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Bueng Problem R1-6C.

FR-1483

NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report of Test

of

Model CBM-46061A Amplifier
for
Sub-Aqueous Echo Ranging

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION,
WASHINGTON, D.C.

Number of Pages: Text 13 Plates - 18

Authorization: BuEng. ltr. C-867/50(8-8-R8) of 10 August 1938.

Date of Test 12 August to 24 August 1938

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Distribution:
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TABLE OF CONTENTS

APPENDICES

AUTHORIZATION

1. The tests covered by this report were authorized by reference (a). Other pertinent data are listed as references (b) to (e) inclusive.

Reference: (a) BuEng. ltr. C-S67/50(8-8-R8) of 10 August 1 938.
(b) BuEng. Spec. RE 13A 527C, Underwater Sound Equipment.
(c) BuEng. Spec. RE 13A 600, Vacuum Tubes.
(d) Submarine Signal Co. Preliminary Instruction Pamphlet #7275.
(e) BuEng. ltr. S68(8-8-R6) of 9 August 1938.

OBJECT OF TEST

2. The object of these tests was to determine how closely the subject equipment meets the requirements of Bureau specifications, reference (b) above, and to record any other data of particular interest not covered by the specifications.

ABSTRACT OF TEST

3. The subject equipment was set up in a screened booth with the necessary testing equipment. It was given a general mechanical inspection, and subjected to electrical tests to determine its performance with regard to the following:

(a) Input impedance.
(b) Power consumption.
(c) Sensitivity.
(d) Selectivity.
(e) Image Response.
(f) Intermediate frequency rejection.
(g) Overload selectivity.
(h) Resonant overload.
(i) Frequency and gain stability.
(j) Limiter control.
(k) Audio overload.
(l) Audio fidelity.
(m) Output impedance.
(n) Maximum noise level.
(o) Calibration accuracy.
(p) Blocking.

Conclusions

(a) The Model CBM-46061A amplifier embodies unusual ruggedness; its wiring, including soldering, is exceptionally neat and the general arrangement of parts, though very compact, permits good accessibility to the various parts which may need adjustment or replacement.

(b) The materials employed are generally of excellent quality with a view toward ruggedness and permanence of electrical characteristics. The wire between component parts has a rubber and woven fabric covering which has been treated in such a manner as to maintain good insulating properties under service conditions. Considerable magnetic material has been employed in brackets and supporting members, the anti-corrosive properties of which are not known.

(c) The wiring is color coded and is brought to terminals having good insulation properties with unusually good spacing to reduce the possibility of leakage. All terminals, as well as component parts, including tube sockets, are marked legibly and permanently for reference to wiring diagrams.

(d) The panel controls are symmetrically arranged and permit ease of operation with excellent control of performance. Toggle switches have been employed in three low voltage, low current circuits, which, if like similar switches previously used, may develop contact trouble.

(e) The electrical performance, although generally good from the practical standpoint, fails to wholly meet the specifications for sensitivity, selectivity, image response and image frequency exclusion.

DESCRIPTION OF MATERIAL UNDER TEST

4. The material under test consisted of one sample production model of type CBM 46061A receiver amplifier and of type CBM 20062 power supply unit for use with QC-1A and QC-1B echo ranging equipments. Subject equipment was supplied by the Submarine Signal Company, Boston, Massachusetts, contractor. It was received at the Laboratory on 4 August 1938. Authorization for this test was received on 11 August 1938, covered by reference (a).

5. The type CBM receiver amplifier is designed for cw or mcw signals with a frequency range of 14 to 36 kilocycles. The circuit is of the infraheterodyne type and includes one r-f stage, a first detector, a first oscillator, three i-f stages, a second detector, a cw oscillator, and two audio stages for loud speaker or headset output as well as an amplifier for red light output comprising two stages fed by the first audio stage. The input impedance is variable in three steps of 300, 1500, and 5000 ohms and is balanced with respect to ground. The first oscillator tuning condenser is ganged with the r-f input tuning condenser to give an i.f. of 60 kilocycles. The i-f amplifier is provided with a switch for changing from "sharp" to "broad" tuning by loosening the coupling in the two i-f transformers. The first and second detectors are "varistors" or copper oxide rectifier balanced demodulators. The relatively low impedance of these varistor units necessitates the use of step down and step up input and output transformers with each unit. The second oscillator may be adjusted from 60 to 61.6 kilocycles to provide a beat note for cw reception, or may be shut down for mcw work. The output of the first audio stage may be switched to filter circuits giving three varieties of audio response: a peak at 800 cycles, a band from 600 to 1000 cycles, or, with filters cut out, a fidelity curve flat from 200 to 3000 cycles. An attenuator is included in the audio output circuit to the phones to limit the phone signal to a proper level. A silicon carbide protector unit is provided in each a-f output circuit in parallel with an output transformer primary. The plate circuit of the second audio stage, supplying phones and loud speaker, is provided with an output limiter consisting of a six-position switch for inserting resistors to prevent the output from exceeding 6 mw by amounts specified in decibels upon the switch dial.

6. The r-f input circuit is also provided with a socket for a limiting device, but the limiting tube was not provided with the set; therefore, all of the following tests were made without this tube, V113, in the circuit.

7. The following tubes were provided with the receiver amplifier:

CONFIDENTIAL

No.	Tube Type	I_p m.a.	G_m umhos	Std G_m	Function
V101	6C6	2.2	1050	1275	r-f amp.
V102	6D6	8.5	1370	1600	1st i.f.
V103	6D6	9.5	1450	1600	2nd i.f.
V104	6D6	7.7	1370	1600	3rd i.f.
V105	6C6	2.0	920	1275	1st a.f.
V106	41	28.5	1730	2200	2nd a.f.
V107	76	5.1	1040	1350	1st indicator a.f.
V108	41	32.5	1850	2200	2nd indicator a.f.
V109	76	5.3	1040	1350	cw-osc.
V110	76	5.5	1380	1350	1st het. osc.

8. The CBM 20062 power supply unit consists of the conventional power transformer, rectifier tube and filter circuits to furnish proper plate, screen, bias and filament voltages to the receiver-amplifier.

APPARATUS AND METHODS OF TEST

9. The following apparatus was employed in testing subject equipment:

General Radio Standard Signal Generator, Model LC-A, Ser. No. 1.
General Radio Output Milliwatt Meter, Type 583 A, Ser. No. 74.
NRL output microwattmeter, 600 ohms.
Weston vacuum tube voltmeter, Model 669.
General Radio Decade Box, Type 102-J, Ser. No. 3326.
General Radio Oscillator, Type CAG-60004 (part of Model LN equipment).
General Radio Beat Frequency Oscillator, Type 713-AS10, Ser. No.395.
NRL sonic transmitter, Type QB, Serial No. 1
Dumont Cathode Ray Oscillograph, Type 171, Ser. No. 927.

ACCURACY OF TEST RESULTS

Name of Test		Estimated Overall Accuracy
1. Sensitivity	voltage output/voltage input	± 10. %
2. Selectivity	DB	± 1 db
	variation of frequency with rotation of main tuning dial	± 0.1 %
3. Frequency stability measurements		± 2. cycles
4. Overall voltage gains/voltage noise ratios		± 10%
5. Audio characteristics		± .5 db
	frequency	± 2 %
6. Audio input voltages		± 2 %
7. Audio output voltages		± 5 %
8. Input impedance		±10 %
9. Output impedance between 150 and 3000 cycles		± 7 %
below 150 and above 3000		±20 %

10. The methods of test and the data obtained are discussed in the following section. The paragraph numbers apply to reference (b), the controlling specification.

RESULTS OF TESTS

11. Par. 2-2. The outside dimensions of the amplifier case were found to be as follows:

Depth	15-1/16"
Height	14-1/4"
Width	22"

The depth is 1/16" greater than the value specified.

12. Par. 2-3. The case is very rigidly and massively constructed and is provided with holes through its top for stacking with indicator and remote control units as shown in Fig. 1 of reference (b).

13. Par. 2-4. Weight of receiver in case, including mounting feet is 143 pounds. Weight of receiver in case without mounting feet is 130 pounds. Weight of power supply unit is 26 pounds. Maximum weight of receiver amplifier tolerated in specifications is 125 pounds.

14. Par. 2-5. No means are taken to minimize effects of shock and vibration. No tube sockets are cushioned.

15. Par. 2-6. The amplifier and power supply cables are securely clipped to the inside of the case.

16. Par. 2-7. All connections are made to rigidly mounted terminal boards by screws and lock washers.

17. Par. 2-8. The connecting cable is flexible and permits the chassis to be partially withdrawn for examination and tube replacement without disconnecting any lead.

18. Par. 2-9. Tests with a permanent magnet indicate that several items on the chassis are of iron or steel (possibly stainless steel):

Chassis - support guide rails.
Shaft on input coil tap switch; this shaft appears to be corroding in several small spots.
Cases of most paper condensers and audio transformers.
Condenser, resistor and jack supporting brackets.
Chassis base plate and support angles.
Case latches and catches.
Stop plate for safety switch.
Aluminum parts appear to have an anodized finish; other parts are finished in aluminum lacquer.

19. Par. 2-10. The amplifier panel is secured in complete accordance with this paragraph.

20. Par. 2-11. The chassis is designed in accordance with this paragraph.

21. Par. 2-12. All controls and indicating devices are mounted on front of panel.

22. Par. 2-13. The front panel is provided with all required controls and devices.

23. Par. 2-14. Control is by vernier only, no direct drive being provided.

24. Par. 2-15. The main tuning vernier has a ratio of 40:1.

25. Par. 2-16. Verniers are of the split-gear type and the total of all play is about 1/2 vernier division. The play was about one vernier division when the equipment was received, and could not be adjusted to much less than 1/2 division without causing binding. The vernier control mechanism is of excellent construction and is convenient to operate.

26. Par. 2-17. The vernier and counter divisions are marked as specified. The calibration is not linear with respect to frequency, but the specification fails to define a tolerance.

27. Par. 2-18. No difficulty was experienced from glare at the tuning dial windows, although it is not known whether the latter are of anti-glare glass. The glass is firmly secured to the panel.

28. Par. 2-19. More than two figures on both vernier and counter dials are visible at all times.

29. Par. 2-20. The power supply is mounted separately from the amplifier.

30. Par. 2-21. The working range of the amplifier is approximately 14 to 36 kilocycles.

31. Par. 2-22. Taps A and C on the r-f input transformer are suited to receiving energy from magnetostriction or rochelle salt underwater sound projectors. Suitable output circuits are provided for phones, loud speaker, or red light.

32. Par. 2-23. All vacuum tubes used in the receiver amplifier are chosen from among the types listed in this paragraph.

33. Par. 2-24. The power supply requirements laid down in this paragraph are fulfilled; the power consumed is 84 watts; the maximum d-c working voltage 290 volts.

34. Par. 2-25. All connections to the amplifier enter through the rear panel.

35. Par. 2-26. The terminal board is not conveniently accessible for connecting the cables with the amplifier partially withdrawn from the case.

36. Par. 2-27. The connecting cables are constructed and grounded as required by this paragraph.

37. Par. 2-28. It was not ascertained whether all moving contacts were silver-faced.

38. Par. 2-29. The input impedances and input selector switches meet the requirements given.

39. Par. 2-30. The frequency range of the amplifier is covered in one band.

40. Par. 2-31. Sensitivity control is provided for the if stages but not for the r-f stage.

41. Par. 2-32. The sensitivity control operates independently of the output limiter.

42. Par. 2-33. The sensitivity control introduces no noticeable extraneous noise in the audio output.

43. Par. 2-34. No independent sensitivity control is provided in the output circuit to the illuminating index (red light) in the receiver. Such control may be in the indicator, however,

44. Par. 2-35. The sensitivity control operates over a range of approximately 80 decibels in steps of less than 1 decibel.

45. Par. 2-36. The broadening of selectivity obtained by placing the i-f stages in the "broad" condition is not symmetrical around the resonance point obtained with i-f stages in the "sharp" condition. Readjustment of tuning is required for optimum output when the i-f amplifier selectivity control is shifted.

46. Par. 2-37. The output limiter functions in accordance with the requirements laid down in this paragraph. The limiter characteristics are given in Plates 1 and 2. The data show that the limiter characteristics are flat to the highest input voltage employed: up to 1/2 volt on cw (although the curves are not extended beyond 1/10 volt).

47. Par. 2-38. (1) The output limiter (O.L.) functions instantaneously.

48. Par. 2-38. (2) The O.L. operates on transients.
(3) The O.L. introduces no appreciable noise into the audio output circuits.

