REPORT NO. R-1613

DATE 1 May 1940

SUBJECT

Test of Model XDZ Radio Direction Finder Equipment

DECLASSIFIED by NRL Contract
Declassification Team
Date: 17 MAY 2016
Reviewer's name(s): A. THOMPSON, P. HANNA
Declassification authority: NAVY DECLASS MANUAL, 11DEC 2012, 08 SERIES

FR-1613

NAVAL RESEARCH LABORATORY

WASHINGTON 20, D. C.

DISTRIBUTION STATEMENT A APPLIES
Further distribution authorized by UNLIMITED only.

DECLASSIFIED: By authority of 5000A Dated: X Jan 1958

Entered By: E. Bliss Code 2027

DECLASSIFIED

B

[redacted]AL

1 May 1940 NRL Report No. R-1613

NAVY DEPARTMENT

Report of Test

of

Model XDZ Radio Direction Finder Equipment.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

Number of Pages: Text - 15 Tables - 28 Plates - 41

Authorization: BuEng. ltr. F42-1/69 (7-27-R6) of 3 October 1939

Date of Test : 15 Jan. 1940 to 1 Apr. 1940.

Prepared by: R. A. Gordon, Associate Radio Engineer.

K. M. Soukaras, Assistant Radio Engineer.

Reviewed by: M. H. Schrenk, Radio Engineer, Chief of Section.

A. Hoyt Taylor, Head Physicist, Superintendent, Radio Division.

Approved by: H. G. Bowen, Rear Admiral, USN, Director.

Distribution: BuEng. (10)

gfw

DECLASSIFIED

MAY 7 - 1940

[redacted]

TABLE OF CONTENTS

	Page
Authorization	1
Object of Test	1
Abstract of Test	1
Conclusions	1a
Recommendations	1c
Equipment Under Test	2
Method of Test	2
Discussion of Probable Errors	6
Results	6

APPENDICES

Audio Output Characteristic	Table	1
Audio Fidelity		2
Audio Filter Characteristic		3
Volume Control Characteristic		4
Frequency Calibration		5
Tuning Control Setting		6
Oscillator Frequency Drift		7
Efficiency and Frequency Drift of I.F. Amplifiers		8
"Q" of H.F. Loops, Ser.Nos. 1 and 2		9
"Q" of L.F. Loops, Ser.Nos. 1 and 2		10
"Q" of Loop, Model CXS Equipment		11
Loop Sensitivity		12
Directional Sensitivity, Ser. No. 1		13
Directional Sensitivity, Ser. No. 2		14
Directional Sensitivity Model CXS Equipment		15
Repeated Bearing Accuracy, 100 MV/M Field		16
Repeated Bearing Accuracy, 500 MV/M Field		17
Repeated Bearing Accuracy, 200,000 MV/M Field		18
Receiver Selectivity, Ser. No. 1		19
Receiver Selectivity, Ser. No. 1		20
Receiver Selectivity, Ser. No. 2		21
Receiver Selectivity, Ser. No. 2		22
Receiver Sensitivity, Ser. Nos. 1 and 2		23
I.F.Image Ratio		24
I.F.Rejection Ratio		25
Weight of Equipment		26
Dimensions of Equipment		27
Power Consumption		28

DECLASSIFIED

MAY 7 - 1940

[redacted]

APPENDICES (Cont.)

Effect of Humidity on Equipment, 70 kcs.	Plate	1
Effect of Humidity on Equipment, 750 kcs. . . .		2
Effect of Humidity on Equipment, 1300 kcs. . . .		3
Effect of Temperature on Equipment, 50 kcs. . .		4
Effect of Temperature on Equipment, 50 kds. . .		5
Effect of Temperature on Equipment, 1200 kcs. .		6
Effect of Temperature on Equipment, 1200 kcs . .		7
Receiver Selectivity, 15 kcs, Ser. No. 1		8
Receiver Selectivity, 41 kcs, Ser. No. 1		9
Receiver Selectivity, 70 kcs, Ser. No. 1		10
Receiver Selectivity, 100 kcs, Ser. No. 1 . . .		11
Receiver Selectivity, 300 kcs, Ser. No. 1 . . .		12
Receiver Selectivity, 900 kcs, Ser. No. 1 . . .		13
Receiver Selectivity, 1500 kcs, Ser. No. 1 . . .		14
Receiver Selectivity, 15 kcs, Ser. No. 2 . . .		15
Receiver Selectivity, 41 kcs. Ser. No. 2 . . .		16
Receiver Selectivity, 70 kcs, Ser. No. 2 . . .		17
Receiver Selectivity, 100 kcs, Ser. No. 2 . . .		18
Receiver Selectivity, 300 kcs, Ser. No. 2 . . .		19
Receiver Selectivity, 900 kcs, Ser. No. 2 . . .		20
Receiver Selectivity, 1500 kcs, Ser. No. 2 . . .		21
Bilateral-Unilateral Polar Characteristic, 20 kcs		22
Bilateral-Unilateral Polar Characteristic, 400 kcs		23
Bilateral-Unilateral Polar Characteristic, 1300 kcs		24
Bilateral-Unilateral Polar Characteristic, 363 kcs		25
Loop Sensitivity Measuring Circuit		26
Volume Control Characteristic		27
Receiver Oscillator Frequency Drift		28
Temperature Effect on I.F. Amplifiers		29
Directional Sensitivity, Models XDZ and CXS . .		30
Receiver Sensitivity, Ser. Nos. 1 and 2		31
Audio Filter Characteristics		32
Audio Fidelity Characteristics, 200 kcs		33
Audio Fidelity Characteristics, 400 kcs		34
Audio Fidelity Characteristics, 600 kcs		35
Audio Fidelity Characteristics, 1000 kcs.		36
Audio Fidelity Characteristics, 1500 kcs.		37
Photograph of Complete Equipment		38
Photograph of Disassembled Parts		39
Photograph of Receiver, Top View		40
Photograph of Receiver, Bottom View		41

DECLASSIFIED

MAY 7 - 1940

[redacted]

AUTHORIZATION

1. The tests herein reported were authorized by Bureau of Engineering letter, reference (a). Additional references pertinent to these tests are listed as references (b) to (e).

Reference: (a) BuEng. ltr. F42-1/69 (7-27-R6) of 3 October 1939.
(b) BuEng. Conf. Specifications
(c) NRL Report No. 1575 of 20 Nov. 1939.
(d) RCA Mfg. Co. Conf. ltr. to INM Phila., Pa., of 12 January 1940.
(e) BuEng. Conf. ltr. C-NOs-67427 (1-17-DR1) of 31 January 1940.

OBJECT OF TEST

2. The object of these tests is to determine the compliance of the equipment with the requirements of the specifications, reference (b).

ABSTRACT OF TEST

3. The equipment was checked for size and weight, mechanical construction, electrical performance, and its adaptability for use in the Naval Service as required by reference (b).

4. The tests include measurements of efficiency over a temperature range of -30°C. to 50° C. with a relative humidity of 95%; the effect of high temperature and humidity upon the unilateral operation; comparison of bilateral maximum sensitivity with that of the Model CXS Equipment; operation as a bilateral and unilateral direction finder; loop sensitivity; receiver selectivity; image ratio; i-f rejection ratio; overall audio response; current drain and resetability; the ability of the equipment to repeat bearings at various field strengths; the width of the minima at various field strengths; unilateral maximum output to bilateral maximum output ratio; unilateral maximum to minimum ratio and bilateral maximum to minimum ratio at various frequencies; operation of the equipment under vibration; operation of the equipment after an acceleration of 8 g (258 ft/sec/sec); observation of operation in field with various sense antennas. No observations of night effect were made; information on this subject may be obtained from reference (c).

5. At the conclusions of these tests the equipment was submitted to the Naval Air Station at Anacostia for flight tests in accordance with reference (b).

DECLASSIFIED

MAY 7 - 1940

[redacted]

The tests of the Model XDZ Direction Finder Equipment were conducted on two preliminary models. As a result of these tests the following conclusions were reached.

(a) From the observations made of the equipments operation and the results of the various tests conducted, it is believed that the Model XDZ equipment, with modifications, will give long and dependable service to Naval Aircraft.

(b) The material used, with but a few exceptions, is of a high quality. The exceptions to this are the supporting metal frames of the tuning condensers, and some of the fixed condenser metal cases are composed of magnetic material.

(c) The workmanship in general is satisfactory and the equipment with modifications should give dependable service.

(d) The design and layout of the component parts are not considered satisfactory in that the loop selector relay is mounted in the base of the loop housing and cannot be readily adjusted or serviced. The loop cable connector plug is constructed in such manner that it may be readily inserted incorrectly, and so render the equipment inoperative.

(e) The construction of the loop base fitting to the loop extension shaft appears to be thoroughly sealed against water seepage at high velocity.

(f) The sensitivity of the equipment is inferior to that of the Model CXS equipment. It is believed that the sensitivity of the Model XDZ could be improved.

(g) Positive bilateral and unilateral indication is provided over the frequency range 15 to 70 and 100 to 1500 kilocycles. Excellent unilateral operation is obtained over the frequency range on a fixed sense antenna with one initial adjustment and subsequent small adjustment of the unilateral adjustment.

(h) The equipment operated satisfactorily over a temperature range of -30 to 50 degrees centigrade with a relative humidity of 95 per cent. The loss in efficiency due to temperature effect is not considered detrimental to the equipment as the efficiency returned to normal upon return of the temperature to its initial value. The slight reduction in unilateral ratio due to humidity effect was compensated for by a readjustment of the unilateral manual adjustment.

DECLASSIFIED

MAY 7 - 1940

[redacted]

(i) The equipment does not meet the requirements of reference (b) on the following.

Receiver Tuning Control Resetability.
Receiver Selectivity.
Plug Receptacle Construction.
Loop Transfer Relay not readily accessible for servicing.

(j) The equipment satisfactorily met the requirements of reference (b) on the following.

Receiver Audio Distortion.
Receiver Overall Audio Response.
Total Current Drain.
Simplicity of operation.
Operating controls
Repeated bearings
Width of minima
Unilateral operation
Bilateral operation
Loop sensitivity
Operation from -30 to 50°C.
Operation at 95% relative humidity, temperature 50°C
Dimensions and weights
Receiver image ratio
Receiver i-f rejection ratio
Receiver volume control characteristics
Waterproof loop coupling
Loop insulation to ground

(k) The points wherein the equipment does not meet the requirements of the specifications, with the exception of the inaccessibility of the loop transfer relay, are of a nature that may readily be corrected or do not detract seriously from the suitability and serviceability for Naval Aircraft use.

DECLASSIFIED

MAY 7 - 1940

[redacted]

Recommendations

It is recommended that:

(a) The loop connecting cable plugs be of the non-locking type. A plug similar to the Cannon or Army-Navy plug will be satisfactory.

(b) The loop connecting cable plug receptacles be modified so as to permit insertion of the plug in only one position.

(c) The loop windings be impregnated with a moisture-proof compound suitable for r-f operation.

(d) An additional output telephone jack be supplied on the front panel of the receiver as close to the present jack as possible.

(e) The telephone output jack cover be removed.

(f) The set screws in all manual control knobs be standardized for size, preferably by the use of set screws that utilize the Bristo type wrench. At least one Bristo wrench to be supplied and mounted on the receiver chassis.

(g) The trimmer capacitors' adjustment holes be enlarged to accommodate a screw driver having a 1/4" shaft.

(h) Two separate fuses be used, one connected in the primary low voltage input to the dynamotor and one connected in the high voltage output of the dynamotor. Both fuses to be located on the rear of the receiver front panel and be readily accessible upon pulling the receiver a few inches forward in its case.

(i) A redesign of the loop mounting base be made in order to relocate the mounting of the loop transfer relay, in order that repairs or adjustments to this relay may be readily accomplished.

(j) A circuit revision be made to prevent feedback resulting in an audio "howl" when the receiver is tuned to a signal of approximately 176 kilocycles or twice the intermediate frequency.

(k) Both the unilateral and receiver tuning controls be modified so as to be readily operable but not affected by vibration.

(l) The inside flange surface of the loop rotating hand wheel be corrugated to permit adequate finger or hand grip.

(m) The circuit diagram furnished with the instruction book be redrawn and made clear and legible.

DECLASSIFIED

MAY 7 - 1940

(n) The metal framework of the receiver tuning condenser, being of magnetic material, be treated with a moisture-proof compound to prevent rusting or that stainless steel be used.

(o) The directional sensitivity of future equipment of this type be increased.

(p) The loop transfer relay operates so as to connect the proper loop to the receiver when the loop is mounted above or below the aircraft.

(q) The specification requirements for sensitivity of future equipment of this type be in terms of directional sensitivity measured in a radiated field, standard output 50 milliwatts, 4/1 signal plus noise to noise.

(r) A sliding adjustable mask be provided on the azimuth dial, covering approximately 180 degrees of the dial in order to simplify unilateral to bilateral bearing determination.

(s) The loop transfer relay contacts be either pinned or bent over to prevent turning from their initial setting.

(t) All loop leads connecting to the contacts of the loop transfer relay be enclosed in an insulated sleeve to prevent shorting or grounding of the loops caused by loose strands of wire.

(u) The loop locking mechanism be altered so as to allow the use of an ordinary screw instead of a special tool for locking the loop in place.

(v) All flexible leads connecting the loops to the loop relay be arranged so as to prevent any possibility of grounding or shorting when the loop is locked in place.

(w) Schematic symbols and tube type numbers shall be stamped on component parts and adjacent to tube sockets.

(x) Loop terminal connections be stamped with designating symbols agreeing with circuit diagram.

(y) The receiver tuning control gearing be modified so as to improve the resetability of the receiver.

(z) The vacuum tube shields used in the receiver be replaced by a type that enables the easy removal of the shield cap and tube.

DECLASSIFIED

MAY 7 - 1940

[redacted]

EQUIPMENT UNDER TEST

6. The Model XDZ Equipment was manufactured by the Radio Corporation of America, located at Camden, New Jersey. This equipment consists of a receiver, removable plug-in type shielded loop, loop mounting with attached azimuth dial and rotating hand wheel, dynamotor and associated connecting cables comprising a complete direction finder. The equipment operates from a twelve volt battery supply. The equipment is designed to give definite and reliable bilateral and unilateral bearing indications over a frequency range from 15 to 70 kilocycles and 100 to 1500 kilocycles with a minimum of adjustments.

7. The receiver is an 8 tube superheterodyne operating on the 200 volt d-c output of a dynamotor for plate voltage and the 12 volt d-c supply for the vacuum tubes' heater voltage. A neon tube is supplied for signal overload protection. The frequency range is covered in six bands, selected by a single front panel control. The loop antenna consists of two separate loops, one for the frequency range 1500 to 100 kilocycles and one for the frequency range 70 to 15 kilocycles. The loops are selected by a relay which is operated by the frequency band switch located on the receiver front panel. Bands 1 and 2, which cover a frequency range 15 to 70 kilocycles, energize the relay which selects the low frequency loop. Bands 3, 4, 5 and 6 cover the frequency range 100 to 1500 kilocycles. On these bands the loop selector relay is de-energized, selecting the high frequency loop.

8. The equipment is designed to receive telephone communication over the frequency range 1500 to 200 kilocycles. From 200 to 15 kilocycles telephone communication cannot be obtained as single side band reception only is provided. CW operation is provided over the entire frequency range of the equipment.

9. The three lower frequency bands, 200 to 15 kilocycles, are intended primarily for cw operation, but they may be used, with limitations for mcw operation. Below 200 kilocycles the attenuation is high for the higher modulation frequencies, but mcw may be received provided it is limited to a low single-frequency tone modulation.

10. The rotatable loop plugs into the loop pedestal assembly and is locked in place. Four slip rings are provided to conduct the loop windings and loop selector relay control currents to the receiver.

METHOD OF TEST

11. The equipment was inspected and checked for size, weight, and mechanical construction. It was then tested to determine its compliance with the electrical requirements of the specifications, reference (b).

12. The tests to determine the receiver output with humidity and temperature were conducted in a well-shielded temperature and humidity control room. The loop, receiver, and dynamotor with interconnecting

DECLASSIFIED
MAY 7 - 1940

cables were placed in this room. The loop was electromagnetically coupled to a horizontal single wire transmission line terminated at one end in a resistance equal to its surge impedance and fed at the other through a concentric transmission line, by a General Radio standard signal generator situated outside the room. The receiver volume control was adjusted for a 4:1 signal-plus-noise to noise ratio for a 10 milliwatt output, as read by a power output meter. The output of the signal generator was then adjusted until the receiver delivered 10.0 volts to a suitable output meter. The receiver output was recorded with variations of temperature and humidity. In these tests, the loop plane was at maximum position; audio filter switch to "Broad"; operation cw or mcw as desired.

13. To determine the ability of the equipment to withstand acceleration without damage of 258 feet per second per second in any direction, the receiver was mounted, in a specially designed acceleration test machine, first in a horizontal and then in a vertical position. It was arranged that the "dropping" of the receiver trace out a curve on a sheet of paper revolving at a constant speed. By means of the curve and the known speed of rotation of the paper the acceleration may be computed.

14. The vibration test was conducted by mounting the equipment on a specially designed platform capable of vibrating at various rates with a maximum amplitude of 3/32 inch.

15. To test for the bilateral cw sensitivity of the equipment, with the signal injected in series with the loop, the electrical network shown in Plate 26 was used. An unmodulated signal from a standard signal generator was injected at the center of the loop antenna winding. The total attenuation ratio from the S.S.G. to the loop was 1000:1. The receiver volume control and the input to the loop were adjusted to produce a signal-plus-noise to noise ratio of 4:1. The output audio signal, consisting of a 1000 cycles per second cw beat note, gave a power output of 10 milliwatts delivered into a 600 ohm non-inductive resistive load.

16. The receiver selectivity characteristics were determined as follows: A standard signal generator was connected through a 200 micro-microfarad dummy antenna to the receiver "ANT" post. The receiver was set for NON-DIRectional mcw reception. A suitable microammeter was inserted in the second detector cathode return circuit. The receiver volume control was turned clockwise as far as it could go to maximum gain and the current with no signal was noted. The strength of the input signal at resonance was then adjusted until an arbitrary value of twice the no signal current with the gain control set to maximum was reached. The current was maintained constant while the signal generator was detuned below and above resonance with the input signal strength correspondingly increased to 2, 10, 100 and 1000 times its initial adjustment at resonance.

DECLASSIFIED

MAY 7 - 1940

[redacted]

17. The image ratio and i-f rejection ratio were obtained under the following operation conditions: Selector switch at "NON-DIR."; CW-MCW switch at "CW"; audio "BROAD"; volume control adjusted for a 4:1 signal-plus-noise to noise ratio for a 10 milliwatt output delivered into a 600 ohm non-inductive resistive load; signal generator in series with a 200 micromicrofarad dummy antenna.

18. The image ratio was determined by adjusting the standard signal generator and receiver to resonance and 10 milliwatts output and then adjusting the standard signal generator to the image frequency and increasing the input until the receiver output of 10 milliwatts was again obtained. The ratio of the input voltage at these different settings is then computed.

19. The rejection ratio was determined by adjusting the standard signal generator and receiver to resonance and 10 milliwatts output and then adjusting the standard signal generator to the intermediate frequency and increasing the input until the receiver output of 10 milliwatts was again obtained. The ratio of the input voltage at these different settings is then computed.

20. The volume control characteristic was obtained as follows: A polar coordinate scale was placed under a volume control knob containing a pointer. The extreme counter-clockwise position was taken as zero degrees. The operation conditions were as follows: A standard signal generator, in series with a 200 micromicrofarad dummy antenna, was connected to the receiver "ANT" post; selector switch at "NON DIR"; frequency 750 kilocycles on band 6; cw-mcw switch at "CW"; output load resistance 600 ohms non-inductive; output level held at 150 milliwatts for all signal inputs. The volume control was turned clockwise in steps and a record made of microvolts input against knob displacement. The receiver was then adjusted to a 1050 cycle beat note. The volume control knob was next turned counter-clockwise and a change in the beat note was recorded.

21. The audio output characteristics were obtained as follows: CW-MCW switch at "MCW"; audio "BROAD". The second detector tube was removed. An audio oscillator, of known harmonic distortion of less than 1 per cent, was connected, in series, with a 1 megohm resistor, to the plate and cathode contacts of the second detector tube socket. The audio input was adjusted until an audio output of 300 milliwatts from the receiver was delivered to a 600 ohm non-inductive resistance load. A wave analyzer was connected to the output and the second, third, and fourth harmonic distortions on input frequencies of 400 and 1000 cycles/sec., respectively, were obtained. The distortion above the fourth harmonic was negligible. The procedure employed in the determination of total distortion was as follows: At 400 cycles per second input frequency the wave analyzer output was adjusted to an arbitrary value of 100. The analyzer frequency was then changed to 800, 1200, and 1600 cycles per second, corresponding to the second, third, and fourth harmonic of the

DECLASSIFIED
MAY 7 - 1940

400 cycle input frequency. The output reading of the wave analyzer was recorded for each harmonic and the total distortion computed by taking the square root of the sum of the squares for each harmonic output. To test for radio frequency currents in the headset the following procedure was employed: Selector switch at "NON-DIR"; CW-MCW switch at "CW"; standard signal generator in series with a 200 micromicrofarad dummy antenna feeding an unmodulated signal to the receiver; volume control to maximum position. The phone cords were placed in the vicinity of the antenna post and any evidence of instability noted as the receiver was tuned through its range.

22. The audio fidelity characteristic was obtained as follows: A standard signal generator provided with external modulation was connected, in series with a 200 micromicrofarad dummy antenna, to the receiver. The modulation was adjusted to 30 per cent at every measurement. With the modulation frequency set initially at 1000 cycles per second the volume control was adjusted to produce a receiver output of 10 db above 1 milliwatt in an output power meter calibrated in decibels. The modulation frequency was then varied from 200 to 2000 cycles per second and the output in db noted. The unmodulated carrier was 100 microvolts and the receiver output delivered into a 600 ohm non-inductive resistance.

23. The audio filter characteristic was obtained as follows: A beat frequency oscillator was connected to the grid of the second detector. A wave analyzer calibrated in decibels was connected across the 600 ohm output meter into which the receiver output was delivered. Audio switch at "SHARP". The input frequency was adjusted to the resonant frequency of the filter which occurred at 1050 cycles. Keeping a constant input voltage, the input frequency was changed from 400 to 2000 cycles and the wave analyzer output in db recorded.

24. The frequency calibration of the receiver was checked by means of a frequency indicator, Model LM-1.

25. The tuning control setting of the receiver was also checked by the same frequency indicator. The tuning dial of the receiver was set at 500 divisions in band 6, the actual frequency being determined by the Model LM-1. The tuning point on the receiver was then approached clockwise and counterclockwise, the dial being reset at the 500 divisions point and the actual frequency determined, in both directions, by the frequency indicator. Several measurements were made and the mean determined.

26. The loop sensitivity was obtained by coupling to the transmission line and recording the field strength necessary to produce an output of 10 milliwatts with a signal plus noise to noise ratio of 4:1. The loop in this case was rotated to the maximum position. The field intensity at the center of the loop was measured by means of an RCA Type TMV-75-B field intensity meter.

DECLASSIFIED
MAY 7 - 1940

[redacted]

27. The bilateral and unilateral patterns were obtained by coupling the loop to a transmission line and rotating the loop.

DISCUSSION OF PROBABLE ERRORS

28. The following is a list of auxiliary equipment used in conducting the tests and the per cent accuracy of their calibration as guaranteed by the manufacturer:

(a)	General Radio Standard Signal Generator Type 605-B, Ser. No. 814	± 3%
(b)	General Radio Output Meter, Type 483-C, Ser.No.67	± 5%
(c)	General Radio Output Power Meter, Type 583-A, Ser. No. 49	± 7%
(d)	General Radio Beat Frequency Oscillator, Type 713-B, Ser. No. 49	± 1% (Distortion)
(e)	General Radio Wave Analyzer, Type 736-A, Ser. No. 118	± 5%
(f)	Crystal Frequency Indicator, Type LM-1, Ser.No. 5	± 0.01%
(g)	RCA Field Intensity Meter, Type TMV-75-B. . . .	±15%
(h)	G. E. Microammeter, 0-200.	±10%

RESULTS

Sensitivity

29. The directional sensitivity of the Model XDZ equipment is less than the directional sensitivity of the Model CXS equipment over the frequency range 15 to 1500 kilocycles. Sensitivity comparison curves of the two equipments are shown on Plate 30. From these values it is seen that the sensitivity of the Model XDZ averages approximately one-fourth the sensitivity of the Model CXS. Practical application of this variance in sensitivity gives the Model XDZ a reduced operating range over the Model CXS.

30. Over the frequency range 15 to 200 kilocycles, which is the frequency range over which this type equipment relies for night operation, the XDZ sensitivity is approximately one-third that of the CXS, thus the operating range of the XDZ is somewhat less than the CSX over the frequency range where maximum performance is desired.

31. Direct comparison of sensitivity was made on mcw operation from 1500 to 200 kilocycles. Below 200 kilocycles comparison was made on cw operation due to side band attenuation variation of the two receivers for a modulated wave. If we assume that, for low frequency waves of 15 to 100 kilocycles, the field strength attenuation over sea water for distances in excess of 400 miles is a function of the square of the distance, then the operating range of the Model XDZ will be approximately two-thirds that of the Model CXS. The Model XDZ utilizes a loop approximately 13" diameter consisting of 100 turns for the frequency

MAY 7 - 1940

[redacted]

range 15 to 70 kcs, the loop being enclosed with an aluminum shield. The Model CXS utilizes a loop of approximately 12" diameter, the loop consisting of 36 turns, the loop being enclosed in a copper shield. From the above figures it appears that the effective height of the Model XDZ loop is approximately four times greater than that of the Model CXS.

32. A comparison of the value of the loop "Q" of the two equipments shows that (Tables 9 and 10) at frequencies below 100 kilocycles the "Q" of the CXS loop is approximately 80 per cent greater than the "Q" of the XDZ loop.

33. The sensitivity of the receivers used in each equipment is practically equal which precludes that the increased sensitivity of the CXS, in comparison with the XDZ, is attained by the design of the equipment from the loop to the receiver input.

34. In view of the above, an increase in the directional sensitivity would appear advisable for future equipment of the Model XDZ type.

Unilateral Operation (3-52)

35. Under ideal conditions for normally polarized waves the unilateral or sense indication of the equipment is considered satisfactory. Operating as a unilateral direction finder, using a given sense antenna whose capacity ranges from 200 to 800 micromicrofarads and having an initial unilateral maximum to minimum signal ratio adjustment, definite unilateral indication with maximum to minimum ratios greater than 25 to 1 is readily obtained over the entire frequency range with slight adjustment of the manual unilateral adjustment control. Operating under average field conditions unilateral maximum to minimum output voltage ratios of 8 to 1 or greater were obtained. The unilateral operation requires one initial adjustment for a given sense antenna. This adjustment should be made at 200 kilocycles for optimum unilateral performance while the antenna equalizer adjustment should be made at 400 kilocycles. Adjustments made at other frequencies, however, resulted in excellent unilateral operation over the entire frequency range of the equipment. These adjustments are not critical and the results show that the unilateral operation is flexible enough so as not to require any one or more critical adjustments.

36. Excellent unilateral indication was maintained by the equipment when operating over a range of temperature from -30 to 50° C. with a relative humidity of 95 per cent at temperatures above 0°C. A slight reduction of the unilateral maximum to minimum output voltage ratio was observed with high percentage humidity. However, this was corrected by a slight readjustment of the unilateral adjustment manual control.

37. A unilateral maximum output voltage of 150 per cent of the bilateral maximum output voltage is maintained over the frequency range of the equipment as can be seen from Plates 22 to 25, inclusive.

DECLASSIFIED

MAY 7 - 1940

38. No detuning of the loop is necessary to obtain optimum unilateral performance and it is not necessary to retune the loop when changing from unilateral to bilateral operation.

39. No provision for masking the azimuth scale is incorporated in this equipment. The use of a scale mask practically eliminates the possibility of obtaining a reverse bilateral bearing when shifting from unilateral to bilateral direction finding. It is believed that the incorporation of such a feature would be desirable to the successful operation of this equipment.

Bilateral Operation (3-21)

40. Bilateral operation of this equipment is considered satisfactory. Under practically ideal reception of normally polarized waves, sharp well defined minima is obtained with exact 180° ambiguity of bearing. Bilateral maximum to minimum output voltage ratios under the above conditions of greater than 40 to 1 were obtained. Operating under average field conditions ratios of 20 to 1 or greater were observed. Optimum bilateral performance is obtained without retuning of the loop after shifting from unilateral to bilateral. Bilateral operating characteristics are shown on Plates 22 to 25, inclusive.

Operation at Various Temperatures (2-10)

41. The equipment operated satisfactorily over a temperature range of -30 to 50°C. All controls were readily operable. The loop selector relay gave no indication of sluggish action.

