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SUBJECT

An Amplifier Standardizing Aircraft Interphone Equipment

by

P. R. G. Verbeke

NAVAL RESEARCH LABORATORY

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Report on

<u>An Amplifier Standardizing Aircraft Interphone Equipment</u>

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Prepared by: P. R. G. Verbeke
P. R. G. Verbeke, Contract Employe

Submitted by: C. H. Fraser
C. H. Fraser, Head of Special Development Section

Reviewed by: A. Hoyt Taylor
A. Hoyt Taylor, Supt, Radio Division

Approved by: A. H. VanKeuren
A. H. VanKeuren, Rear Admiral, USN
Director

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AN AMPLIFIER STANDARDIZING AIRCRAFT INTERPHONE EQUIPMENT

1. Abstract

1.1 The amplifier described in this report was designed for interphone communication on all types of aircraft having from two to thirty-two stations. It was developed to replace models RL5, RL7, RL9, and RL24C, standardizing interphone equipment on all planes.

1.2 Sufficient power is available to supply one hundred twenty-five milliwatts per headphone for thirty-two stations at low altitude, or two hundred fifty milliwatts per headphone for sixteen stations at altitudes above twenty thousand feet. Provision for a maximum of thirty-two stations is more than ample for all existing planes and allows for future increases in installations. An automatic load compensating arrangement is featured along with flexibility in adaptation to large or small planes.

2. Introduction

2.1 The design of this interphone amplifier was undertaken to fill the need for standardization and interchangeability of aircraft intercommunication equipment, particularly on all carrier based planes. The following specifications were established when the project was assigned:

(a) The plate voltage is to be supplied by an integral twenty-eight volt dynamotor furnishing 250 volts d.c. at 60 milliamperes.

(b) Provision is to be made for current for a 200 ohm carbon microphone.

(c) A high impedance radio input controlled externally by a relay is to be provided to alternate with the 200 ohm input.

(d) The audio frequency range is to be plus or minus 3 db from 350 to 3500 cycles. Frequencies above 3500 cycles must be limited by suitable filters so that the output at 5000 cycles is 25 db down.

(e) The ambient noise level should not be greater than 40 db below one watt.

(f) Degenerative feedback should be incorporated to compensate for the impedance mismatch of the output load due to changes in the number of headphones in use.

(g) Standard values of parts are to be used wherever possible.

2.2 The large number of types of interphone amplifiers in use at present requires excessive numbers of spare parts to be carried on hand for repairs. Standardizing on one amplifier would achieve maximum economy in maintenance, and maximum flexibility and simplicity in all installations.

3. Results of Preliminary Circuit

3.1 A preliminary model of the amplifier was constructed, based on a two stage circuit supplied by the Bureau of Aeronautics. Tests of this model which employed a type 6SJ7 and a type 6V6 tube, indicated that the 6SJ7 received too much voltage from the microphone, and yet failed to drive the 6V6 to its rated output. The microphone input filter did not give sufficient high frequency cut-off, and used non-standard capacitor values.

4. Redesign of Microphone Input

4.1 The microphone filter circuit was modified to provide a greater attenuation of frequencies above 3500 cycles, and to incorporate standard condenser values. This modified filter circuit has proven very effective in eliminating undesirable high frequencies, and in maintaining flat response in the operating range as shown by the curve on Plate 6. These characteristics make it desirable for any voice communication circuit, and it may be desirable to incorporate the design in future radio transmitters.

4.2 The production model of the amplifier will incorporate an automatic gain control in the microphone input circuit, which will be controlled by barometric pressure. This device, represented by the tap switch at the 200 ohm microphone input on Plate 1, compensates for the reduction of sound conductivity in air at high altitudes. A semi-adjustable gain control is provided to allow occasional changes in volume level.