49. Par. 2-39. The O.L. is controlled as specified in this paragraph.

50. Par. 2-40. The output telephone jack is connected as specified.

51. Par. 2-41 (1) The size and range of the output meter are as specified.

(2) The responsiveness and damping factor of the output meter were not determined.

(3) The instrument is calibrated as specified.

(4) The range switch operates according to specifications.

(5) The instrument does not use a separate winding on the output transformer. The power consumed in the instrument was not determined.

52. Par. 2-42. The heterodyne "on-off" switch functions as specified.

53. Par. 2-43. The excellence of shielding and static balance of the output transformer secondaries was not determined. The freedom of the output from r-f potentials was not ascertained.

54. Par. 2-44. A suitable red light amplifier is provided as specified.

55. Par. 2-45. Loud speaker and telephones were not furnished for test with the amplifier.

56. Par. 2-46. Items (1), (3), (4) and (5) were complied with during tests.

(2) 300 and 3000 ohm resistors were used in series with the input circuits during tests with input taps A and C, respectively.

(6) The transconductance of the vacuum tubes used is below the specification maxima as shown in paragraph 7 of this report.

57. Par. 2-47. Plate 3 shows that the cw sensitivity is better than 1/2 microvolt when the low impedance input tap "A" is used. When high impedance tap "C" is used, the sensitivity varies from 1.3 to 2.4 microvolts. The i-f amplifier was used in the "sharp" condition for these tests as specified. The sensitivity figures are for the actual voltages applied at the receiver input terminals.

58. Par. 2-48. Plate 4 shows that the mcw sensitivity varies between 1 and 3 microvolts for input tap "A" and between 5.4 and 18 microvolts for input tap "C" using the i-f amplifier in the "broad" condition. The sensitivity figures are for actual voltages applied at the receiver input terminals.

59. Par. 2-49. On mcw tests the amplifier was operated to place the noise 10 decibels below the signal with the i-f amplifier in the "broad" condition.

60. Par. 2-50. The selectivity in the "sharp" condition lies outside the shaded portion of the selectivity curves shown on Fig. 2 of reference (b). For example, the experimental selectivity curve given on Plate 5 shows that the response is down 14 decibels 1 kilocycle below resonant frequency and down 20 decibels 1 kilocycle above resonant frequency as compared to the minimum tolerated value of 24 decibels from Fig. 2 of reference (b).

61. Par. 2-51. The selectivity curve in the "broad" i-f condition, Plates 5 and 6, falls within the shaded portion of Fig. 3, reference (b), down to about 15 decibels on the low frequency side, and about 30 decibels on the high frequency side of resonance. Below these points the experimental curves show greater than the tolerated broadness.

62. Par. 2-52. By comparing the reception of a 25 kilocycle signal with that of a 145 kilocycle signal, it was found that the response to this image was down 75 decibels for a cw signal and 65.6 decibels for a mcw signal with 1000 cycle modulation. This fails to meet the requirement of 80 decibels attenuation. Attenuation of secondary images is satisfactory.

63. Par. 2-53. Using a 60 kilocycle input, with the receiver tuned to 30 kilocycles, a response 51.5 decibels below resonant response was obtained on cw signals and 38.1 db below for 1000 cycle mcw signals; in these tests, the low impedance tap A was used and the i-f amplifier was in the "sharp" condition. Thus the receiver amplifier does not meet the requirement of 60 decibels attenuation to direct reception of the i.f.

64. Par. 2-54. The spurious responses obtained, with all oscillators operating, are well below the tolerated value.

65. Par. 2-55. The maximum undistorted output was not determined.

66. Par. 2-56. Resonant overload, as defined in par. 2-75(10) of reference (b), occurs at an input of 15.9 microvolts at 30 kilocycles, with an output of 1.4 watts. The specification is well met in this respect.

67. Par. 2-57. The audio fidelity curves are given on Plate 7. The requirements of the specification are met by these curves.

[redacted]

(1) In "flat" condition, the response varies less than one decibel between 200 cycles and 3000 cycles.

(2) In "band" condition, the response varies one decibel between 600 and 1000 cycles.

(3) In "peak" condition, the resonance peak occurs at 815 cycles. The response curve drops 12 decibels when 20% above or below the value at resonance.

The output level of response of the three bands was alike within 3 decibels.

68. Par. 2-58. The change from "sharp" to "broad" is accomplished by a single panel control.

(1) Plates 8 and 9 indicate that the change from "sharp" to "broad" shifts the position of resonance by 1500 cycles. The specification is not met in this particular.

(2) On a 25 kilocycle signal, the overall gain is reduced by 9 decibels for cw and increased by 4 decibels for 1000 cycles mcw, when the i-f amplifier is switched from "sharp" to "broad", retuning to resonance for each condition, and adjusting the gain control for specified signal to noise ratio. The overall gain is reduced by 13 decibels on cw and increased by 3 decibels on mcw when the i.f. amplifier is switched from "sharp" to "broad" without retuning, but with adjustment of gain control to place noise 20 decibels below cw signal or 10 decibels below mcw signal.

Thus, the specified maximum of 1 decibel is exceeded in each test.

(3) The change from "sharp" to "broad" i.f. changes the best note only a few cycles.

69. Par. 2-59. Depression at the nose of the cw selectivity curves may be noted with "broad" i.f. on plates 8 and 9. That of plate 9 reaches 4 decibels whereas the specified tolerance is 3 decibels.

70. Par. 2-60. (1) The variation in a 1000 cycle audio beat note was $\pm$ 5 cycles for change in line voltage from 104 to 126 volts. The corresponding variation in gain was $\pm$ 1 decibel. Specification met.

(2) Turning on or off output limiter or varying output level varies the frequency of a 1000 cycle beat note by 4 cycles.

(3) With cw input below threshold of limiter operation, changing the output limiter from off to 0 changes a 1000

cycle beat note 4 cycles and decreases the gain by 7.65 decibels. Specifications met with respect to frequency variation and gain variation, the maximum tolerated variation being 15 decibels.

(4) Less than one cycle change in 1000 cycle beat was observed when the gain control was varied from maximum to minimum with input adjusted to hold standard output. Specification met.

(5) A variation of less than 2 cycles was observed in 1000 cycle beat note during variation of input from 5 to 100,000 microvolts with O.L. on and set for standard output (10 microvolt signal) and manual sensitivity controls adjusted for standard noise level. Specification met.

(6) Trimmers were not disturbed. There were no panel operated trimmers in this receiver.

71. Par. 2-61. The frequency drift was not determined as a function of time duration of operation.

72. Par. 2-62. The gain was not determined as a function of time duration of operation.

73. Par. 2-63. No temperature runs were made.

74. Par. 2-64. No overload selectivity is plotted since all interfering signals are within the audio spectrum for this receiver. A selectivity curve showing the attenuation of an interfering signal is shown on plate 10, taken with two signal generators.

75. Par. 2-65. No appreciable evidence of spurious oscillations was detected at full gain with output limiter inoperative. However, the tubes used did not have the maximum transconductance permitted by Specifications RE 13A 60, so it is not possible to state conclusively that the present specification is met.

76. Par. 2-66. The activity of oscillator operation was not ascertained.

77. Par. 2-67. Suitable tubes were not available for making the tests called for in this paragraph.

78. Par. 2-68. Recovery time: A sonic depth finder transmitter, type QB, Serial No. 1, was used to block the receiver, the effect being observed by a Dumont oscillograph, type 171, Serial No. 927, connected to the output of the subject receiver amplifier. The transmitter was keyed at various speeds by a dot wheel; the output was coupled to the receiver through a condenser the capacity of which was changed to obtain various input voltages. Simultaneously, a signal generator, with 1000 cycle mcw output at 25 kilocycles was coupled to the receiver input tap A through a 320 ohm series resistor.

The recovery period is the time between the end of the dot and the return of the normal 1000 cycle signal from the signal generator to the initial value. With the oscillograph connected directly to the transmitter, it was found that the dot length was 1.8" and the space 0.5" on the oscillograph at 660 dots per second. At 170 dots per second, the dot was 1.0" and the space 0.5".

79. With the oscillograph connected to the receiver output and coupled so loosely to the transmitter that no blocking took place, dot speeds of this same order of magnitude were clearly received. With all equipment tuned to 25 kilocycles, 100 volts from the transmitter was placed on the receiver by means of a 0.01 mfd condenser (this voltage was measured by connecting the oscillograph to receiver input). One-half of input coil A was used and the equivalent of a 7.5 microvolt signal was applied to the receiver from the signal generator. At 160 dots per second, recovery just becomes apparent before reblocking. Full recovery requires a somewhat greater time interval. With the object of accurately determining the recovery time, attempts were made to photograph the oscillograph trace when the keying speed was 600 dots per minute, with 100 volts from transmitter and 5 microvolts from signal generator, but the results were unsatisfactory. The receiver was available for too short a time to repeat this test.

80. Par. 2-69. Temperature runs were not made.

81. Par. 2-70. Temperature and humidity runs were not made.

82. Par. 2-71. Test was not made at 51.5° C.

83. Par. 2-72. Trimmers are provided, but their setting was not disturbed during these tests. Air dielectric trimmer condensers are provided in the i-f amplifier.

84. Par. 2-73 (1) The audio beat oscillator is adjustable as specified.

(2) Receiver amplifier was not checked for proper alignment at 1000 cycles frequency output. Specification performance is attained in many, but not all particulars.

85. Par. 2-74. No mechanical vibration tests were carried out.

86. In accordance with paragraph 1 (g) of reference (a), the input and output impedances were determined as a function of the frequency and are plotted on Plates 11, 12, and 13. The output impedance is the minimum value of curves on Plates 12 and 13.

87. The resistors and condensers are very rigidly and accessibly mounted and numbered with unusual care to correspond with the designations on Submarine Signal Company diagram SK 3761.

88. The chassis interlock or safety switch fails to close unless the chassis is vigorously pushed home in the box. This defect could be easily rectified by bending the switch-supporting bracket.

89. Photographs of the receiver and power pack are shown in plates 15 to 19 inclusive. Plate 14 shows a front view of the receiver in its case. Plate 15 shows a top view of the receiver removed from the case. Plate 16 shows a top view with covers removed from individual units. Plate 17 shows a bottom view with the cover removed. Plate 18 shows a view of the power pack.

90. Summary of Defects.

(a) Par. 11. The receiver exceeds the size limitation in depth by 1/16 inch.

(b) Par. 13. The receiver exceeds the weight limitation by five pounds excluding the mounting feet, and by eighteen pounds when the feet are included.

(c) Par. 14. No provision is made to protect delicate parts from strains due to shock or vibration.

(d) Par. 18. All fixtures are not of non-ferrous materials.

(e) Par. 35. The terminal board is not conveniently accessible for connecting the cables with the amplifier partially withdrawn from the case.

(f) Par. 45. Resonance occurs at a different frequency for "broad i.f." from that at "sharp i.f.".

(g) Par. 57 and 58. The sensitivity on input tap "C" fails to meet the requirements on both cw and mcw.

(h) Par. 60 and 61. The selectivity in both the "sharp" and the "broad" conditions fails to meet the requirements of the specification.

(i) Par. 62. The primary image response is greater than allowed in the specification.

(j) Par. 63. The direct i-f response is greater than specified.

(k) Par. 68. The change in overall gain of the receiver when switching between "sharp" and "broad" i.f. exceeds the specified tolerance.

(l) Par. 69. The cw selectivity in the "broad" condition as indicated on plate 9 does not have as flat a nose as specified.