42. A reduction in the overall efficiency of the equipment at the higher temperatures was observed. With the complete equipment subjected to temperature changes a 60 per cent reduction in efficiency was noted at temperatures above 0° C. With the loop alone subjected to temperature changes a 15 per cent reduction in sensitivity was noted at the same temperatures. The highest percentage reduction was found to be caused by temperature effect upon the i-f stages of the receiver, as stated in "Receiver Operation".

43. This loss in efficiency of the equipment at the higher temperatures is not considered serious as the equipment is capable of returning to normal operating conditions upon resumption of normal temperatures.

Effect of Humidity (2-10).

44. The equipment operated satisfactorily at a temperature of 50°C. and a relative humidity of 95 per cent. There was little change in operation of the equipment due to humidity. A 15 per cent reduction in efficiency was the maximum loss observed, and it is believed that this was due more to temperature effect than humidity as the effect of temperature upon the loop showed a loss of 15 per cent in efficiency. At the higher relative humidity, above 60 per cent, a slight reduction in unilateral maximum to minimum output voltage was noticed. This was

DECLASSIFIED
MAY 7 - 1940

entirely corrected, however, by a slight readjustment of the manual unilateral control.

45. The loop was also subjected to a salt spray test of 100 per cent humidity at a temperature of 55° C. for a period of 55 hours. At the conclusion of this test the loop showed no loss in sensitivity.

46. The loop and loop supporting pedestal were subjected to a water spray test. The water was directed with considerable force directly upon the loop lower fitting to the pedestal which is the point of possible water seepage into the loop connections. After 30 minutes of this test the loop and loop base receptacles showed no sign of water seepage. It is therefore expected that this loop assembly construction will adequately meet service conditions.

Effect of Vibration

47. The equipment, when subjected to vibrations of various amplitudes and frequency, operated satisfactorily. The vibration frequencies ranged from 600 to 2000 vibrations per minute and the amplitude of vibration from 1/16 to 3/32 inch.

48. No damage to the equipment resulted from these tests. Slight detuning of the receiver was noted but not of a serious nature. Telephone communication was received with slight vibration modulation at frequencies above 600 kilocycles, but the intelligibility was sufficient to identify the transmitting station.

Effect of Acceleration (2-9)

49. The equipment was subjected to an acceleration test of 8 g. The equipment was mounted in both a horizontal and vertical position.

50. No damage to the equipment resulted from these tests. The equipment was dropped twice in each position with the only deviation from normal operation being a 10 per cent loss in output, of which 5 per cent was due to change of the gain control and 5 per cent due to detuning of the receiver. These controls should be provided with more friction to obviate change in setting due to shock.

Receiver Operation

51 The receiver used as a part of this equipment is an eight tube superheterodyne, possessing a high degree of sensitivity and selectivity. Six frequency bands are employed by the receiver to cover the range 15 to 70 and 100 to 1500 kilocycles. The receiver has incorporated a tuned filter for sharp tuning operation, which is operated by a single switch located on the front panel.

DECLASSIFIED

MAY 7 - 1940

[redacted]

52. The first Model XDZ received was found to have a defective receiver in that a severe audio howl resulted when tuning the receiver to a frequency of twice the intermediate frequency, or 176 kilocycles. This feedback was of such intensity as to make the receiver inoperable around a frequency of 176 kilocycles. This difficulty was remedied by decreasing the screen voltage and increasing the screen r-f grounding capacity of the first i-f tube. The new value of screen dropping resistor is 10,000 ohms, and the new value of screen grounding capacity is .5 microfarad. In addition, an r-f filter was incorporated in the secondary circuit of the audio output transformer designed to reject the second i-f harmonic. These changes completely removed the above defects, and the second Model XDZ, with these changes incorporated, showed no evidence of instability of operation on any of the above points.

53. It was noticed on the first model that the oscillator would stop oscillating at frequent intervals. An investigation failed to find any defect in circuit, voltages or parts. A new tube was installed and no further trouble from oscillator failure occurred. The second model performed without any failures of the oscillator during the time used.

54. The frequency calibration of the receiver, from 300 to 1500 kilocycles, is approximately from .05 to .10 per cent of the actual frequency as can be seen from Table 5. However, as this is well within audibility, it is considered as satisfactory.

55. The receiver resetability does not meet the requirements of the specifications when resetting from a clockwise direction. At 1085 kilocycles the counter-clockwise resetability is within the requirements, but the reset from a clockwise direction exceeds the requirements by .37 per cent or 3300 cycles, as shown in Table 6. This is apparently caused by the mechanical construction of the tuning condenser driving mechanism. It is believed that this condition could be improved in the present equipment.

56. The receiver was subjected to a temperature range of from -20 to 50° C. in order to determine the receiver circuit responsible for the loss in efficiency of the equipment at these temperatures. It was observed that the maximum oscillator frequency drift, for a 10°C. change in temperature, was .0067 per cent per degree centigrade. This is considered to be an average drift for circuits of this type. The i-f stages alone showed a loss in efficiency of 50 per cent at temperatures above 30° C., the frequency drift being .11 per cent. It is believed that the i-f stages are mainly responsible for the 60 per cent loss in overall efficiency of the equipment at temperatures above 30° C. Tables 5, 7 and 8 contain data of these tests.

57. The audio output, audio fidelity, audio filter and volume control characteristics meet the specification requirements. Data concerning these measurements are contained in Tables 1 to 4, inclusive.

DECLASSIFIED

58. The supporting frame of the gang tuning condensers is of magnetic material and should be treated with a weather proof corrosion resisting material.

59. Several of the by-pass condensers used in the receiver circuits are enclosed in metallic cases having magnetic properties. These condensers were subjected to a salt spray, high temperature corrosion test for a period of 55 hours, which corresponds to approximately 6 years' sea service. The cases showed some rusting after 33 hours, or approximately 4 years' service. After the 55 hours tests, the cases showed definite corrosion on the container surface but the cases were not punctured and the condensers were as good as initially measured.

Mechanical Construction

60. With few exceptions, the mechanical layout and the material used is of a high order. The exceptions to this are the location and mounting of the loop transfer relay arrangement of the relay contacts, construction of the cable plug contacts and receptacles, and the loop locking mechanism.

61. The loop transfer relay is located on the base of the loop housing. In order to service this relay it requires that the loop be removed from the loop pedestal socket, remove eight flange securing screws and removal of two relay securing screws. The relay can then be lifted approximately 3/4" from its securing base, which is not considered sufficient for adequate servicing and adjusting of the relay contacts. A redesign of the loop base would be necessary to allow for removal of the relay for servicing and adjusting.

62. The loop leads are brought from the two loops through a supporting insulated panel and thence to the relay contacts. On the first Model XDZ these leads were shorted and grounded to the loop casing. One of the loops being inoperable, these leads were trimmed and resoldered to the relay contacts and the loops operated satisfactorily. The loop windings are of Litz wire and were not impregnated with any moisture protecting compound. It is believed that the windings should be protected by a coating of a high quality compound and the loop leads enclosed in an insulating sleeve.

63. The second Model XDZ, Ser. No. 2, upon arrival at the Laboratory was inoperable on the high frequency loop due to inability of the loop transfer relay to return to its de-energized position. This condition was remedied by readjusting of the relay armature spring. Further difficulty was encountered by several strands of the loop leads shorting to ground.

64. The loop relay on the second Model XDZ failed to operate when the loop was placed in a position 180° from normal, which would be the case when mounted under an airplane. This condition was also remedied

DECLASSIFIED

MAY 7 - 1940

[redacted]

with the adjustment as described in the foregoing paragraph.

65. The contacts of the loop transfer relay are mounted on an insulated base and secured to this base by rivets. No provision is made to prevent these contacts from turning and short circuiting. Several of the contacts on the first Model XDZ were found to be shorted and were rearranged and soldered to the rivets to prevent further trouble. No trouble of this nature was experienced on the second Model XDZ. These contacts should be either pinned or soldered to prevent future trouble from this source due to the close proximity of the contacts necessitated by the small space allotted for the relay as the loop must be removed from its pedestal and disassembled in order to service the relay.

66. All cable plugs are of the double locking nut type and are not considered as applicable in operation as the single sliding nut type such as the Cannon or Army-Navy Plug. The replacing of these plugs with the Cannon or Army-Navy type plug would greatly improve and facilitate the removal and installation of the equipment.

67. The cable receptacle contacts are not strong enough mechanically to withstand service use and are so arranged that the plug may be inserted wrongly, thus rendering the equipment inoperative. By the adoption of either the Cannon or Army-Navy type plug and receptacle this condition will be overcome.

68. The loop locking mechanism practically requires a special screw driver or tool to lock and unlock the loop from its plug socket. It is practically impossible to operate this locking device with an ordinary screw driver. It is believed that a change in the design of the locking screw would materially improve this operation.

69. The plug-in loop construction appears to be thoroughly waterproof. A steady stream of water at hydrant pressure was applied directly at the ring seal of the loop assembly for a period of one-half hour. No evidence of water seepage through this seal was visible.

Dimensions and Weights (3-19) (3-20)

70. The weight of the equipment, exclusive of the loop extension shaft, is 65.15 pounds. The maximum weight, using the 113" extension shaft, is 77.6 pounds. The weights and dimensions of the several parts are listed in tables 26 and 27.

71. Comments are herein made relating to reference (d) as requested by reference (e). The paragraphs are numbered in accordance with corresponding paragraphs of reference (d).

(1) The use of mica capacitors other than those supplied by Cornell-Dubilier is acceptable provided these capacitors meet the requirements of Specification RE 48A 154A.

DECLASSIFIED

(2) Schematic symbols, stamped on components, should apply also to loop terminal block and loop relay contacts.

(3) Suitable.

(4) Suitable.

(5) Provides additional strength.

(6) Suitable.

(7) Does not specify what type stop nuts are to be used.

(8) Reduction of backlash an improvement in operation.

(9) Simplifies wiring and diagram to some extent.

(10) Suitable, provided a special tool is not required for adjustments.

(11) This has been done on preliminary models.

DECLASSIFIED

[redacted]

Conclusions

The tests of the Model XDZ Direction Finder Equipment were conducted on two preliminary models. As a result of these tests the following conclusions were reached.

(a) From the observations made of the equipments operation and the results of the various tests conducted, it is believed that the Model XDZ equipment, with modifications, will give long and dependable service to Naval Aircraft.

(b) The material used, with but a few exceptions, is of a high quality. The exceptions to this are the supporting metal frames of the tuning condensers, and some of the fixed condenser metal cases are composed of magnetic material.

(c) The workmanship in general is satisfactory and the equipment with modifications should give dependable service.

(d) The design and layout of the component parts are not considered satisfactory in that the loop selector relay is mounted in the base of the loop housing and cannot be readily adjusted or serviced. The loop cable connector plug is constructed in such manner that it may be readily inserted incorrectly, and so render the equipment inoperative.

(e) The construction of the loop base fitting to the loop extension shaft appears to be thoroughly sealed against water seepage at high velocity.

(f) The sensitivity of the equipment is inferior to that of the Model CXS equipment. It is believed that the sensitivity of the Model XDZ could be improved.

(g) Positive bilateral and unilateral indication is provided over the frequency range 15 to 70 and 100 to 1500 kilocycles. Excellent unilateral operation is obtained over the frequency range on a fixed sense antenna with one initial adjustment and subsequent small adjustment of the unilateral adjustment.

(h) The equipment operated satisfactorily over a temperature range of -30 to 50 degrees centigrade with a relative humidity of 95 per cent. The loss in efficiency due to temperature effect is not considered detrimental to the equipment as the efficiency returned to normal upon return of the temperature to its initial value. The slight reduction in unilateral ratio due to humidity effect was compensated for by a readjustment of the unilateral manual adjustment.

DECLASSIFIED
MAY 7 - 1940

(i) The equipment does not meet the requirements of reference (b) on the following:

Receiver Tuning Control Resetability
Receiver Selectivity.
Plug Receptacle Construction
Loop Transfer Relay not readily accessible for servicing.

(j) The equipment satisfactorily met the requirements of reference (b) on the following.

Receiver Audio Distortion.
Receiver Overall Audio Response
Total Current Drain.
Simplicity of operation.
Operating controls
Repeated bearings
Width of minima
Unilateral operation
Bilateral operation
Loop sensitivity
Operation from -30 to 50°C.
Operation at 95% relative humidity, temperature 50°C.
Dimensions and weights
Receiver image ratio
Receiver i-f rejection ratio
Receiver volume control characteristics
Waterproof loop coupling
Loop insulation to ground

(k) The points wherein the equipment does not meet the requirements of the specifications, with the exception of the inaccessibility of the loop transfer relay, are of a nature that may readily be corrected or do not detract seriously from the suitability and serviceability for Naval Aircraft use.

DECLASSIFIED

CONFIDENTIAL

TABLE I.

Model XDZ Direction Finder, Ser. No. 1.

Audio Output Characteristic
300 Milliwatts Output.

	Input Freq. (Cycles/Sec.)	Wave Analyzer Freq. (cycles/Sec.)	Wave Analyzer Output	Total Harmonic Distortion %
(a)	400	400	100	7.7
		800	6.0	
		1200	4.6	
		1600	100	
(b)	1000	1000	100	8
		2000	6.4	
		3000	4.5	
		4000	1.4	

No evidence of direct current or radio frequency currents in the headset.

Specification:
The total distortion should not exceed 10% and there shall be no direct current or appreciable radio frequency currents in the headset.

DECLASSIFIED

CONFIDENTIAL

TABLE 2 (Continued)

6	1000	1400	10	0
		1600	9	- 1
		1800	8	- 2
		2000	7.8	- 2.2
6	1500	200	4	- 6
		400	6.8	- 3.2
		600	7.8	- 2.2
		800	9	- 1
		1000	10	0
		1200	10.3	+ 0.3
		1400	10	0
		1600	9	- 1
		1800	8.3	- 1.7
		2000	8.5	- 1.5

Specifications:

The overall audio response shall not vary by more than 8 db from the response at 1000 cycle modulation.

DECLASSIFIED
(2)
MAY 7 - 1940

CONFIDENTIAL

TABLE 2

Model XDZ Direction Finder, Ser. No. 1.

Audio Fidelity Characteristic
Unmodulated carrier 100 microvolts
modulated 30%. 600 ohms output load.

Band	Carrier Freq. (KC)	Modulation Freq. (Cycles)	Audio Output (db)	Relative Loss (db)
4	200	200	14	+ 4
		400	14.5	+ 4.5
		600	13	+ 3
		800	11	+ 1
		1000	10	0
		1200	9	- 1
		1400	9	- 1
		1600	9.5	- 0.5
		1800	11	+ 1
		2000	14	+ 4
4	400	200	6	- 4
		400	8	- 2
		600	9	- 1
		800	9.5	- 0.5
		1000	10	0
		1200	10.5	+ 0.5
		1400	10	0
		1600	9	- 1
		1800	7	- 2
		2000	6	- 4
5	600	200	15	+ 5
		400	15.5	+ 5.5
		600	14	+ 4
		800	12	+ 2
		1000	10	0
		1200	8.5	- 1.5
		1400	7.2	- 2.8
		1600	6.5	- 3.5
		1800	6.5	- 3.5
		2000	8.0	- 2.0
6	1000	200	4	- 6
		400	6.5	- 3.5
		600	8	- 2
		800	9	- 1
		1000	10	0
		1200	10.3	+ 0.3

DECLASSIFIED

[redacted]

TABLE 3.

Model XDZ Direction Finder Ser. No. 1

Audio Filter Characteristic.

Frequency (Cycles/Sec)	Wave Analyzer Output (db)	Relative Loss (db)	Specification Relative Loss (db)
1050	129.6	0	0
800	94.8	34.8	25
600	74.8	54.8	45
400	65.0	64.6	60
1200	110.0	19.6	15
1500	81.1	48.5	35
2000	50.0	79.6	50

TABLE 4

Volume Control Characteristic for a Constant Receiver Output of 150 milliwatts.

Volume Control Displacement (Degrees)	Receiver Input (Microvolts)
0	100,000
90	40,000
120	3,080
150	235
180	27.8
210	8
240	4.7
270	1.1

Frequency shift: +24 cycles/sec

Specification:

The volume control shall not change the beat note by more than 100 cycles.

DECLASSIFIED

[redacted]

TABLE 5.

Model XDZ Direction Finder, Ser. No. 1.

Check of Receiver Frequency Calibration.

Band	Tuning Dial Setting (Divs.)	Calibration Freq. (KC)	Actual Freq. (KC)	Percent of Actual Frequency
6	1000	1525	1524.0	.065
	500	1088	1085.4	.28
	000	743	744.5	.20
5	1000	811	810.8	.024
	500	580	567.8	2.2
	000	397	396.2	.20
4.	1000	405	405.6	.14
	500	290	289.0	.34

No Specification.

TABLE 6

Check of Tuning Control Setting.
Band 6. Dial Setting 500 Divisions.
Actual Frequency 1085.4 KC.

Clockwise Approach		Counter Clockwise Approach	
LM-1 (Divs)	LM-1 Freq. (KC)	LM-1 (Divs)	LM-1 Freq. (KC)
1779.5	1081.60	1799.0	1085.48
1781.0	1081.90	1799.0	1085.48
1780.5	1081.80	1799.9	1085.66
1780.0	1081.70	1797.0	1085.18
1782.0	1082.10	1797.9	1085.26
	Mean Freq.(KC) 1081.82		Mean Freq. (KC) 1085.41

Frequency error = 1085.41 - 1081.82
= *3590 cycles/sec

Specification limit = 0.00025 (1085.41)
= 272 cycles/sec.

* Does not meet the Specification.
Exceeds spec. by .37%

DECLASSIFIED

CONFIDENTIAL

TABLE 7

Model XDZ Direction Finder, Ser. No. 1.

Frequency Drift with Temperature, 1st Oscillator of Receiver
CFI Oscillator, Cycles/div. = 41.6

Time	Temp. (°C)	CFI Oscil. (Divs.)	CFI Freq. (KC)	Δ F (Cycles)	% Δ F per 10°C	%Δ F/°C
1417	-20	347.7	200	0	0	0
1420	-10	347.7	200	0	0	0
1430	0	349.0	200.054	54	0.027	0.0027
1447	+10	352.0	200.178	124	0.062	0.0062
1508	+20	354.7	200.291	113	0.056	0.0056
1536	+30	358.0	200.426	135	0.067	0.0067
1600	+40	361.2	200.559	133	0.066	0.0066
1628	+50	363.8	200.667	108	0.054	0.0054

Total frequency change: 667 cycles/sec. or 0.33%.

No Specifications.

TABLE 8

Efficiency and Frequency Drift of I.F. Amplifiers with Temperature. Constant Input of 392 μV, 50% modulation. Initial Receiver Output of 200 MW.

Time	Temp. (°C)	Input Freq. (KC)	Δ F Input (Divs.)	Δ F Input (%)	Power Output (MW)	Change of Output (%)
1230	-20	87	0	0	200	0
1250	-10	87	0	0	194	3
1303	0	87	0	0	186	7
1323	+10	87	0	0	170	15
1348	+20	87	0	0	150	25
1408	+30	87	0	0	133	33
1435	+40	87	0.5	+ 0.05	117	41
1500	+50	87	1.5	+ 0.15	100	50
1600	+22	87	1.1	+ 0.11	118	41

When operated next morning at room temperature, the output recovered to 150 milliwatts.

No Specification.

DECLASSIFIED

CONFIDENTIAL

TABLE 9

XDZ Direction Finder
Q Variation with Frequency of High Frequency Loops,
Ser. Nos. 1 and 2.

(L.F.Loop Shorted)

C (μμf)	Loop Ser. 1 Freq. (KC)	Q	Loop Ser. 2 Freq. (KC)	Q
50	3470	24	3150	25
100	2500	22	2550	32
150	1960	10	2190	32
200	2150	27	1980	20
250	2000	36	1703	22
300	1610	42	1588	32.5
350	1470	47	1480	41
400	1400	50	1410	46
500	1280	50	1290	50
600	1210	52	1210	52
700	1120	52	1125	55
800	1100	56	1050	57.5
900	990	59	990	60
1000	960	61	950	60
1100	920	62	920	61
1200	880	63	880	62
1300	840	64	842	63
1400	810	64	810	63
1500	790	64	787	63
1600	770	64	770	63
1700	745	64	743	64
1800	722	65	720	64
1900	702	65	700	65
2500	590	65	587	65
2900	550	66	548	65
5000	435	63	433	63
7500	350	60	350	60
9000	320	57	320	58
20000	218	23	217	25

Natural frequency of High Frequency Loop is approximately 5000 KC.

No Specification.

DECLASSIFIED

[redacted]

TABLE 10

XDZ Direction Finder

Q Variation with Frequency of Low Frequency Loops, Ser. Nos. 1 and 2.

C (μμf)	Loop Ser. 1. Freq. (KC)	Q	Loop Ser. 2 Freq. (KC)	Q
50	175	42	177	39
100	146	53	147	50
150	130	56	132	53
200	115	63	117	60
250	106	64	107	62.5
300	99	77	100	68
350	93	77	93	70
400	88	74	88.5	67
450	83.5	72	84	67
500	81.3	67	82	63
550	80	67	80.3	63
600	77	66	77	62.5
650	73.8	65	74	62
700	71	65	71.3	62
750	68.5	65	69	62
800	66.5	64.5	67	62
900	62.8	64	63	61
1000	60.2	63	60.5	62
1100	58.2	63	58.4	62
1200	55.5	63	55.8	61
1300	53.3	62	53.7	60
1400	51.3	62	51.7	59
1535	50	60	50.3	58

Natural frequency of Low Frequency Loop is 23.0 KC.

No Specification.

DECLASSIFIED

MAY 7 - 1940

[redacted]

TABLE 11

Model CXS Direction Finder, Ser. No. 2.

Q Variation of Loop with Frequency.
High Frequency Loop (Two separate windings in parallel)
Low Frequency Loop (Windings in series)

	L.F.Loop		H.F.Loop	
C (uuf)	Freq. (KC)	Q	Freq. (KC)	Q
0+	617	27	1130	20
50	574	37	1070	26
100	495	55	940	42
150	443	72	848	57
200	403	86	778	70
250	374	98	722	82
300	350	107	678	92
350	327	117	640	100
400	310	124	607	108
450	295	132	580	117
500	287	132	565	119
600	272	132	535	123
700	253	138	500	132
800	237	142	468	142
900	224	145	445	198
1000	216	148	426	155
1100	208	150	413	160
1200	200	152	395	167
1400	184	153	367	170
1500	179	151	358	167
1600	175	150	350	169
1900	160	151	318	177
2500	136	135	270	180
5000	100	127	200	156
7500	82	125	162	156
8500	77	124		

DECLASSIFIED

[redacted]

TABLE 12

Model XDZ Direction Finder, Ser. No. 1.

Bilateral CW. Sensitivity. Signal-plus-noise to noise Ratio of 4:1, 10 MW Output. Input Signal Injected at Center of Loop.

Band	Test Frequency (KC)	Loop Signal Strength (Microvolts)	
	15	0.120	
1	20	0.100	
	30	0.090	
	32	0.120	max. gain.
2	50	0.110	
	70	0.115	
	100	0.018	
3	150	0.023	
	200	0.020	
	200	0.046	
4	250	0.073	
	400	0.054	
	400	0.076	
5	700	0.080	
	800	0.064	
	750	0.100	
6	900	0.070	
	1200	0.100	
	1500	0.060	

Specification requirement: 5 microvolts.

[redacted]

TABLE 13

Model XDZ Direction Finder, Ser. No. 1.

Loop (Radiated Field) Sensitivity. Loop coupled to Transmission Line. 30% Modulation. 4:1 Signal-plus-Noise to Noise Ratio. 10 MW Power Output.

Loop Intensity (R.F.).

Band	Freq. (KC)	Field Intensity Microvolts per meter CW	MCW
6	1500	12.8	40
	1000	24	90
	750	19	69
5	800	20	75
	600	24	92
	450	20	91
4	400	30	136
	300	30	120
	210	42	188
3	200	20	81
	150	26	124
	105	36	140
2	70	8	46
	50	10	80
	33	18.6	140
1	30	15	140
	20	22	200
	16	28	300

No Specification.

DECLASSIFIED

MAY 7 - 1940

CONFIDENTIAL

TABLE 14

Model XDZ Direction Finder, Ser. No. 2.

Loop (Radiated Field) Sensitivity. Loop Coupled to Transmission Line. 30% Modulation. Signal-plus-noise to noise Ratio of 4:1. Power Output 10 MW.

Band	Freq. (KC)	Field Intensity Microvolts per meter CW	MCW	Unilateral Ratio Measured at 1000 $\mu V/M$ Min (MW)	Max. (MW)	Ratio
6	1500	7.5	18	0.5	50	100:1
	1000	16.4	38.8	0.5	50	100:1
	750	15	37.3			100:1
5	800	9.7	26.9	0.5	50	100:1
	600	14.5	39.5	0.5	50	100:1
	450	16.4	45			100:1
4	400	17.2	56.7	0.5	50	72:1
	300	19.4	64.2			100:1
	210	27	76			100:1
3	200	15.7	55.2	0.5	50	73:1
	150	17.2	73.2	0.6	50	83:1
	105	23.9	106	0.75	50	67:1
2	70	6.4	34.4	0.5	50	100:1
	50	9.0	52.2	0.5	50	100:1
	33	14.8	90	0.5	50	100:1
1	30	14.6	101	0.5	50	53:1
	20	15	141	0.5	50	100:1
	16	37.3	299	0.5	50	100:1

No Specification for Sensitivity.

Specification requirement for a unilateral ratio of at least 8 to 1

[redacted]

TABLE 15

Model CXS Direction Finder, Ser. No. 2.

Loop (Radiated Field) MCW Sensitivity.
Loop Center 22" from Transmission Line. Signal-plus-Noise to Noise Ratio, 4:1.
40 MW Output.

Band	Freq. (KC)	Field Intensity Microvolts per meter MCW		Field Intensity Microvolts per meter CW
		Wide Band	Narrow Band	Wide Band
H	1500	10.9	6.5	2.7
H	1025	14.7	10.8	4.1
G	750	5.2	3.5	1.3
G	600	8.0	5.2	2.0
F	450	12.4	7.7	2.8
E	300	12.3	10.0	4.0
E	200	17.3	12.4	5.1
D	150	12.0	11.3	2.8
D	105	18.7	14.7	4.7
C	70	16.0		4.5
C	50	21.4		3.2
B	33	34.7		6.1
A	20	56.0		11.2
A	16	81.3		

No Specification.

DECLASSIFIED

MAY 7 - 1940

CONFIDENTIAL

TABLE 16

Model XDZ Direction Finder, Ser. No. 1.

Polar Characteristic (Bilateral)

100 Microvolts/Meter, CW Signal, Loop Coupled to Transmission line.

Band	Freq. (KC)	Original and Reset Bearing (Degrees)	Reciprocal Bearing (Degrees)	Bearing Error (Degrees)	Width of Null (Degrees)
1	20	0	180	0	6
2	50	0	180	0	5
3	150	0	180	0	8
4	300	0	180	0	6
5	500	0	180	0	6
6	1500	0	180	0	4

Specification:

It shall be possible to take repeated bearings with a variation in bearing obtained to be not more than plus or minus 2 degrees. The two minimum signal points shall be not more than 182 degrees nor less than 178 degrees apart.

TABLE 17

500 Microvolts/Meter, CW Signal, Loop Coupled to Transmission Line.

Band	Freq. (KC)	Original and Reset Bearing (Degrees)	Reciprocal Bearing (Degrees)	Bearing Error (Degrees)	Width of Null (Degrees)
1	20	0	180	0	5
2	50	0	180	0	1
3	150	0	180	0	2
4	300	0	180	0	4
5	500	0	180	0	3
6	1500	0	180	0	1

Specification:

It shall be possible to take repeated bearings with variations of not more than plus or minus 1 degree, provided that the signal wave front is known to be normally polarized.

DECLASSIFIED

MAY 7 - 1940

[redacted]

TABLE 18

Model XDZ Direction Finder, Ser. No. 1.

Polar Characteristic (Bilateral)

200,000 Microvolts/meter, CW Signal, Loop Coupled to Transmission Line.

Band	Freq. (KC)	Original and Reset Bearing (Degrees	Reciprocal Bearing (Degrees)	Bearing Error (Degrees)	Width of Null (Degrees)
1	20	0	180	0	< 1
2	50	0	180	0	< 1
3	150	0	180	0	< 1
4	300	0	180	0	< 1
5	500	0	180	0	< 1
6	1500	0	180	0	< 1

Specification:

It shall be possible to take repeated bearings with variations of not more than plus or minus 1 degree, provided that the signal wave front is known to be normally polarized.

