. The manual volume control of either equipment complies with these specifications.

191. Par.6-32. The manual volume control used in the CRV-46031 and CRV-46031A Receivers are of wire wound construction. The resistance element of either manual volume control is so wound that its resistance variation from one end to the other approaches a logarithmic rate.

192. Par.6-33. The output transformer of either of the CRV-46031 or CRV-46031A Receivers has a secondary winding designed to match one pair of Navy type telephone receivers (600 ohms at 1,000 cycles) using unshielded telephone cords. This is not in compliance with specification requirement of 20,000 ohms. Refer to Plate 95 for load characteristics of the output transformer.

193. Par.6-34. The output transformer of either type of receiver referred to above has a shielded primary which isolates the d.c. potentials and substantially all of the radio frequency potentials from the telephone cords; and a secondary which is electro-magnetically balanced so that the opposite sides of the telephone line are substantially at the same instantaneous potential (regardless of sign) with respect to ground.

194. Par.6-35. The Models DO, DO-1, DO-2, and DO-3 Equipments are considered as being generally capable of rendering continuous service without serious deterioration or damage to integral parts with the exception of the band selector switches and vacuum tubes. The band selector switches have not proven to give at all times positive and faultless contacts. The wire wound volume control can be expected to wear and hence become noisy in time. The toggle switch as used for switching from "sense" to "balance" has failed to make positive contact in the Laboratory. The power cable for the Model DO-3 equipment developed open circuits in the plus and minus "B" conductors in less than a year's service. These two conductors were insulated with rubber only, while the other two conductors were insulated with rubber and cotton braid. This fact may have some bearing on the cause of the failure of the rubber insulated conductors.

195. Par.6-36. Refer to pars.2-3 to 2-5 inclusive of refs.(b) and (c) for a complete discussion of this subject.

196. Par.6-37. Electrolytic condensers have not been used in any equipment.

197. Par.6-38. Owing to the lack of available equipment for conducting a test in accordance with these specifications, no data relative to specification compliance can be given at this time. However,

the Model DO-1 Equipment mounted in the Laboratory radio test truck, was found to operate effectively on 375 kilocycles while in an ACW field in excess of 3 volts per meter at 284 kilocycles. While the sensitivity control could not attenuate sufficiently to provide normal signal levels from this field, it appeared that two reasonably opposite minima could be had even on the 3 volts per meter field. No scale of degrees was available to check the minimum displacement.

198. Par.6-39 to 6-43 inclusive. All equipments comply with these specifications.

199. The results of the tests conducted on the subject equipments, which have a direct bearing on the final determination of the performance characteristics of these equipments and which are not directly covered by specifications, refs. (b) and (c), will be reported upon herewith.

(a) The curves on Plate 3 show that the errors introduced in the true resistance and inductance of the loop due to coupling between the loop and the screened booth are negligible when the loop is placed at distances greater than 3 feet from either end of the screened booth, and with its plane centrally located and parallel to the sides of the screened booth. At this distance also, the errors are still negligible if the plane of the loop is placed parallel to the ends of the screened booth. The position chosen for the loop for the tests for specification compliance was approximately centrally located within, and with its plane parallel to, the two sides of the screened booth. Under this condition, it can be safely assumed that the errors due to coupling between the loop and the screened both can be ignored for all of the tests conducted in accordance with specifications, refs. (b) and (c).

(b) Plate 4 shows the wave length squared curves for determining the true inductances and distributed capacitances of the CRV-69003 Loop assembly to gether with its associated 9 foot coupling cable as used with the Model DO and DO-1 Equipments, the CRV-69004 loop assembly together with its associated 9 foot coupling cable as used with the Model DO-2 Equipment, and finally the CRV-69004 Loop assembly together with the associated coupling transformers and 35 foot transmission line as used with the Model DO-3 Equipment. The CRV-69005B loop pedestal was used for all of the three combinations. The calculation of the true inductance of each of the three combinations noted above is based on the following formula:

$$L = \frac{\frac{\Delta \lambda^2}{\Delta C}}{3.553}$$

where L = true inductance in microhenries.

$\frac{\Delta \lambda^2}{\Delta C}$ = incremental slope of the curve.

3.553 = a constant

The distance from the origin to the intercept of the curve with the axis of abscissae determines the distributed capacitance of the particular loop and its associated pedestal and loop coupling devices.

(c) The true inductances and distributed capacitances of the Loop, Loop Pedestal, and loop coupling devices for each of the four subject equipments are as follows:

Type of Equipment	Industance Microhenries	Distributed capacitance micromicrofarads
Model DO	63.2	150
Model DO-1	63.2	150
Model DO-2	63.2	150
Model DO-3	67.0	110

The instruction book rates the inductance of each of the CRV-69003 and CRV-69004 Loops at 60 microhenries, but does not state specifically whether the coupling leads were included. A check of the loop inductances measured at the loop terminals of the CRV-69003 and CRV-69004 Loop assemblies at 1000 cycles on a General Radio type 650A Impedance Bridge gives a value of 60 microhenries for each loop.

(d) The wave length squared curves gave a value of 145 micromicrofarads for the sum of the capacitances existing in distributed form for the loop, the pedestal leads down to the slip rings, the shielded cable and the receiver terminal leads; i.e., to the point of attachment to the receiver chassis connection plugs for each of the Models DO, DO-1, and DO-2 Equipments. Subsequent measurements at 1000 cycles on a General Radio type 650A Impedance Bridge gave a value of 33.9 micromicrofarads for the pedestal leads and slip rings, and 103 micromicrofarads for the cable leads. This leaves 12.6 micromicrofarads for the loop proper. This obviously applies to each of the CRV-69003 and CRV-69004 loops. That the wave length squared curve should show a lesser value of total loop circuit capacitance for the Model DO-3 equipment than for the other equipments is due probably to a slight mismatching between the loop and the measuring circuit through the coupling transformers. Since the reflected capacitances of the loop and transmission line varies as the square of the turns ratio of the receiver coupling transformer, a too high ratio for the receiver input transformer would show a capacitance across its receiver input terminals to be lower than the true capacitance.

(e) The inductances of the loop circuit load coils as measured at 1000 cycles on a General Radio type 650A Impedance Bridge (the measurements being made at the loop terminals on the receiver chassis and with the loop tuning condenser shorted) are as follows:

Band	Inductance Microhenries (NRL Test)	Inductance Microhenries (RCA rating)
H.F.	12.5	No data
M.F.	396.0	395.0
L.F.	2440.0	2094.0

RCA ratings represent twice the values given for the individual load coils. Circuit wiring mutual inductance and the effects of shielding are not allowed for in the RCA figures but were measured as used in the Laboratory tests.

(f) The calculation of the effective heights of the CRV-69003 and CRV-69004 loops between the frequency range of 100 and 1500 kilocycles is based on the following formula which applies to any loop:

$$h = \frac{w \;\; a \;\; N}{3} \; 10^{-12}$$

where

h = effective height in meters
a = area of loop in square centimeters
N = number of turns
w = $2 \pi f$ where f = frequency in cycles.

Each of the CRV-69003 and CRV-69004 Loops are wound with 8 turns (assumed, since it was possible to count the turns in only the CRV-69004 Loop) of stranded cotton braid insulated, tinned copper wire having a diameter equivalent to #16 B&S gauge. The mean diameter of the CRV-69003 Loop is 54.30 cm. The mean length of each side of the CRV-69004 Loop is 50.2 cm. The variation of the effective heights of the output loops, with frequency, as calculated from the above formula using the constants noted, is shown on Plate 5. It will be observed that the effective height of the CRV-69004 Loop is better than for the CRV-69003 Loop at any frequency and varies respectively from 0.0042 to 0.0632 meters between the low and high frequency ends of the receiver range; while the effective heights of the CRV-69003 Loop vary from .00387 to 0.0581,respectively, between these same frequency limits.

(g) Loop Circuit Radio Frequency Resistances. Plates 6, 7, and 8 show the radio frequency resistances of the loop circuits of the low frequency, medium frequency, and high frequency bands of, respectively, the Models DO and DO-1 Equipment, the Model DO-2 Equipment and finally, the Model DO-3 Equipment. The circuits to which these characteristics apply include the loop, loop coupling cable (or coupling transformers and transmission line in the case of the Model DO-3 Equipment) loop coupling coil and the load coils used in the low frequency and medium frequency bands respectively. The resistances shown are quite normal except for those shown for the high frequency band of the Models DO and DO-1 Equipment. In this instance, the curve has an abnormal shape, being practically linear instead of curved as for the corresponding curves shown on Plates 7 and 8. The doubtful points were checked and rechecked without change in results. From the tests made on these equipments, no explanation for the peculiar characteristic is apparent. It is to be noted that the loop circuit resistances are quite independent of the type of loop used when either is direct connected to the receiver. However, when the loop coupling transformers and transmission line are employed the radio frequency resistance of each band increases by a factor varying from 1.1 to 2 depending upon the frequency, the greatest increase being at the highest frequency.

(h) Loop Circuit "Q's". The loop circuit Q's calculated from the true loop circuit inductances discussed above and the radio frequency resistances shown on Plates 6 and 7 are shown for each band on Plates 9 and 10 for the Models DO and DO-2 Equipments. These curves are based on the formula:

$$Q = \frac{w\,L}{R}$$

where L = loop circuit inductance (includes loop and load coil inductances) in millihenries

R = radio frequency resistance of loop circuit in ohms

$w = 2\pi f$ where f = frequency in kilocycles

Plate 9 shows a decided irregularity in the shape of of the curve for the high frequency band of the Models DO and DO-1 equipments. This irregularity reverts back to that mentioned in connection with a less pronounced irregularity in the radio frequency resistance curve for this same band in the previous paragraph. Taken as an average, the loop circuits of the

Model DO-2 equipment have slightly higher Q's than do the Models DO and DO-1 equipments which employ the smaller of the two types of loops furnished with their equipments. The loop circuit Q's of the Model DO-3 equipment employing the coupling transformers and transmission line were measured as described in METHOD OF TEST and are less than those for the other equipments at corresponding frequencies. They are represented for each band of this Equipment on Plate 11. However, at no frequency does the ratio between corresponding Q's exceed a factor of 2.5 to 1.

(i) Loop circuit selectivities are shown on Plates 43 to 51 inclusive for each band of the Models DO, DO-1, DO-2, and DO-3 equipments. The curves shown for the latter equipment were actually measured, the procedure of measurement having already been described in the earlier part of this report. The selectivity curves shown for the other equipments have been calculated from the loop circuit Q's at the several resonant frequencies for which the selectivity curves are shown. The calculations were based on the universal resonance curve as given in Terman's "Radio Engineering". The selectivity curves shown on Plates 43 to 51 inclusive illustrate some very interesting facts. Comparing corresponding loop circuit selectivities of the Equipments employing direct connected loops with each other, it will be noted that there are but small differences between them. On the other hand they are sharper than the corresponding loop circuit selectivity curves for the Model DO-3 Equipment, the latter employing a loop tuned through a transformer coupled transmission line. Going still further and comparing these curves with the loop circuit Q curves shown on Plates 9 to 11 inclusive, it will be noted that the greater the Q the greater the selectivity. The results of these measurements and calculations are as they should be, that is, for a given frequency the greater the circuit Q the sharper will the selectivity of the circuit be at that frequency.

(j) Overload characteristic of audio system. Plate 92 shows an overload characteristic which applies to the audio system of either the CRV-46031 or CRV-46031A receiver. The audio system of either receiver is suitable for 50 milliwatts of undistorted output into a 600 ohm load. Standard Output occurs well below the knee of the curve. An analysis of the 1000 cycle output signal of the a.c. operated equipments reveals that the percentage of the hum frequency and its harmonics in terms of output signal amplitude increases approximately two to one, from Standard Output down to 1 milliwatt output, with the 60 cycle fundamental predominating. The third harmonic of the signal frequency remains practically constant for all output signal levels. The second harmonic of the signal frequency increases rapidly for output signal levels greater than 3 milliwatts. Refer to Plate 94.

The total harmonic content of the output signal contributed by the rectifier power unit is considered as being very low. The total content of all harmonics does not exceed 5% of the output signal frequency for Standard Output. Similar curves are shown in Plate 93 for the Model DO equipment when operated from batteries. Obviously, only the harmonics of the signal frequency appear. Regulation curves for the CRV-20011 and CRV-20011A Power Units for normal full load are shown on Plates 96 and 97, respectively. The regulation of these units is considered as being good and are such that the variation in heater voltage for a change of line voltage of ± 5% of normal does not exceed the limits permitted by the tube manufacturer's guarantee. The applied voltage of the tube heaters of the d.c. operated equipment is lower than that for the a.c. operated equipments, but is still within the tolerance set by the tube manufacturer. The curves shown on Plates 98 and 99 clearly demonstrate the ineffectiveness of the radio frequency filter in the CRV-20011A Power Unit when this unit is operated on a noisy line. It has been emphasized throughout this report in connection with other tests that the maximum noise level of the Model DO equipment when operated from a line is excessive. The radio frequency attenuation characteristic of the CRV-20011A Power Unit is several times better than for the d.c. power unit and is due largely to the shielded power transformer. The effectiveness of the a.f. filter of the CRV-20011A Power Unit is clearly demonstrated on Plate 100.

200. Par.7-1, 7-2. The Balancer of either the CRV-46031 or CRV-46031A Receivers complies with these specifications.

201. Par.7-3. A panel control operates the Balancer through a vernier having a ratio of 20 to 1.

202. Par.7-4. The Balancer is vernier controlled only.

203. Par.7-5, 7-6. The Balancers of both types of Receivers comply with these specifications. It is to be noted, however, that the specifications for the calibration of the Balancer scale is contradictory with the specifications of Par.4-20 of refs. (b) and (c). Specification compliance in this regard is met only for the subject paragraph references.

204. Par.7-7. The electrical and mechanical designs of the balancer of either receiver is such, that at any frequency, their centers of balance coincide within 2% or less (specification limit, 5%), as indicated by tests in accordance with par.9-4 of refs. (b) and (c). For specific data refer to Table 12.

205. Par.7-8. The tests for maximum balance effect were not conducted in strict agreement with the specifications of par.7-8 and 9-5 of refs. (b) and (c). The test procedure actually followed was to apply a radio frequency signal, either CW or modulated, to a standard balance antenna in accordance with the specification of par.9-5 and then measure the microvolts input required to produce Standard Output at the ± 50 settings of the balancer control. These measurements were made for both CW and MCW input signals at three frequencies within each band of the receivers under test. The results of the measurements made on CW are tabulated in Table 13 for the Models DO, DO-1, DO-2, and DO-3 Equipments. From this data, it will be noted that the difference between the microvolts per meter input at the +50 setting and the microvolts per meter input at the -50 setting is not greater than 5% of the input at either setting. The data for the measurements made on MCW were not tabulated. Reference to the curves noted below will indicate convincingly that equally as good balance effects at plus and minus 50 settings of the balancer control can be obtained on MCW as on CW. Curves showing the balancer sensitivities measured at each tenth division; plus or minus, and at the settings for complete null, on the Balancer control scale are shown on Plates 25 to 42 inclusive. These curves show the relation between microvolts per meter, input versus balancer dial divisions, for three frequencies of each band and for CW and MCW inputs for the four types of Equipments covered by these specifications. All four Equipments comply with the specification requirements of pars. 7-7 and 7-8 of refs. (b) and (c).

206. Par.7-9. In each type of Receiver, the design of the Balancer is such that the quadrature voltage variation, with respect to the variation of the Balancer settings is, for all practical purposes and intents, within the limits of the 1.6 to 2.4 power of such setting at any frequency within the range of the receiver. The relationships between these two variables are shown on Plates 52 to 55 inclusive,in which the ratios between the quadrature voltage at ± 50 setting to the quadrature voltage at any other plus or minus setting are indicated. These latter settings correspond in sign with the 50 setting, plotted against Balancer dial settings in divisions, plus or minus. On the same curves are shown the limiting curves, the area between them being cross sectioned to show more clearly the extent to which the Balancer curves are within the specification requirements. These curves were calculated from measured data of microvolts per meter of CW input required to produce Standard Output at the several settings, both plus and minus, of the balancer control. The curves were plotted by taking the ratio of the microvolts per meter input at +50 to the microvolts at each of the 10 major scale divisions on the plus side of the scale and plotting these values against their corresponding scale setting. Similar calculations were made for the minus side of the scale. The sign of the 50 setting at which the ratio between that setting and the microvolt input at neutral was taken was governed by the sign of the scale setting at which neutral occurred. Obviously, then, the ratios at +50 and -50 settings are each equal to unity. Having thus plotted the curve, the limiting curves were plotted using the following formulae so as to make for centralization of the above curves within the area bounded by the limiting curves.

$$Y_0 = K_0 \Delta^{1.6}$$

$$Y_1 = K_0 \Delta^{2.4}$$

where $$K_0 = \frac{\frac{B_{50}}{B_x}}{\Delta^n}$$

Δ = Balancer dial setting in divisions,

and where B_{50}/B_x is a constant chosen for a given balancer dial setting that will centralize the quadrature voltage curves within the bounds of the limiting curves. For all of the limiting curves shown in Plates 52 to 55 inclusive a value of $B_{50}/B_x = 0.11$ for $\Delta = 30$ and $n = 1.6$ were found to be the most suitable. The same constant K_0 was used for the calculations of the Y_0 and Y_1 ordinates. Curves shown on Plates 52 to 55 inclusive are for CW inputs only. The close similarity between the curves shown on Plate 52 for the Model DO equipment, and the corresponding curves for the same frequency and shown on Plate 54, indicates that the ratio of B_{50}/B_x for any given setting of eitherBalancer is approximately the same. The curves shown on these plates demonstrates further, that, with the exceptions of the settings of the balancer at and near the null settings, this statement is also true at any frequency. Theoretically the setting at null for the ideal condition should occur at "0" on the balancer scale and the ratio of B_{50}/B_x should be zero. However, owing to the small extraneous couplings existing, the theoretical ideal has not been realized. The ratios of B_{50}/B_x as well as the Balancer control settings at null, will and do vary with the frequency and will also differ somewhat for different receivers at the same frequencies. The fact that the quadrature voltage curves fall outside of the limiting curves at and near the null settings is not important because these adjustments are not critical, owing to the fact that the CW input at null required to produce standard output is many times greater than the input required at the ± 50 settings. Moreover, the maximum departure of the actual curves from the limiting curves represents only about 7-1/2% of 2-1/2 divisions of the total range of the balancer control. Within the range of critical adjustment; that is, where the ratios between the sensitivity at 50 setting to the sensitivity at any other setting is not more than 1 to 100, the curves are well within the specification limits. Similar curves for MCW inputs were not plotted because their value would not justify the expenditure of the time required to prepare them. From an examination of Plates 25 to 42 inclusive, it is self evident that such curves, if plotted, would bear the same close relationship to one another and would be within the specification limits to the same extent as are those plotted on Plates 52 to 55 inclusive.

207. Par. 7-10. The interpretation of the specifications for these paragraphs has been that the design of the Balancer of either type of Receiver shall be such that at the maximum settings, with the use of a Standard Balance Antenna and at any frequency within the range of the equipment and with the receiver tuned to this frequency, the quadrature voltage induced at the first grid by the balance antenna shall not be more than 3 nor less than 0.166 times the in-phase maximum loop voltage produced at the first grid by a given field strength. The Laboratory

assumes that this interpretation establishes the desired intent and purpose of these specifications, although differing literally from them. Plates 101 to 105 inclusive show curves based upon the Laboratory's interpretation of these specifications, for the four types of equipments covered by this report. The following conclusions are derived from these curves.

(a) From Plates 101 to 105, it is evident that the Model DO Equipment should require a less favorable balance antenna than the other three. While there are available but few data on which to base engineering design, this Laboratory believes that service use requires balance performance close to the "Lower Limit" lines of the above plates. There has been little information available from which to formulate specifications for such performance. With the available data of this report, a few measurements of the effective height of sample shipboard balance antennas and the calibration data on balance for these sample installations, it should now be simple to evaluate a number of representstive cases to show the actual relative strengths of the quadrature fields about the loops. An obstacle to such a program in the past has been the difficulty of measuring the effective height of an antenna. This may be done, in terms of the field at the loop, by the use of a signal generator at the loop center and the antenna post, through a dummy antenna of equal constants, to measure the field strength at the loop and the microvolts induced in the antenna by a given signal. The antenna constants could easily be measured by means of a radio frequency bridge, with the signal generator for a driver and the receiver for a detector. This would permit a more representative specification for the balance antenna constants and effective height.

(b) Except for the Model DO Equipment, the low and high frequency ends of the low frequency and medium frequency bands fall outside of the specification limits.

(c) For all equipments the ratios of the quadrature to in-phase microvolts per meter inputs for Standard Output is badly out of proportion at the high frequency end of the high frequency band of all but the Model DO-3 Equipment. This is believed to be partly due to the fact, as shown by tests made with a grid dip oscillator, that the Balancer circuit near 1500 kilocycles is less sensitive than it might be, owing to unintentional but avoidable coupling between the active balancer circuit and the supposedly open circuited sense circuit, thus introducing losses and affecting the phases. This coupling is believed to be capacitive between the balancer and sense circuit leads, which are laced together and connected to a common anti-capacity switch operated by the band switch on the main panel. The excessive ratio is further demonstrated by actual bearings taken on 1350 kilocycles in which the balancer had to be adjusted at maximum setting to obtain only an approximate balance, and in addition, the two minima were not opposite. The fact that the ratio at 1500 kilocycles for the Model DO-3 equipment is not as great as for the other equipments at the same frequency is probably due to the fact that the effective efficiency of the loop, transmission line, and coupling transformers at this frequency is less than for either the CRV-64003 or CRV-64004 loops direct connected, while the antenna efficiency is but little impaired. Insufficient balance effect for frequencies above 1000 kilocycles may result in unsatisfactory operation.

(d) In general, except as noted in (b) and (c) above, the four types of Equipments comply with these specifications.

208. Par.7-11. The Balancer of either type of receiver operates in a noiseless manner. In the receivers tested, the Balancers operated in a smooth and even manner without sticking or jerking and are capable of being reset by calibration data only to within one division of the scale marking for any predetermined quadrature voltage. The design of the balancer mechanism does not predicate its operating indefinitely in acceptance with this specification. The friction is provided by two phosphor bronze spring strips which serve as a track for the rollers in the Balancer coil carriage. It has been demonstrated in the field that these spring strips in some of the receivers are either too flexible or too stiff. In the former case, slipping of the rollers is in evidence and in the latter case, a jerky control is the net result.

209. Par.7-12. The design of the Balancer of either receiver is such that its variation from zero to maximum in either direction with a Standard Balance Antenna in use, introduces detuning of the loop circuit in only the high frequency band. There is no evidence of detuning in the medium or low frequency bands. Only at the low frequency end of the high frequency band does the effect of detuning exceed the limits of these specifications. In this latter instance the sensitivity is reduced 31.6% (specification limit, 25%).

210. Par.7-13. Both types of receivers comply with these specifications. A sense circuit is provided for taking unilateral bearings. The circuit is arranged so that it may be cut in or out at will by means of a toggle switch operated from the front panel. The procedure provided for determining whether a bearing or its reciprocal is correct is as follows:

A. Throw sense balance switch to "Sense" and adjust Antenna Tuning control to resonance.

B. If, when looking down on the Azimuth Scale set for a bilateral minimum, swinging the loop <u>clockwise</u> increases the signal intensity and the signal intensity decreases when the loop is swung <u>counter-clockwise</u>, the previously observed bilateral bearing is correct.

C. Conversely, an opposite effect regarding the increase of signal intensity indicates that a reciprocal bearing is correct.

211. Par.7-14. With any of these types of direction finding equipment, sense determinations are recorded with three operations. One operation is required to throw the "Sense-Balance" switch to "Sense" where it remains fixed throughout the sense determination. The antenna control must then be adjusted for resonance, after which the loop is rotated for

observation. The antenna tuning control is not considered sufficiently rapid.

212. Par.7-15, 7-16. Both bilateral and sense tuning of either receiver are too slow and laborious to assure its maximum usefulness as a searching receiver. The sense tuning is not critical and requires no vernier. Sense operation was found to be only fair to poor. The bilateral minima must be shifted at least 15° for safe sense determination, preferably much more. The Model DO-3 equipment has too strong antenna effect, owing, possibly, to the attenuation in the loop circuit. More sense resistance in each band of this equipment is required to improve the sense determinations. In the other types of equipments less sense resistance would result in better sense performance. In some cases the unilateral bearings were doubtful, owing to a lack of discrimination between the effects for counter clockwise and clockwise rotation of the loop after the initial bearing on bilateral had been determined. However, this cannot be considered as a reversal of the sense determinations. In the latter respect, the four Direction Finder Equipments comply with the specifications. It is the opinion of the Laboratory that the prohibition of too definite a sense determination has been over-stressed, as it tends to lead the designer to employ a somewhat indefinite form of sense observation, such as has been observed in the subject models and the Model DM equipment. If the operator accidentally left his switch on "Sense" instead of "Balance", he would, if properly trained, immediately recognize the failure of the balance adjustment to operate. While Plates 15 to 24 show the "sense" sensitivity substantially equal to that of the "loop" as it should be for good performance, it should be remembered that the average balance antenna probably has an effective height differing materially from the specified two meters, and that an adjustable sense resistor for each band should permit the required compensation for antenna size to be permanently made at the time of installation, as successfully done in the Model DK equipment.

213. Par.8-1 to 8-8 inclusive. The definitions as prescribed by these paragraphs have been applied in making the tests described in this report.

214. Par.9-1 to 9-9 inclusive. Under METHOD OF TESTS of this report a complete description of the test procedure followed for each test has been given. Unless otherwise stated, the tests applied to the subject equipments are in strict compliance with these specifications.

215. Par.10-1, 10-2. All equipments comply with these specifications. Physically the spare parts boxes of all equipments covered by this report are interchangeable. The contents of the boxes are all interchangeable for the Models DO-1, DO-2, and DO-3 Equipments.

216. Par.10-3. The spare parts boxes are of rugged construction. The material used in the construction of the covers as well as the boxes proper is 3/4" thick. The boxes and covers are assembled with doved tailed corner joints, glued together and further secured with wood screws. Flat head screws were used throughout. The heads of these

screws rest in countersunk holes which are filled with putty to prevent corrosion of the screw heads. The four outside corners are reinforced with 1/2" thick wood strips which are held in place with the same screws which secure the vertical corners together. The screws used are presumably iron inasmuch as the hinge screws are of iron. The cover of each box is fastened to the box with two internal type cadmium plated iron hinges. The retaining pins of the hinges are of brass without any form of plating. These retaining pins are, therefore, subject to corrosion if exposed to humid salt atmospheres. Each hinge is fastened with 6 cadmium plated flat head iron wood screws. A cadmium plated hasp and staple secured to the box with 7 cadmium plated flat head wood screws (three for the hasp and four for the staple) are provided on each box for a padlock. No padlock was furnished with any of the boxes, however. The hasps are tied shut with 1/2" wide cotton tape. On each side of the box is mounted an iron chest handle fastened to the box with three flat head iron wood screws. The chest handles and mounting screws are finished with a baked black lacquer.

217. Par.10-4. All boxes are finished on the outside with light battleship gray paint. These specifications require dark battleship gray paint. Their interiors are finished with a mahogany varnish. The lettering stenciled on the front of the box is in compliance with these specifications.

218. Par.10-5, 10-6. All spare parts boxes comply with these specifications.

219. Par.11-1. Inasmuch as the subject of this specification does not come within the object of these tests, no comments are in order here.

220. Par.12-1 to 12-5 inclusive. All equipments comply in general with the requirements of this specification.

221. Par.12-6. As no final instruction books for any of the four types of equipments covered by this report were furnished, no comments relative to their compliance with this specification can be given at this time.

222. Par.13-1, 13-2. The Model DO-3 Radio Direction Finding Equipment complies with these specifications. The maximum reduction in the overall loop sensitivity as the result of the use of the coupling transformers and 35 foot transmission line is less than 3 to 1, the greatest reduction being in the high frequency band.

223. Par.13-3. The CRV-47047 Loop Output Transformer and CRV-47048 Receiver Input Transformer are designed as to be complete, ready for installation and of such nature as to require no modification of the basic equipments in order to permit their use. Each transformer is housed in a 1/8" thick case fabricated from "eraydo" alloy and finished with red paint. All seams of the basic case are carefully and uniformly soldered. The top cover plate is secured to the case with eight #6-32 nickel plated round head brass machine screws which

screw into the tapped holes symmetrically arranged around the top edge of the case. Cadmium plated phosphor bronze lock washers are used under the heads of the screws. The base is a flat plate of 1/8"thick "eraydo" alloy, secured to the case with countersunk head screws and extends beyond the two opposite ends of the case to provide mounting flanges. Each flange is provided with two 9/32" diameter mounting holes. The base dimensions are 7-1/4" x 4", the top dimensions are 5-3/4" x 4" and the height is 5-1/2". Each flange is 3/4" wide. The overall dimensions are, therefore, height - 5-1/2", width - 4", length - 7-1/4". The primary and secondary windings of each transformer are wound side by side and spaced apart to provide the correct amount of mutual coupling. These windings are mounted in a phenolic insulating tube, through the side of which pass the leads. The ends of the insulating tube are closed with flanged discs of the same material, and secured to the insulating tube with #4-40 nickel plated round head brass machine screws. The cover discs are flanged so that the outer rim has the same diameter as the outside diameter of the insulating tube, while the inner flange is such as to fit snugly inside of the insulating tube. The transformer winding assembly is filled with powdered iron, the permeability of which is not known. This assembly is mounted to a terminal board by means of suitable nickel plated brass brackets. The terminal board is in turn mounted on bosses inside of the case. The transformer leads are soldered to standard Yaxley terminals mounted on the terminal board and having a soldering lug at one end and a screw terminal at the other. The CRV-47047 Loop Output Transformer is equipped with a 16" cable and collector brush assembly. The 16" cable, except for its length, and the collector brush assembly is identical to cable and collector brush assembly described under par.5-34 to 5-36 inclusive of ref.(c) and par.5-29 to 5-31 inclusive of ref.(b). The flexible cable is mounted to one end of the case with a standard "Breeze" bulkhead fitting and retaining nut. The flexible leads to the collector brushes are connected to the main terminal board in the transformer unit. In a similar fashion the CRV-47046 Receiver Input Transformer is equipped with a 16" cable and loop and antenna jack panel assembly. The cable except for its length and the loop and antenna jack panel assembly have likewise been described under the above reference paragraphs. The constants of the CRV-47046 and CRV-47047 transformers are as follows:

	Terminals 1 to 2*			Terminals 4 to 5*		
Type No.	Inductance microhenries at 1000 cycles	DC Res. Ohms	Q at 1000 Cycles	Inductance microhenries at 1000 cycles	DC Res. Ohms	Q at 1000 Cycles
CRV-47046	150.0	0.474	1.85	57	0.240	1.30
CRV-47047	142.5	0.510	1.42	60	0.270	1.10

*In the CRV-47046 Transformer, terminals 1 and 2 connect to the receiver loop terminals, while terminals 4 and 5 connect to the transmission line. In the CRV-47047 transformer, terminals 1 and 2 connect to the collector brushes, while terminals 4 and 5 connect to the transmission line. The mutual inductance between the primary and secondary windings of the CRV-47046 transformer is 38 microhenries and 28.75 microhenries for the CRV-47047 transformer.

224. Par.13-4, 13-5. The band switching of the loop receiver coupling is not used or required.

225. Par.13-6. The 35 foot transmission line used in the tests reported herein was constructed to have the following characteristics as prescribed in the manufacturer's instruction book IB 23265. The constants are:

Impedance	- 218 ohms
Inductance	- .514 microhenries per foot
Capacity	- 4.34 micromicrofarads per foot

This transmission line was constructed by using two enameled copper conductors #16 B&S gauge, spaced 1/4" on centers and centrally located within "Breeze" non-magnetic shielded conduit of 1" inside diameter. Bakelite spacers placed at frequent intervals along the transmissionline and within the conduit were used to prevent vibration of the transmission line conductors and its attendant danger of grounding the conductors against the conduit. In order to facilitate construction of the transmission line and to prevent the spacers from collecting together at one end of the conduit as the conductors are pulled through, each wire was sleeved with spaghetti tubing cut to equal lengths and serving to maintain equal spacing between the bakelite spacers. No provision is made in either of the CRV-47046 or CRV-47047 transformers for securing the transmission cable to them. Connection of the transmission cable to the coupling transformers must be made at the time of installation. This arrangement permits the most advantageous arrangement of the coupling transformers and transmission line to suit the special peculiarities of any particular installation.

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

(a) Par.1-5. The receiver power cable for the Model DO-3 Equipment failed in less than a year's service, a break having occurred in each of the high voltage conductors.

(b) Par.2-3 to 2-5 incl. There is self interference of the pig tail connectors on the variometers. The pig tail connectors are of stranded copper wire insulated with cotton braid sleeving. This is not sufficient protection against corrosive action of humid atmosphere. The connectors are further in danger of breakage owing to their self interference.

(c) The holes provided in the loop circuit coil shield and the radio frequency and oscillator coil shield for making trimmer condenser adjustments are not, for all cases, in strict alignment with the adjustment screws in the trimmer condensers.

(d) The paper dielectric by-pass condensers in the receiver and power units do not comply with specifications, ref.(j), owing to the use of fiber insulation for the terminal panels and to the fact that they are not entirely metal clad. The terminals for the paper dielectric condensers, transformers, and chokes used in the receiver and power units are mounted to their respective terminal panels with eyelets. This method of securing the terminals is not satisfactory since the internal leads passing through these open eyelets are exposed to corrosive action of humid salt atmospheres.

(e) Corrosion has appeared on the soldering lug terminals of the range switch for the output meter on both types of receivers.

(f) The telephone jacks used on both types of receivers do not comply with specifications, ref.(d).

(g) There is interference between the intermediate frequency oscillator tube shield and the dial lamp bracket mounted directly in front of it of such extent to make it difficult to replace the dial lamp. Owing to the interference of one of the panel thumb screw retaining blocks with the intermediate frequency oscillator tube shield as a direct result of the bowing of the receiver cabinet, it is difficult to insert the receiver chassis of the CRV-46031A Receiver into its cabinet without damaging this tube shield.

(h) The use of cotton and rubber braid insulation on the conductors for the radio frequency circuit is questionable even though the insulation is **treated.**

(i) The horizontal shelf of the chassis of the CRV-20011A Power Unit was bowed inward probably as a result of the unit having been dropped.

(j) The cable clamp screws of both types of power units are, owing to their size, subject to breakage.

(k) The +B terminal of the load resistor of the CRV-20011A Power Unit is too close to the rectifier tube socket mounting for safe operation. The plate leads to the rectifier tube lie against the sharp edges of the shock mounting frame supporting the tube socket and hence are subject to impairment of the insulation resulting in a voltage breakdown in due time.

(l) Par.2-8. There is insufficient clearance between the high tension fuse and the receiver chassis frame on each type of receiver. The fuses show signs of corrosion around the ferrules.

(m) Par.2-13. The engraved letters and figures on the mica dielectric condensers in the receiver units are not filled with wax, white or otherwise. Their readability is, therefore, impaired. No Navy type number appears on the Faradon mica dielectric condensers in the radio frequency filter of either type of power unit. For either type of receiver no Navy type numbers have been provided on the loop, intermediate frequency and oscillator trimming condensers, loop load coils, radio frequency and oscillator coils, intermediate transformers, intermediate oscillator coils, toggle switches, or range switch for the output meter. The fixed carbon rod resistors are identified by color code.

(n) Par.3-7, 3-8. The Models DO and DO-3 do not comply with these specifications owing to the large displacement of bilateral minima at some frequencies.

(o) Par.3-9. The Model DO and DO-3 Equipments do not comply with these specifications owing to the fact that the unilateral indications are only fair to poor.

(p) Par.3-10, 3-11. It is believed that there is inadequate filtering provided in the +B on heater circuits of the CRV-46031 Receiver to permit the Model DO Equipments' operating in compliance with these specifications from separate batteries in a typical service installation.

(q) Par.4-1. There is a decided bowing of the cabinet for the CRV-46031AReceiver, and a similar bowing, although to a lesser degree, of the cabinet of the CRV-46031 Receiver. The bowing of these cabinets makes the complete insertion of their respective receiver chassis difficult. The reenforcing strips on the tops and the bottoms of the cabinets are not adequate, from the standpoint of strength, to prevent cabinets' bowing.

(r) The button type guides mounted in the bottoms of the receiver cabinets are unsatisfactory because of the difficulty to align the guide flanges on the receiver chassis under the rear button guides.

(s) Owing to the fact that the cables furnished with each equipment have an outside cotton braid insulation, moisture may enter the receiver cabinet through the cable fittings by virtue of wick effect. It is also possible for water to enter between separate conductors of the cable.

(t) The terminal lug of the +B cable lead attached to the power plug panel, mounted inside of the receiver cabinet of either type of receiver, is too close to one of the panel supporting pillars to assure continuous receiver operation under conditions of vibration. The securing screws for the power plug panel should be larger inasmuch as those furnished are subject to breakage.

(u) The threaded ends of the screws securing the brass strips which, in turn, secure the rubber gaskets to the cover of the cabinet of the CRV-46031 Receiver, protrude inside of the cover and are apt to injure an operator's hand or arm.

(v) No provision is made in the cabinet for either type of receiver for trimming the loop and antenna circuits with the receiver chassis in its normal position in its cabinet.

(w) Par.4-2. The width of the CRV-46031 Receiver cabinet does not comply with this specification.

(x) Par.4-6. No provision for calibration has been furnished on the calibration chart on each receiver for the antenna tuning control settings.

(y) Par.4-14. The knurled head thumb screws for securing the front panels of the receivers to the cabinets are not satisfactory in that they are not easily loosened without tools. This is particularly true with the CRV-46031 receiver where there is very little clearance between the thumb screws and the cabinet.

(z) Par.4-16. No name plate is provided for the output meter of either type of receiver or the voltmeter on the CRV-46031 Receiver. No name plate or engraving is provided for either type of receiver to indicate the association of the range switch with the output meter. Exception is taken to the labelling for the sensitivity control. This control should be labelled "SENSITIVITY" instead of "VOLUME". No calibrated scale or engraving is provided to permit accurate determination of the setting of the sensitivity control of either type of receiver.

(aa) Par.4-19. The band selector switches employed in both types of receivers are not satisfactory. They are not designed to assure positive contacts between the 4 inside fixed contacts and 4 moveable flat spring contacts on each switch. These switches have proven themselves to be faulty during these tests and in the service.

(bb) Par.4-23. The friction device provided in the balancer coil mechanism of either type of receiver is not designed to assure continuously smooth operation of the balancer control without slipping or jerking. This defect, while not apparent for the receivers tested at the Laboratory, has manifested itself in the service.

(cc) Par.4-30. The screw fit steel shield cans for the intermediate frequency transformers are, in some cases, difficult to remove. Their present design is such that if corrosion takes place in the threaded joint between the top and base of the shield can assembly, it would be impossible to separate them without seriously damaging the screw fit cover unless special tools were employed. Such tools have not been supplied with any of the four types of Equipments covered by this report.

(dd) Par.4-31. For both types of receivers the ganged tuning condenser assembly must be removed to replace or service the radio frequency and intermediate frequency tube sockets, intermediate frequency transformers, and the sensitivity control. All tube sockets and small molded mica dielectric condensers are riveted in place; hence, making their replacement difficult. It is to be noted also, in connection with the tube sockets, that except for the second detector and audio frequency tube sockets, the same rivets which secure the tube sockets also secure the corresponding tube shields to the receiver chassis frame.

(ee) Par.4-42. The overall dimensions of the CRV-20011 and CRV-20011A power units exceed the dimensions of these specifications.

(ff) Par.4-43. No provision has been made for mounting the cabinets of the CRV-20011 or CRV-20011A Power Units either under or on top of a shelf.

(gg) The nickel plating on the thumb screw retaining angles in the CRV-20011A Power Unit cabinet has rubbed off during the short usage of the unit in the Laboratory.

(hh) Par.5-2. The cross sectional dimensions of the CRV-69003 round loop exceeds the limits of these specifications. The loop has a rectangular rather than a square cross section as required by the specifications. The diagonal dimension of the CRV-69004 square loop does not comply with these specifications.

(ii) Par.5-15. The CRV-69003 and CRV-69004 Loops are difficult to remove from their loop pedestals, without damaging the loop connecting plugs in the top of the loop pedestals, by a lone man without assistance. A lone man cannot adequately lift the loop assembly and at the same time keep one or more of the clamping dogs from falling and catching in their retaining slots in the pedestal.

(jj) Par.5-16. An aluminum cap provided with each of the CRV-69005 and CRV-69005B Pedestals and placed over the top of the pedestals, when the loop is dismounted, does not render the loop pedestal water-tight, although under this condition the loop pedestal is spray-proof. The specification requirements in this regard are, therefore, not met.

(kk) Par.5-28. The plating on the slip rings is not permanent. During the short usage of the loop pedestal for the Model DO-3 Equipment for the tests conducted at the Laboratory, the plating wore off where the brushes made contact with the slip rings.

(ll) Par.5-34 to 5-36 incl. The screws for securing the cover plate of the collector ring brush assembly of any equipment to the corresponding loop pedestal assembly containing the collector rings are subject to breakage.

(mm) Par.6-1. The loop sensitivities for CW or MCW reception for the Models DO, DO-1, DO-2, or DO-3 Equipments do not comply with the requirements of these specifications.

(nn) Par.6-2. The MCW selectivities for the low frequency band of each of the four types of Equipments under conditions of optimum gain failed to comply with the specification requirements.

(oo) Par.6-3. The image selectivities for the upper half of the high frequency band of any equipment fail to meet specification requirements.

(pp) Par.6-11. The loop trimmer condenser for the Model DO-3 Equipment does not adequately trim this circuit for best selectivity owing to too high an LC product for the loop circuit. Best sensitivity was obtained with the trimmer condenser adjusted for minimum capacity and when this capacity was reduced still further by the substitution of another condenser adjusted for a still lower capacity, no change was noted in the sensitivity of the receiver at the test frequency.

(qq) Par.6-18. The frequency stability of the Models DO, DO-1, DO-2, and DO-3 equipments when subjected to mechanical shocks do not comply with the requirements of these specifications.

(rr) Par.6-20. The high frequency band of the CRV-46031A Receiver does not comply with this specification.

(ss) Par.6-25. The range of the sensitivity (volume) control of the CRV-46031A Receiver for CW reception does not comply with these specifications.

(tt) Par.6-27. The selectivities of the low frequency bands of each of the Models DO, DO-1, DO-2, and DO-3 equipments for MCW reception, at reduced gain, fail to comply with the requirements of this specification.

(uu) Par.6-33. The secondary winding of the output transformer of the CRV-46031 and CRV-46031A receivers is designed to match a 600-ohm instead of a 20,000 ohm load as required by these specifications.

(vv) Par.7-17. Detuning of the receiver by an adjustment of the balancer from +50 -50 settings, occurs for the high frequency band of each equipment by an amount slightly in excess of the specification limit.

(ww) Par.7-15, 7-16. Both bilateral and sense tuning of either type of receiver is too slow and laborious to assure its maximum usefulness as a searching receiver. Sense operation of any of the four types of equipments was found to be only fair to poor.

(xx) Par.10-4. The outside finish of the spare parts boxes for these equipments does not comply with the specifications.

(yy) Par.12-6. No final instruction books have been supplied with any of the four types of equipments covered by this report.

CONCLUSIONS

227. The Models DO, DO-1, and DO-3 Equipments (the Model DO-2 Equipment was not furnished to the Laboratory for test) are, in general, ruggedly constructed, present a pleasing appearance, and the workmanship is, in general, of very high quality. The materials employed are generally of excellent quality. The coil construction is commendable, all coils being thoroughly protected against all forms of corrosive action by a thick coating of a wax compound. With few exceptions, the component parts are accessible for inspection and servicing. The band selector switches and the toggle switches are a source of trouble and are, therefore, untrustworthy.

228. In general, these equipments when operated in the service with reasonable care, can be expected to yield results which will exceed all previous models of direction finder equipments.

229. The minima are almost always exactly opposite and are not shifted by tuning or changing the sensitivity control setting. Perfect balance is obtainable at all but the highest frequencies. The failure to obtain perfect balance at and near the upper limit of the frequency ranges of these equipments is due to coupling between the active balance circuit with the supposedly inactive sense circuit at these frequencies.

230. The sense feature is workable but weak at most frequencies and failed completely at some frequencies due to the lack of a means for compensating the sense resistance for each band to suit the characteristics of the antenna.

231. While the loop sensitivities do not comply with the specification limits, these sensitivities are adequate at all frequencies to give excellent bilateral operation of these equipments.

232. The efficiency of the transmission line operated equipment (Model DO-3) is considered favorable and is such that remote loop tuning can be considered practicable. It is probable that the small loss that must be necessarily expected from transmission line coupling may be more than compensated for by the more favorably located position of the loop.

233. The effectiveness of the CRV-46031 and CRV-46031A Receivers as direction finder receivers is limited owing to slow and cumbersome tuning controls provided with these receivers.

234. The balancer mechanism is ingenious and its performance is commendable.

235. The power unit furnished with the Model DO equipment is inadequately filtered to permit good direction finder performance from this equipment when operated on a line.

Table 1
Measuring Instruments

Instrument No.	Type No.	Description	Ser.#	Manufacturer's Rated Accuracy
1	LC-A	Standard signal generator General Radio Company	1	Frequency calibration 0.1% at all frequencies. Output at any level down to 5 microvolts within ±5% below 1500 kcs. At one microvolt level to 0 level is so rated that the 1 microvolt reading shall not differ by 1/5 of the 5 microvolt reading by more than -25%, or +50% at any frequency.
2	513B	Beat frequency audio oscillator General Radio Company	44	Harmonic content above 100 cps ±5%; frequency calibration 2%.
3	636A	Wave analyzer General Radio Company	102	5% above 1 and 2 millivolt ranges; 10% for the 1 and 2 millivolt ranges.
4	583A	Power output meter General Radio Company	16	Impedance 8%, output - 0.3 db
5	483C	20,000 ohm output voltmeter General Radio Company	106	6% - full scale
6	S	6-60-600 d.c. microammeter Sensitive Research Corp'n	2342	1% - full scale
7	341	0-150-750 volt a.c. voltmeter Weston Elec. Inst. Corp'n	7909	1/2 of 1% full scale
8	200C	Variac General Radio Company		
9	NRL	600 ohm output meter Naval Research Laboratory		±3% full scale for all ranges
10	418	Standard balance antenna General Radio Company		± 10%
11	NRL	Slide-back tube voltmeter Naval Research Laboratory		3% full scale
12	650A	Impedance bridge General Radio Company	103	0.1 of 1% for inductance or capacity
13	516C	Radio frequency bridge General Radio Company	23	0.1 ohm for direct measurement of resistance
14	663	Volt ohmmeter Weston Elec.Inst.Corp'n	844	2% full scale for all ranges.
15	exp.mod.	Tuned r.f. receiver Naval Research Laboratory		
16	222	Precision condenser General Radio Company		0.1% of the maximum capacity.

Table 2

Application of Measuring Instruments to Tests

Test (see par.3 & 4)	Instrument Numbers (See first column of Table 1)	
	Model DO equipment	Model DO-1, DO-2, DO-3 equipments
a	9	9
b, d, e, g, h, j, l, g, s	1, 9, 14	1, 7, 8, 9
c	1, 5, 9, 14	1, 5, 7, 8, 9
f	1, 9, 10, 14	1, 7, 8, 9, 10
i, m, n, o	1, 2, 9, 14	1, 2, 7, 8, 9
r	1, 6, 9, 14	1, 6, 7, 8, 9
t, u, v	1, 9, 10, 14	1, 7, 8, 9, 10
aa	1, 5, 13, 14, 15, 16	
bb	1, 11, 12, 16	1, 11, 12, 16
dd, ee	1, 5, 13, 15	1, 5, 7, 8, 9, 13, 15
ff		1, 5, 7, 8, 9, 13, 15
gg, hh, kk	2, 3, 4, 5, 14	2, 3, 4, 5, 7, 8
ii	1, 9, 14	1, 7, 8, 9, 14
jj	1, 5, 15	1, 5, 15

Table 3

Average Loop Sensitivities on CW

	Sensitivity-Microvolts per meter						Specification Limit Microvolts per meter	
Band	DO*	DO**	DO***	DO-1	DO-2	DO-3	DO, DO-1, DO-2,	DO-3
HF	37.66	57.04	11.57	33.42	23.89	39.63	10	17.50
MF	75.48	176.88	26.04	57.25	47.66	60.16	25	43.75
LF	326.41	301.8	74.38	83.18	73.20	110.84	60	105.00

* Line operated (quiet line)
** Line operated (noisy line)
*** Battery operated

Table 4

Average Loop Sensitivities on MCW

	Sensitivity-Microvolts per meter				
Band	DO*	DO**	DO-1	DO-2	DO-3
HF	34.34	27.12	124.36	88.75	140.88
MF	156.74	26.89	73.58	66.22	86.10
LF	174.10	105.34	92.14	81.84	123.20

* Line operated (noise level)
** Battery operated

Table 5

Average Maximum Noise Level CW Operation

Band	Maximum Noise Level Volts					
	DO*	DO**	DO***	DO-1	DO-2	DO-3
HF	0.784	1.52	0.484	0.386	0.386	0.386
MF	2.040	3.20	1.030	0.594	0.594	0.594
LF	1.530	2.06	0.760	0.795	0.795	0.795

* Line operated (quiet line)
** Line operated (noisy line)
*** Battery operated

Table 6

Average Maximum Noise Level - MCW Operation

Band	Maximum Noise Level Volts					
	DO*	DO**	DO***	DO-1	DO-2	DO-3
HF	0.164	0.414	0.026	0.036	0.036	0.036
MF	1.098	2.468	0.132	0.088	0.088	0.088
LF	0.614	0.644	0.076	0.152	0.152	0.152

* Line operated (quiet line)
** Line operated (noisy line)
*** Battery operated

Table 7

Frequency Overlap CRV-46031 Receiver

Band	Freq. Range Kcs	Overlap Freq. Bands	Kcs	Percent of overlap from low end of band to overlap frequency	Percent of overlap from high end of band to overlap frequency	Total percent of overlap between adjacent bands
LF	96.0-243.5			4.00*	7.74	
		LF-MF	226.0			13.94
MF	212.0-600.0			6.20	4.53	
		MF-HF	574.0			8.71
HF	550.0-1585.0			4.18	5.66**	

* Percent overlap from 96 to 100 kcs
** Percent overlap from 1500 to 1585 kcs

Table 8

Frequency Overlap CRV-46031A Receiver

Band	Freq. Range Kcs	Overlap Freq. Bands	Kcs	Percent of overlap from low end of band to overlap frequency	Percent of overlap from high end of band to overlap frequency	Total percent of overlap between adjacent bands
LF	95.5-248.0			4.50*	6.88	
		LF-MF	232.0			12.90
MF	218.0-610.0			6.02	6.46	
		MF-HF	573.0			12.22
HF	540.0-1600.0			5.76	6.66**	

* Percent overlap from 95.5 to 100 kcs
** Percent overlap from 1500 to 1600 kcs

Table 9

Frequency Stability vs. Change in Line Voltage

CRV-46031 Receiver D.C. Line Operated

Band	Freq.Kcs	*Change in Beat Note Frequency - Cycles +5% Normal Line Volt.	-5% Normal Line Volt
LF	200	1.0	0.5
MF	400	2.0	3.0
HF	1300	15.0	17.0
		CRV-46031A Receiver A.C. Line Operated	
LF	200	3.0	7.0
MF	400	11.0	9.0
HF	1300	17.0	29.0

*Specification limit - 200 cycles.

Table 10

Frequency Stability vs. Change in Input Signal Intensity

CRV-46031 Receiver			CRV-46031A Receiver		
Band	Freq.kcs.	Change in Beat Note Freq.Cycles	Band	Freq.kcs.	Change in Beat Note Freq.Cycles
LF	200	3.0	LF	200	3.0
MF	400	5.5	MF	400	3.0
HF	1300	5.0	HF	1300	8.0

*Specification limit - 100 cycles

Table 11

Frequency Stability vs. Change in Volume Control Setting

CRV-46031 Receiver			CRV-46031A Receiver		
Band	Freq.kcs	* Change in Beat Note Freq.Cycles	Band	Freq.kcs	*Change in Beat Note Freq.Cycles
LF	200	9.0	LF	200	28
MF	400	19.0	MF	400	47
HF	1300	23.0	HF	1300	157**

* Specification limit - 100 cycles
** Does not comply with specifications.

Table 12

Coincidence of Mechanical and Electrical Centers of Balancer

	Model DO*		Model DO**		Models DO-1, DO-2, DO-3	
Freq. Kcs	Dial Div.	% off Mech. Center	Dial Div.	% off Mech. Center	Dial Div.	% off Mech. Center
100	0	0	0	0	+1.0	2.0
158	0	0	0	0	+0.5	1.0
244	0	0	0	0	+0.5	1.0
225	-1.0	2.0	-0.5	1.0	+0.5	1.0
370	-0.5	1.0	-0.75	1.5	+0.5	1.0
600	-1.0	2.0	-0.5	1.0	0	0
550	0	0	0	0	+0.5	1.0
908	0	0	0	0	+0.5	1.0
1500	-1.0	2.0	-1.0	2.0	0	0

* 115 volt D.C. line operated
** 115 volt battery operated

Table 13

Symmetry of Balancer at ± 50 Settings on CW

Freq. Kcs	Model DO* Microvolts/Meter-Input +50	Model DO* Microvolts/Meter-Input -50	Model DO** Microvolts/Meter-Input +50	Model DO** Microvolts/Meter-Input -50	Model DO-1, DO-2, DO-3 Microvolts/Meter-Input +50	Model DO-1, DO-2, DO-3 Microvolts/Meter-Input -50
100	400.0	415.0	135.5	135.5	590.0	585.0
158	247.5	245.0	82.0	81.5	137.0	131.0
244	345.0	347.0	60.5	60.5	300.0	295.0
225	280.0	285.0	65.5	66.0	166.0	161.0
370	110.0	109.0	23.9	24.7	99.0	99.0
600	69.0	70.5	15.6	15.6	118.0	118.5
550	32.2	32.5	6.6	6.6	43.5	43.0
908	56.0	55.0	8.7	9.0	39.0	36.0
1500	225.0	225.0	60.0	60.0	169.0	174.0

* 115 volt D.C. line operated
** 115 volt battery operated

Table 14

Displacement of Bilateral Minima

Type of Equipment	Band	Frequency Kilocycles	Displacement from 180°	Width of Minimum Degrees
DO	L	106	0.6	0.1
DO	L	195	0.5	0.3
DO	M	300	0.0	0.1
DO	M	630	2.3	0.3
DO	H	630	0.0	0.1
DO	H	950	0.8	0.1
DO	H	1350	1.7	-
DO-3	L	106	0.1	0.1
DO-3	L	113	0.1	3.0
DO-3	M	630	0.0	0.4
DO-3	M	300	0.0	1.0
DO-3	H	630	1.0	0.1
DO-3	H	950	0.8	0.1

Table 15

Frequency Stability under Shock

Application of Shock	Beat Note Frequency Change - Cycles 200 kcs	400 kcs	1300 kcs
	CRV-46031 Receiver		
Top	78	320*	27
Sides	39	43	8
	CRV-46031A Receiver		
Top	107	142*	33
Sides	3	180*	54

*Does not comply with specifications.