5. Modifications and General Features

5.1 The amplifier circuit was redesigned to use a type 6SL7 twin triode and a type 6V6 in three stages. This combination supplied the desired gain and ample drive for the power stage. Plate and grid impedances were kept low in order to avoid stray pick-up, and to stabilize performance under supply voltage variations and tube replacements.

5.2 A degenerative feedback circuit was coupled from the plate of the output stage to the plate of the second stage to compensate for distortion caused by the variation in the number of headphones in use. Under the most severe conditions of mismatch, the distortion remains below fifteen per cent. With this arrangement, the power supplied each headphone is independent of the number of headphones in use.

5.3 Due to the value of bias used, the second stage will saturate if the input becomes too large, thus preventing overdrive of the output tube and subsequent overloading of the dynamotor. The high and low power switch is provided to limit the maximum output available for smaller installations. The production model will employ an easily accessible terminal board which will replace this switch by using jumpers to adapt both the input and output circuits to any installation, large or small. The performance data of the NRL model is presented in the Appendix.

5.4 The final circuit, which is to be employed in the production model is shown on Plate 1. Frequency response and distortion curves for high and low output connections are shown on Plates 2, 3, 4, and 5. The response of the low pass filter is represented by the curve on Plate 6. Plates 7, 8, 9, and 10 present various views of the NRL model.

6. Conclusions

6.1 Although this amplifier was conceived to standardize all similar equipment employed by carrier based aircraft. it was designed sufficiently flexible and powerful to standardize interphone equipment on all existing planes and with sufficient power reserve for any plane contemplated. This has been accomplished with but slight sacrifice in size and weight for the smaller installations and with no sacrifice in power consumption.

7. Appendix

Performance Data

Number of tubes: 2. - one 6SL7GT and one 6V6GT

Input impedance: 200 ohms and 10,000 ohms

Output impedance: high power output - 30 ohms
low power output - 150 ohms

Weight: 9 pounds with Dynamotor and vibration mounts

Power supply: 28 volts direct current:
1.6 amperes on high power output
1.4 amperes on low power output

High voltage load: 51 ma 250 volts on high power
32 ma 250 volts on low power

Dynamotor: 28 volts d.c. to 250 volts d.c. 60 ma

Rated high power output: 4 watts with 8 per cent distortion
Rated low power output: 1.75 watts with 8 per cent distortion
Maximum high power output: 6.8 watts with 27 per cent distortion