CONCLUSIONS

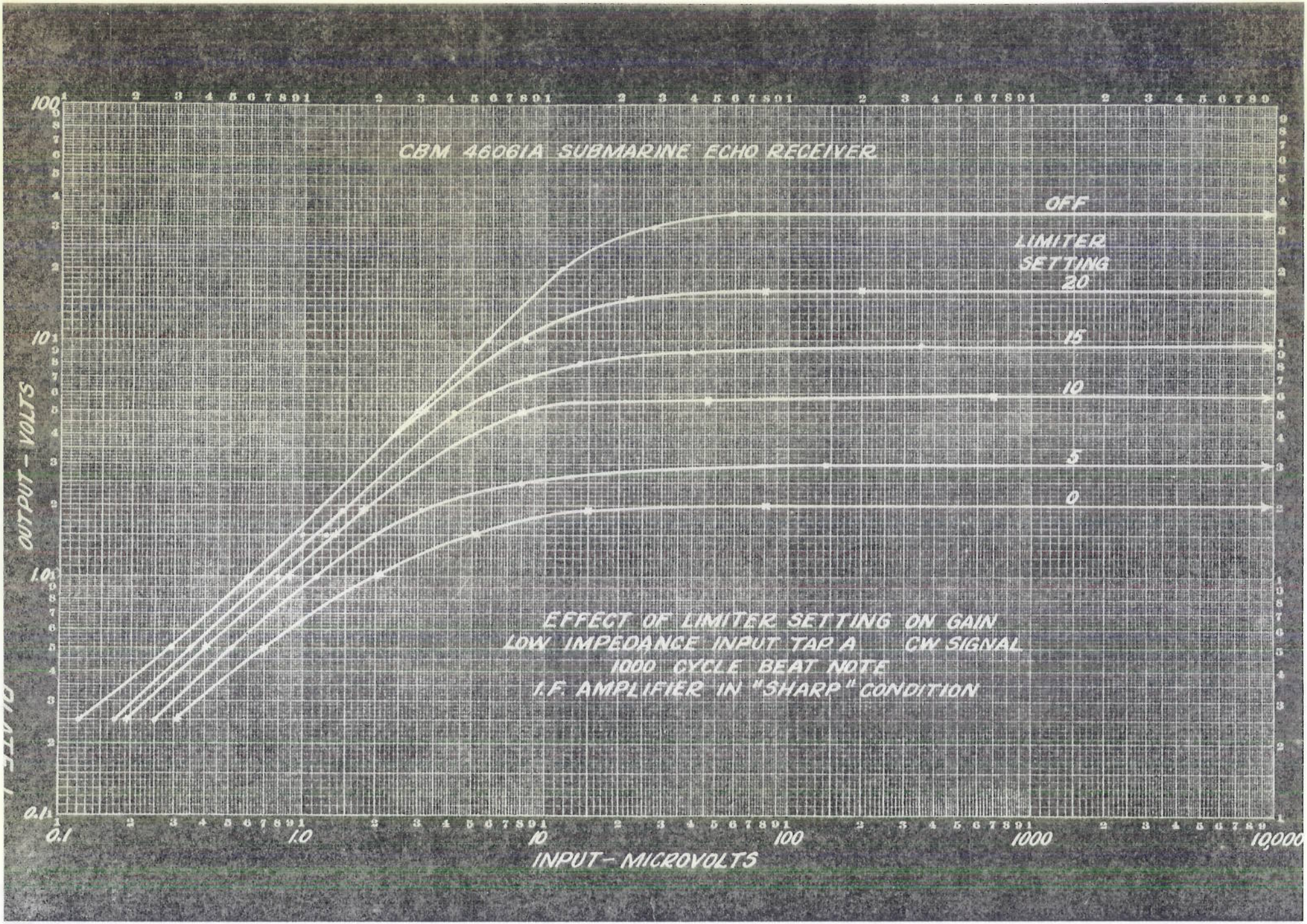
91. The Model CBM-46061A amplifier embodies unusual ruggedness; its wiring, including soldering, is exceptionally neat and the general arrangement of parts, though very compact, permits good accessibility to the various parts which may need adjustment or replacement.

92. The materials employed are generally of excellent quality with a view toward ruggedness and permanence of electrical characteristics. The wire between component parts has a rubber and woven fabric covering which has been treated in such a manner as to maintain good insulating properties under service conditions. Considerable magnetic material has been employed in brackets and supporting members, the anti-corrosive properties of which are not known.

93. The wiring is color coded and is brought to terminals having good insulation properties with unusually good spacing to reduce the possibility of leakage. All terminals, as well as component parts, including tube sockets, are marked legibly and permanently for reference to wiring diagrams.

94. The panel controls are symmetrically arranged and permit ease of operation with excellent control of performance. Toggle switches have been employed in three low voltage, low current circuits, which, if like similar switches previously used, may develop contact trouble.

95. The electrical performance, although generally good from the practical standpoint, fails to wholly meet the specifications for sensitivity, selectivity, image response and image frequency exclusion.


CBM 46061A SUBMARINE ECHO RECEIVER
OFF
LIMITER SETTING
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15
10
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EFFECT OF LIMITER SETTING ON GAIN
LOW IMPEDANCE INPUT TAP A C.W. SIGNAL
1000 CYCLE BEAT NOTE
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INPUT - MICROVOLTS
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100
1000
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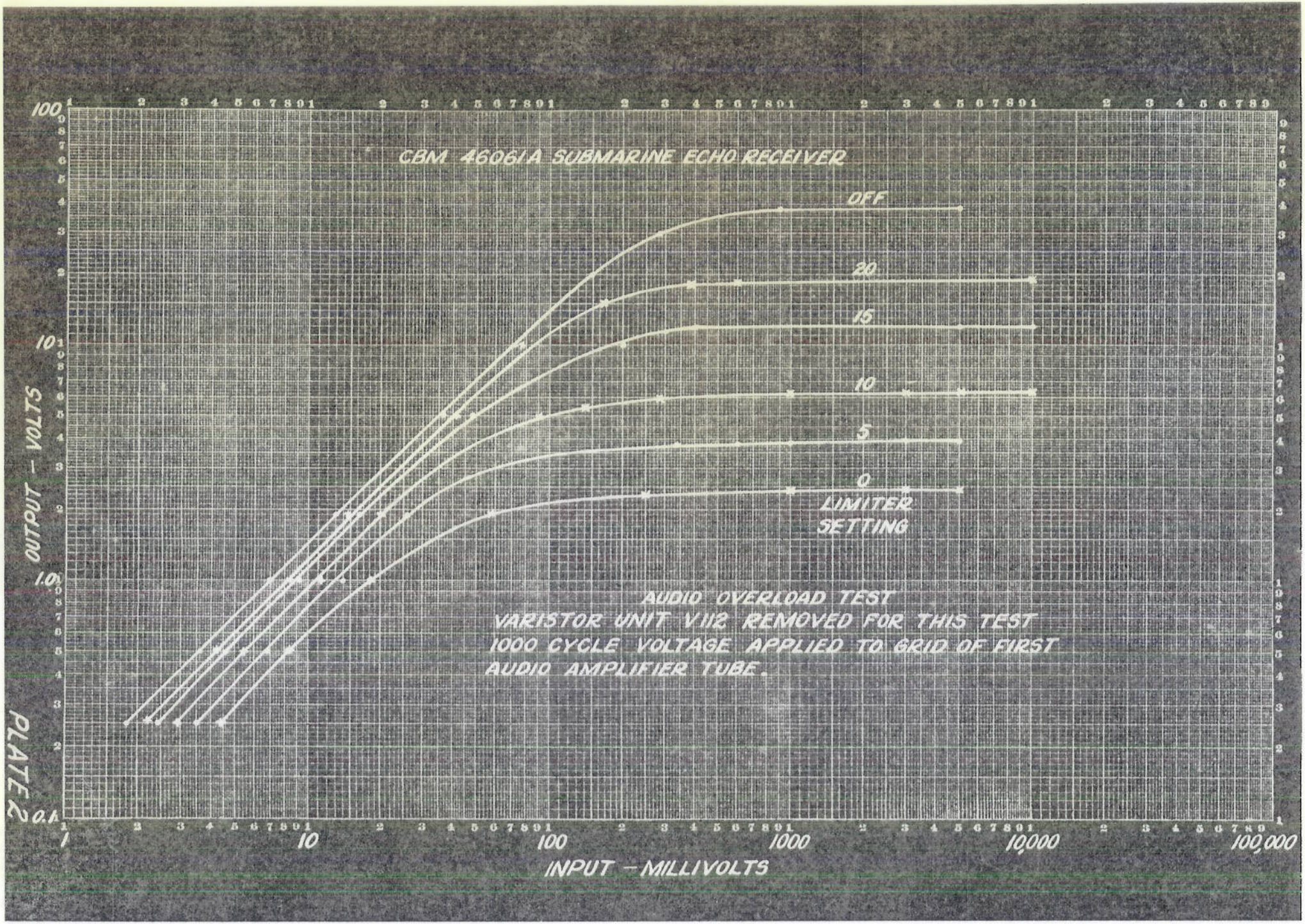
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OFF
20
15
10
5
0
LIMITER SETTING
AUDIO OVERLOAD TEST
VARISTOR UNIT V112 REMOVED FOR THIS TEST
1000 CYCLE VOLTAGE APPLIED TO GRID OF FIRST AUDIO AMPLIFIER TUBE.
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INPUT - MILLIVOLTS
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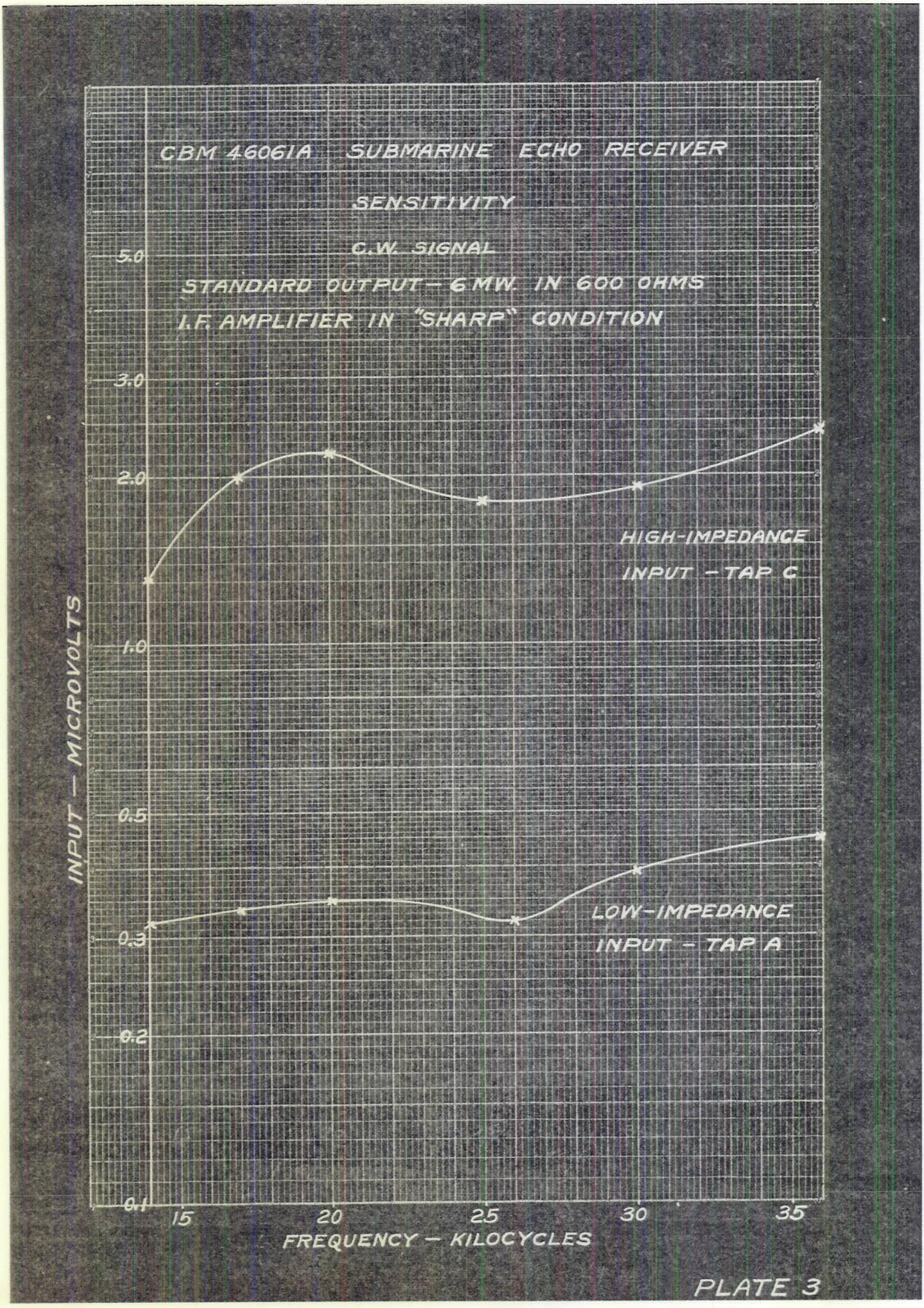
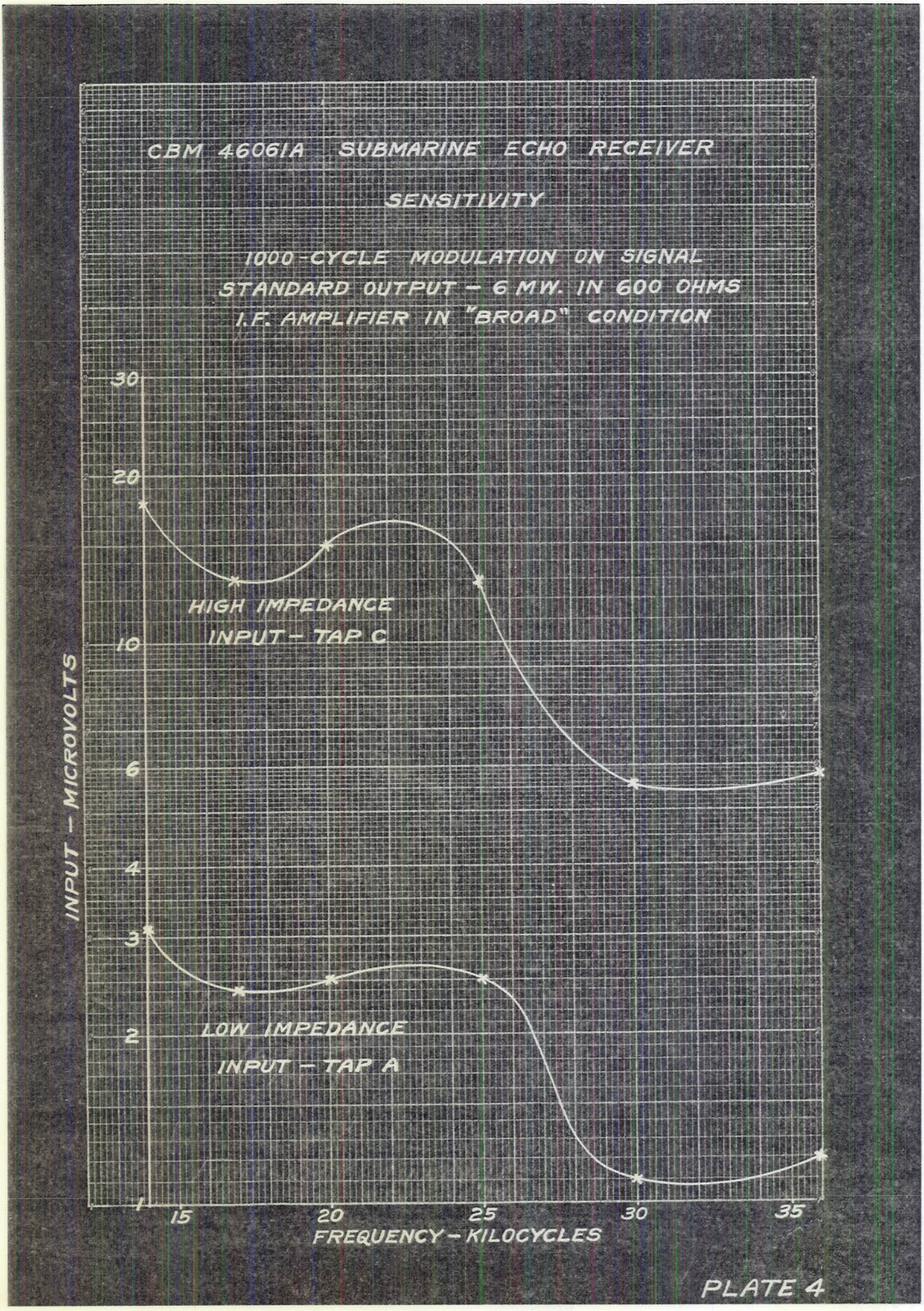
100
1000
10,000
100,000