Table 16

Time Constants of CRV-46031A Receiver

Freq.Kcs	Time Constant - secs.
150	.00417
400	.00333
1000	.00278

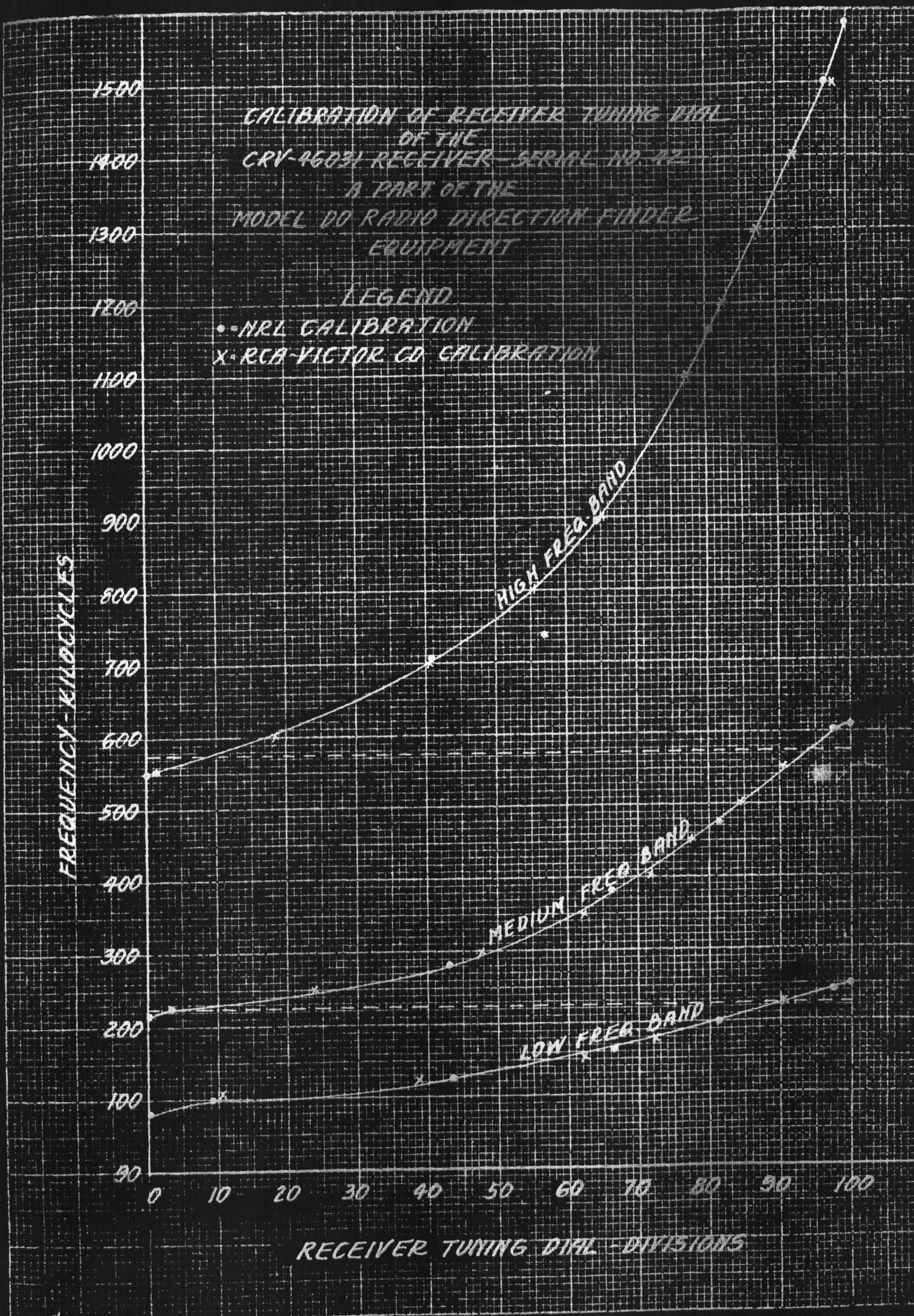

CALIBRATION OF RECEIVER TUNING DIAL
OF THE
CRV-46031 RECEIVER - SERIAL NO. 42
A PART OF THE
MODEL DO RADIO DIRECTION FINDER
EQUIPMENT
LEGEND
• = NRL CALIBRATION
X = RCA-VICTOR CO. CALIBRATION
HIGH FREQ. BAND
MEDIUM FREQ. BAND
LOW FREQ. BAND
FREQUENCY - KILOCYCLES
90
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
0
10
20
30
40
50
60
70
80
90
100
RECEIVER TUNING DIAL - DIVISIONS

PLATE I

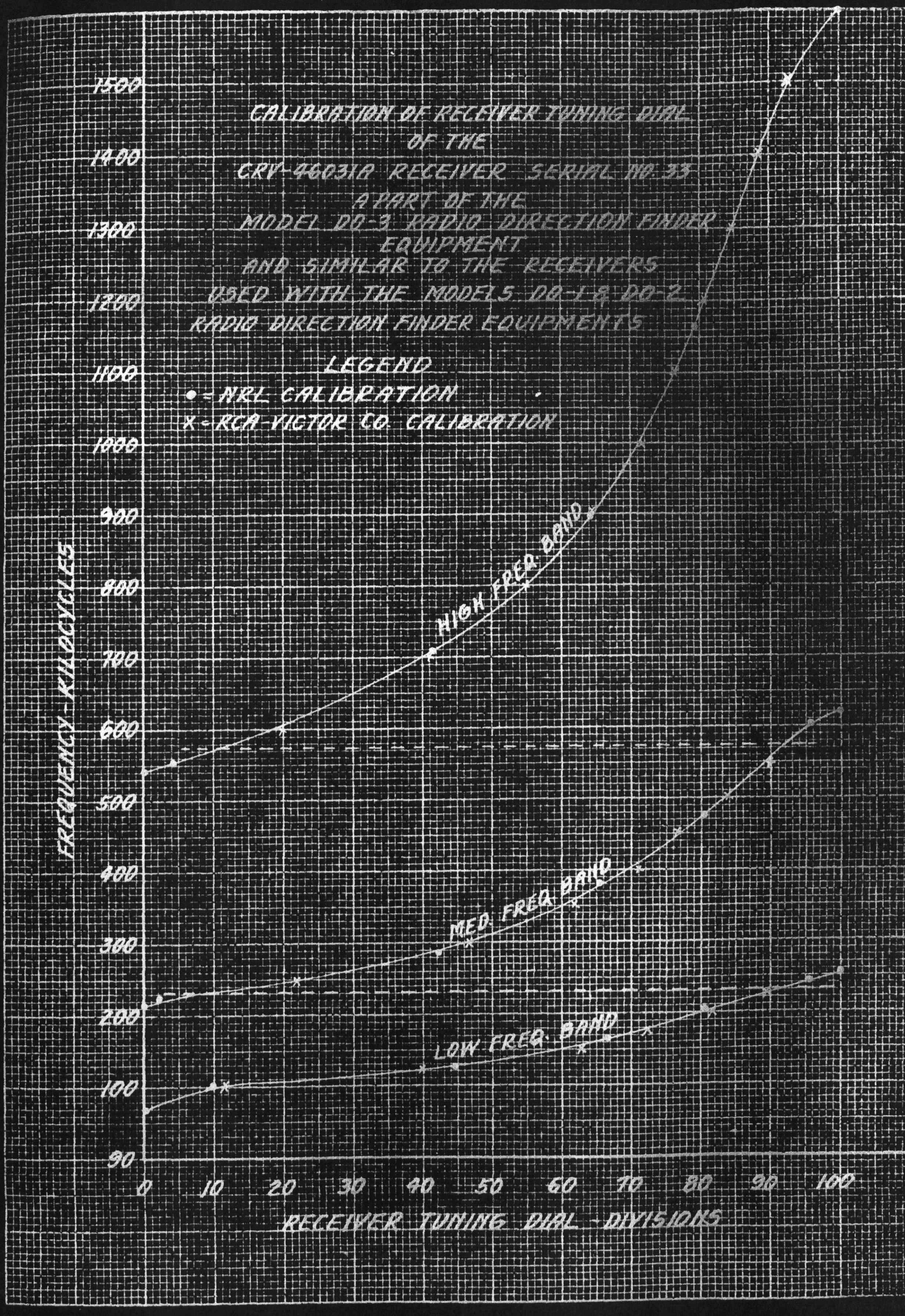

CALIBRATION OF RECEIVER TUNING DIAL
OF THE
CRV-46031A RECEIVER SERIAL NO. 33
A PART OF THE
MODEL DO-3 RADIO DIRECTION FINDER
EQUIPMENT
AND SIMILAR TO THE RECEIVERS
USED WITH THE MODELS DO-1 & DO-2
RADIO DIRECTION FINDER EQUIPMENTS
LEGEND
● = NRL CALIBRATION
X = RCA-VICTOR CO. CALIBRATION
HIGH FREQ. BAND
MED. FREQ. BAND
LOW FREQ. BAND
FREQUENCY - KILOCYCLES
RECEIVER TUNING DIAL - DIVISIONS
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
90
0
10
20
30
40
50
60
70
80
90
100

PLATE 2

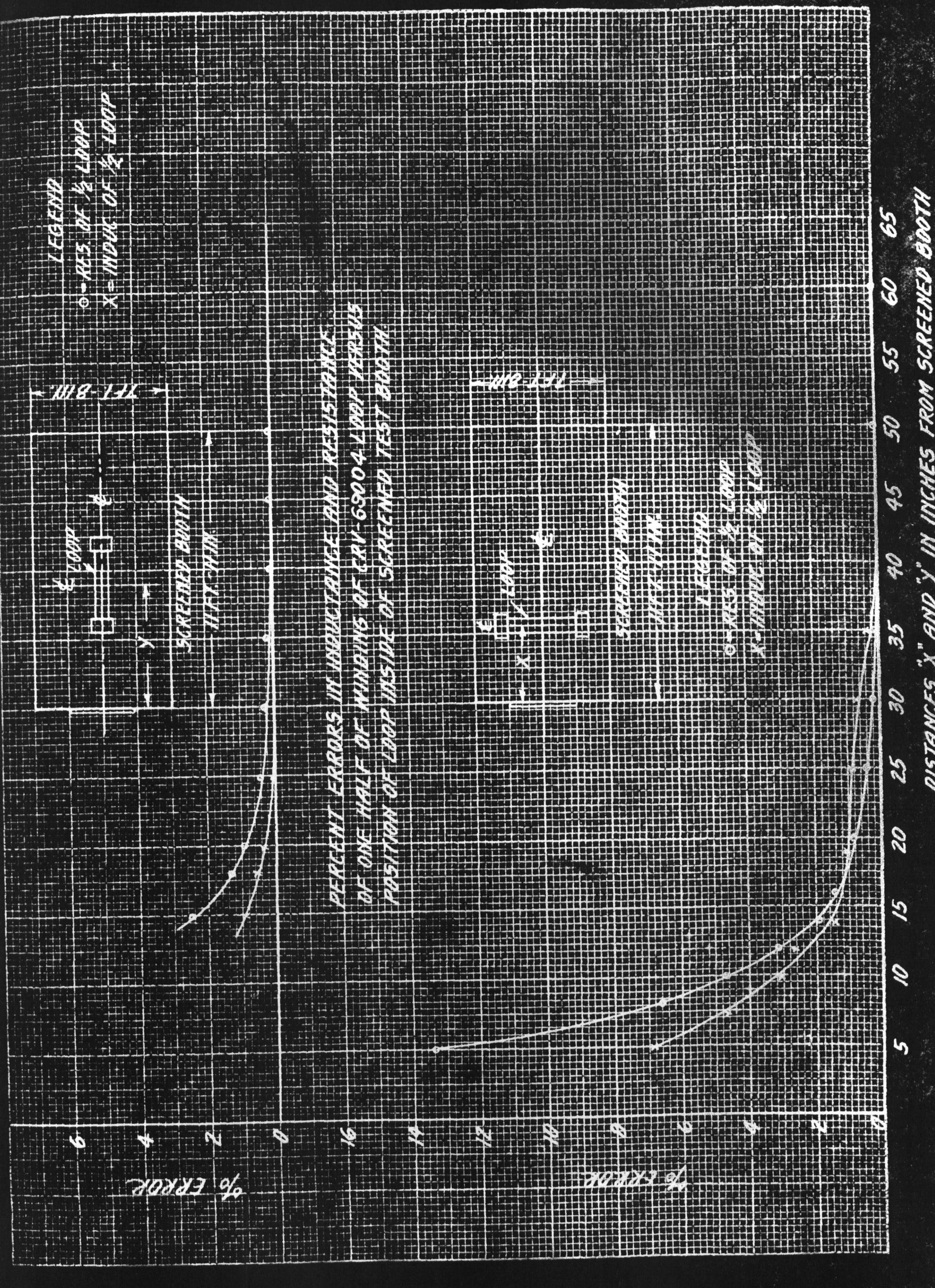

PERCENT ERRORS IN INDUCTANCE AND RESISTANCE OF ONE HALF OF WINDING OF CRV-69004 LOOP VERSUS POSITION OF LOOP INSIDE OF SCREENED TEST BOOTH
LEGEND
⊙-RES. OF ½ LOOP
X-INDUC. OF ½ LOOP
SCREENED BOOTH
% ERROR
DISTANCES "X" AND "Y" IN INCHES FROM SCREENED BOOTH

PLATE 3

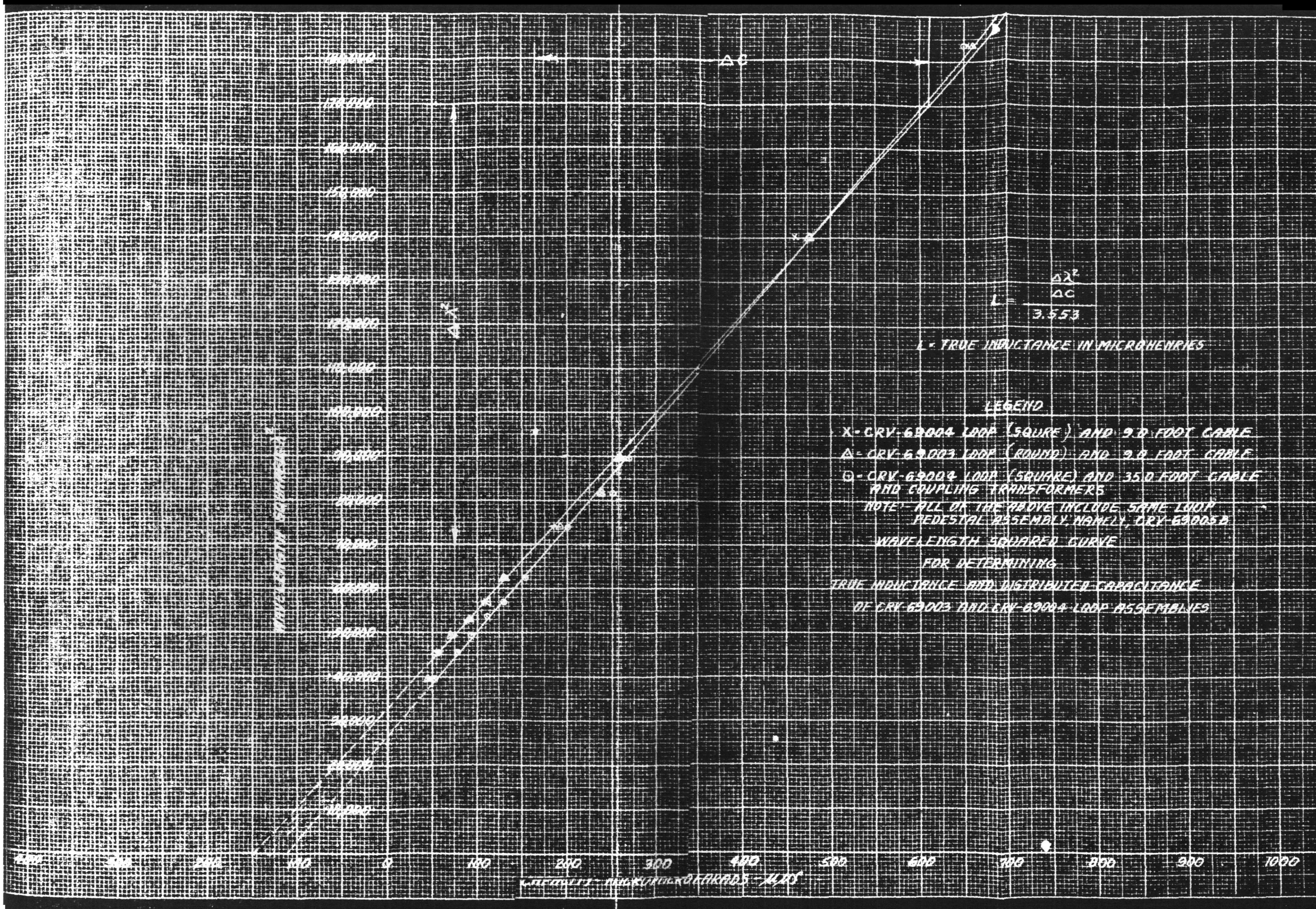

ΔC
Δλ²
$L = \frac{\Delta\lambda^2 / \Delta C}{3.553}$
L = TRUE INDUCTANCE IN MICROHENRIES
LEGEND
X - CRV-69004 LOOP (SQURE) AND 9.0 FOOT CABLE
Δ - CRV-69003 LOOP (ROUND) AND 9.0 FOOT CABLE
⊙ - CRV-69004 LOOP (SQUARE) AND 35.0 FOOT CABLE AND COUPLING TRANSFORMERS
NOTE: ALL OF THE ABOVE INCLUDE SAME LOOP PEDESTAL ASSEMBLY, NAMELY, CRV-69005B
WAVELENGTH SQUARED CURVE
FOR DETERMINING
TRUE INDUCTANCE AND DISTRIBUTED CAPACITANCE
OF CRV-69003 AND CRV-69004 LOOP ASSEMBLIES
WAVELENGTH SQUARED
CAPACITY - MICROMICROFARADS - MMF
0
100
200
300
400
500
600
700
800
900
1000
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
100,000
110,000
120,000
130,000
140,000
150,000
160,000
170,000
180,000

PLATE 4

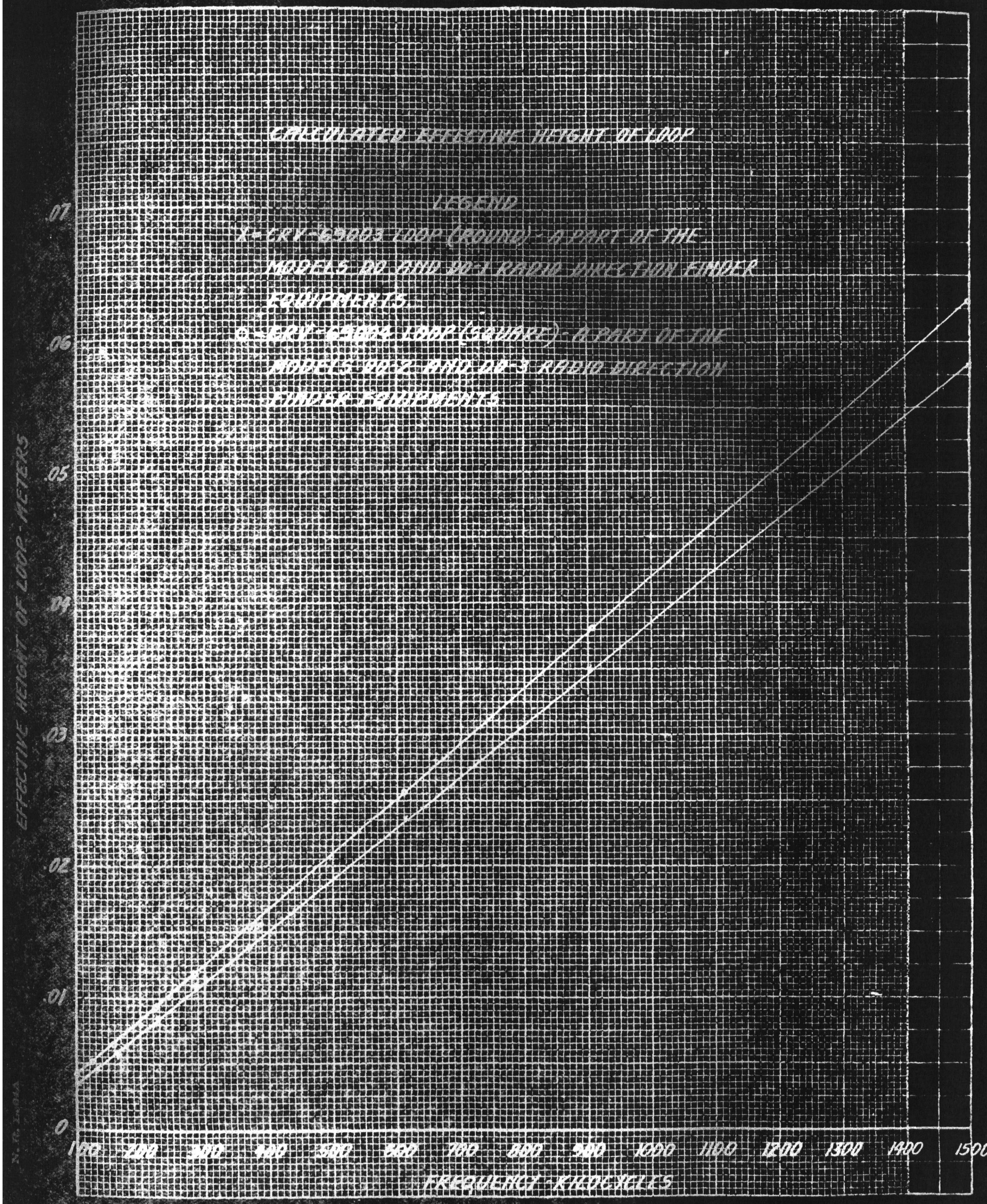

CALCULATED EFFECTIVE HEIGHT OF LOOP
LEGEND
X - CRV-69003 LOOP (ROUND) - A PART OF THE MODELS DD AND DD-1 RADIO DIRECTION FINDER EQUIPMENTS.
⊙ - CRV-69004 LOOP (SQUARE) - A PART OF THE MODELS DD-2 AND DD-3 RADIO DIRECTION FINDER EQUIPMENTS.
EFFECTIVE HEIGHT OF LOOP - METERS
.07
.06
.05
.04
.03
.02
.01
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
FREQUENCY - KILOCYCLES

PLATE 5

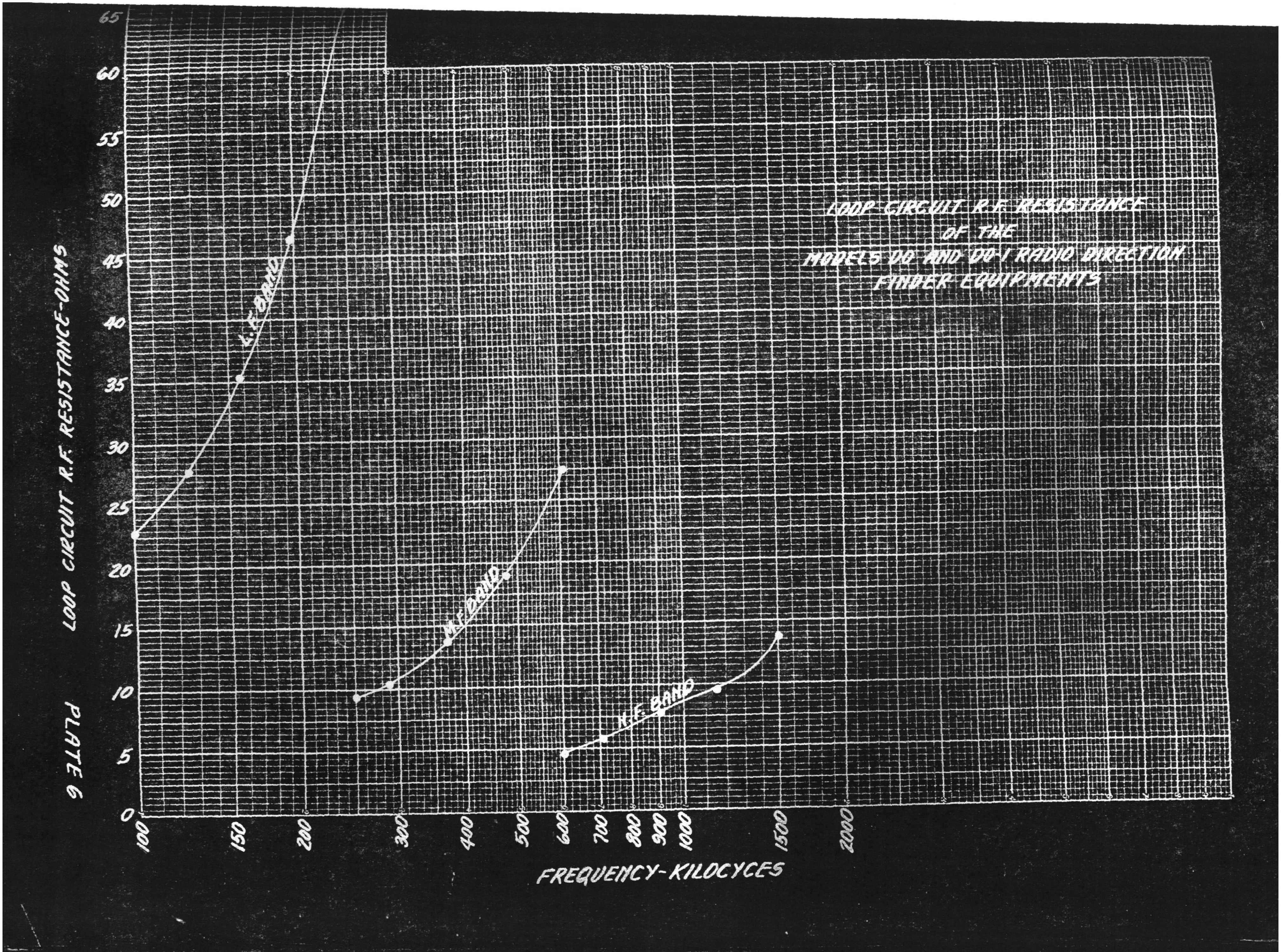

LOOP CIRCUIT R.F. RESISTANCE
OF THE
MODELS DO AND DO-1 RADIO DIRECTION
FINDER EQUIPMENTS
L.F. BAND
M.F. BAND
H.F. BAND
LOOP CIRCUIT R.F. RESISTANCE-OHMS
0
5
10
15
20
25
30
35
40
45
50
55
60
65
100
150
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY-KILOCYCES

PLATE 6

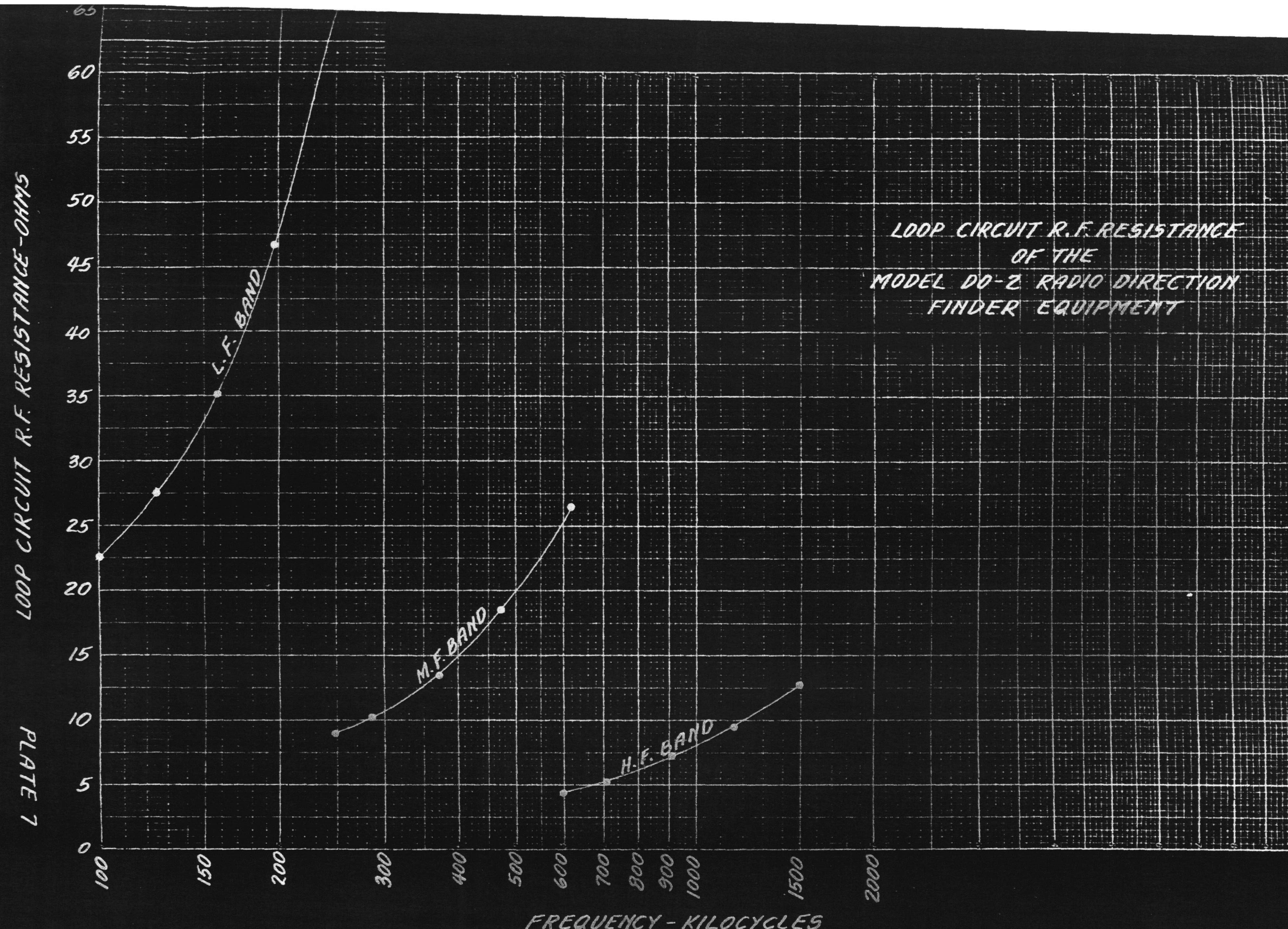
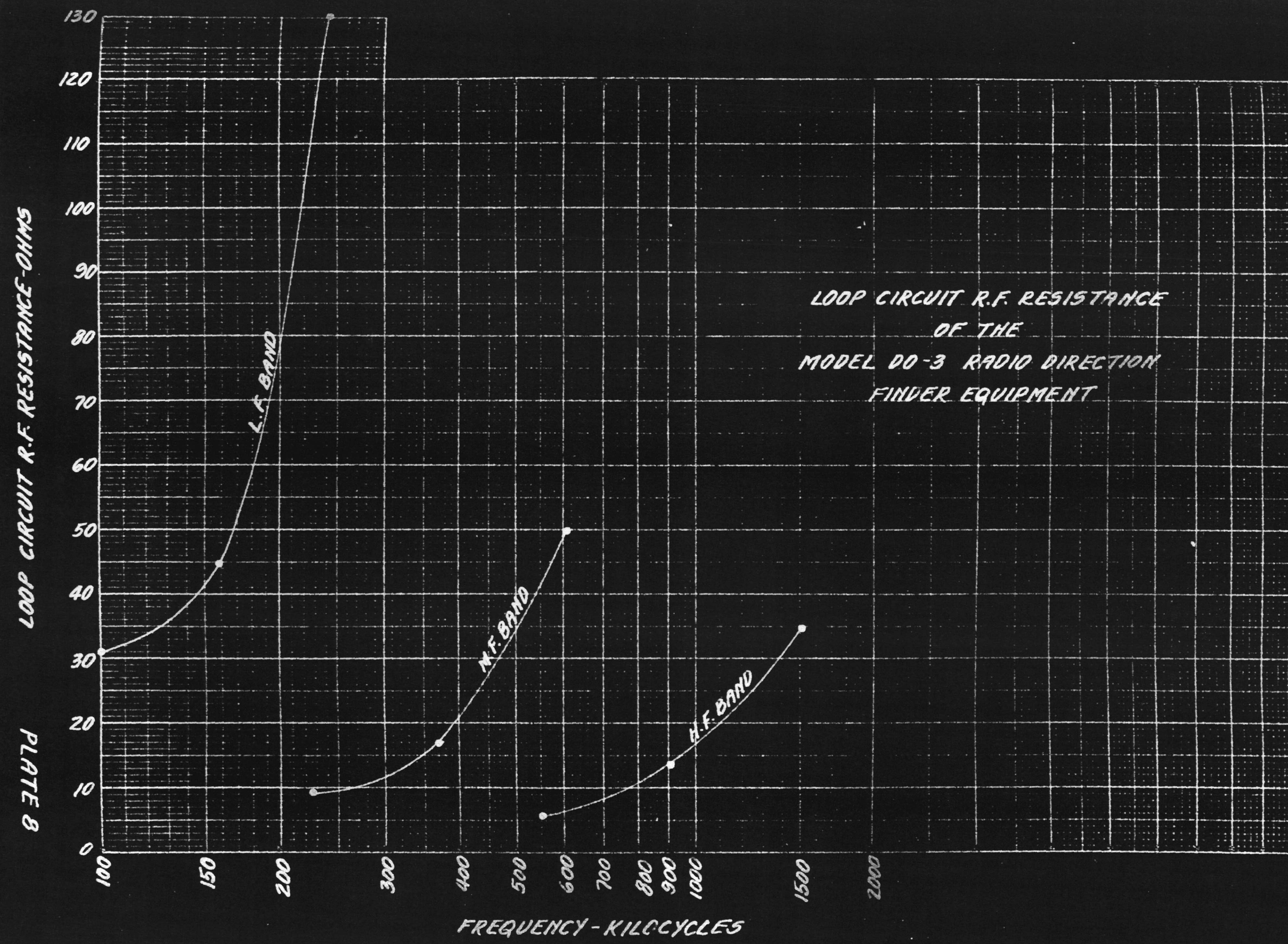

LOOP CIRCUIT R.F. RESISTANCE
OF THE
MODEL DO-2 RADIO DIRECTION
FINDER EQUIPMENT
L.F. BAND
M.F. BAND
H.F. BAND
LOOP CIRCUIT R.F. RESISTANCE-OHMS
FREQUENCY - KILOCYCLES
0
5
10
15
20
25
30
35
40
45
50
55
60
65
100
150
200
300
400
500
600
700
800
900
1000
1500
2000

PLATE 7



LOOP CIRCUIT R.F. RESISTANCE
OF THE
MODEL DO-3 RADIO DIRECTION
FINDER EQUIPMENT
L.F. BAND
M.F. BAND
H.F. BAND
LOOP CIRCUIT R.F. RESISTANCE-OHMS
FREQUENCY-KILOCYCLES
0
10
20
30
40
50
60
70
80
90
100
110
120
130
100
150
200
300
400
500
600
700
800
900
1000
1500
2000

PLATE 8

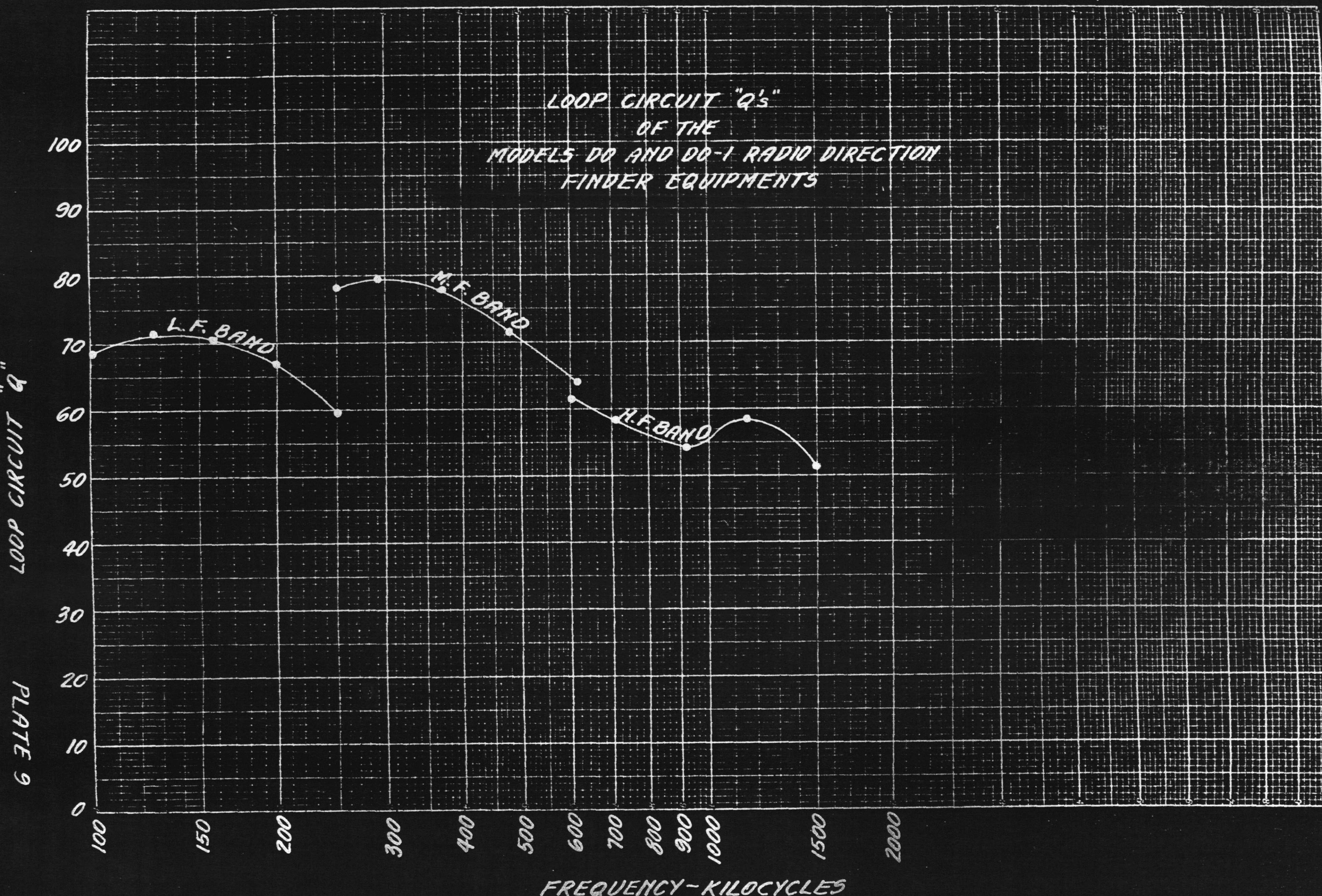

LOOP CIRCUIT "Q's"
OF THE
MODELS DO AND DO-1 RADIO DIRECTION
FINDER EQUIPMENTS
L.F. BAND
M.F. BAND
H.F. BAND
100
90
80
70
60
50
40
30
20
10
0
100
150
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY-KILOCYCLES
LOOP CIRCUIT "Q"

PLATE 9

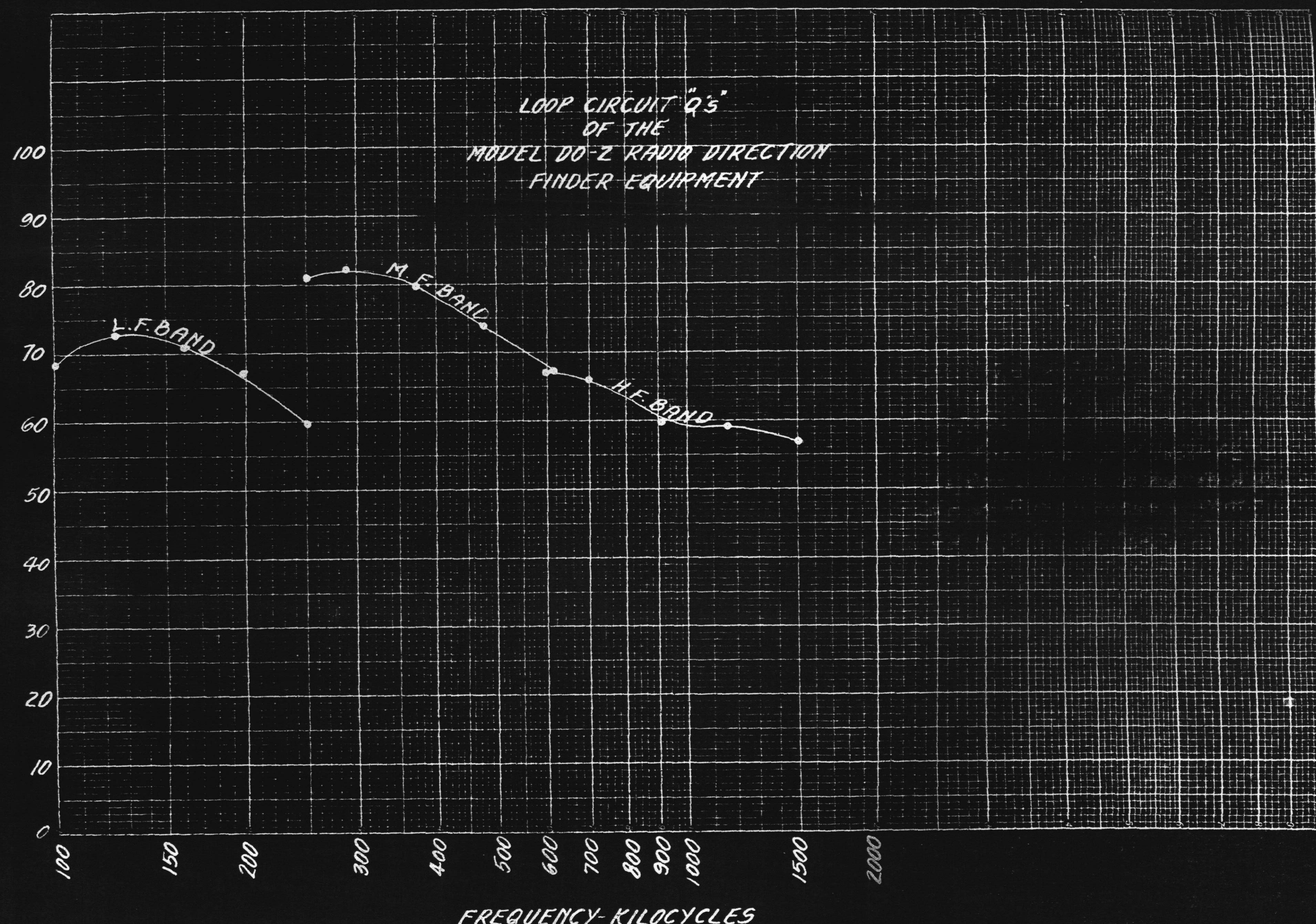

LOOP CIRCUIT "Q's"
OF THE
MODEL DO-Z RADIO DIRECTION
FINDER EQUIPMENT
L.F. BAND
M.F. BAND
H.F. BAND
LOOP CIRCUIT "Q"
FREQUENCY-KILOCYCLES
100
90
80
70
60
50
40
30
20
10
0
100
150
200
300
400
500
600
700
800
900
1000
1500
2000

PLATE 10

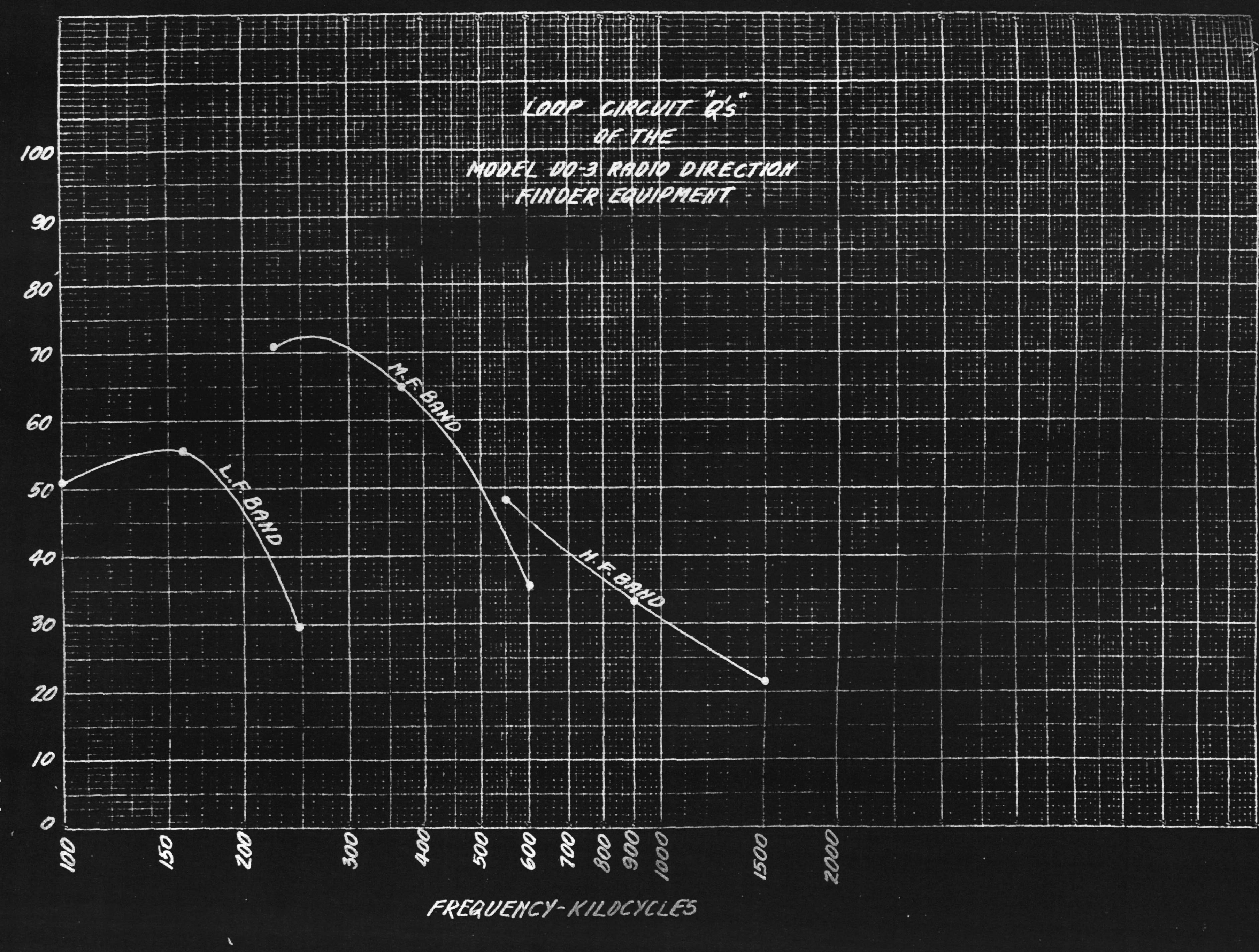

LOOP CIRCUIT "Q's"
OF THE
MODEL DO-3 RADIO DIRECTION
FINDER EQUIPMENT
LOOP CIRCUIT "Q"
0
10
20
30
40
50
60
70
80
90
100
L.F. BAND
M.F. BAND
H.F. BAND
100
150
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY-KILOCYCLES

PLATE 11

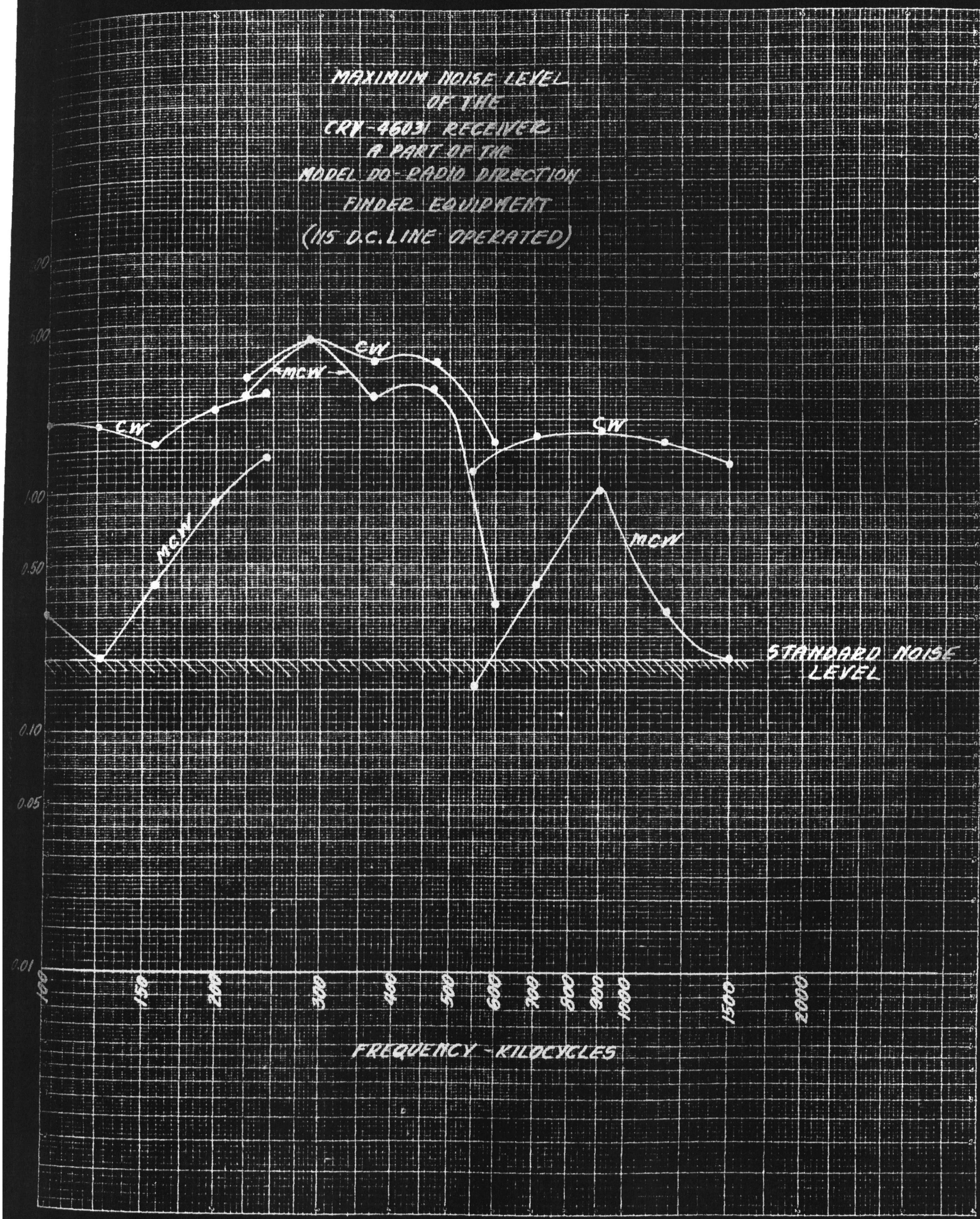
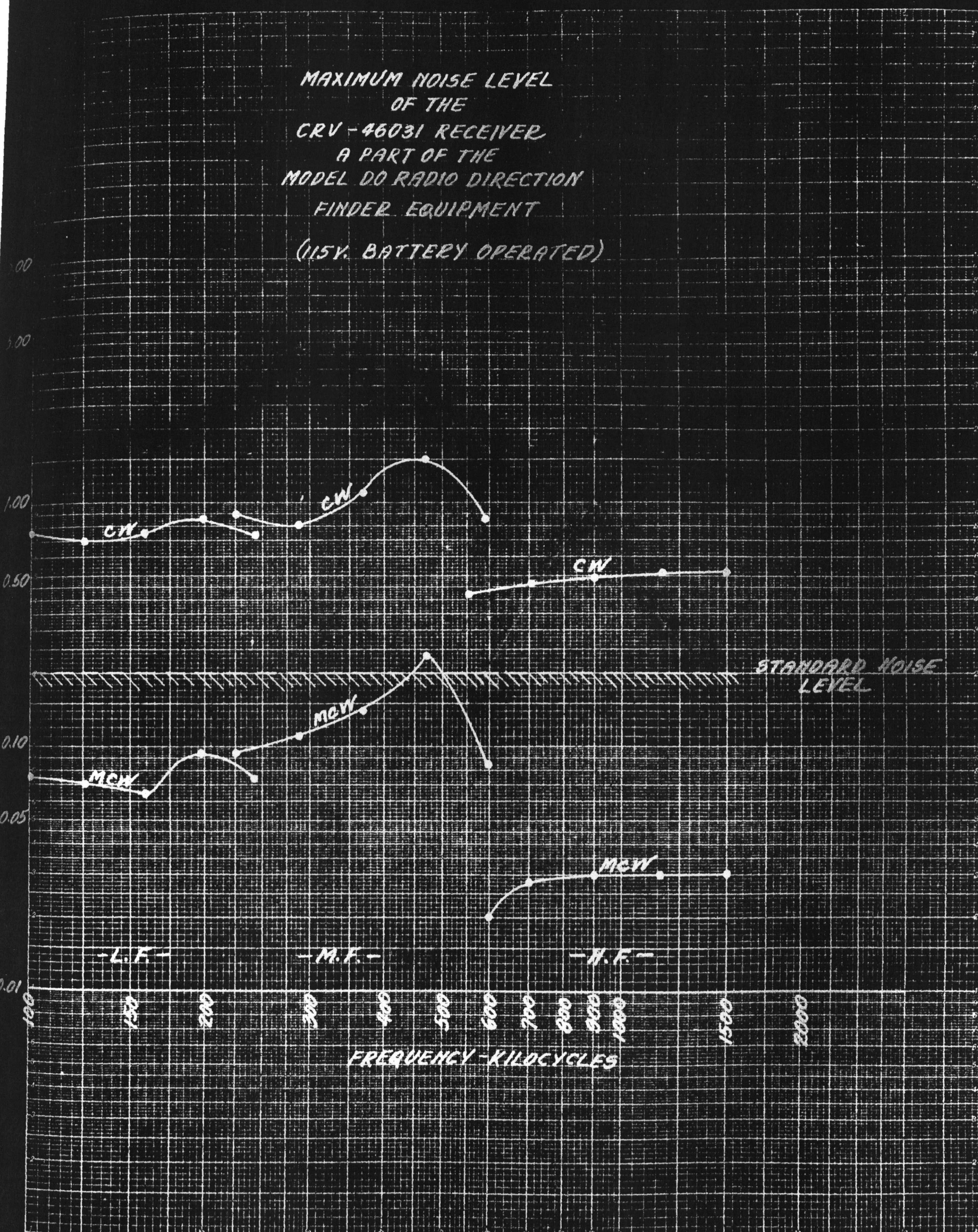
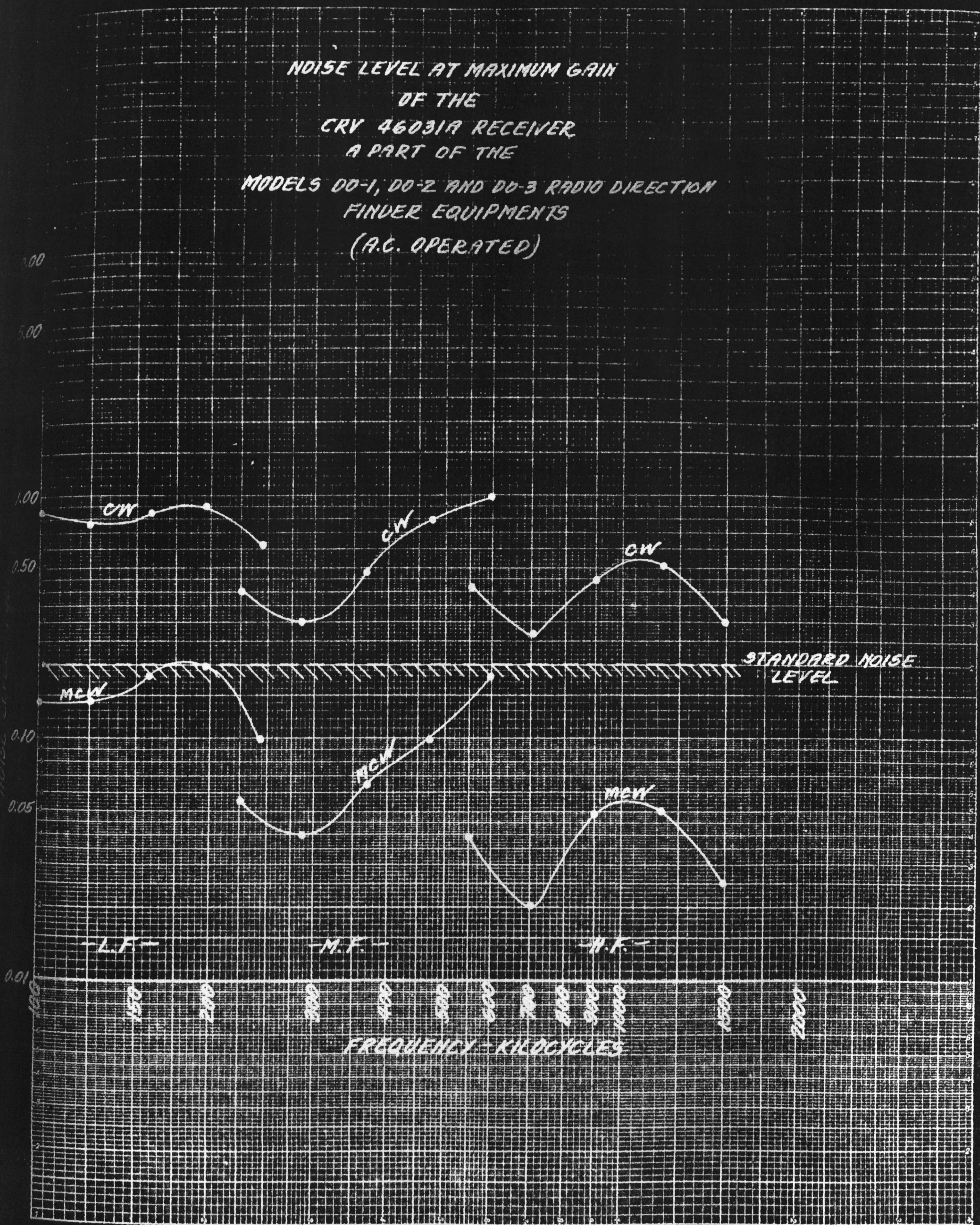

MAXIMUM NOISE LEVEL
OF THE
CRV-46031 RECEIVER
A PART OF THE
MODEL DO - RADIO DIRECTION
FINDER EQUIPMENT
(115 D.C. LINE OPERATED)
CW
MCW
STANDARD NOISE LEVEL
10.00
5.00
1.00
0.50
0.10
0.05
0.01
100
150
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY - KILOCYCLES

PLATE 12



MAXIMUM NOISE LEVEL
OF THE
CRV-46031 RECEIVER
A PART OF THE
MODEL DO RADIO DIRECTION
FINDER EQUIPMENT
(115V. BATTERY OPERATED)
1.00
0.50
0.10
0.05
0.01
CW
CW
CW
STANDARD NOISE LEVEL
MCW
MCW
MCW
-L.F.-
-M.F.-
-H.F.-
100
150
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY-KILOCYCLES

PLATE 13


NOISE LEVEL AT MAXIMUM GAIN
OF THE
CRV 46031A RECEIVER
A PART OF THE
MODELS DO-1, DO-2 AND DO-3 RADIO DIRECTION
FINDER EQUIPMENTS
(A.C. OPERATED)
1.00
0.50
0.10
0.05
0.01
CW
MCW
STANDARD NOISE
LEVEL
-L.F.-
-M.F.-
-H.F.-
100
150
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY - KILOCYCLES

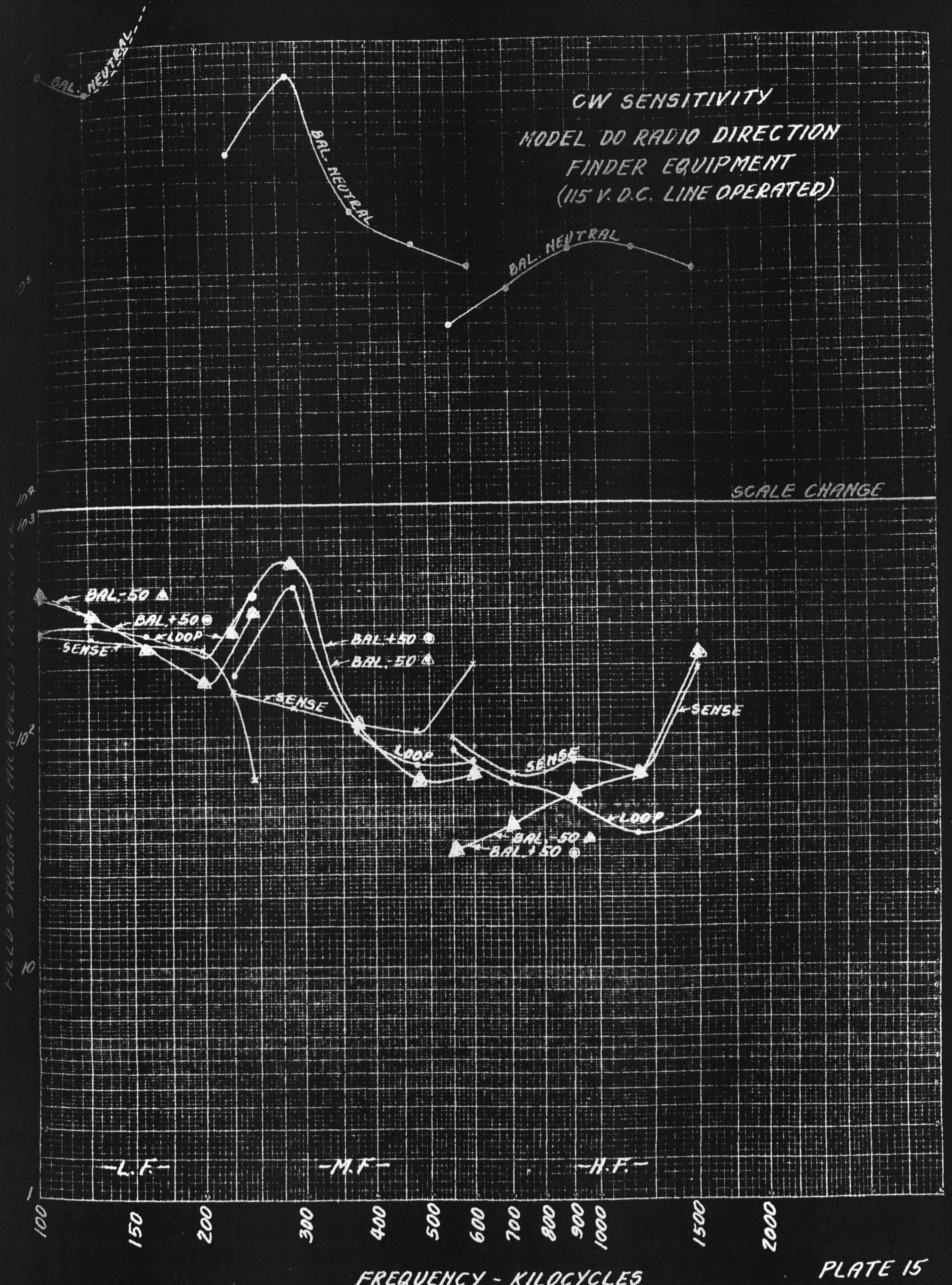
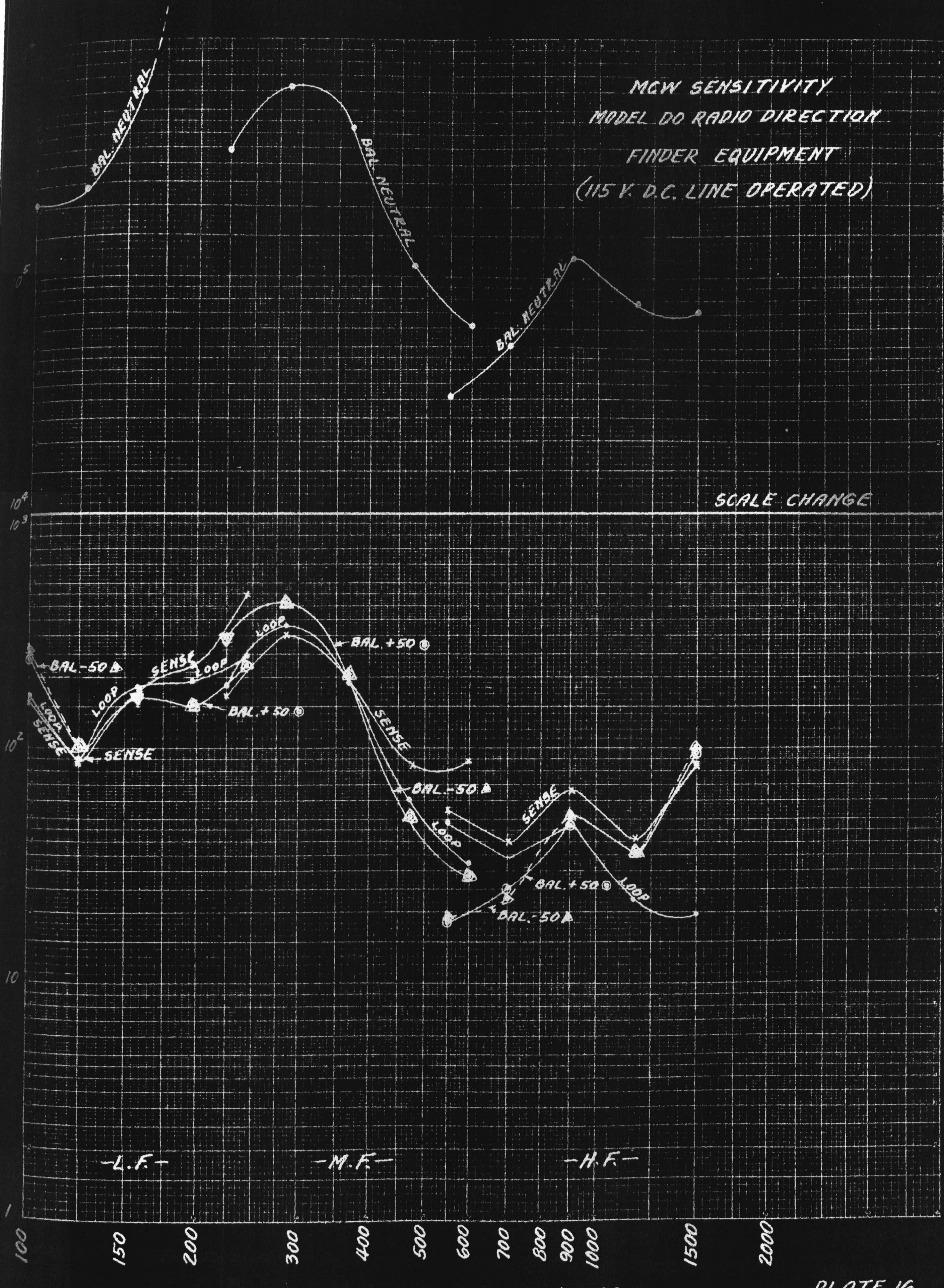

CW SENSITIVITY
MODEL DO RADIO DIRECTION
FINDER EQUIPMENT
(115 V. D.C. LINE OPERATED)
BAL. NEUTRAL
SCALE CHANGE
BAL.-50
BAL.+50
LOOP
SENSE
10³
10²
10
1
100
150
200
300
400
500
600
700
800
900
1000
1500
2000
-L.F.-
-M.F.-
-H.F.-
FIELD STRENGTH MICROVOLTS PER METER
FREQUENCY - KILOCYCLES

PLATE 15



MCW SENSITIVITY
MODEL DO RADIO DIRECTION
FINDER EQUIPMENT
(115 V. D.C. LINE OPERATED)
BAL. NEUTRAL
BAL. NEUTRAL
BAL. NEUTRAL
SCALE CHANGE
BAL.-50
SENSE
LOOP
LOOP
SENSE
BAL. +50
BAL. +50
SENSE
BAL.-50
LOOP
SENSE
BAL. +50
LOOP
BAL.-50
-L.F.-
-M.F.-
-H.F.-
10^5
10^4
10^3
10^2
10
1
100
150
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY-KILOCYCLES