Maximum low power output: 4.5 watts with 23 per cent distortion

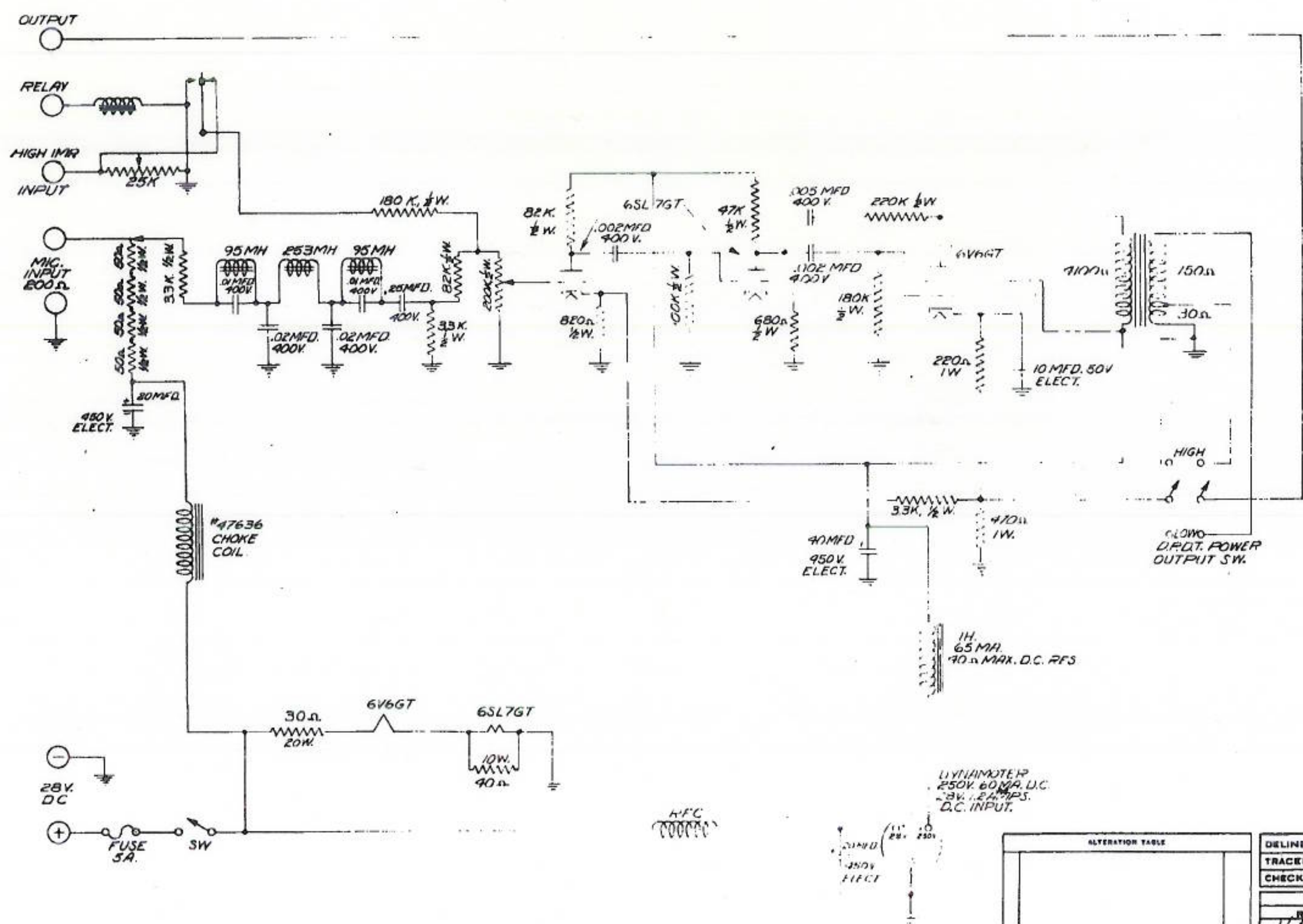
Rated output is obtained with .25 volt input signal with 6 db gain left in the gain control

Noise level: 56 db below 1 watt

Frequency range: plus or minus 1 db from 350 cps to 3500 cps; down 30 db at 5000 cps.

Microphone current: 40 ma at 28 volts

N. R. L. 65



ALTERATION TABLE

SYMBOLS AND THEIR EQUIV. TOLERANCES (UNLESS OTHERWISE NOTED)

SYMBOL 1	±.0005
SYMBOL 2	±.0010
SYMBOL 2½	±.0030
SYMBOL 3	±.0050
SYMBOL 3½	±.0100
SYMBOL 4	±.0250
SYMBOL 5	

DELINEATOR	H. T. SMITH	IN CHARGE OF RADIO DRAFTING	CHIEF DRAFTSMAN
TRACER		CRL	
CHECKER			

APPROVAL

RADIO ENGINEER	SUPT. OF RADIO DIVISION
H. O. [illegible]	

FOR DIRECTOR

COMDR. U. S. N.