PLATE 2

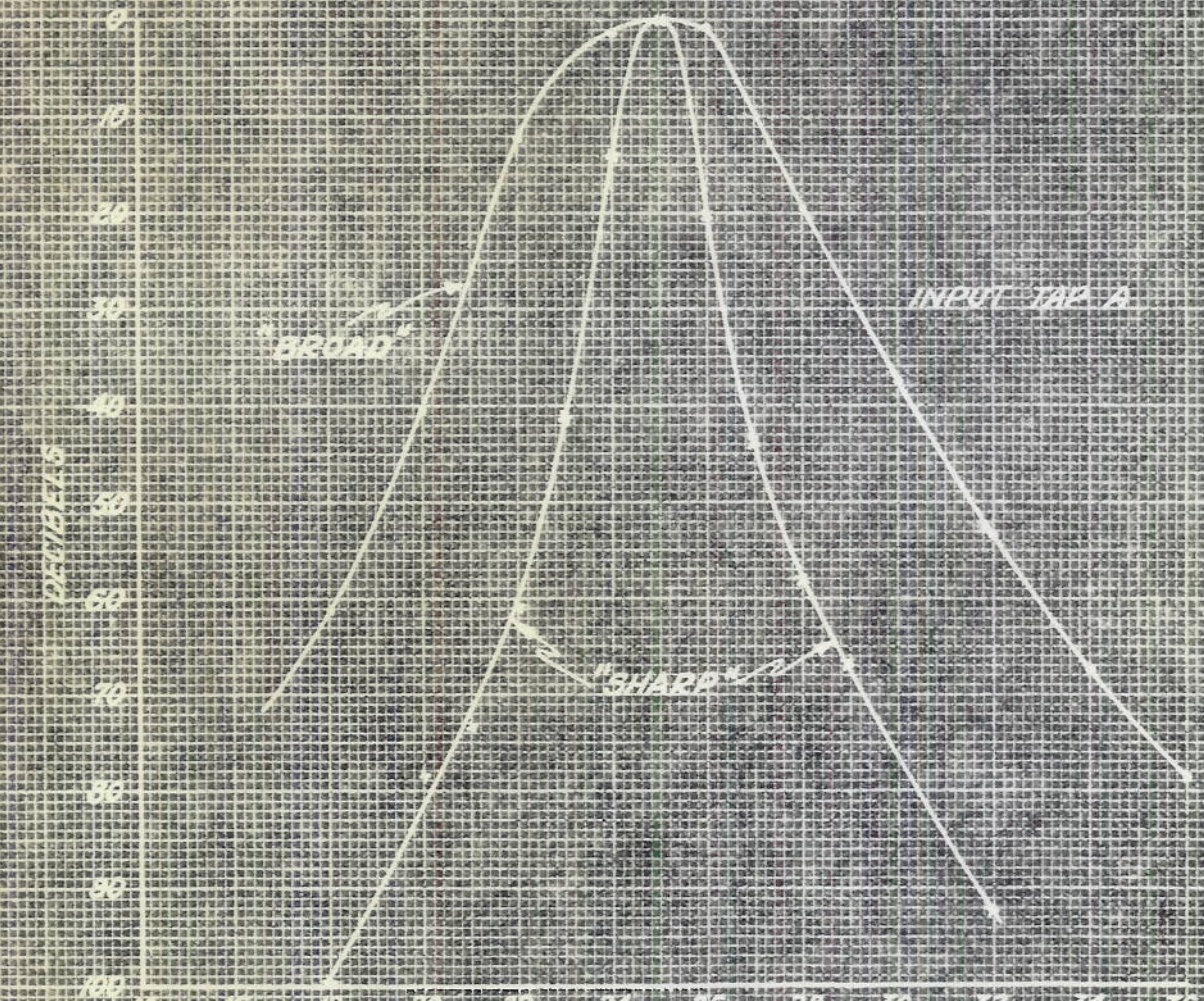

CBM 46061A SUBMARINE ECHO RECEIVER
SENSITIVITY
C.W. SIGNAL
STANDARD OUTPUT – 6 MW. IN 600 OHMS
I.F. AMPLIFIER IN "SHARP" CONDITION
5.0
3.0
2.0
1.0
0.5
0.3
0.2
0.1
INPUT – MICROVOLTS
HIGH-IMPEDANCE
INPUT – TAP C
LOW-IMPEDANCE
INPUT – TAP A
15
20
25
30
35
FREQUENCY – KILOCYCLES
PLATE 3


CBM 4606IA SUBMARINE ECHO RECEIVER
SENSITIVITY
1000-CYCLE MODULATION ON SIGNAL
STANDARD OUTPUT – 6 MW. IN 600 OHMS
I.F. AMPLIFIER IN "BROAD" CONDITION
INPUT – MICROVOLTS
30
20
10
6
4
3
2
1
HIGH IMPEDANCE
INPUT – TAP C
LOW IMPEDANCE
INPUT – TAP A
15
20
25
30
35
FREQUENCY – KILOCYCLES
PLATE 4

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

DATE

CRM-46467A SUBMARINE BAND RECEIVER
SELECTIVITY
IF AMPLIFIER IN "BROAD" OR "SHARP" CONDITION
STANDARD OUTPUT = 6MW IN 600 OHMS
LOW IMPEDANCE INPUT TAP WITH 300 OHM SERIES RESISTOR
RECEIVER TUNED TO RESONANCE FOR EACH CURVE



SHEET

PLATE 5

BELLEVUE, D. C.