PLATE 16

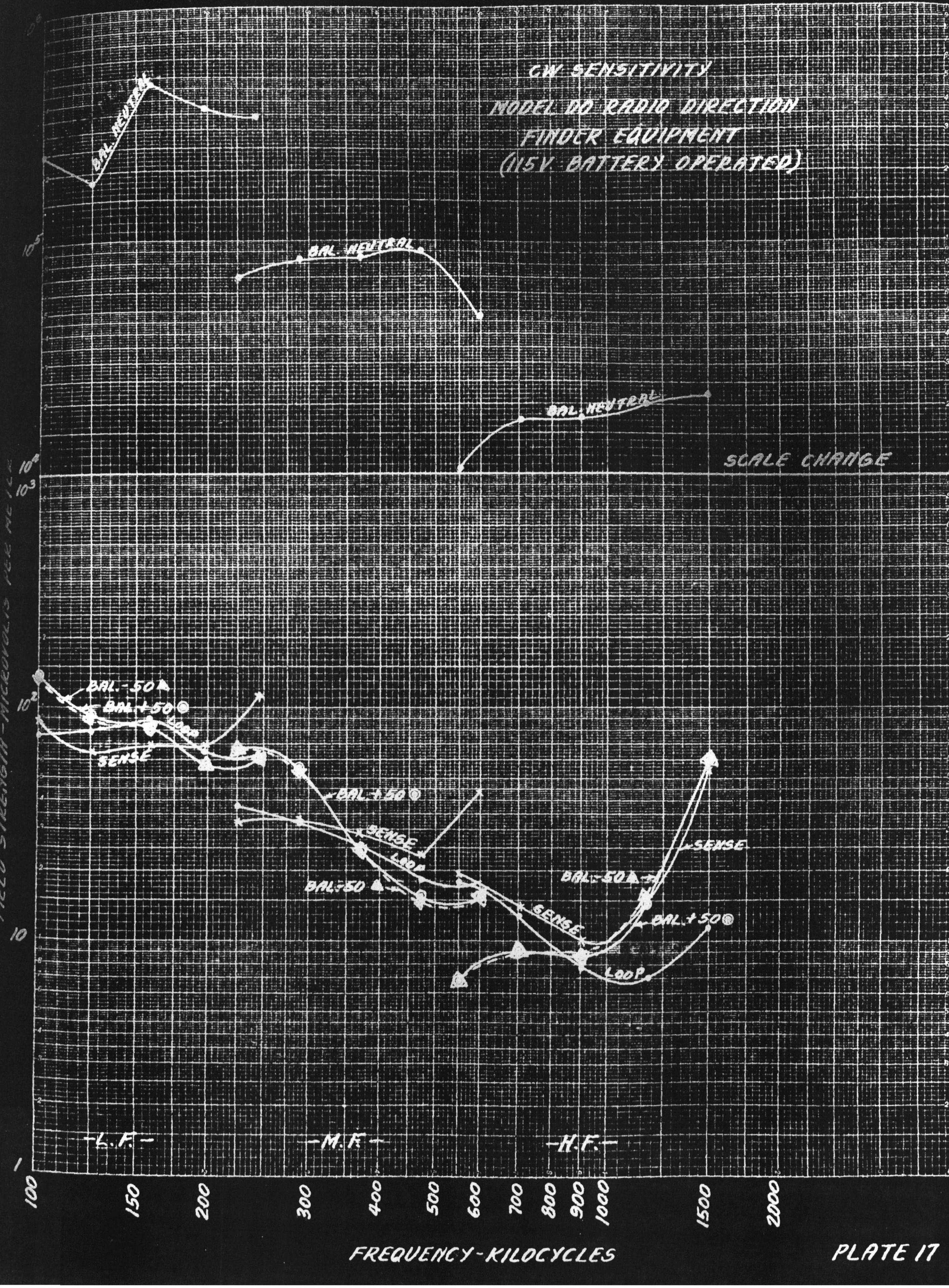
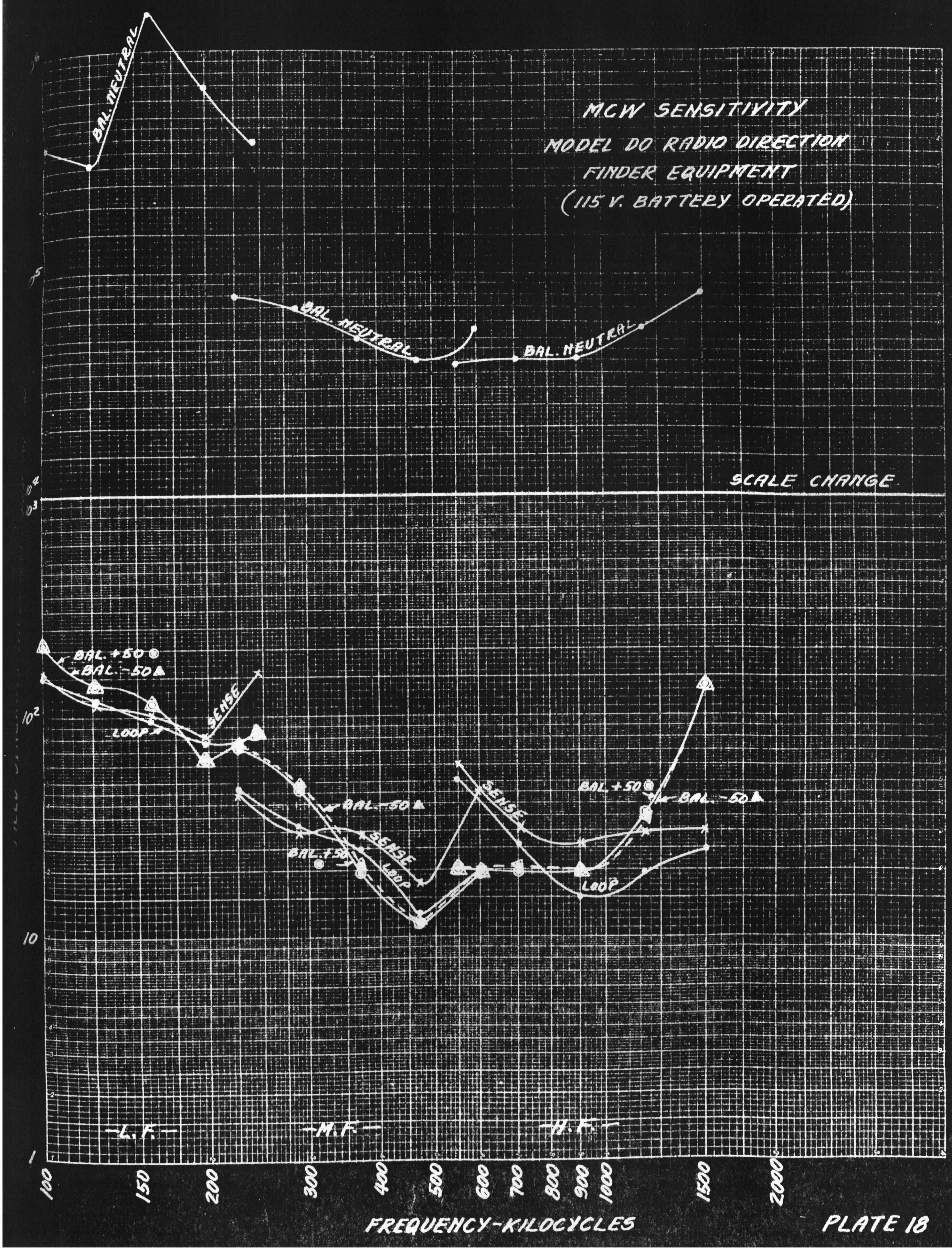

CW SENSITIVITY
MODEL DO RADIO DIRECTION
FINDER EQUIPMENT
(115V. BATTERY OPERATED)
BAL. NEUTRAL
BAL. NEUTRAL
BAL. NEUTRAL
SCALE CHANGE
BAL.-50
BAL.+50
LOOP
SENSE
BAL.+50
SENSE
LOOP
BAL.-50
SENSE
BAL.-50
SENSE
BAL.+50
LOOP
-L.F.-
-M.F.-
-H.F.-
FIELD STRENGTH-MICROVOLTS PER METER
FREQUENCY-KILOCYCLES
100
150
200
300
400
500
600
700
800
900
1000
1500
2000

PLATE 17



MCW SENSITIVITY
MODEL DO RADIO DIRECTION
FINDER EQUIPMENT
(115 V. BATTERY OPERATED)
BAL. NEUTRAL
BAL. NEUTRAL
BAL. NEUTRAL
SCALE CHANGE
BAL. +50
BAL. -50
LOOP
SENSE
BAL. -50
SENSE
BAL. +50
LOOP
SENSE
BAL. +50
BAL. -50
LOOP
-L.F.-
-M.F.-
-H.F.-
1
10
10²
10³
10⁴
10⁵
10⁶
100
150
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY-KILOCYCLES

PLATE 18

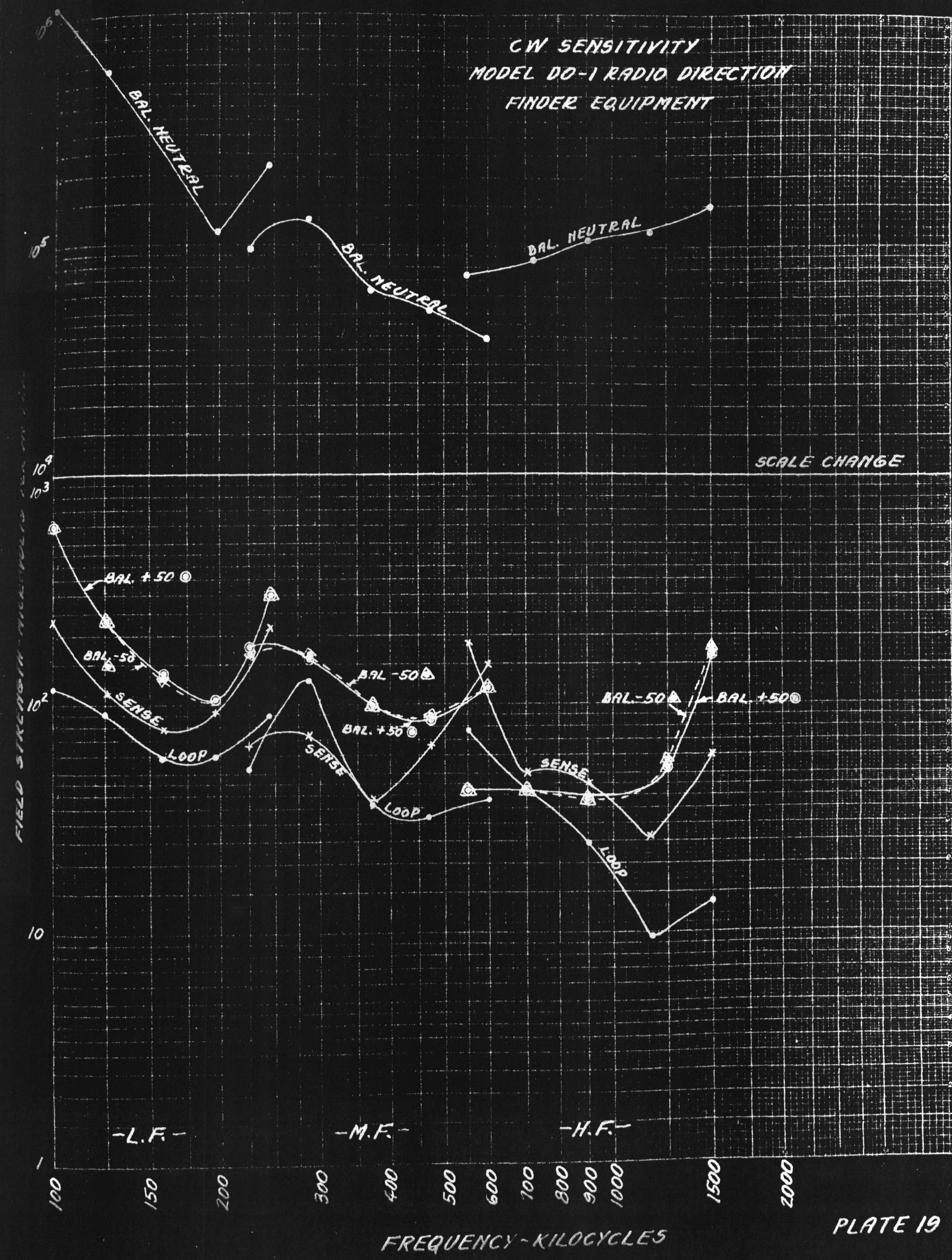

CW SENSITIVITY
MODEL DO-1 RADIO DIRECTION
FINDER EQUIPMENT
BAL. NEUTRAL
BAL. NEUTRAL
BAL. NEUTRAL
SCALE CHANGE
BAL. +50
BAL.-50
SENSE
LOOP
BAL.-50
BAL. +50
SENSE
LOOP
BAL.-50
BAL.+50
SENSE
LOOP
-L.F.-
-M.F.-
-H.F.-
FIELD STRENGTH-MICROVOLTS PER METER
FREQUENCY-KILOCYCLES
100
150
200
300
400
500
600
700
800
900
1000
1500
2000

PLATE 19

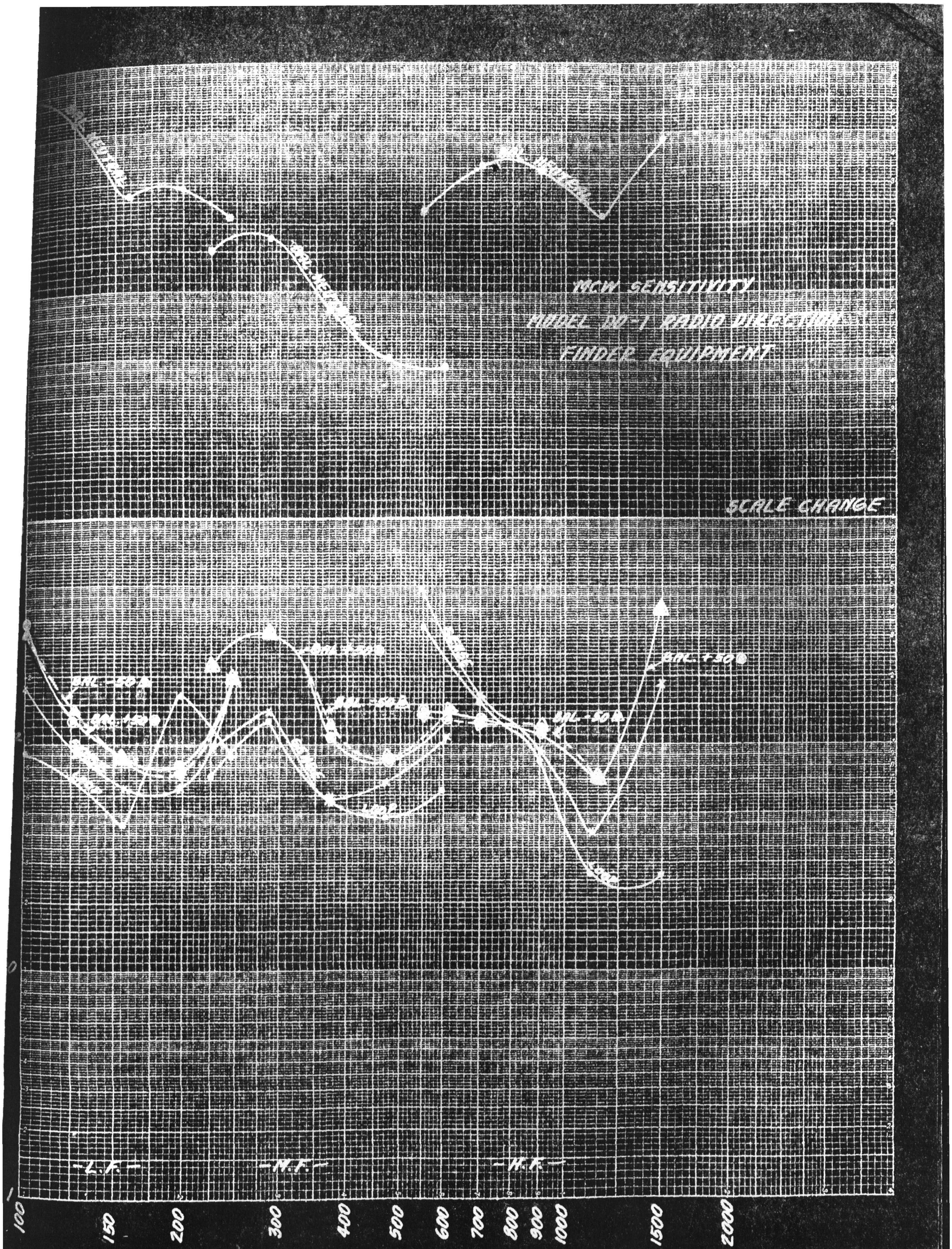
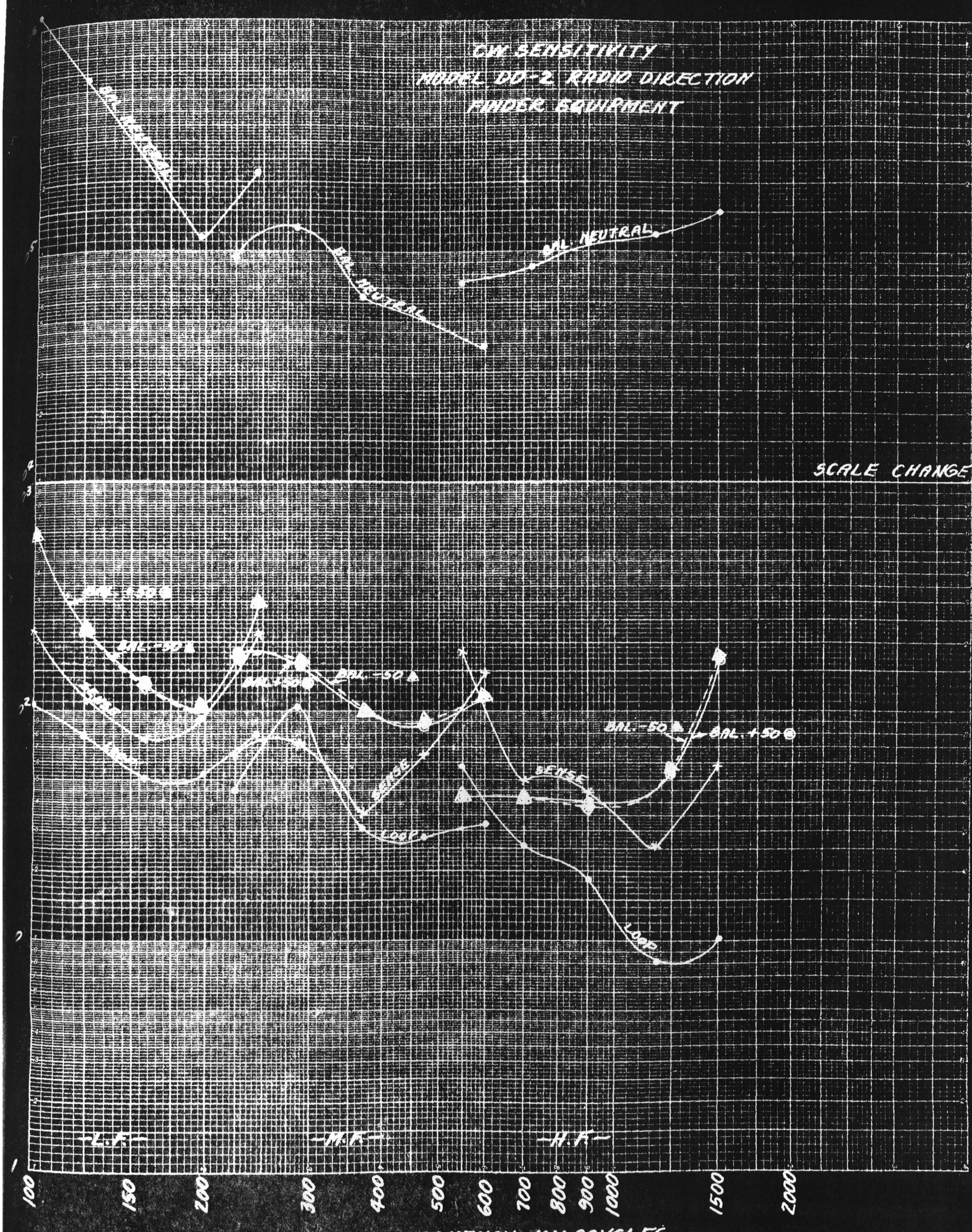
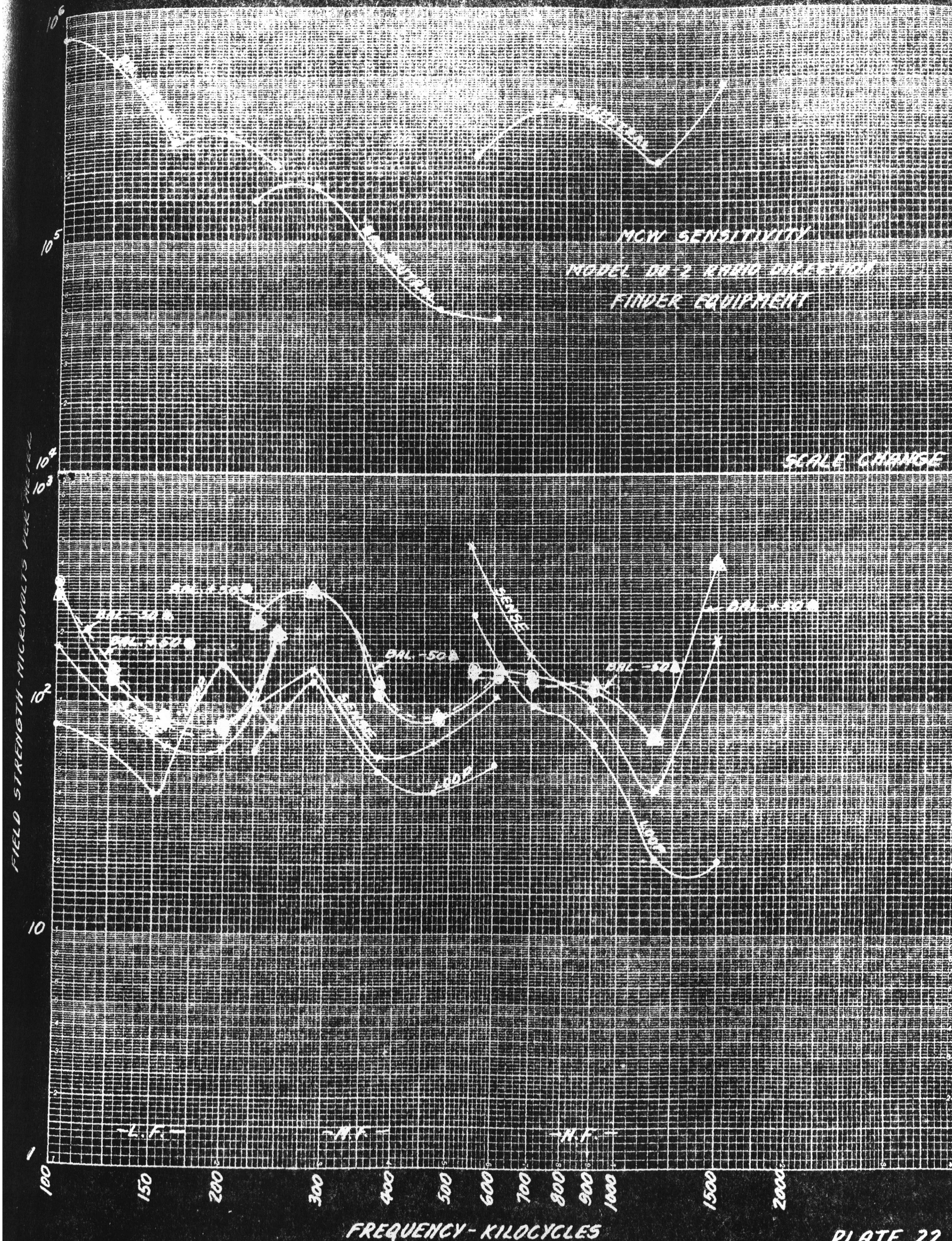

MCW SENSITIVITY
MODEL DO-1 RADIO DIRECTION
FINDER EQUIPMENT
SCALE CHANGE
BAL. NEUTRAL
BAL. +50
BAL. -50
-L.F.-
-M.F.-
-H.F.-
100
150
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY-KILOCYCLES

PLATE 20



CW SENSITIVITY
MODEL DO-2 RADIO DIRECTION
FINDER EQUIPMENT
BAL. NEUTRAL
BAL. NEUTRAL
BAL. NEUTRAL
SCALE CHANGE
BAL. +50
BAL. -50
BAL. +50
BAL. -50
SENSE
LOOP
SENSE
LOOP
SENSE
LOOP
BAL. -50
BAL. +50
-L.F.-
-M.F.-
-H.F.-
100
150
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY-KILOCYCLES

PLATE 21



MCW SENSITIVITY
MODEL DO-2 RADIO DIRECTION
FINDER EQUIPMENT
SCALE CHANGE
FIELD STRENGTH - MICROVOLTS PER METER
FREQUENCY - KILOCYCLES
BAL.+50
BAL.-50
SENSE
LOOP
-L.F.-
-M.F.-
-H.F.-

PLATE 22

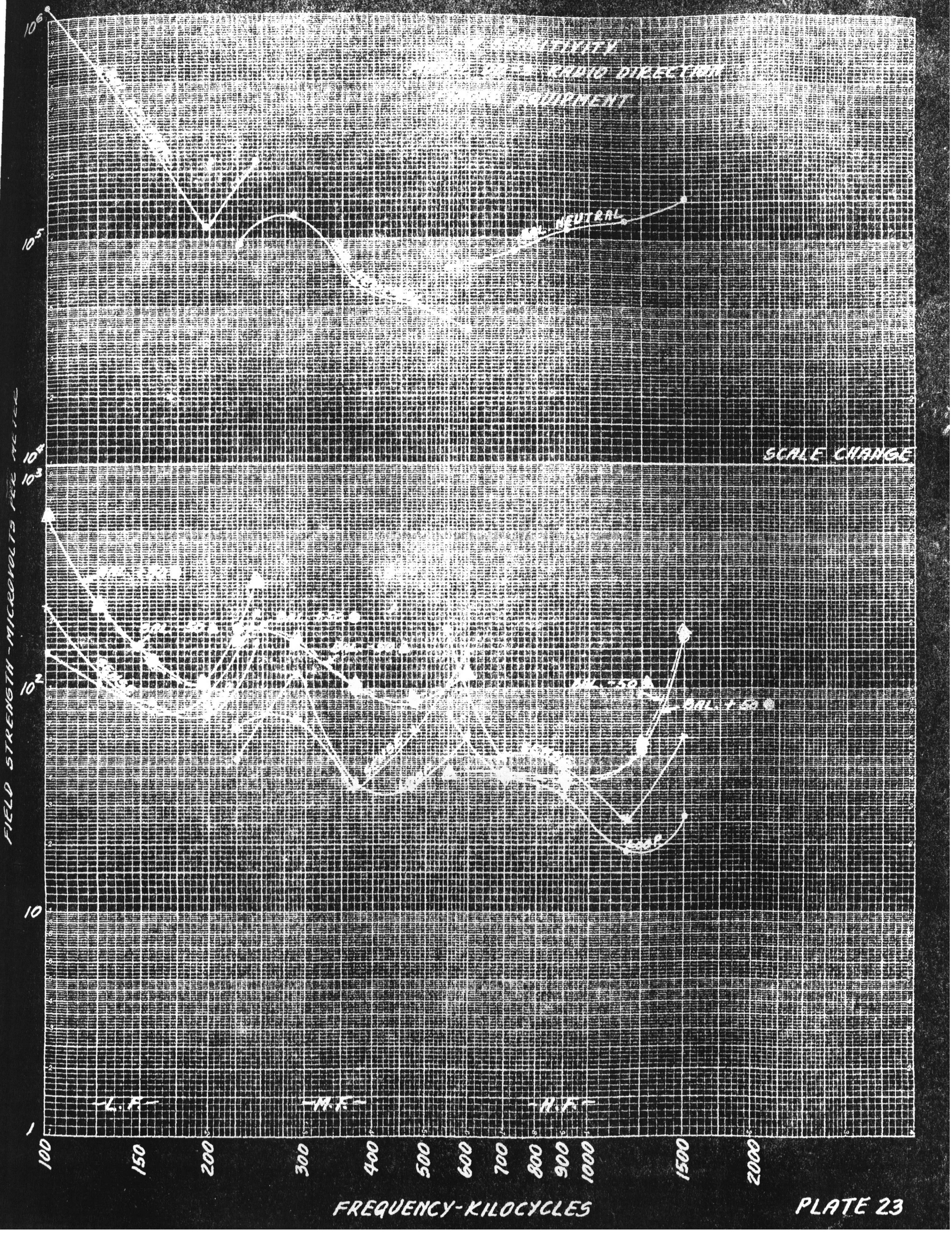

SENSITIVITY
RADIO DIRECTION
EQUIPMENT
BAL. NEUTRAL
SCALE CHANGE
BAL.-50
BAL.+50
LOOP
-L.F.-
-M.F.-
-H.F.-
FIELD STRENGTH-MICROVOLTS PER METER
100
150
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY-KILOCYCLES

PLATE 23

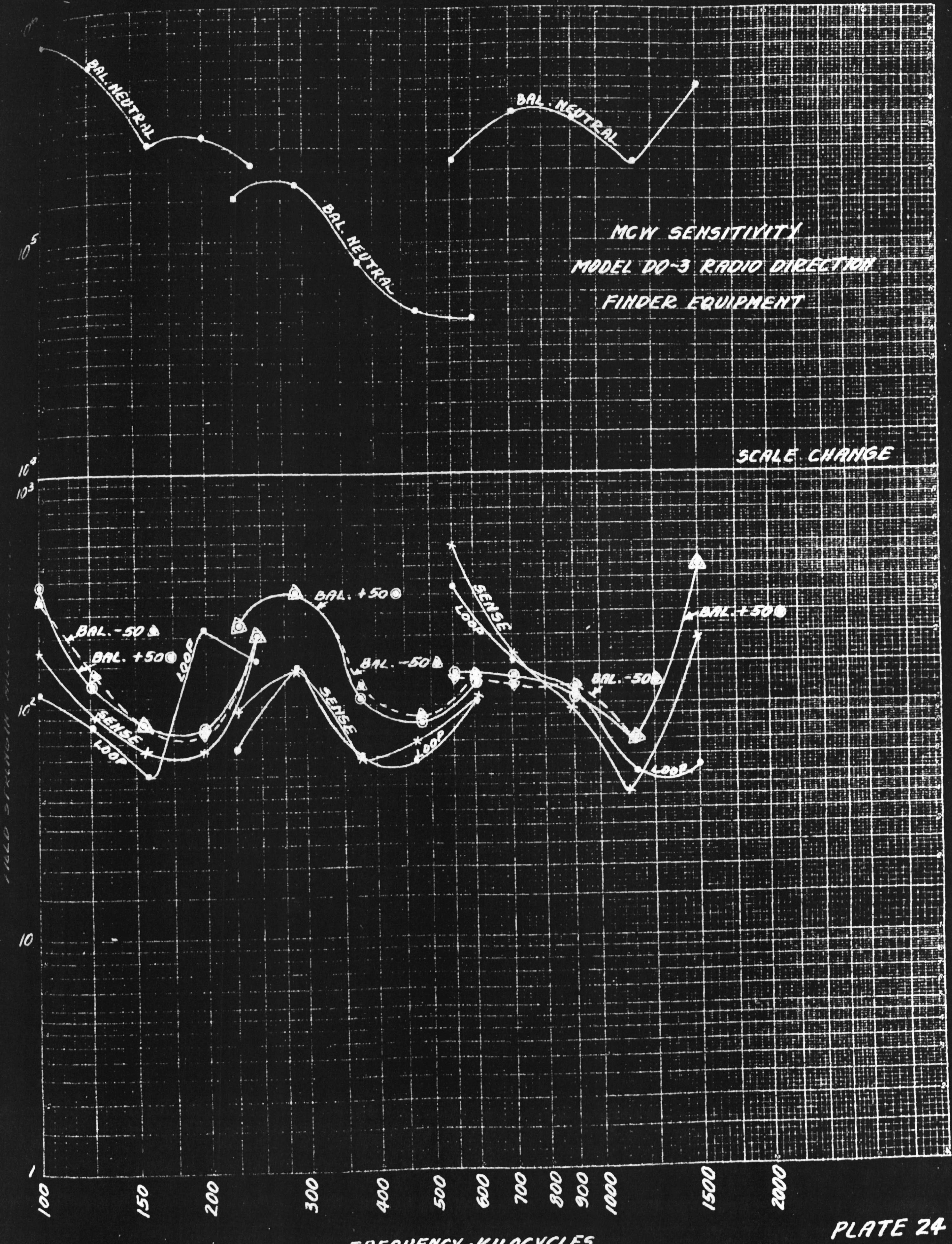

MCW SENSITIVITY
MODEL DO-3 RADIO DIRECTION
FINDER EQUIPMENT
SCALE CHANGE
BAL. NEUTRAL
BAL. NEUTRAL
BAL. NEUTRAL
BAL. +50
BAL. -50
BAL. +50
BAL. -50
BAL. +50
BAL. -50
LOOP
SENSE
LOOP
SENSE
LOOP
SENSE
LOOP
LOOP
10^5
10^4
10^3
10^2
10
1
100
150
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY-KILOCYCLES

PLATE 24

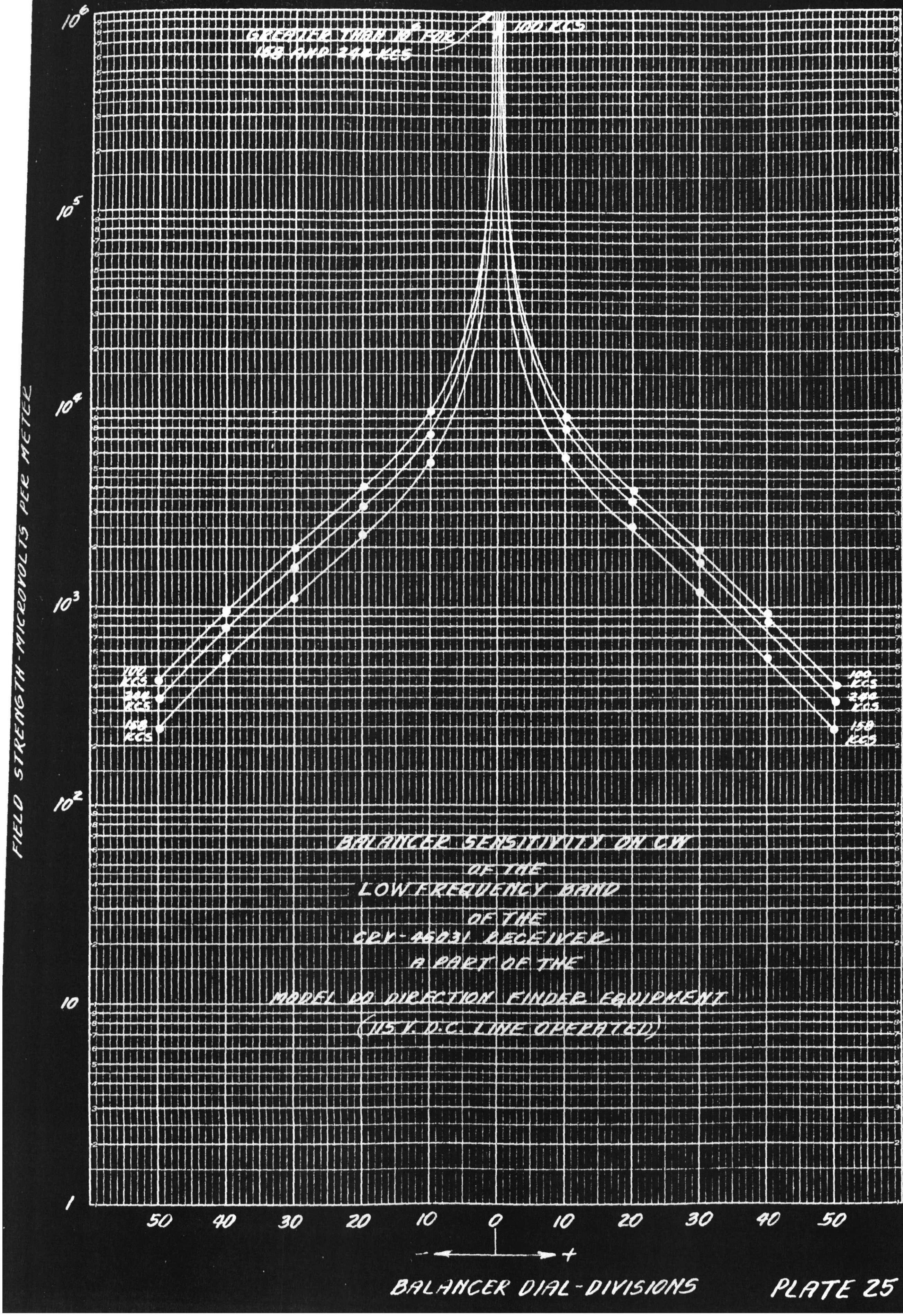
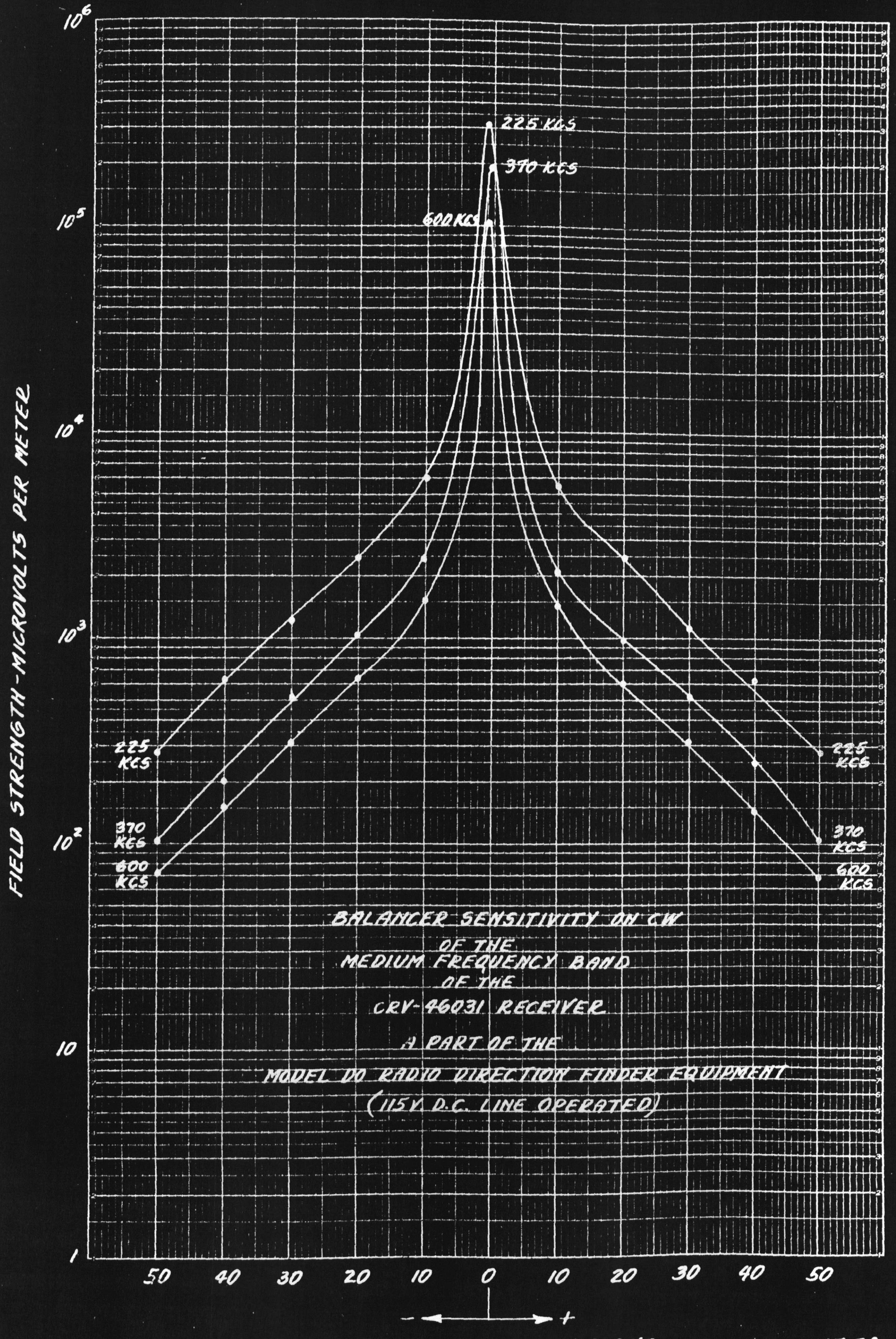

GREATER THAN 10^6 FOR 158 AND 242 KCS
100 KCS
100 KCS
242 KCS
158 KCS
BALANCER SENSITIVITY ON CW
OF THE
LOW FREQUENCY BAND
OF THE
CRV-46031 RECEIVER
A PART OF THE
MODEL DO DIRECTION FINDER EQUIPMENT
(115 V. D.C. LINE OPERATED)
FIELD STRENGTH - MICROVOLTS PER METER
10^6
10^5
10^4
10^3
10^2
10
1
50 40 30 20 10 0 10 20 30 40 50
- +
BALANCER DIAL - DIVISIONS

PLATE 25



225 KCS
370 KCS
600 KCS
FIELD STRENGTH-MICROVOLTS PER METER
10^6
10^5
10^4
10^3
10^2
10
1
50 40 30 20 10 0 10 20 30 40 50
- +
BALANCER SENSITIVITY ON CW
OF THE
MEDIUM FREQUENCY BAND
OF THE
CRV-46031 RECEIVER
A PART OF THE
MODEL DO RADIO DIRECTION FINDER EQUIPMENT
(115V. D.C. LINE OPERATED)
BALACER DIAL DIVISIONS

PLATE 26

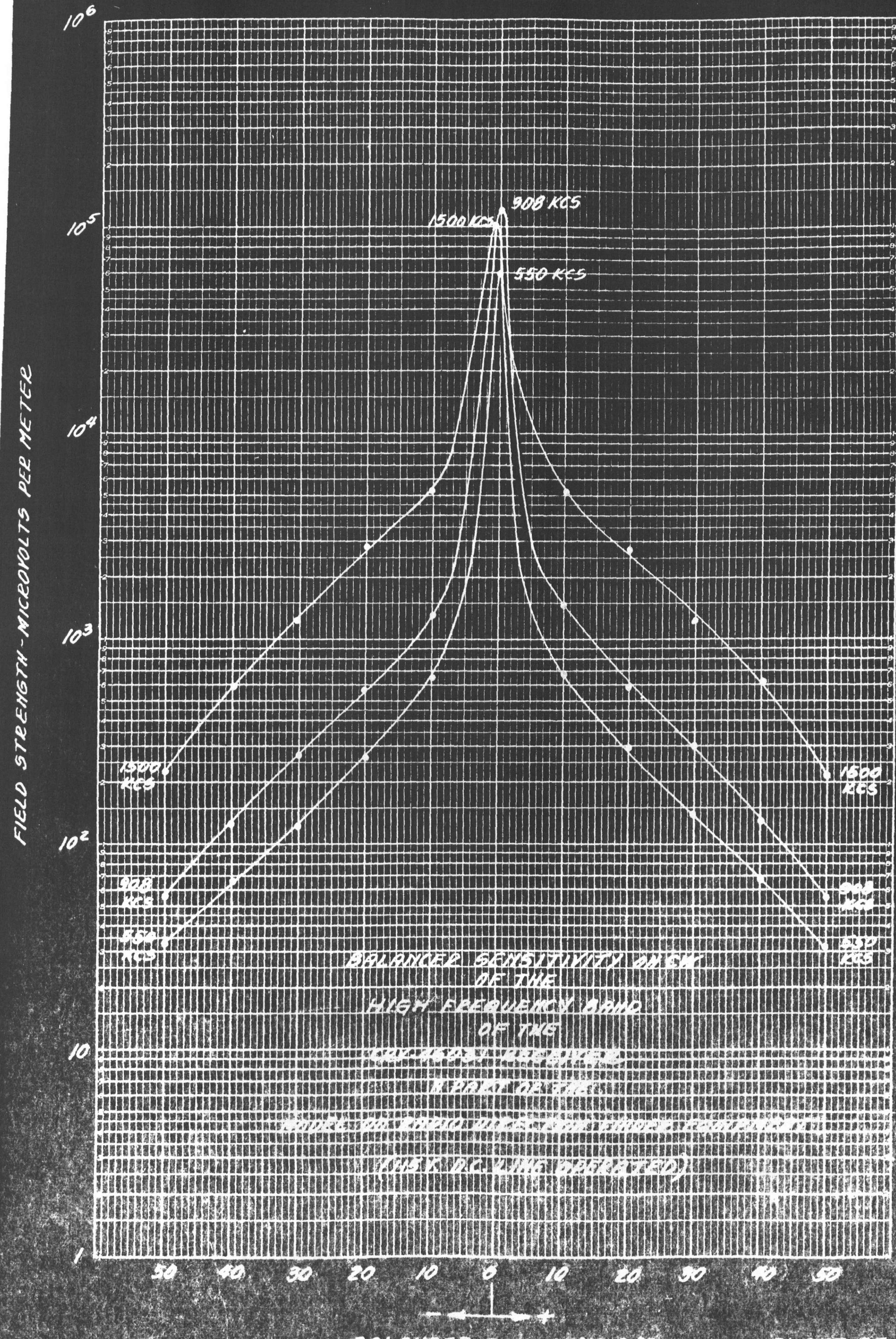

FIELD STRENGTH - MICROVOLTS PER METER
10⁶
10⁵
10⁴
10³
10²
10
1
908 KCS
1500 KCS
550 KCS
1500 KCS
908 KCS
550 KCS
OF THE
HIGH FREQUENCY BAND
OF THE
50 40 30 20 10 0 10 20 30 40 50
BALANCER DIAL DIVISIONS

PLATE 23

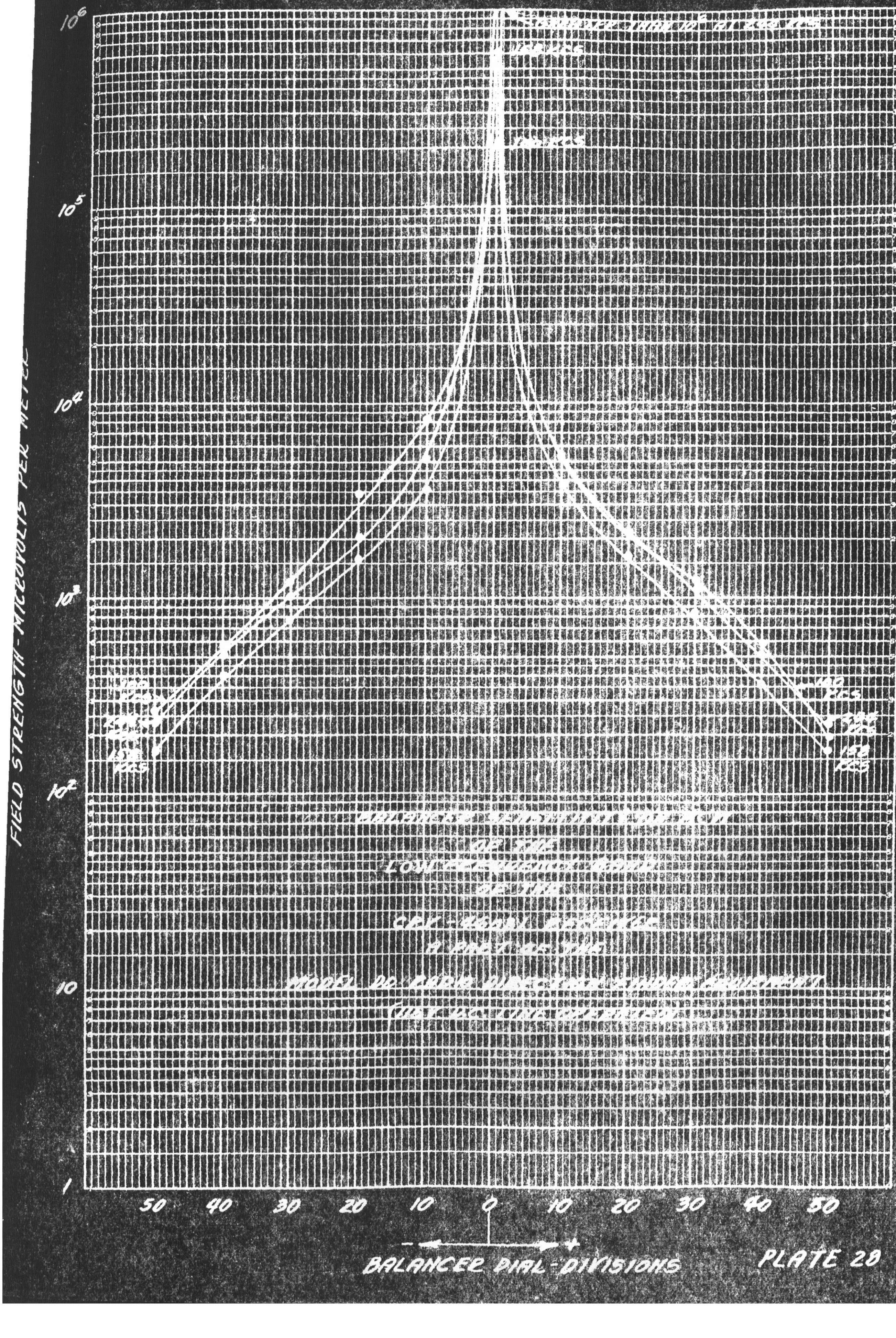

FIELD STRENGTH - MICROVOLTS PER METER
10^6
10^5
10^4
10^3
10^2
10
1
50
40
30
20
10
0
10
20
30
40
50
BALANCER DIAL-DIVISIONS

PLATE 28

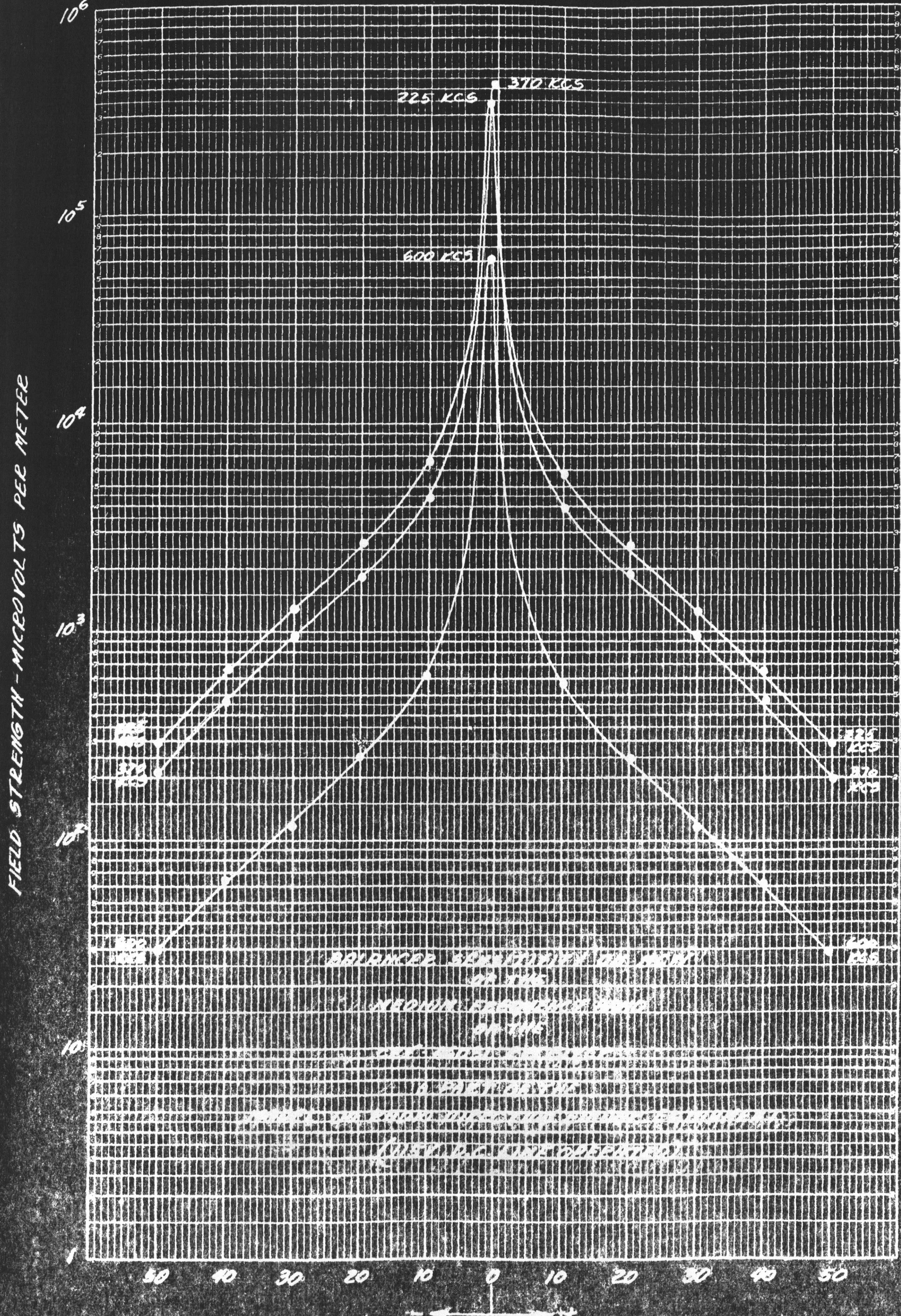

FIELD STRENGTH - MICROVOLTS PER METER
10⁶
10⁵
10⁴
10³
1
370 KCS
225 KCS
600 KCS
225 KCS
370 KCS
600 KCS
OF THE
OF THE
50
40
30
20
10
0
10
20
30
40
50
BALANCER DIAL DIVISIONS

PLATE 29

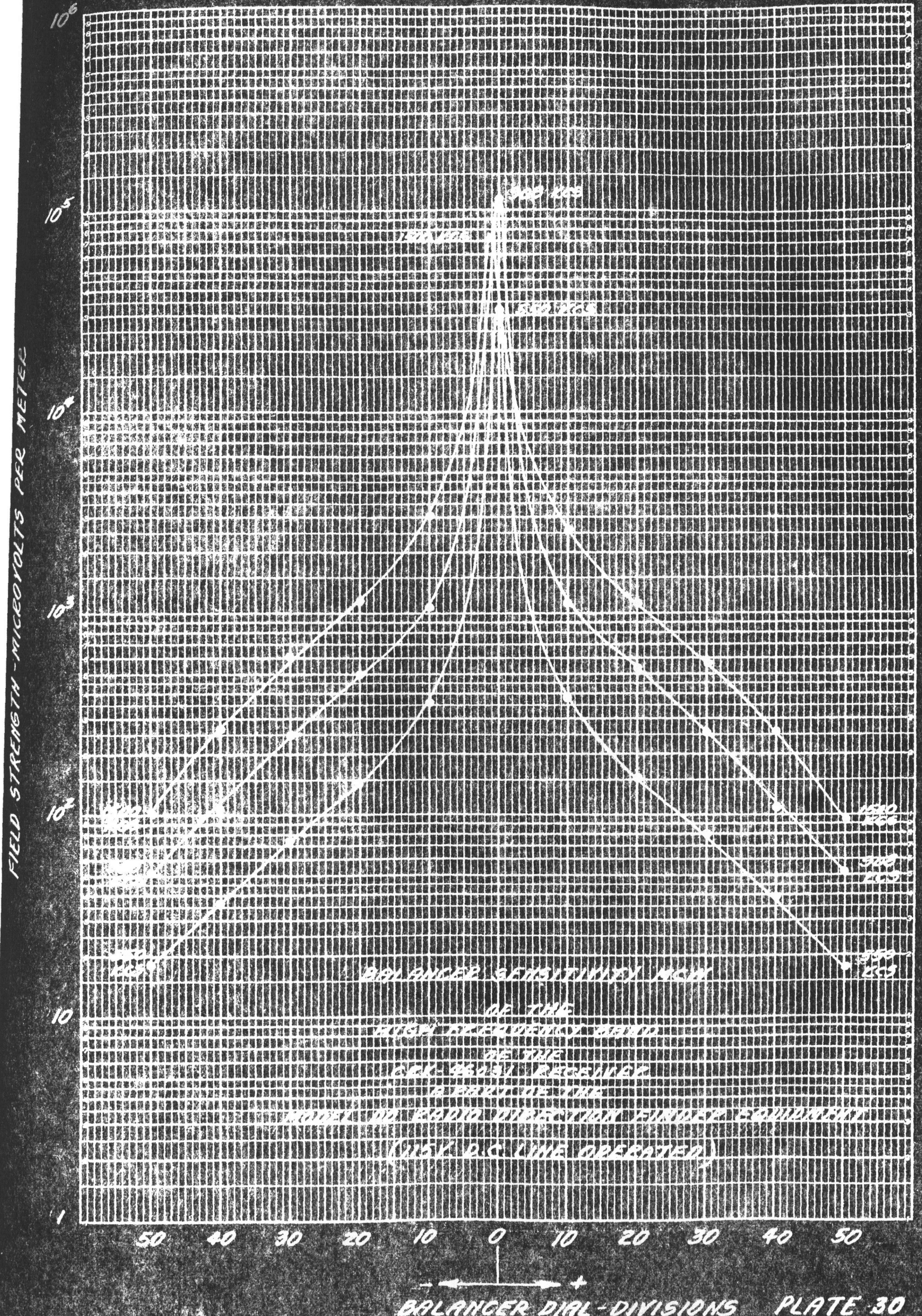
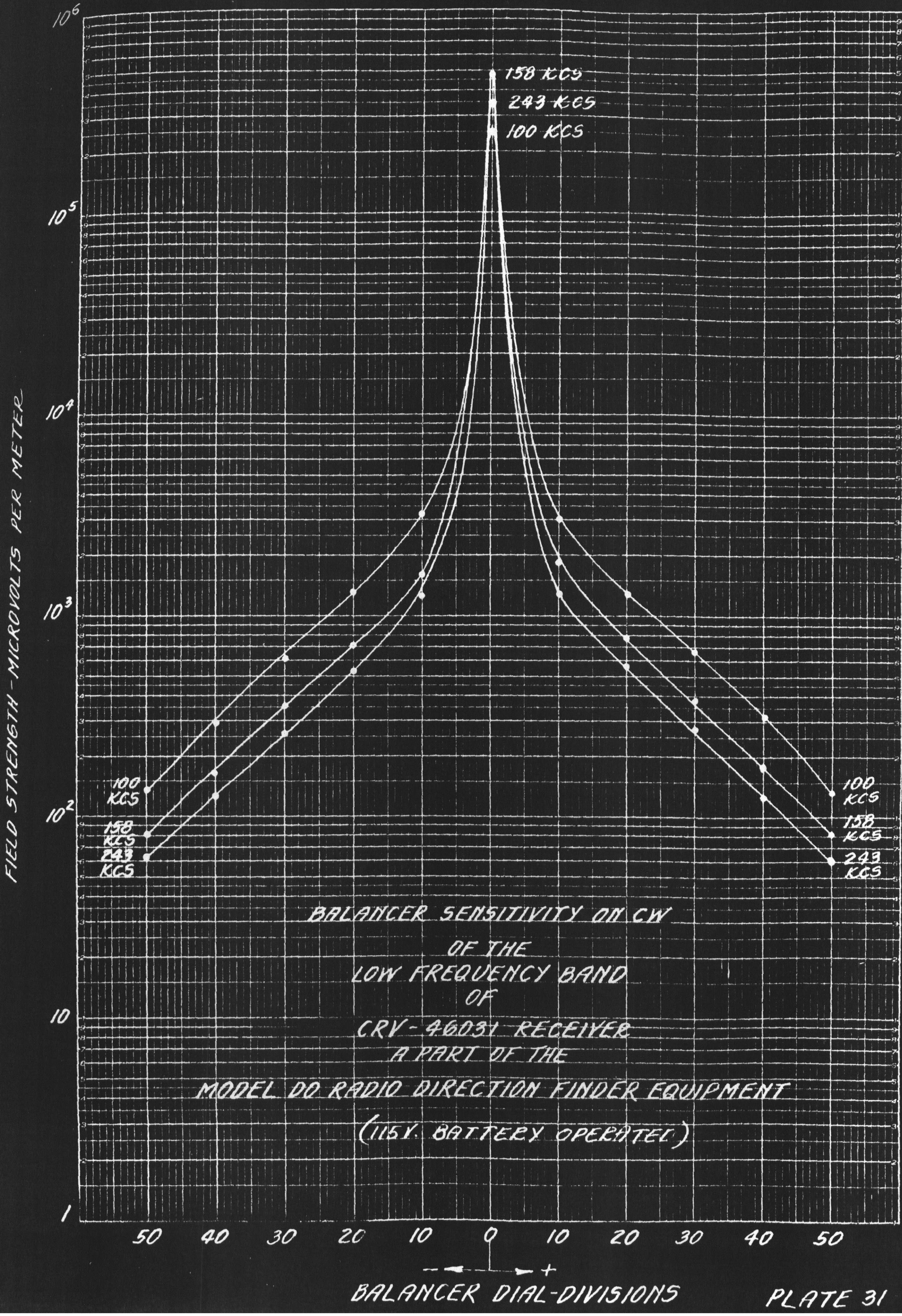
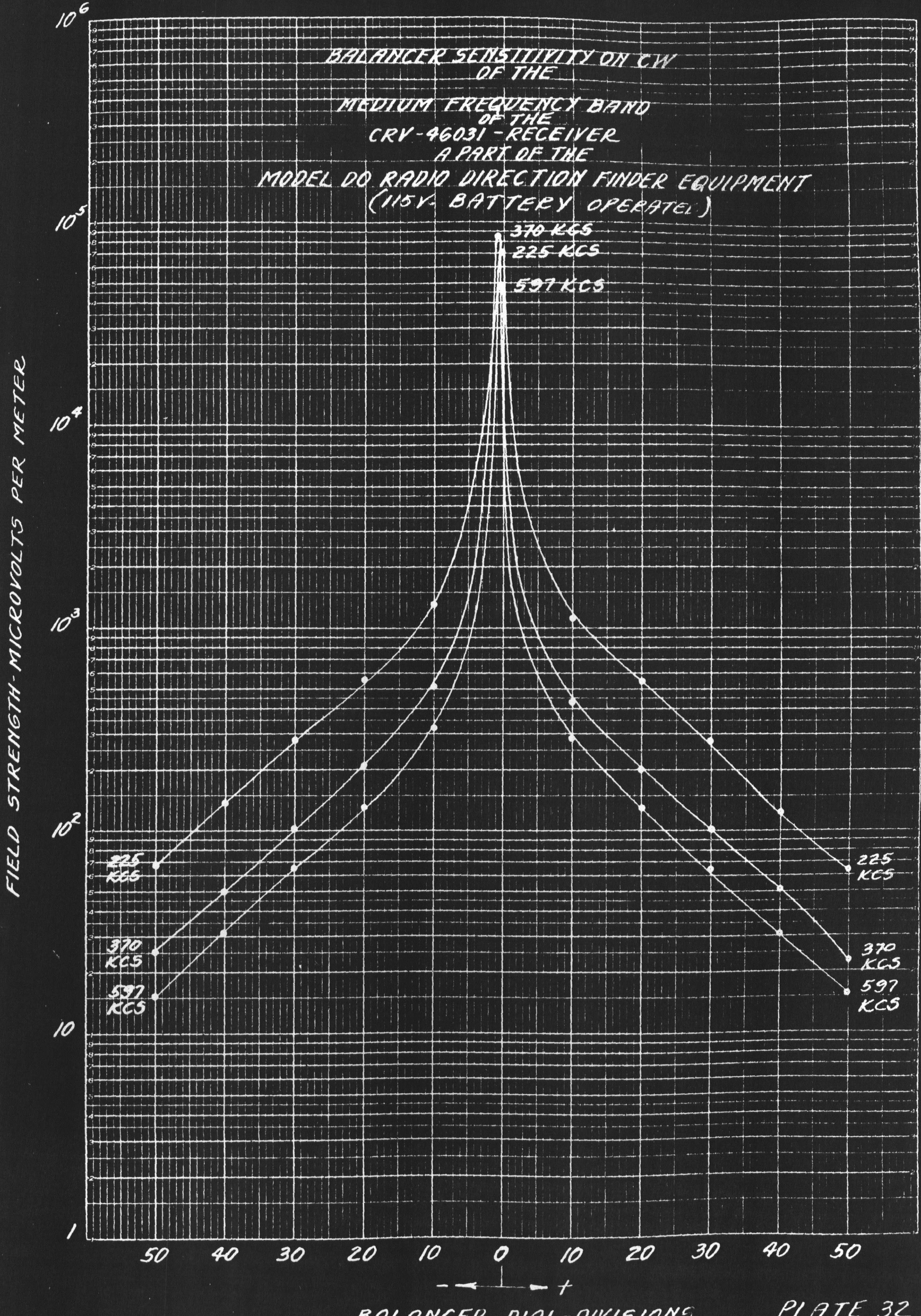