BUREAU OF SHIPS	REFERENCE

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

INTERPHONE AMPLIFIER
SCHEMATIC

SCALE DATE

RA

PLATE

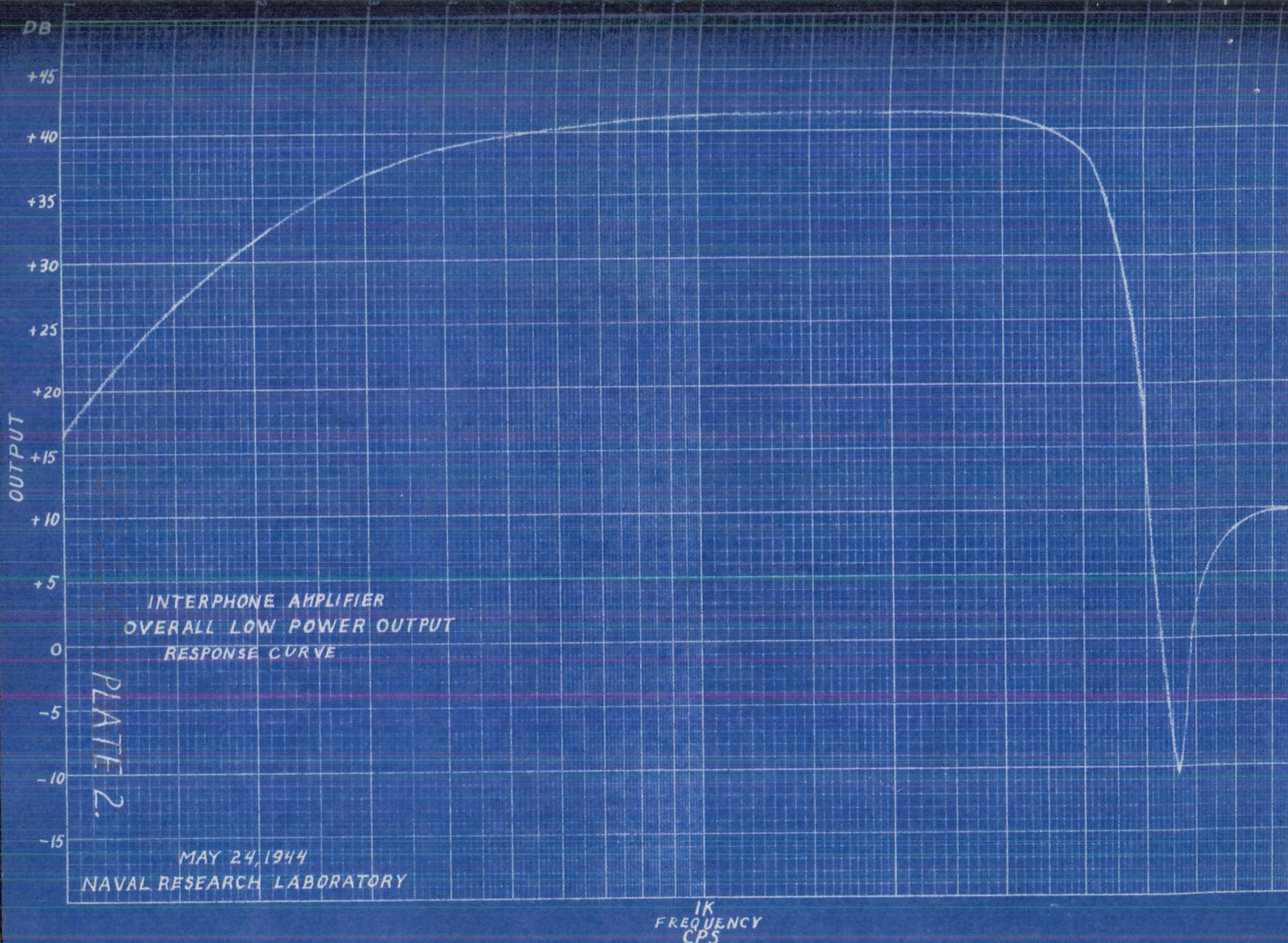
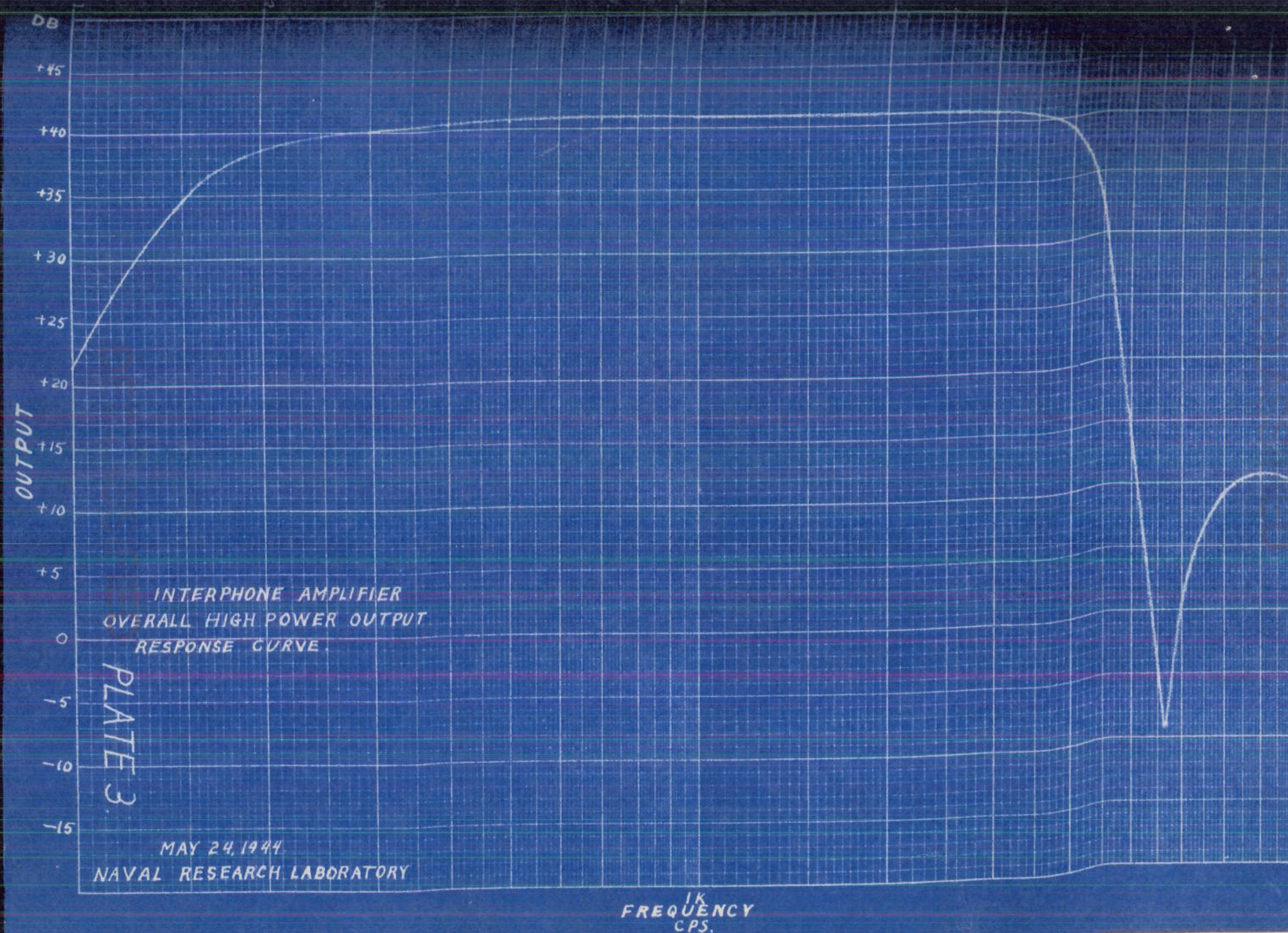