DECLASSIFIED

CONFIDENTIAL

TABLE 19

Model XDZ Direction Finder, Ser. No. 1.
Receiver Selectivity
2nd detector current: No signal, I = 50 μa. With signal, I=100 ua.

Band	Test Freq. (KC)	Initial Adjustment of Input Signal Times	Initial Adjustment of Input Signal (μV)	Std. Sig. Gen. Divisions (-)	Std. Sig. Gen. Divisions (+)	%△F (-)	%△F (+)	△F in KC. (-)	△F in KC. (+)
1	15	1	13						
		2	26	14	12	1.4	1.2	0.210	0.180
		10	130	30	26	3.0	2.6	0.450	0.390
		100	1300	58	55	5.8	5.5	0.870	0.825
		1000	13000	93	90	9.3	9.0	1.395	1.350
2	41	1	16						
		2	32	7.0	8.5	0.70	0.85	0.287	0.348
		10	160	15.8	18.0	1.58	1.80	0.647	0.737
		100	1600	28.5	31.5	2.85	3.15	1.17	1.29
		1000	16000	51.0	43.0	5.10	4.30	2.09	1.77
2	70	1	10						
		2	20	4.8	5.5	0.48	0.55	0.336	0.384
		10	100	10.5	12.5	1.05	1.25	0.735	0.875
		100	1000	18.8	24.0	1.88	2.40	1.31	1.68
		1000	10000	28.0	37.6	2.80	3.76	1.96	2.63
3	100	1	15						
		2	30	4.2	6.0	0.42	0.60	0.42	0.60
		10	150	9.1	12.2	0.91	1.22	0.91	1.22
		100	1500	15.0	20.8	1.50	2.08	1.50	2.08
		1000	15000	22.0	32.0	2.20	3.20	2.20	3.20
4	300	1	2						
		1.25	2.5	3.0	2.1	0.30	0.21	0.90	0.63
		1.50	3.0	10.0	2.7	1.00	0.27	3.00	0.81
		2.0	4	11.0	3.0	1.10	0.30	3.30	0.90
		10	20	13.0	5.2	1.30	0.52	3.90	1.56
		100	200	14.3	8.0	1.43	0.80	4.29	2.40
		1000	2000	16.3	11.6	1.63	1.16	4.89	3.48
6	900	1	3						
		1.5	4.5	1.0	1.1	0.10	0.11	0.90	0.99
		2	6	4.0	1.3	0.40	0.13	3.60	1.17
		10	30	5.0	2.2	0.50	0.22	4.50	1.98
		100	300	5.6	3.7	0.56	0.37	5.04	3.33
		1000	3000	7.8	6.0	0.78	0.60	7.02	5.40
6	1500	1	1						
		1.5	1.5	0.50	1.0	0.05	0.1	0.75	1.50
		2	2	2.30	1.6	0.23	0.16	3.45	2.40
		10	10	3.0	2.0	0.30	0.20	4.50	3.00
		100	100	3.3	2.3	0.33	0.23	4.95	3.45
		1000	1000	4.8	3.6	0.48	0.36	7.20	5.40

DECLASSIFIED

CONFIDENTIAL

TABLE 20

Model XDZ Direction Finder, Ser. No. 1.
Receiver Selectivity
(Band Width at Various Levels)

Resonant Freq. (KC).	Band Width 20 db. Receiver (KC)	Band Width 20 db. Specification (KC) Max.	Band Width 40 db. Receiver (KC)	Band Width 40 db. Specification (KC) Max.	Band Width 60 db. Receiver (KC)	Band Width 60 db. Specification (KC) Max.
15	0.86	1.8	1.70	3.2	2.75	5.2
41	1.38	2.7	2.46	3.8	3.86	5.5
70	1.61	2.8	2.99	4.0	4.59	5.6
100	2.13	2.8	3.58	4.4	5.40	6.0
300	5.46	5.6	6.69	8.0	8.37	11.6
900	6.48	5.8	8.37	8.4	12.42*	12.0
1500	7.5*	6.5	8.4	9.6	12.6*	12.4

* Does not meet the specifications.

DECLASSIFIED
MAY 7 - 1940

[redacted] CONFIDENTIAL

TABLE 21

Model XDZ Direction Finder, Ser. No. 2.
Receiver Selectivity.

No Signal, I = 62 ua. With signal, I = 120 ua

Band	Freq. (KC)	Times Input at resonance	S.S.G. (μV)	S.S.G. Divisions (-)	S.S.G. Divisions (+)	△ F in (-)	△ F in (+)	Band Width (KC)
1	15	1	10					
		2	20	10.5	14.8	0.16	0.22	0.38
		10	100	27.5	32.5	0.42	0.49	0.91
		100	1000	53	57.5	0.79	0.86	1.65
		1000	10000	86	90	1.29	1.35	2.64
2	41	1	9.35					
		2	18.7	7.0	7.5	0.287	0.308	0.595
		10	93.5	10.8	15.0	0.433	0.615	1.048
		100	935	28.2	28.0	1.16	1.15	2.31
		1000	9350	42	46	1.72	1.88	3.60
2	70	1	3.75					
		2	7.5	4.8	5.2	0.336	0.364	0.70
		10	37.5	10.3	11.8	0.72	0.83	1.55
		100	375	18.0	22.2	1.26	1.55	2.81
		1000	3750	25.5	35.0	1.78	2.45	4.23
3	100	1	9.75					
		2	19.5	4.5	4.55	0.45	0.455	0.905
		10	97.5	8.4	10.5	0.84	1.05	1.89
		100	975	14.0	19.5	1.40	1.95	3.35
		1000	9750	20.5	30.5	2.05	3.05	5.1
	Output current with signal = 150. ua							
4	300	1	1.0					
		1.25	1.25	1.6	1.8	0.48	0.54	1.02
		1.3	1.3	1.6	1.8	0.48	0.54	1.02
		1.4	1.4	1.8	1.8	0.54	0.54	1.08
		1.5	1.5	2.2	2.1	0.66	0.63	1.29
		1.7	1.7	2.8	2.5	0.84	0.75	1.59
		1.9	1.9	3.6	2.6	1.08	0.78	1.86
		2	2	(8.4 (8.3	2.8	2.49	0.84	3.33
		10	10	13.0	4.0	3.90	1.20	5.10
		100	100	16.0	8.0	4.80	2.40	7.20
		1000	1000	19.2	11.0	5.76	3.30	9.06
	Output current with signal = 120 ua.							
5	900		2.3 (dip)					
			1.5	1.5	)	1.35	)	2.88
		1	1.05		1.7)		1.53)	
		1.5	1.57	1.5	2.7	1.35	2.42	3.77
		2	2.1	1.8	3.1	1.62	2.79	4.41
		10	10.5	2.7	3.8	2.43	3.42	5.85
		100	105	3.8	5.5	3.42	4.95	8.37
		1000	1050	5.0	7.8	4.50	7.02	11.52

DECLASSIFIED

MAY 7 - 1940

CONFIDENTIAL

TABLE 21 (Continued)

Model XDZ Direction Finder, Ser. No. 2.

Band	Freq. (KC)	Times Input at resonance	S.S.G. (μV)	S.S.G. Divisions (-)	S.S.G. Divisions (+)	Δ F in KC (-)	Δ F in KC (+)	Band Width (KC)
6	1500		1.44 (dip)					
			0.8		0.8)		1.2)	2.40
		1	0.7	0.8	)	1.2	)	
		10	7	1.9	1.9	2.85	2.85	5.70
		100	70	2.8	2.8	4.2	4.2	8.40
		1000	700	3.8	3.9	5.7	5.85	11.55

TABLE 22

Receiver Selectivity

Resonant Freq. (KC)	Band Width 20 db. Rec. (KC)	Band Width 20 db. Spec. (KC) Max.	Band Width 40 db. Rec. (KC)	Band Width 40 db. Spec. (KC) Max.	Band Width 60 db. Rec. (KC)	Band Width 60 db. Spec. (KC) Max.
15	0.91	1.8	1.65	3.2	2.64	5.2
41	1.05	2.7	2.31	3.8	3.60	5.5
70	1.55	2.8	2.81	4.0	4.23	5.6
100	1.89	2.8	3.35	4.4	5.10	6.0
300	5.10	5.6	7.20	8.0	9.06	11.6
900	5.85*	5.8	8.37	8.4	11.52	12.0
1500	5.70	6.5	8.40	9.6	11.55	12.4

* Does not meet the specifications.

DECLASSIFIED

TABLE 23

Model ADZ Direction Finder.

Receiver Antenna Sensitivity, Ser. Nos. 1 and 2.

4:1 Signal-plus-Noise to Noise Power Ratio, Output Load 600 Ohms, Output level 10 MW, Dummy Antenna 200 μμf, in Series with S.S.G.

Band	Freq. (KC)	Receiver Ser. 1 Input (μV)	Receiver Ser. 2 Input (μV)
1	15	4.6	2.6
	20	3.0	1.35
	30	0.8	0.5
2	35	1.7	1.2
	50	0.7	0.3
	70	0.5	0.3
3	100	0.9	0.8
	150	1.1	0.3
	200	0.45	0.2
4	200	1.30	0.75
	300	0.85	0.4
	400	0.45	0.3
5	400	1.00	0.5
	600	0.70	0.3
	800	0.35	0.3
6	750	0.80	0.4
	900	0.85	0.3
	1200	0.50	0.25
	1500	0.35	0.2

Specification requirements = 5 microvolts.

DECLASSIFIED

MAY 7 - 1940

CONFIDENTIAL

TABLE 24

Model XDZ Direction Finder, Ser. No. 1.

Receiver I.F. Image Ratio.

Band (No)	Freq. (KC)	Input (uV)	Image Freq. (KC)	Input (uV)	Image Ratio	Specification Image Ratio
1	15	2.3	191	32×10^3	13.9×10^3	10×10^3
2	41	1.0	217	70×10^3	70×10^3	
2	70	0.5	246	38×10^3	76×10^3	10×10^3
3	100	1.0	276	100×10^3	100×10^3	10×10^3
4	300	0.7	476	100×10^3	143×10^3	
5	600	0.6	776	74×10^3	123×10^3	
6	1000	0.6	1176	3.8×10^3	6.3×10^3	0.4×10^3
6	1500	0.3	1676	1.33×10^3	4.4×10^3	0.5×10^3

DECLASSIFIED

TABLE 25

Model XDZ Direction Finder, Ser. No. 1.

Receiver I.F. Rejection Ratio.

Band (No)	Freq. (KC)	Input (uV)	I.F. (KC)		Input (uV)	Rejection Ratio	Specification Rejection Ratio
1	15	2.3	88	89 87.8	100×10^3 93×10^3	43.5×10^3 40.5×10^3	10×10^3
2	41	1.0	88	89 87.8	22×10^3 58×10^3	22×10^3 58×10^3	
2	70	0.45	88	89 87.8	13×10^3 3.8×10^3	29×10^3 8.4×10^3	3×10^3
3	100	0.80	88	89 88.8	0.67×10^3 79×10^3	0.84×10^3 99×10^3	$.8 \times 10^3$
4	300	0.50 0.60	88	86.5 85.2	64×10^3 0.09×10^3	128×10^3 115×10^3	
5	600	0.95	88	86.2	0.38×10^3	0.4×10^3	
6	1000	0.40	88	90	3.3×10^3	$*8.3 \times 10^3$	10×10^3
6	1500	0.30	88	88	30×10^3	10×10^3	10×10^3

* Does not meet the specifications.

MAY 2 - 1940

[redacted]

TABLE 26

Weight of Equipment

Loop Cable	6.75 lb.	Receiver and Base	36.3 lb.
Power Cable	2.00 lb.	Loop Antenna	2.9 lb.
Dynamotor Cable	2.65 lb.	Loop Pedestal	7.1 lb.
Dynamotor Base	7.45 lb.	Loop Extension Shaft	1.316 lb/ft

TABLE 27

Dimensions of Equipment

Unit	Height	Length	Width
Receiver with mounting base	10 3/16"	19 5/8"	12"
Dynamotor with base and filter	5 7/8"	7 7/8"	4 9/32"

Loop Diameter - - 13 3/4"
Loop Cross Section - 1 1/2"
Loop Handwheel diameter 8"
Loop Extension Shaft - Long = 113"; Short = 14 3/8"

TABLE 28

Power Consumption

Supply Voltage	10.5 Volts	12.5 Volts
Loop relay energized	3.10 Amperes	3.45 Amperes
Loop relay de-energized	2.90 Amperes	3.10 Amperes
Maximum power drain	31.5 Watts	43.2 Watts.

DECLASSIFIED

MAY 7 - 1940

NA6/F42-1/69(161)
Serial 40039

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

JCL:cc

[redacted]

10 Apr. 1940

From: Commanding Officer.
To : Director, Naval Research Laboratory.

Subject: Aircraft Radio - Test of Preliminary Model DZ Equipment: Confidential Conteact 67427 with Radio Corporation of America, Contractor.

Reference: (a) BuEng Conf. ltr. F42-1/69 (7-27-R1) of 4 October 1939.
(b) BuEng Conf. Specification RE 13A 539B.

1. The model XDZ direction finding equipment has been carefully inspected and flight tested in accordance with reference (a). The subject equipment arrived at this station on March 5, 1940 but tests were delayed for some time due to the lack of a suitable airplane. Serial No. 1 of the subject equipment was given fairly extensive flight tests totalling approximately 15 hours of flying time and serial No. 2 was tested on a single flight. All flight tests were made in JE-1 airplane #0795.

2. Description of Equipment. The model XDZ direction finder is of the aural null type. It is equipped with a rotatable loop and provides bilateral, unilateral, and non-directional operation, both CW and MCW, throughout the frequency range of 15 to 70 kc and 100 to 1500 kc. Loop rotation is secured by means of a loop extension shaft and handwheel for direct manual operation.

3. Electrical Performance. Generally satisfactory electrical performance was obtained during all tests including one flight to an altitude of 25,000 feet. Of particular interest was the excellent unilateral operation obtained throughout the frequency range when using any sense antenna from a small fixed antenna to a 200 foot trailing antenna.

4. Weights and Dimensions. The weight and overall dimensions of the subject equipment are as follows:

Unit	Height	Width	Length	Weight
Receiver & Shock Mount	10 5/32"	12"	19 11/16"	36.4
Dynamotor & Dynamotor Filter	5 7/8"	4 5/16"	7 7/8"	7.4

DECLASSIFIED
MAY 27 1940

NA6/F42-1/69(161)
Serial 40039

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

JLC:cc

Subject: Aircraft Radio - Test of Preliminary Model DZ Equipment: Confidential Contract 67427 with Radio Corporation of American, Contractor.

Unit	Height	Width	Length	Weight
Loop	16 5/8"	14" (dia)		2.8
Loop Pedestal	22 5/8"(min)	8" (dia)		8.6
Loop Extension Shaft	114"			12.5
Receiver to Dynamotor Cable			144"	2.6
Battery to Dynamotor Cable			117"	2.2
Receiver to Loop Cable			300"	7.0
			TOTAL	79.5 lbs.

5. Installation Facility. It is believed that the subject equipment can be readily installed in any patrol plane where a suitable loop location is available which permits direct access to the loop rotator. However it will be necessary to provide a reinforced mounting hole which is large enough to accommodate the neck of the loop. At present the diameter of the neck of the loop is 3 1/4" but this may be changed in production equipments. If a mounting hole be provided which is suitable for the model DZ loop, it will be necessary to fabricate an adapter whenever it is desired to mount one of the present Navy direction finders in the subject airplane. This procedure appears to be feasible.

6. Mechanical Inspection. Changes in the design of the subject equipment which would make it more suitable for Naval service are enumerated below (Numbers in parentheses refer to paragraphs of reference (b).):

A. Loop.

(1) Present design of plugging loop into loop mounting pedestal did not provide water tight joint (Ser. No. 1). (3-27)

(2) Loop relay is inaccessible; accessibility for servicing, even during flight should be provided if possible. (2-14)

[redacted]

DECLASSIFIED
MAY 27 1940

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

JCL:cc

Subject: Aircraft Radio - Test of Preliminary Model DZ Equipment: Confidential Contract 67427 with Radio Corporation of America, Contractor.

---

(3) Loop mounting plate which secures assembly to skin of ship should have eight mounting holes instead of four to increase strength. (1-1)

(4) Eliminate unused plate on loop mounting pedestal.

(5) Eliminate four securing holes on azimuth scale housing and substitute clamps suitable for holding loop extension shaft in rigid position. The Navy should furnish braces extending from the clamps to the plane structure. (1-1)

(6) Strengthen locking device; remove pointer on brake. (3-17)

(7) Improve grip on handwheel. (3-16)

(8) Make aximuth scale adjustable throughout 360°. (1-1)

(9) The design of loop rotator and locking device furnished by the same contractor for the Army type SCR-242-A compass is considered preferable to the design submitted with the model XDZ. (3-31)

B. Receiver.

(1) Use standard A-N plugs and receptacles. (3-45)

(2) Eliminate cover for headphone jack and provide one additional jack.

(3) Stake front panel toggle switches.

(4) Rotate fuse mounting 90°; provide secondary as well as primary fuse and provide an additional suitably marked mount for one spare fuse of each type.

(5) Unilateral knob and tuning knob are split. (Ser. No. 1) (3-16)

(6) All knobs and audio broad-sharp switch use Mac-it set screws. Condenser assembly uses Bristo set screws. For uniformity Bristo are preferred throughout. Suitable wrenches should be supplies.

[redacted]

DECLASSIFIED
MAY 27 1940

NA6/F42-1/69(161)
Serial 40039

U. S. NAVAL AIR STATION

ANACOSTIA D. C.

JCL:cc

Subject: Aircraft Radio - Test of Preliminary Model DZ
Equipment: Confidential Contract 67427 with Radio Corporation of America, Contractor.

C. Dynamotor.

(1) Simplify base construction.

D. Receiver Case.

(1) Increase size of securing blocks to accommodate four rivets instead of two and make blocks of dural or stainless steel. (2-4)

(2) Provide studs on case for safety wiring locking bar. Hole in stud should accommodate .060" diameter wire.

E. Receiver Shock Mount.

(1) More sturdy construction is desired: The use of six Lord mounting buttons instead of four is suggested.

F. Instruction Book.

(1) Circuit diagram is difficult to understand; this is particularly true of circuits relating to the loop.

(2) The photographs are not of the best quality.

(3) List vacuum tubes in parts list.

(4) Rewrite paragraph 5.3 dealing with unilateral reception.

G. Nameplates.

(1) Frequency range shown on nameplates should be 15 to 70; 100 to 1500 kc rather than 15-1500 kc.

(2) Eliminate "For Bands Viz" and also lovest line on frequency calibration nameplate. Enlarge calibration if possible.

(3) Provide instruction nameplate on loop mounting pedestal. The following wording of this nameplate is suggested:

1. Non-Dir. Tune in signal.

2. Bilat. Rotate loop to minimum.

[redacted]

DECLASSIFIED

MAY 27 1948

NA6/F42-1/69(161)
Serial 40039

U. S. NAVAL AIR STATION

ANACOSTIA D. C.

JCL:cc

Subject: Aircraft Radio - Test of Preliminary Model DZ Equipment: Confidential Contract 67427 with Radio Corporation of America, Contractor.

---

3. Unilat. Increase loop setting 90° and turn unilateral adjustment throughout its range. If minimum response is noted, bearing obtained in step 2 is correct. If no minimum response is noted, repeat procedure using reciprocal of bearing obtained in s tep 2.

S. P. GINDER

Copies: Bueng (2)
Buaero
N.A.F.

[redacted]

DECLASSIFIED
MAY 27 1940

MODEL XDZ DIRECTION FINDER, SER. NO. 1.
LOOP AND RECEIVER IN TEMP. ROOM
TEMP. 50° C. – OPERATION CW. – 70 KC.
EFFECT OF HUMIDITY

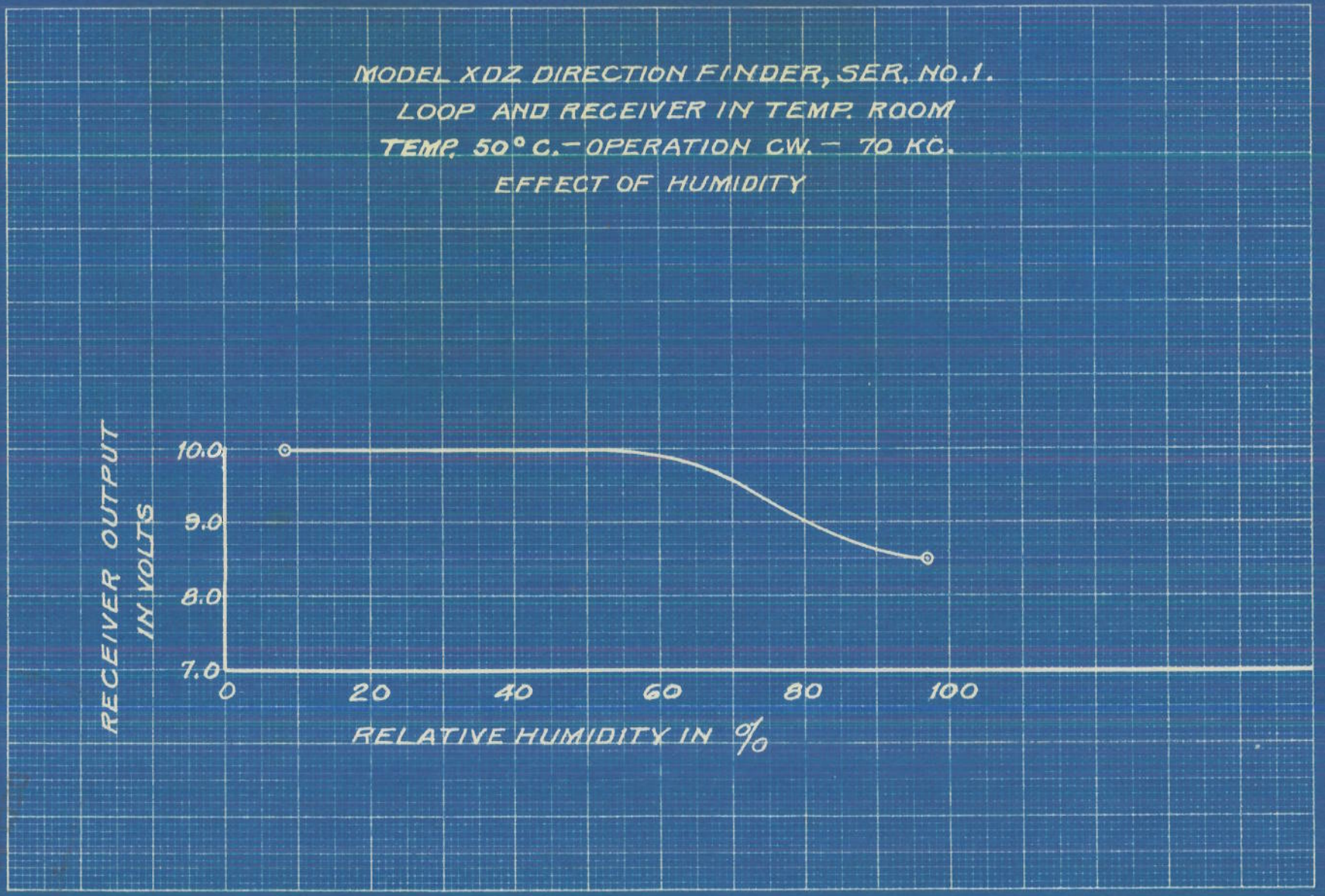


PLATE 1

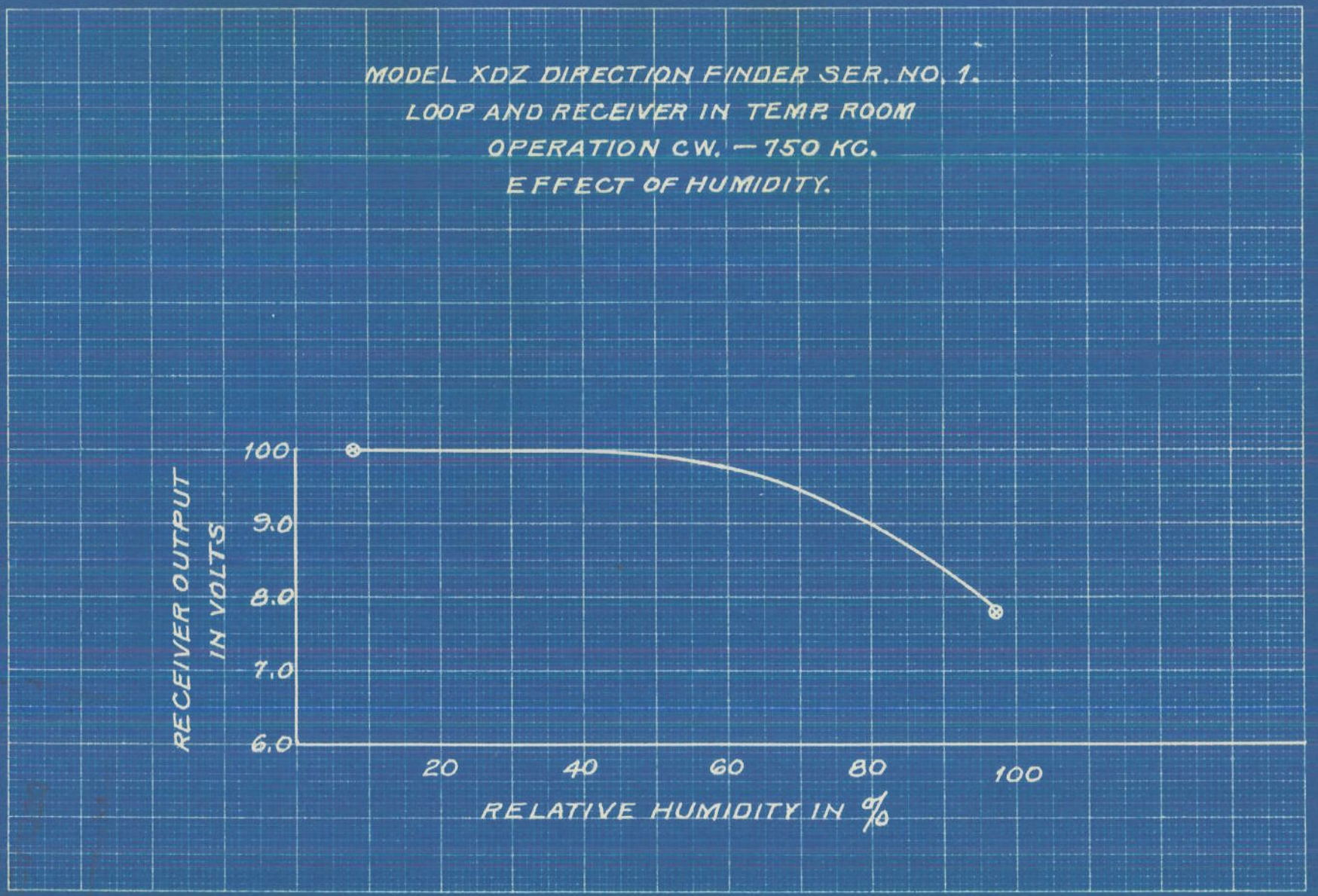

MODEL XDZ DIRECTION FINDER SER. NO. 1.
LOOP AND RECEIVER IN TEMP. ROOM
OPERATION CW. — 750 KC.
EFFECT OF HUMIDITY.
RECEIVER OUTPUT IN VOLTS
10.0
9.0
8.0
7.0
6.0
20
40
60
80
100
RELATIVE HUMIDITY IN %