FIELD STRENGTH - MICROVOLTS PER METER
10^6
10^5
10^4
10^3
10^2
10
1
50 40 30 20 10 0 10 20 30 40 50
- +
BALANCER DIAL-DIVISIONS
BALANCER SENSITIVITY MCW
OF THE
HIGH FREQUENCY BAND
OF THE
RECEIVER
A PART OF THE
RADIO DIRECTION FINDER EQUIPMENT
(115 V. D.C. LINE OPERATED)

PLATE 30



158 KCS
243 KCS
100 KCS
100 KCS
158 KCS
243 KCS
FIELD STRENGTH - MICROVOLTS PER METER
10^6
10^5
10^4
10^3
10^2
10
1
50 40 30 20 10 0 10 20 30 40 50
- +
BALANCER SENSITIVITY ON CW
OF THE
LOW FREQUENCY BAND
OF
CRV-46031 RECEIVER
A PART OF THE
MODEL DO RADIO DIRECTION FINDER EQUIPMENT
(115V. BATTERY OPERATED)
BALANCER DIAL-DIVISIONS

PLATE 31


BALANCER SENSITIVITY ON CW
OF THE
MEDIUM FREQUENCY BAND
OF THE
CRV-46031-RECEIVER
A PART OF THE
MODEL DO RADIO DIRECTION FINDER EQUIPMENT
(115V- BATTERY OPERATED)
370 KCS
225 KCS
597 KCS
225 KCS
370 KCS
597 KCS
225 KCS
370 KCS
597 KCS
FIELD STRENGTH-MICROVOLTS PER METER
10⁶
10⁵
10⁴
10³
10²
10
1
50
40
30
20
10
0
10
20
30
40
50
- +
BALANCER DIAL-DIVISIONS
PLATE 32

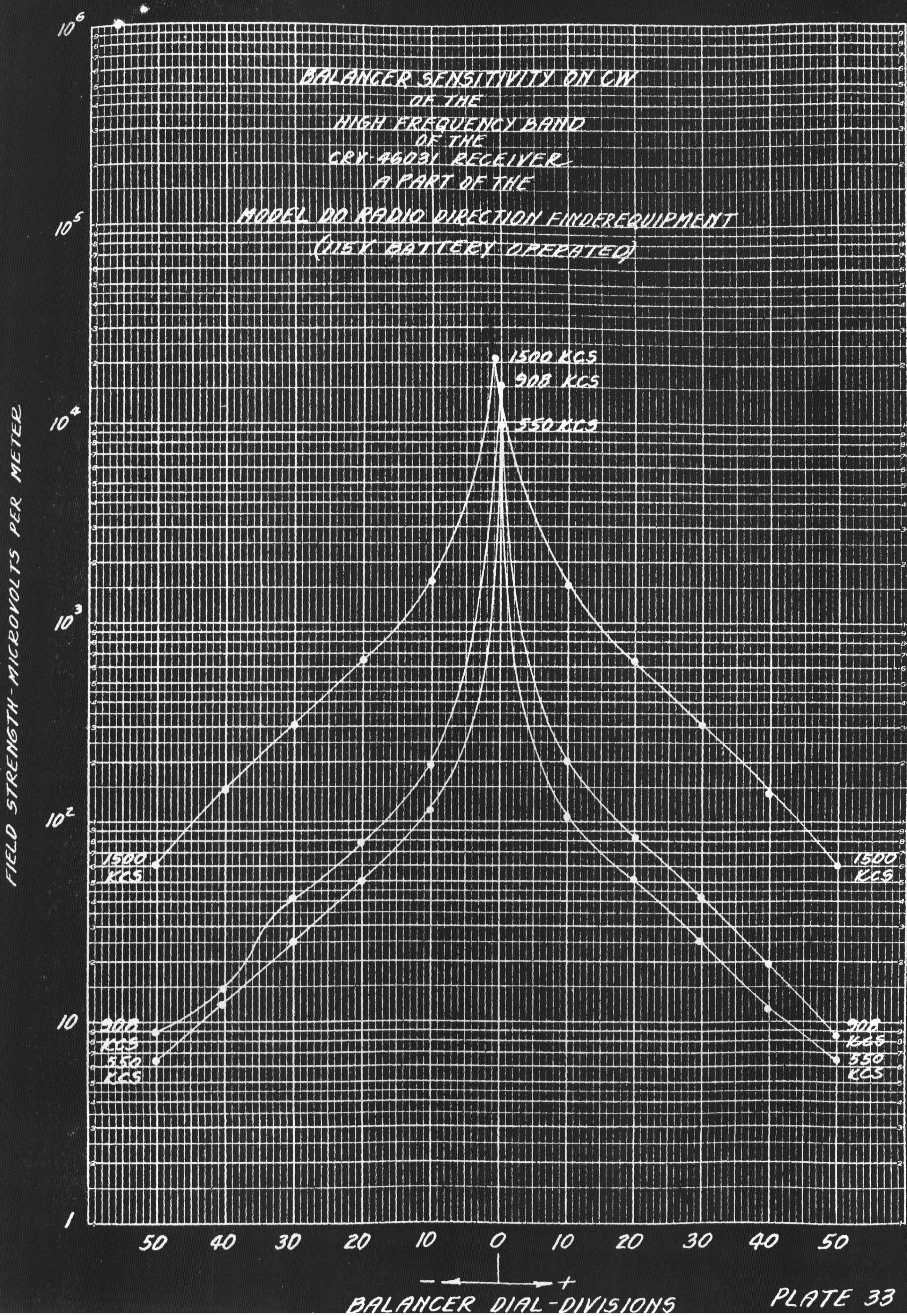
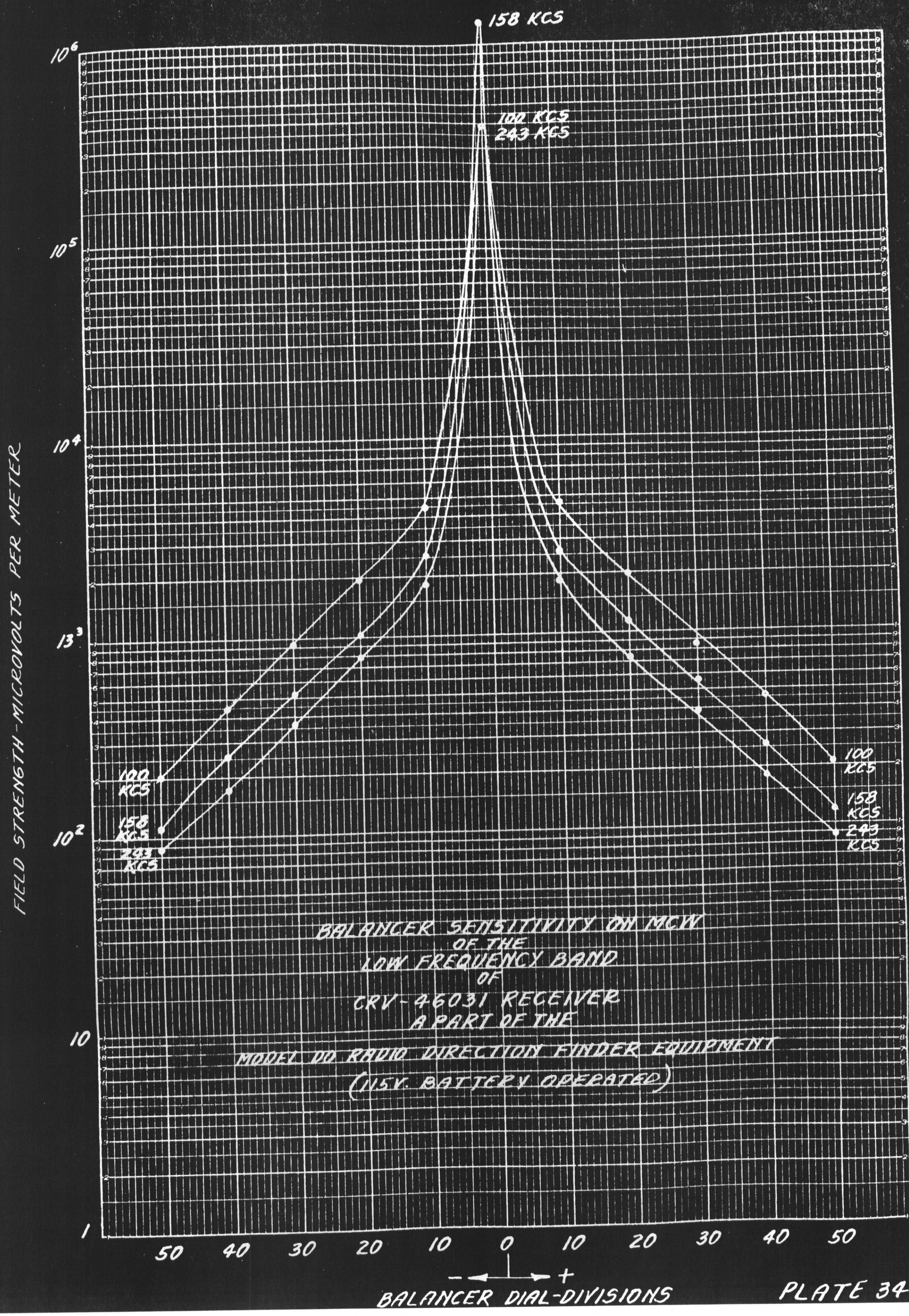
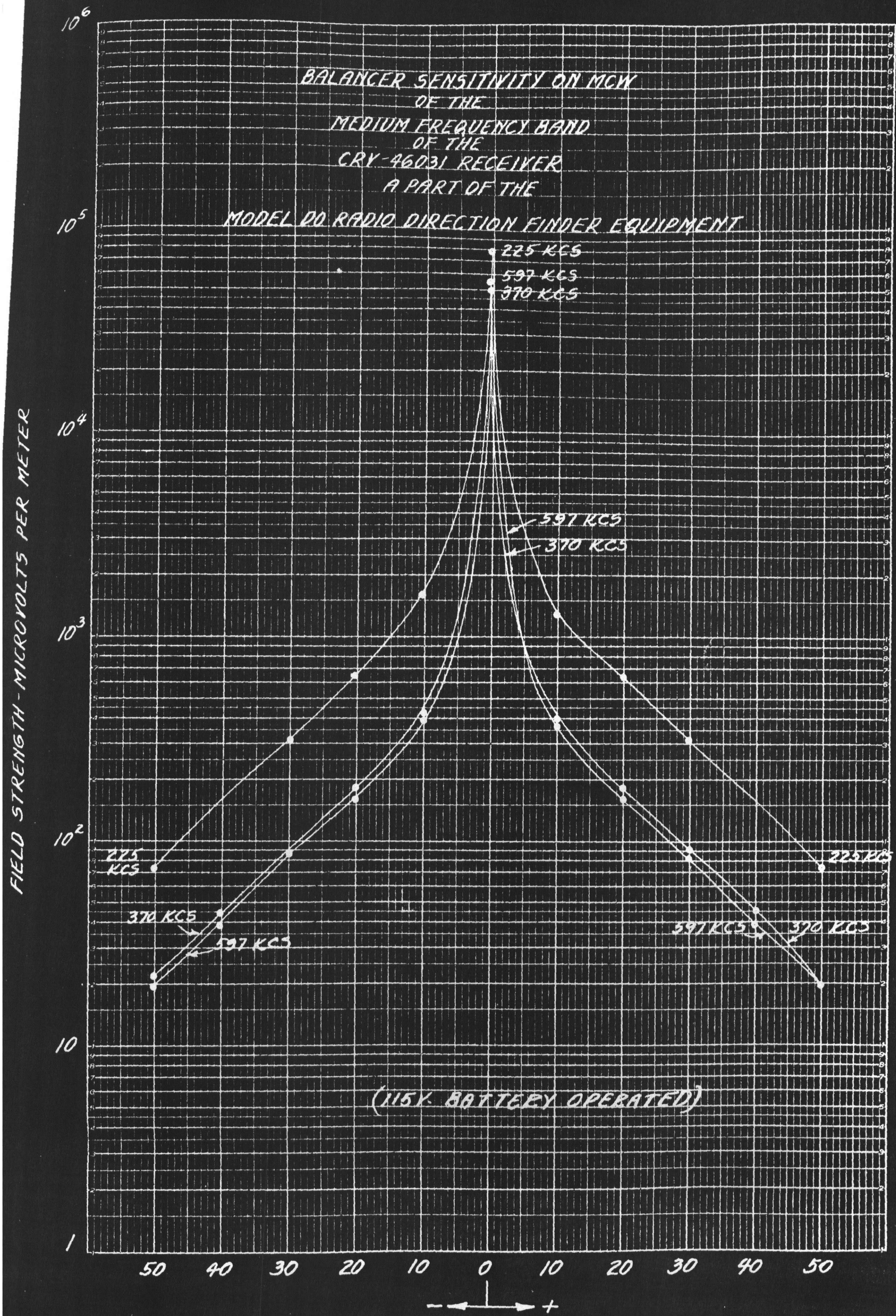

BALANCER SENSITIVITY ON CW
OF THE
HIGH FREQUENCY BAND
OF THE
CRV-46031 RECEIVER
A PART OF THE
MODEL DO RADIO DIRECTION FINDER EQUIPMENT
(115 V BATTERY OPERATED)
1500 KCS
908 KCS
550 KCS
FIELD STRENGTH - MICROVOLTS PER METER
10^6
10^5
10^4
10^3
10^2
10
1
50 40 30 20 10 0 10 20 30 40 50
- +
BALANCER DIAL-DIVISIONS

PLATE 33



158 KCS
100 KCS
243 KCS
10^6
10^5
10^4
13^3
10^2
10
1
100 KCS
158 KCS
243 KCS
BALANCER SENSITIVITY ON MCW
OF THE
LOW FREQUENCY BAND
OF
CRV-46031 RECEIVER
A PART OF THE
MODEL DO RADIO DIRECTION FINDER EQUIPMENT
(115V. BATTERY OPERATED)
FIELD STRENGTH-MICROVOLTS PER METER
50 40 30 20 10 0 10 20 30 40 50
- +
BALANCER DIAL-DIVISIONS

PLATE 34



BALANCER SENSITIVITY ON MCW
OF THE
MEDIUM FREQUENCY BAND
OF THE
CRY-46031 RECEIVER
A PART OF THE
MODEL DO RADIO DIRECTION FINDER EQUIPMENT
FIELD STRENGTH - MICROVOLTS PER METER
10^6
10^5
10^4
10^3
10^2
10
1
225 KCS
597 KCS
370 KCS
597 KCS
370 KCS
225 KCS
370 KCS
597 KCS
225 KCS
597 KCS
370 KCS
(115V. BATTERY OPERATED)
50 40 30 20 10 0 10 20 30 40 50
− +
BALANCER DIAL-DIVISIONS

PLATE 35

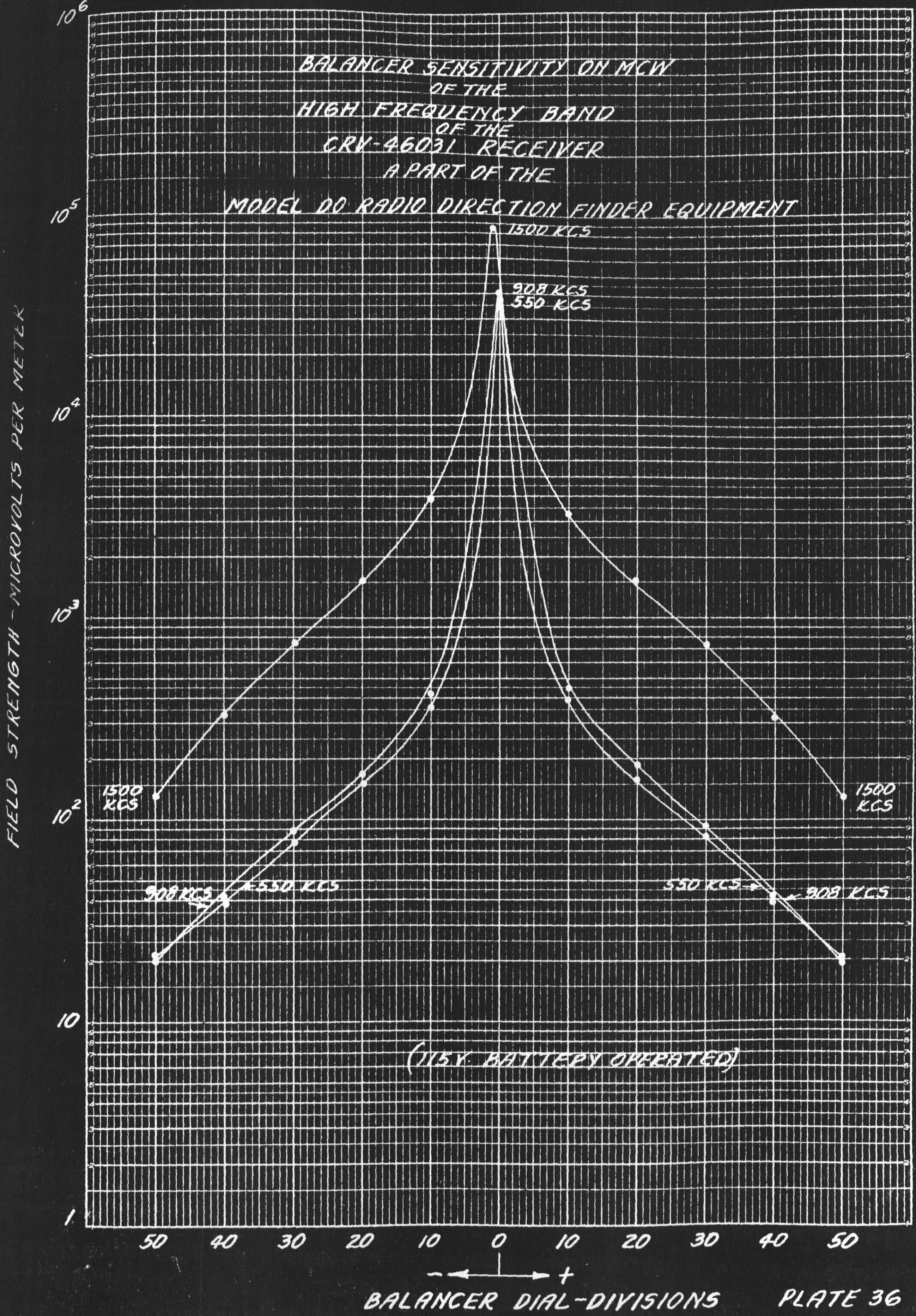
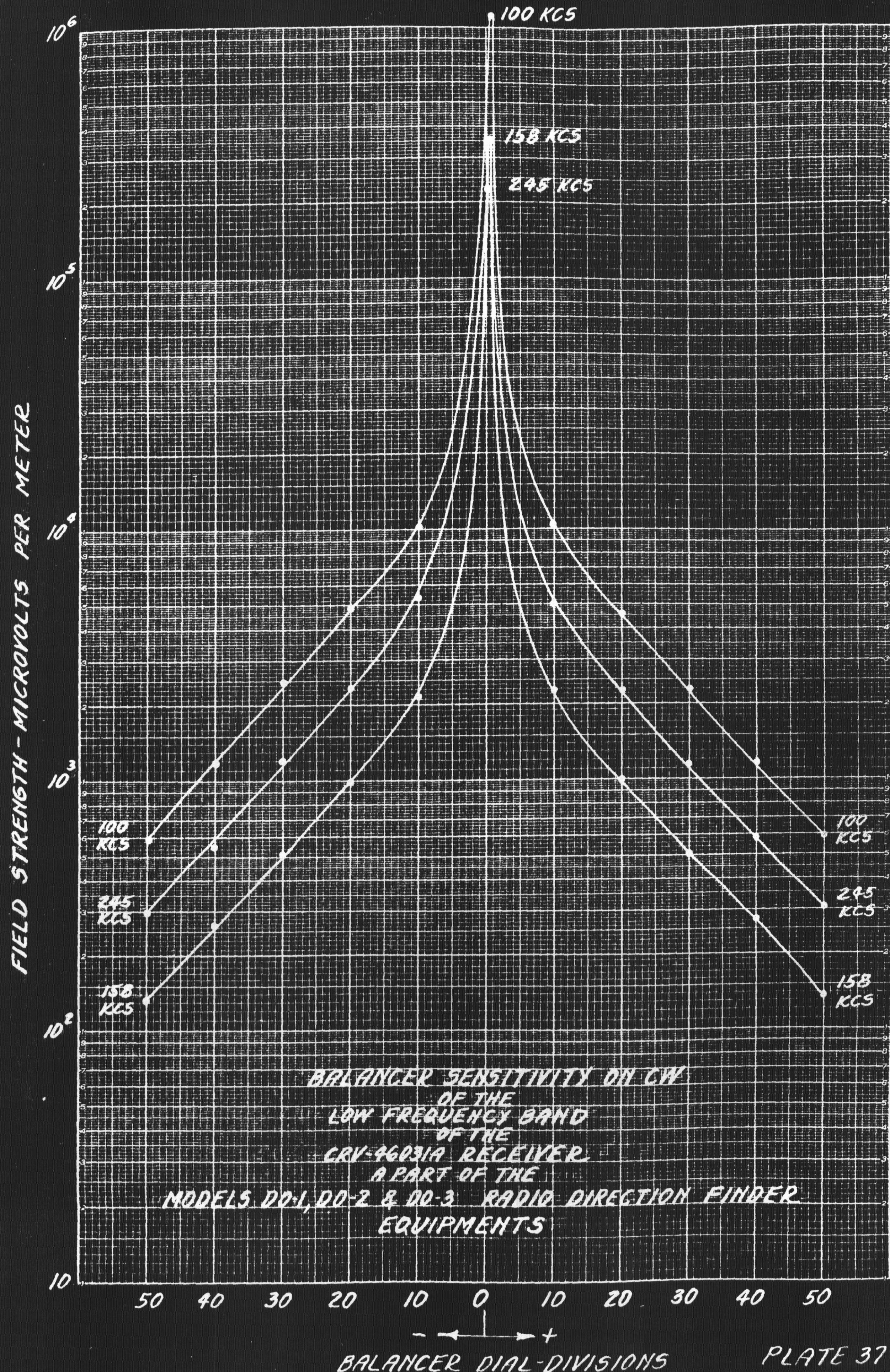

BALANCER SENSITIVITY ON MCW
OF THE
HIGH FREQUENCY BAND
OF THE
CRV-46031 RECEIVER
A PART OF THE
MODEL DO RADIO DIRECTION FINDER EQUIPMENT
1500 KCS
908 KCS
550 KCS
1500 KCS
908 KCS
550 KCS
1500 KCS
550 KCS
908 KCS
(115 V. BATTERY OPERATED)
FIELD STRENGTH - MICROVOLTS PER METER
10^6
10^5
10^4
10^3
10^2
10
1
50 40 30 20 10 0 10 20 30 40 50
- +
BALANCER DIAL-DIVISIONS

PLATE 36



FIELD STRENGTH - MICROVOLTS PER METER
10⁶
10⁵
10⁴
10³
10²
10
100 KCS
158 KCS
245 KCS
100 KCS
245 KCS
158 KCS
100 KCS
245 KCS
158 KCS
50 40 30 20 10 0 10 20 30 40 50
- +
BALANCER DIAL-DIVISIONS
BALANCER SENSITIVITY ON CW
OF THE
LOW FREQUENCY BAND
OF THE
CRV-46031A RECEIVER
A PART OF THE
MODELS DO-1, DO-2 & DO-3 RADIO DIRECTION FINDER
EQUIPMENTS

PLATE 37

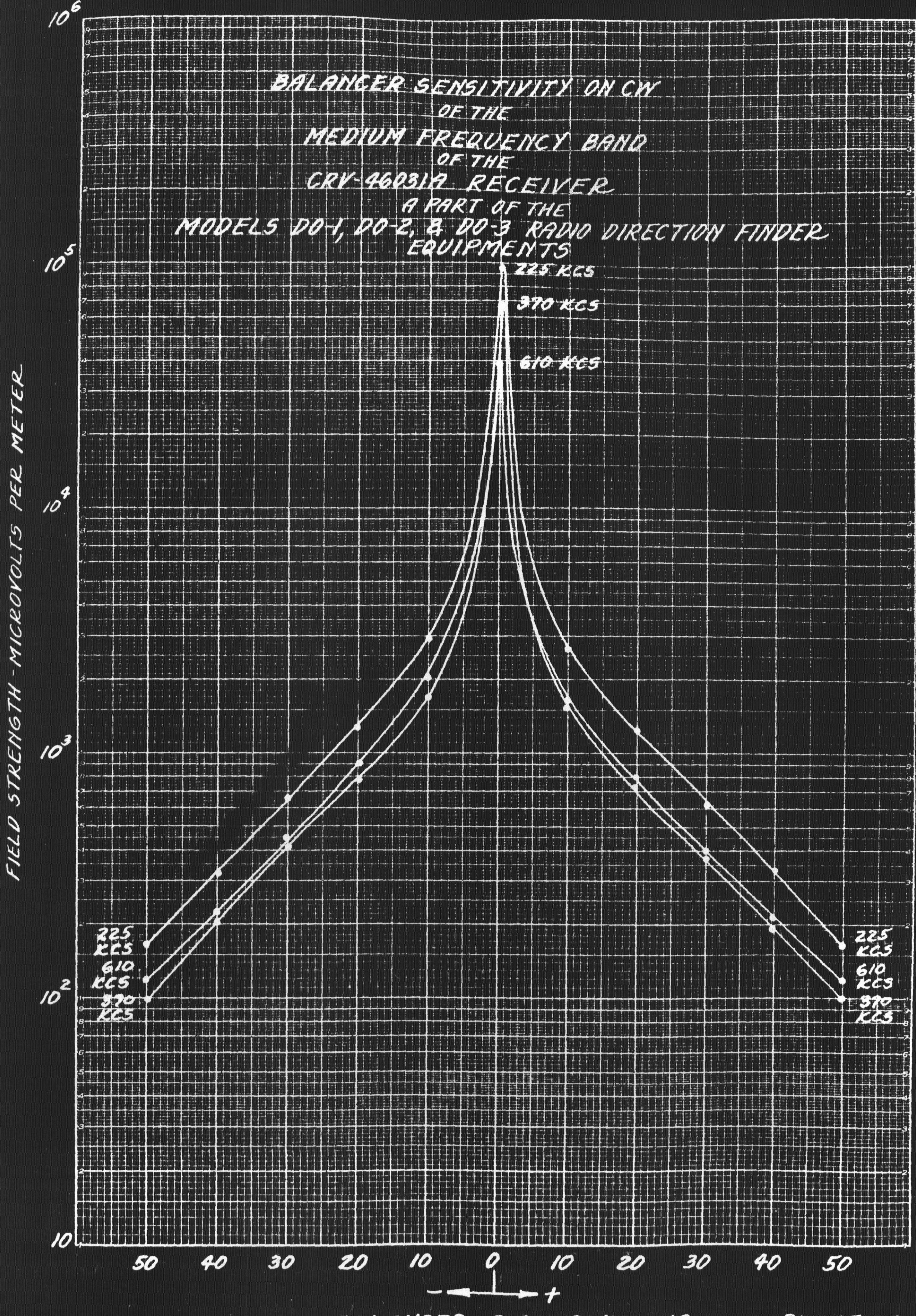
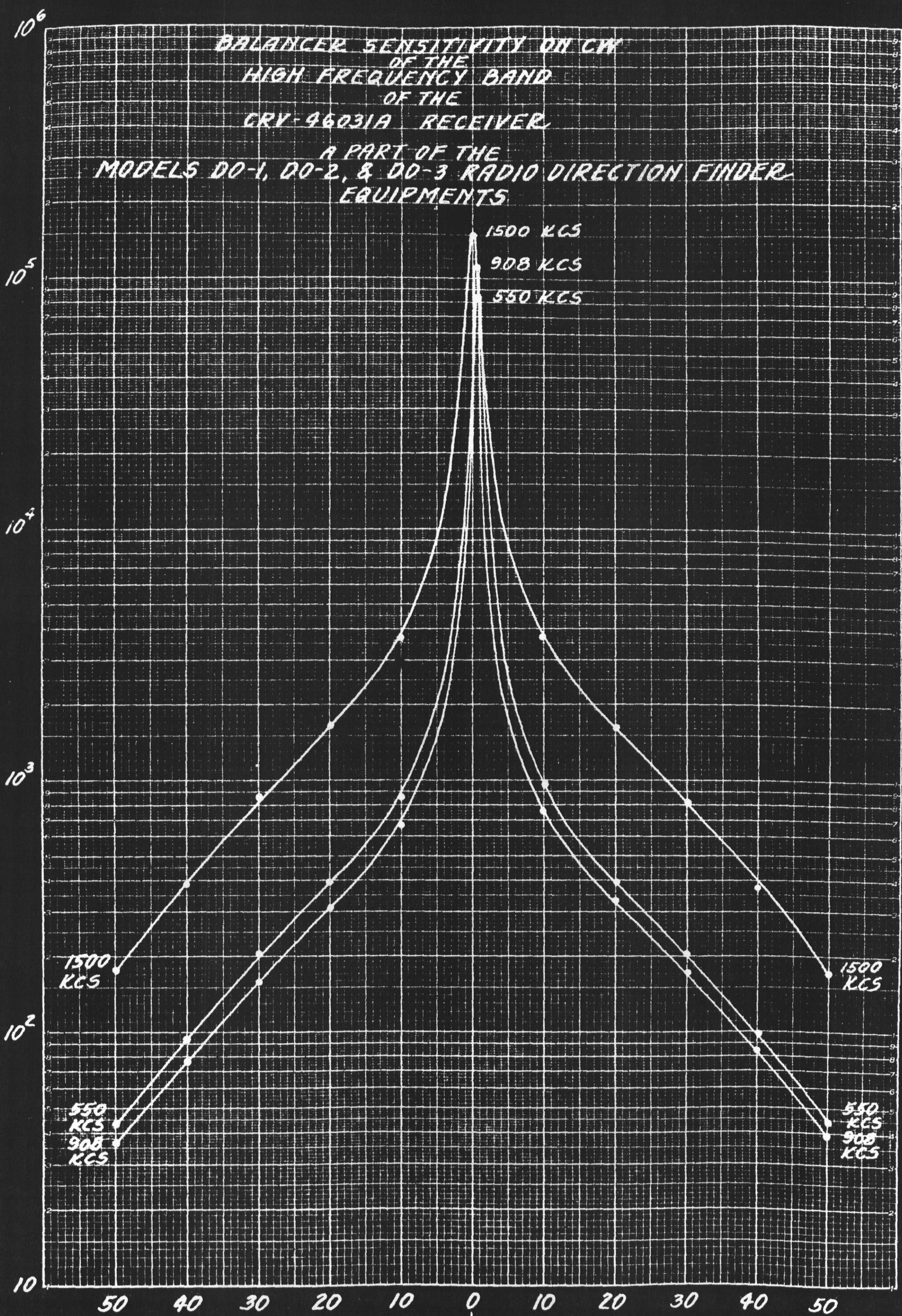

BALANCER SENSITIVITY ON CW
OF THE
MEDIUM FREQUENCY BAND
OF THE
CRV-46031A RECEIVER
A PART OF THE
MODELS DO-1, DO-2, & DO-3 RADIO DIRECTION FINDER
EQUIPMENTS
225 KCS
370 KCS
610 KCS
FIELD STRENGTH - MICROVOLTS PER METER
10^6
10^5
10^4
10^3
10^2
10
50
40
30
20
10
0
10
20
30
40
50
− +
BALANCER DIAL-DIVISIONS

PLATE 38


BALANCER SENSITIVITY ON CW
OF THE
HIGH FREQUENCY BAND
OF THE
CRV-46031A RECEIVER
A PART OF THE
MODELS DO-1, DO-2, & DO-3 RADIO DIRECTION FINDER
EQUIPMENTS
1500 KCS
908 KCS
550 KCS
1500 KCS
550 KCS
908 KCS
FIELD STRENGTH-MICROVOLTS PER METER
BALANCER DIAL-DIVISIONS
50 40 30 20 10 0 10 20 30 40 50
10
10^2
10^3
10^4
10^5
10^6
PLATE 39

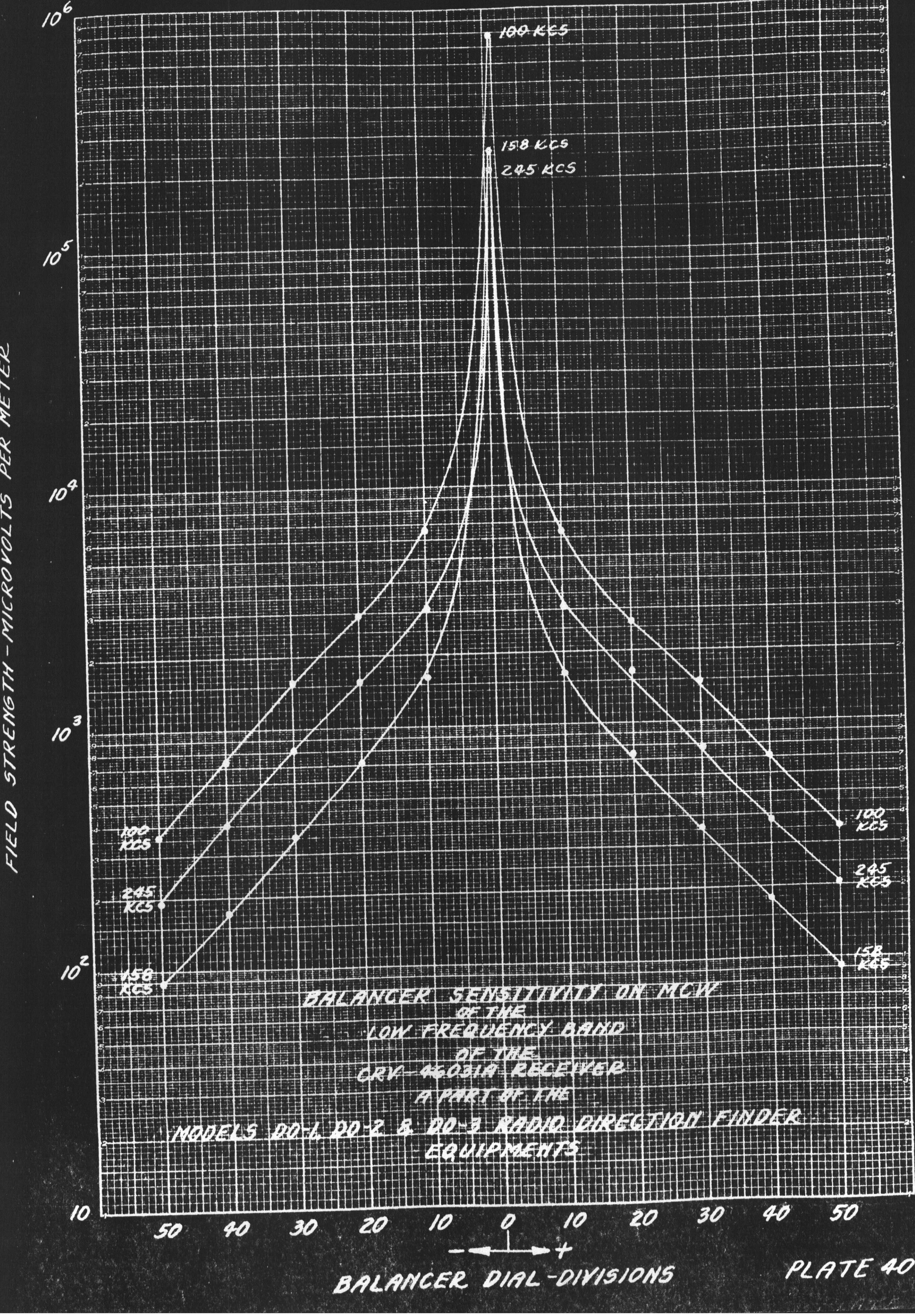

BALANCER SENSITIVITY ON MCW
OF THE
LOW FREQUENCY BAND
OF THE
CRV-46031A RECEIVER
A PART OF THE
MODELS DO-1, DO-2 & DO-3 RADIO DIRECTION FINDER
EQUIPMENTS
FIELD STRENGTH - MICROVOLTS PER METER
10^6
10^5
10^4
10^3
10^2
10
100 KCS
158 KCS
245 KCS
50 40 30 20 10 0 10 20 30 40 50
− +
BALANCER DIAL-DIVISIONS

PLATE 40

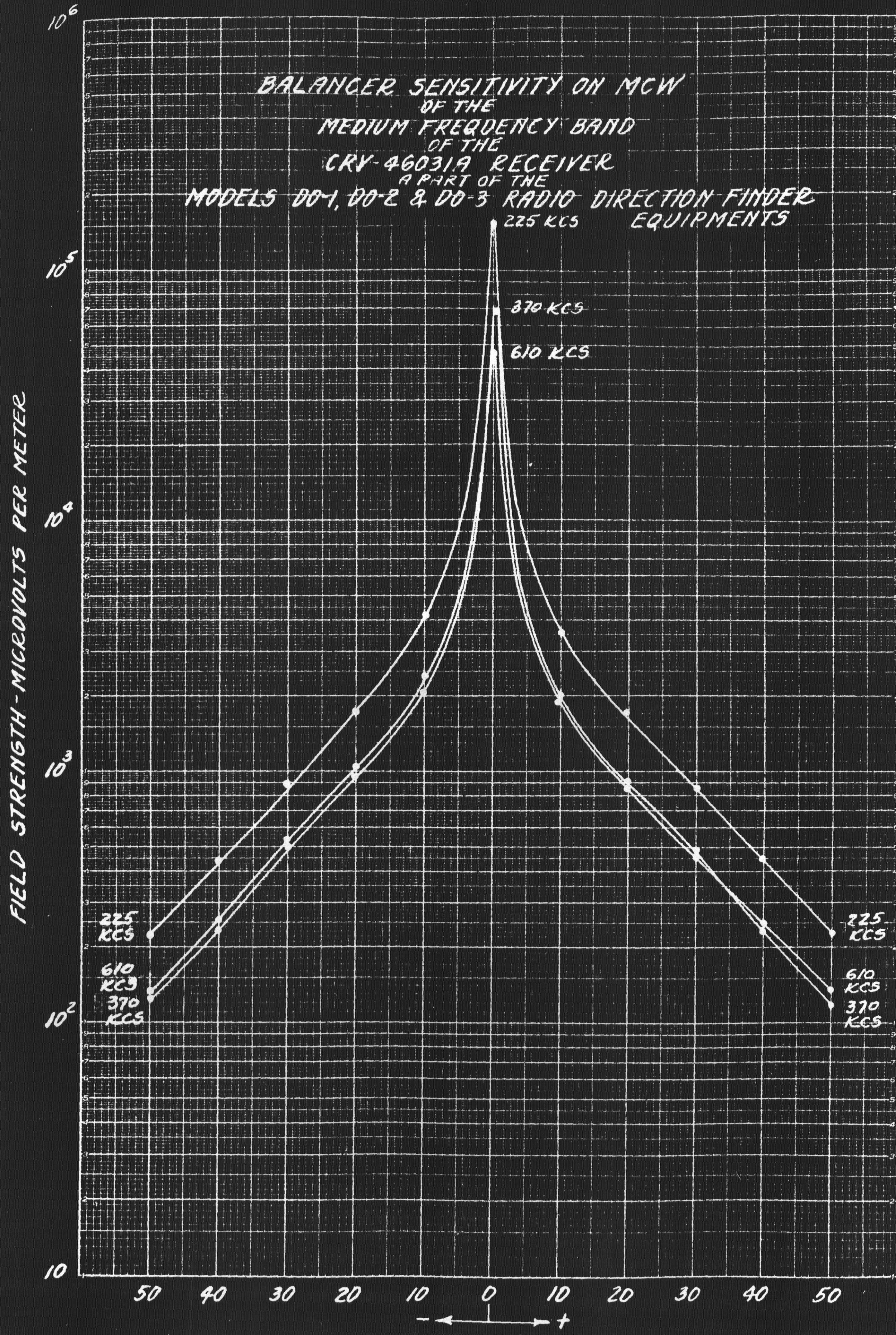

BALANCER SENSITIVITY ON MCW
OF THE
MEDIUM FREQUENCY BAND
OF THE
CRV-46031A RECEIVER
A PART OF THE
MODELS DO-1, DO-2 & DO-3 RADIO DIRECTION FINDER EQUIPMENTS
225 KCS
370 KCS
610 KCS
FIELD STRENGTH - MICROVOLTS PER METER
10^6
10^5
10^4
10^3
10^2
10
225 KCS
610 KCS
370 KCS
50 40 30 20 10 0 10 20 30 40 50
- +
BALANCER DIAL-DIVISIONS

PLATE 41

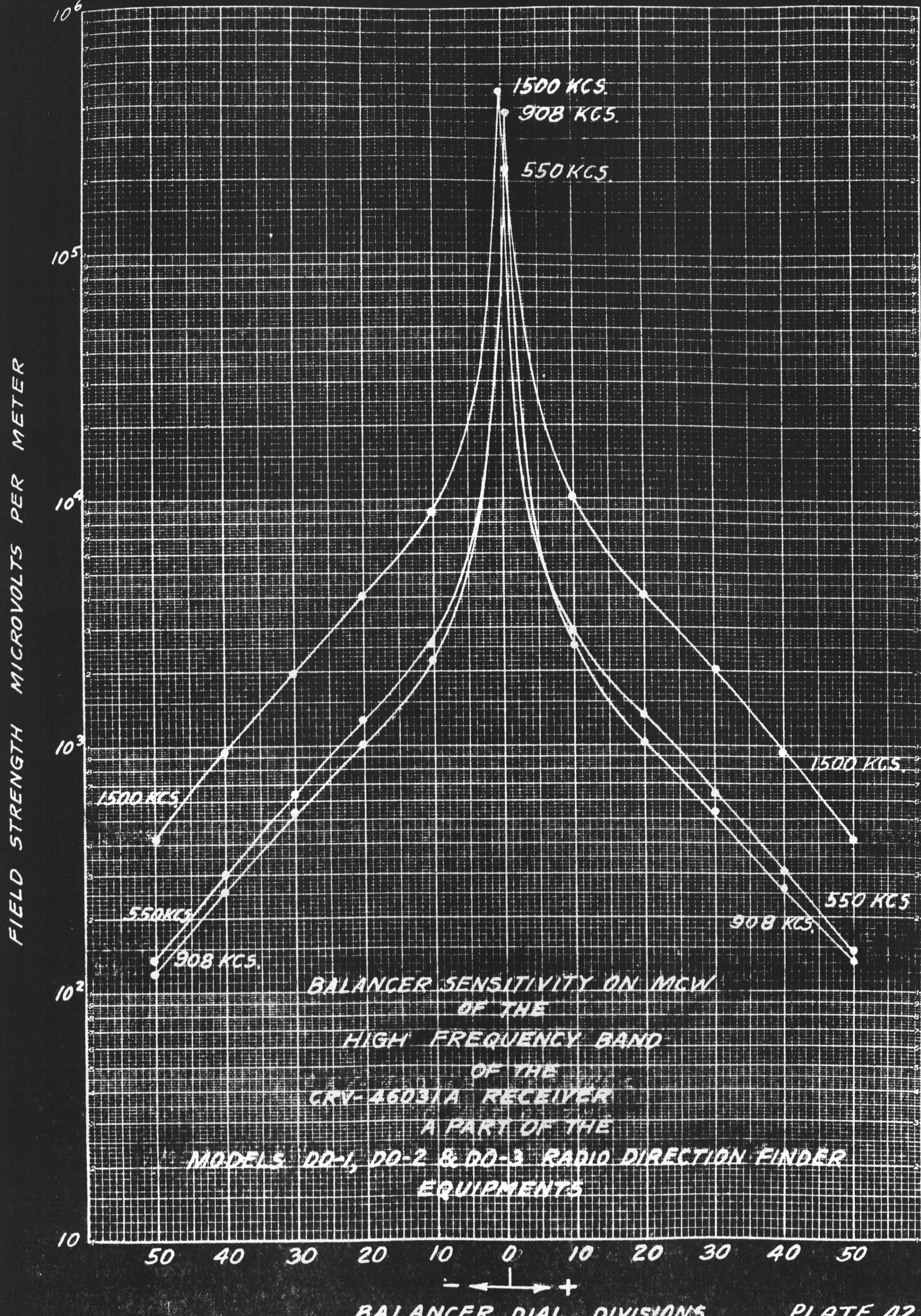
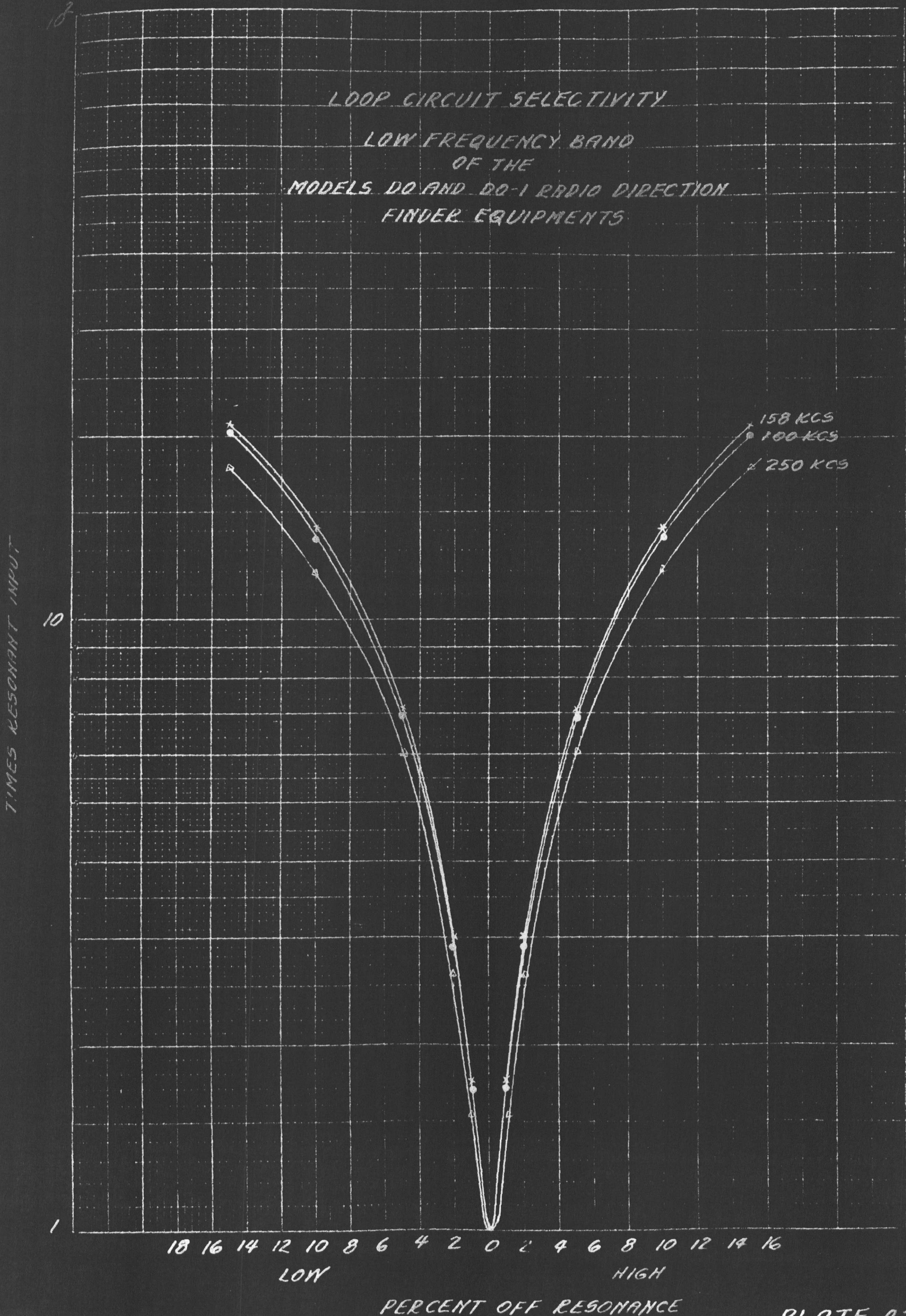
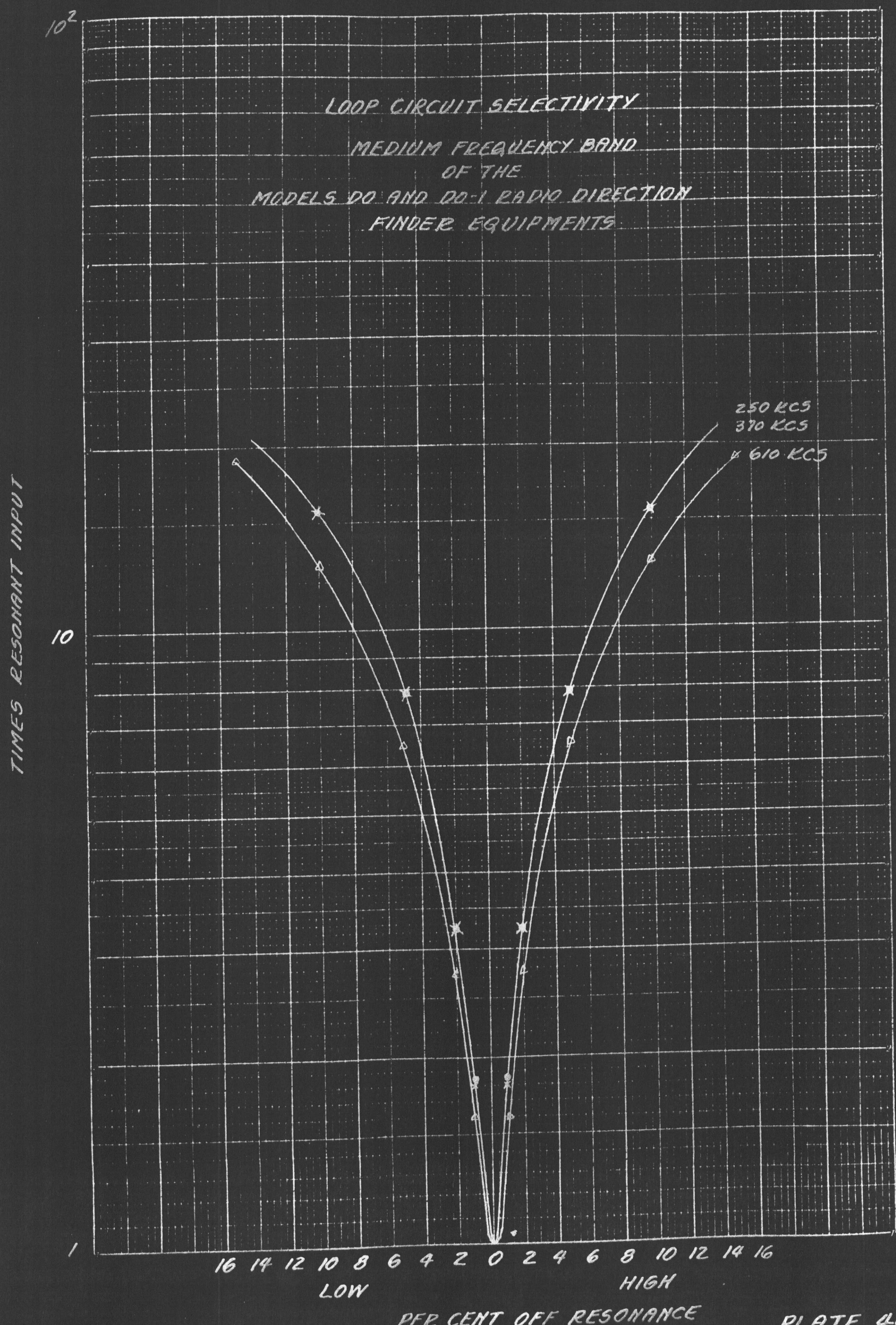

1500 KCS.
908 KCS.
550 KCS.
1500 KCS.
550 KCS.
908 KCS.
1500 KCS.
550 KCS
908 KCS.
BALANCER SENSITIVITY ON MCW
OF THE
HIGH FREQUENCY BAND
OF THE
CRV-46031A RECEIVER
A PART OF THE
MODELS DO-1, DO-2 & DO-3 RADIO DIRECTION FINDER
EQUIPMENTS
FIELD STRENGTH MICROVOLTS PER METER
10^6
10^5
10^4
10^3
10^2
10
50 40 30 20 10 0 10 20 30 40 50
BALANCER DIAL DIVISIONS

PLATE 42



LOOP CIRCUIT SELECTIVITY
LOW FREQUENCY BAND
OF THE
MODELS DO AND DO-1 RADIO DIRECTION
FINDER EQUIPMENTS
158 KCS
100 KCS
250 KCS
TIMES RESONANT INPUT
18
10
1
18 16 14 12 10 8 6 4 2 0 2 4 6 8 10 12 14 16
LOW
HIGH
PERCENT OFF RESONANCE

PLATE 43



LOOP CIRCUIT SELECTIVITY
MEDIUM FREQUENCY BAND
OF THE
MODELS DO AND DO-1 RADIO DIRECTION
FINDER EQUIPMENTS
250 KCS
370 KCS
610 KCS
TIMES RESONANT INPUT
10^2
10
1
16 14 12 10 8 6 4 2 0 2 4 6 8 10 12 14 16
LOW
HIGH
PER CENT OFF RESONANCE

PLATE 44

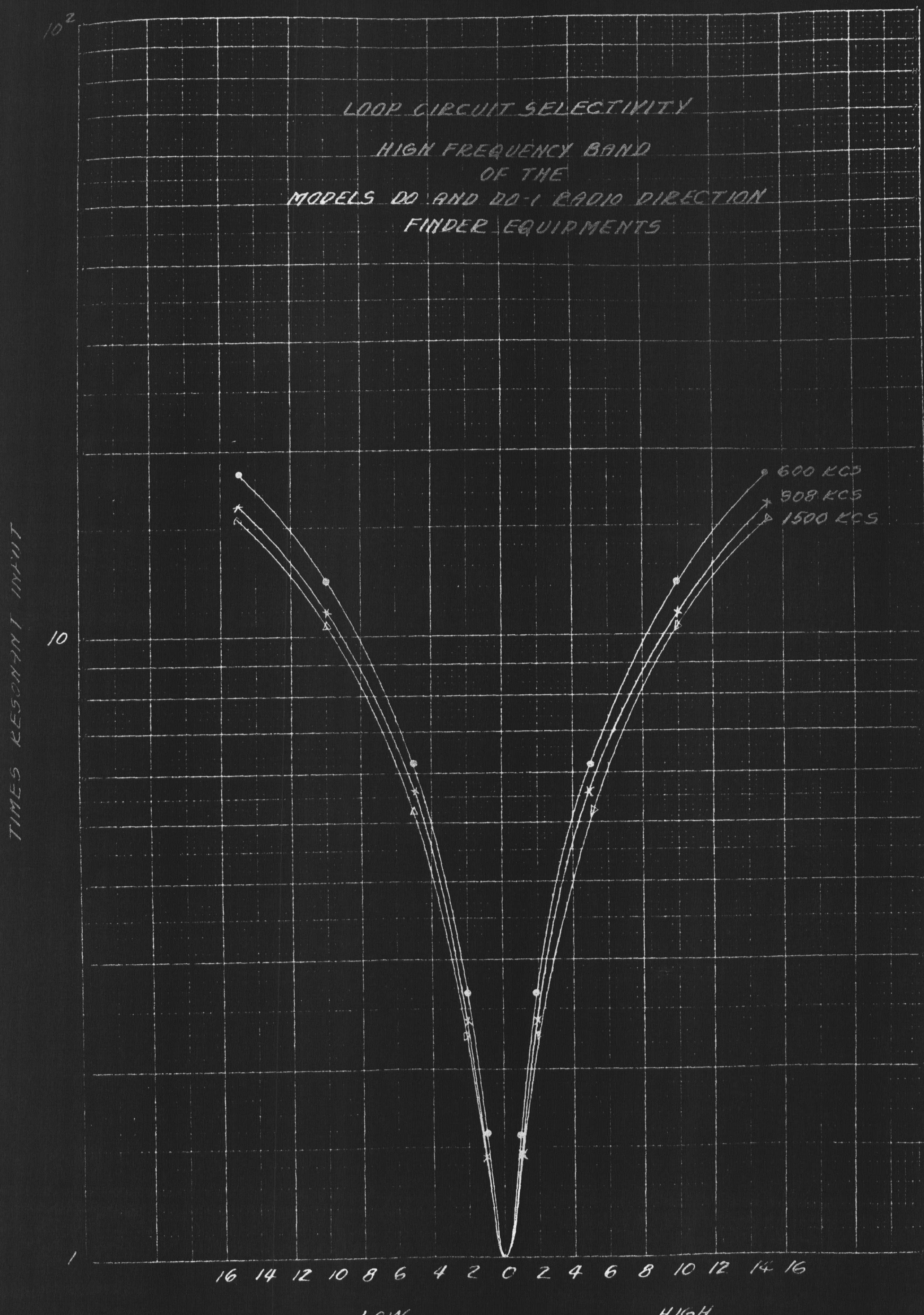
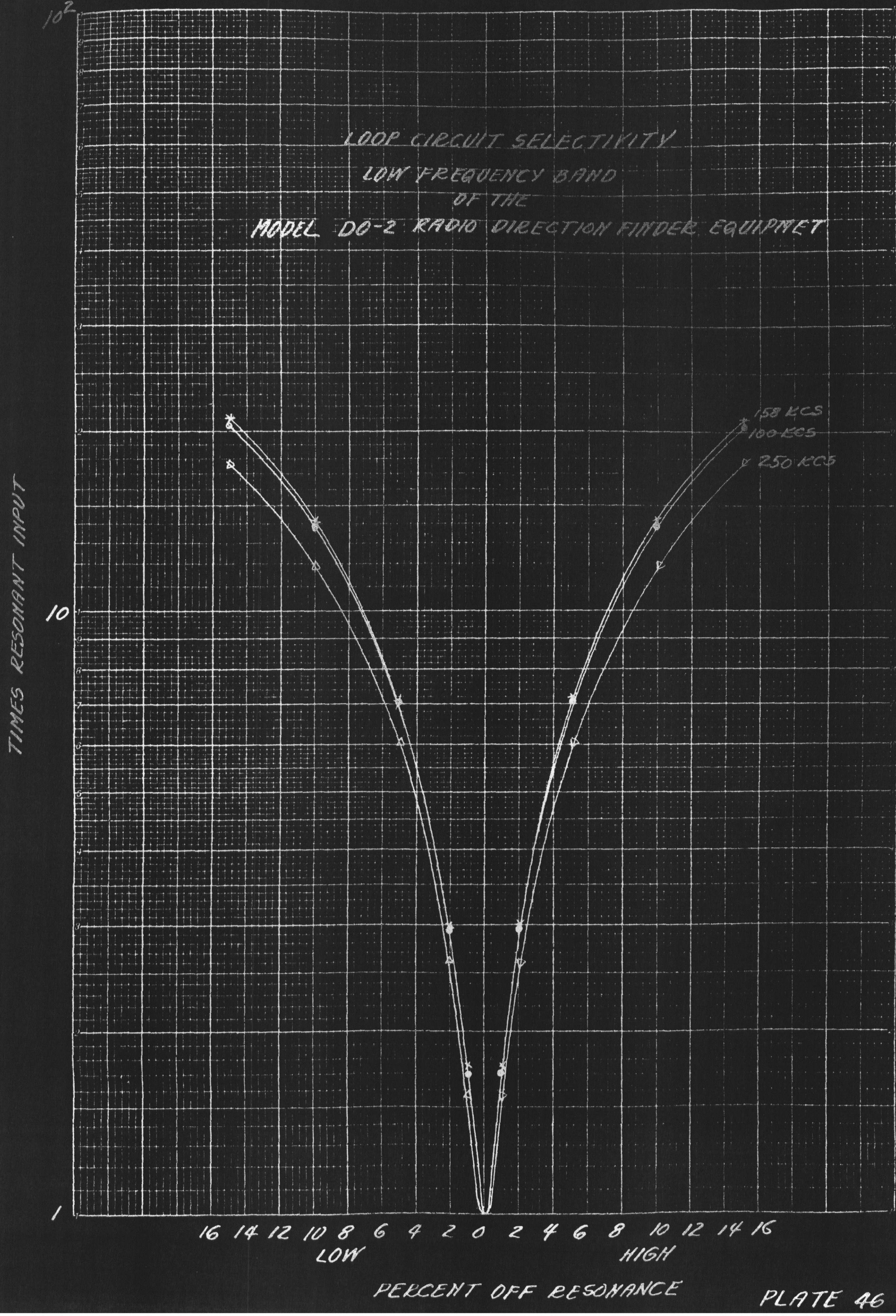

LOOP CIRCUIT SELECTIVITY
HIGH FREQUENCY BAND
OF THE
MODELS DO AND DO-1 RADIO DIRECTION
FINDER EQUIPMENTS
600 KCS
908 KCS
1500 KCS
10^2
10
1
TIMES RESONANT INPUT
16 14 12 10 8 6 4 2 0 2 4 6 8 10 12 14 16
LOW
HIGH
PERCENT OFF RESONANCE

PLATE 45



LOOP CIRCUIT SELECTIVITY
LOW FREQUENCY BAND
OF THE
MODEL DO-2 RADIO DIRECTION FINDER EQUIPMET
158 KCS
100 KCS
250 KCS
TIMES RESONANT INPUT
10²
10
1
16 14 12 10 8 6 4 2 0 2 4 6 8 10 12 14 16
LOW
HIGH
PERCENT OFF RESONANCE