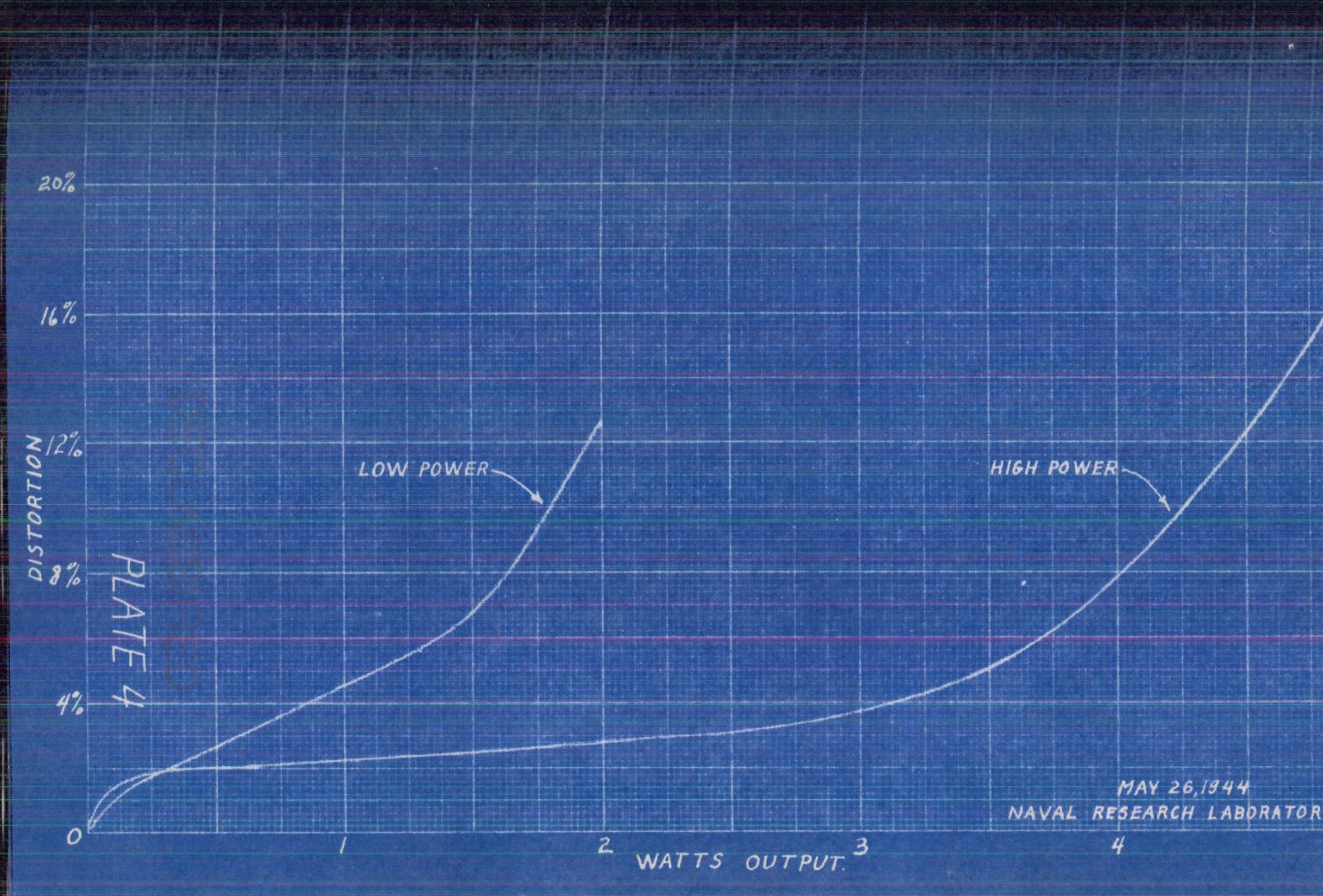
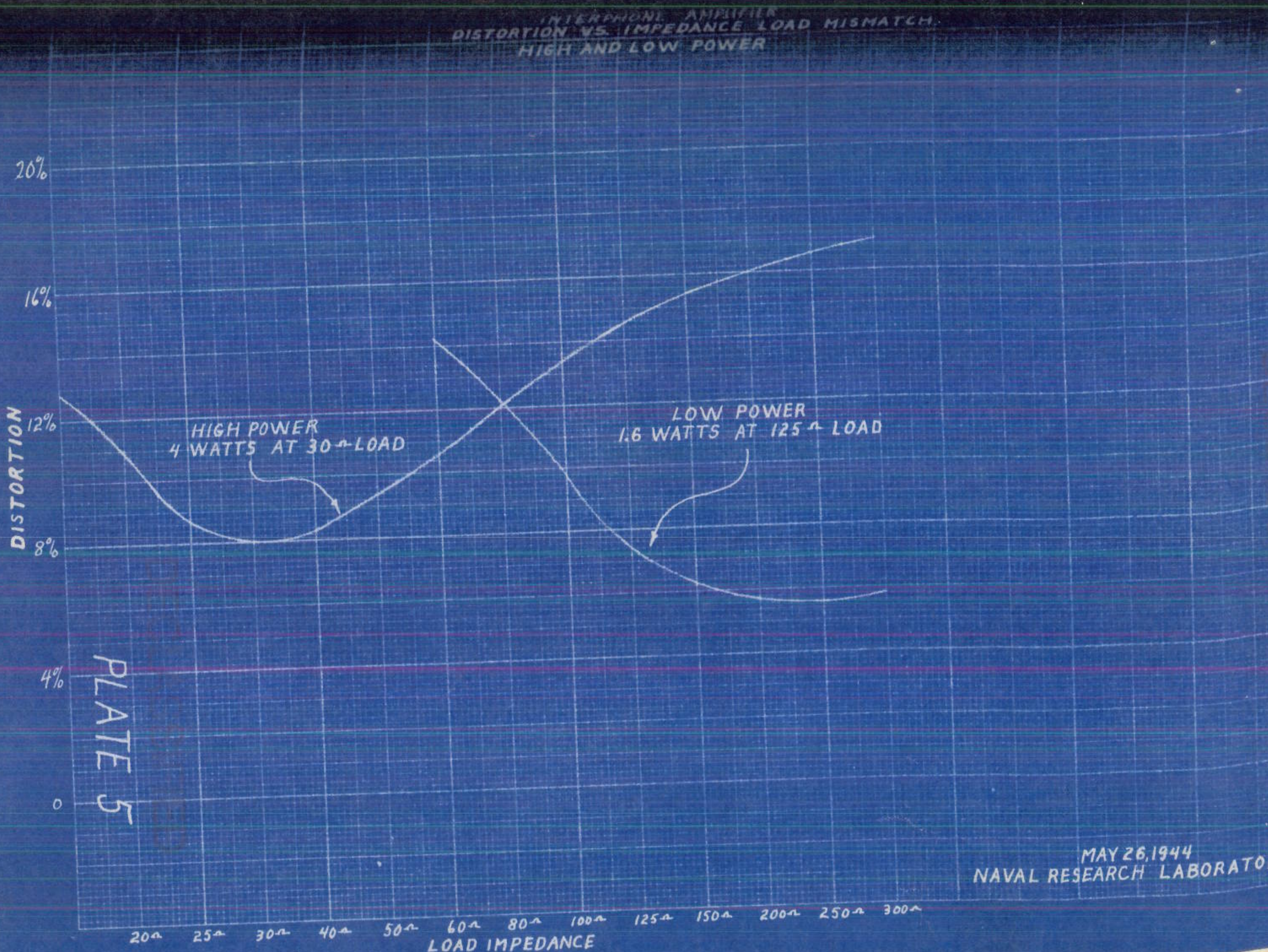