PLATE 2

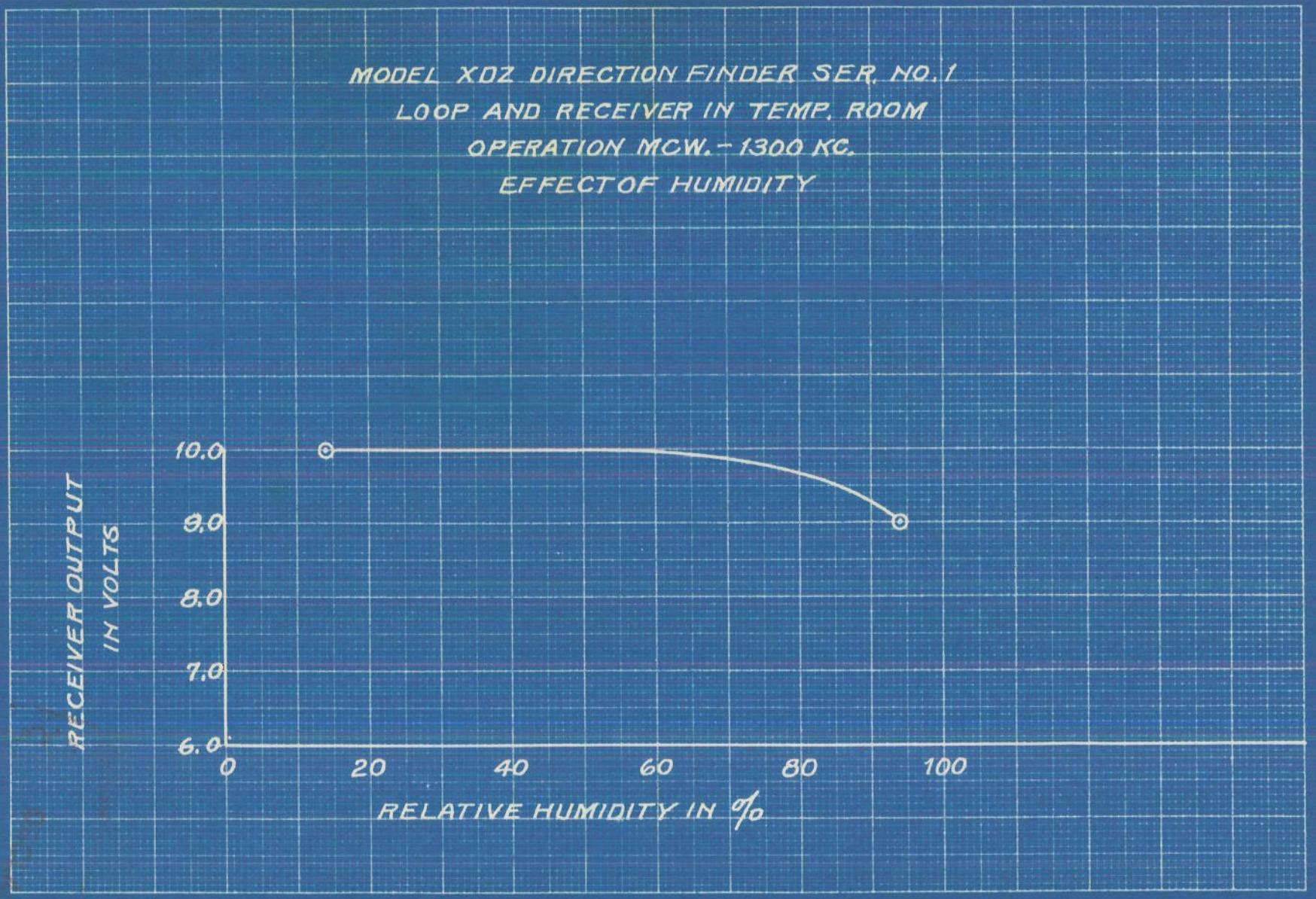

MODEL XDZ DIRECTION FINDER SER. NO. 1
LOOP AND RECEIVER IN TEMP. ROOM
OPERATION MCW. - 1300 KC.
EFFECT OF HUMIDITY
RECEIVER OUTPUT IN VOLTS
10.0
9.0
8.0
7.0
6.0
0
20
40
60
80
100
RELATIVE HUMIDITY IN %

PLATE 3

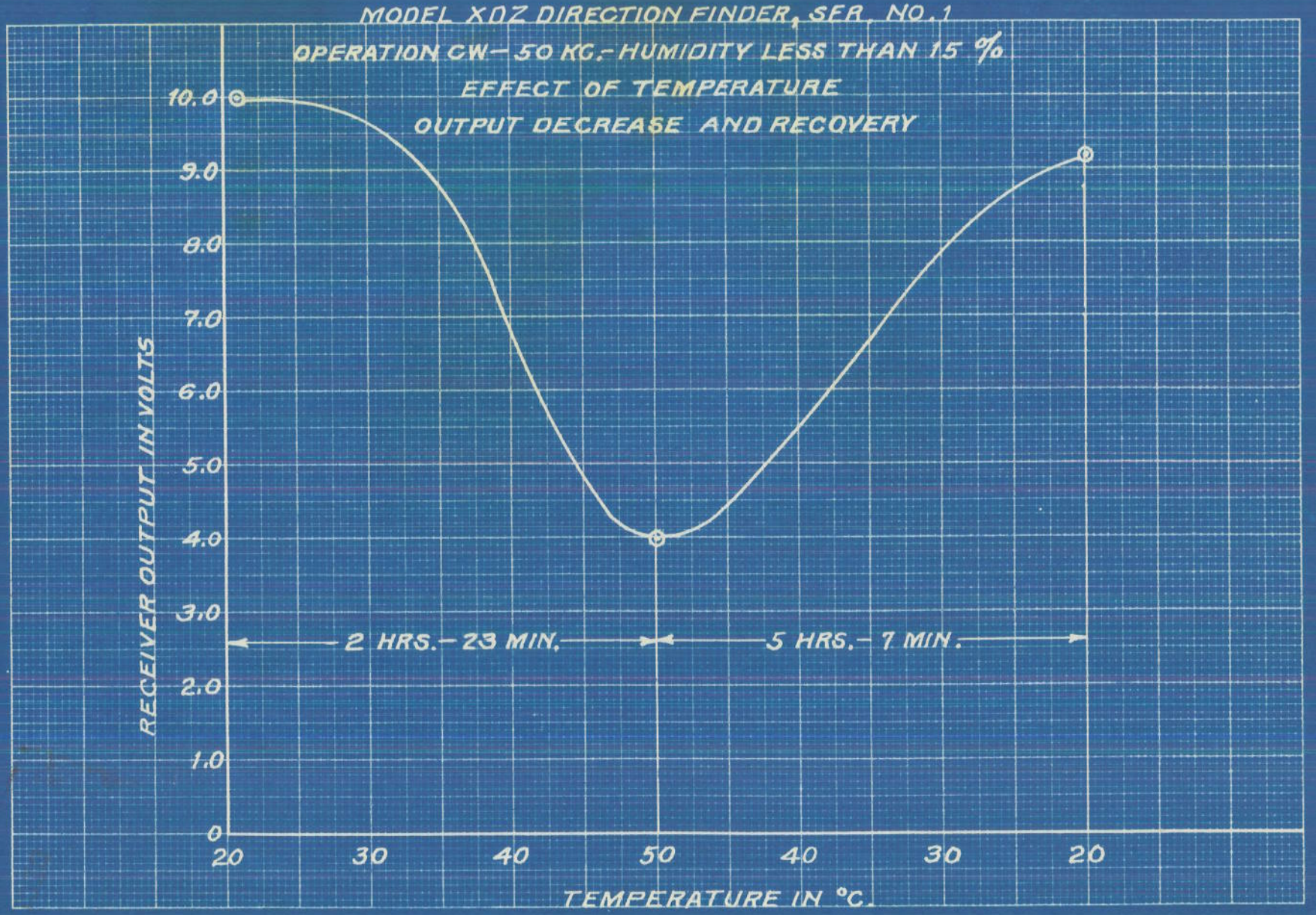

MODEL XDZ DIRECTION FINDER, SER. NO. 1
OPERATION CW – 50 KC. – HUMIDITY LESS THAN 15 %
EFFECT OF TEMPERATURE
OUTPUT DECREASE AND RECOVERY
RECEIVER OUTPUT IN VOLTS
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
2 HRS. – 23 MIN.
5 HRS. – 7 MIN.
20
30
40
50
40
30
20
TEMPERATURE IN °C.

PLATE 4

MODEL XDZ DIRECTION FINDER, SER. NO. 1.
OPERATION: C.W. - 50 KC. HUMIDITY LESS THAN 20 %
RECEIVER AT NORMAL AMBIENT TEMP. OF 23 °C.
EFFECT OF TEMPERATURE

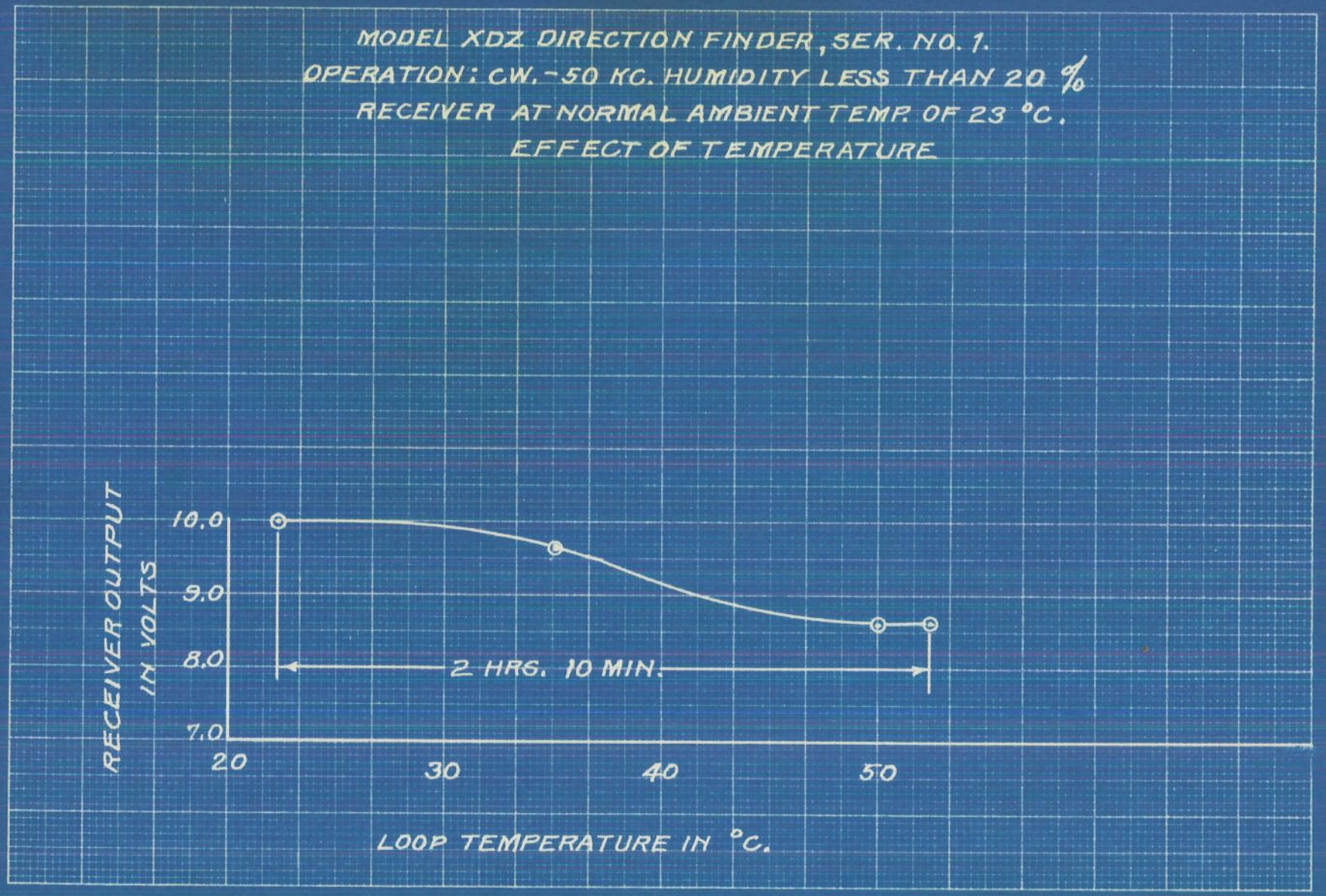


PLATE 5

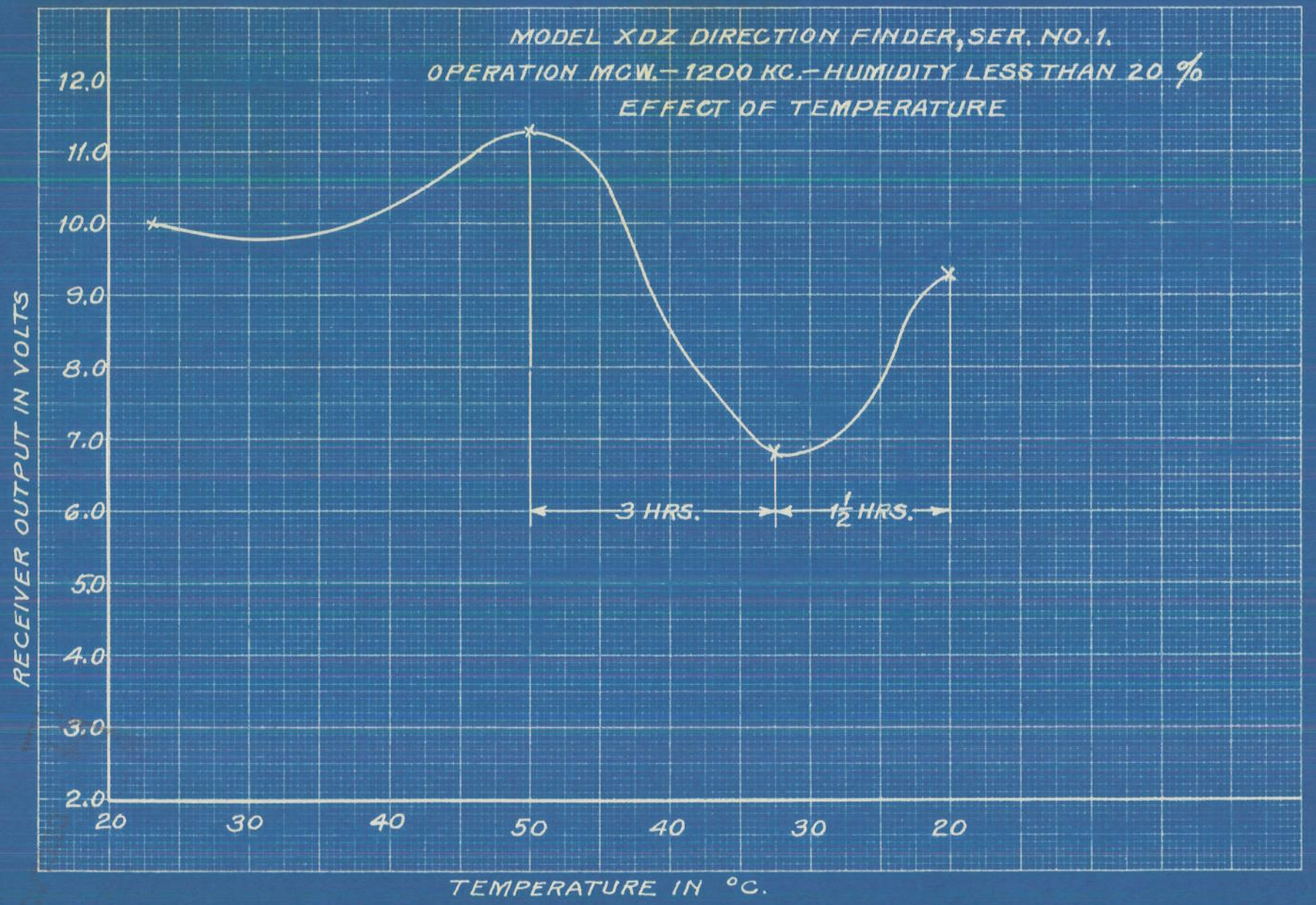
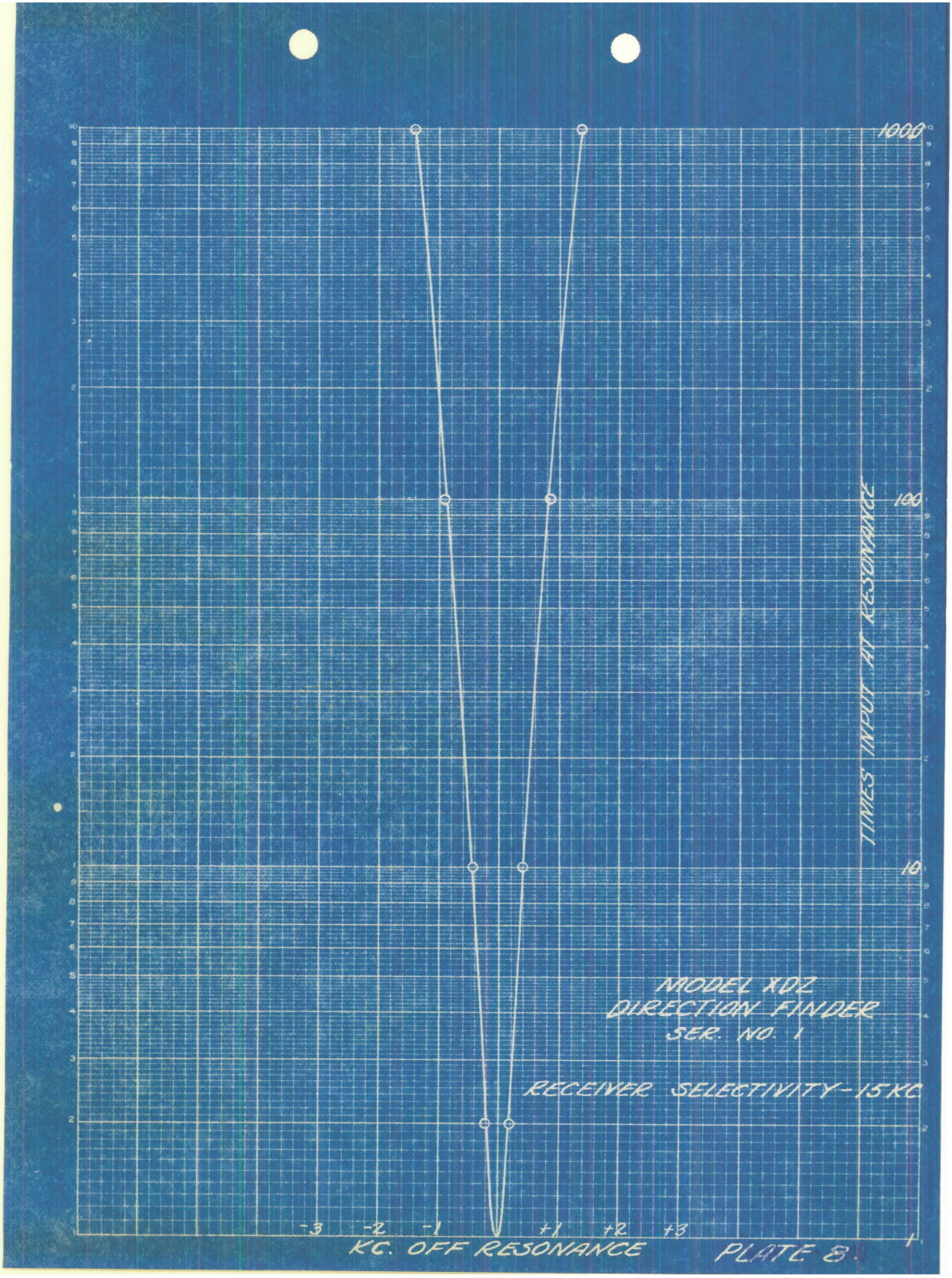

MODEL XDZ DIRECTION FINDER, SER. NO. 1.
OPERATION MCW. – 1200 KC. – HUMIDITY LESS THAN 20 %
EFFECT OF TEMPERATURE
RECEIVER OUTPUT IN VOLTS
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
3 HRS.
1½ HRS.
20
30
40
50
40
30
20
TEMPERATURE IN °C.

PLATE 7


1000
100
10
1
TIMES INPUT AT RESONANCE
MODEL XDZ
DIRECTION FINDER
SER. NO. 1
RECEIVER SELECTIVITY - 1.5 KC
-3
-2
-1
+1
+2
+3
KC. OFF RESONANCE
PLATE 8.

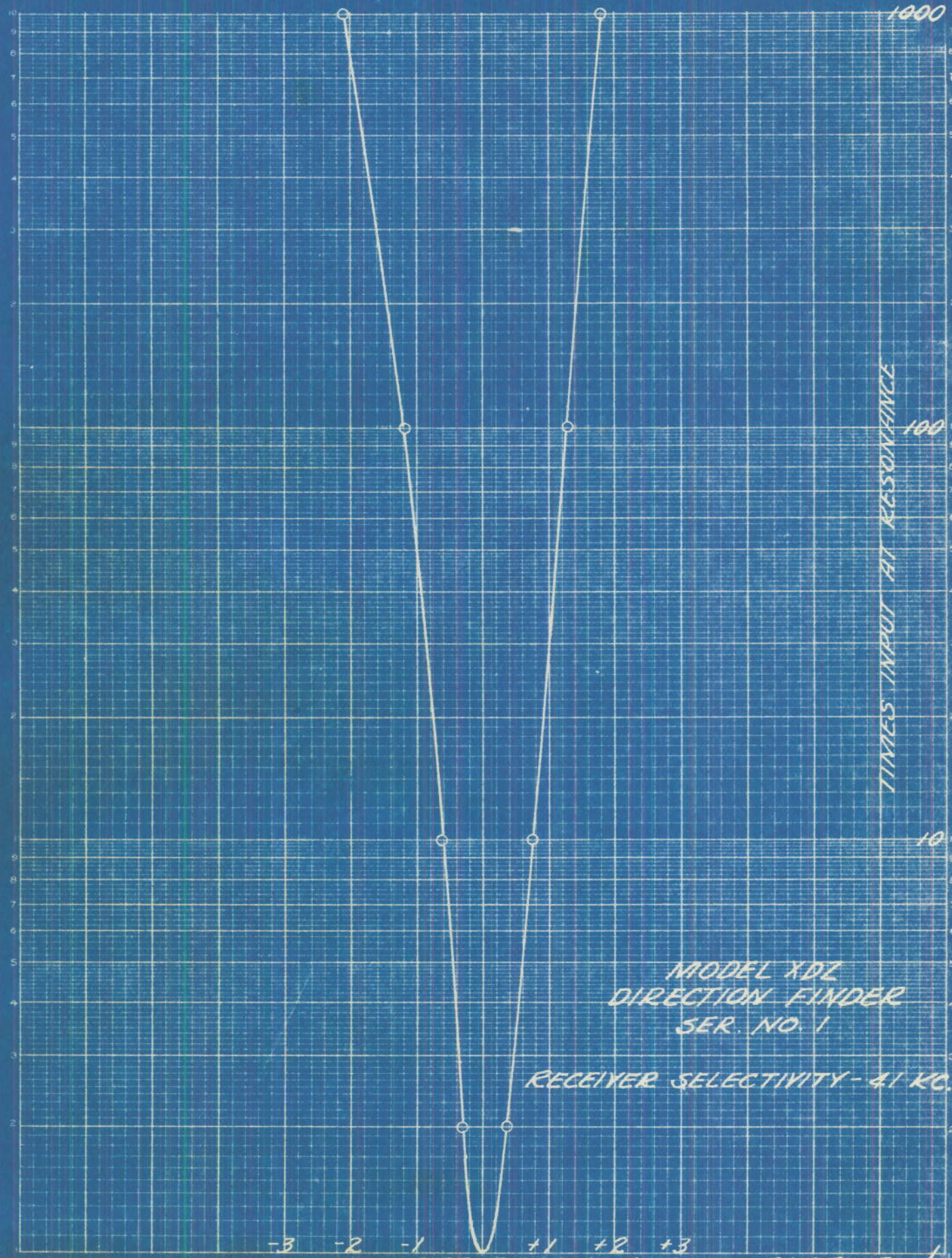

1000
100
10
TIMES INPUT AT RESONANCE
MODEL XDZ
DIRECTION FINDER
SER. NO. 1
RECEIVER SELECTIVITY - 41 KC.
-3
-2
-1
+1
+2
+3
KC. OFF RESONANCE

PLATE 9.

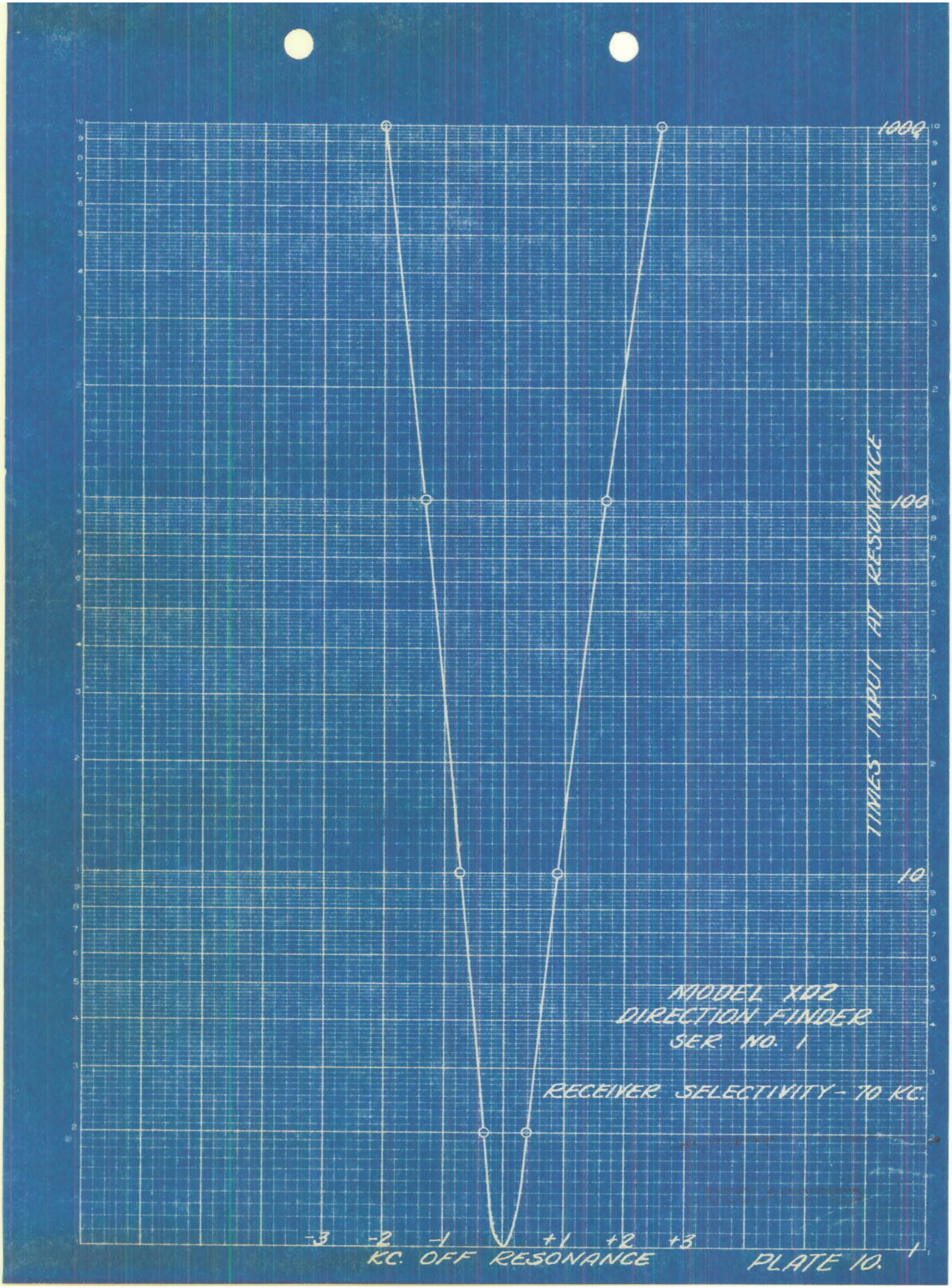

1000
100
10
TIMES INPUT AT RESONANCE
MODEL XDZ
DIRECTION FINDER
SER. NO. 1
RECEIVER SELECTIVITY - 70 KC.
-3
-2
-1
+1
+2
+3
KC. OFF RESONANCE

PLATE 10.