DATE

CBM 46014 SUBMARINE ECHO RECEIVER

SELECTIVITY

I.F. AMPLIFIER IN "BROAD" OR "SHARP" CONDITION

STANDARD OUTPUT = 6MW IN 600 OHMS

HIGH IMPEDANCE INPUT TAP WITH 3000 OHM SERIES RESISTOR

RECEIVER TUNED TO RESONANCE FOR EACH CURVE

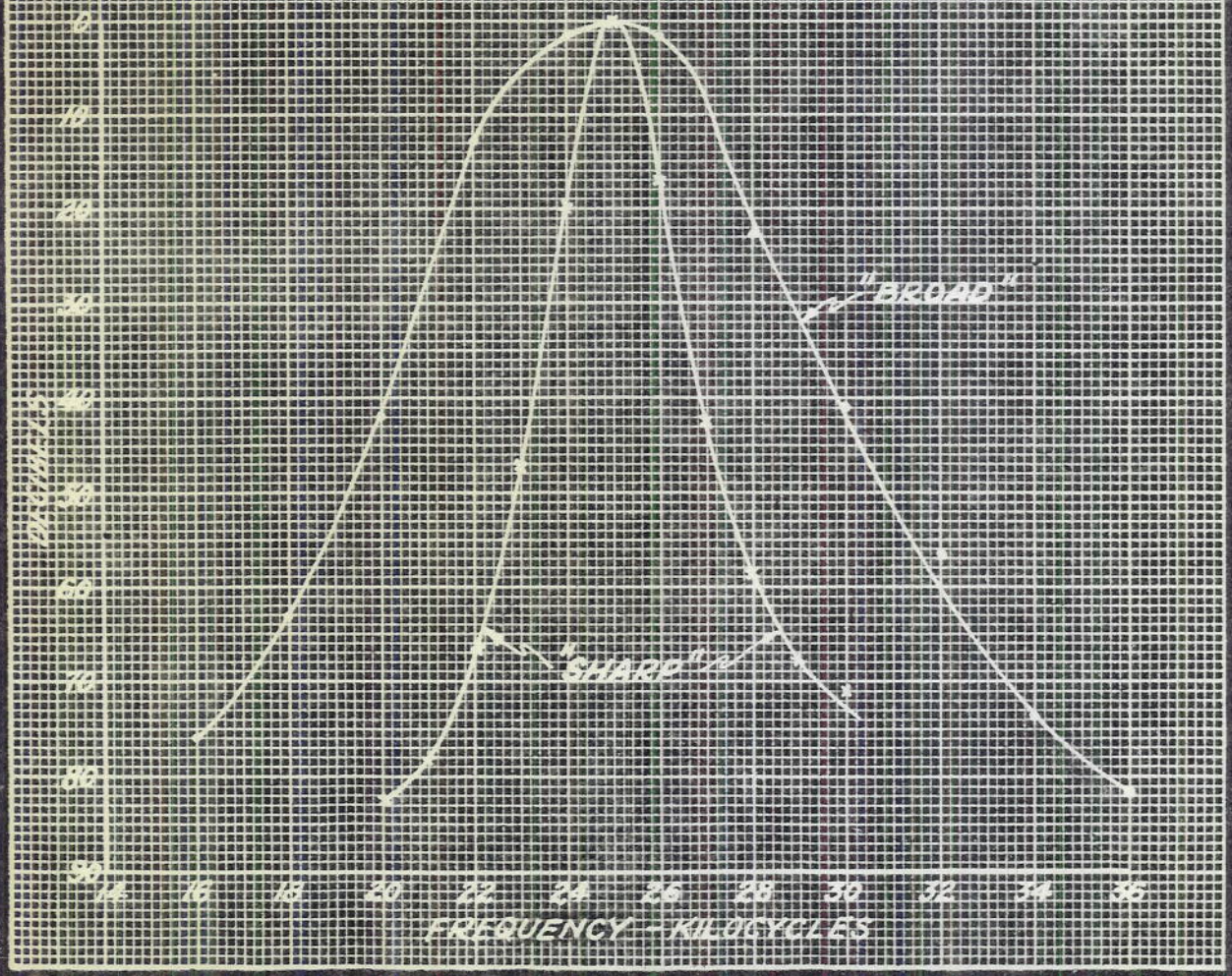
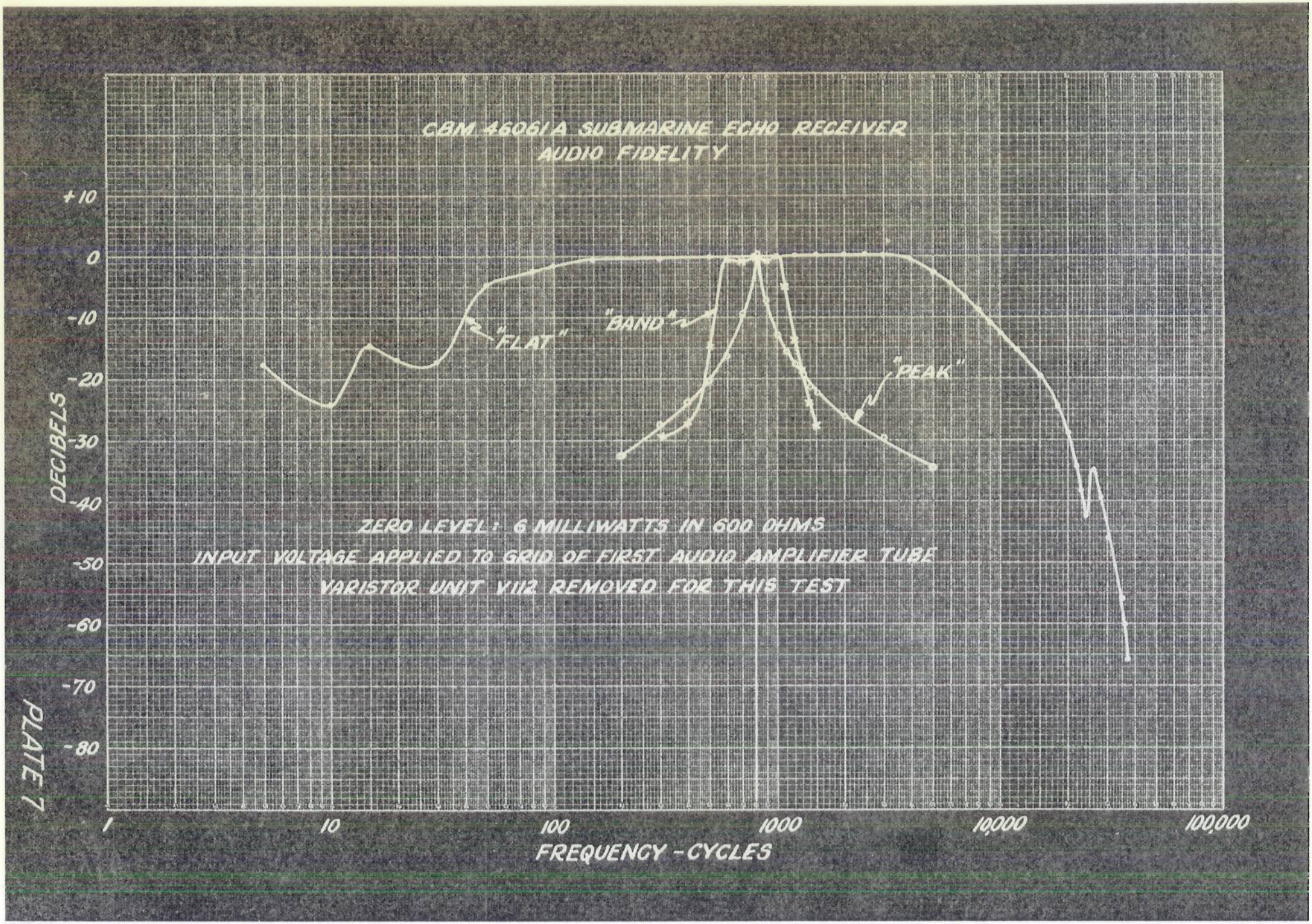


PLATE 6


CBM 46061A SUBMARINE ECHO RECEIVER
AUDIO FIDELITY
+10
0
-10
-20
-30
-40
-50
-60
-70
-80
DECIBELS
"FLAT"
"BAND"
"PEAK"
ZERO LEVEL: 6 MILLIWATTS IN 600 OHMS
INPUT VOLTAGE APPLIED TO GRID OF FIRST AUDIO AMPLIFIER TUBE
VARISTOR UNIT V112 REMOVED FOR THIS TEST
1
10
100
1000
10,000
100,000
FREQUENCY - CYCLES
PLATE 7

BELLEVUE, D. C.

DATE

CBM 46006A SUBMARINE ECHO RECEIVER
SELECTIVITY
RADIO FREQUENCY AND INTERMEDIATE FREQUENCY STAGES
I.F. AMPLIFIER IN "BROAD" OR "SHARP" CONDITION.
C.W. SIGNAL
LOW IMPEDANCE INPUT AT TAP A
OUTPUT = 0.8 VOLT AT PLATE OF LAST INTERMEDIATE
FREQUENCY TUBE.

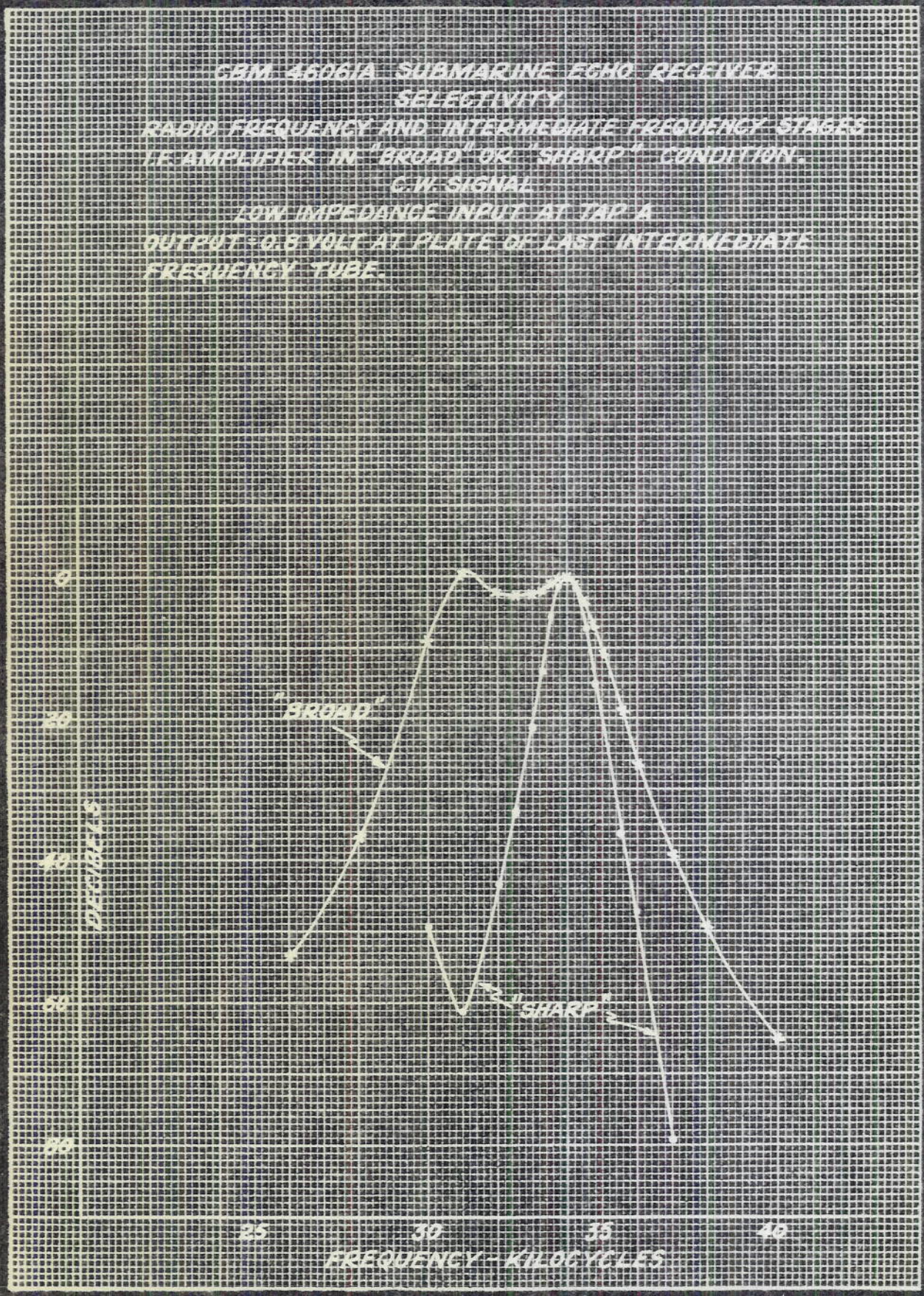


PLATE 8

BELLEVUE, D. C.

DATE

CBM 460G1A SUBMARINE ECHO RECEIVER

SELECTIVITY

RADIO FREQUENCY AND INTERMEDIATE FREQUENCY STAGES ONLY

I.F. AMPLIFIER IN "BROAD" OR "SHARP" CONDITION.

C.W. SIGNAL

LOW IMPEDANCE INPUT AT TAP A

OUTPUT-0.8 VOLT AT PLATE OF LAST INTERMEDIATE FREQUENCY TUBE.

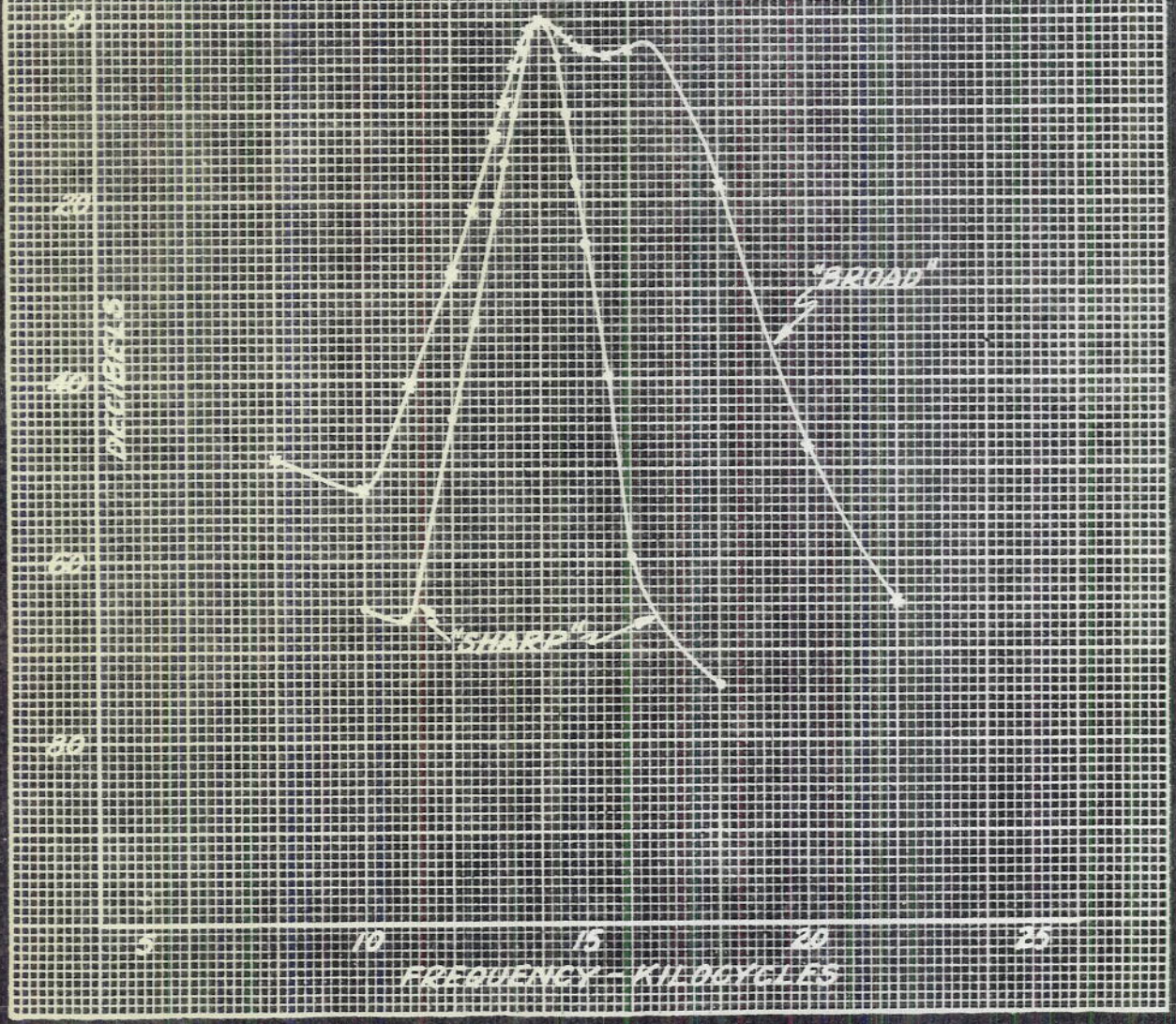


PLATE 9

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

DATE

CBM 46094 SUBMARINE ECHO RECEIVER
TWO SIGNAL SELECTIVITY
TWO SIGNAL GENERATORS:
#1 SET TO GIVE STANDARD OUTPUT OF 0 MW IN 500 OHMS AT 28 KC RESONANT POINT
#2 SET TO FREQUENCY GIVEN BY ABSCISSA AT VOLTAGE NECESSARY TO MAINTAIN OUTPUT OF 6 DECIBELS ABOVE STANDARD