PLATE 46

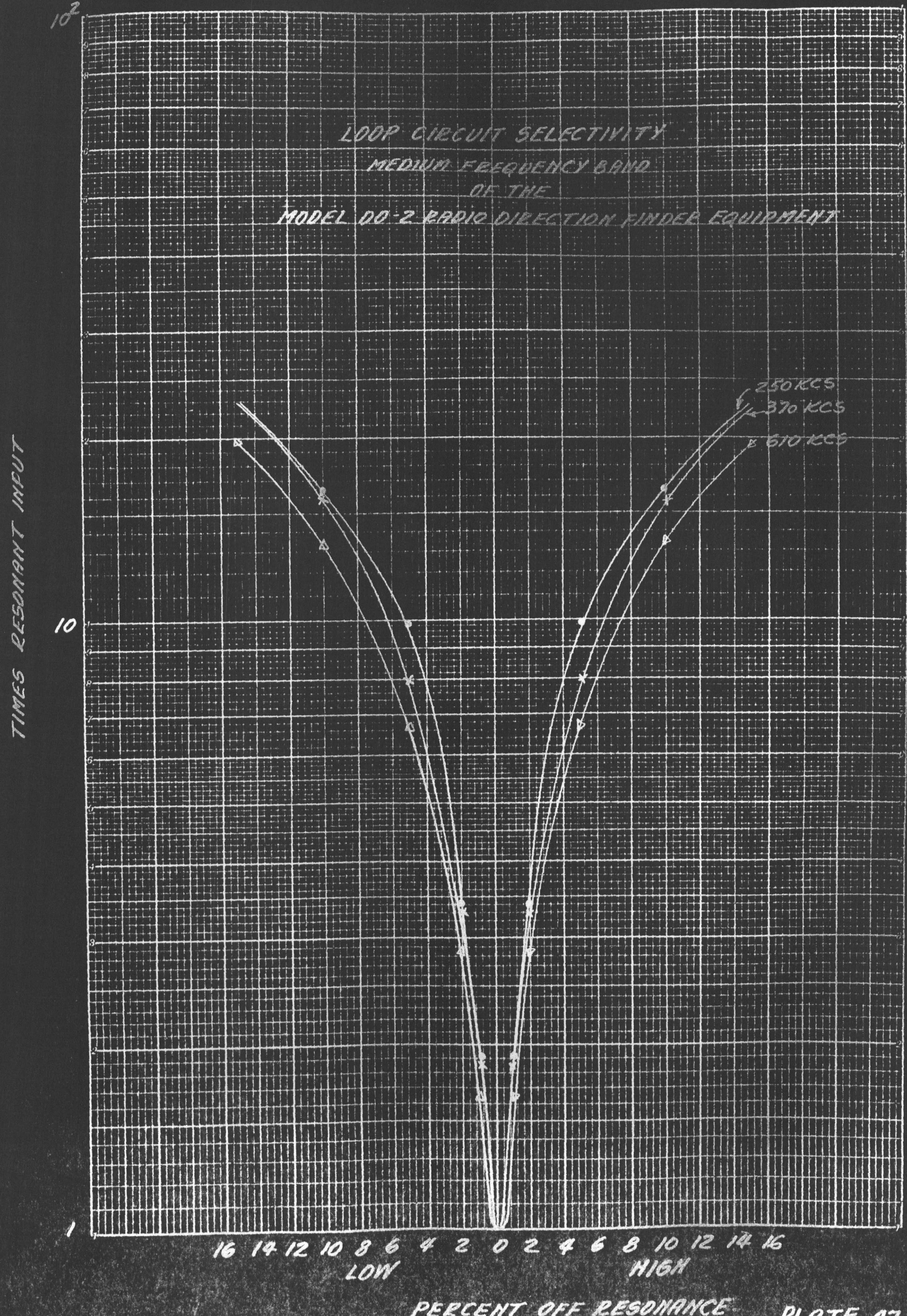
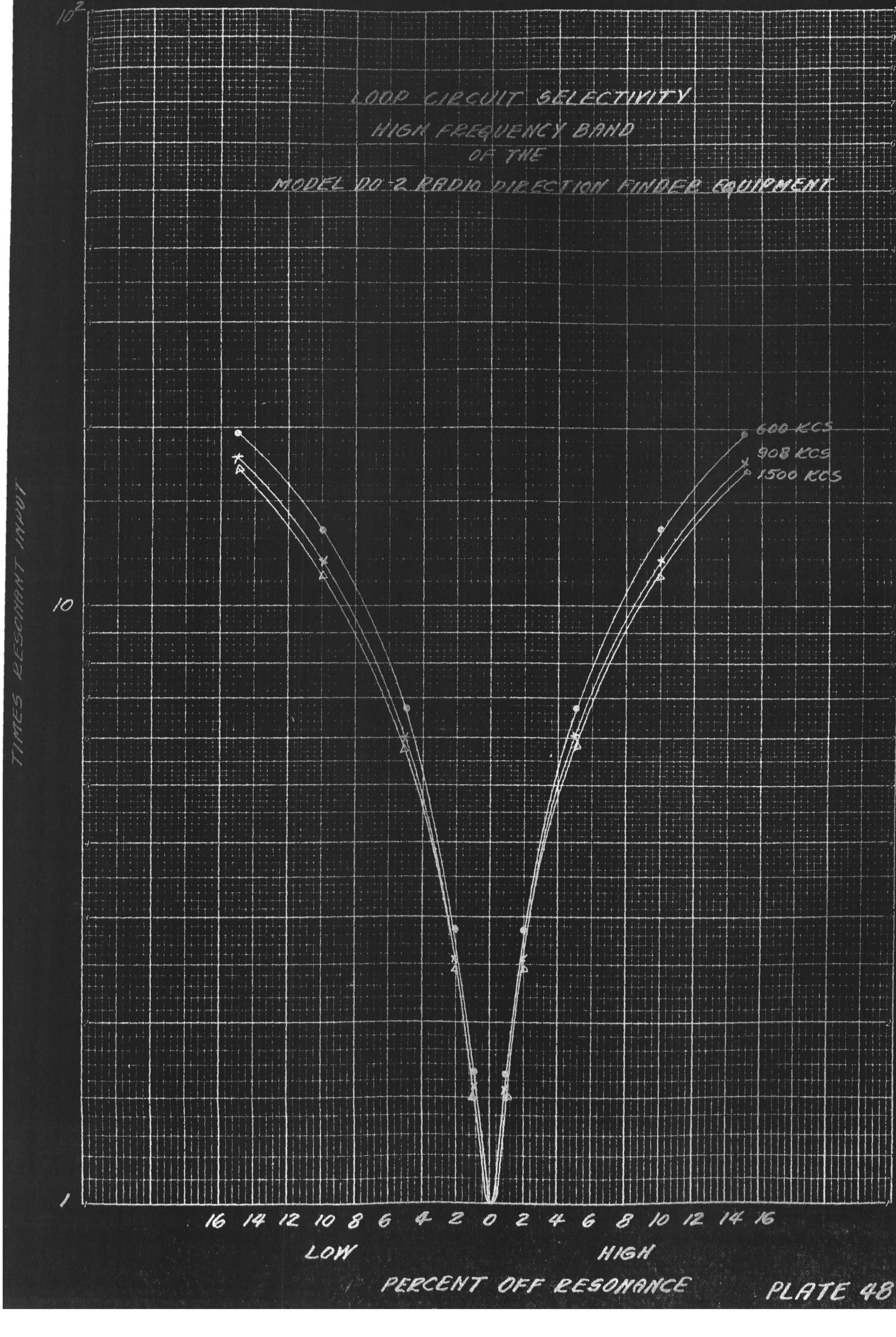
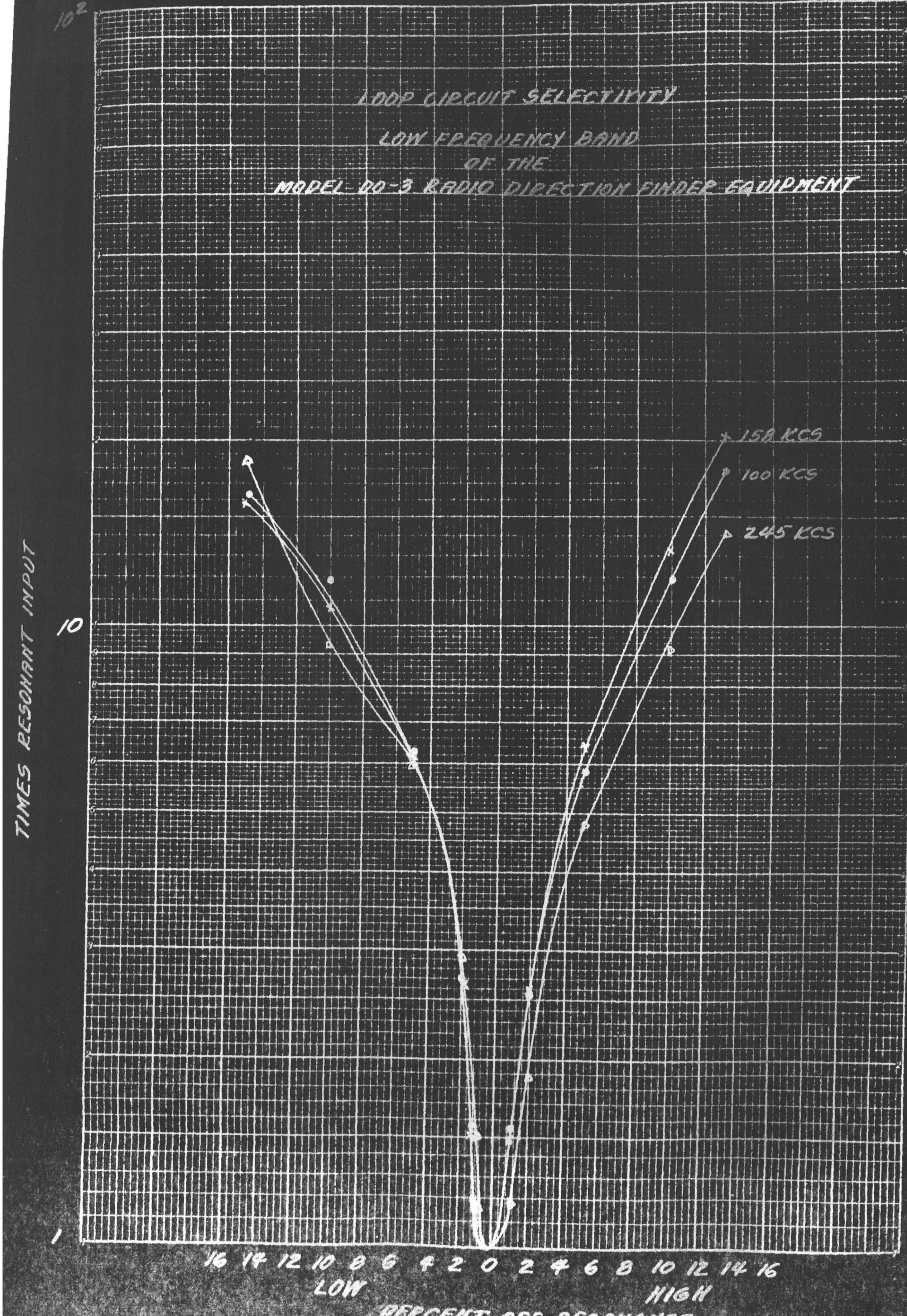

LOOP CIRCUIT SELECTIVITY
MEDIUM FREQUENCY BAND
OF THE
MODEL DO-2 RADIO DIRECTION FINDER EQUIPMENT
250 KCS
370 KCS
610 KCS
10^2
10
1
TIMES RESONANT INPUT
16 14 12 10 8 6 4 2 0 2 4 6 8 10 12 14 16
LOW
HIGH
PERCENT OFF RESONANCE

PLATE 47



LOOP CIRCUIT SELECTIVITY
HIGH FREQUENCY BAND
OF THE
MODEL DO-2 RADIO DIRECTION FINDER EQUIPMENT
600 KCS
908 KCS
1500 KCS
TIMES RESONANT INPUT
10²
10
1
16 14 12 10 8 6 4 2 0 2 4 6 8 10 12 14 16
LOW
HIGH
PERCENT OFF RESONANCE

PLATE 48



LOOP CIRCUIT SELECTIVITY
LOW FREQUENCY BAND
OF THE
MODEL DO-3 RADIO DIRECTION FINDER EQUIPMENT
TIMES RESONANT INPUT
10²
10
1
158 KCS
100 KCS
245 KCS
16 14 12 10 8 6 4 2 0 2 4 6 8 10 12 14 16
LOW
HIGH
PERCENT OFF RESONANCE

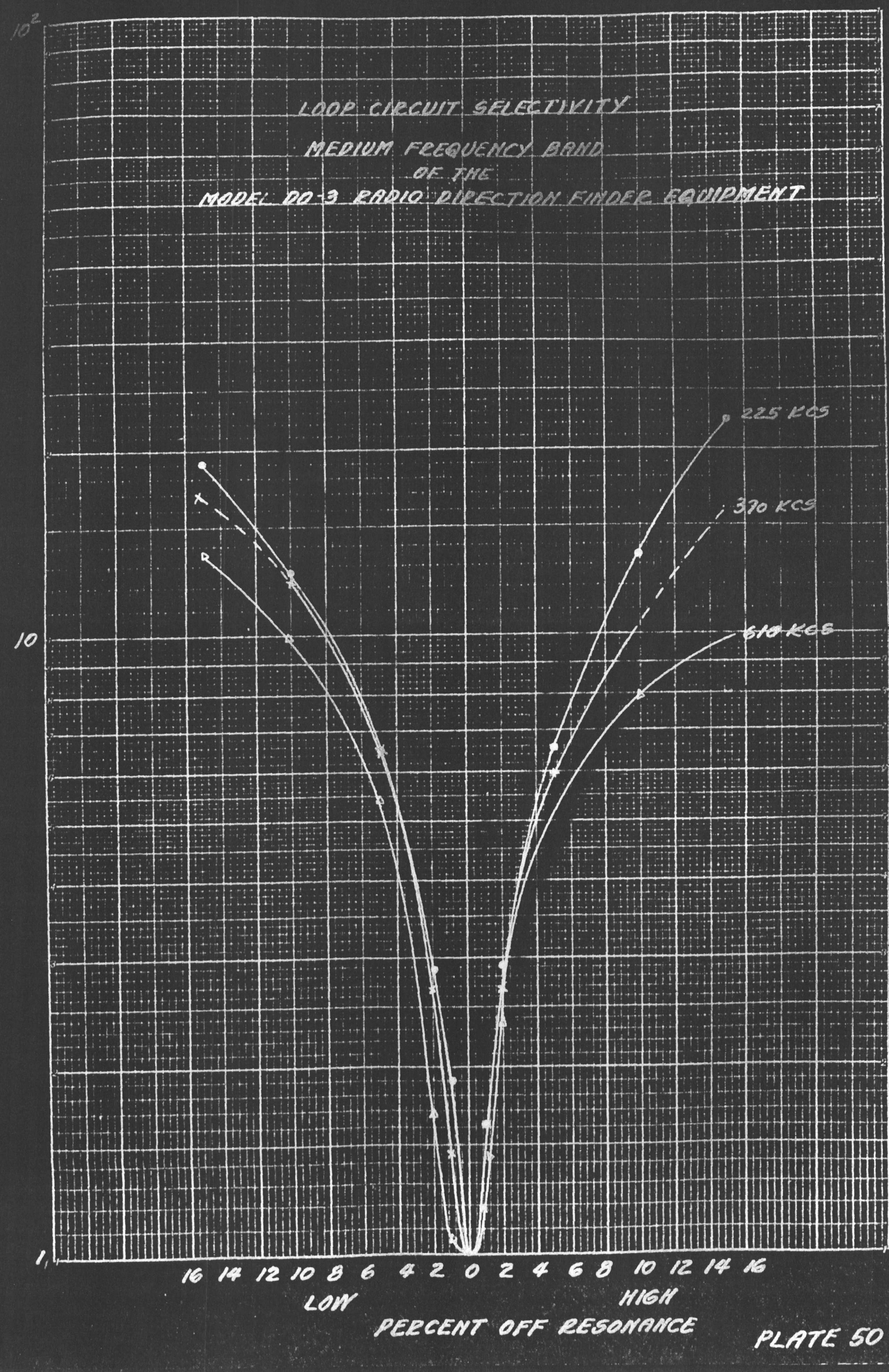

LOOP CIRCUIT SELECTIVITY
MEDIUM FREQUENCY BAND
OF THE
MODEL DO-3 RADIO DIRECTION FINDER EQUIPMENT
225 KCS
370 KCS
610 KCS
10^2
10
1
TIMES RESONANT INPUT
16 14 12 10 8 6 4 2 0 2 4 6 8 10 12 14 16
LOW
HIGH
PERCENT OFF RESONANCE

PLATE 50

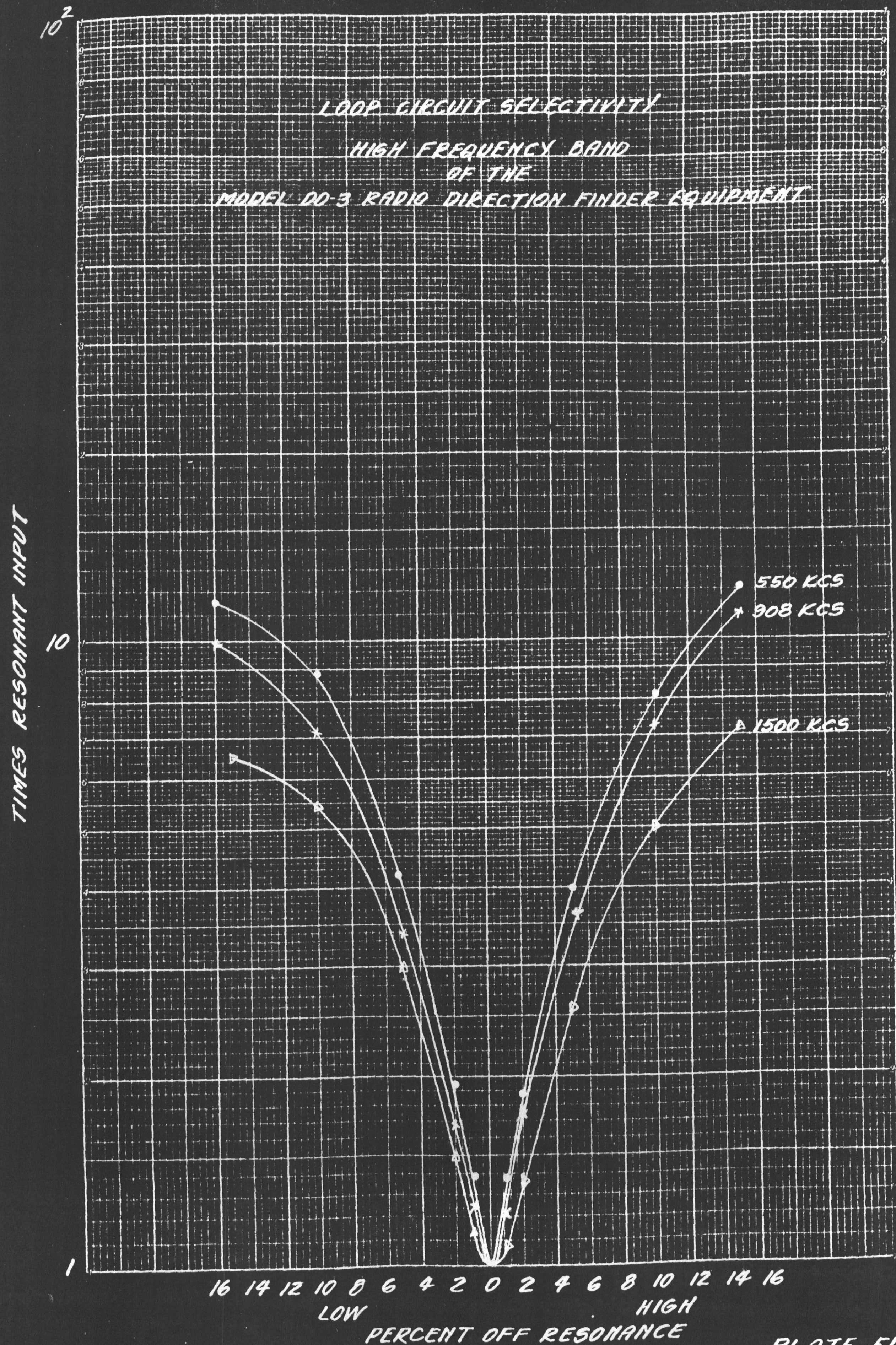

LOOP CIRCUIT SELECTIVITY
HIGH FREQUENCY BAND
OF THE
MODEL DD-3 RADIO DIRECTION FINDER EQUIPMENT
10^2
10
1
TIMES RESONANT INPUT
550 KCS
908 KCS
1500 KCS
16 14 12 10 8 6 4 2 0 2 4 6 8 10 12 14 16
LOW
HIGH
PERCENT OFF RESONANCE

PLATE 51

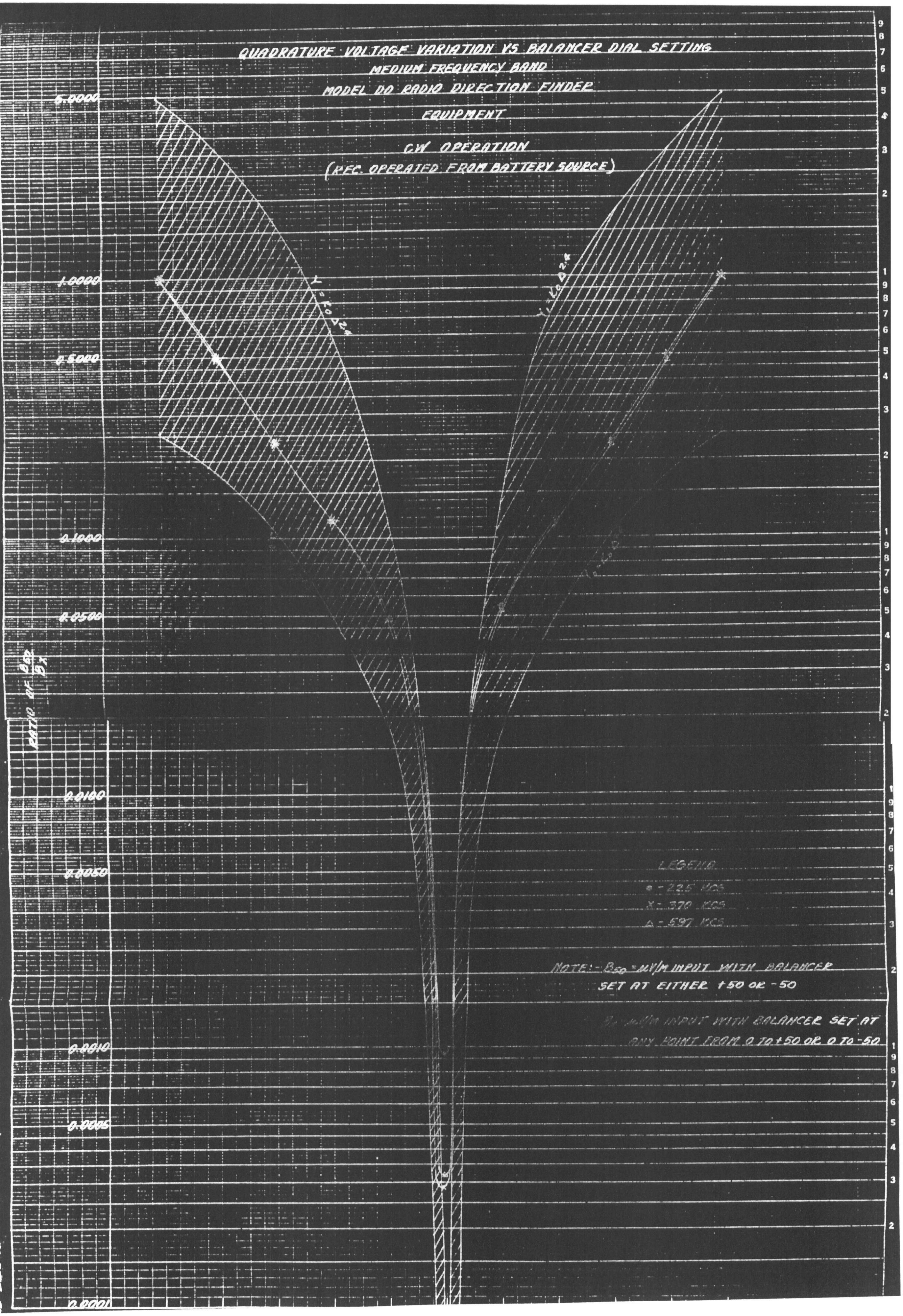

QUADRATURE VOLTAGE VARIATION VS BALANCER DIAL SETTING
MEDIUM FREQUENCY BAND
MODEL DO RADIO DIRECTION FINDER
EQUIPMENT
CW OPERATION
(REC. OPERATED FROM BATTERY SOURCE)
5.0000
1.0000
0.5000
0.1000
0.0500
0.0100
0.0050
0.0010
0.0005
0.0001
LEGEND
• - 225 KCS
X - 370 KCS
Δ - 597 KCS
NOTE:- B50 = µV/M INPUT WITH BALANCER
SET AT EITHER +50 OR -50
µV/M INPUT WITH BALANCER SET AT
ANY POINT FROM 0 TO +50 OR 0 TO -50

PLATE 52

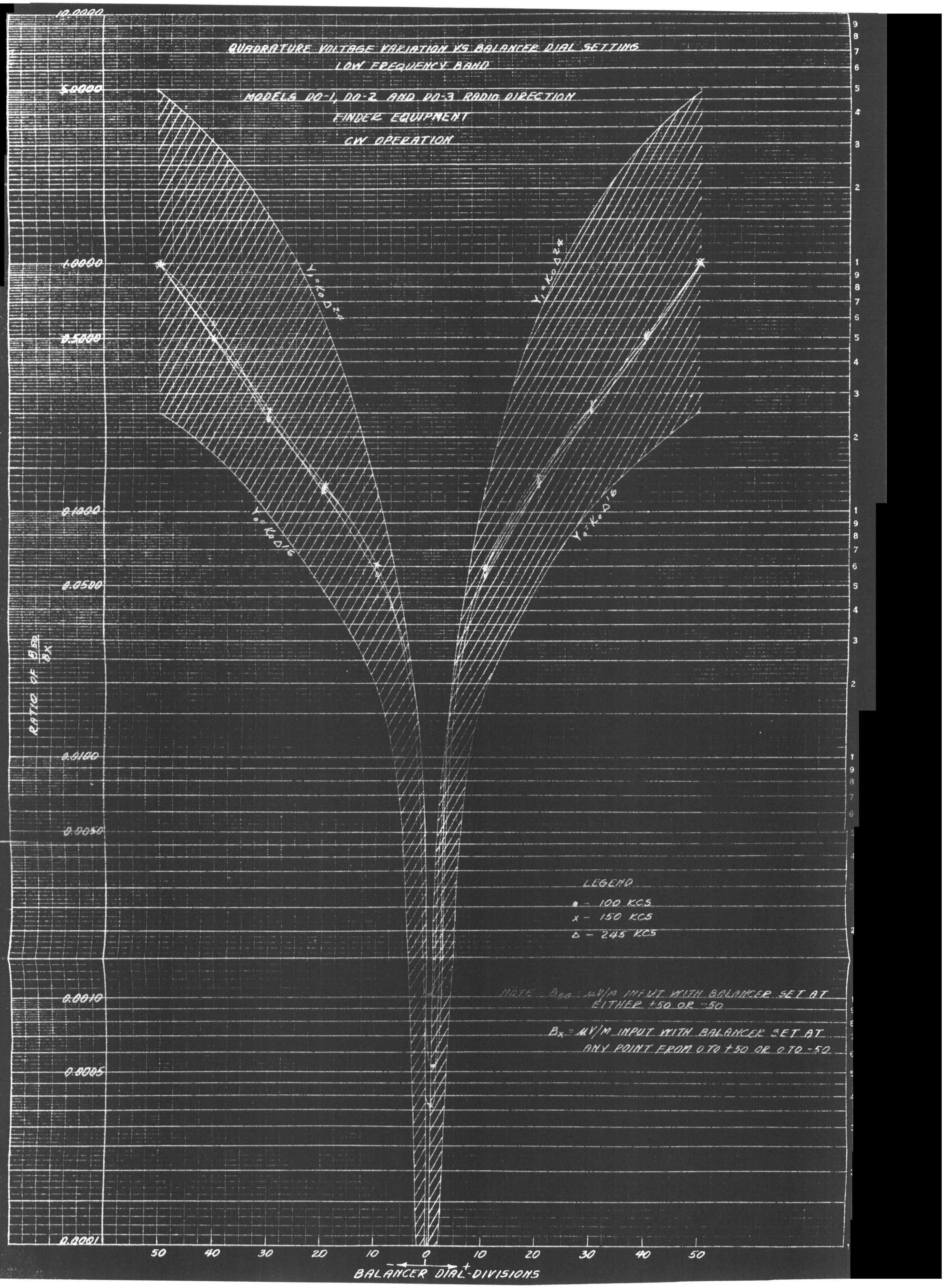

QUADRATURE VOLTAGE VARIATION VS BALANCER DIAL SETTING
LOW FREQUENCY BAND
MODELS DO-1, DO-2 AND DO-3 RADIO DIRECTION
FINDER EQUIPMENT
CW OPERATION
10.0000
5.0000
1.0000
0.5000
0.1000
0.0500
0.0100
0.0050
0.0010
0.0005
0.0001
RATIO OF B50/BX
LEGEND
• - 100 KCS
x - 150 KCS
Δ - 245 KCS
NOTE: B50 = μV/M INPUT WITH BALANCER SET AT EITHER +50 OR -50
BX = μV/M INPUT WITH BALANCER SET AT ANY POINT FROM 0 TO +50 OR 0 TO -50
50 40 30 20 10 0 10 20 30 40 50
BALANCER DIAL-DIVISIONS

PLATE 53

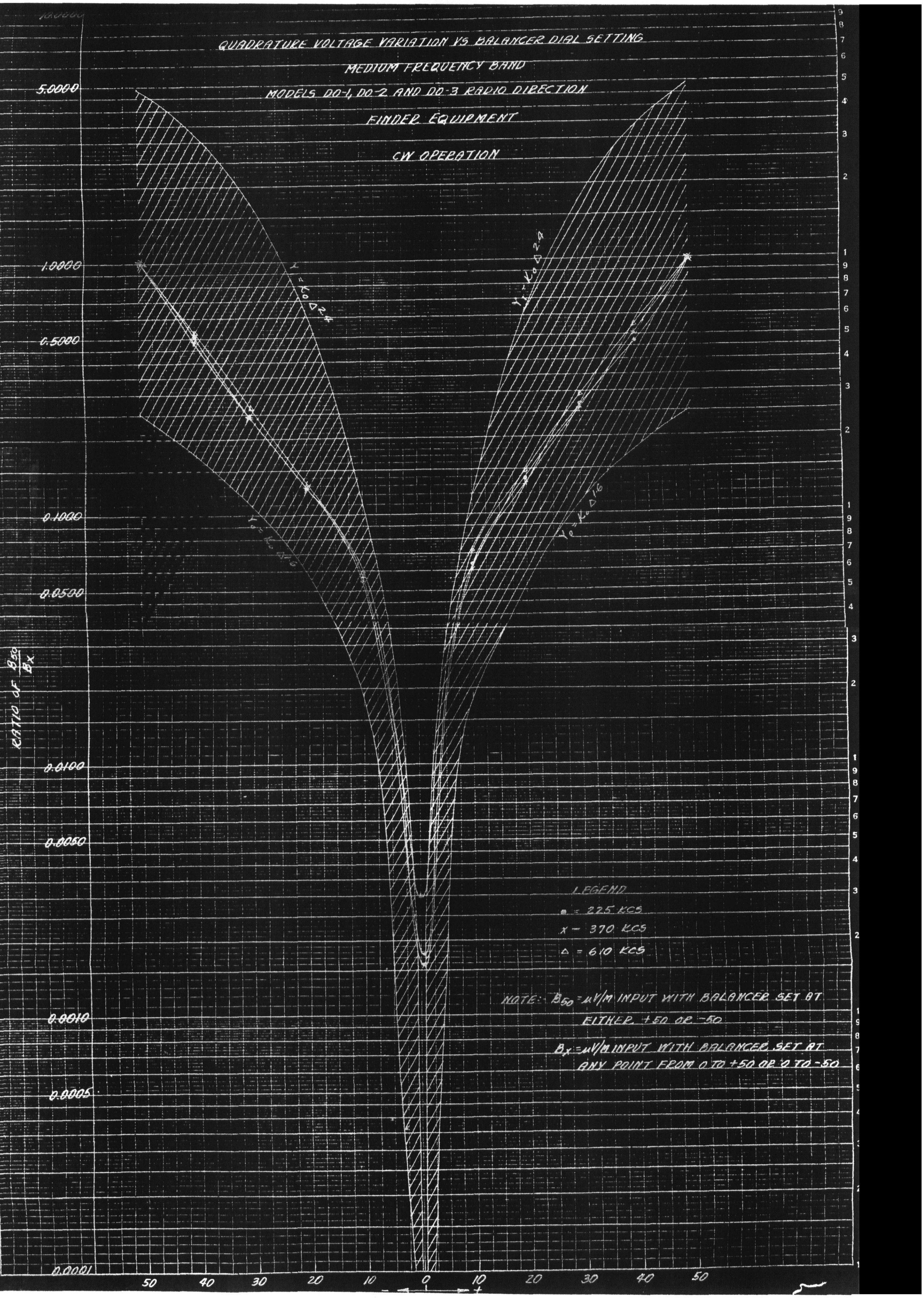
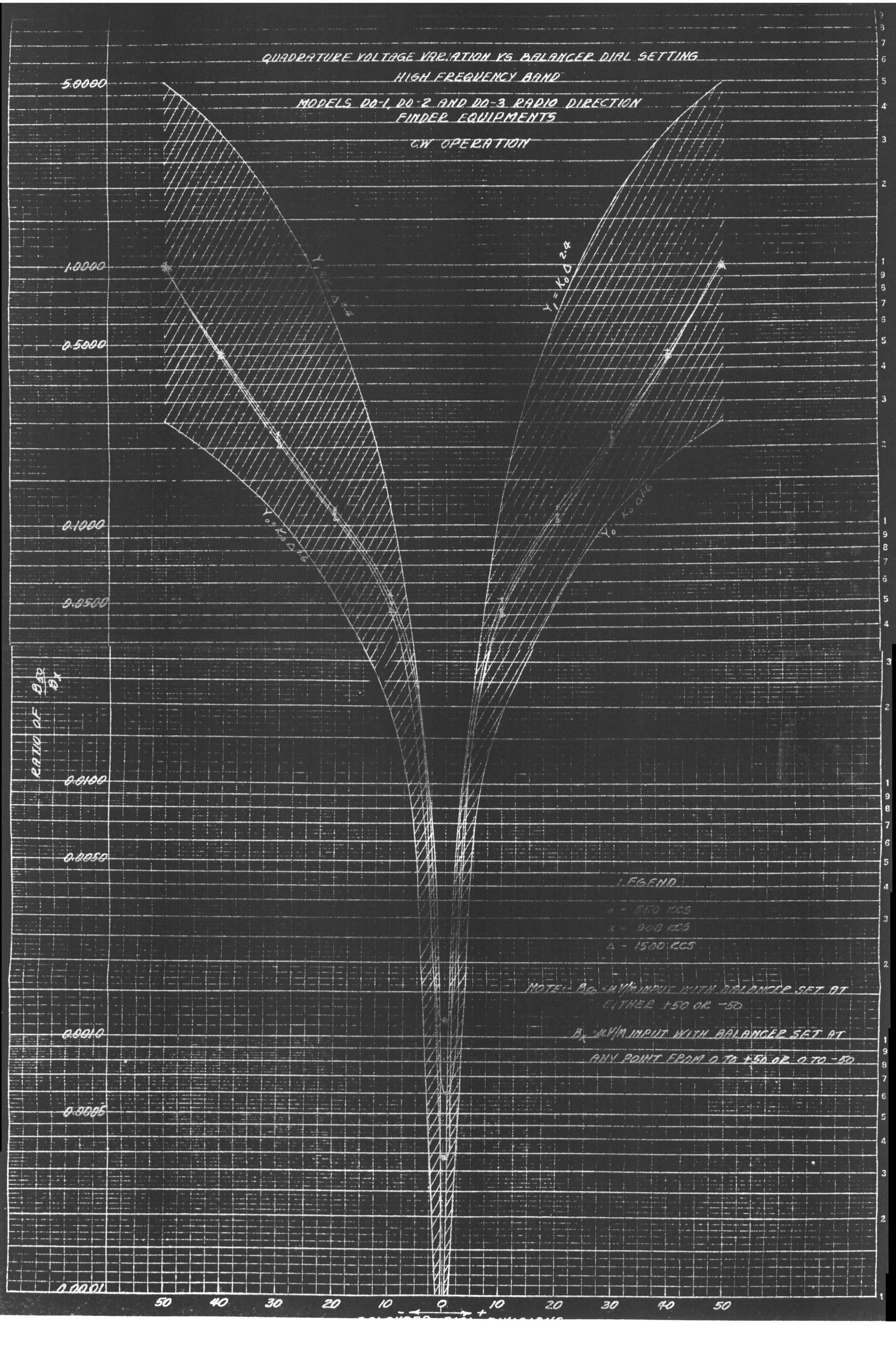

QUADRATURE VOLTAGE VARIATION VS BALANCER DIAL SETTING
MEDIUM FREQUENCY BAND
MODELS DO-1, DO-2 AND DO-3 RADIO DIRECTION
FINDER EQUIPMENT
CW OPERATION
5.0000
1.0000
0.5000
0.1000
0.0500
0.0100
0.0050
0.0010
0.0005
0.0001
RATIO OF $\frac{B_{50}}{B_X}$
50
40
30
20
10
0
10
20
30
40
50
LEGEND
• = 225 KCS
x – 370 KCS
△ = 610 KCS
NOTE: B_{50} = μV/M INPUT WITH BALANCER SET AT
EITHER +50 OR -50
B_X = μV/M INPUT WITH BALANCER SET AT
ANY POINT FROM 0 TO +50 OR 0 TO -50

PLATE 54



QUADRATURE VOLTAGE VARIATION VS BALANCER DIAL SETTING
HIGH FREQUENCY BAND
MODELS DO-1, DO-2 AND DO-3 RADIO DIRECTION FINDER EQUIPMENTS
C.W. OPERATION
5.0000
1.0000
0.5000
0.1000
0.0500
0.0100
0.0050
0.0010
0.0005
0.0001
RATIO OF B_{50}/B_X
$Y_1 = K_0 \Delta^{2.4}$
$Y_0 = K_0 \Delta^{1.6}$
LEGEND
• - 550 KCS
x - 908 KCS
Δ - 1500 KCS
NOTE:- B_{50} = µV/M INPUT WITH BALANCER SET AT EITHER +50 OR -50
B_X = µV/M INPUT WITH BALANCER SET AT ANY POINT FROM 0 TO +50 OR 0 TO -50
50 40 30 20 10 0 10 20 30 40 50
- +

PLATE 55

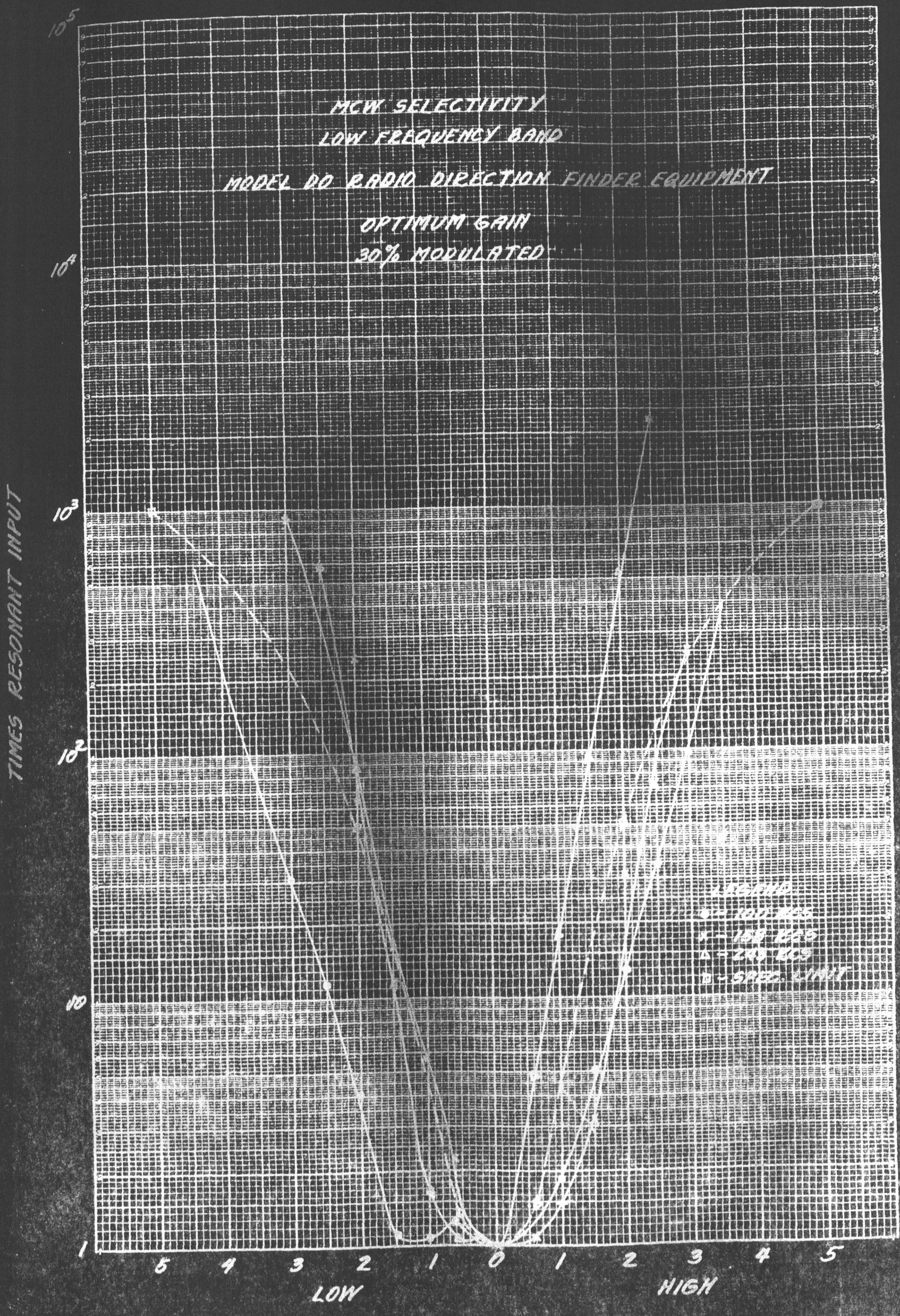
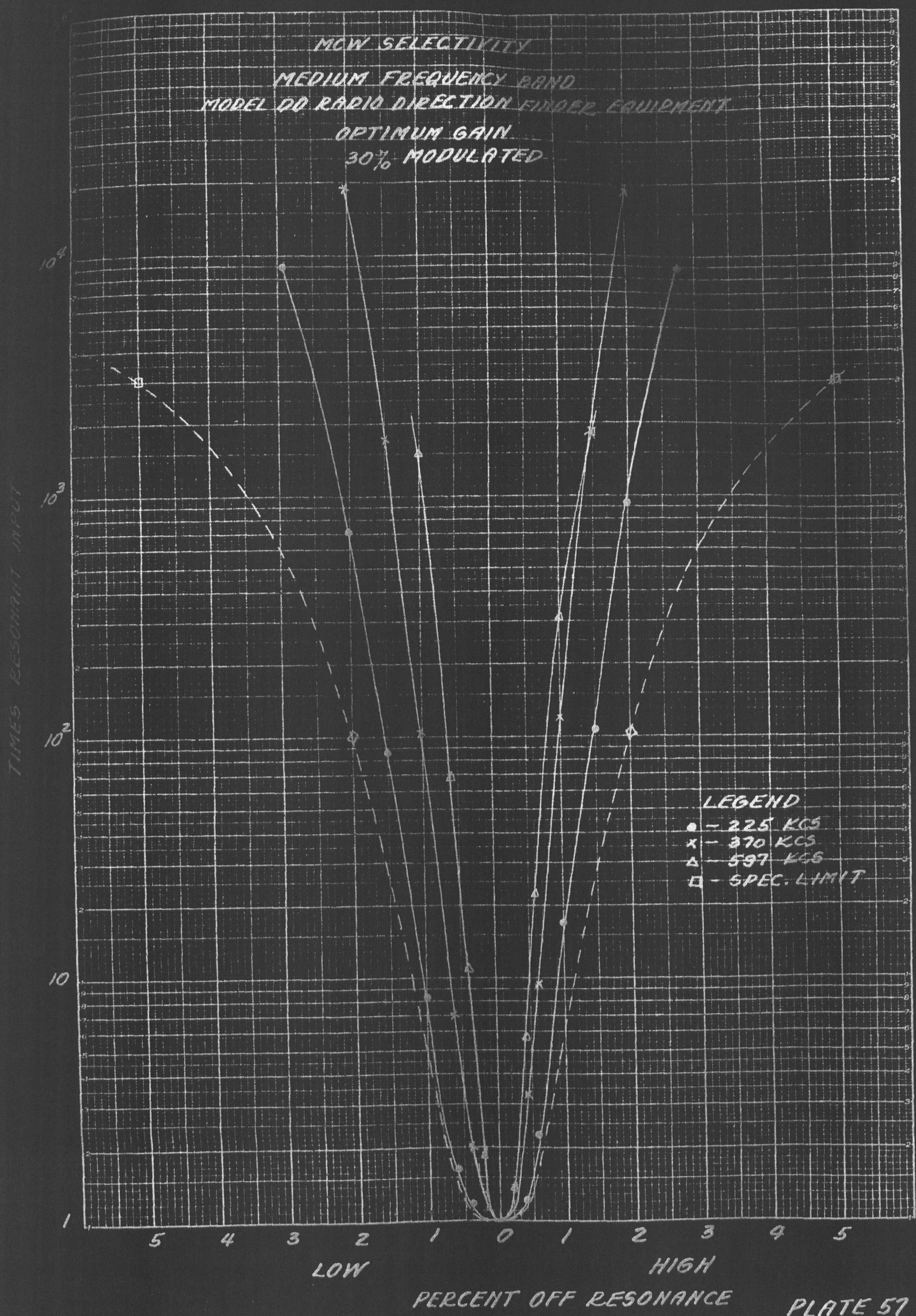
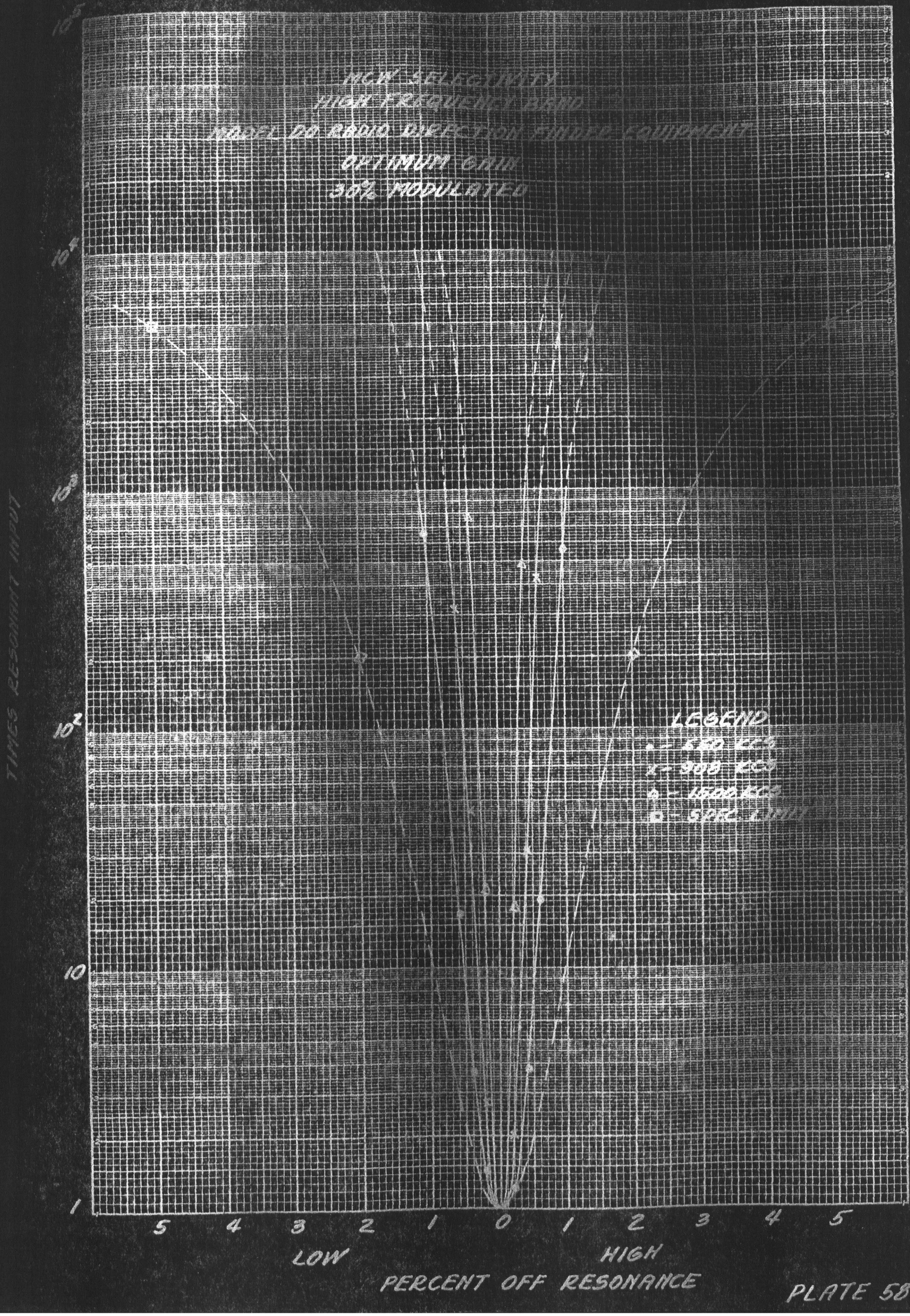

MCW SELECTIVITY
LOW FREQUENCY BAND
MODEL DO RADIO DIRECTION FINDER EQUIPMENT
OPTIMUM GAIN
30% MODULATED
TIMES RESONANT INPUT
LEGEND
□ - SPEC. LIMIT
LOW
HIGH
PERCENT OFF RESONANCE

PLATE 56



MCW SELECTIVITY
MEDIUM FREQUENCY BAND
MODEL DO RADIO DIRECTION FINDER EQUIPMENT
OPTIMUM GAIN
30% MODULATED
TIMES RESONANT INPUT
10⁴
10³
10²
10
1
LEGEND
● - 225 KCS
x - 370 KCS
△ - 597 KCS
□ - SPEC. LIMIT
5 4 3 2 1 0 1 2 3 4 5
LOW
HIGH
PERCENT OFF RESONANCE

PLATE 57



MCW SELECTIVITY
HIGH FREQUENCY BAND
MODEL DQ RADIO DIRECTION FINDER EQUIPMENT
OPTIMUM GAIN
30% MODULATED
LEGEND
- 1500 KCS
- SPEC LIMIT
TIMES RESONANT INPUT
10^5
10^4
10^3
10^2
10
1
5 4 3 2 1 0 1 2 3 4 5
LOW
HIGH
PERCENT OFF RESONANCE

PLATE 58

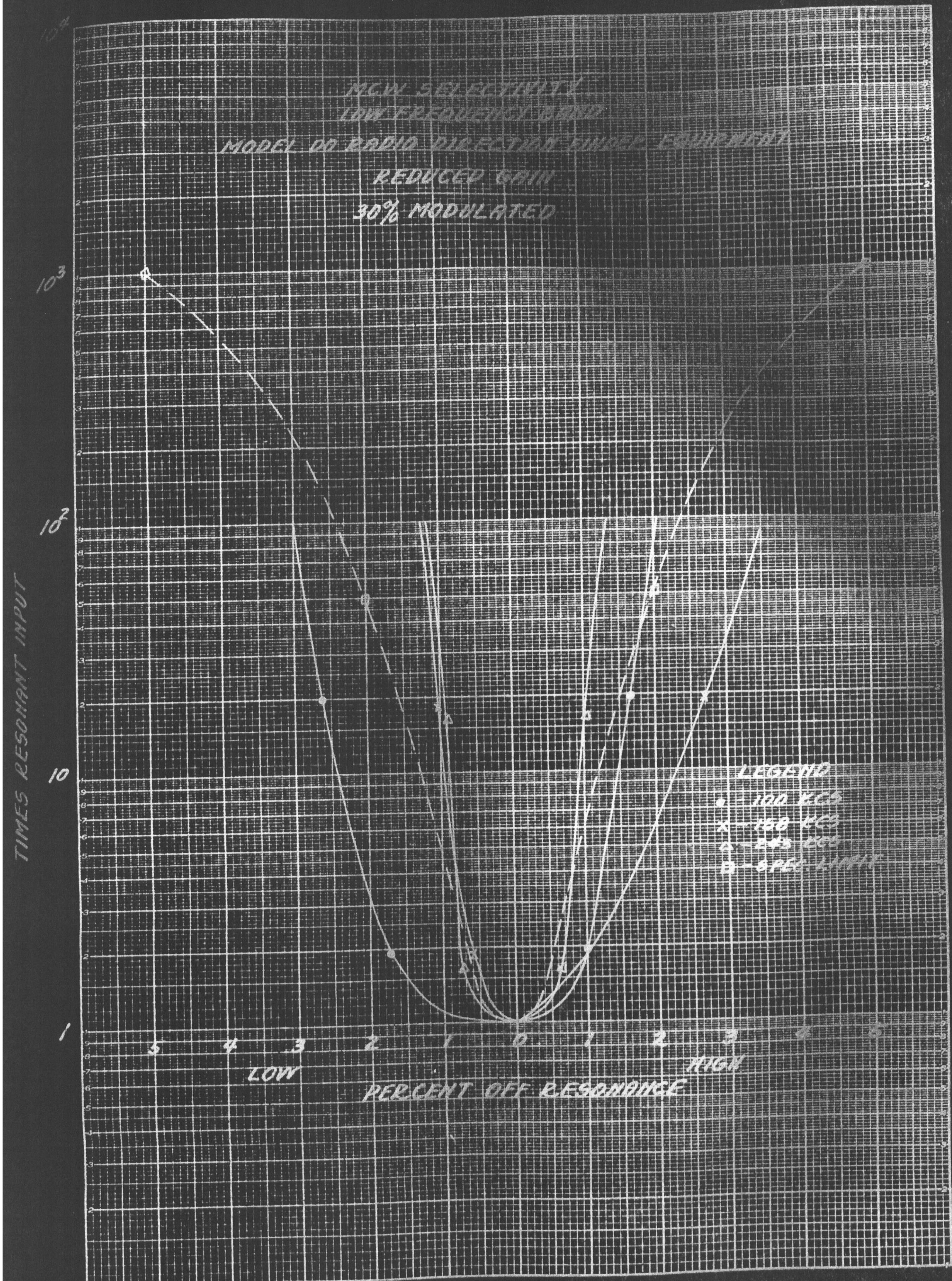

MCW SELECTIVITY
LOW FREQUENCY BAND
MODEL DQ RADIO DIRECTION FINDER EQUIPMENT
REDUCED GAIN
30% MODULATED
TIMES RESONANT INPUT
10
1
5
4
3
2
1
0
1
2
3
LOW
HIGH
PERCENT OFF RESONANCE
LEGEND
• – 100 KCS
X – 168 KCS
□ – SPEC. LIMIT

PLATE 59

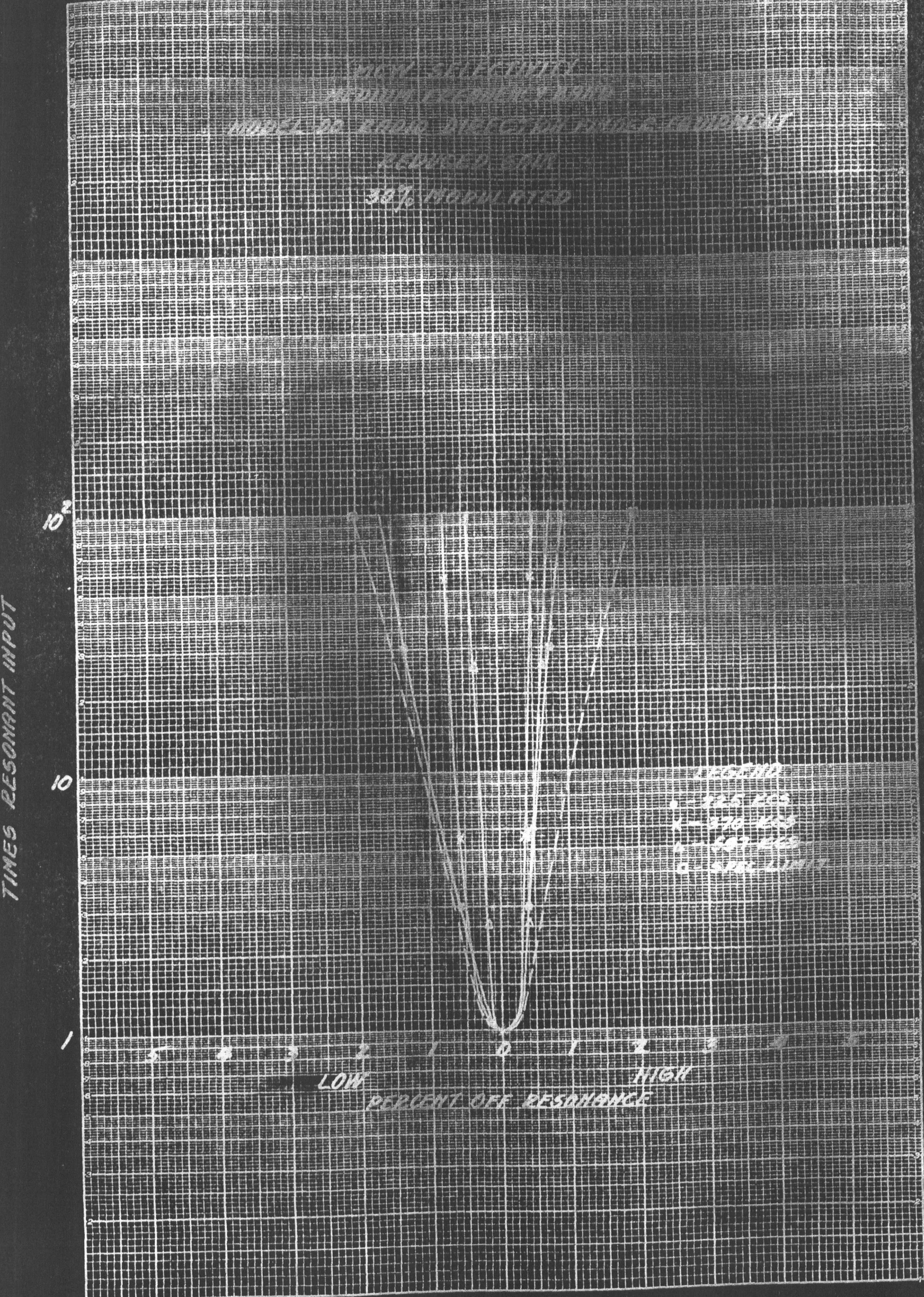

MEDIUM FREQUENCY BAND
REVISED GAIN
30% MODULATED
LEGEND
TIMES RESONANT INPUT
10²
10
1
5 4 3 2 1 0 1 2 3 4 5
LOW
HIGH
PERCENT OFF RESONANCE

PLATE 60

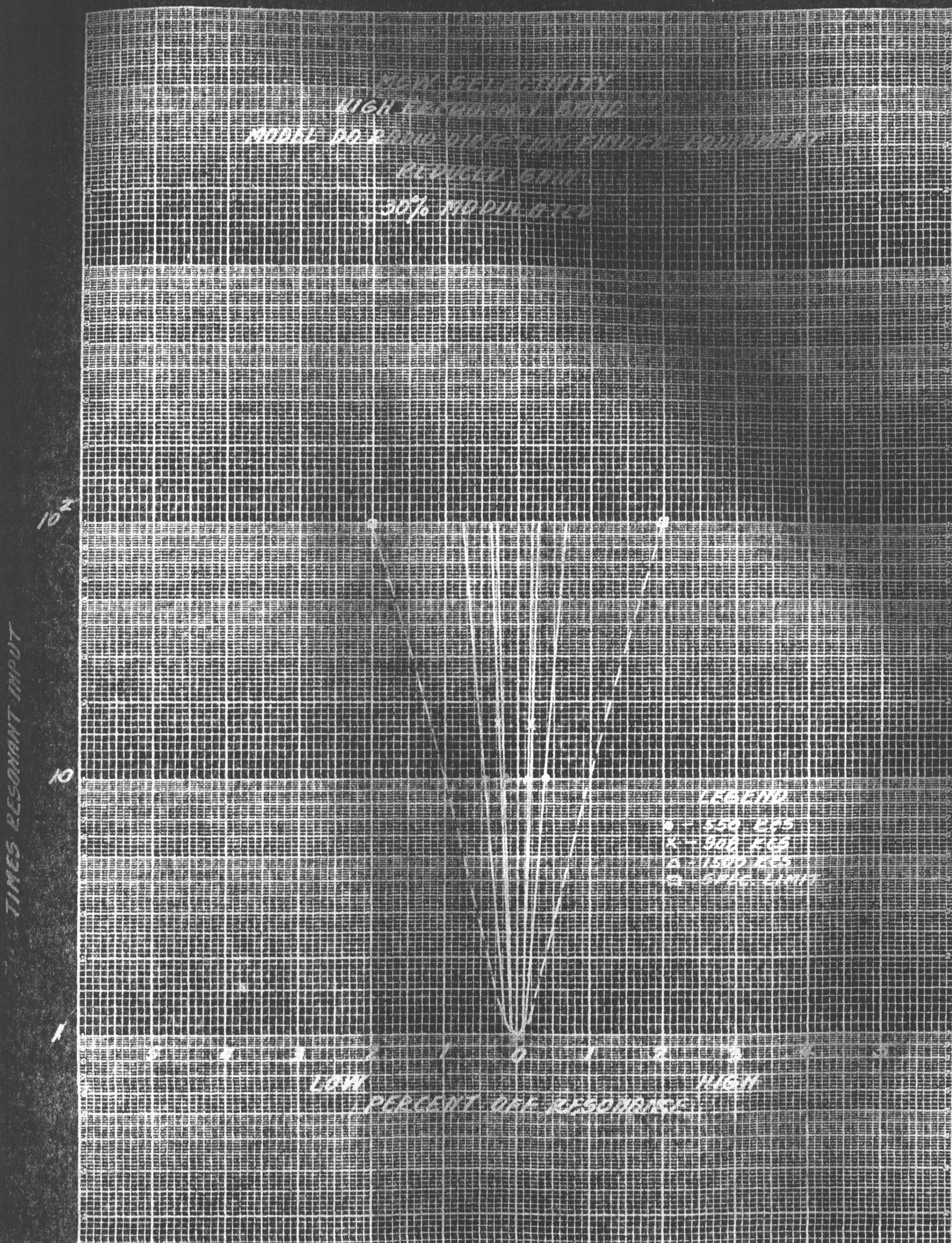

SELECTIVITY
HIGH BAND
MODEL DO
REDUCED GAIN
30% MODULATED
10^2
10
1
TIMES RESONANT INPUT
5 4 3 2 1 0 1 2 3 4 5
LOW
HIGH
PERCENT OFF RESONANCE
LEGEND
• - 550 KCS
X - 900 KCS
Δ - 1500 KCS
□ - SPEC. LIMIT