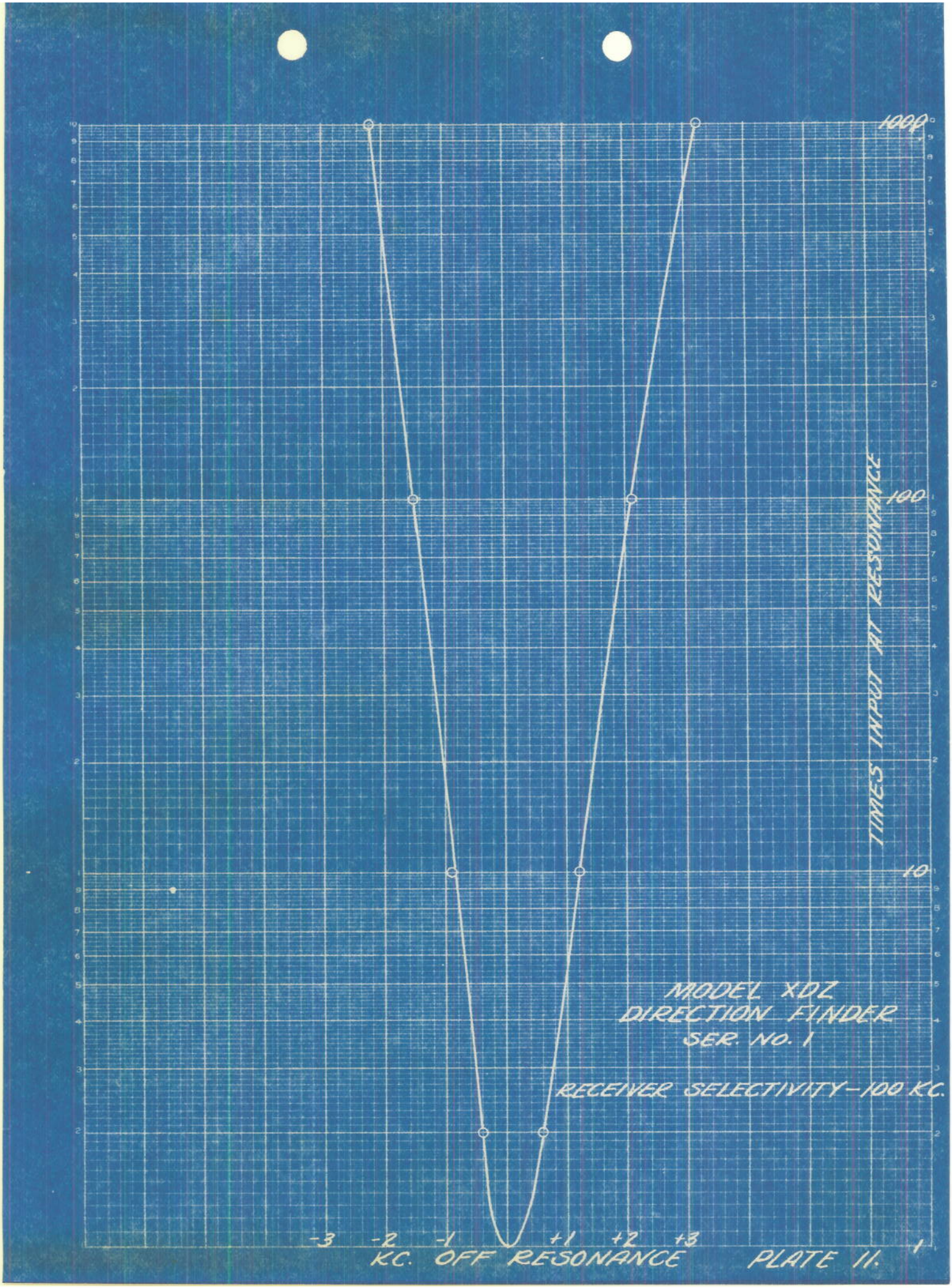

1000
100
10
TIMES INCREASE IN RESONANCE SIGNAL
MODEL XDZ
DIRECTION FINDER
SER. NO. 1
RECEIVER SELECTIVITY - 100 KC.
-3 -2 -1 +1 +2 +3
KC. OFF RESONANCE

PLATE 11.

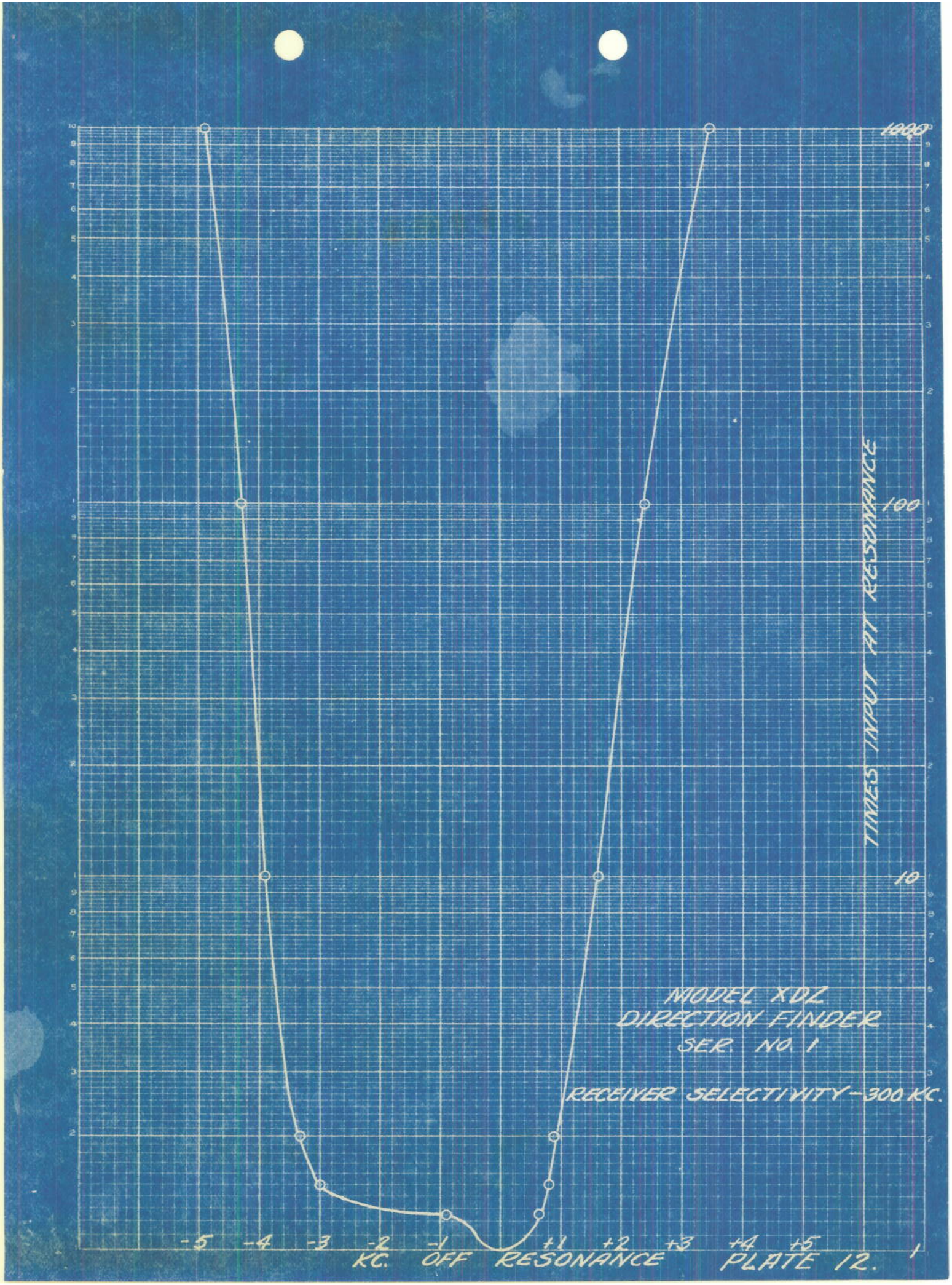

1000
100
10
TIMES INPUT AT RESONANCE
MODEL XDZ
DIRECTION FINDER
SER. NO. 1
RECEIVER SELECTIVITY - 300 KC.
-5 -4 -3 -2 -1 +1 +2 +3 +4 +5
KC. OFF RESONANCE

PLATE 12.

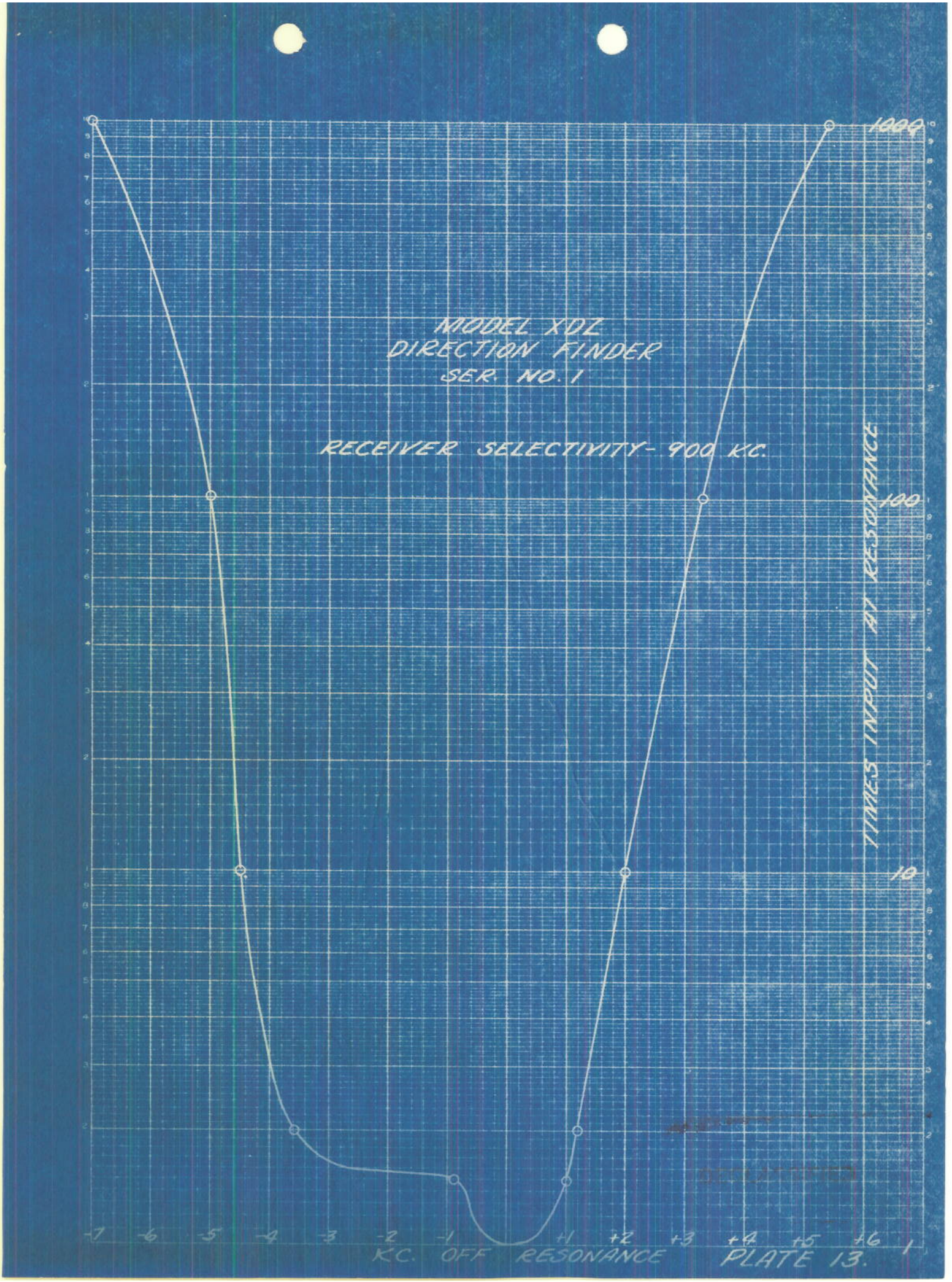

MODEL XDZ
DIRECTION FINDER
SER. NO. 1
RECEIVER SELECTIVITY- 900 KC.
1000
100
10
TIMES INCREASE IN LOUDNESS SCALE
-7
-6
-5
-4
-3
-2
-1
+1
+2
+3
+4
+5
+6
KC. OFF RESONANCE

PLATE 13.

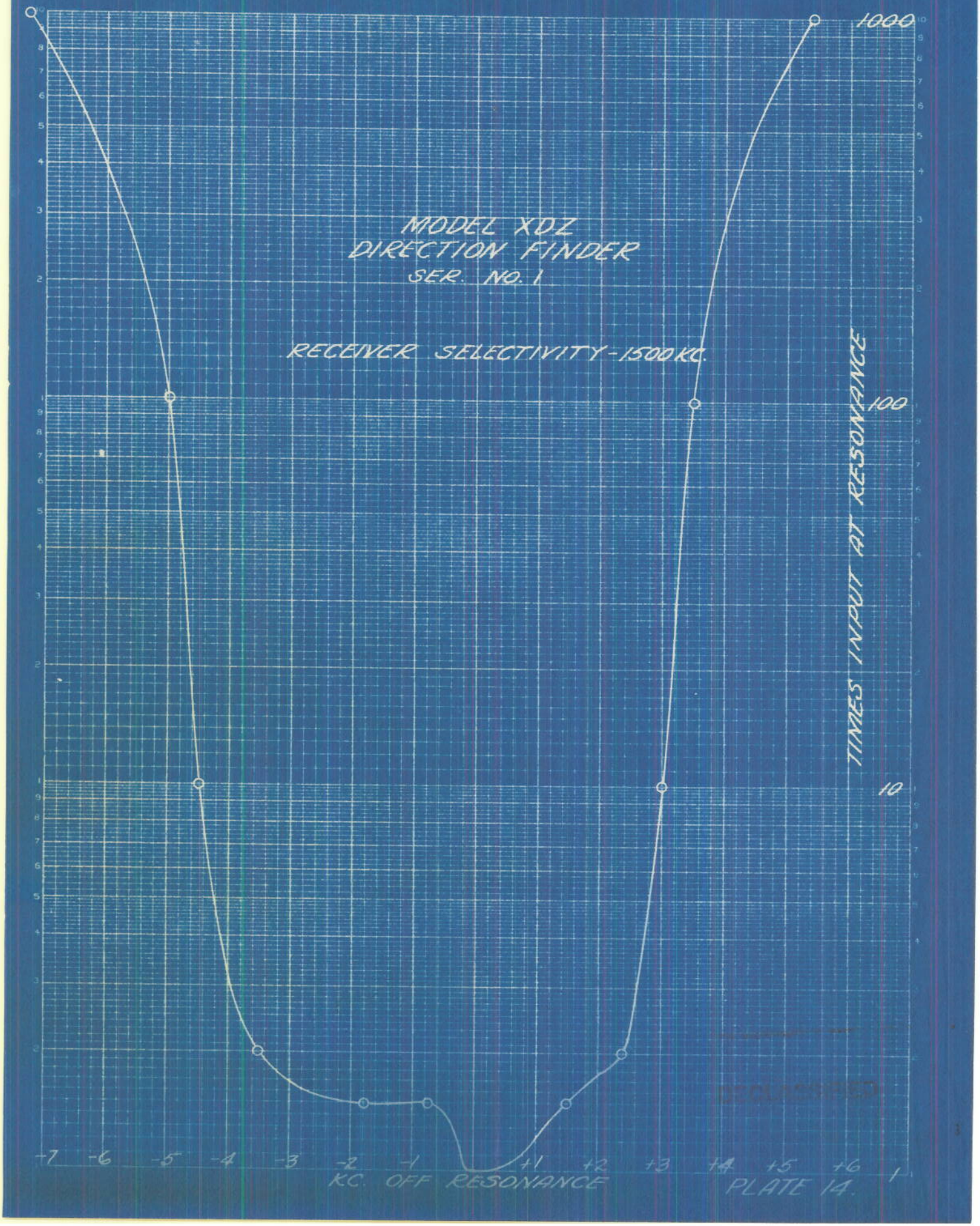

MODEL XDZ
DIRECTION FINDER
SER. NO. 1
RECEIVER SELECTIVITY - 1500 KC.
1000
100
10
TIMES INPUT AT RESONANCE
-7 -6 -5 -4 -3 -2 -1 +1 +2 +3 +4 +5 +6 +7
KC. OFF RESONANCE

PLATE 14.

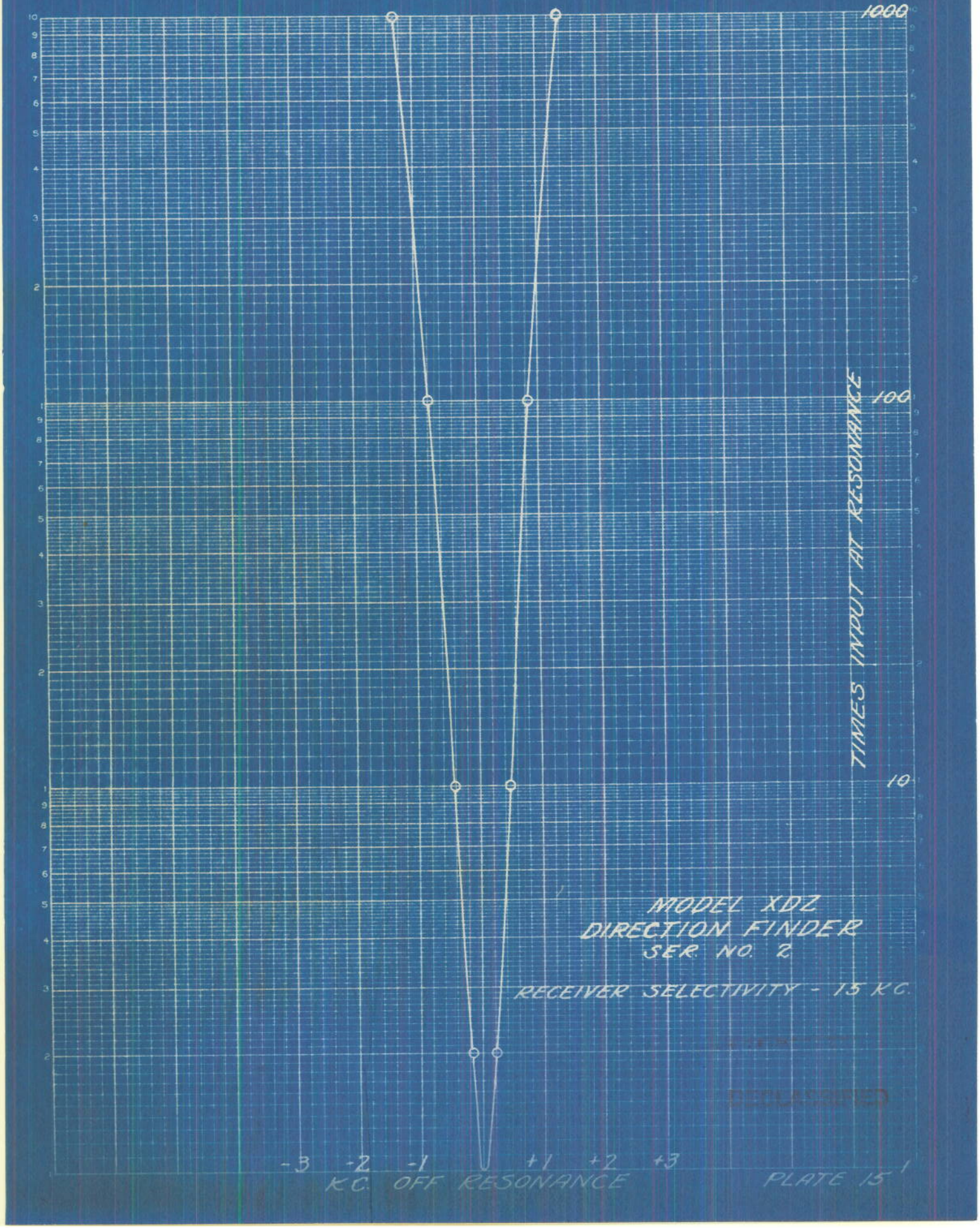
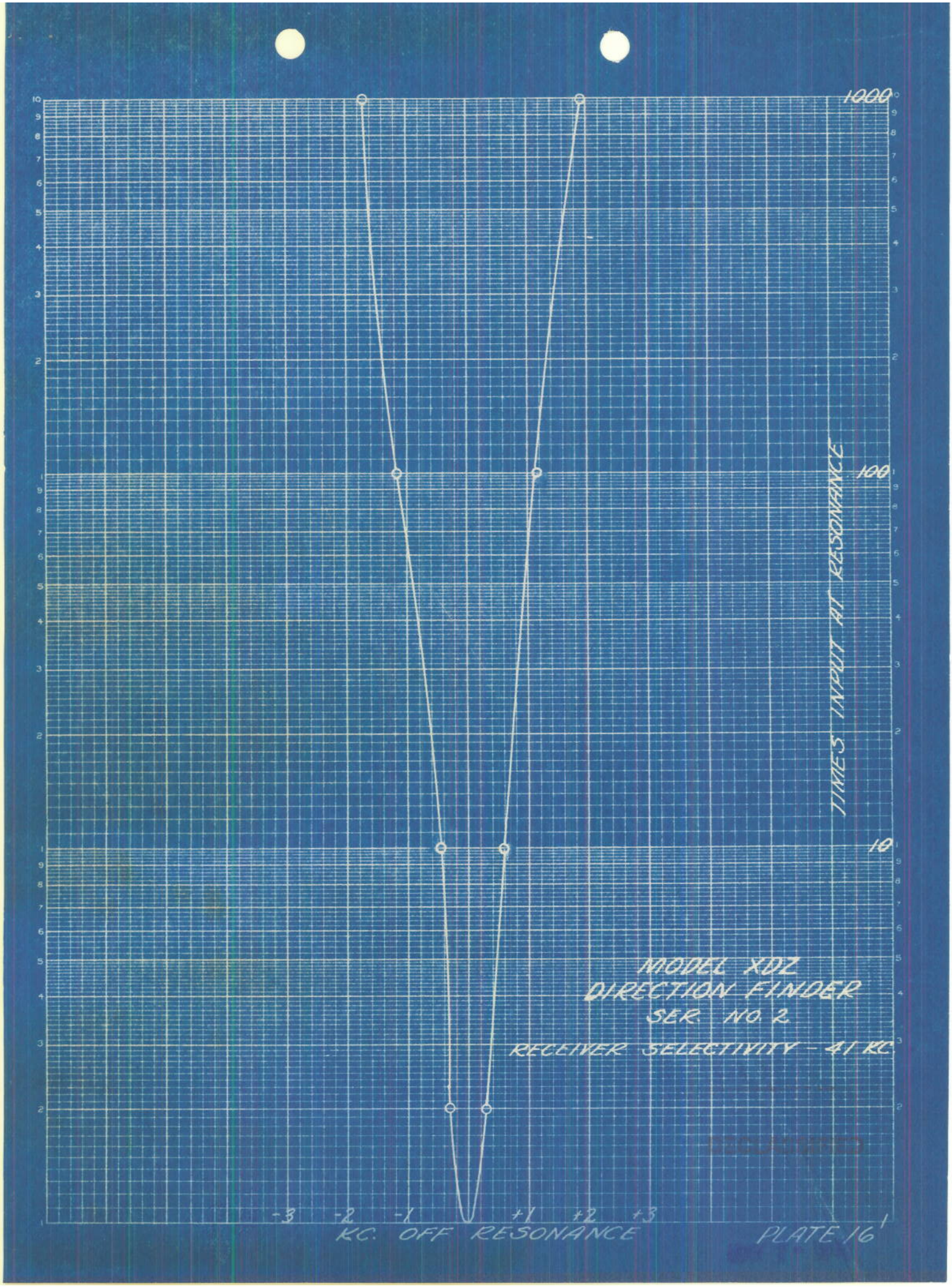

1000
100
10
TIMES INPUT AT RESONANCE
MODEL XDZ
DIRECTION FINDER
SER. NO. 2
RECEIVER SELECTIVITY - 15 K.C.
-3 -2 -1 +1 +2 +3
K.C. OFF RESONANCE

PLATE 15


1000
100
10
TIMES INPUT AT RESONANCE
MODEL XDZ
DIRECTION FINDER
SER. NO. 2
RECEIVER SELECTIVITY - 41 KC.
-3
-2
-1
+1
+2
+3
KC. OFF RESONANCE
PLATE 16

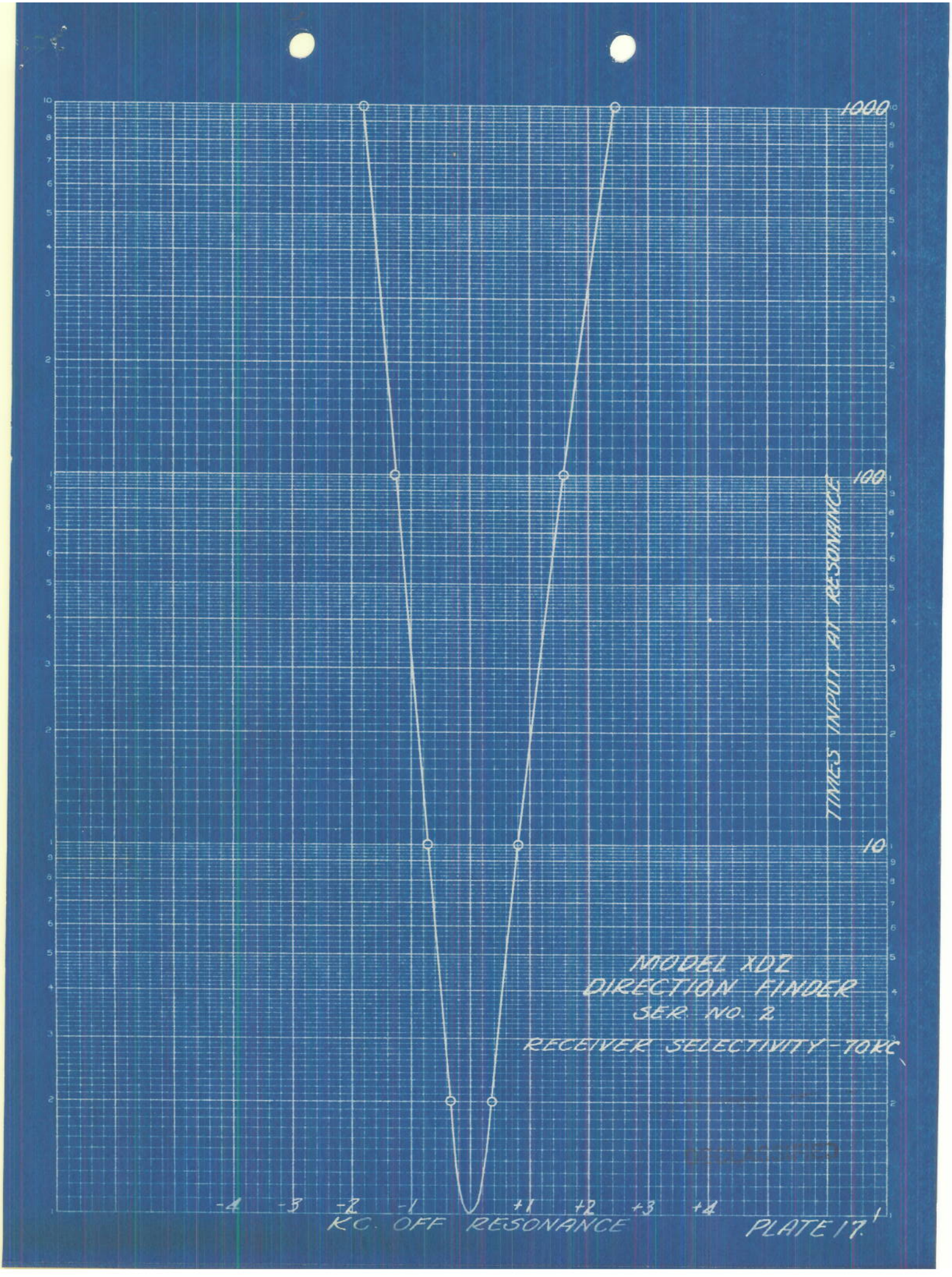

1000
100
10
TIMES INPUT AT RESONANCE
MODEL XDZ
DIRECTION FINDER
SER. NO. 2
RECEIVER SELECTIVITY - 70KC
-4 -3 -2 -1 +1 +2 +3 +4
KC. OFF RESONANCE

PLATE 17.