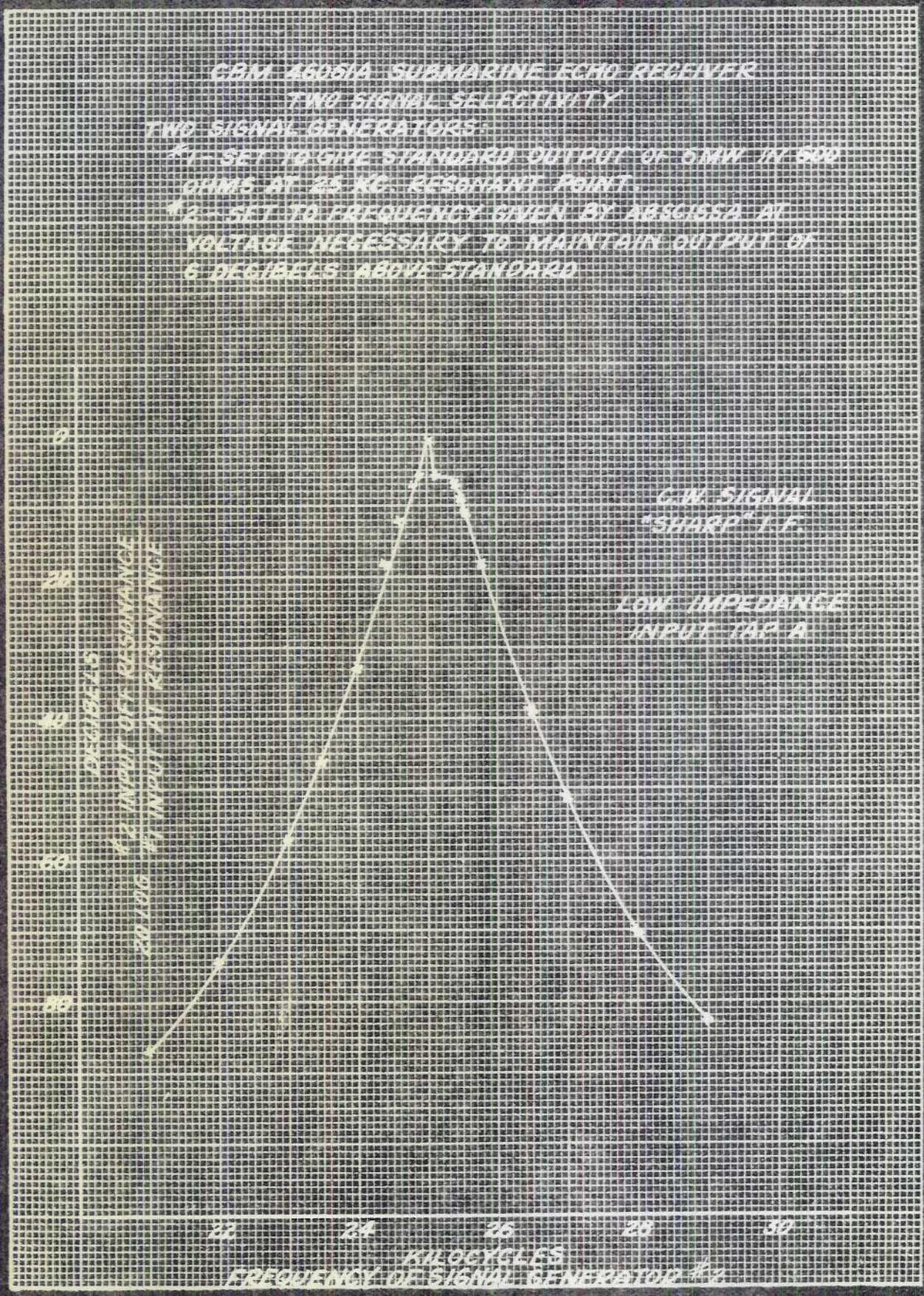


PLATE 10

BELLEVUE, D. C.

DATE

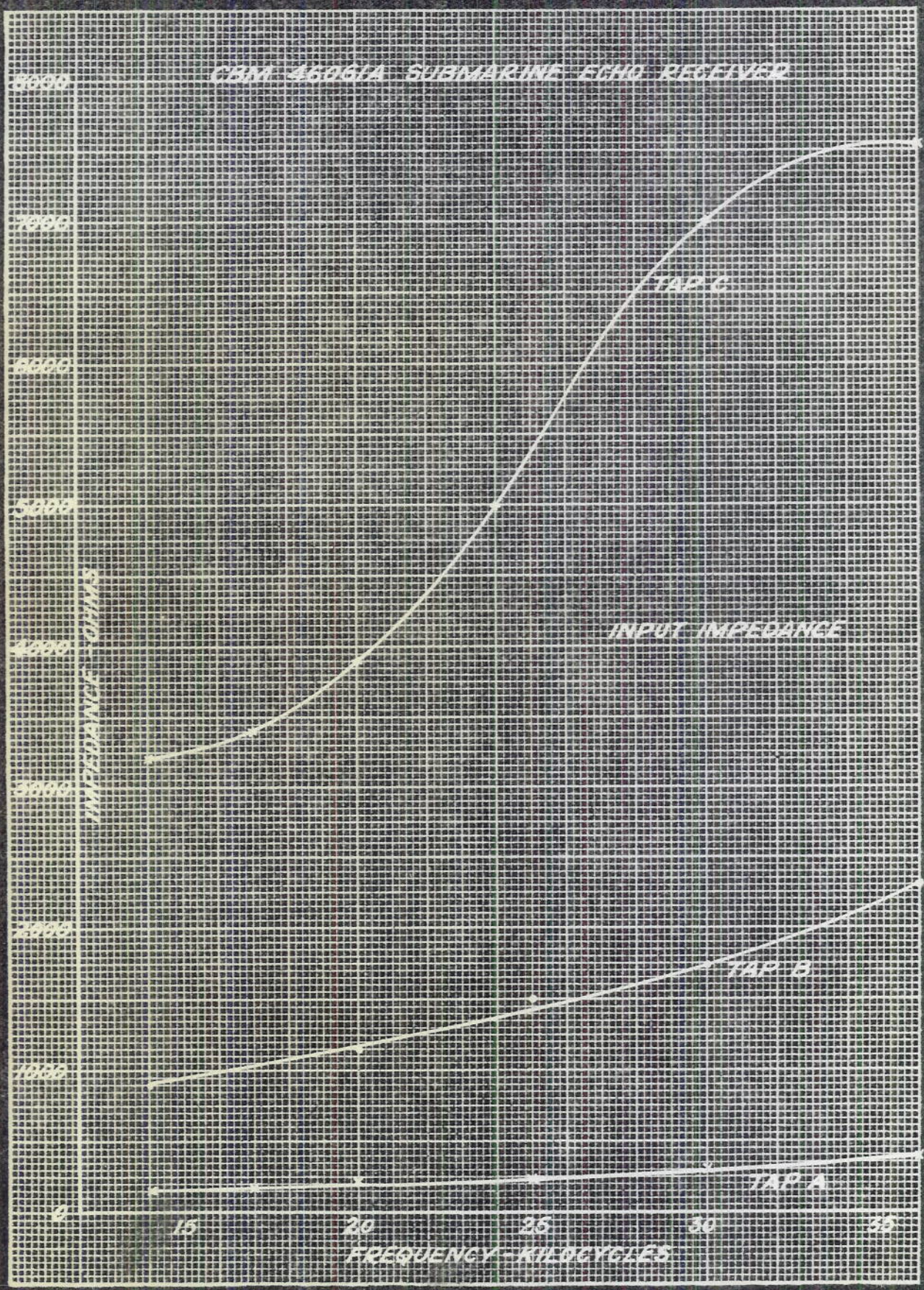
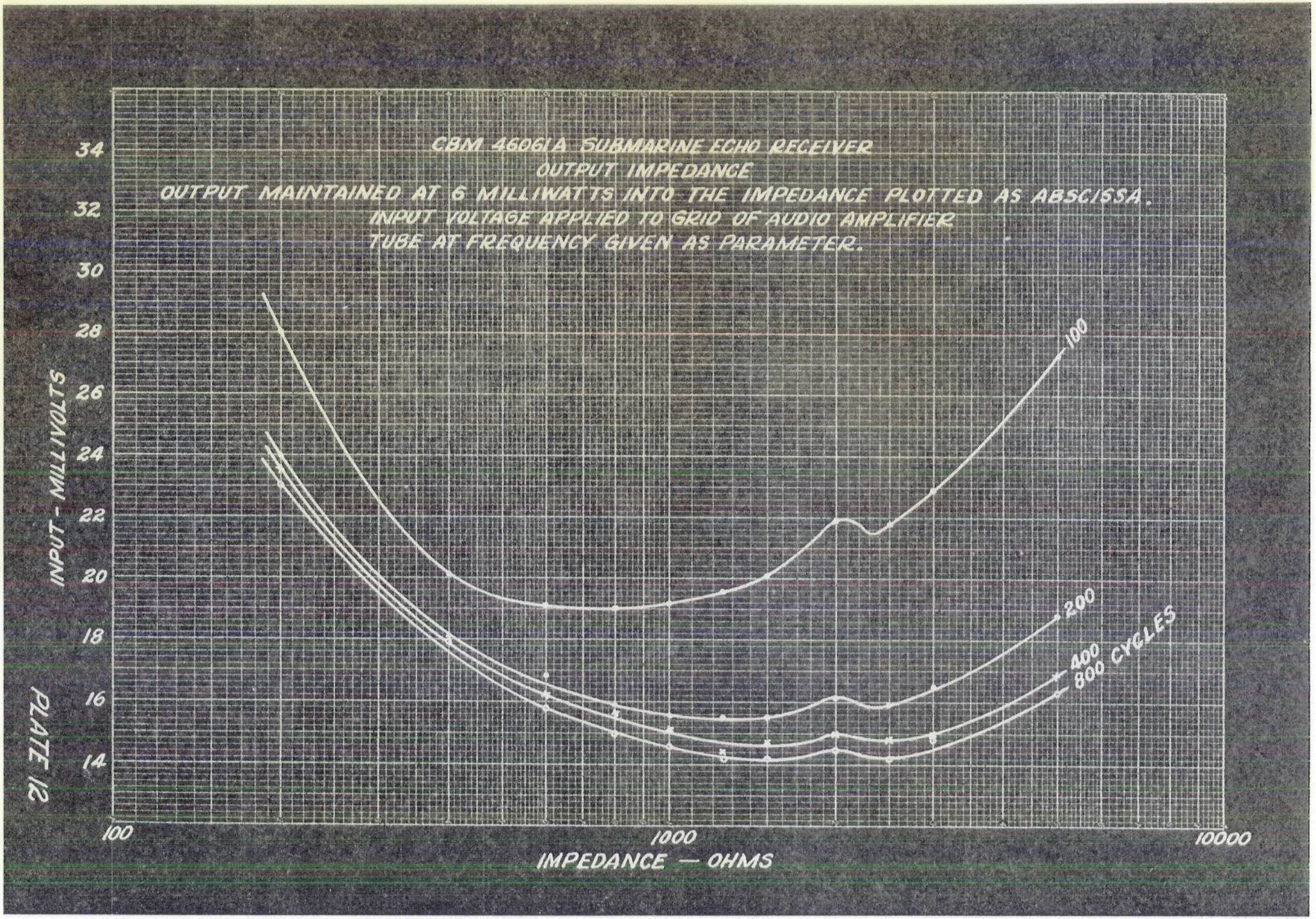
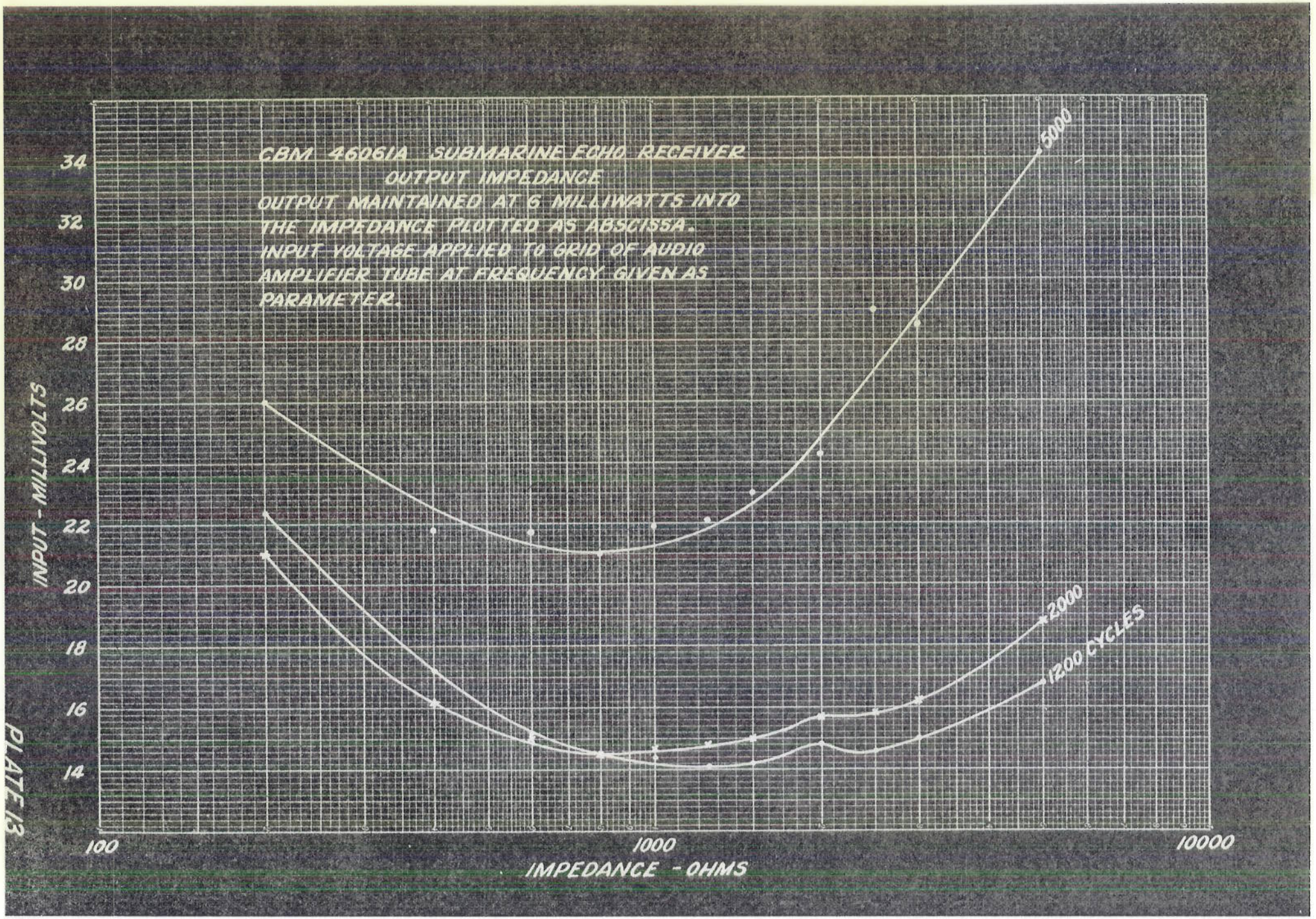