PLATE 61

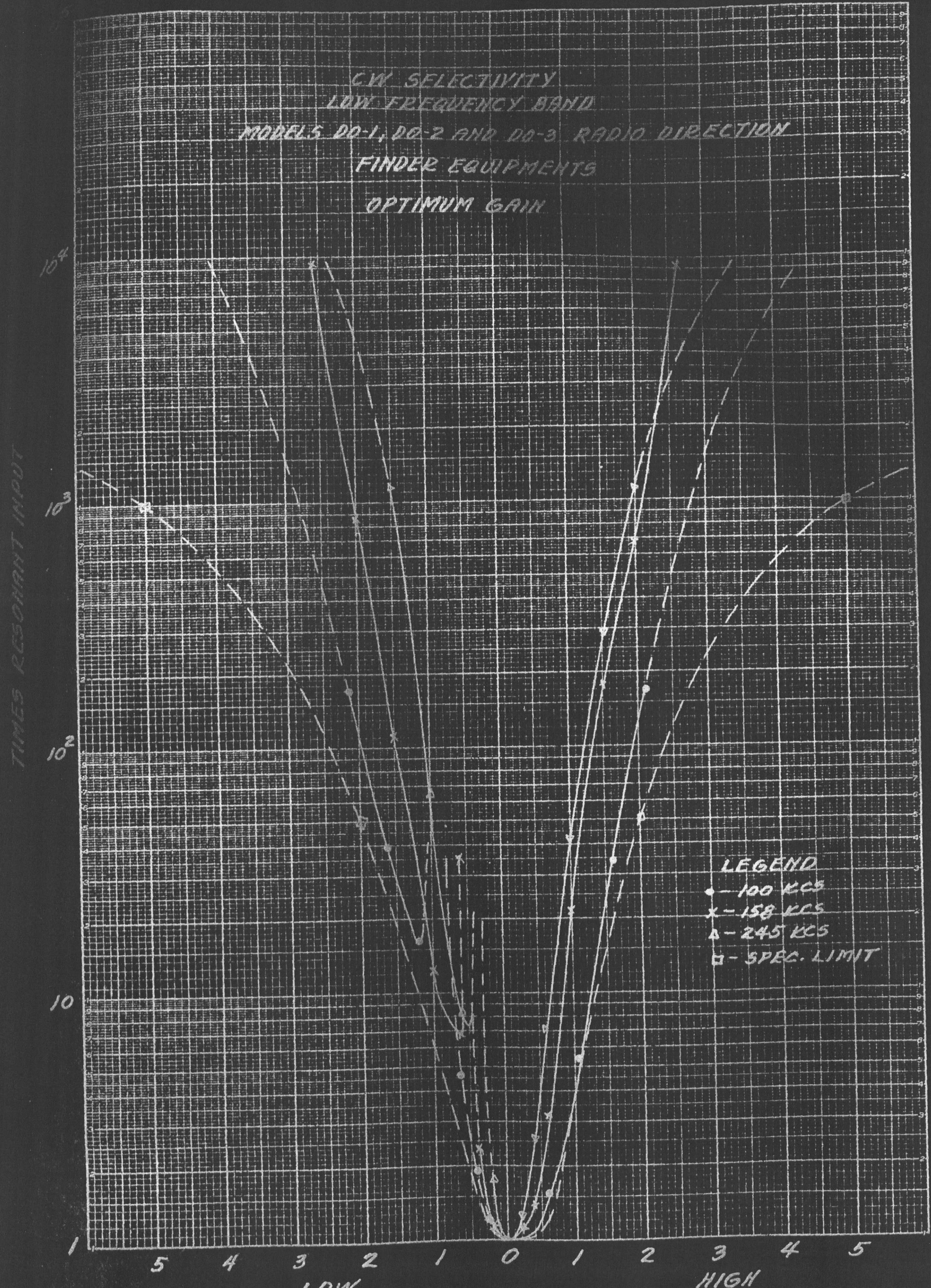
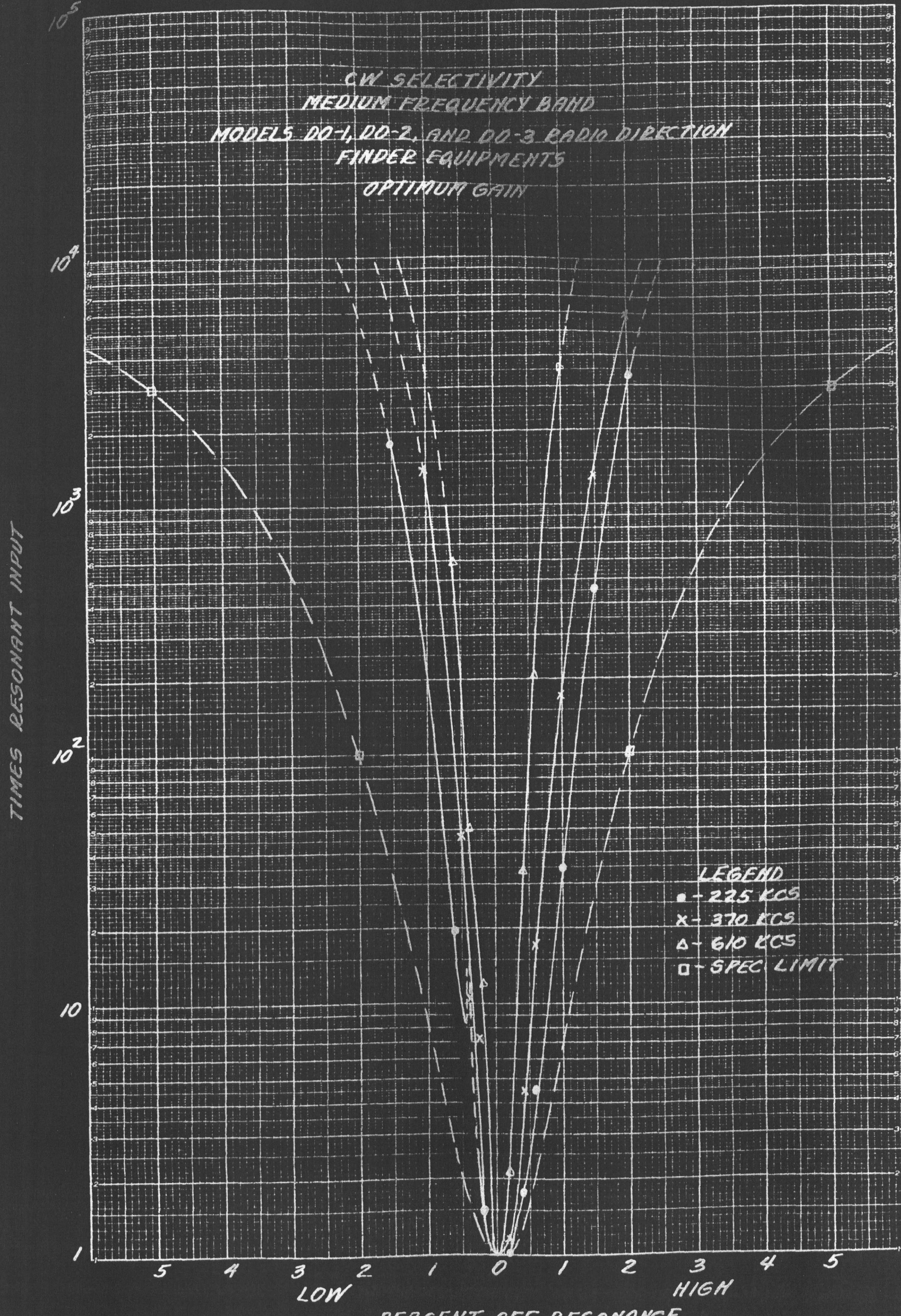

CW SELECTIVITY
LOW FREQUENCY BAND
MODELS DO-1, DO-2 AND DO-3 RADIO DIRECTION
FINDER EQUIPMENTS
OPTIMUM GAIN
TIMES RESONANT INPUT
10^4
10^3
10^2
10
1
5 4 3 2 1 0 1 2 3 4 5
LOW
HIGH
PERCENT OFF RESONANCE
LEGEND
● - 100 KCS
× - 158 KCS
△ - 245 KCS
□ - SPEC. LIMIT

PLATE 62



CW SELECTIVITY
MEDIUM FREQUENCY BAND
MODELS DO-1, DO-2, AND DO-3 RADIO DIRECTION
FINDER EQUIPMENTS
OPTIMUM GAIN
TIMES RESONANT INPUT
10^5
10^4
10^3
10^2
10
1
LEGEND
● - 225 KCS
X - 370 KCS
Δ - 610 KCS
□ - SPEC LIMIT
5 4 3 2 1 0 1 2 3 4 5
LOW
HIGH
PERCENT OFF RESONANCE

PLATE 63

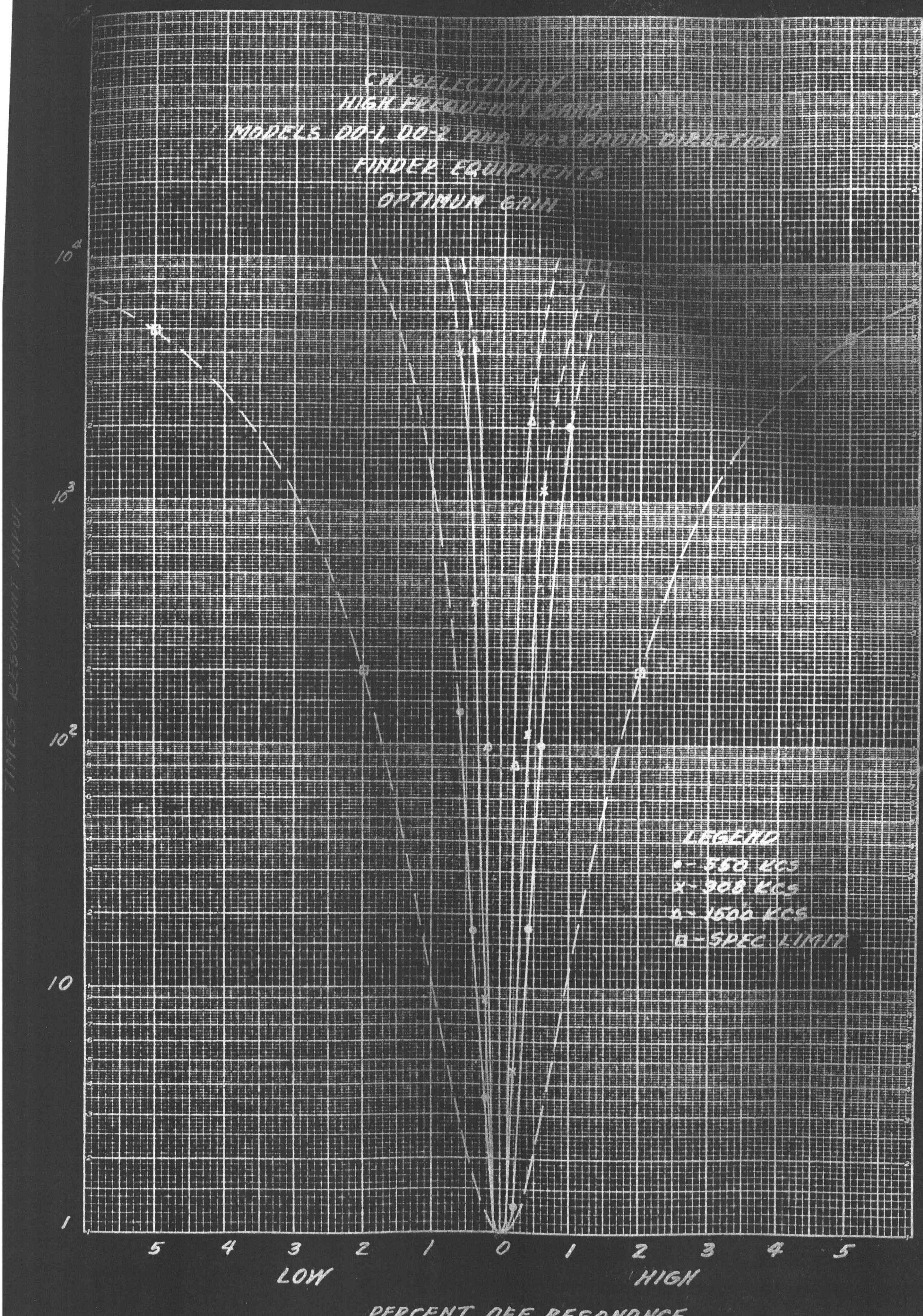
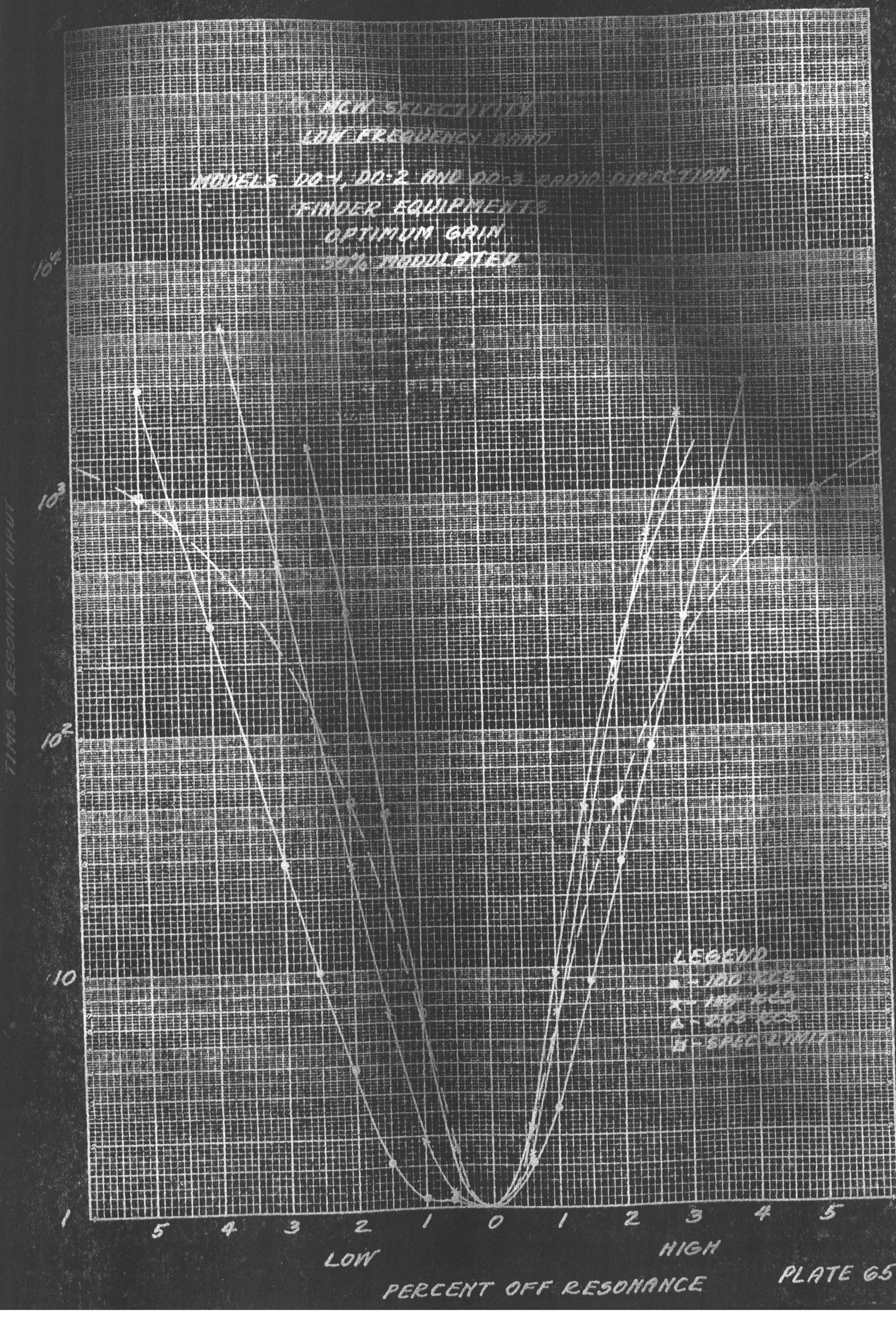

CW SELECTIVITY
HIGH FREQUENCY BAND
MODELS DO-1, DO-2 AND DO-3 RADIO DIRECTION
FINDER EQUIPMENTS
OPTIMUM GAIN
10^5
10^4
10^3
10^2
10
1
TIMES RESONANT INPUT
LEGEND
• - 550 KCS
x - 908 KCS
Δ - 1600 KCS
□ - SPEC. LIMIT
5 4 3 2 1 0 1 2 3 4 5
LOW
HIGH
PERCENT OFF RESONANCE

PLATE 64



MCW SELECTIVITY
LOW FREQUENCY BAND
MODELS DO-1, DO-2 AND DO-3 RADIO DIRECTION
FINDER EQUIPMENTS
OPTIMUM GAIN
30% MODULATED
LEGEND
SPEC LIMIT
TIMES RESONANT INPUT
10^4
10^3
10^2
10
1
5 4 3 2 1 0 1 2 3 4 5
LOW
HIGH
PERCENT OFF RESONANCE

PLATE 65

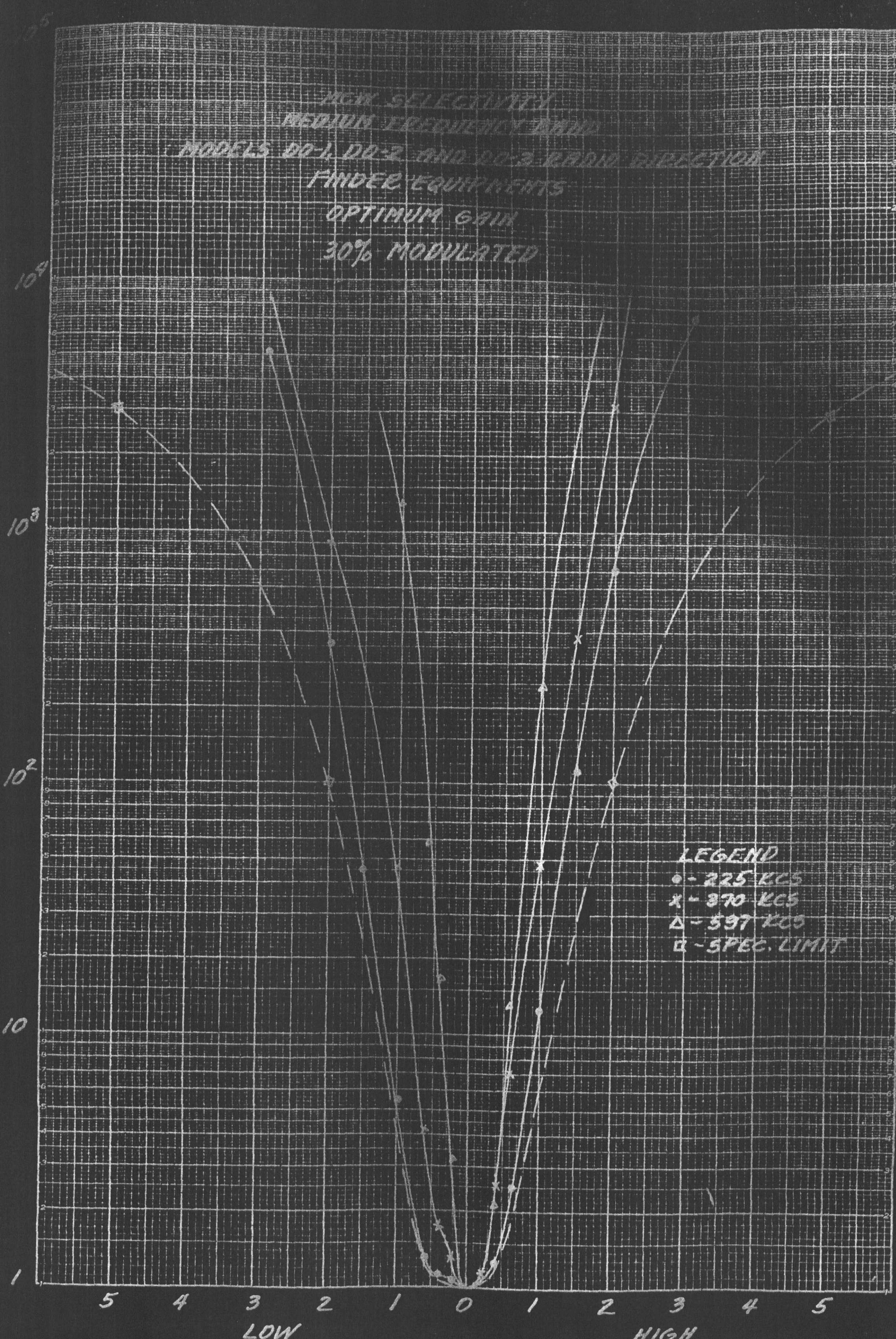

MCW SELECTIVITY
MEDIUM FREQUENCY BAND
MODELS DD-1, DD-2 AND DD-3 RADIO DIRECTION
FINDER EQUIPMENTS
OPTIMUM GAIN
30% MODULATED
LEGEND
● - 225 KCS
x - 370 KCS
Δ - 597 KCS
□ - SPEC. LIMIT
TIMES RESONANT INPUT
10^5
10^4
10^3
10^2
10
1
5 4 3 2 1 0 1 2 3 4 5
LOW
HIGH
PERCENT OFF RESONANCE

PLATE 66

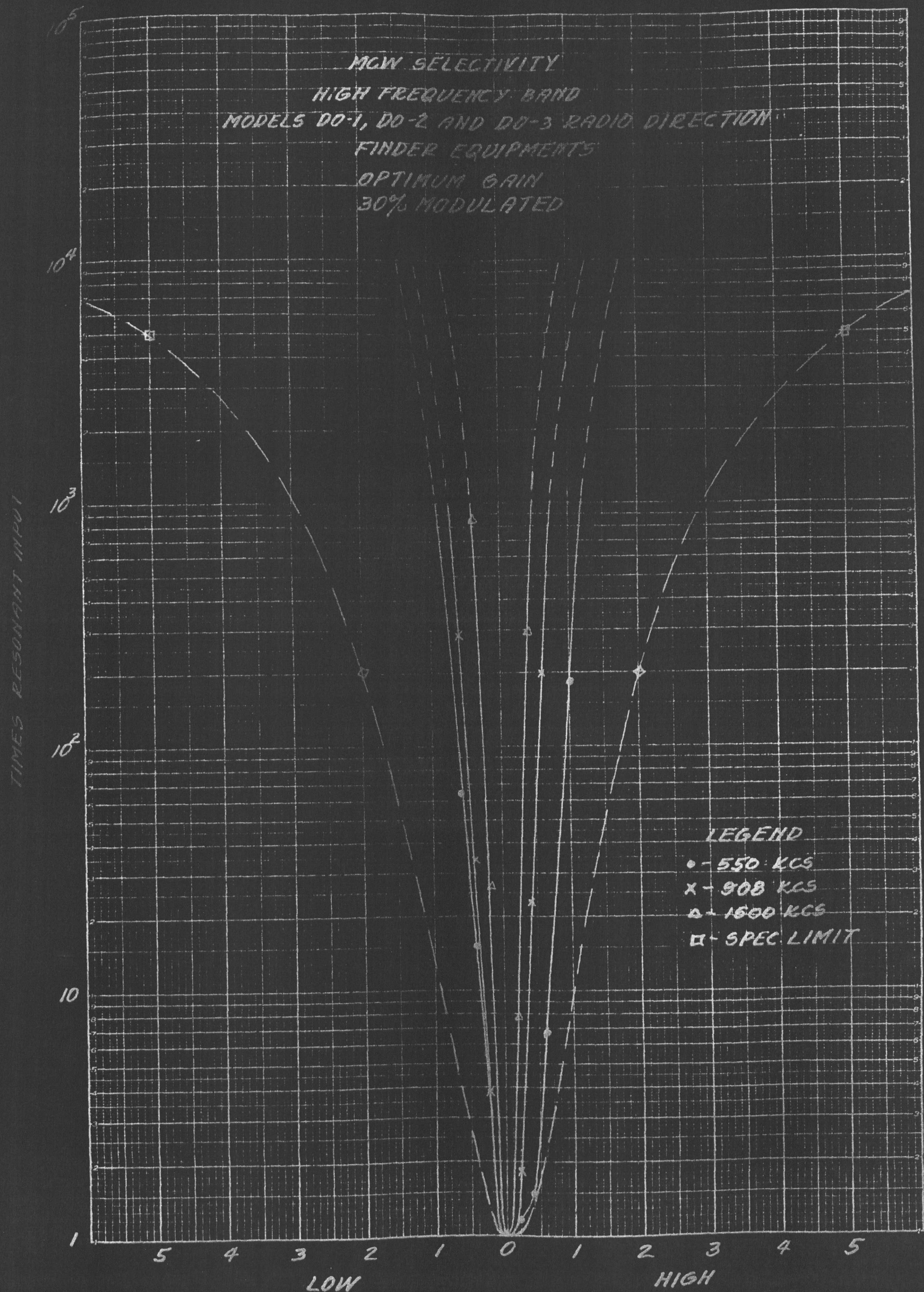
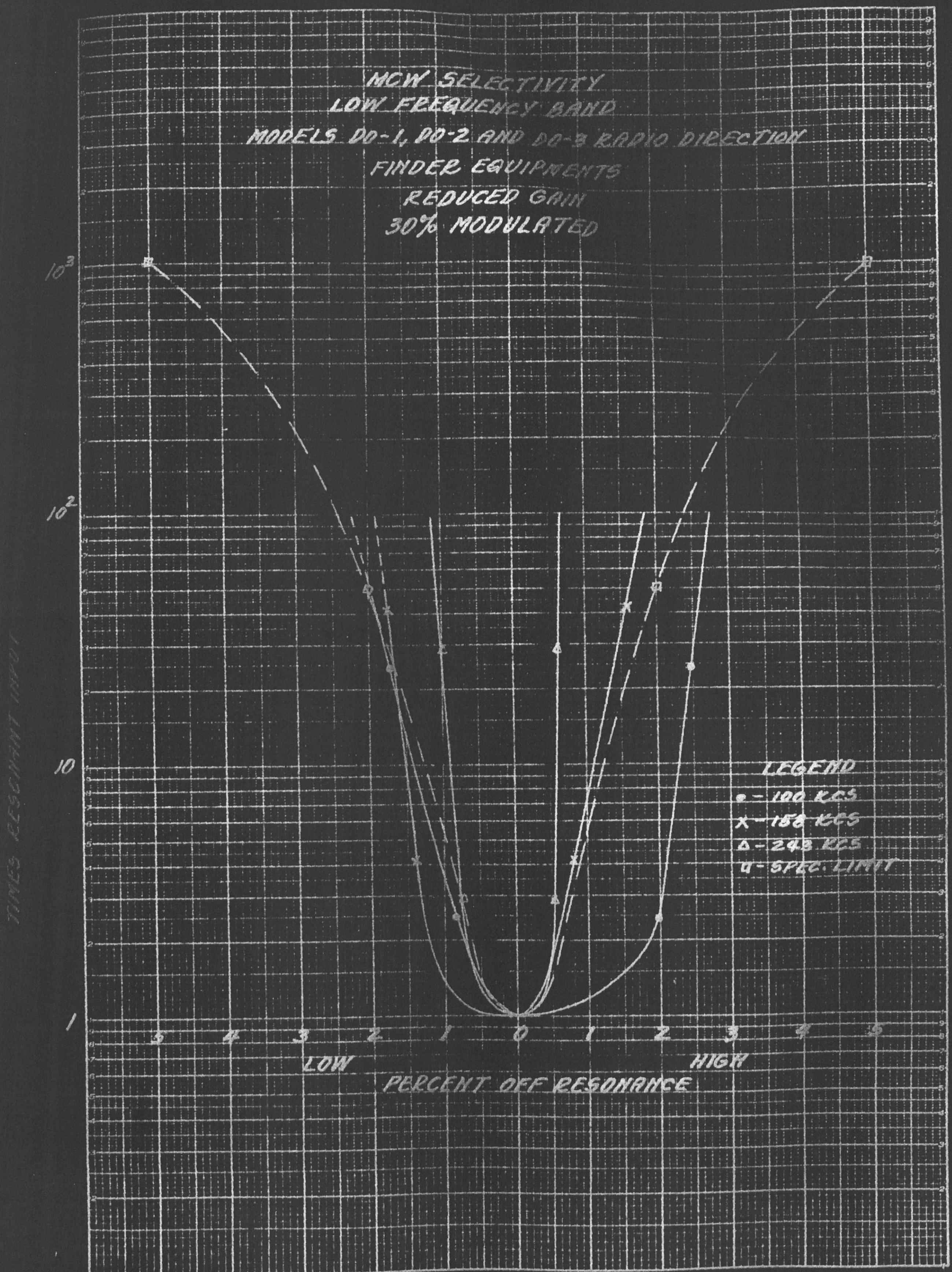
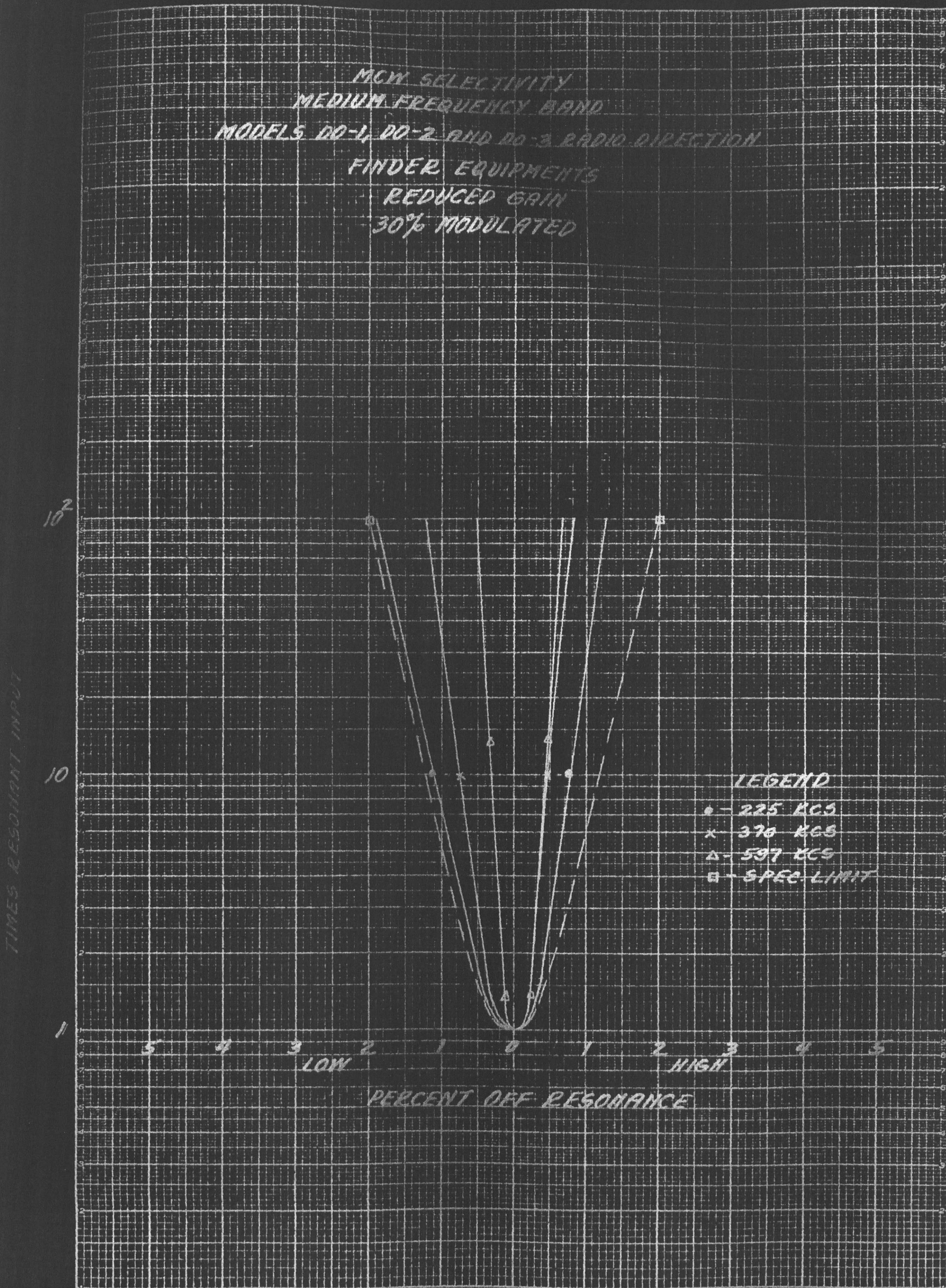

MCW SELECTIVITY
HIGH FREQUENCY BAND
MODELS DO-1, DO-2 AND DO-3 RADIO DIRECTION
FINDER EQUIPMENTS
OPTIMUM GAIN
30% MODULATED
TIMES RESONANT INPUT
10^5
10^4
10^3
10^2
10
1
5 4 3 2 1 0 1 2 3 4 5
LOW
HIGH
LEGEND
• - 550 KCS
X - 908 KCS
Δ - 1600 KCS
□ - SPEC LIMIT
PERCENT OFF RESONANCE

PLATE 67

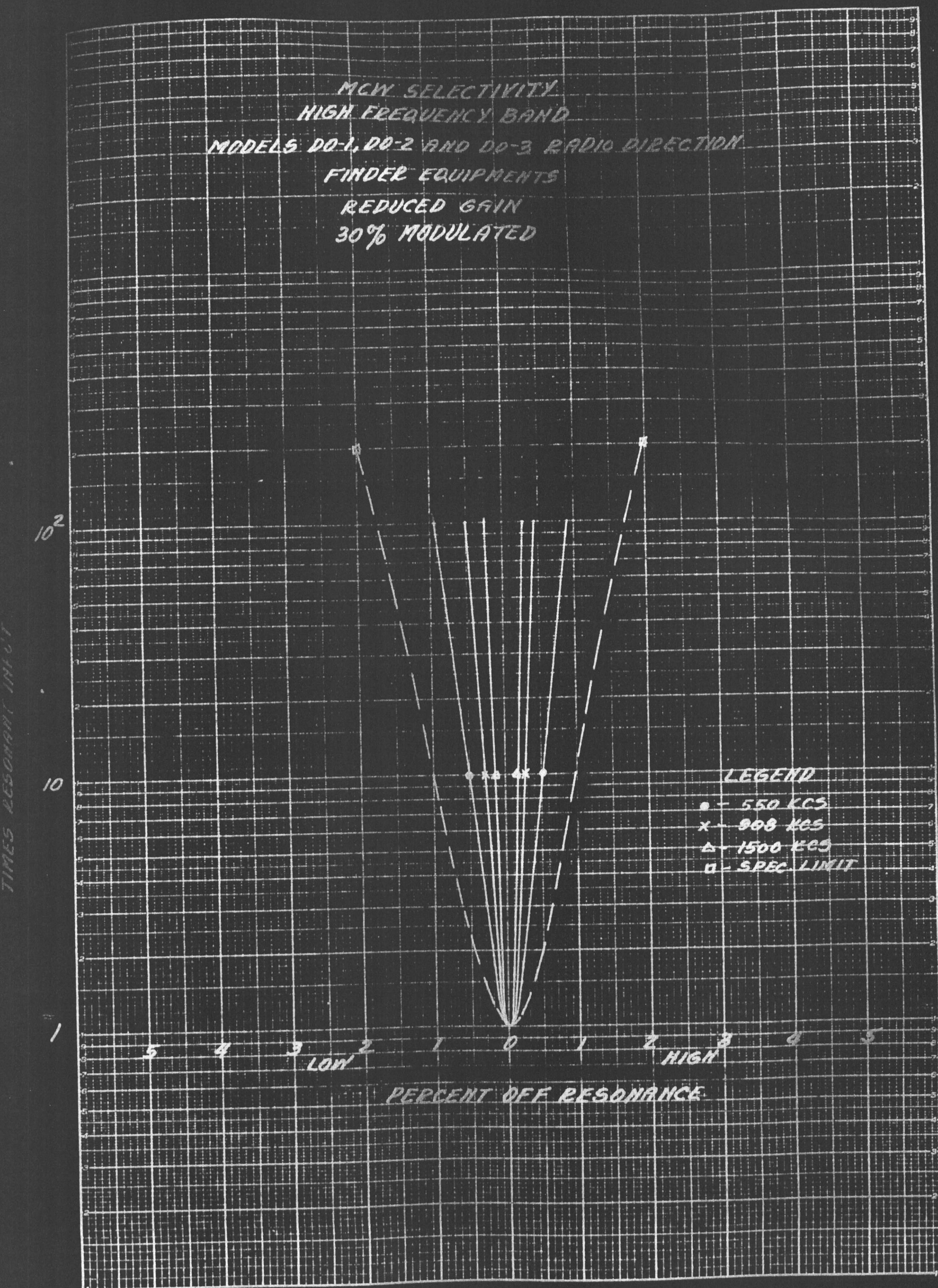


MCW SELECTIVITY
LOW FREQUENCY BAND
MODELS DO-1, DO-2 AND DO-3 RADIO DIRECTION
FINDER EQUIPMENTS
REDUCED GAIN
30% MODULATED
10^3
10^2
10
1
TIMES RESONANT INPUT
5 4 3 2 1 0 1 2 3 4 5
LOW
HIGH
PERCENT OFF RESONANCE
LEGEND
• - 100 KCS
X - 158 KCS
Δ - 248 KCS
□ - SPEC. LIMIT



MCW SELECTIVITY
MEDIUM FREQUENCY BAND
MODELS DO-1, DO-2 AND DO-3 RADIO DIRECTION
FINDER EQUIPMENTS
REDUCED GAIN
30% MODULATED
TIMES RESONANT INPUT
10^2
10
1
5 4 3 2 1 0 1 2 3 4 5
LOW
HIGH
PERCENT OFF RESONANCE
LEGEND
• - 225 KCS
× - 370 KCS
Δ - 597 KCS
□ - SPEC. LIMIT

PLATE 69


MCW SELECTIVITY
HIGH FREQUENCY BAND
MODELS DQ-1, DQ-2 AND DQ-3 RADIO DIRECTION
FINDER EQUIPMENTS
REDUCED GAIN
30% MODULATED
TIMES RESONANT INPUT
10^2
10
1
5
4
3
2
1
0
1
2
3
4
5
LOW
HIGH
PERCENT OFF RESONANCE
LEGEND
● - 550 KCS
x - 908 KCS
△ - 1500 KCS
□ - SPEC. LIMIT

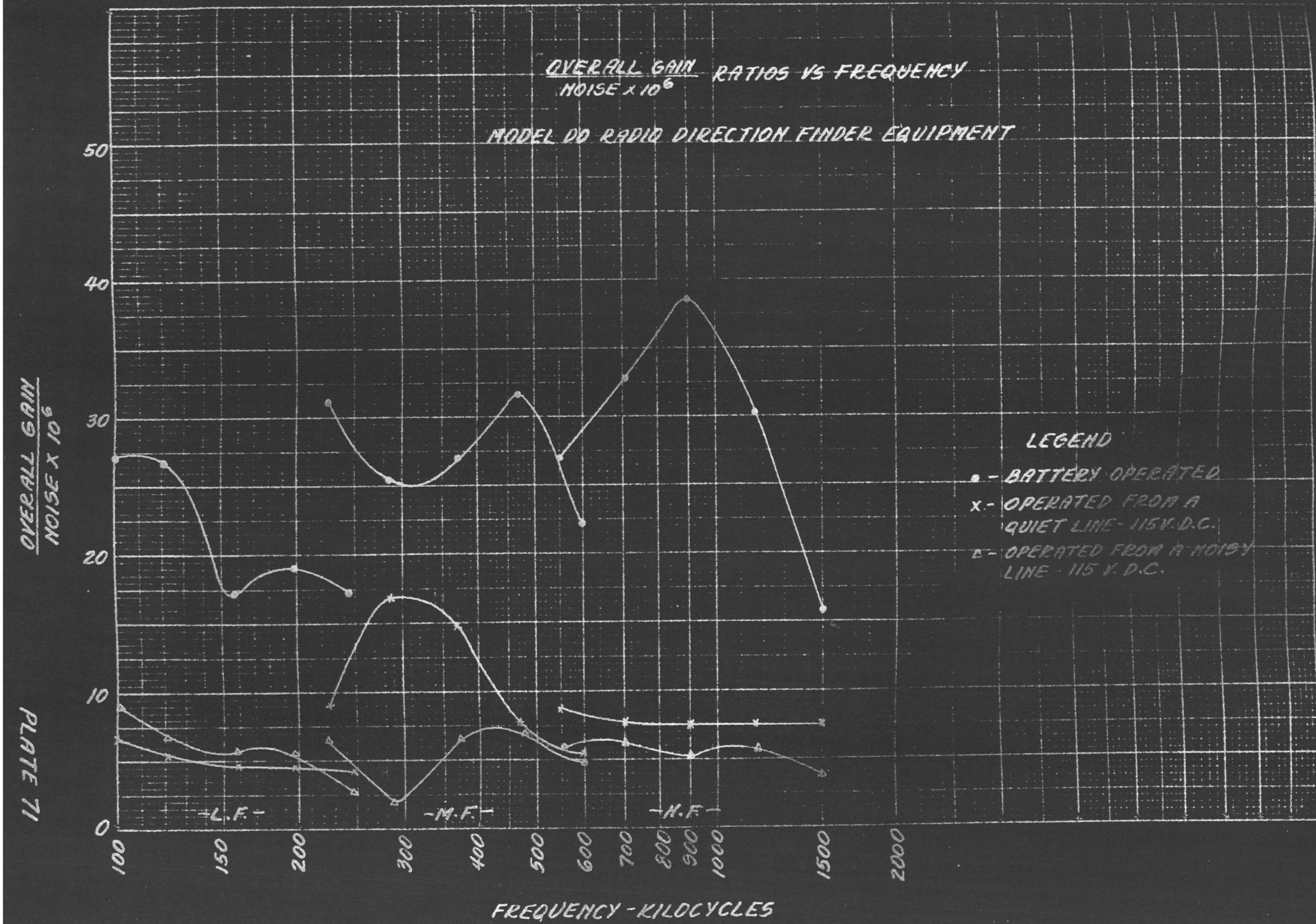

OVERALL GAIN / NOISE x 10^6 RATIOS VS FREQUENCY
MODEL DD RADIO DIRECTION FINDER EQUIPMENT
LEGEND
• - BATTERY OPERATED
x - OPERATED FROM A QUIET LINE - 115 V. D.C.
Δ - OPERATED FROM A NOISY LINE - 115 V. D.C.
-L.F.-
-M.F.-
-H.F.-
0
10
20
30
40
50
100
150
200
300
400
500
600
700
800
900
1000
1500
2000
OVERALL GAIN / NOISE x 10^6
FREQUENCY - KILOCYCLES

PLATE 71

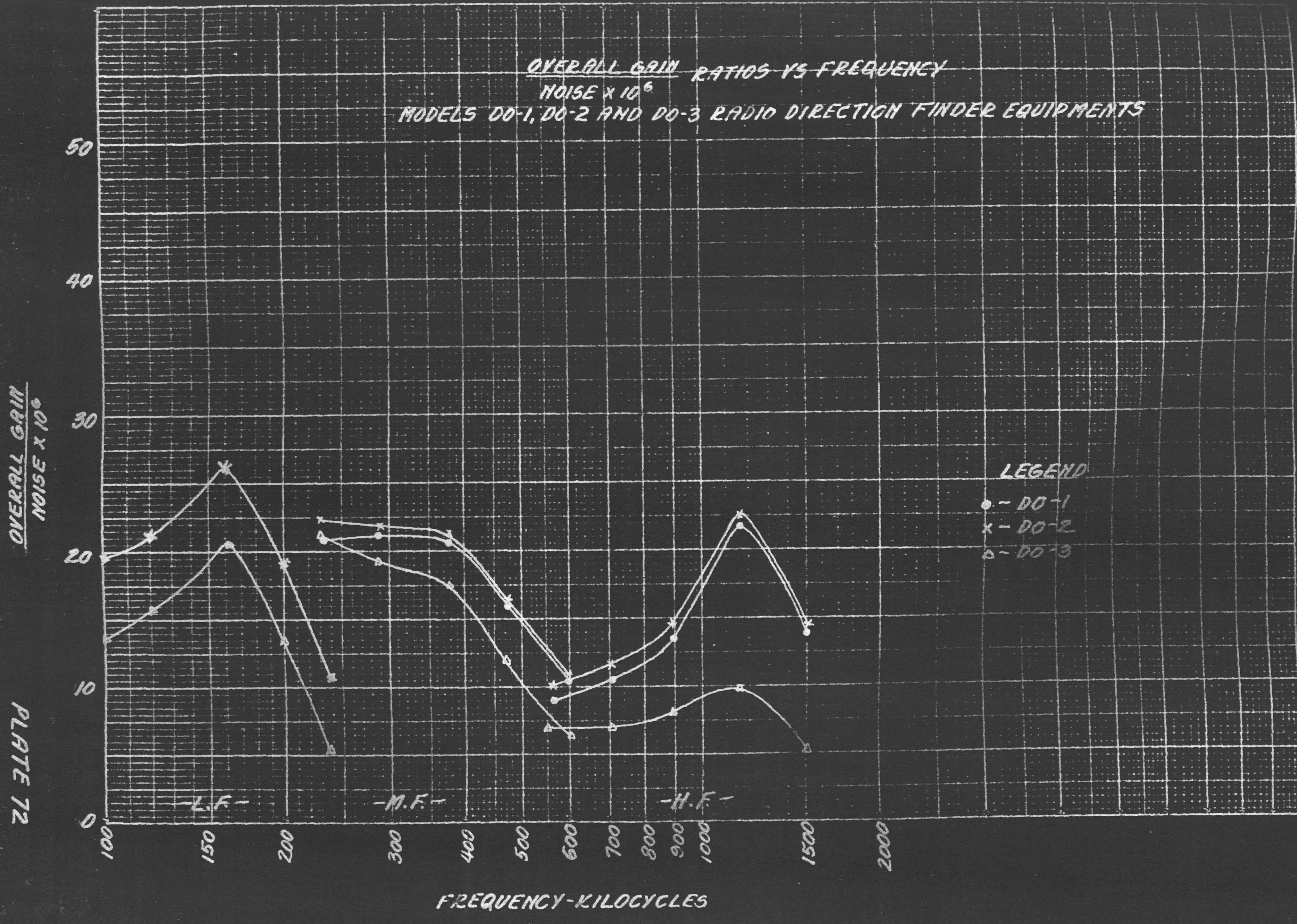
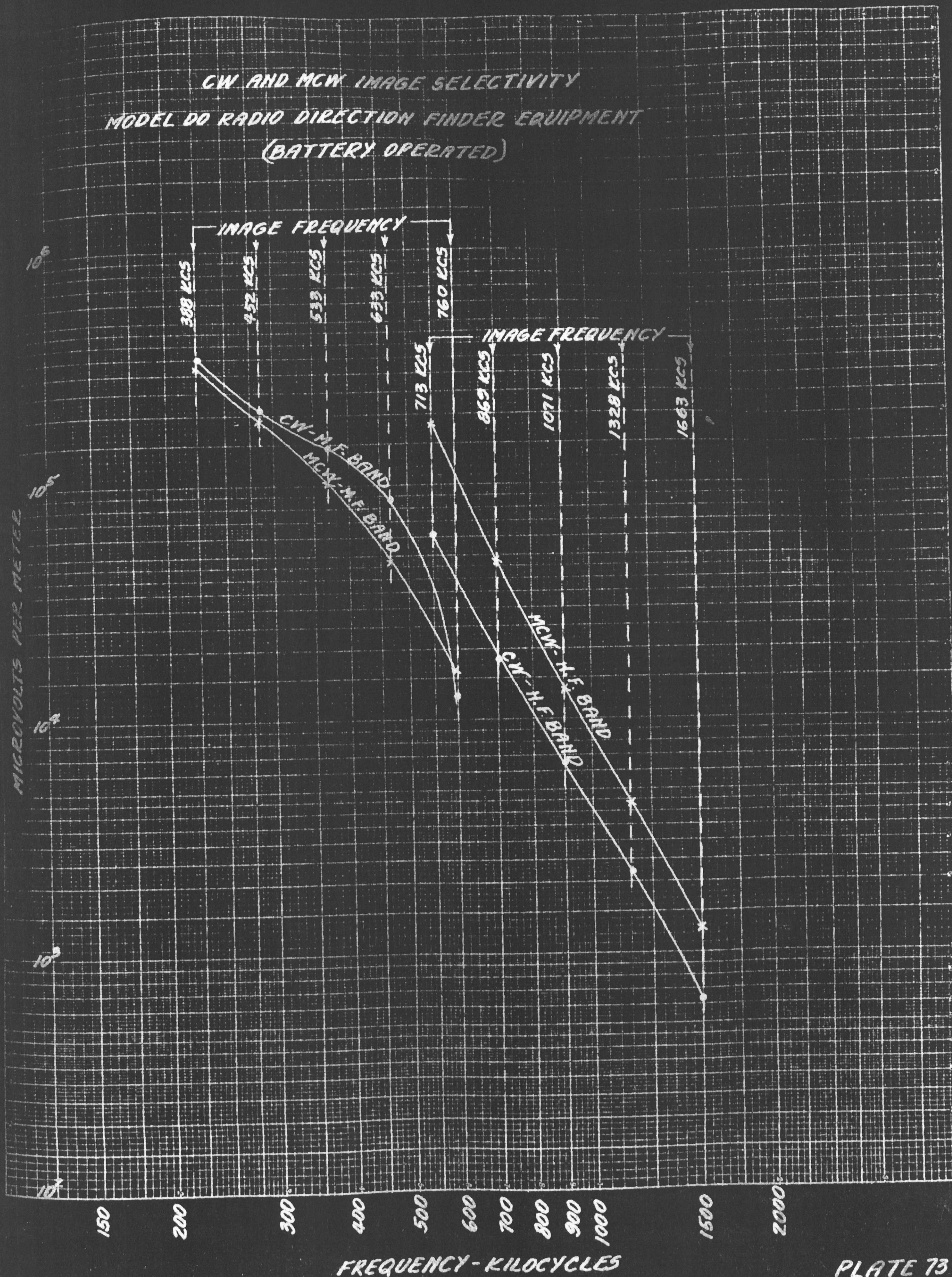
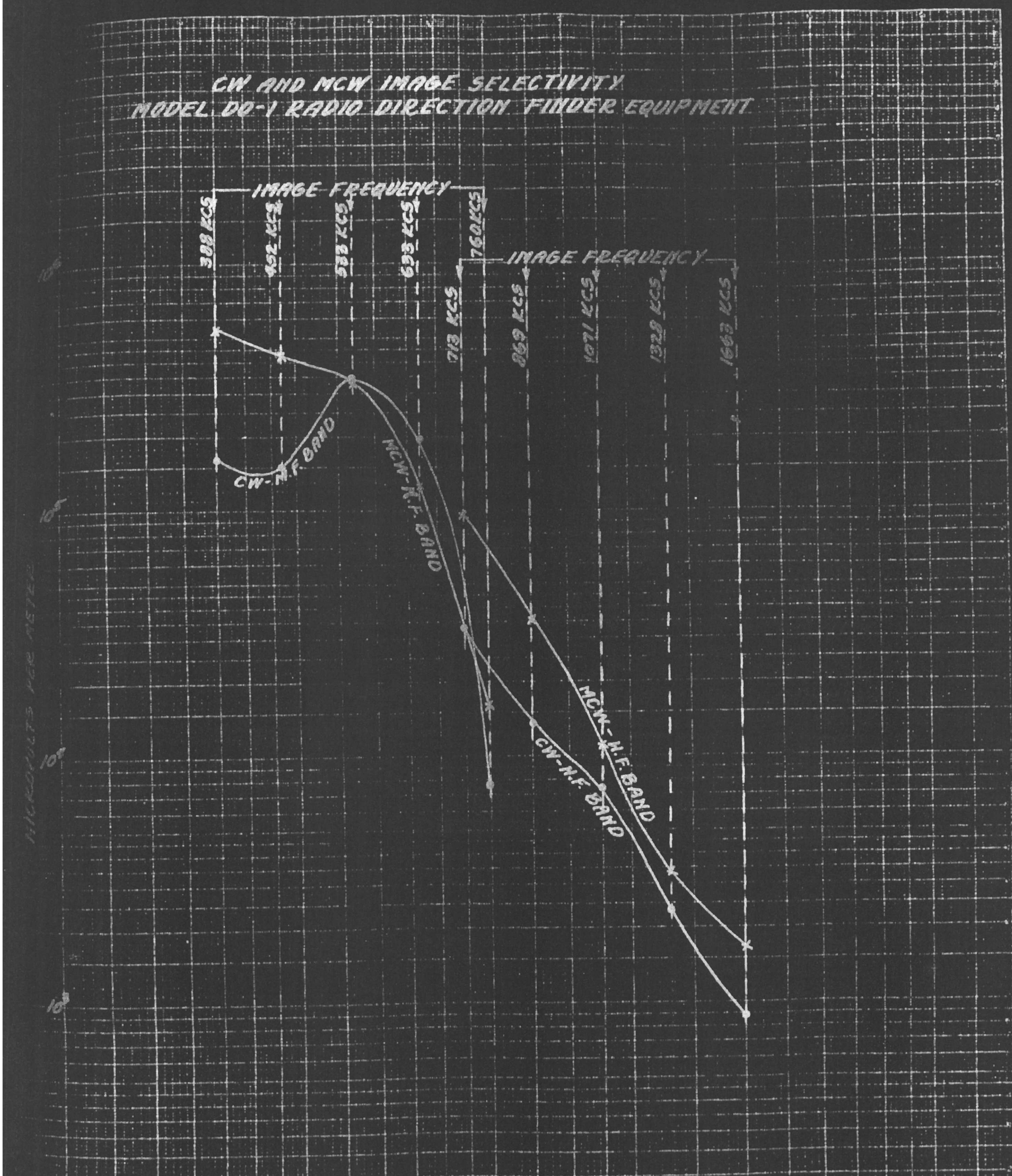

OVERALL GAIN / NOISE x 10^6 RATIOS VS FREQUENCY
MODELS DO-1, DO-2 AND DO-3 RADIO DIRECTION FINDER EQUIPMENTS
LEGEND
● - DO-1
x - DO-2
△ - DO-3
OVERALL GAIN / NOISE x 10^6
0
10
20
30
40
50
100
150
200
300
400
500
600
700
800
900
1000
1500
2000
-L.F.-
-M.F.-
-H.F.-
FREQUENCY-KILOCYCLES

PLATE 72



CW AND MCW IMAGE SELECTIVITY
MODEL DO RADIO DIRECTION FINDER EQUIPMENT
(BATTERY OPERATED)
IMAGE FREQUENCY
388 KCS
452 KCS
533 KCS
633 KCS
760 KCS
IMAGE FREQUENCY
713 KCS
869 KCS
1071 KCS
1328 KCS
1663 KCS
CW-M.F. BAND
MCW-M.F. BAND
MCW-H.F. BAND
CW-H.F. BAND
MICROVOLTS PER METER
150
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY - KILOCYCLES

PLATE 73



CW AND MCW IMAGE SELECTIVITY
MODEL DO-1 RADIO DIRECTION FINDER EQUIPMENT
IMAGE FREQUENCY
388 KCS
452 KCS
538 KCS
638 KCS
760 KCS
IMAGE FREQUENCY
713 KCS
869 KCS
1071 KCS
1328 KCS
1663 KCS
CW-M.F. BAND
MCW-M.F. BAND
MCW-H.F. BAND
CW-H.F. BAND
MICROVOLTS PER METER
150
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY-KILOCYCLES

PLATE 74

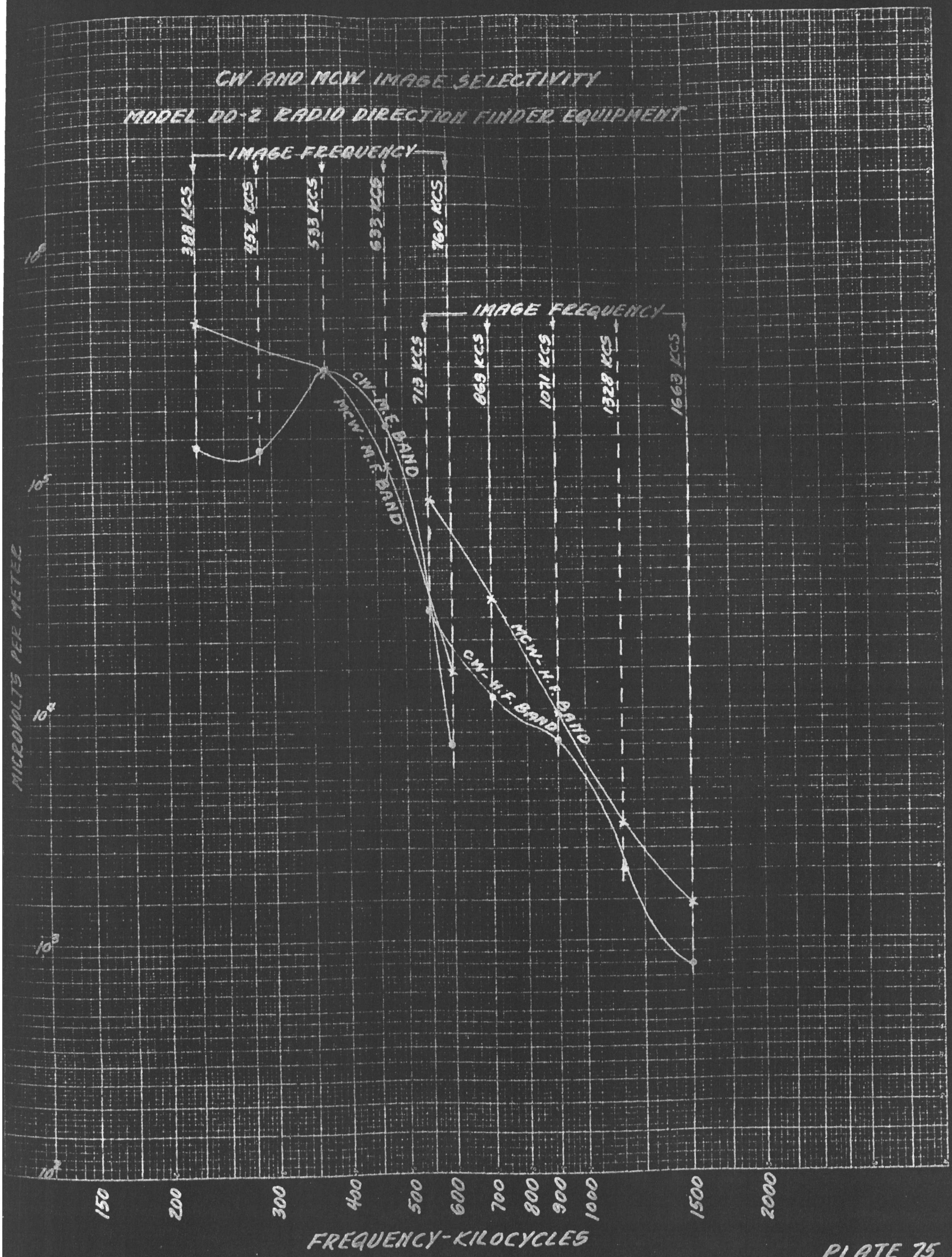

CW AND MCW IMAGE SELECTIVITY
MODEL DO-2 RADIO DIRECTION FINDER EQUIPMENT
IMAGE FREQUENCY
388 KCS
452 KCS
533 KCS
632 KCS
760 KCS
IMAGE FREQUENCY
713 KCS
869 KCS
1071 KCS
1328 KCS
1663 KCS
CW-M.F. BAND
MCW M.F. BAND
MCW-H.F. BAND
CW-H.F. BAND
MICROVOLTS PER METER
10⁶
10⁵
10⁴
10³
10²
150
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY-KILOCYCLES

PLATE 75

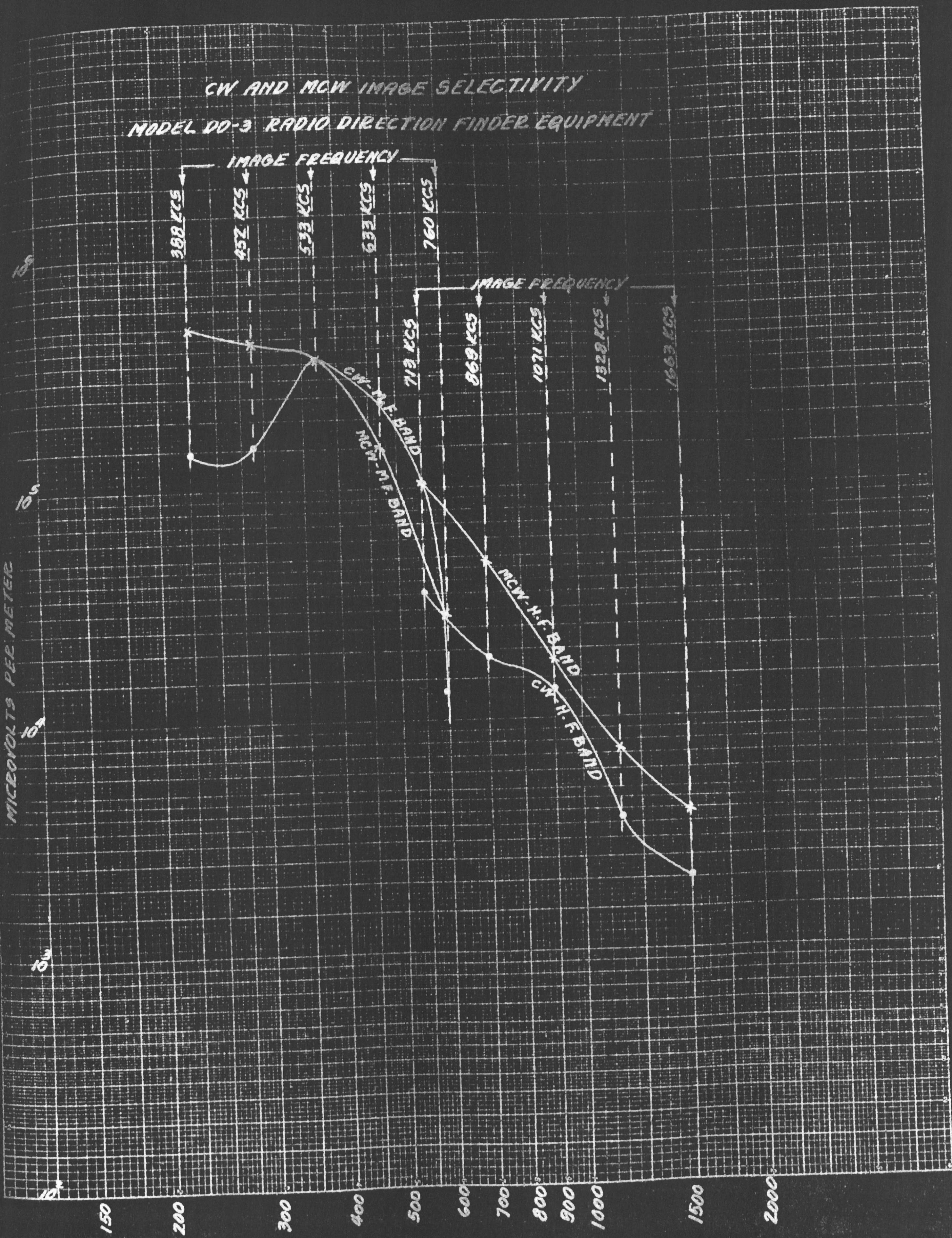

CW AND MCW IMAGE SELECTIVITY
MODEL DO-3 RADIO DIRECTION FINDER EQUIPMENT
IMAGE FREQUENCY
388 KCS
452 KCS
533 KCS
633 KCS
760 KCS
IMAGE FREQUENCY
713 KCS
869 KCS
1071 KCS
1328 KCS
1663 KCS
CW-M.F. BAND
MCW-M.F. BAND
MCW-H.F. BAND
CW-H.F. BAND
MICROVOLTS PER METER
10^6
10^5
10^4
10^3
10^2
150
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY - KILOCYCLES