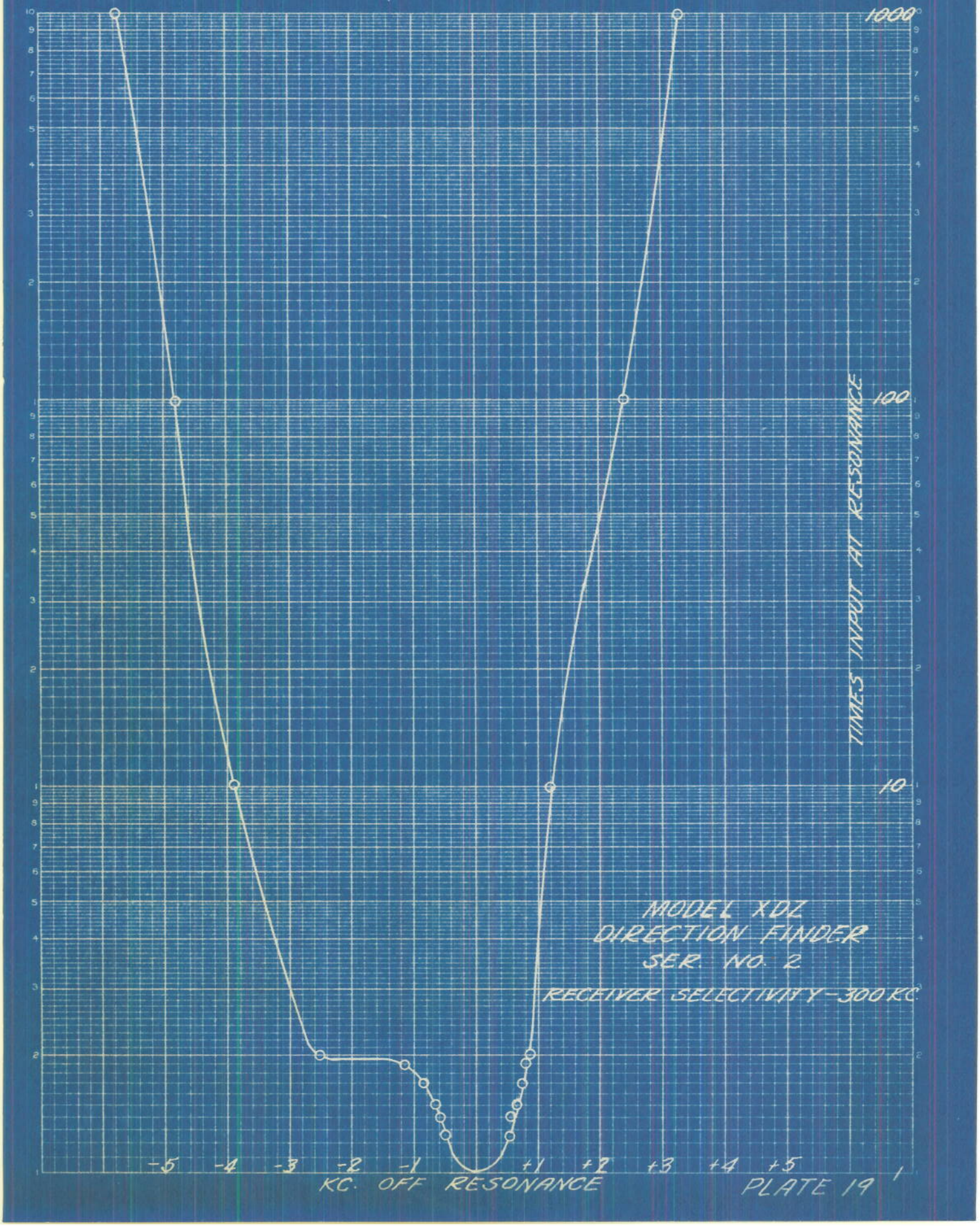

1000
100
10
TIMES INPUT AT RESONANCE
MODEL XDZ
DIRECTION FINDER
SER. NO. 2
RECEIVER SELECTIVITY - 300 KC.
-5
-4
-3
-2
-1
+1
+2
+3
+4
+5
KC. OFF RESONANCE

PLATE 19

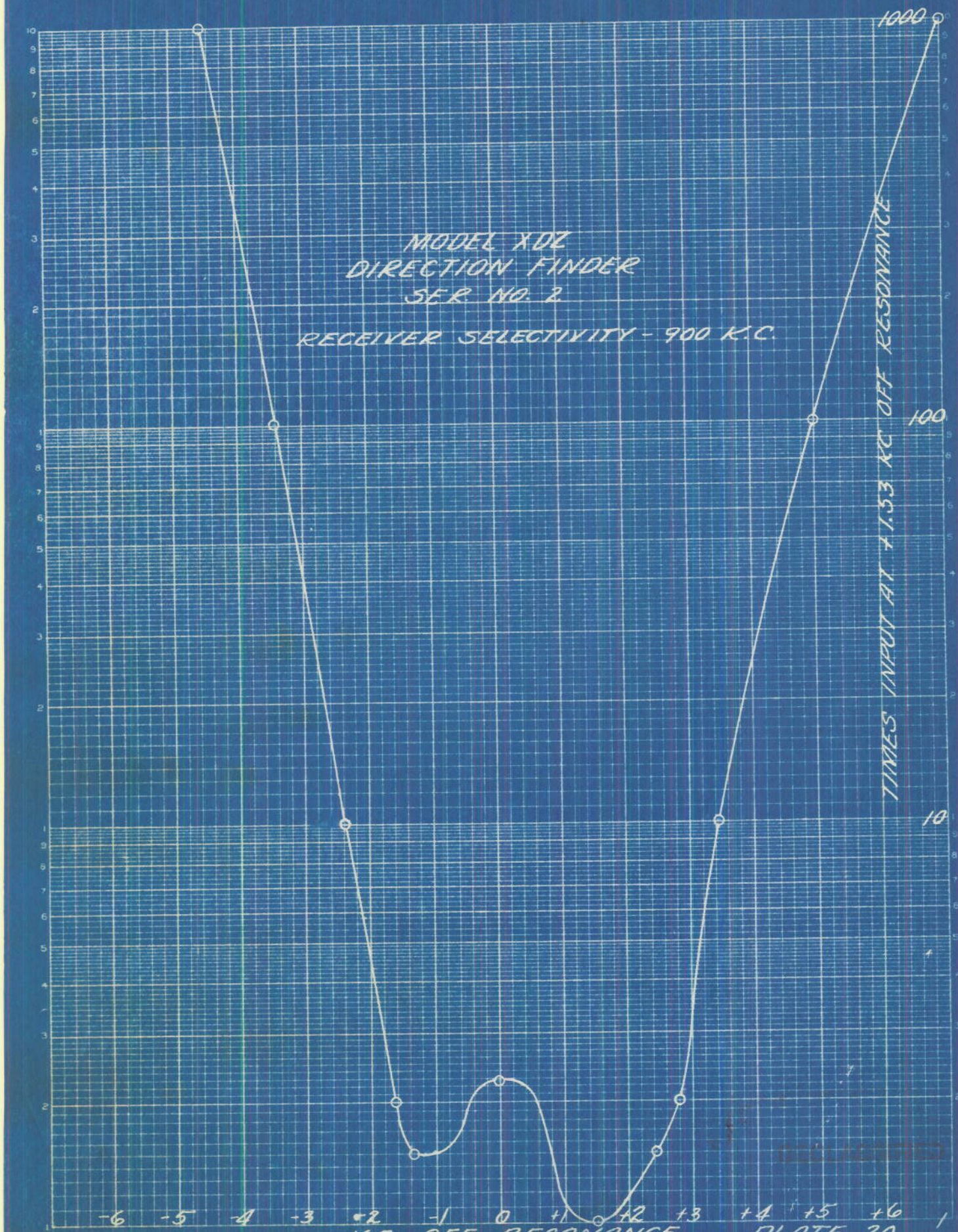

MODEL XDZ
DIRECTION FINDER
SER. NO. 2
RECEIVER SELECTIVITY - 900 K.C.
TIMES INPUT AT ±1.53 KC OFF RESONANCE
1000
100
10
1
-6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6
K.C. OFF RESONANCE

PLATE 20.

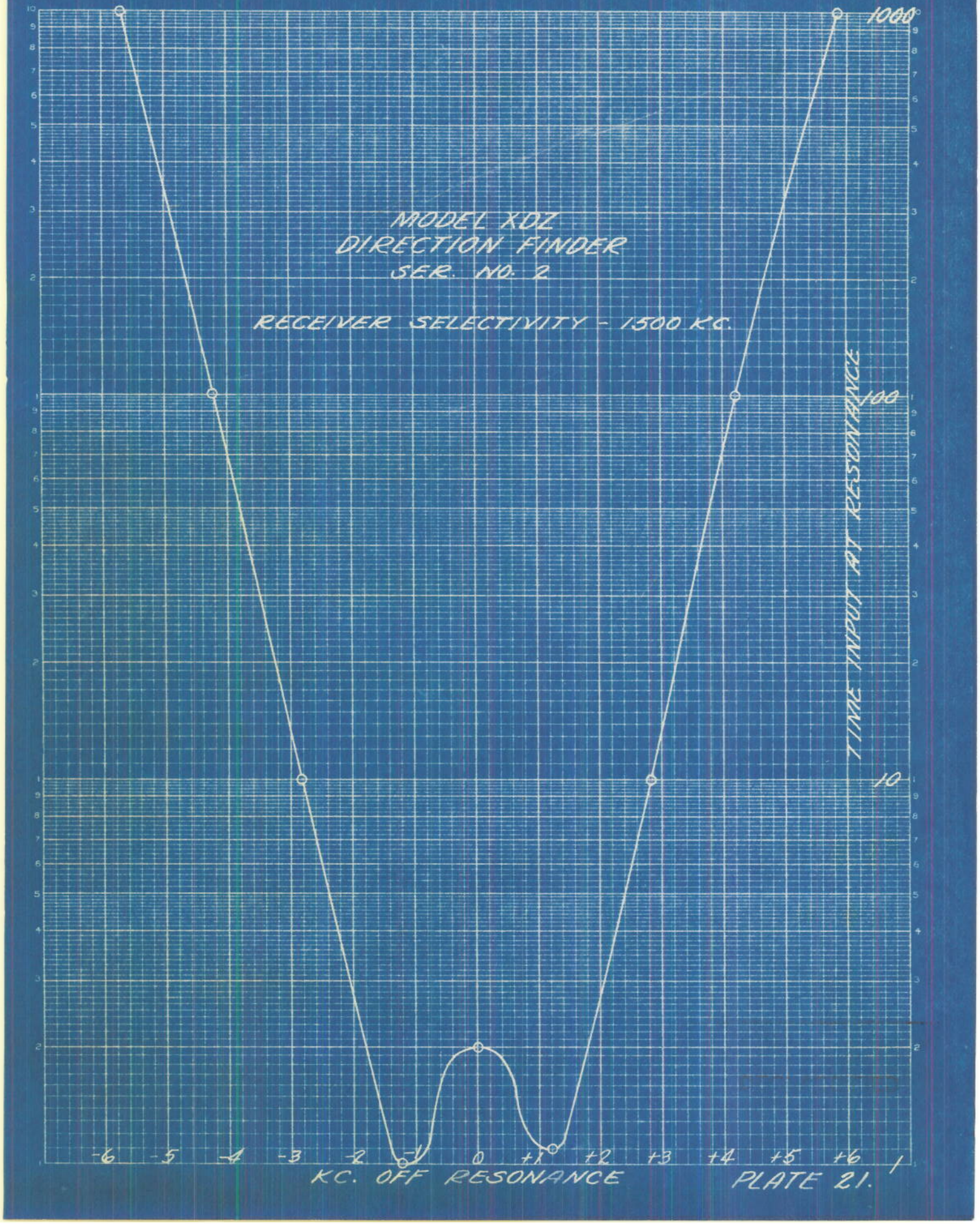
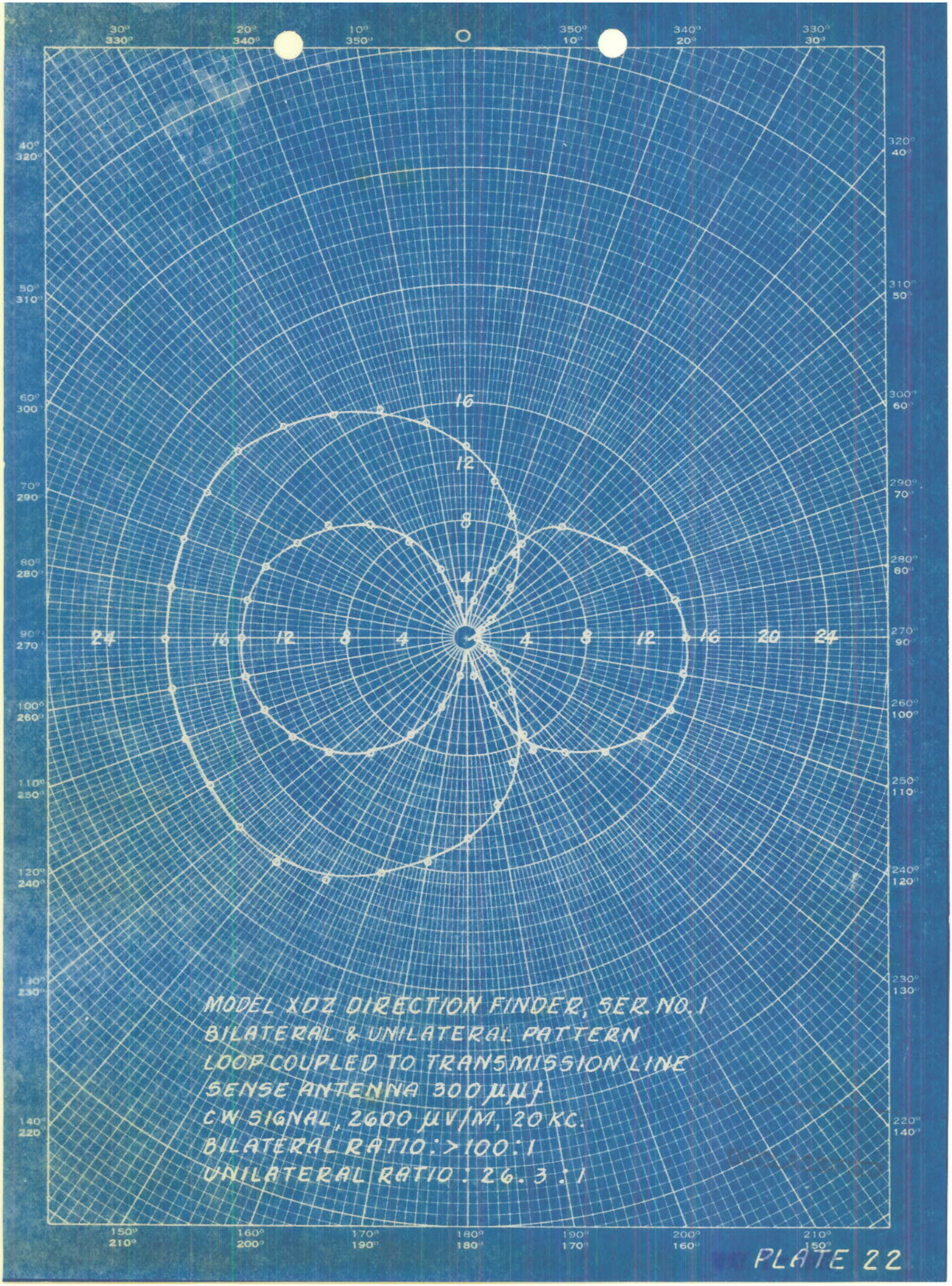

MODEL XDZ
DIRECTION FINDER
SER. NO. 2
RECEIVER SELECTIVITY - 1500 KC.
1000
100
10
TIMES INPUT AT RESONANCE
-6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6
KC. OFF RESONANCE

PLATE 21.


MODEL XDZ DIRECTION FINDER, SER. NO. 1
BILATERAL & UNILATERAL PATTERN
LOOP COUPLED TO TRANSMISSION LINE
SENSE ANTENNA 300 μμf
CW SIGNAL, 2600 μV/M, 20 KC.
BILATERAL RATIO: > 100:1
UNILATERAL RATIO: 26.3:1
PLATE 22

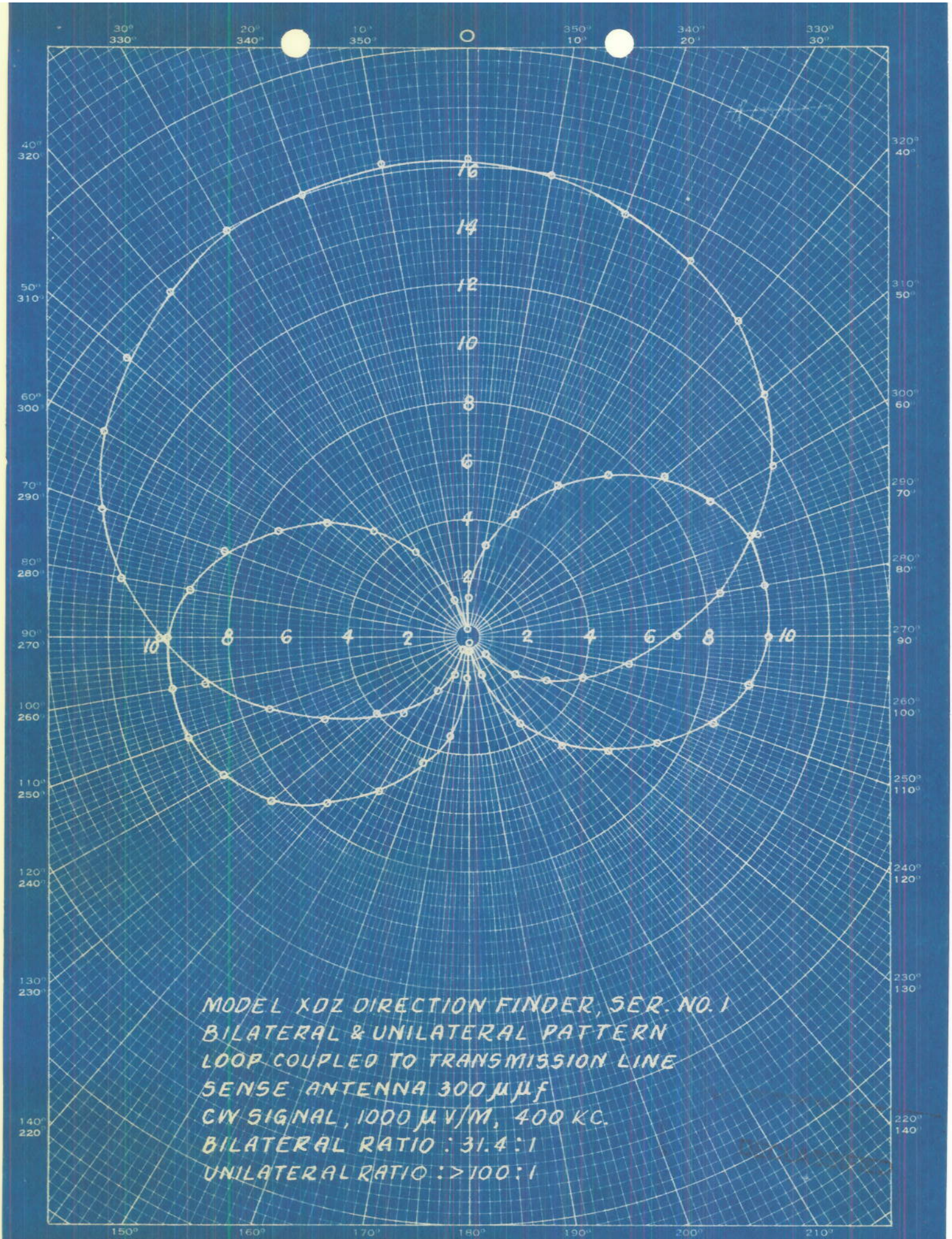
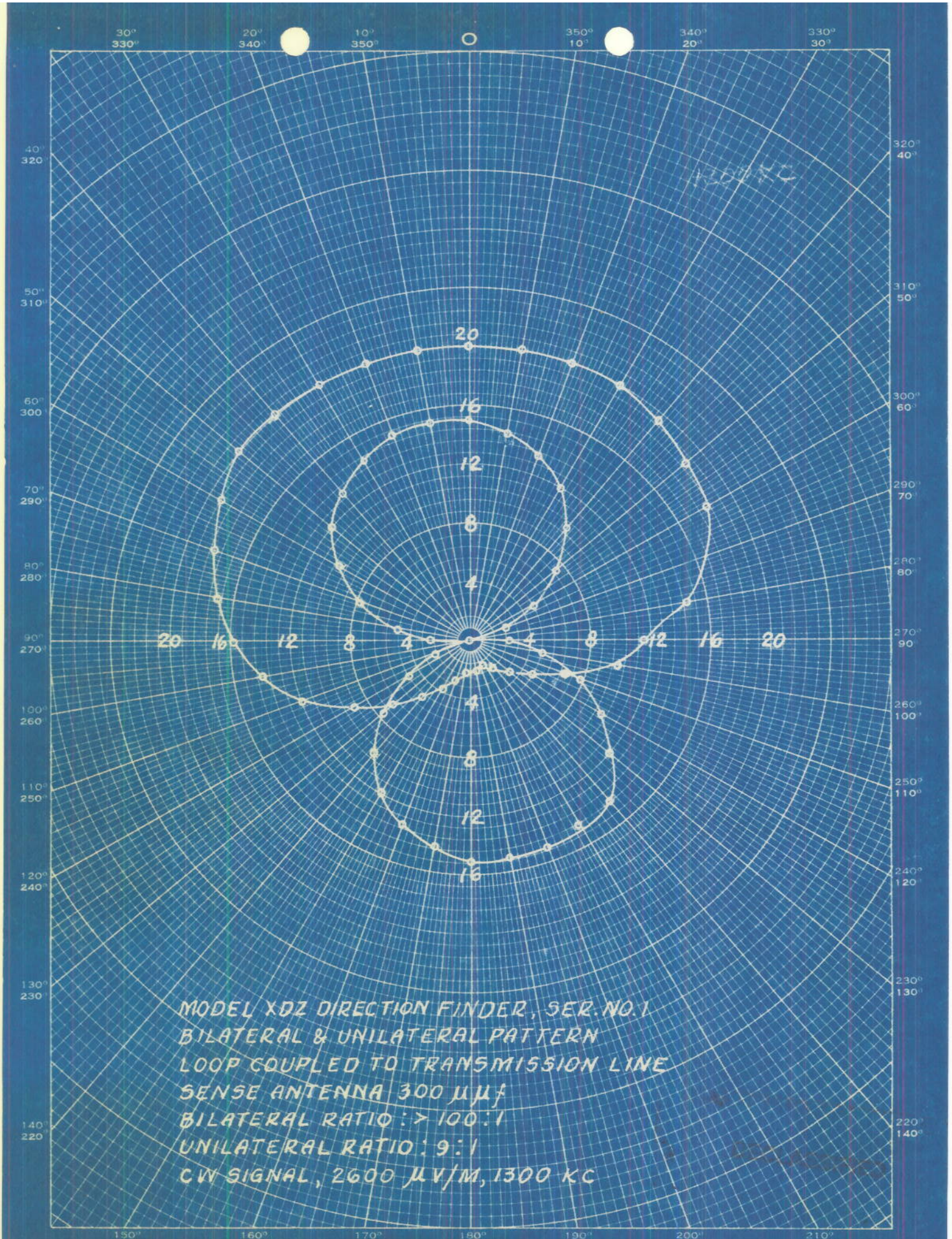
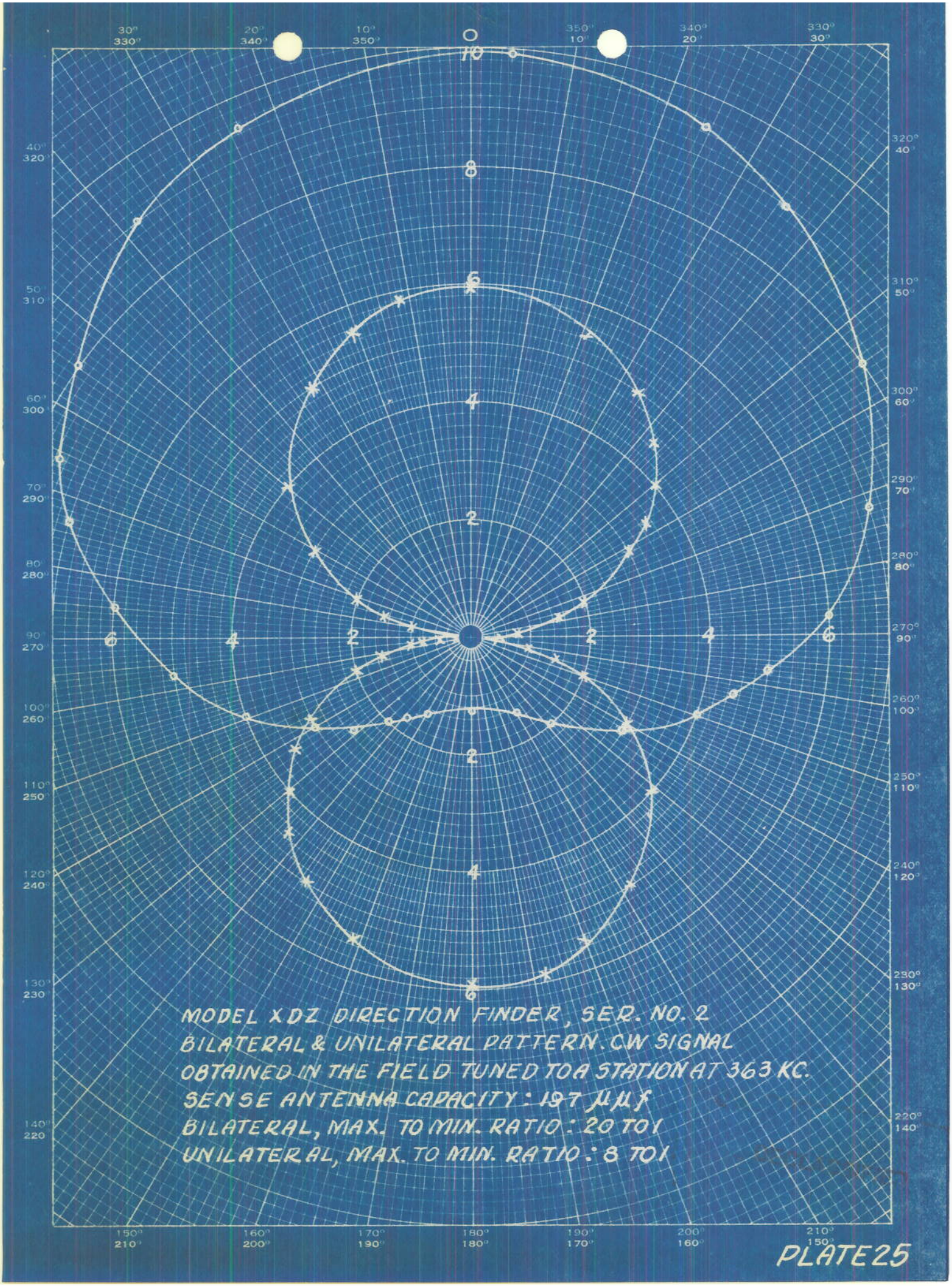

MODEL XDZ DIRECTION FINDER, SER. NO. 1
BILATERAL & UNILATERAL PATTERN
LOOP COUPLED TO TRANSMISSION LINE
SENSE ANTENNA 300 μμf
CW SIGNAL, 1000 μV/M, 400 KC.
BILATERAL RATIO : 31.4 : 1
UNILATERAL RATIO : > 100 : 1

PLATE 23



MODEL XDZ DIRECTION FINDER, SER. NO. 1
BILATERAL & UNILATERAL PATTERN
LOOP COUPLED TO TRANSMISSION LINE
SENSE ANTENNA 300 μμf
BILATERAL RATIO: > 100:1
UNILATERAL RATIO: 9:1
CW SIGNAL, 2600 μV/M, 1300 KC

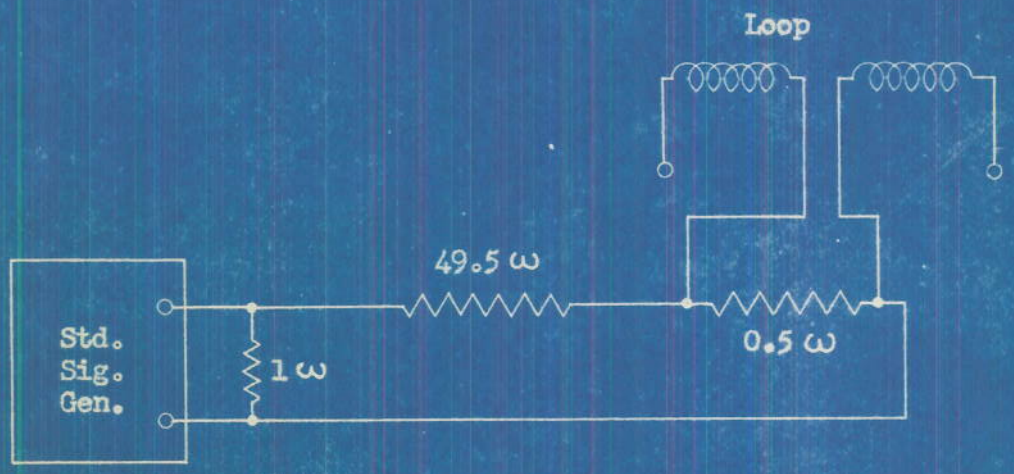
PLATE 24


MODEL XDZ DIRECTION FINDER, SER. NO. 2
BILATERAL & UNILATERAL PATTERN. CW SIGNAL
OBTAINED IN THE FIELD TUNED TO A STATION AT 363 KC.
SENSE ANTENNA CAPACITY: 197 μμf
BILATERAL, MAX. TO MIN. RATIO: 20 TO 1
UNILATERAL, MAX. TO MIN. RATIO: 8 TO 1
PLATE 25

Model XDZ Direction Finder, Ser. No. 1

Bilateral CW Sensitivity
Input Signal Injected at Center of Loop

Total Attenuation Ratio of 1000 to 1
from Standard Signal Generator to Loop



Network Employed for Injecting Small Signal to Center
of Loop to Check Specification Requirement of Paragraph 3-3.