PLATE II


CBM 4606 A SUBMARINE ECHO RECEIVER
OUTPUT IMPEDANCE
OUTPUT MAINTAINED AT 6 MILLIWATTS INTO THE IMPEDANCE PLOTTED AS ABSCISSA.
INPUT VOLTAGE APPLIED TO GRID OF AUDIO AMPLIFIER
TUBE AT FREQUENCY GIVEN AS PARAMETER.
INPUT - MILLIVOLTS
34
32
30
28
26
24
22
20
18
16
14
100
200
400
800 CYCLES
100
1000
10000
IMPEDANCE — OHMS
PLATE 12


CBM 46061A SUBMARINE ECHO RECEIVER
OUTPUT IMPEDANCE
OUTPUT MAINTAINED AT 6 MILLIWATTS INTO THE IMPEDANCE PLOTTED AS ABSCISSA.
INPUT VOLTAGE APPLIED TO GRID OF AUDIO AMPLIFIER TUBE AT FREQUENCY GIVEN AS PARAMETER.
INPUT - MILLIVOLTS
34
32
30
28
26
24
22
20
18
16
14
100
1000
10000
IMPEDANCE - OHMS
5000
2000
1200 CYCLES
PLATE 13

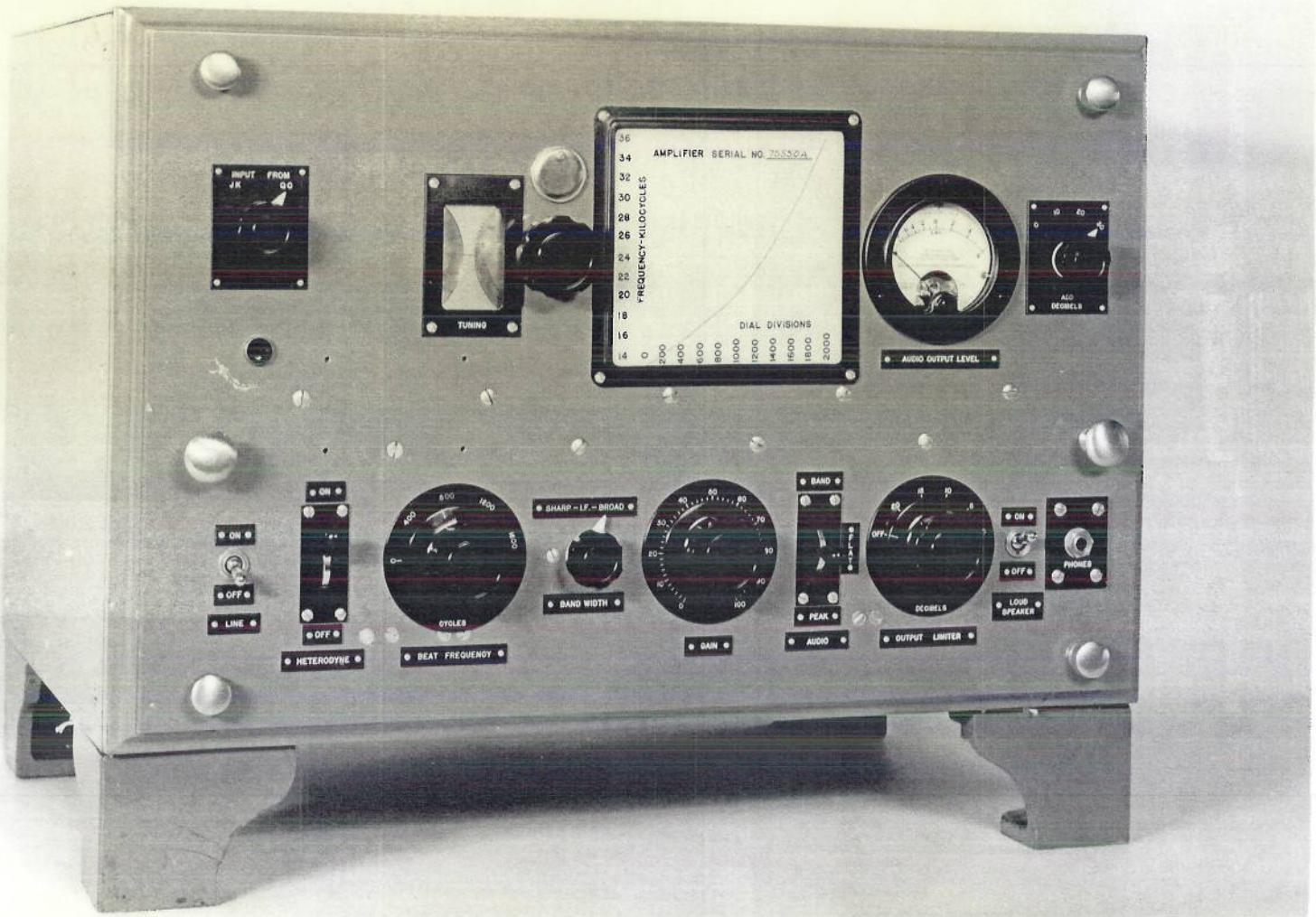

AMPLIFIER SERIAL NO. 7655OA
FREQUENCY-KILOCYCLES
DIAL DIVISIONS
INPUT FROM
JK
GO
TUNING
AUDIO OUTPUT LEVEL
AGC
DECIBELS
ON
OFF
LINE
METERODYNE
BEAT FREQUENCY
CYCLES
SHARP - I.F. - BROAD
BAND WIDTH
GAIN
BAND
PEAK
AUDIO
DECIBELS
OUTPUT LIMITER
LOUD SPEAKER
PHONES