PLATE 76

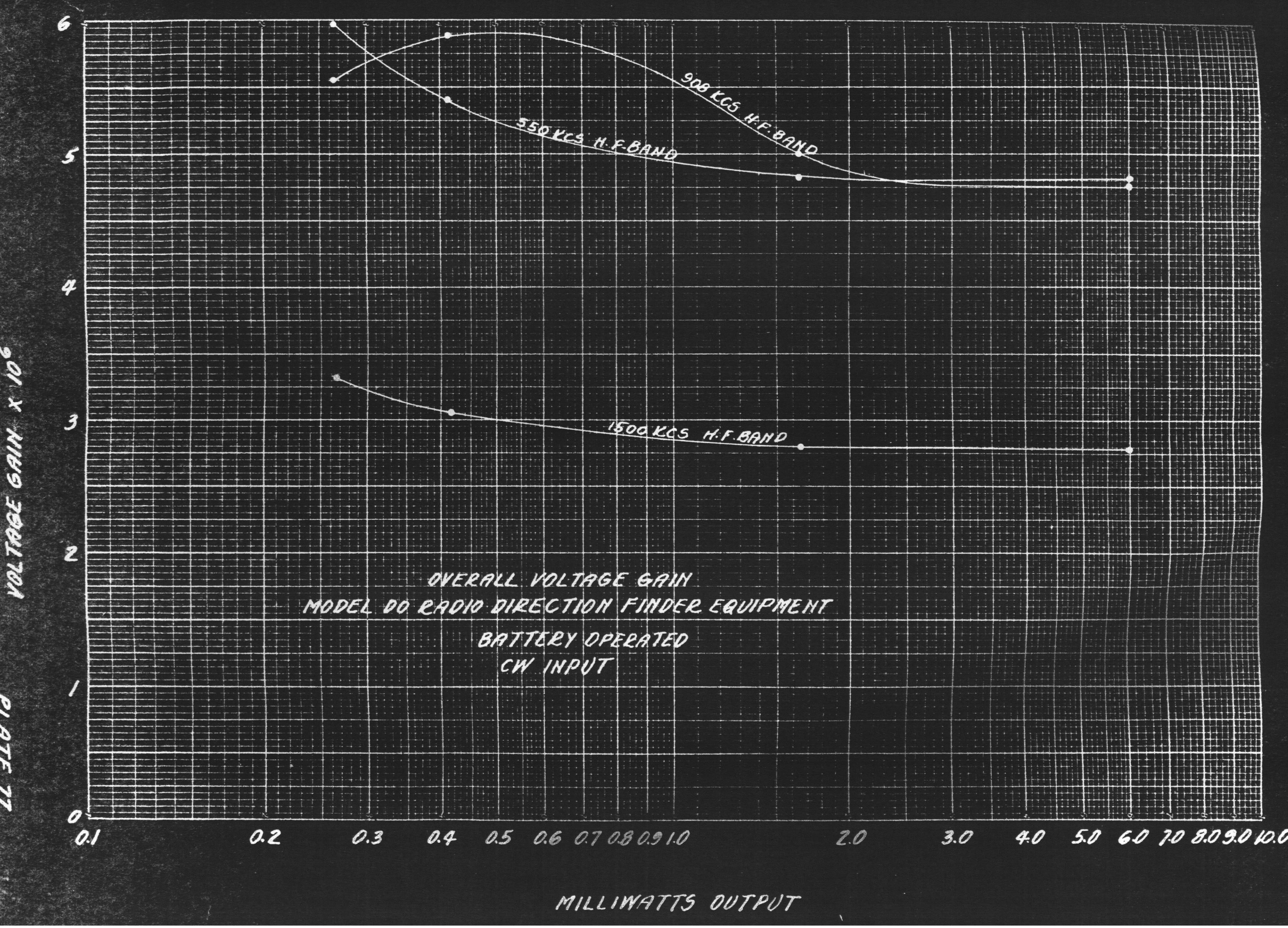
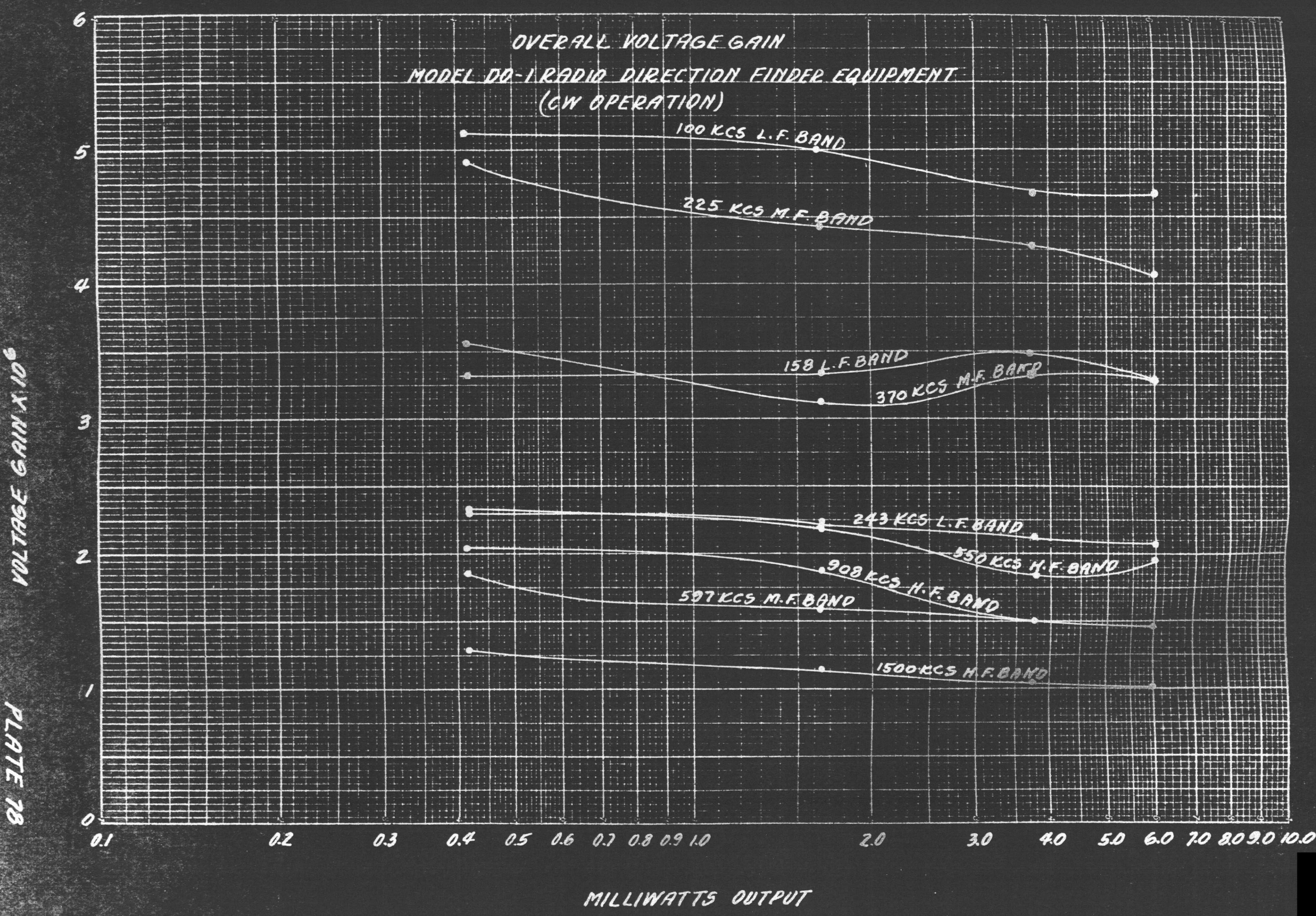

OVERALL VOLTAGE GAIN
MODEL DO RADIO DIRECTION FINDER EQUIPMENT
BATTERY OPERATED
CW INPUT
908 KCS H.F. BAND
550 KCS H.F. BAND
1500 KCS H.F. BAND
VOLTAGE GAIN X 10⁶
0
1
2
3
4
5
6
MILLIWATTS OUTPUT
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0

PLATE 77



OVERALL VOLTAGE GAIN
MODEL DO-1 RADIO DIRECTION FINDER EQUIPMENT
(CW OPERATION)
100 KCS L.F. BAND
225 KCS M.F. BAND
158 L.F. BAND
370 KCS M.F. BAND
243 KCS L.F. BAND
550 KCS H.F. BAND
908 KCS H.F. BAND
597 KCS M.F. BAND
1500 KCS M.F. BAND
VOLTAGE GAIN X 10⁶
MILLIWATTS OUTPUT
0
1
2
3
4
5
6
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0

PLATE 78

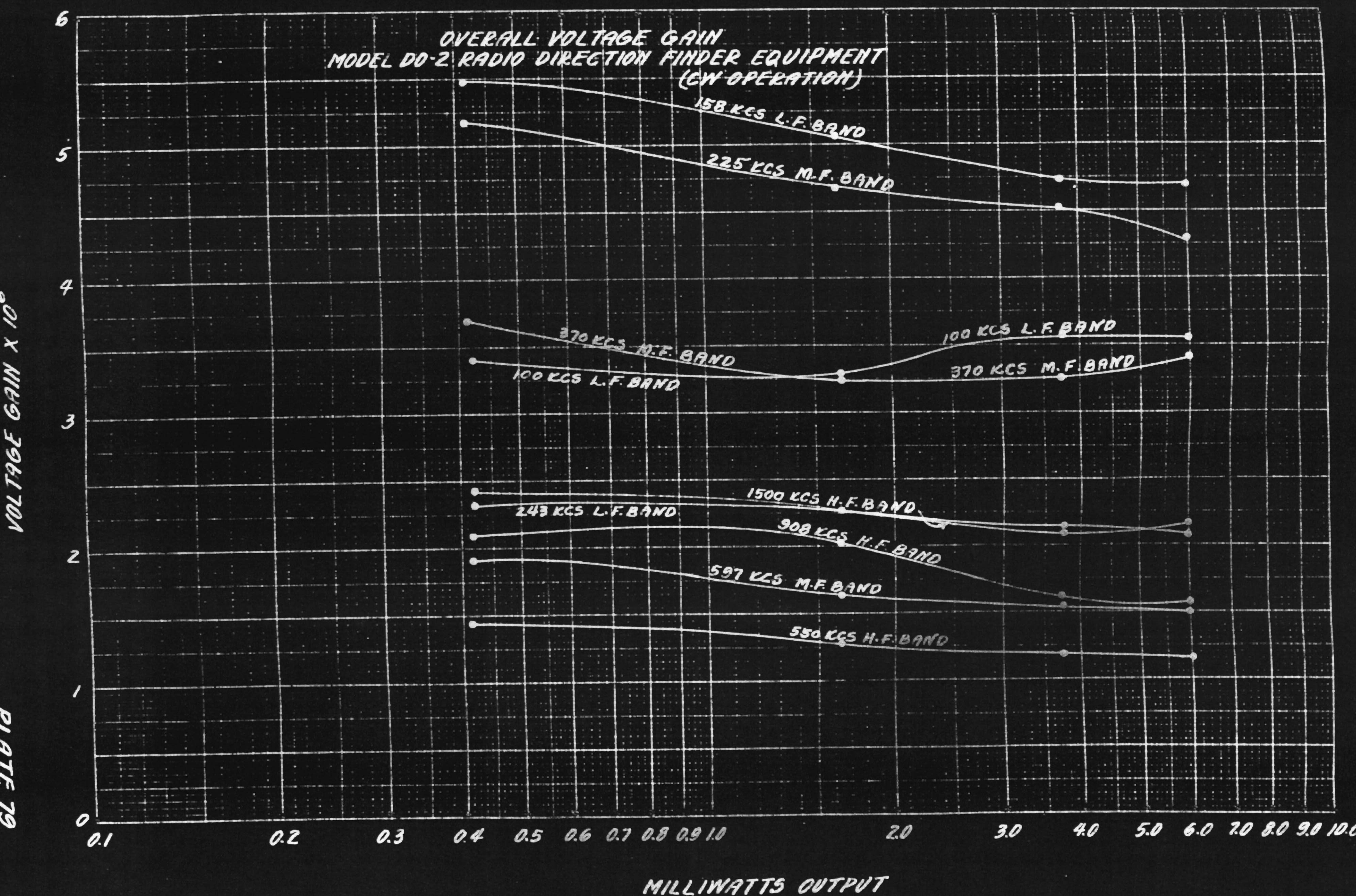

OVERALL VOLTAGE GAIN
MODEL DO-2 RADIO DIRECTION FINDER EQUIPMENT
(CW OPERATION)
158 KCS L.F. BAND
225 KCS M.F. BAND
370 KCS M.F. BAND
100 KCS L.F. BAND
100 KCS L.F. BAND
370 KCS M.F. BAND
1500 KCS H.F. BAND
243 KCS L.F. BAND
908 KCS H.F. BAND
597 KCS M.F. BAND
550 KCS H.F. BAND
VOLTAGE GAIN X 10⁶
0
1
2
3
4
5
6
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
MILLIWATTS OUTPUT

PLATE 79

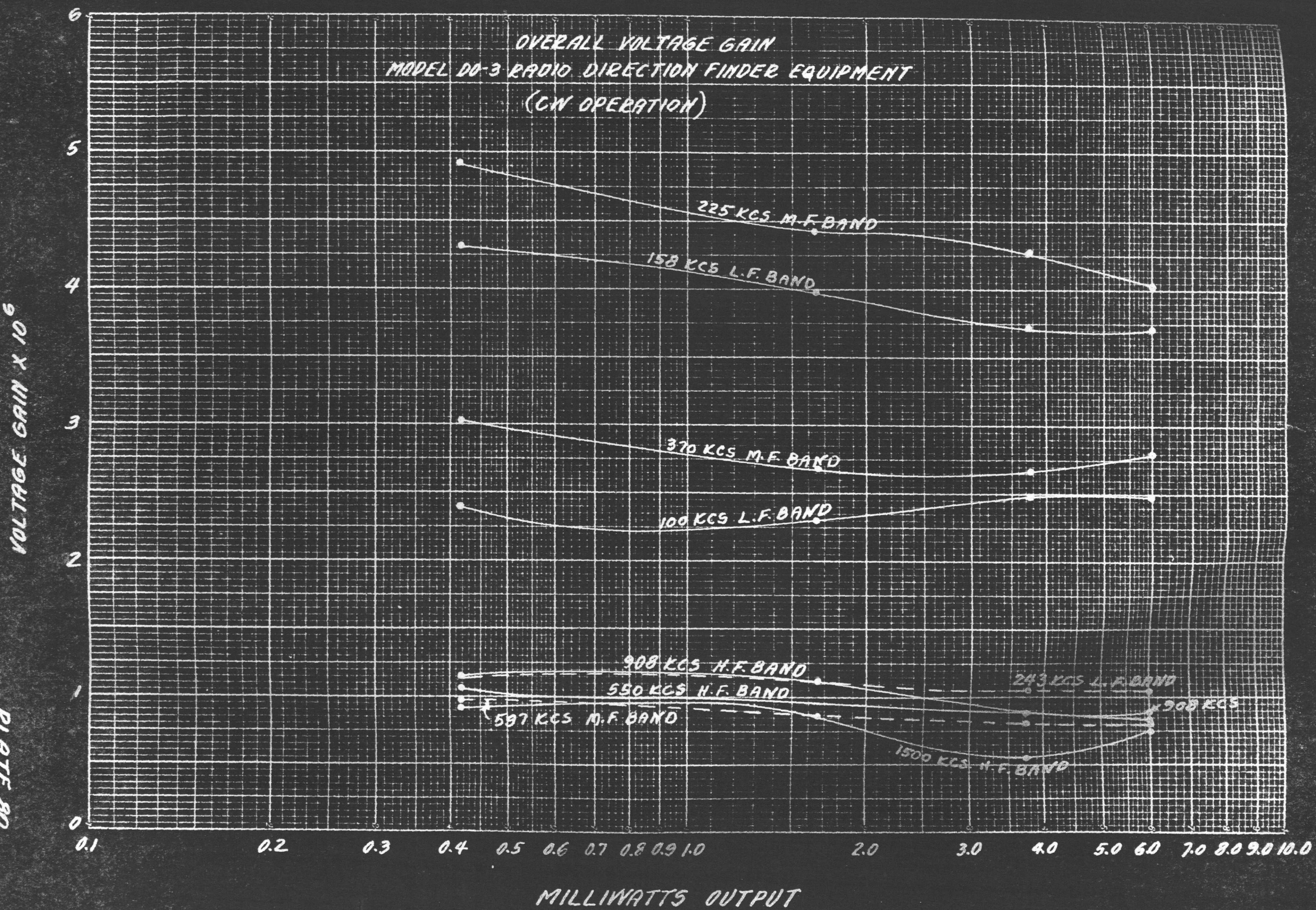

OVERALL VOLTAGE GAIN
MODEL DO-3 RADIO DIRECTION FINDER EQUIPMENT
(C.W OPERATION)
225 KCS M.F. BAND
158 KCS L.F. BAND
370 KCS M.F. BAND
100 KCS L.F. BAND
908 KCS H.F. BAND
550 KCS H.F. BAND
597 KCS M.F. BAND
243 KCS L.F. BAND
908 KCS
1500 KCS H.F. BAND
VOLTAGE GAIN X 10^6
MILLIWATTS OUTPUT
0
1
2
3
4
5
6
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0

PLATE 80

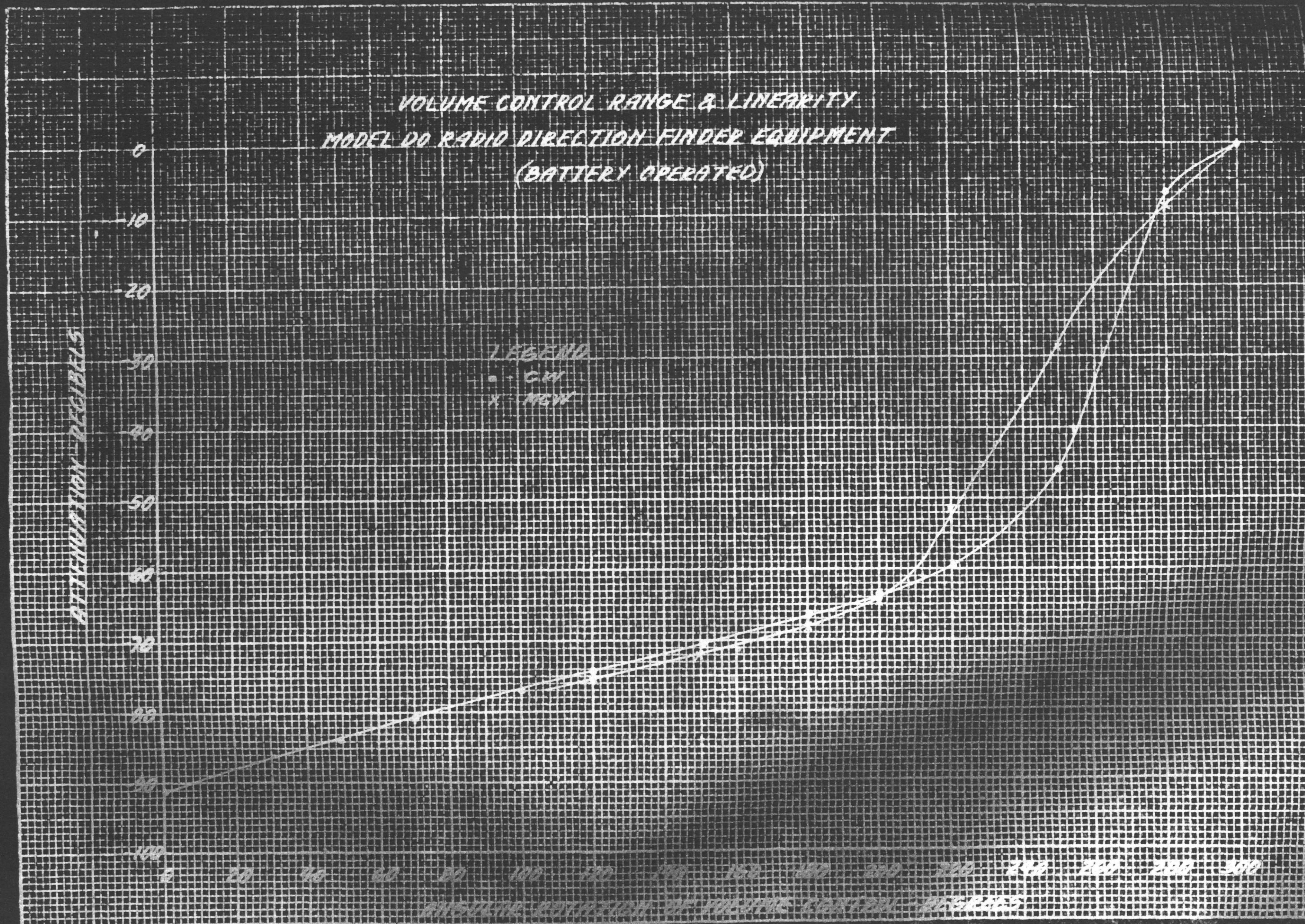

VOLUME CONTROL RANGE & LINEARITY
MODEL DO RADIO DIRECTION FINDER EQUIPMENT
(BATTERY OPERATED)
LEGEND
▪ - C.W.
X - MCW
ATTENUATION - DECIBELS
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
ANGULAR ROTATION OF VOLUME CONTROL - DEGREES

PLATE 81

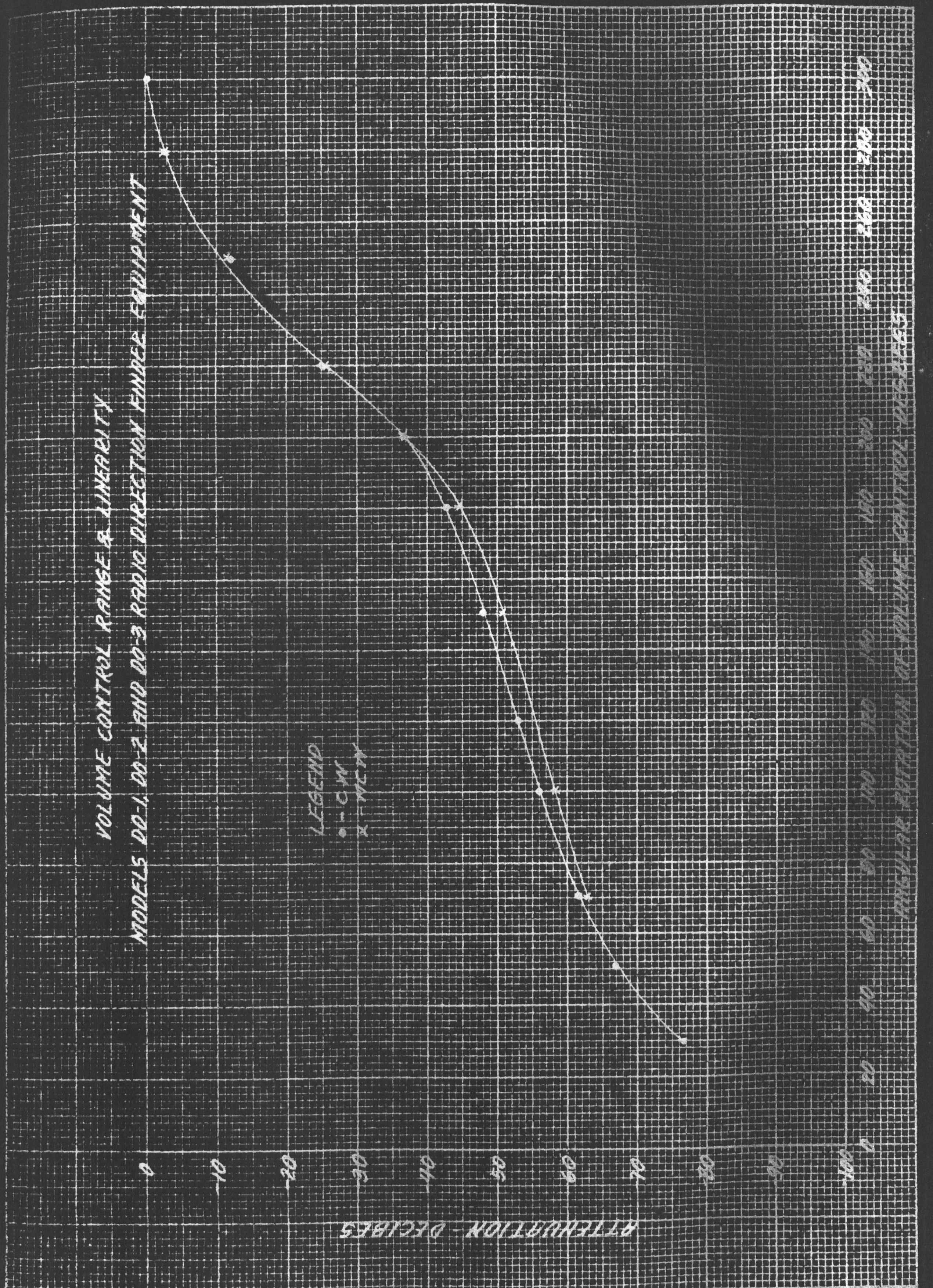

VOLUME CONTROL RANGE & LINEARITY
MODELS DO-1, DO-2 AND DO-3 RADIO DIRECTION FINDER EQUIPMENT
LEGEND
• - CW
x - MCW
ATTENUATION - DECIBELS
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
ANGULAR ROTATION OF VOLUME CONTROL DEGREES
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300

PLATE 82

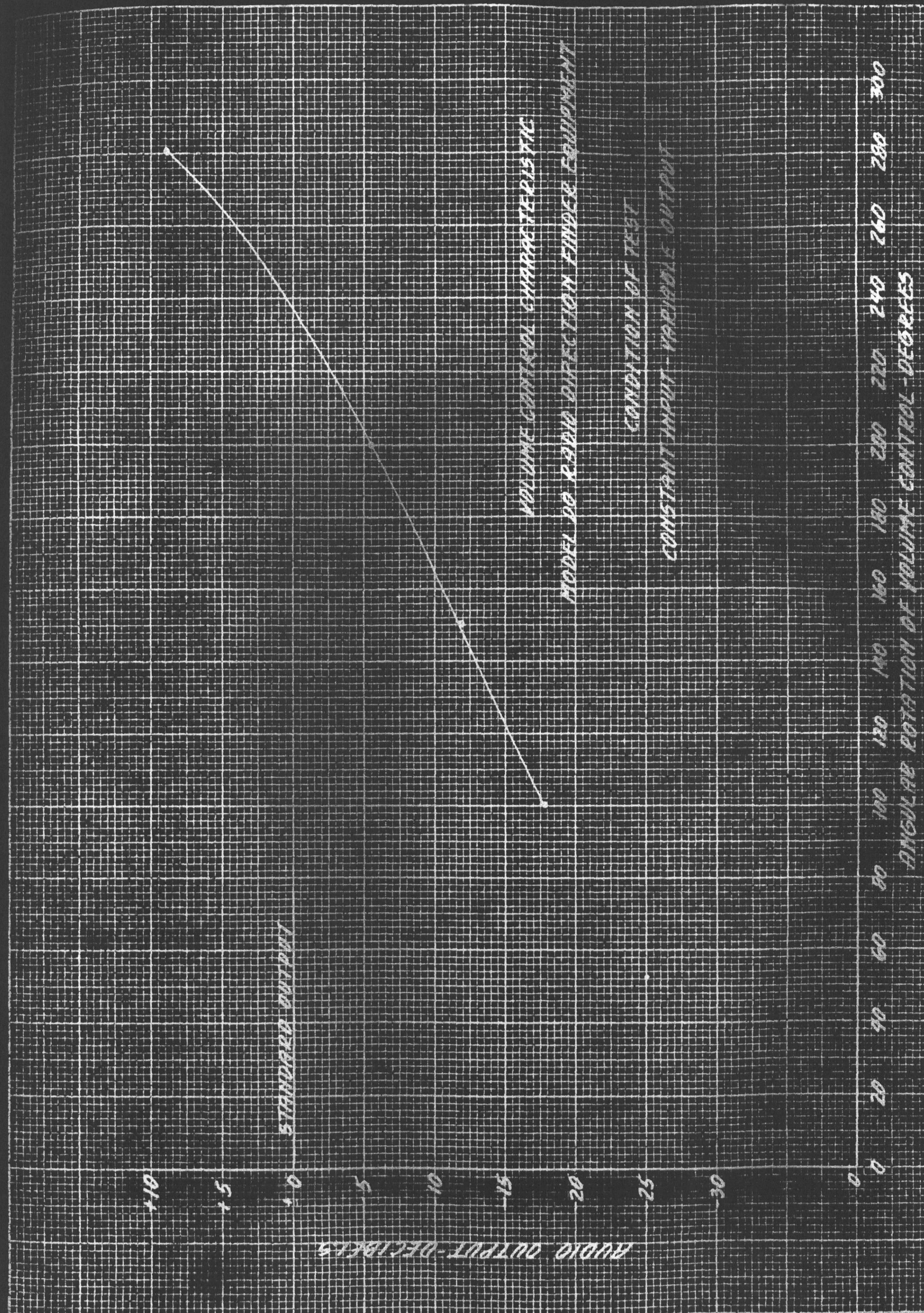
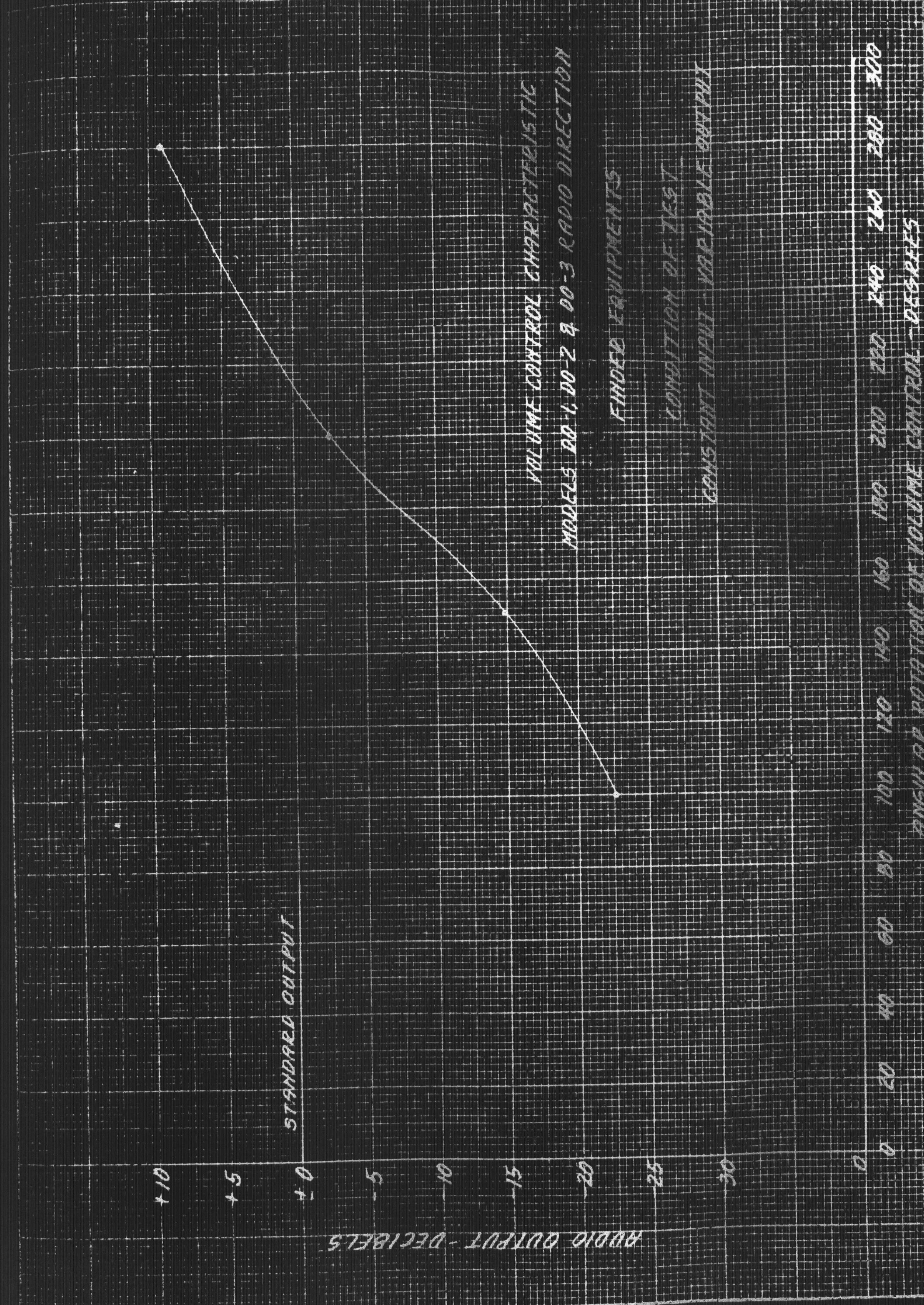
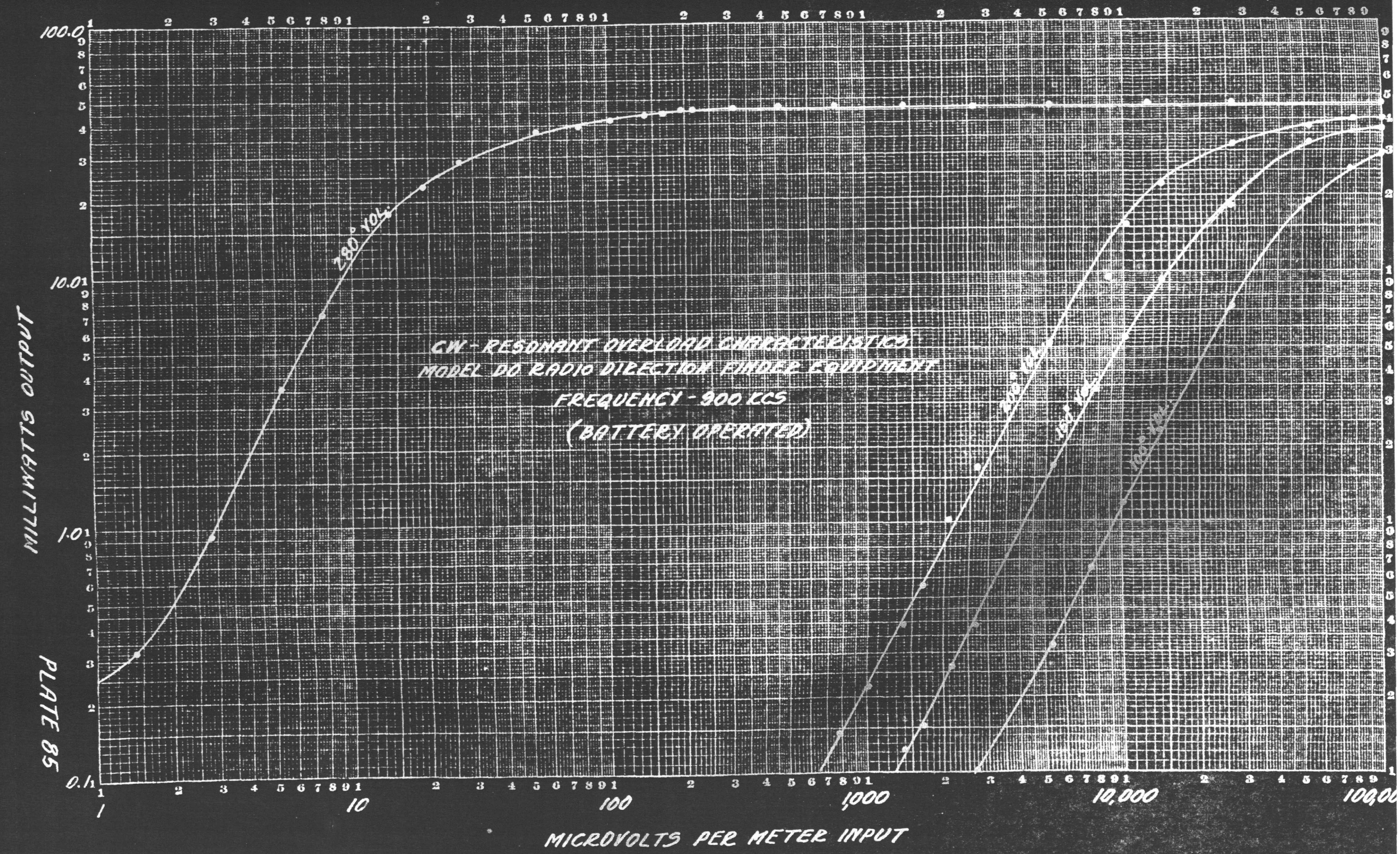

VOLUME CONTROL CHARACTERISTIC
MODEL DO RADIO DIRECTION FINDER EQUIPMENT
CONDITION OF TEST
CONSTANT INPUT-VARIABLE OUTPUT
STANDARD OUTPUT
AUDIO OUTPUT-DECIBELS
+10
+5
0
5
10
15
20
25
30
ANGULAR ROTATION OF VOLUME CONTROL-DEGREES
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300

PLATE 83


VOLUME CONTROL CHARACTERISTIC
MODELS DO-1, DO-2 & DO-3 RADIO DIRECTION
FINDER EQUIPMENTS
CONDITION OF TEST_
CONSTANT INPUT-VARIABLE OUTPUT
STANDARD OUTPUT
AUDIO OUTPUT - DECIBELS
+10
+5
±0
5
10
15
20
25
30
ANGULAR ROTATION OF VOLUME CONTROL - DEGREES
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300



CW - RESONANT OVERLOAD CHARACTERISTICS
MODEL DO RADIO DIRECTION FINDER EQUIPMENT
FREQUENCY - 900 KCS
(BATTERY OPERATED)
280° VOL.
200° VOL.
150° VOL.
100° VOL.
MILLIWATTS OUTPUT
MICROVOLTS PER METER INPUT
100.0
10.01
1.01
0.1
1
10
100
1000
10,000

PLATE 85

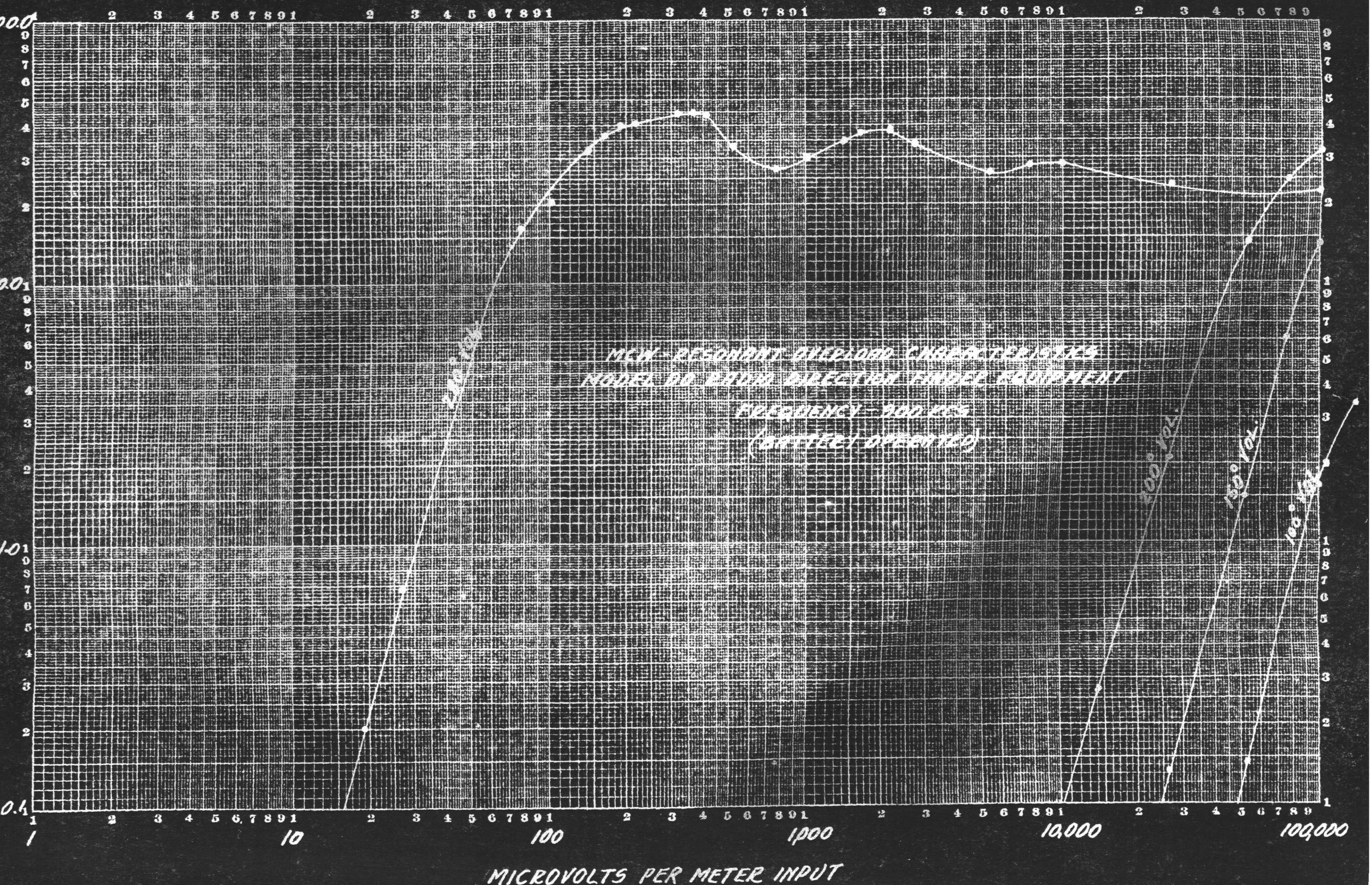

MCW - RESONANT OVERLOAD CHARACTERISTICS
MODEL DO RADIO DIRECTION FINDER EQUIPMENT
FREQUENCY - 300 KCS
(BATTERY OPERATED)
200° VOL.
150° VOL.
100° VOL.
MILLIWATTS OUTPUT
MICROVOLTS PER METER INPUT
100.0
10.0
1.0
0.1
1
10
100
1000
10,000
100,000

PLATE 86

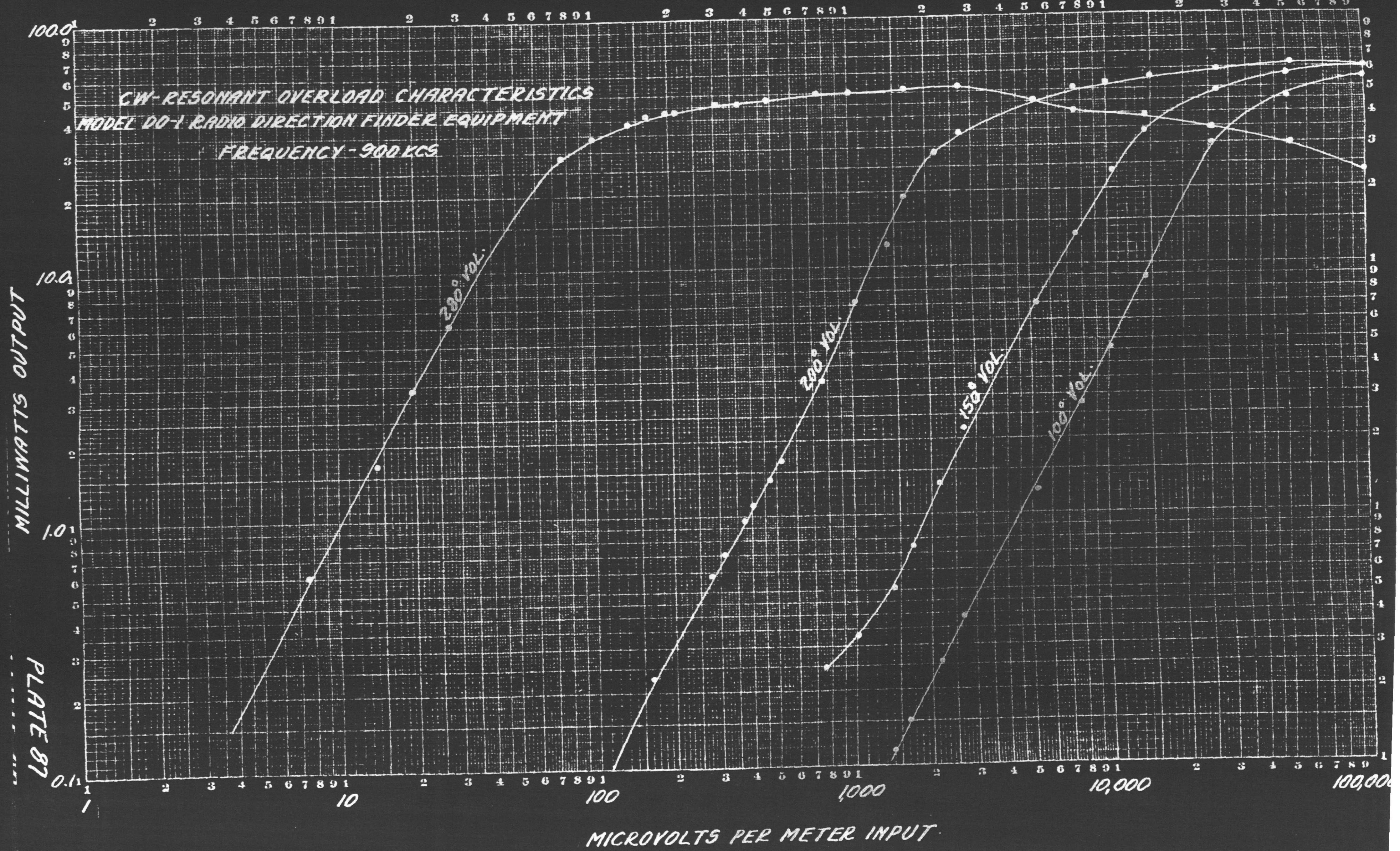
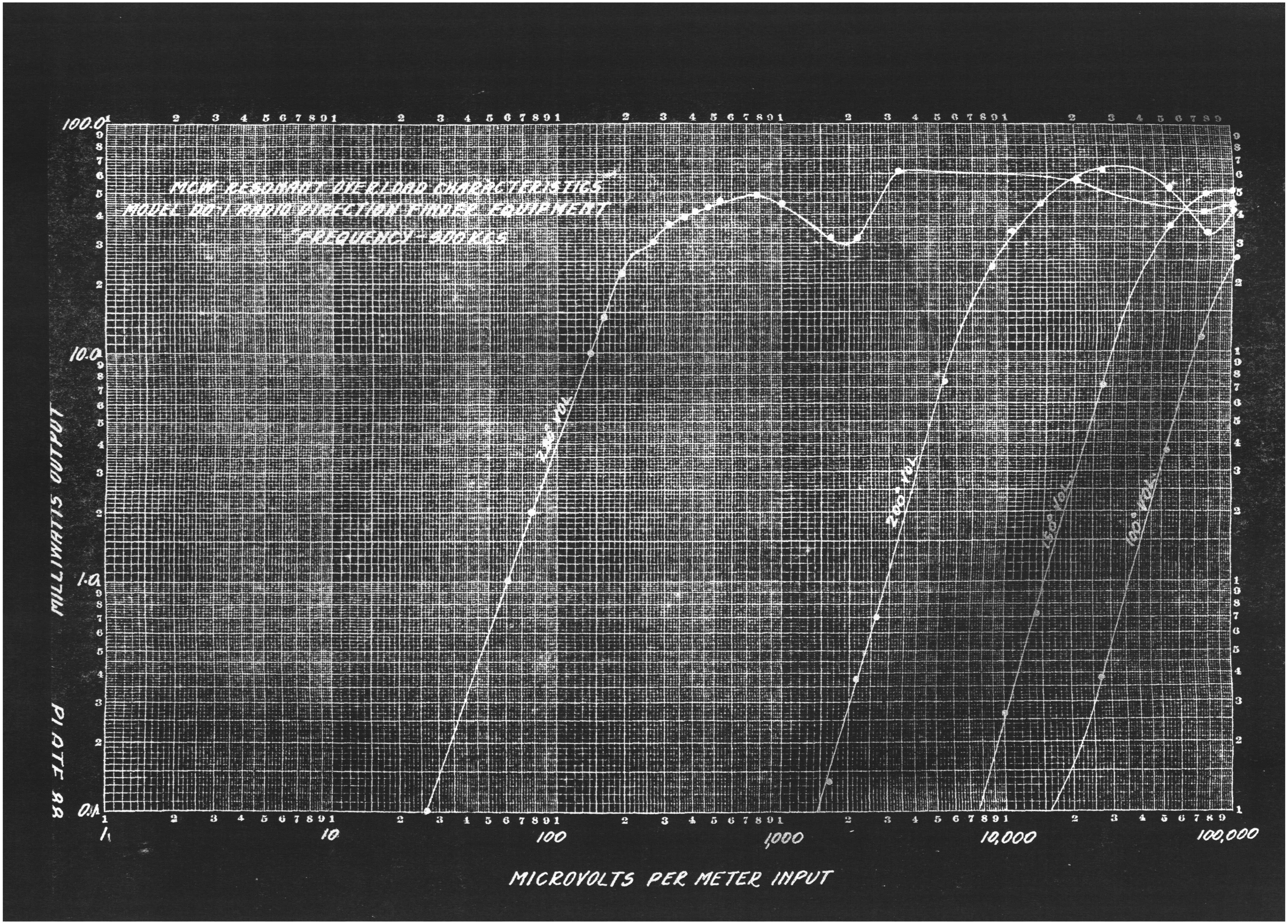
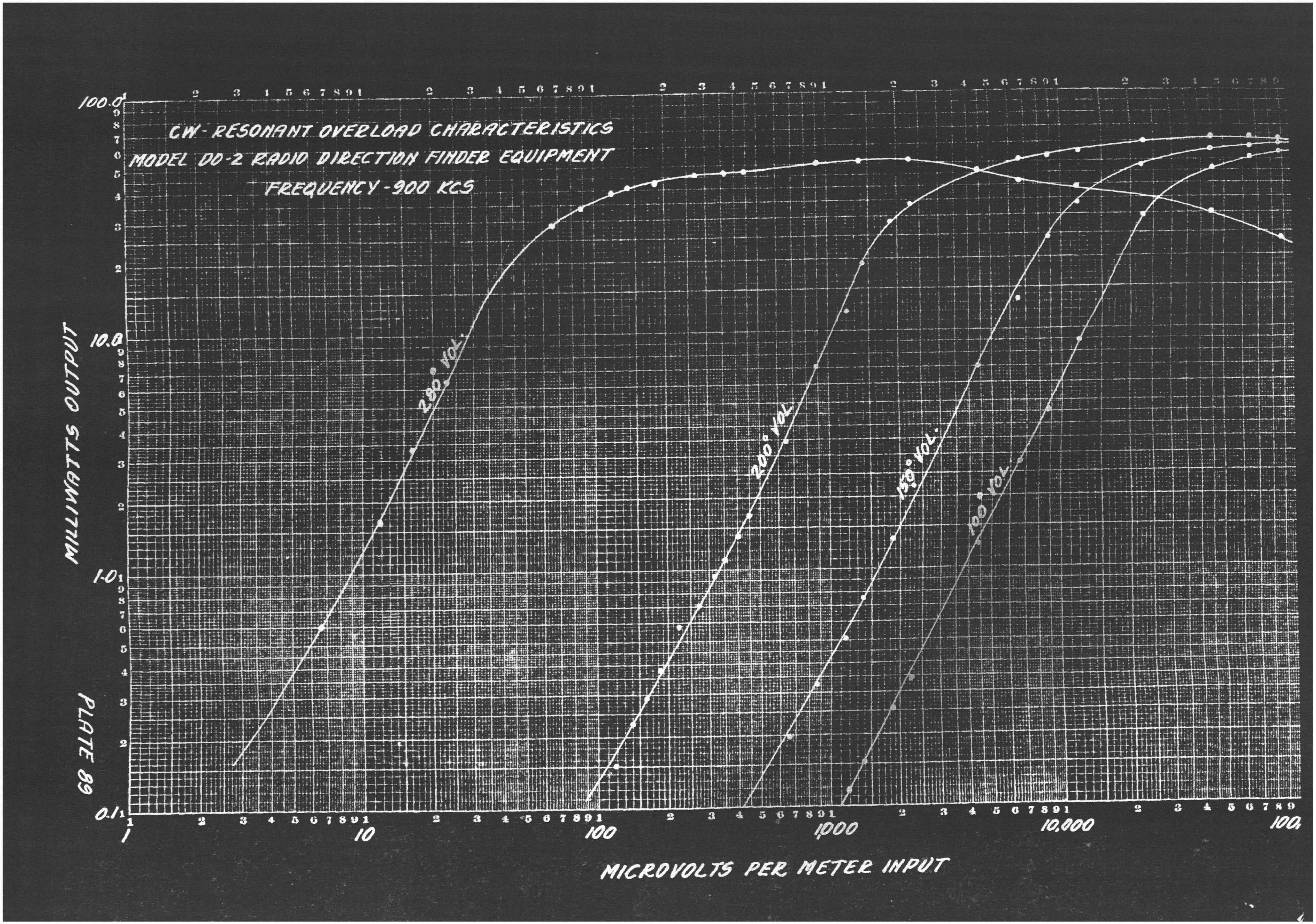
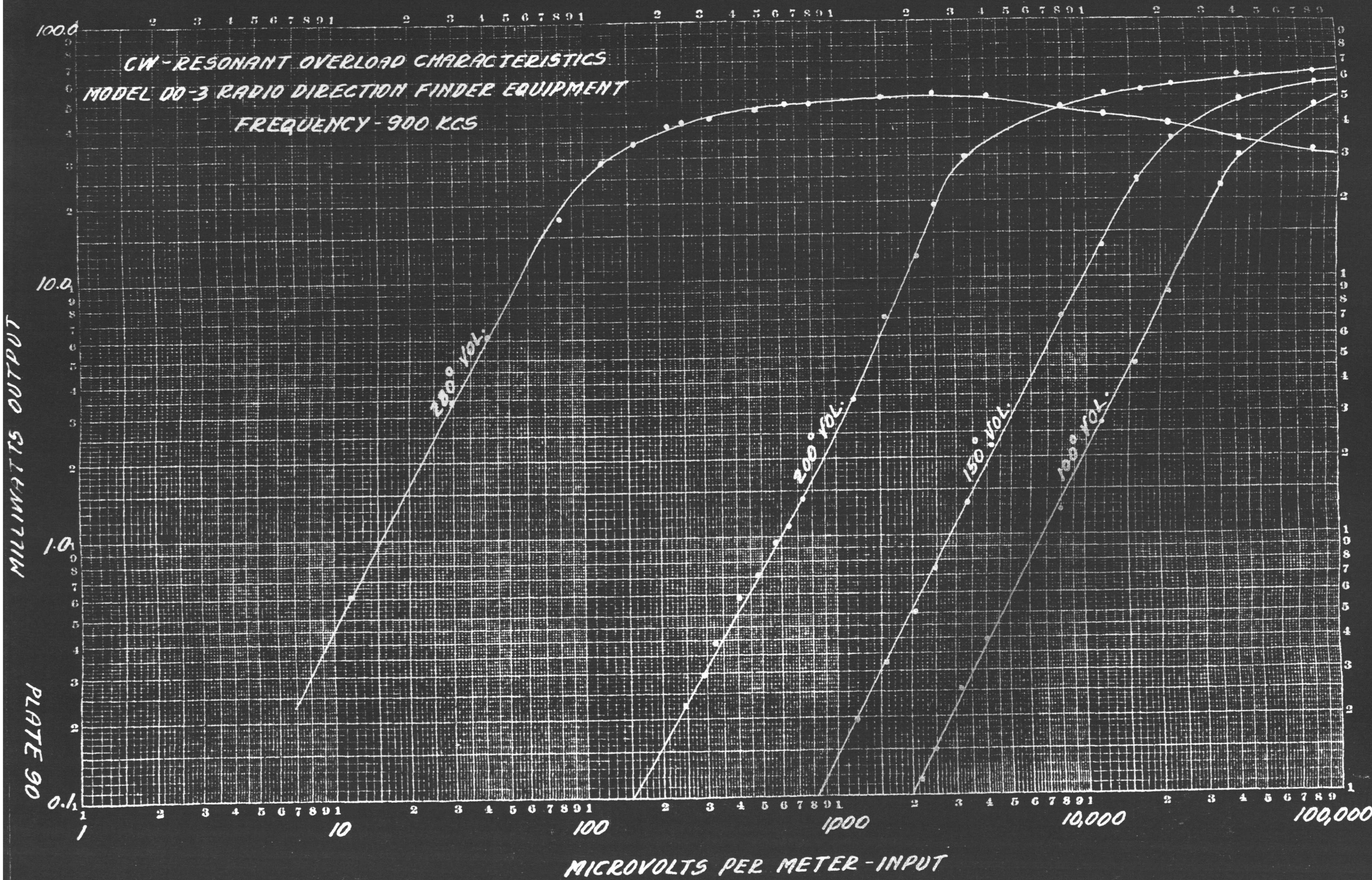

CW-RESONANT OVERLOAD CHARACTERISTICS
MODEL DO-1 RADIO DIRECTION FINDER EQUIPMENT
FREQUENCY - 900 KCS
280° VOL.
200° VOL.
150° VOL.
100° VOL.
MILLIWATTS OUTPUT
100.0
10.0
1.0
0.1
MICROVOLTS PER METER INPUT
1
10
100
1000
10,000
100,000

PLATE 87


MCW RESONANT OVERLOAD CHARACTERISTICS
MODEL DD-1 RADIO DIRECTION FINDER EQUIPMENT
"FREQUENCY" 900 KCS
200° VOL
150° VOL
100° VOL
MILLIWATTS OUTPUT
MICROVOLTS PER METER INPUT
PLATE 88


CW-RESONANT OVERLOAD CHARACTERISTICS
MODEL DD-2 RADIO DIRECTION FINDER EQUIPMENT
FREQUENCY-900 KCS
280° VOL.
200° VOL.
150° VOL.
100° VOL.
MILLIWATTS OUTPUT
MICROVOLTS PER METER INPUT
PLATE 89



CW-RESONANT OVERLOAD CHARACTERISTICS
MODEL DD-3 RADIO DIRECTION FINDER EQUIPMENT
FREQUENCY - 900 KCS
280° VOL.
200° VOL.
150° VOL.
100° VOL.
MILLIWATTS OUTPUT
100.0
10.0
1.0
0.1
1
10
100
1000
10,000
100,000
MICROVOLTS PER METER - INPUT