DECLASSIFIED

PLATE 26

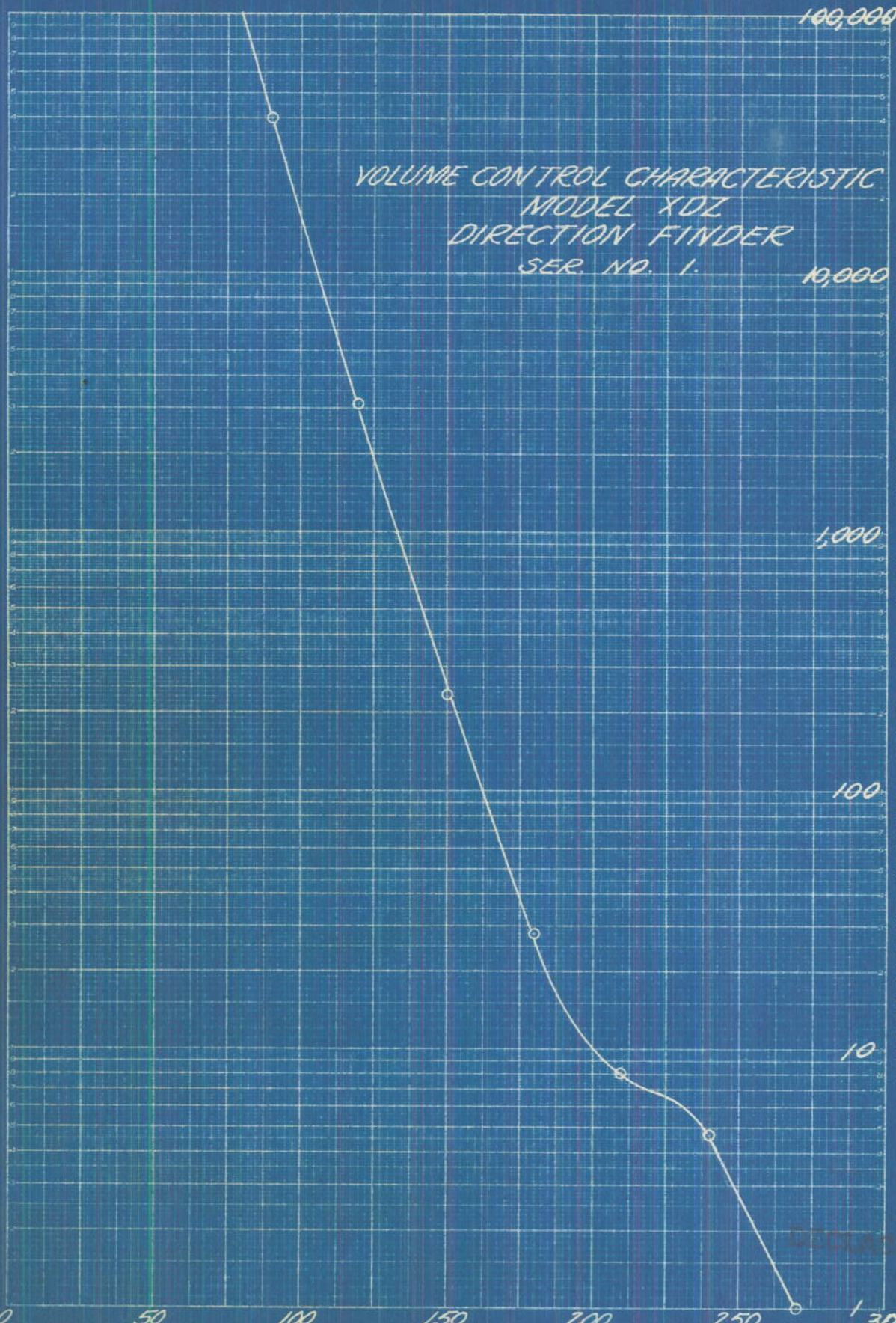

VOLUME CONTROL CHARACTERISTIC
MODEL XDZ
DIRECTION FINDER
SER. NO. 1.
100,000
10,000
1,000
100
10
1
MICRO-VOLTS INPUT FOR 150 MILLI-WATTS OUTPUT
0
50
100
150
200
250
300
VOLUME CONTROL DISPLACEMENT IN DEGREES

PLATE 27.

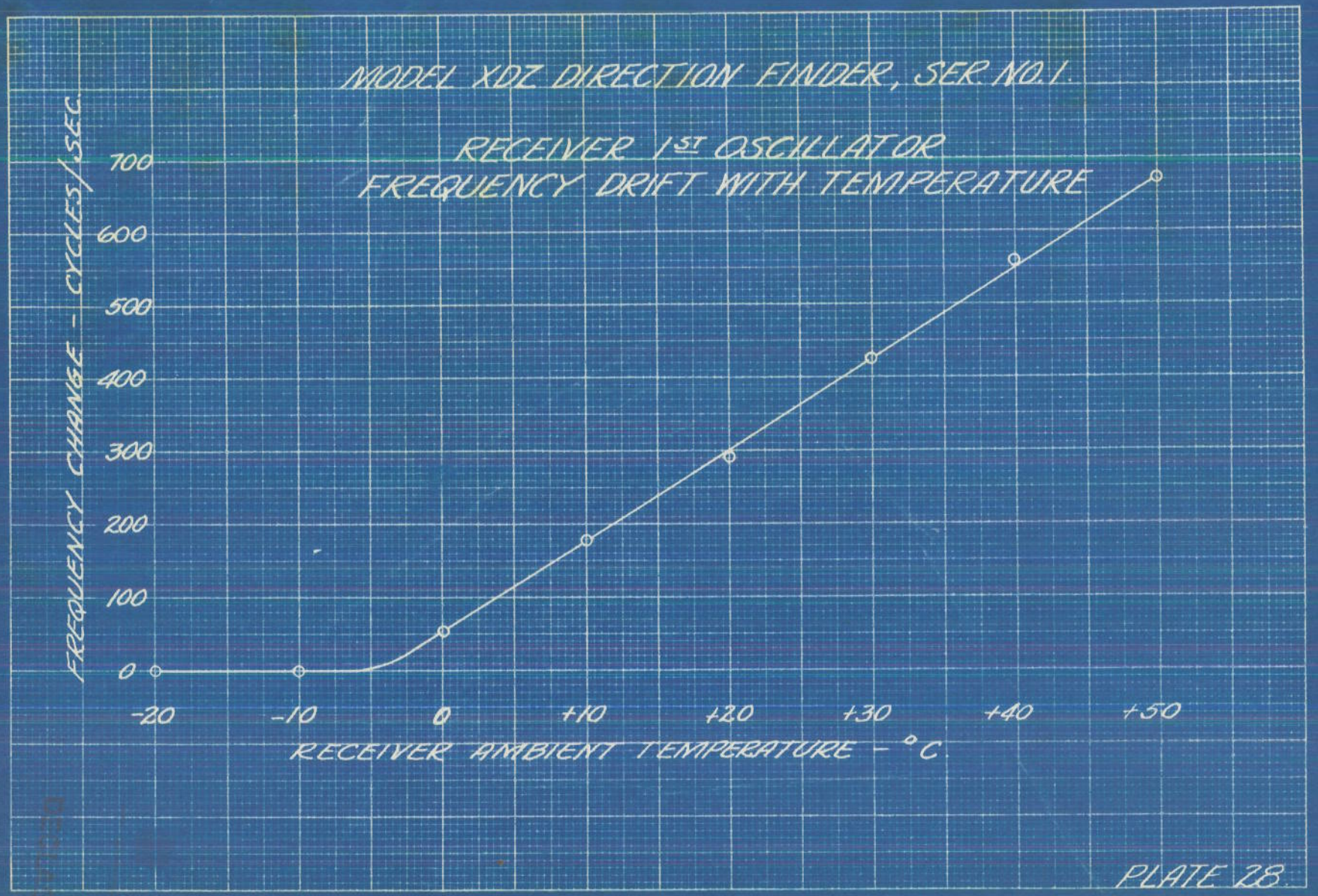

MODEL XDZ DIRECTION FINDER, SER NO.1.
RECEIVER 1ST OSCILLATOR
FREQUENCY DRIFT WITH TEMPERATURE
FREQUENCY CHANGE - CYCLES/SEC.
700
600
500
400
300
200
100
0
-20
-10
0
+10
+20
+30
+40
+50
RECEIVER AMBIENT TEMPERATURE - °C.
PLATE 28.

PLATE 28.

MODEL XDZ DIRECTION FINDER, SER. NO. 1

OUTPUT POWER VARIATION WITH TEMPERATURE OF I.F. AMPLIFIERS OF RECEIVER.

INPUT TO 1ST I.F. = 392 μV.; 50% MODULATION
INITIAL OUTPUT OF RECEIVER = 200 MW.

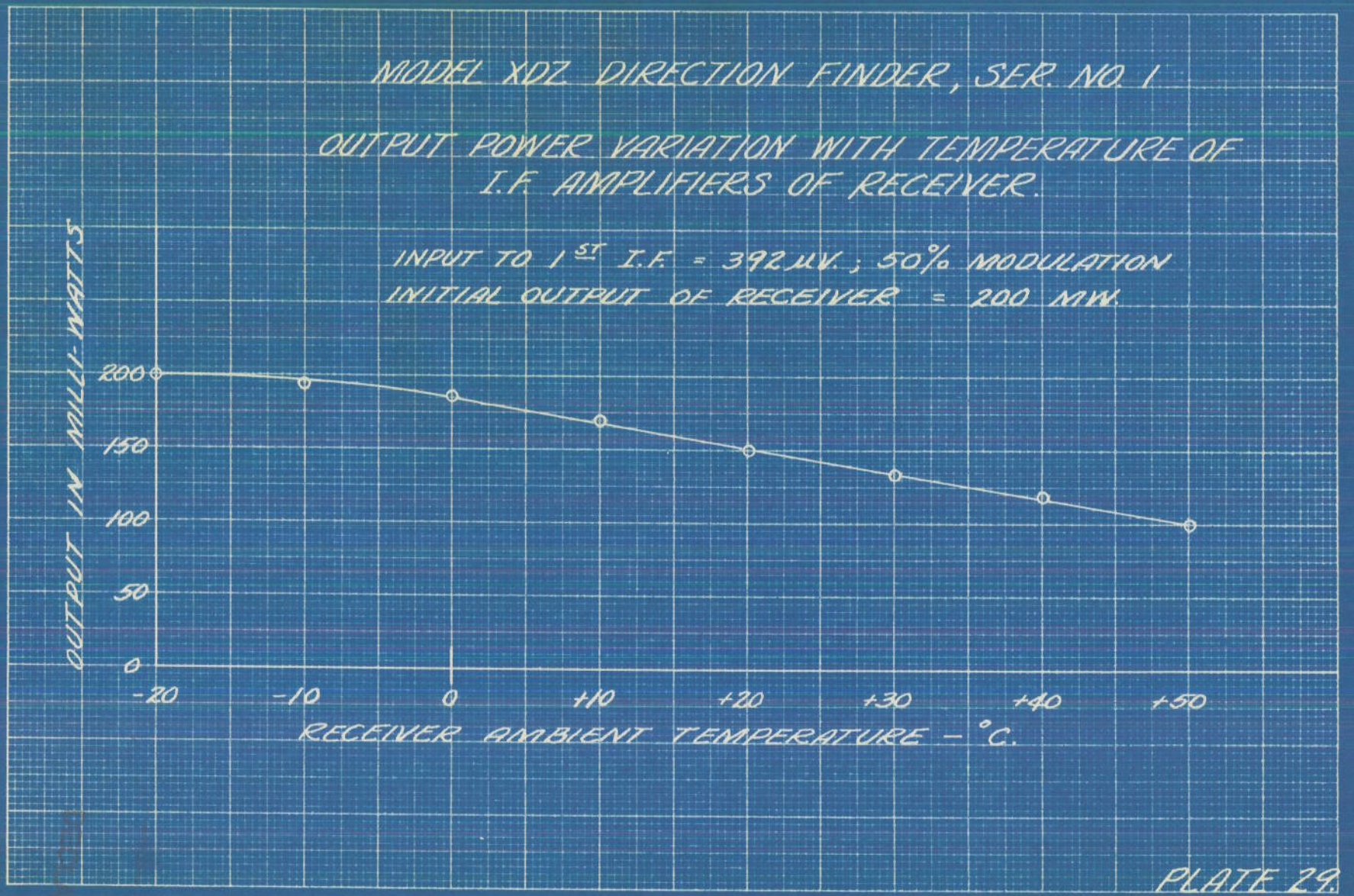
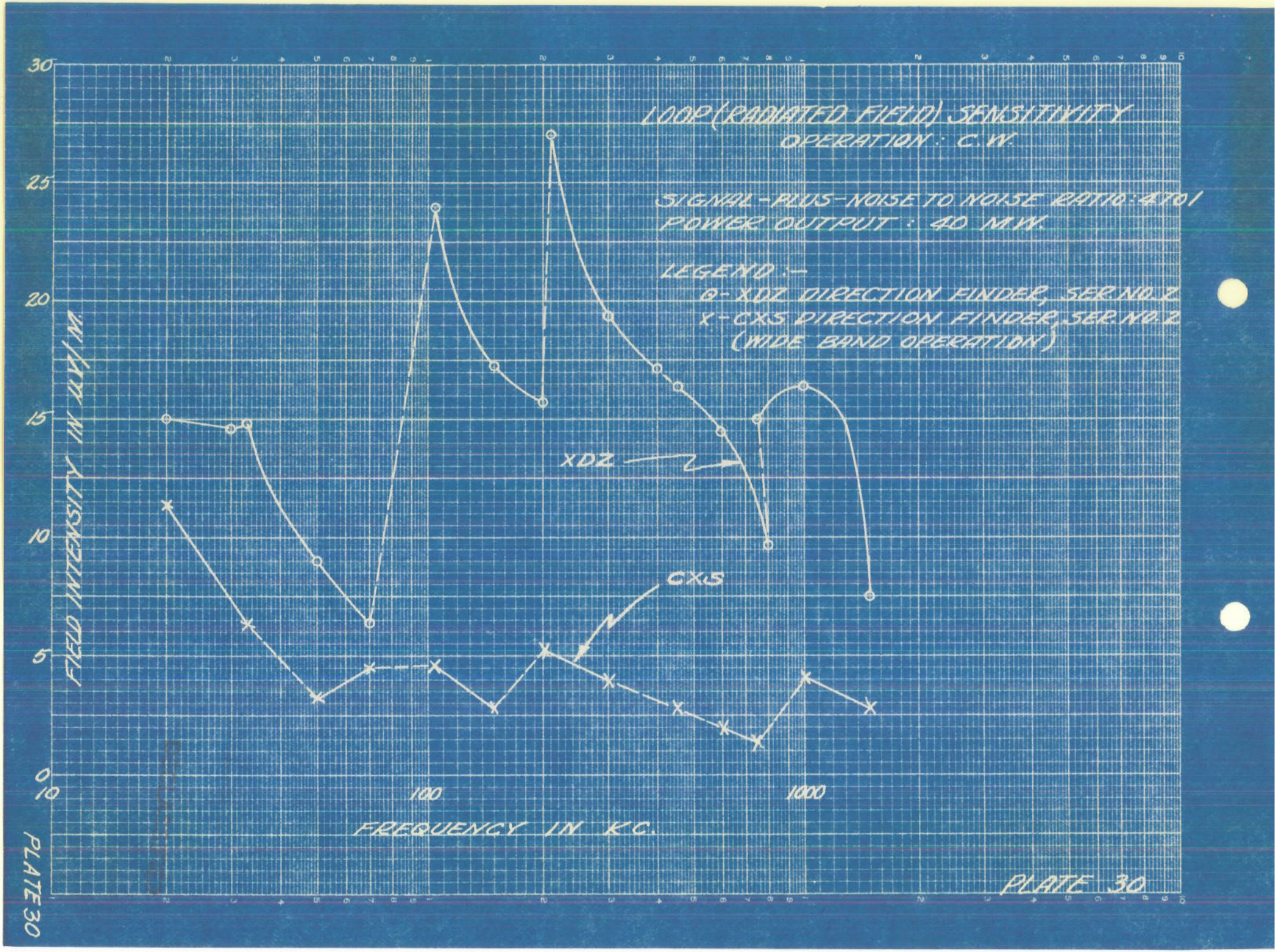
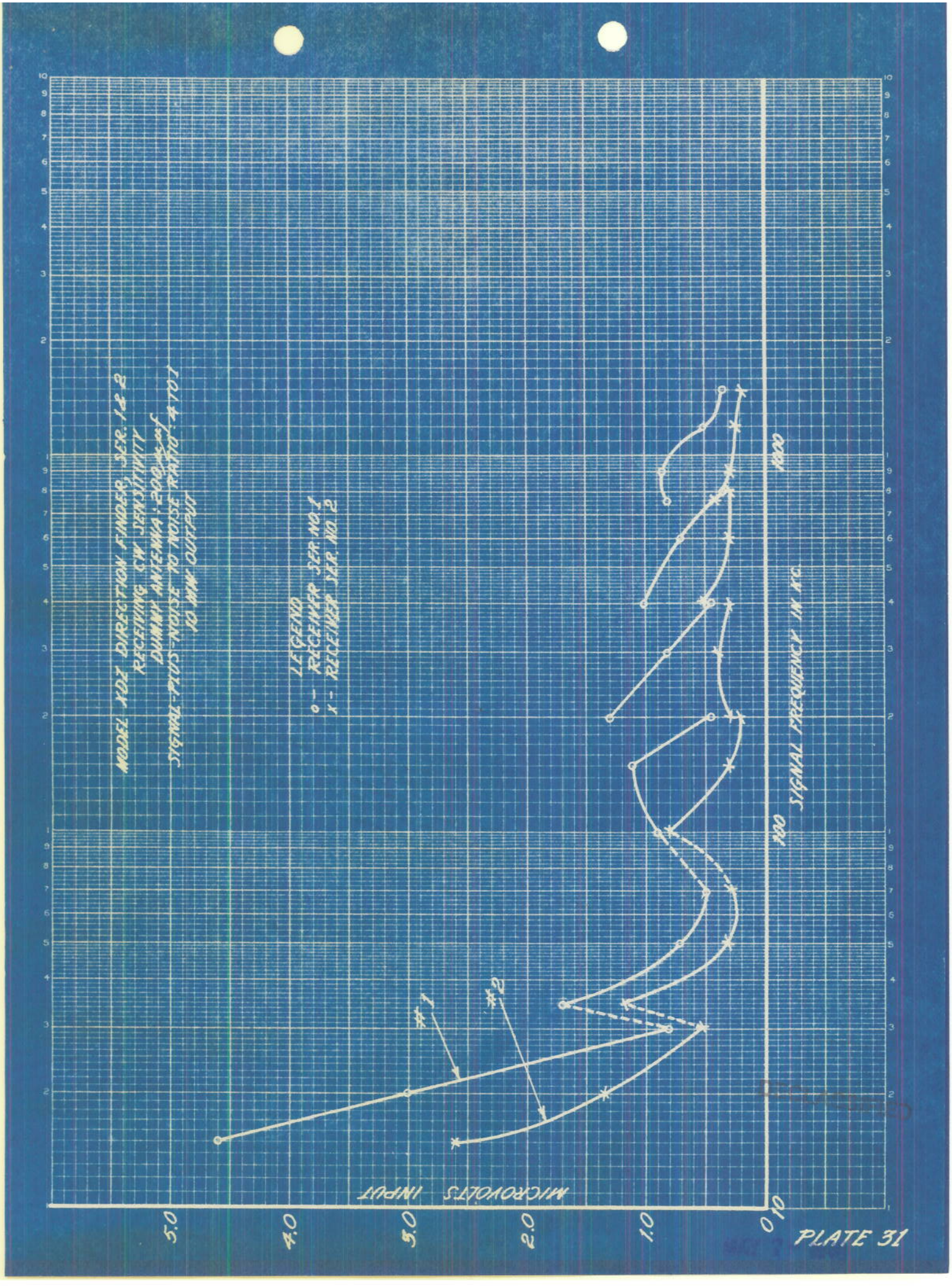


PLATE 29.

PLATE 29


LOOP (RADIATED FIELD) SENSITIVITY
OPERATION : C.W.
SIGNAL-PLUS-NOISE TO NOISE RATIO : 4 TO 1
POWER OUTPUT : 40 M.W.
LEGEND :-
O - XDZ DIRECTION FINDER, SER NO 2
X - CX5 DIRECTION FINDER, SER NO. 2
(WIDE BAND OPERATION)
XDZ
CX5
FIELD INTENSITY IN M/KM IN MILLIVOLTS
30
25
20
15
10
5
0
10
100
1000
FREQUENCY IN K.C.
PLATE 30
PLATE 30


MODEL XDT DIRECTION FINDER, SER. 142
RECEIVING CM SENSITIVITY
DUMMY ANTENNA: 600 OHMS
SIGNAL-PLUS-NOISE TO NOISE RATIO 4 TO 1
AUDIO MW OUTPUT
LEGEND
o - RECEIVER SER NO 1
x - RECEIVER SER NO 2
#1
#2
MICROVOLTS INPUT
5.0
4.0
3.0
2.0
1.0
0
SIGNAL FREQUENCY IN KC
PLATE 31

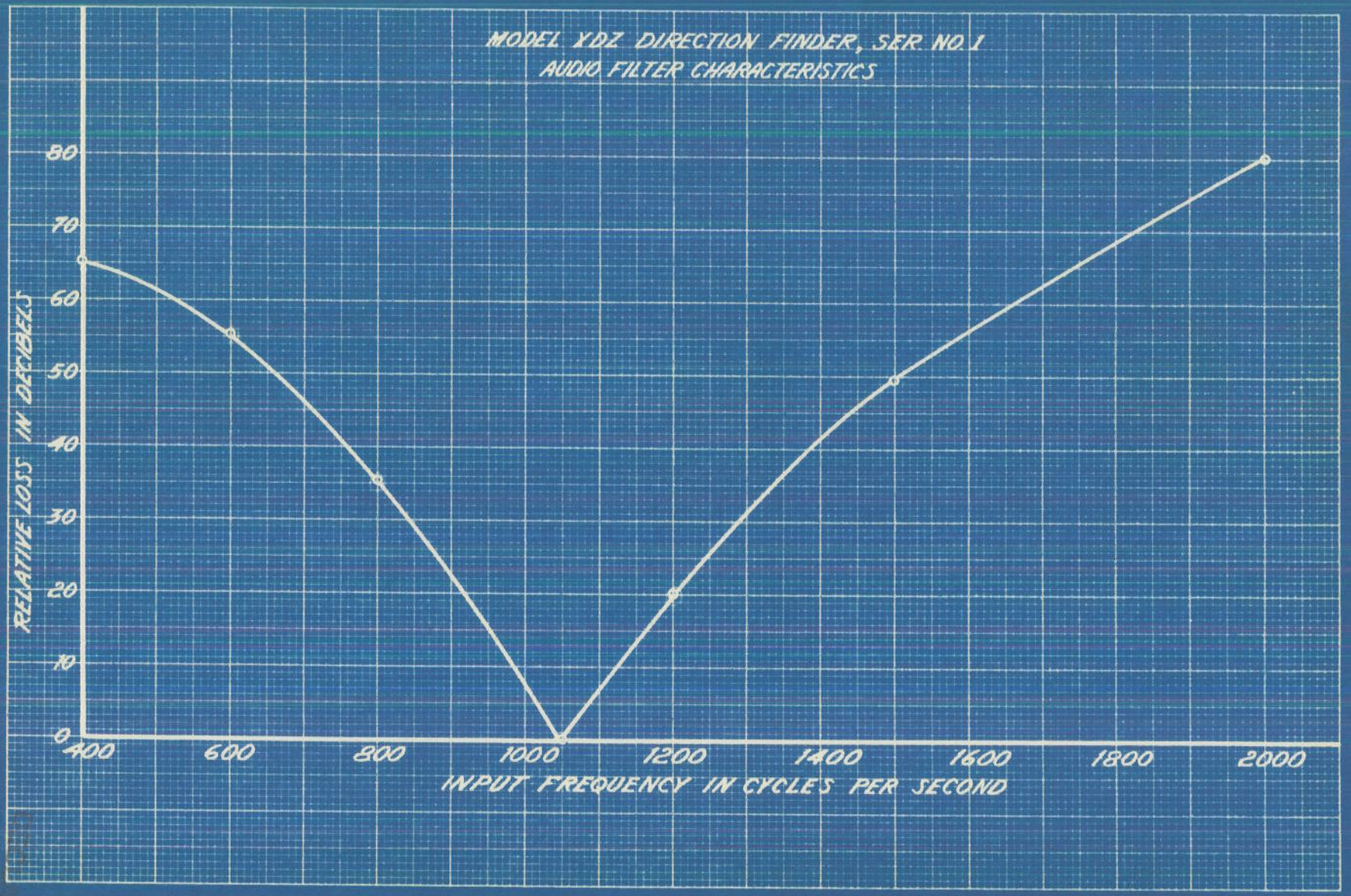

MODEL YDZ DIRECTION FINDER, SER. NO. 1
AUDIO FILTER CHARACTERISTICS
RELATIVE LOSS IN DECIBELS
80
70
60
50
40
30
20
10
0
400
600
800
1000
1200
1400
1600
1800
2000
INPUT FREQUENCY IN CYCLES PER SECOND

PLATE 32

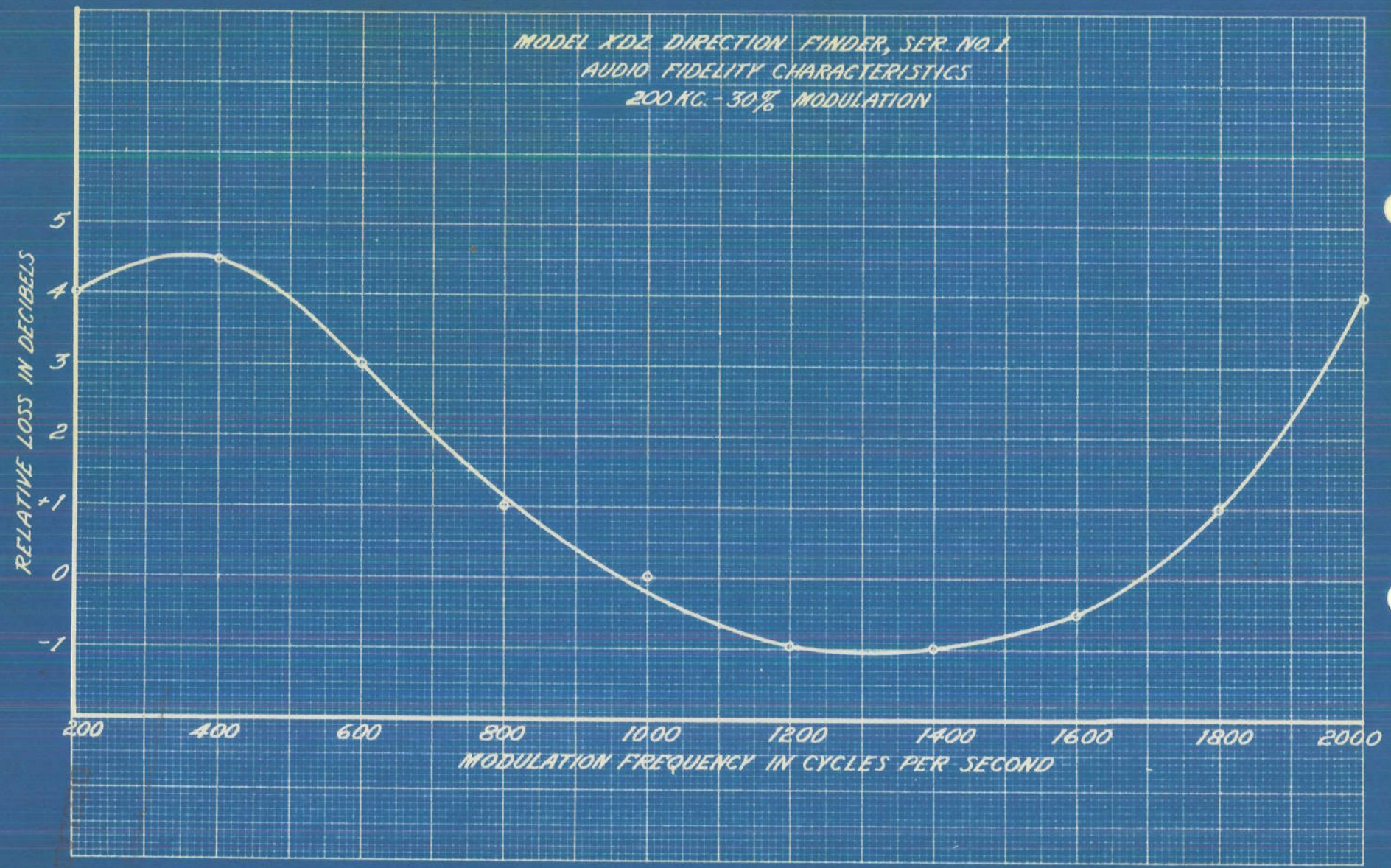

MODEL XDZ DIRECTION FINDER, SER. NO. 1
AUDIO FIDELITY CHARACTERISTICS
200 KC. - 30% MODULATION
RELATIVE LOSS IN DECIBELS
5
4
3
2
+1
0
-1
200
400
600
800
1000
1200
1400
1600
1800
2000
MODULATION FREQUENCY IN CYCLES PER SECOND