Plate 14

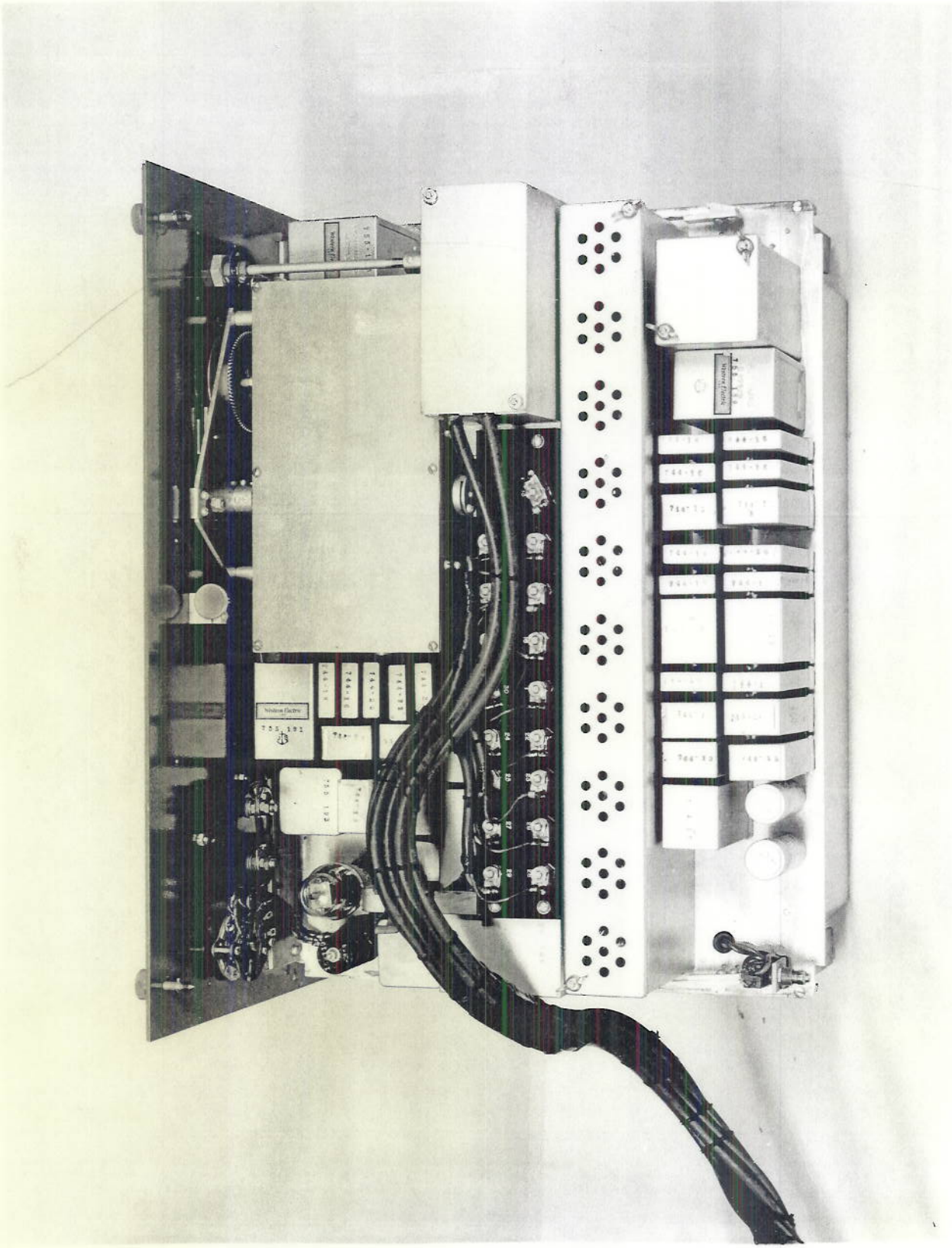


Plate 15

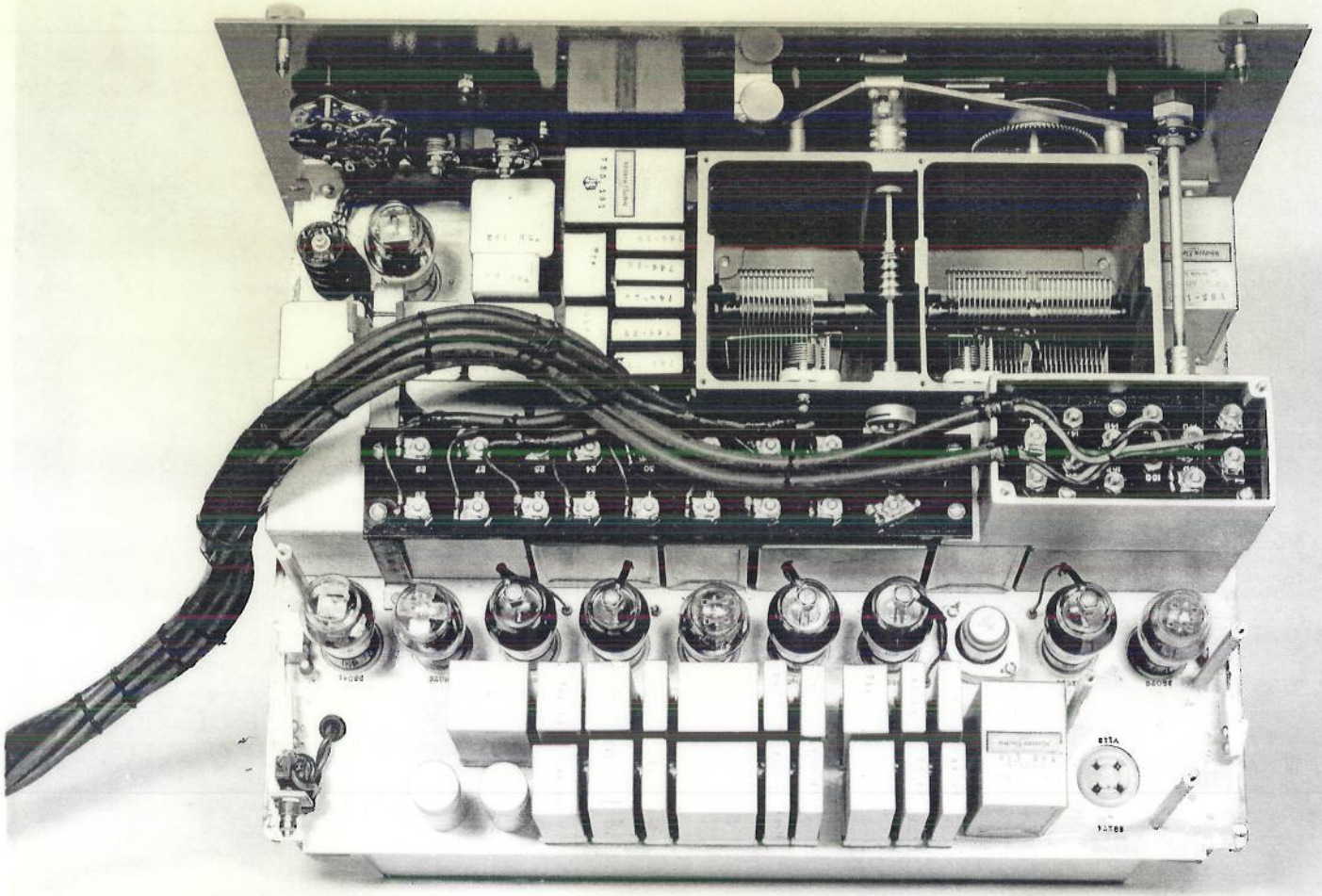


Plate 10

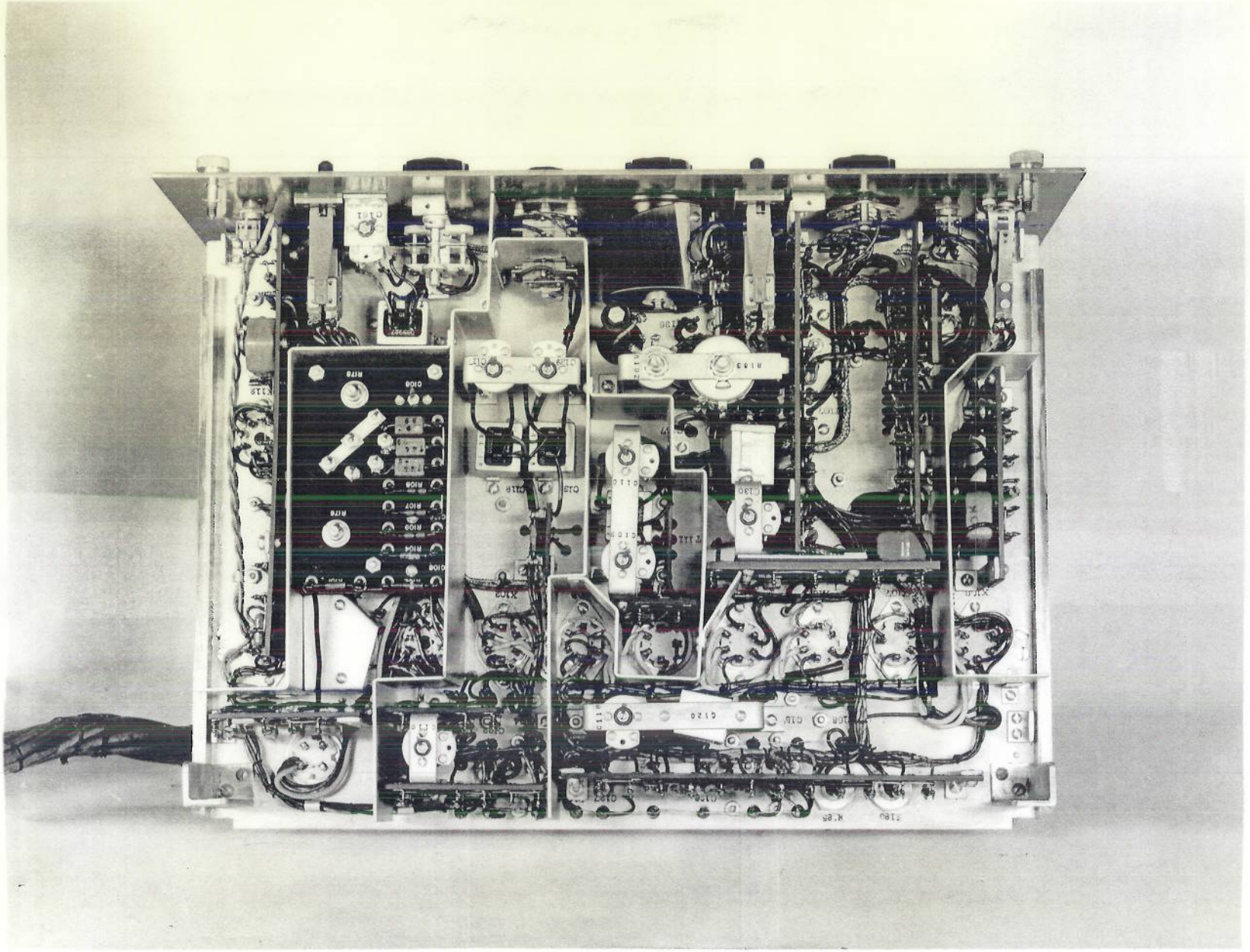


Plate 17

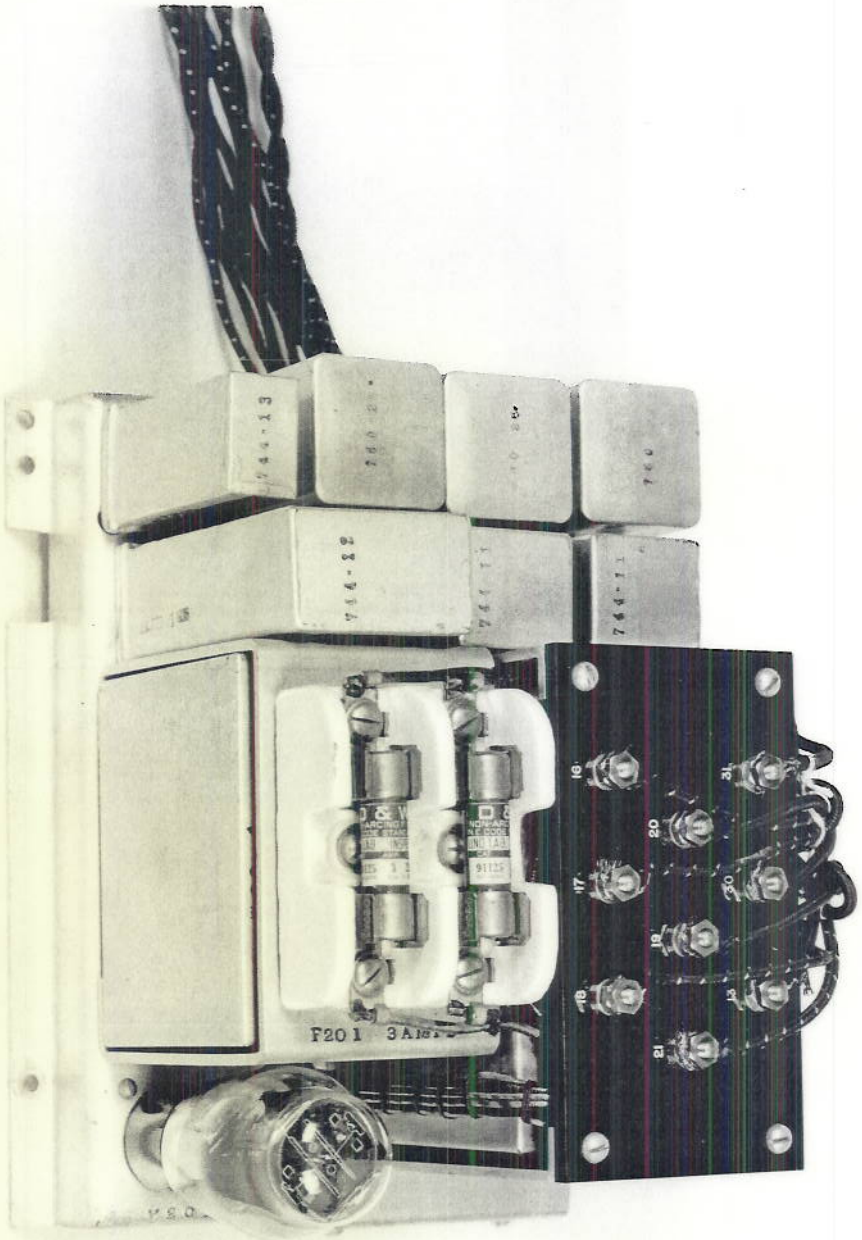


Plate 15