PLATE 90

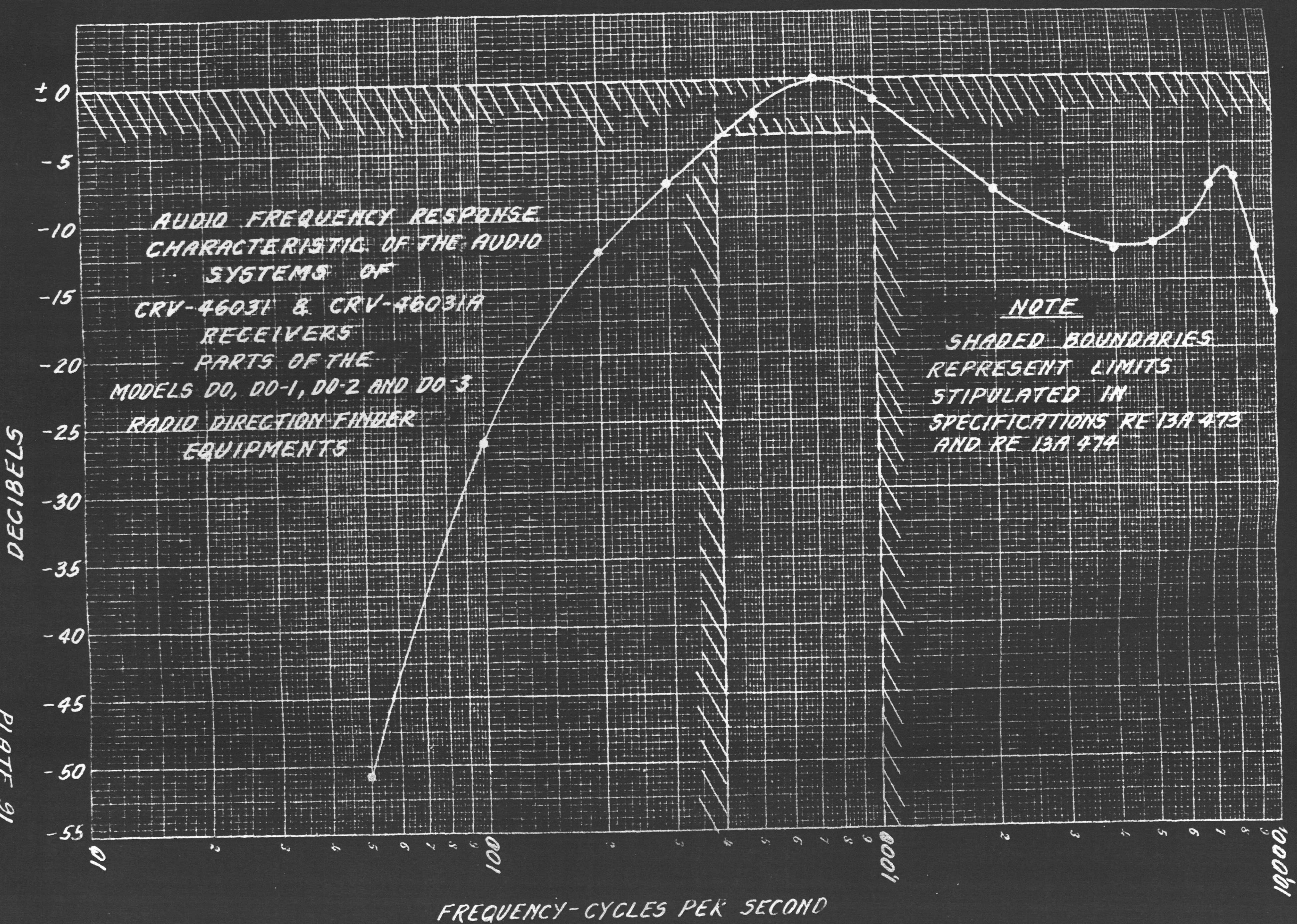
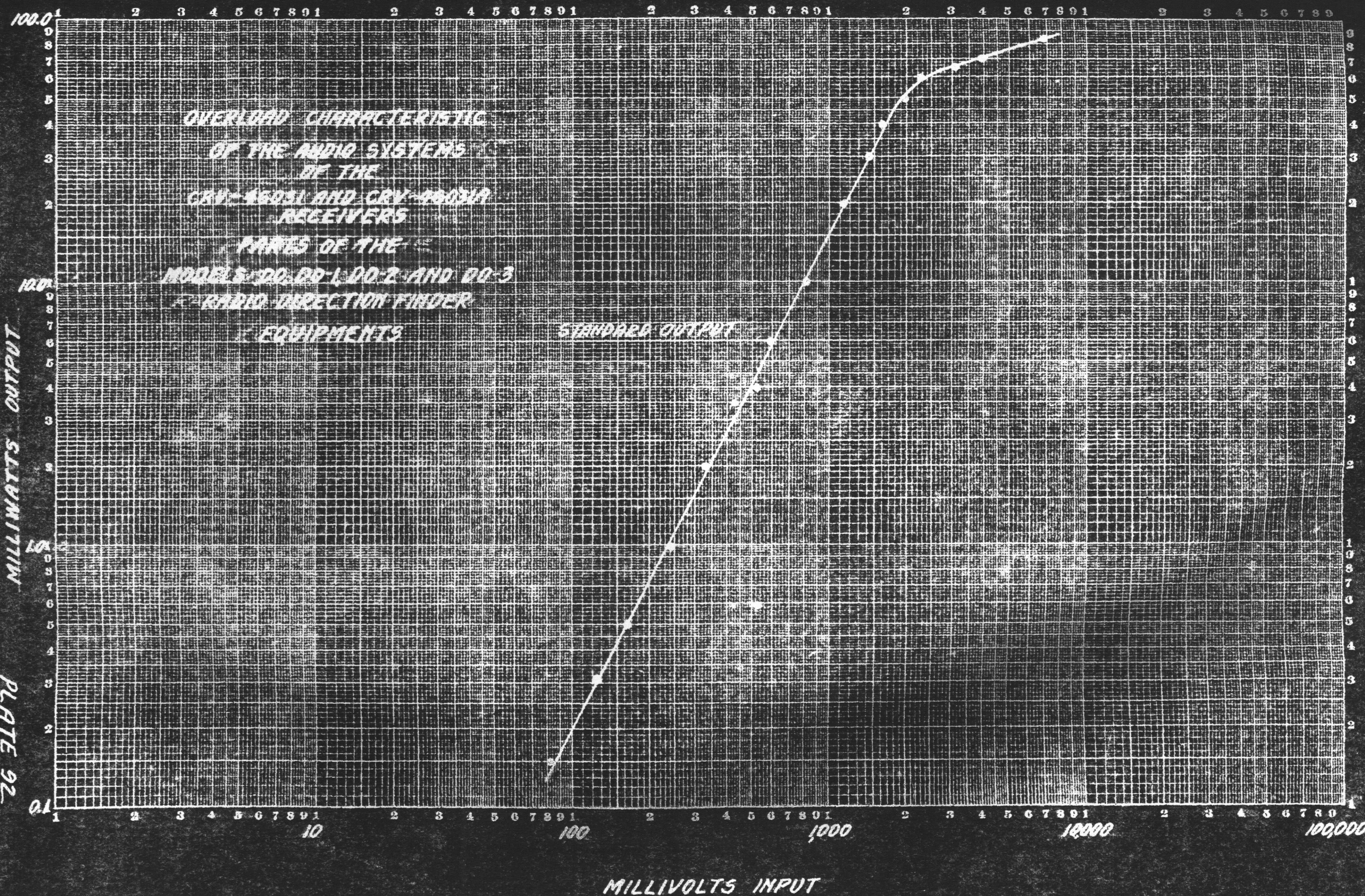
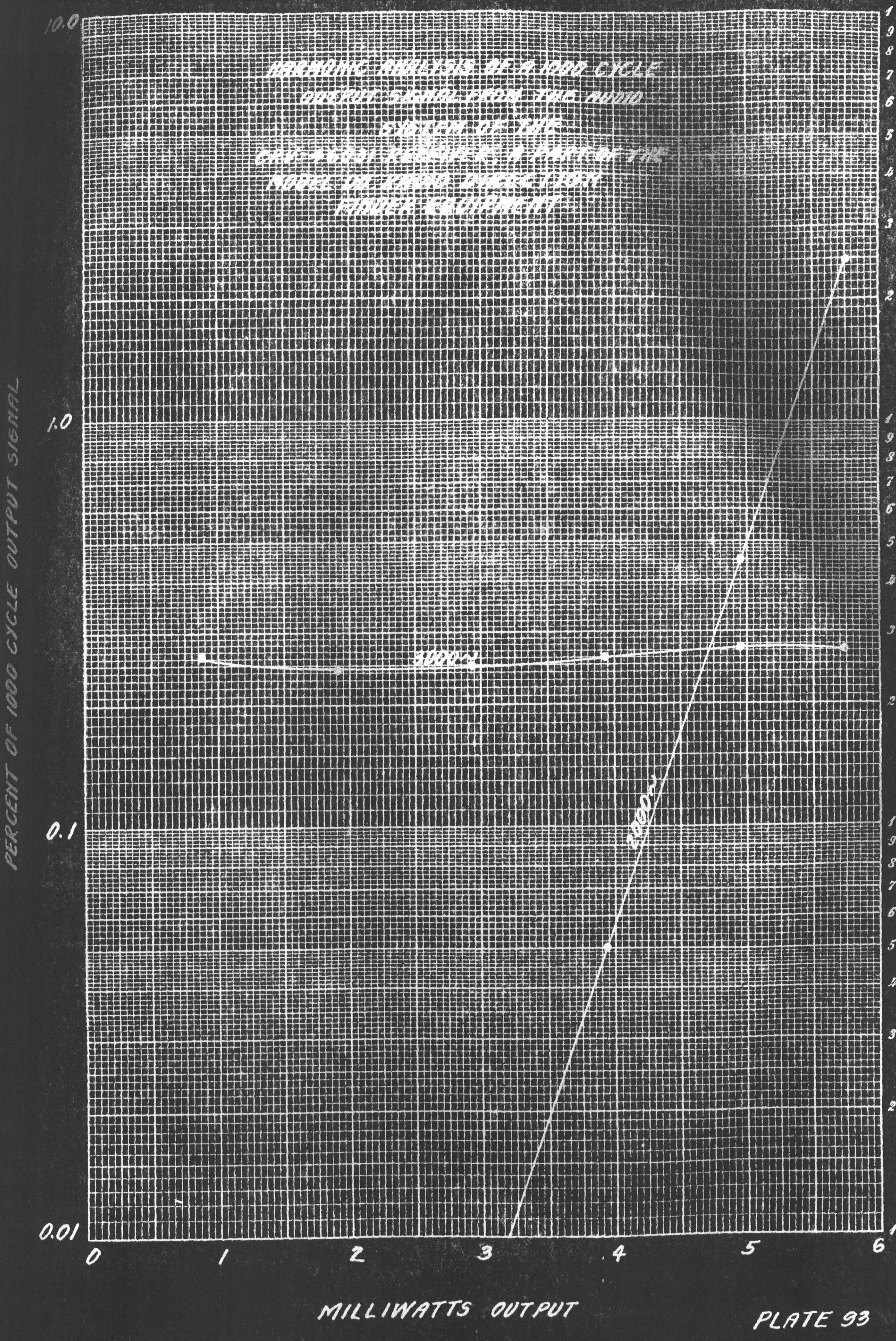

AUDIO FREQUENCY RESPONSE
CHARACTERISTIC OF THE AUDIO
SYSTEMS OF
CRV-46031 & CRV-46031A
RECEIVERS
PARTS OF THE
MODELS DO, DO-1, DO-2 AND DO-3
RADIO DIRECTION FINDER
EQUIPMENTS
NOTE
SHADED BOUNDARIES
REPRESENT LIMITS
STIPULATED IN
SPECIFICATIONS RE 13A 473
AND RE 13A 474
DECIBELS
±0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
10
100
1000
10000
FREQUENCY-CYCLES PER SECOND

PLATE 91



OVERLOAD CHARACTERISTIC
OF THE AUDIO SYSTEMS
OF THE
CRV-46051 AND CRV-46051A
RECEIVERS
PARTS OF THE
MODELS DO, DO-1, DO-2 AND DO-3
RADIO DIRECTION FINDER
EQUIPMENTS
STANDARD OUTPUT
100.0
10.0
1.0
0.1
1
10
100
1000
10000
100,000
MILLIWATTS OUTPUT
MILLIVOLTS INPUT

PLATE 92



HARMONIC ANALYSIS OF A 1000 CYCLE
OUTPUT SIGNAL FROM THE AUDIO
SYSTEM OF THE
FINDER EQUIPMENT
PERCENT OF 1000 CYCLE OUTPUT SIGNAL
10.0
1.0
0.1
0.01
3000~
2000~
0
1
2
3
4
5
6
MILLIWATTS OUTPUT

PLATE 93

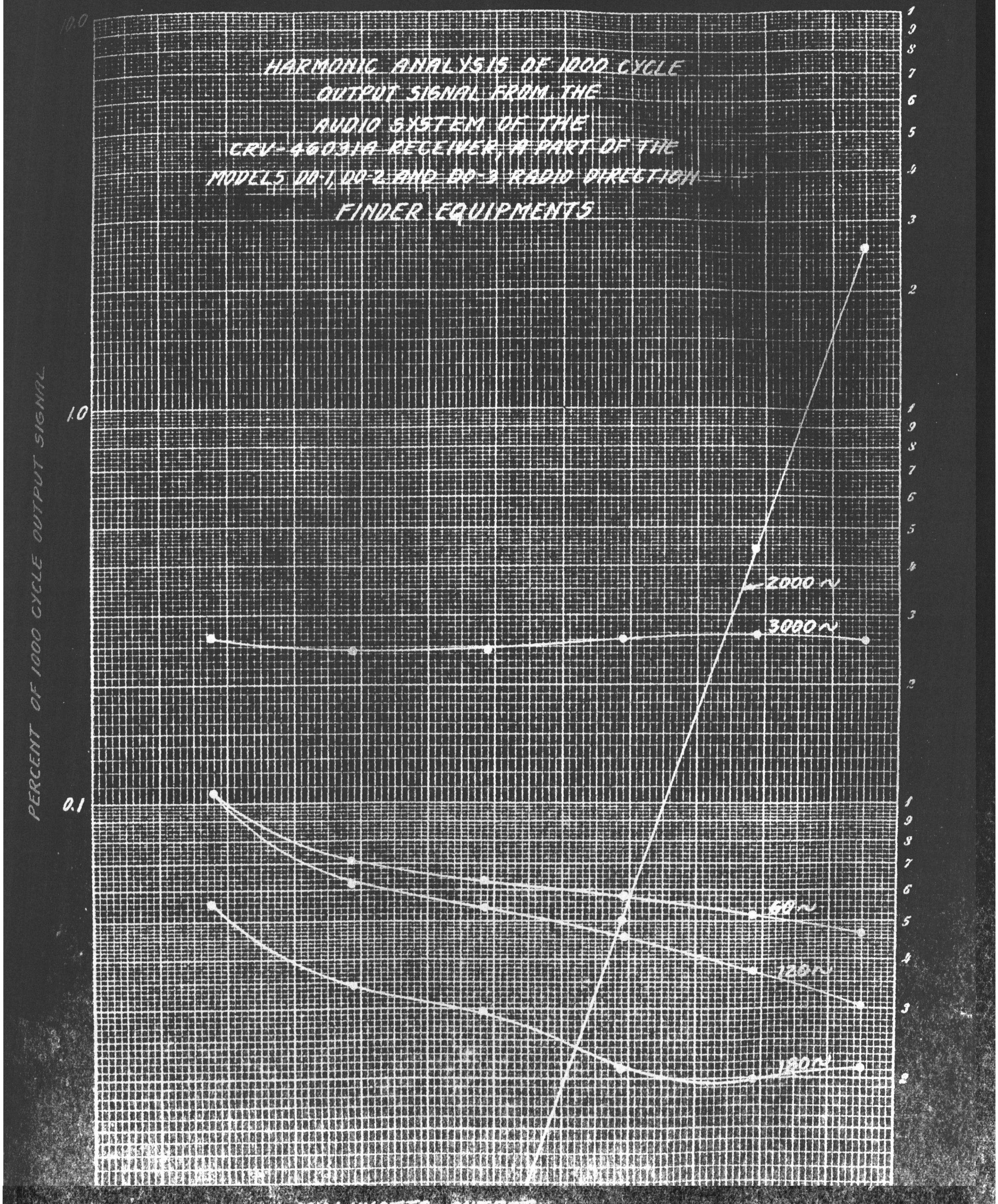

HARMONIC ANALYSIS OF 1000 CYCLE
OUTPUT SIGNAL FROM THE
AUDIO SYSTEM OF THE
CRV-46031A RECEIVER, A PART OF THE
MODELS DO-1, DO-2 AND DO-3 RADIO DIRECTION
FINDER EQUIPMENTS
10.0
1.0
0.1
PERCENT OF 1000 CYCLE OUTPUT SIGNAL
2000 ~
3000 ~
60 ~
120 ~
180 ~
MILLIWATTS OUTPUT

PLATE 94

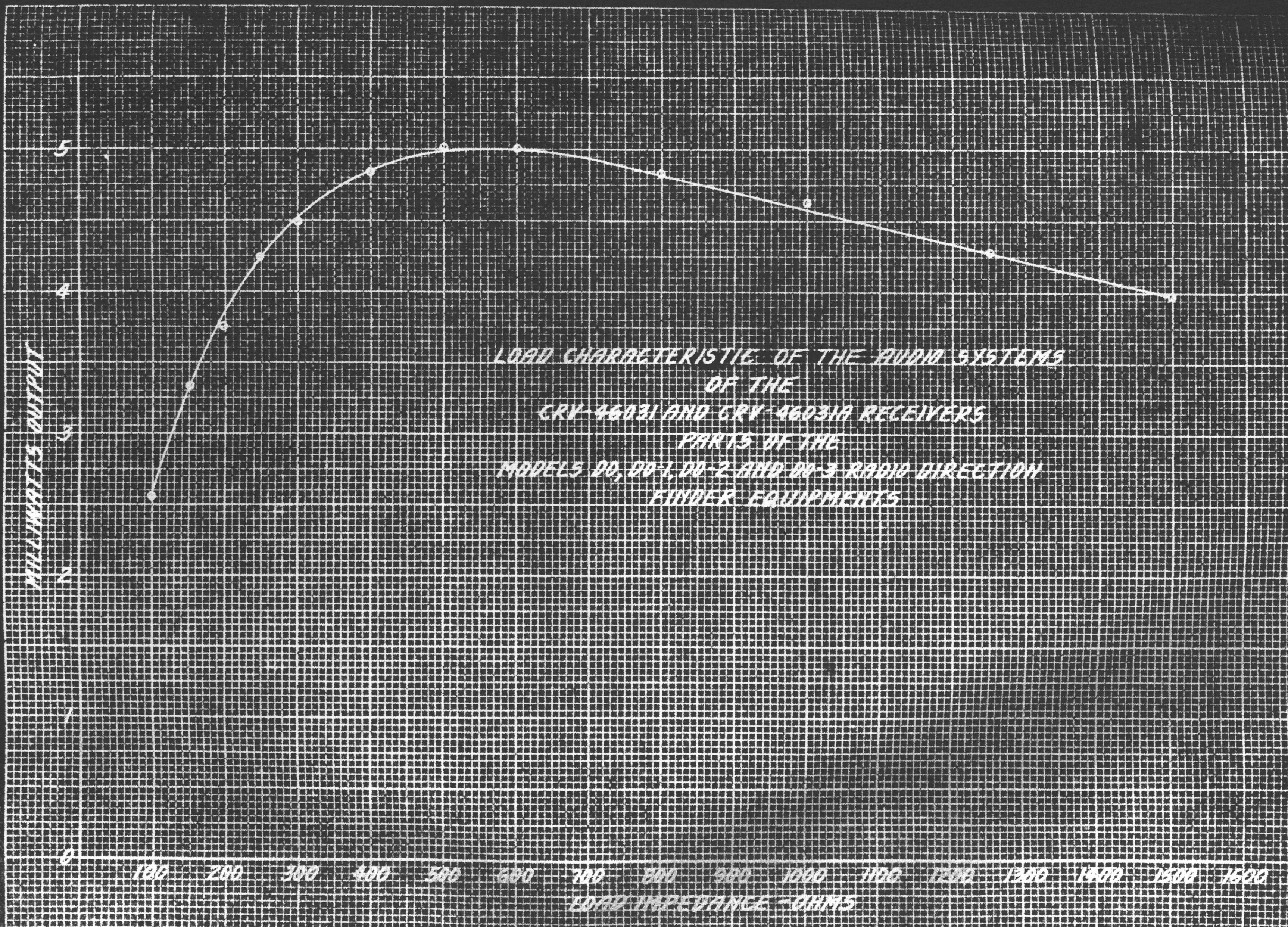

LOAD CHARACTERISTIC OF THE AUDIO SYSTEMS
OF THE
CRV-46031 AND CRV-46031A RECEIVERS
PARTS OF THE
MODELS DO, DO-1, DO-2 AND DO-3 RADIO DIRECTION
FINDER EQUIPMENTS
MILLIWATTS OUTPUT
0
1
2
3
4
5
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
LOAD IMPEDANCE - OHMS

PLATE 95

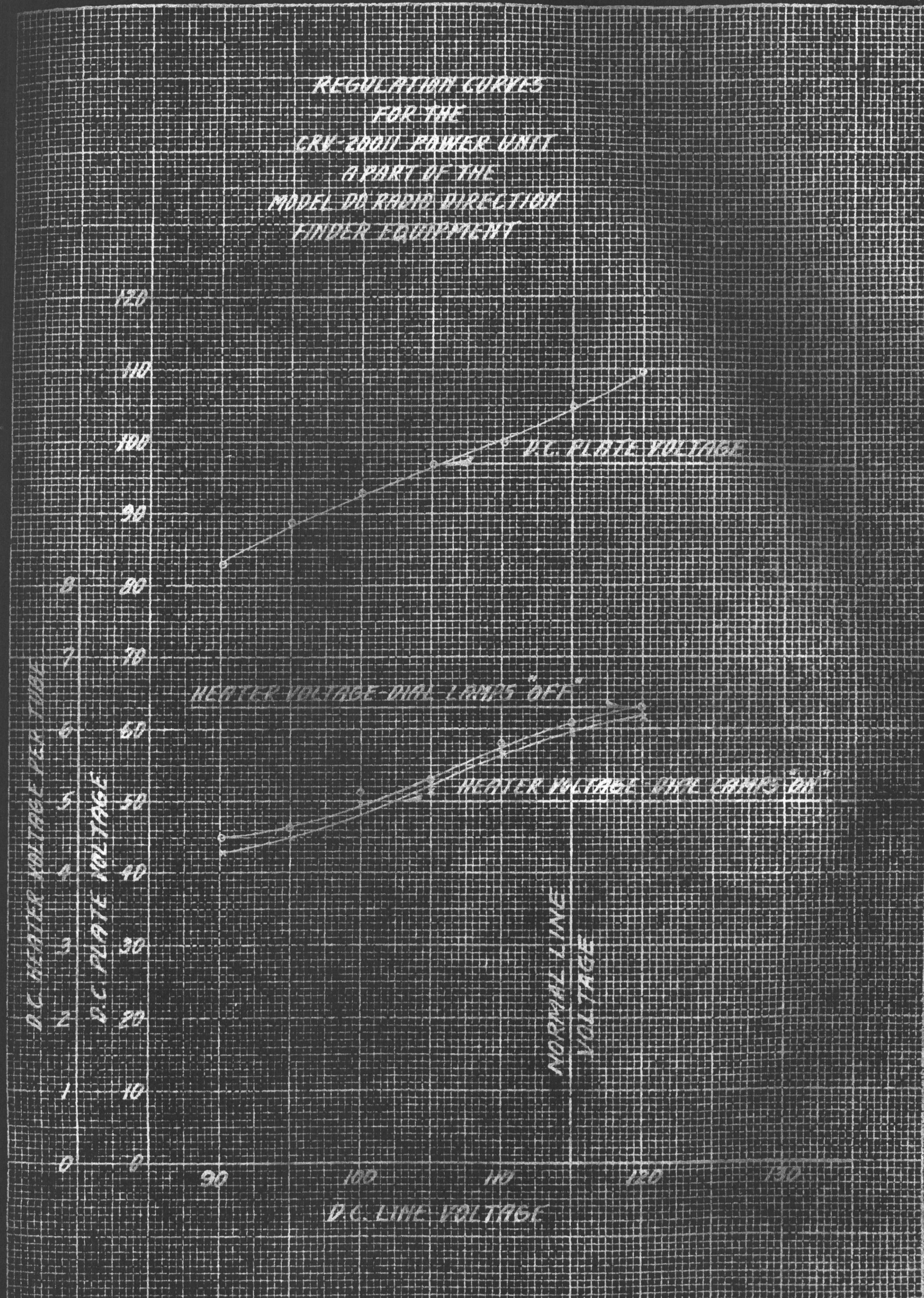
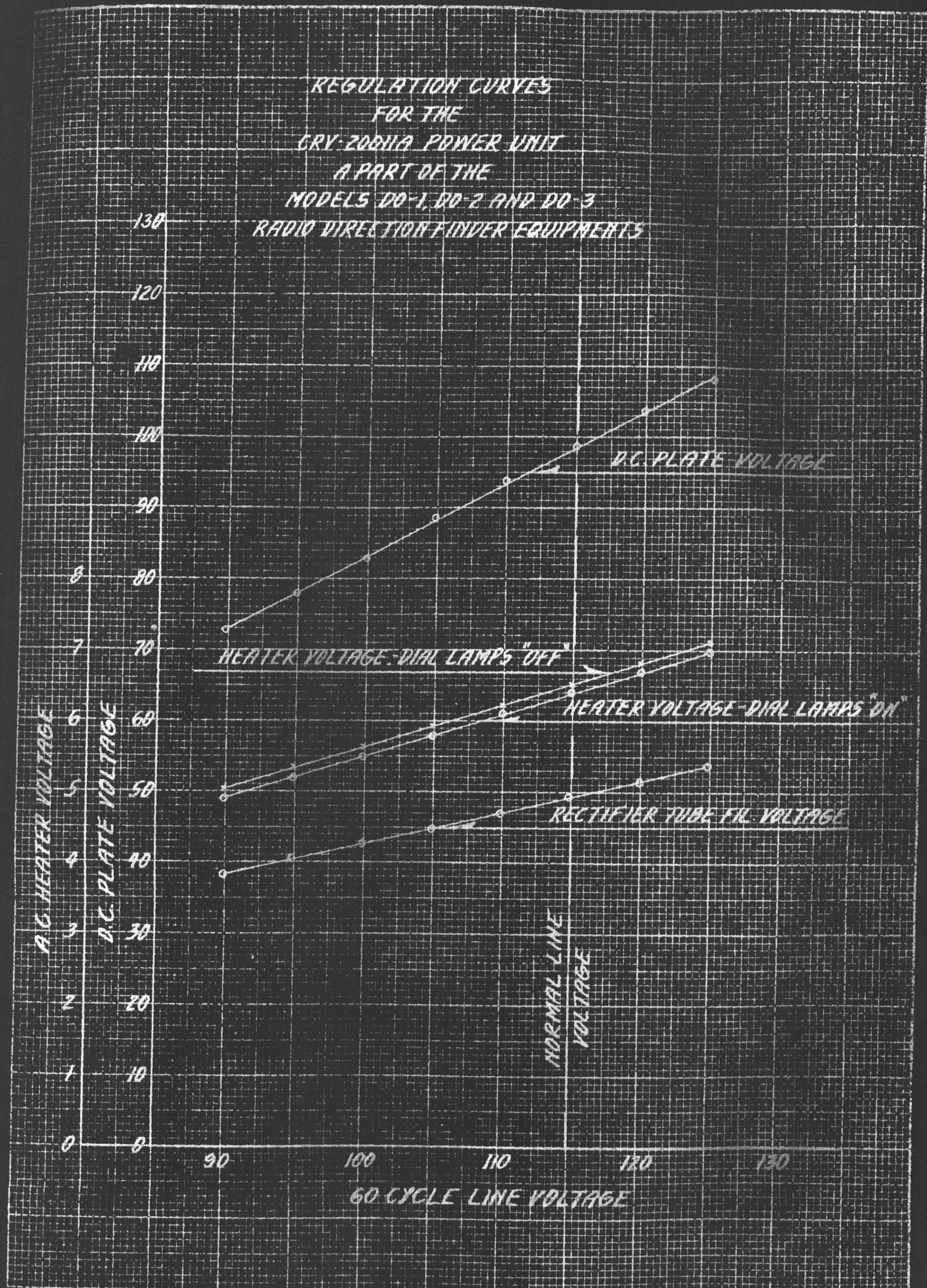

REGULATION CURVES
FOR THE
CRV-20011 POWER UNIT
A PART OF THE
MODEL DQ RADIO DIRECTION
FINDER EQUIPMENT
D.C. PLATE VOLTAGE
HEATER VOLTAGE-DIAL LAMPS "OFF"
HEATER VOLTAGE-DIAL LAMPS "ON"
NORMAL LINE VOLTAGE
D.C. HEATER VOLTAGE PER TUBE
D.C. PLATE VOLTAGE
D.C. LINE VOLTAGE
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
110
120
90
100
110
120
130

PLATE 96


REGULATION CURVES
FOR THE
CRY-20044 POWER UNIT
A PART OF THE
MODELS DO-1, DO-2 AND DO-3
RADIO DIRECTION FINDER EQUIPMENTS
D.C. PLATE VOLTAGE
HEATER VOLTAGE-DIAL LAMPS "OFF"
HEATER VOLTAGE-DIAL LAMPS "ON"
RECTIFIER TUBE FIL. VOLTAGE
NORMAL LINE VOLTAGE
A.C. HEATER VOLTAGE
D.C. PLATE VOLTAGE
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
100
110
120
130
90
100
110
120
130
60 CYCLE LINE VOLTAGE

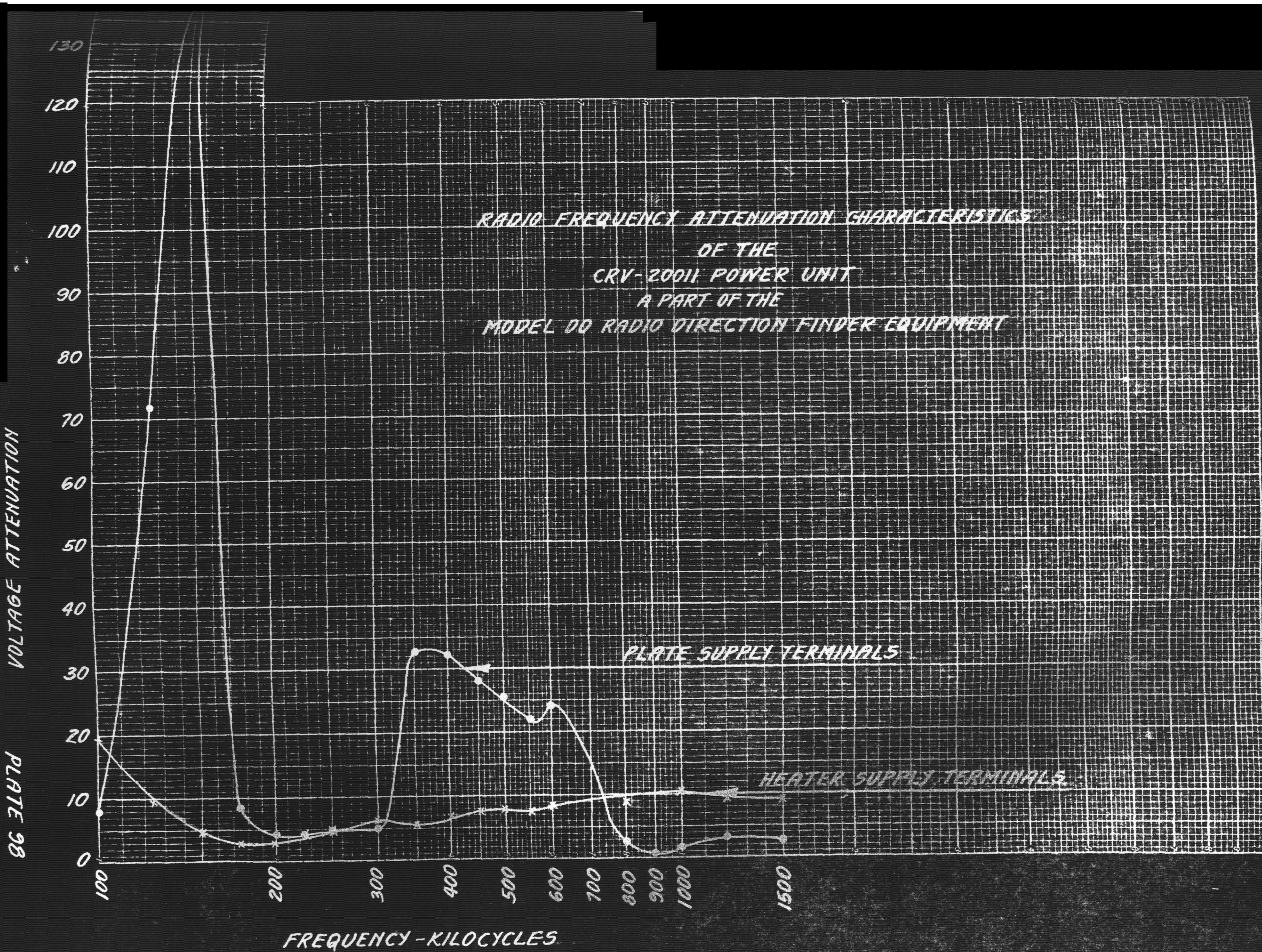

RADIO FREQUENCY ATTENUATION CHARACTERISTICS
OF THE
CRV-20011 POWER UNIT
A PART OF THE
MODEL DO RADIO DIRECTION FINDER EQUIPMENT
PLATE SUPPLY TERMINALS
HEATER SUPPLY TERMINALS
VOLTAGE ATTENUATION
130
120
110
100
90
80
70
60
50
40
30
20
10
0
100
200
300
400
500
600
700
800
900
1000
1500
FREQUENCY - KILOCYCLES

PLATE 98

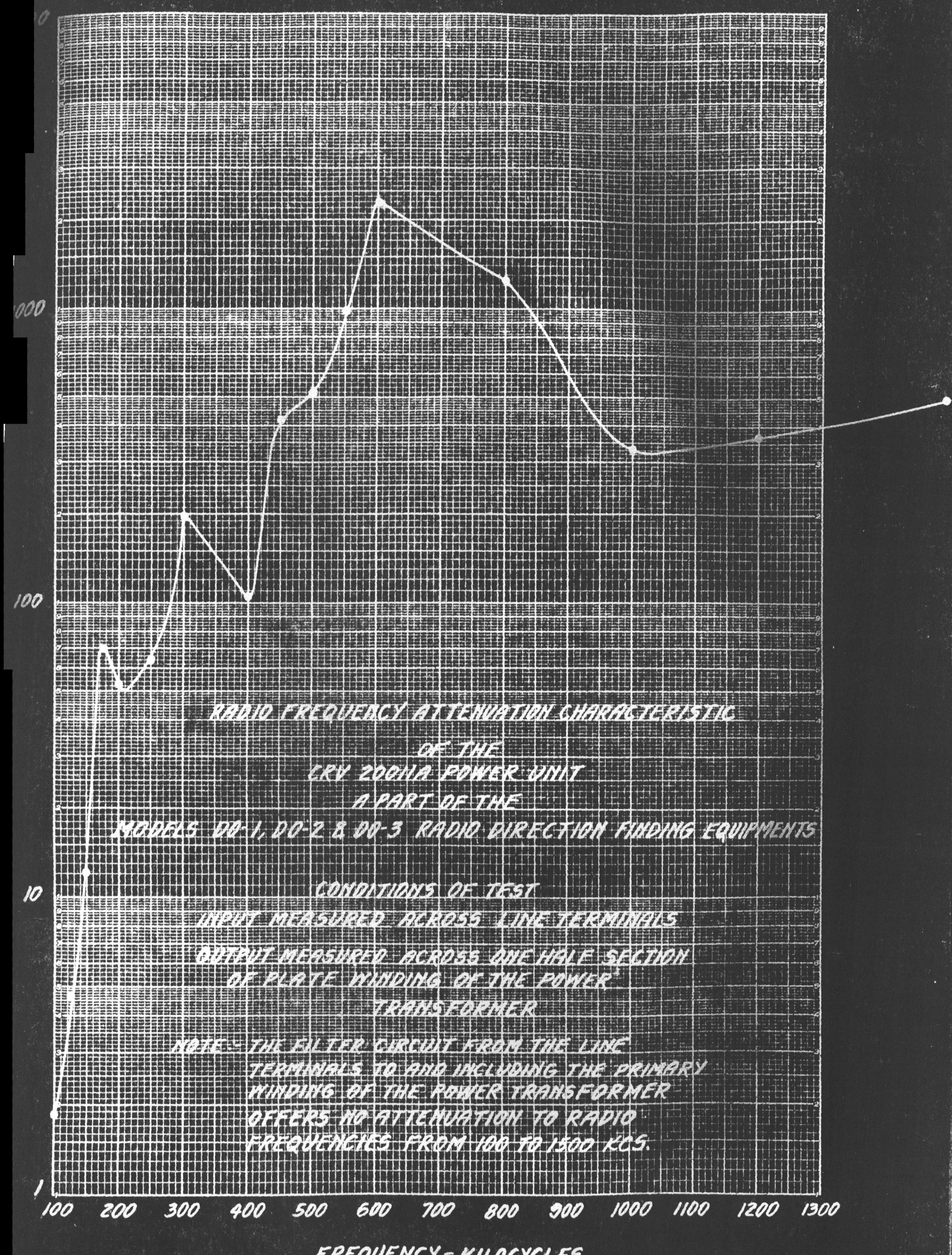

RADIO FREQUENCY ATTENUATION CHARACTERISTIC
OF THE
CRV 200HA POWER UNIT
A PART OF THE
MODELS DO-1, DO-2 & DO-3 RADIO DIRECTION FINDING EQUIPMENTS
CONDITIONS OF TEST
INPUT MEASURED ACROSS LINE TERMINALS
OUTPUT MEASURED ACROSS ONE HALF SECTION
OF PLATE WINDING OF THE POWER
TRANSFORMER
NOTE - THE FILTER CIRCUIT FROM THE LINE
TERMINALS TO AND INCLUDING THE PRIMARY
WINDING OF THE POWER TRANSFORMER
OFFERS NO ATTENUATION TO RADIO
FREQUENCIES FROM 100 TO 1500 KCS.
000
100
10
1
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
FREQUENCY - KILOCYCLES

PLATE 99

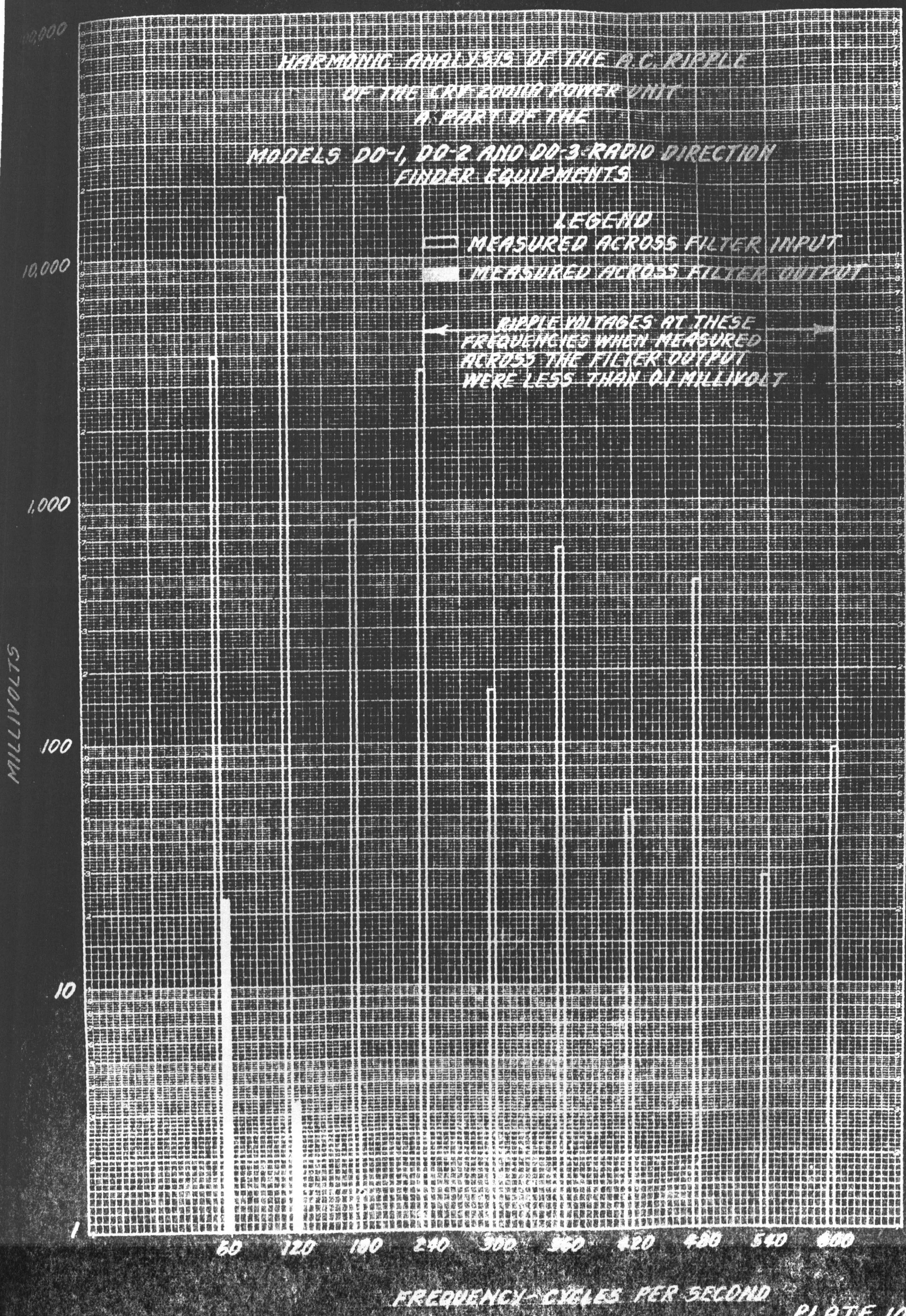

HARMONIC ANALYSIS OF THE A.C. RIPPLE
OF THE CRV 20011A POWER UNIT
A PART OF THE
MODELS DO-1, DO-2 AND DO-3 RADIO DIRECTION
FINDER EQUIPMENTS
LEGEND
MEASURED ACROSS FILTER INPUT
MEASURED ACROSS FILTER OUTPUT
RIPPLE VOLTAGES AT THESE
FREQUENCIES WHEN MEASURED
ACROSS THE FILTER OUTPUT
WERE LESS THAN 0.1 MILLIVOLT
100,000
10,000
1,000
100
10
1
MILLIVOLTS
60
120
180
240
300
360
420
480
540
600
FREQUENCY—CYCLES PER SECOND

PLATE 100

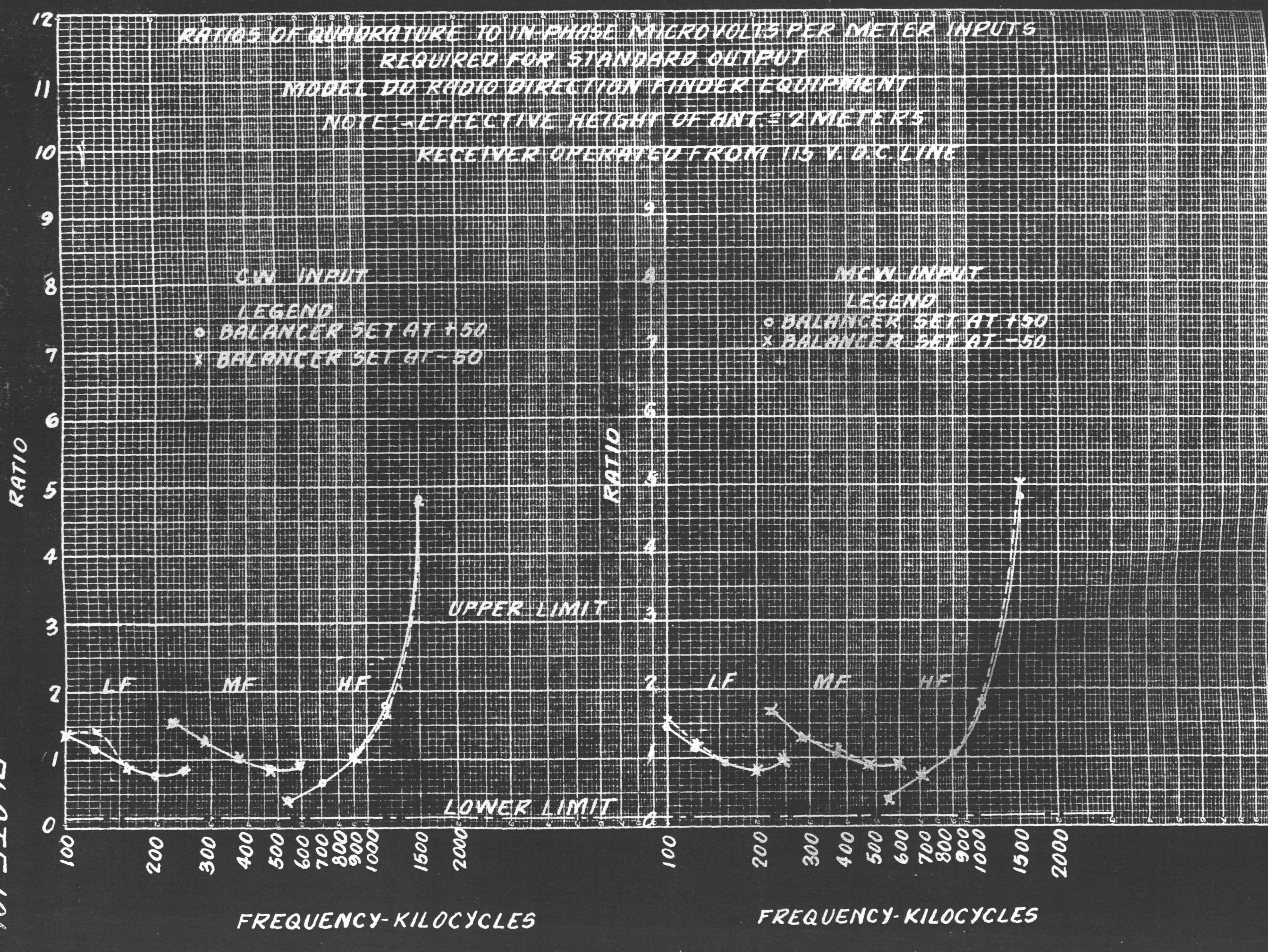
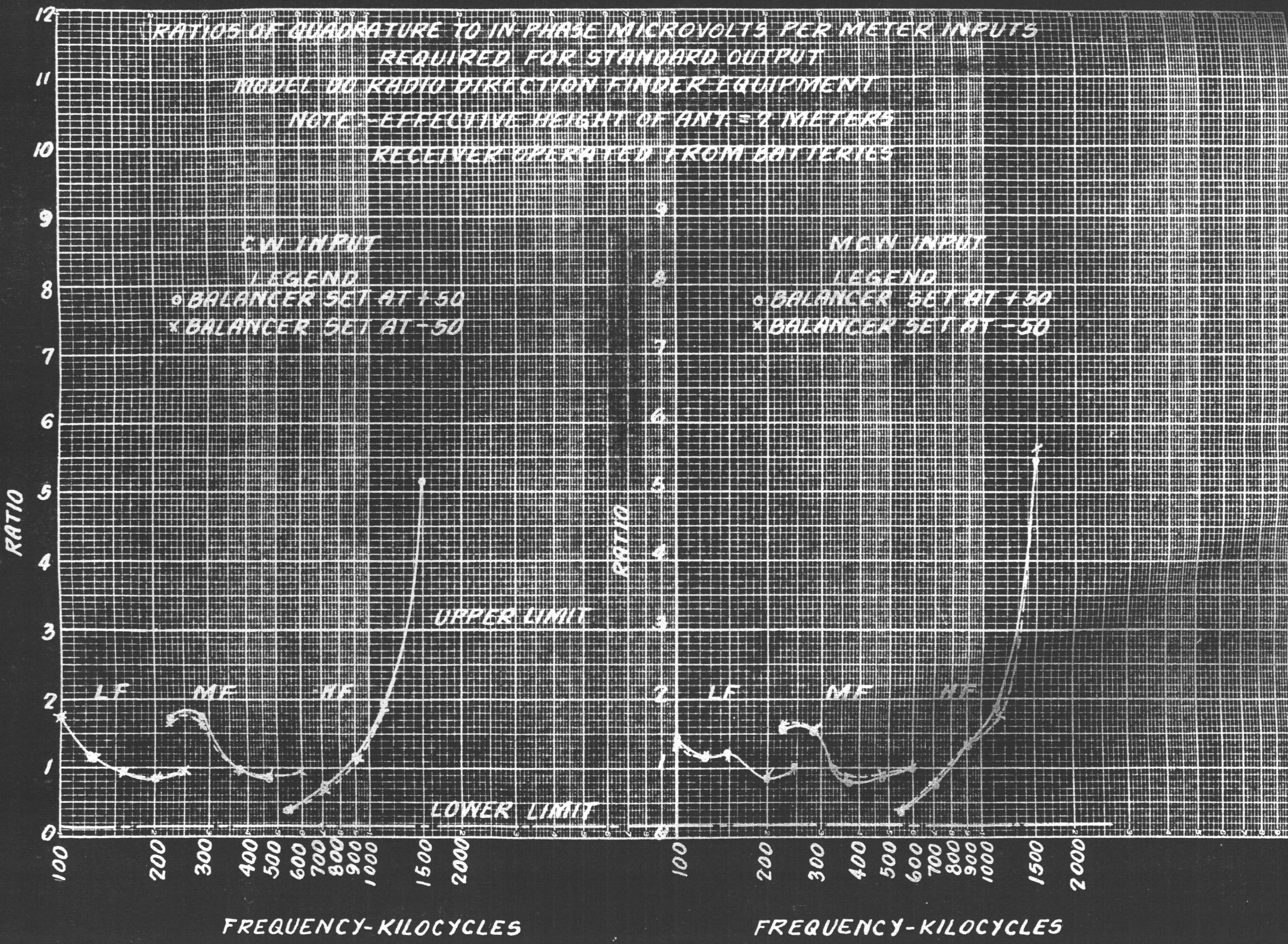
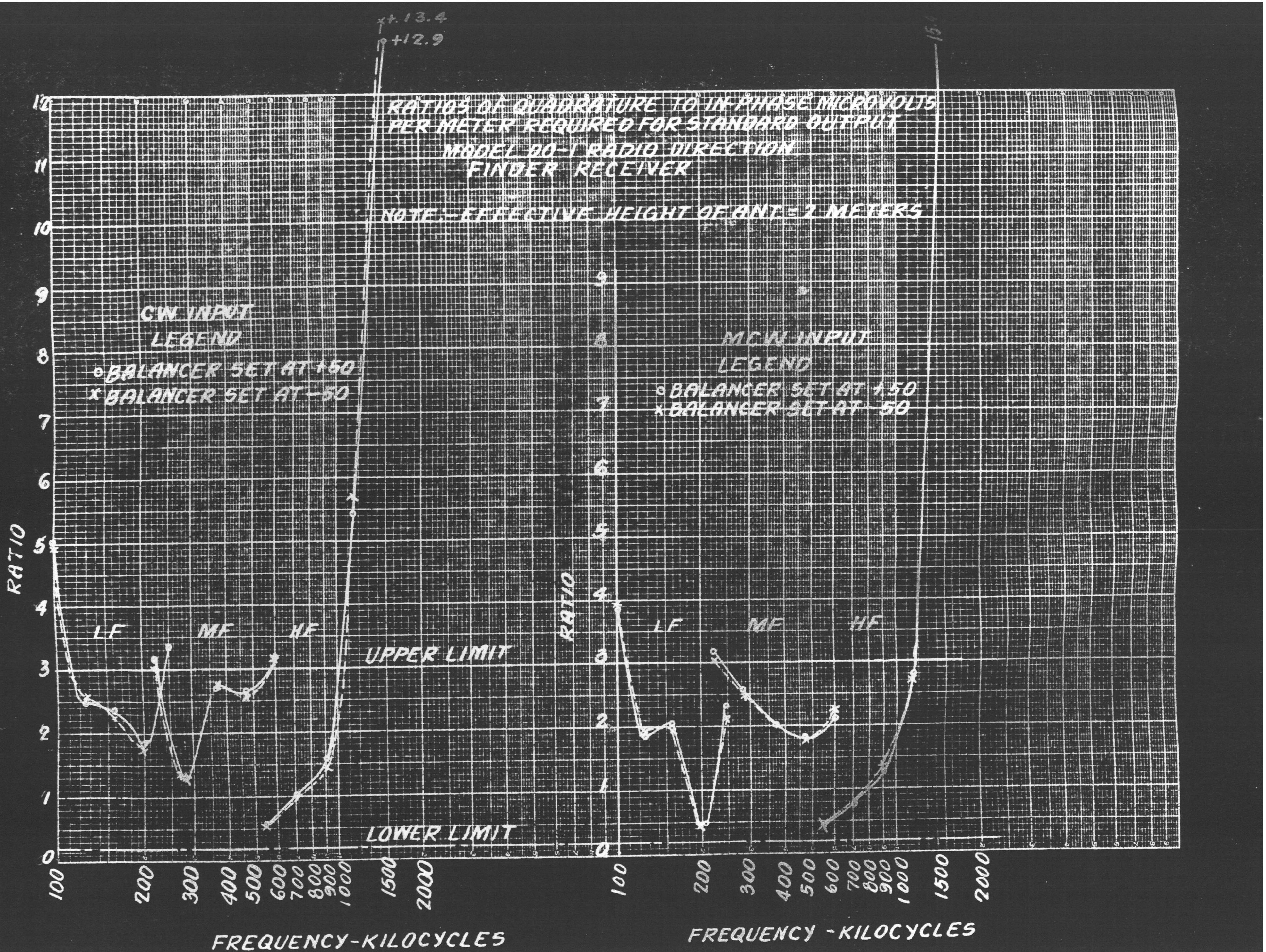

RATIOS OF QUADRATURE TO IN-PHASE MICROVOLTS PER METER INPUTS
REQUIRED FOR STANDARD OUTPUT
MODEL DU RADIO DIRECTION FINDER EQUIPMENT
NOTE:- EFFECTIVE HEIGHT OF ANT. = 2 METERS
RECEIVER OPERATED FROM 115 V. D.C. LINE
C.W. INPUT
LEGEND
○ BALANCER SET AT +50
× BALANCER SET AT -50
MCW INPUT
LEGEND
○ BALANCER SET AT +50
× BALANCER SET AT -50
RATIO
UPPER LIMIT
LOWER LIMIT
LF
MF
HF
FREQUENCY-KILOCYCLES

PLATE 101



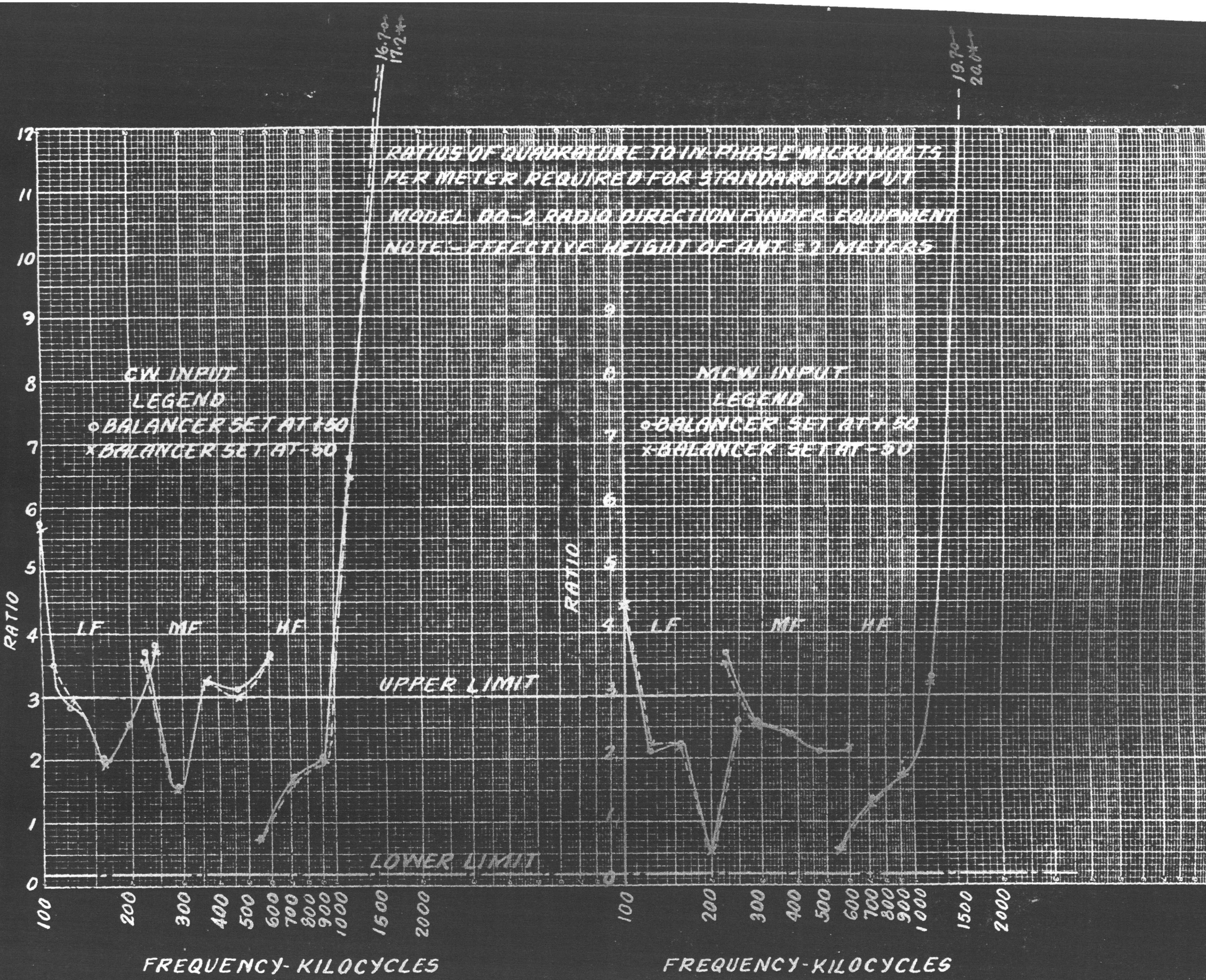
RATIOS OF QUADRATURE TO IN-PHASE MICROVOLTS PER METER INPUTS
REQUIRED FOR STANDARD OUTPUT
MODEL DD RADIO DIRECTION FINDER EQUIPMENT
NOTE - EFFECTIVE HEIGHT OF ANT. = 2 METERS
RECEIVER OPERATED FROM BATTERIES
C.W. INPUT
LEGEND
o BALANCER SET AT +50
x BALANCER SET AT -50
MCW INPUT
LEGEND
o BALANCER SET AT +50
x BALANCER SET AT -50
RATIO
UPPER LIMIT
LOWER LIMIT
LF
MF
HF
0 1 2 3 4 5 6 7 8 9 10 11 12
100 200 300 400 500 600 700 800 900 1000 1500 2000
FREQUENCY-KILOCYCLES

PLATE 102



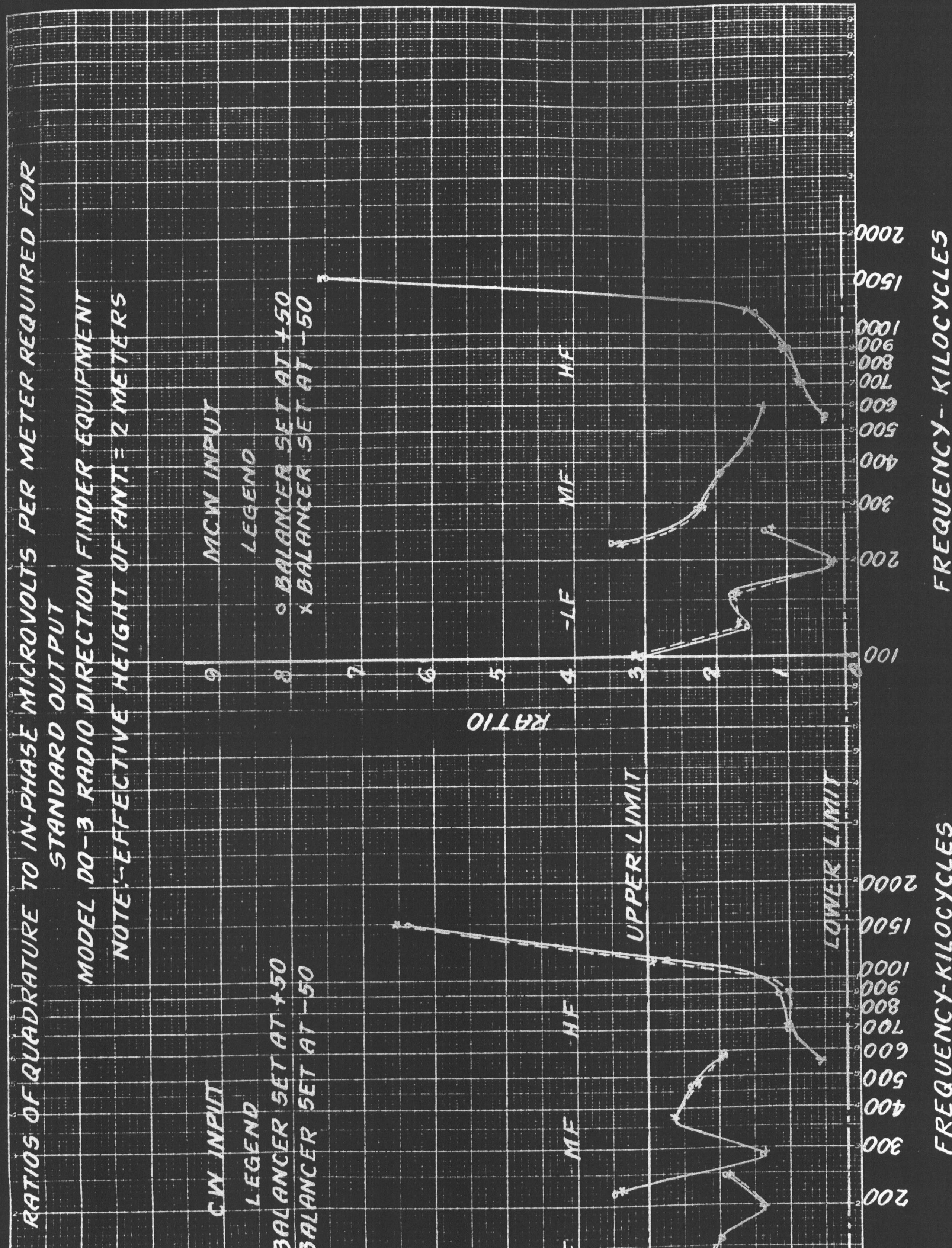
RATIOS OF QUADRATURE TO IN-PHASE MICROVOLTS PER METER REQUIRED FOR STANDARD OUTPUT
MODEL DO-1 RADIO DIRECTION FINDER RECEIVER
NOTE - EFFECTIVE HEIGHT OF ANT = 2 METERS
CW INPUT
LEGEND
o BALANCER SET AT +50
x BALANCER SET AT -50
MCW INPUT
LEGEND
o BALANCER SET AT +50
x BALANCER SET AT -50
x +13.4
o +12.9
15.4
LF
MF
HF
UPPER LIMIT
LOWER LIMIT
RATIO
FREQUENCY-KILOCYCLES
FREQUENCY -KILOCYCLES

PLATE 103



RATIOS OF QUADRATURE TO IN-PHASE MICROVOLTS
PER METER REQUIRED FOR STANDARD OUTPUT
MODEL DQ-2 RADIO DIRECTION FINDER EQUIPMENT
NOTE:- EFFECTIVE HEIGHT OF ANT. = 2 METERS
CW INPUT
LEGEND
○ BALANCER SET AT +50
× BALANCER SET AT -50
MCW INPUT
LEGEND
○ BALANCER SET AT +50
× BALANCER SET AT -50
LF
MF
HF
UPPER LIMIT
LOWER LIMIT
RATIO
16.7
17.2
19.70
20.0
FREQUENCY- KILOCYCLES
FREQUENCY-KILOCYCLES

PLATE 104



RATIOS OF QUADRATURE TO IN-PHASE MICROVOLTS PER METER REQUIRED FOR
STANDARD OUTPUT
MODEL DQ-3 RADIO DIRECTION FINDER EQUIPMENT
NOTE:-EFFECTIVE HEIGHT OF ANT. = 2 METERS
CW INPUT
LEGEND
o BALANCER SET AT +50
x BALANCER SET AT -50
LF
MF
HF
UPPER LIMIT
LOWER LIMIT
RATIO
0
1
2
3
4
5
6
7
8
9
100
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY-KILOCYCLES
MCW INPUT
LEGEND
o BALANCER SET AT +50
x BALANCER SET AT -50
LF
MF
HF
RATIO
FREQUENCY- KILOCYCLES

PLATE 105