PLATE 33

MODEL XDZ DIRECTION FINDER, SER. NO. 1
AUDIO FIDELITY CHARACTERISTICS
400 KC. - 30% MODULATION
MODULATION FREQUENCY IN CYCLES PER SECOND
200
400
600
800
1000
1200
1400
1600
1800
2000
RELATIVE LOSS IN DECIBELS
2
+1
0
-1
2
3
4

PLATE 34

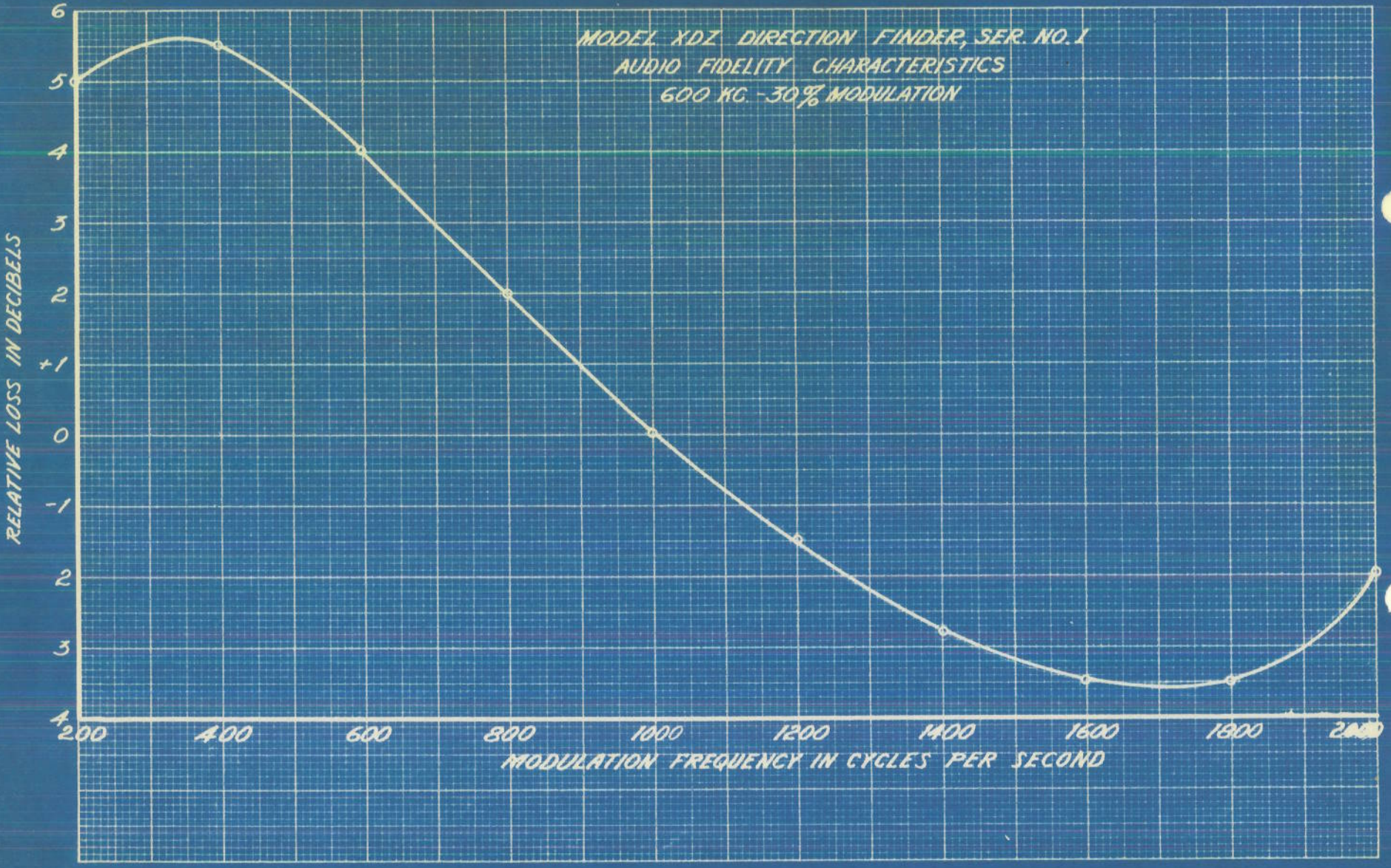

MODEL XDZ DIRECTION FINDER, SER. NO. 1
AUDIO FIDELITY CHARACTERISTICS
600 KC. - 30% MODULATION
RELATIVE LOSS IN DECIBELS
6
5
4
3
2
+1
0
-1
2
3
4
200
400
600
800
1000
1200
1400
1600
1800
MODULATION FREQUENCY IN CYCLES PER SECOND

PLATE 35

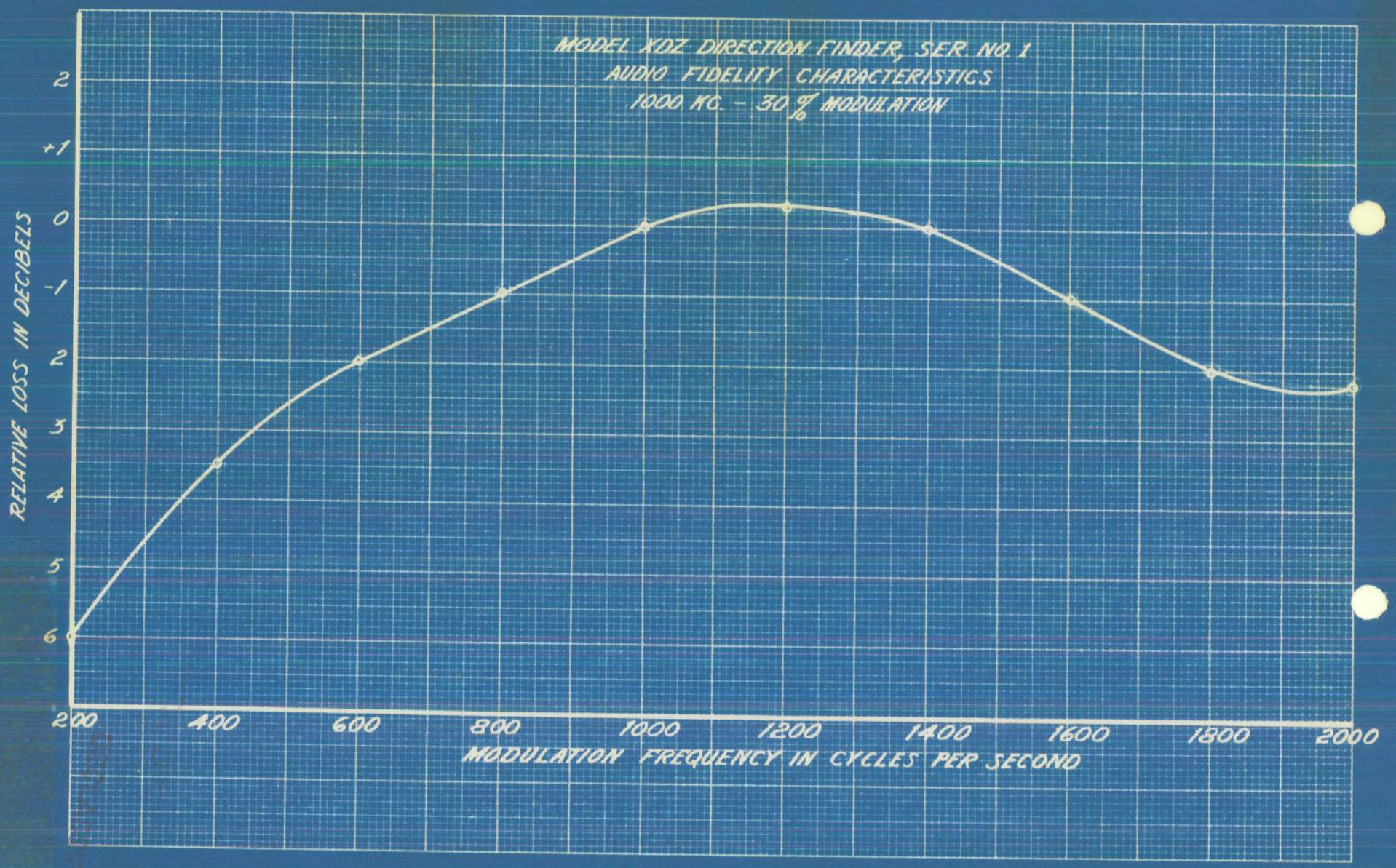

MODEL XDZ DIRECTION FINDER, SER. NO. 1
AUDIO FIDELITY CHARACTERISTICS
1000 KC. - 30 % MODULATION
RELATIVE LOSS IN DECIBELS
2
+1
0
-1
2
3
4
5
6
200
400
600
800
1000
1200
1400
1600
1800
2000
MODULATION FREQUENCY IN CYCLES PER SECOND

PLATE 36

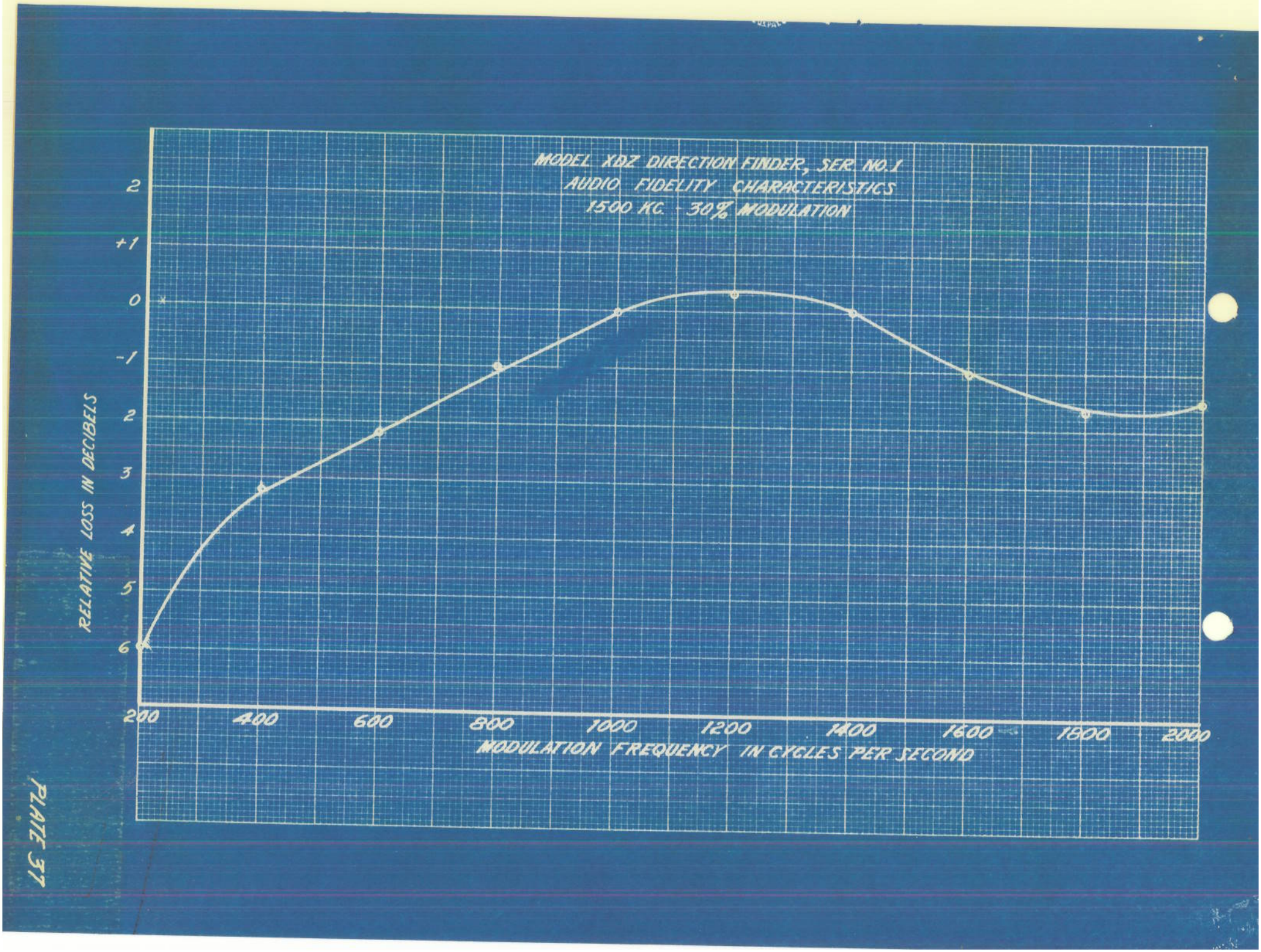

MODEL XDZ DIRECTION FINDER, SER. NO. 1
AUDIO FIDELITY CHARACTERISTICS
1500 KC. - 30% MODULATION
RELATIVE LOSS IN DECIBELS
2
+1
0
-1
2
3
4
5
6
200
400
600
800
1000
1200
1400
1600
1800
2000
MODULATION FREQUENCY IN CYCLES PER SECOND

PLATE 37

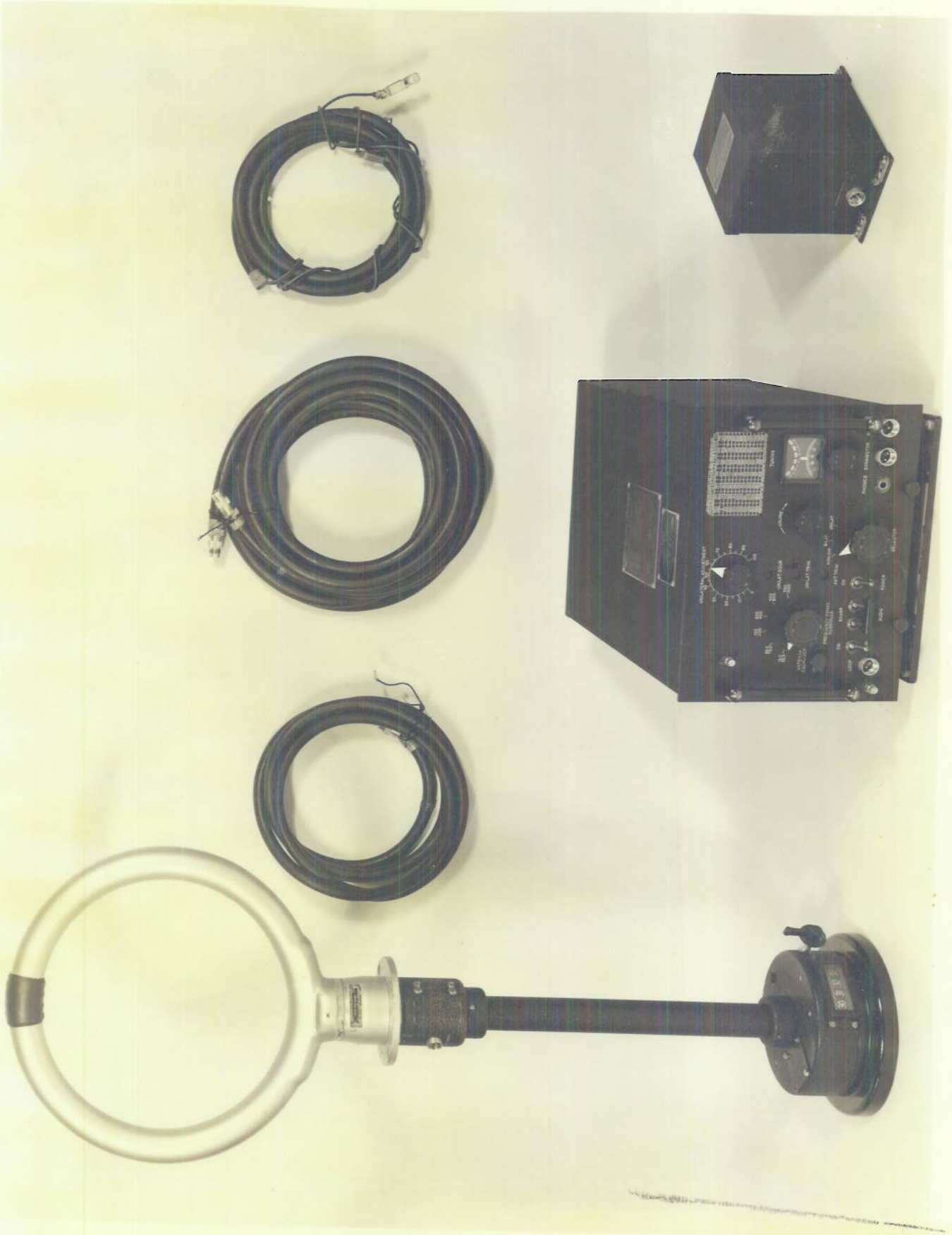


Plate 38

DECLASSIFIED

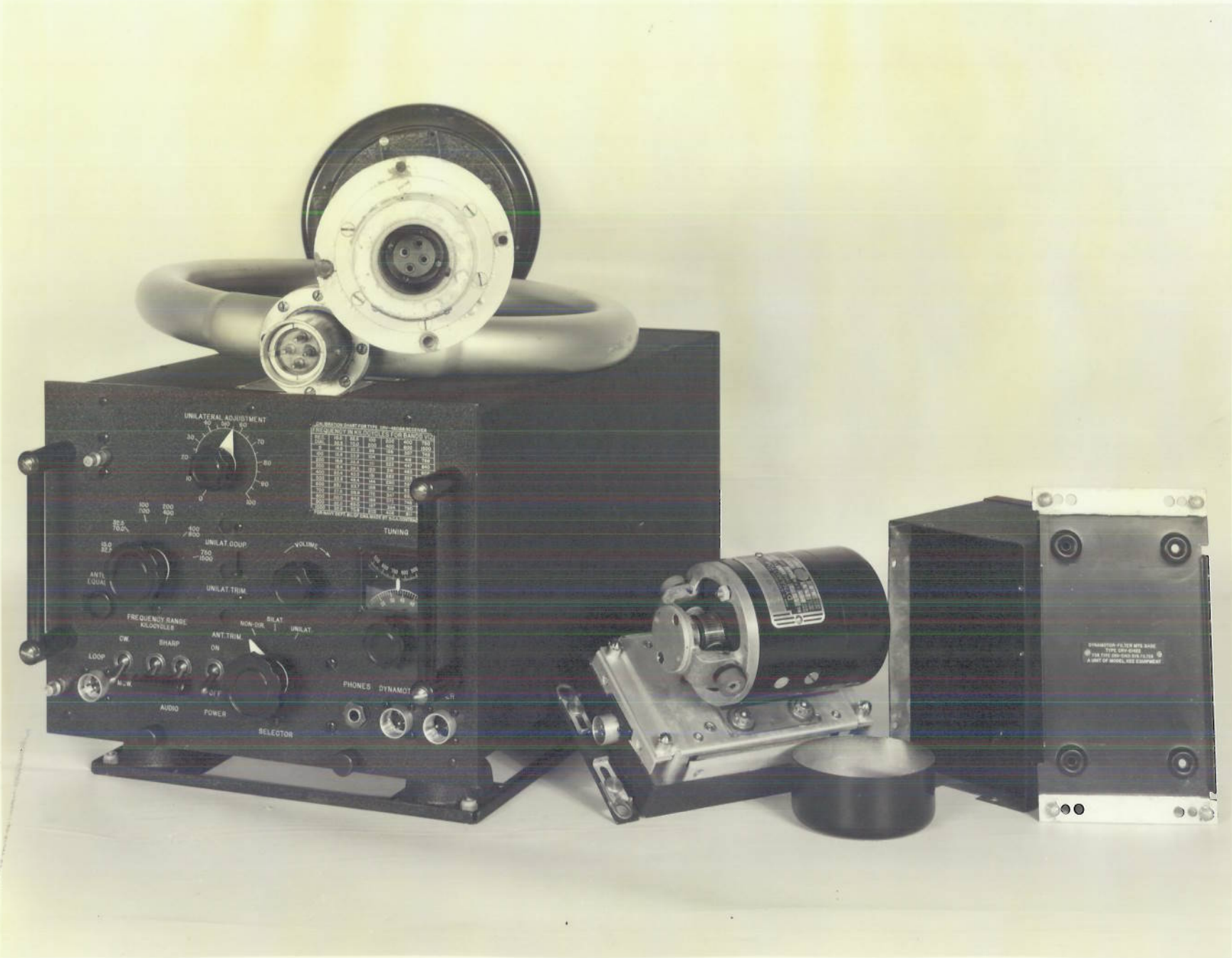


Plate 39

DECLASSIFIED

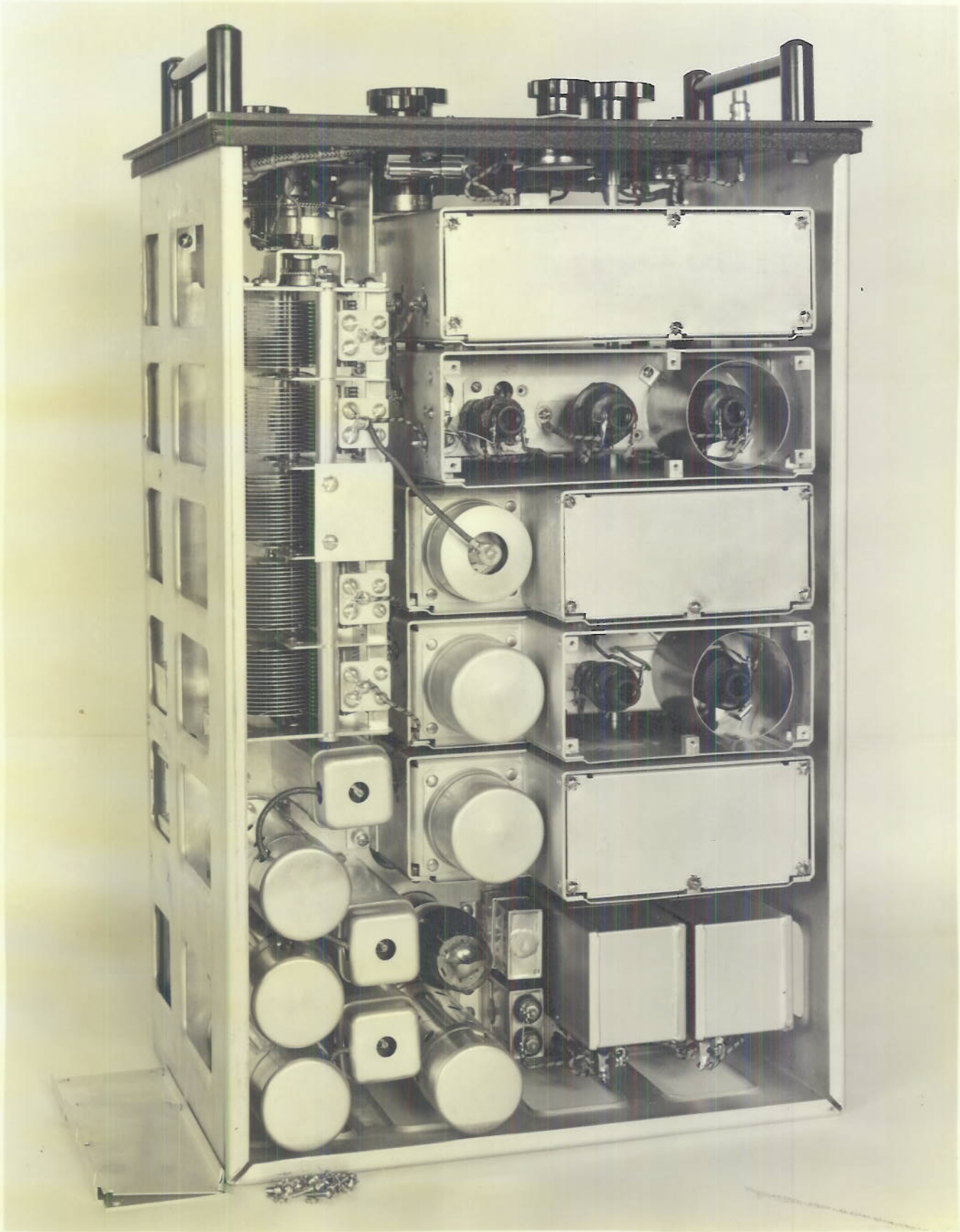


Plate 40

DECLASSIFIED
MAY 7 - 1948

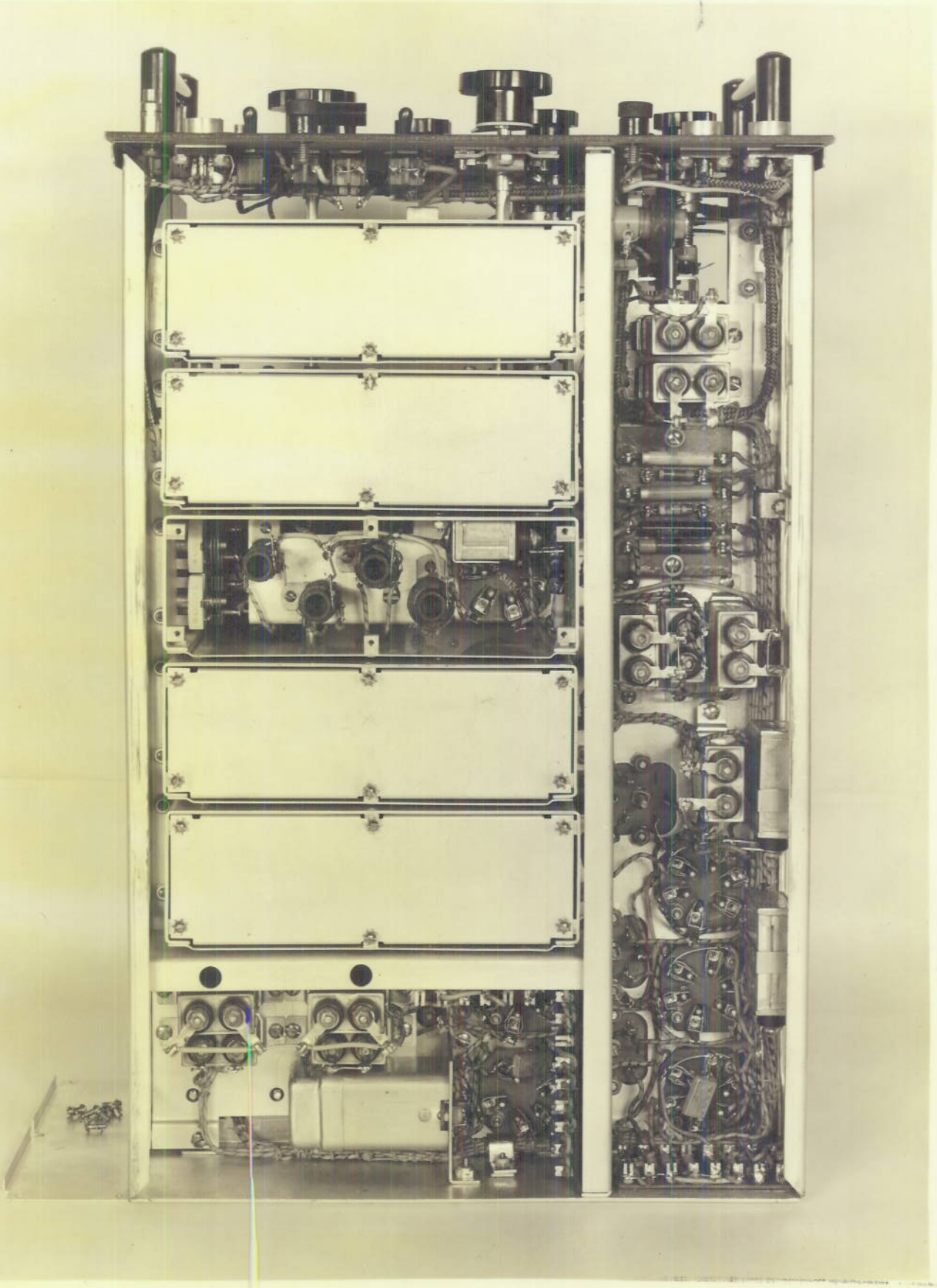


Plate 41

DECLASSIFIED