DB
+45
+40
+35
+30
+25
+20
+15
+10
+5
0
-5
-10
-15
OUTPUT
INTERPHONE AMPLIFIER
OVERALL LOW POWER OUTPUT
RESPONSE CURVE
MAY 24, 1944
NAVAL RESEARCH LABORATORY
1K
FREQUENCY
CPS

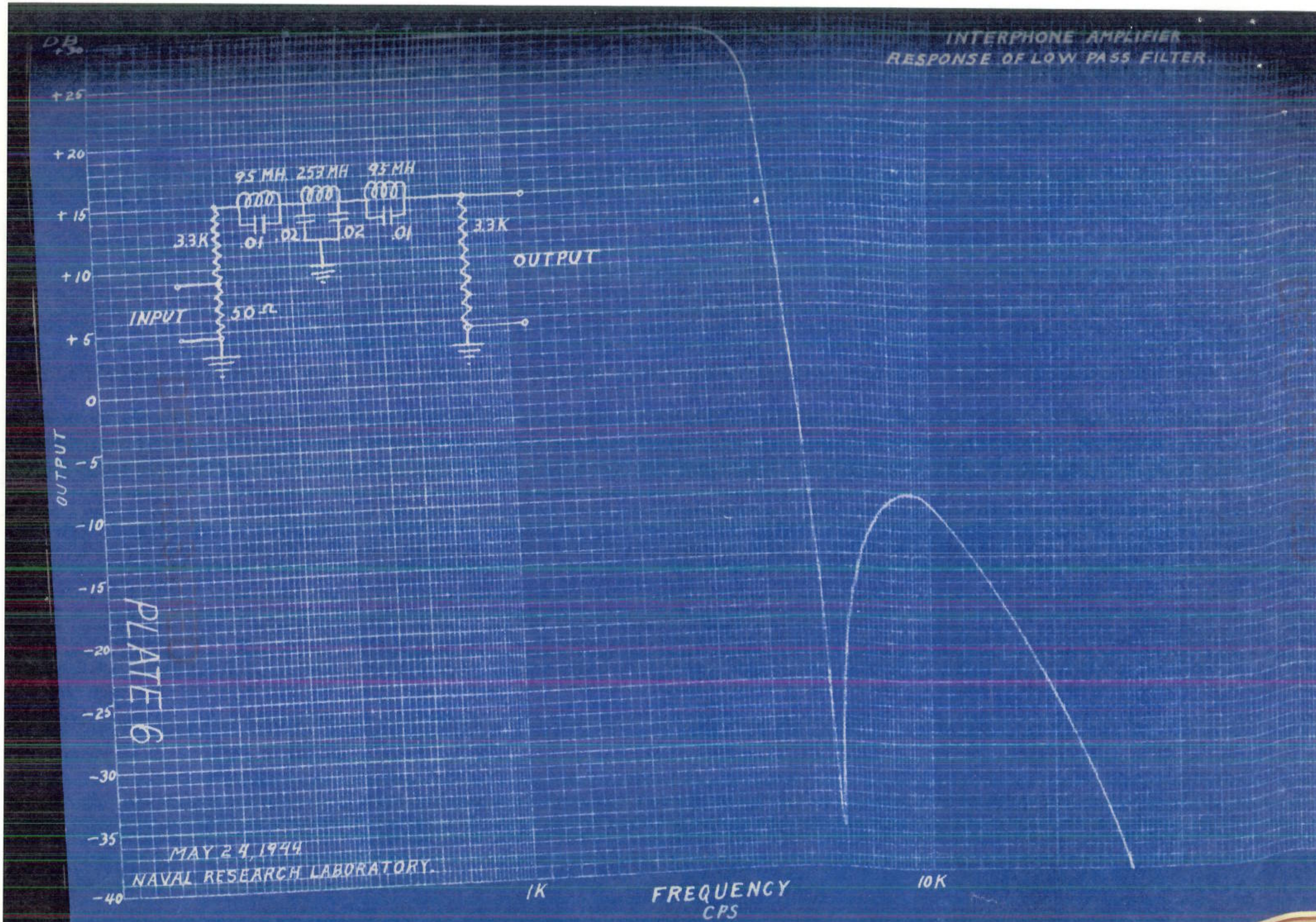
PLATE 2.

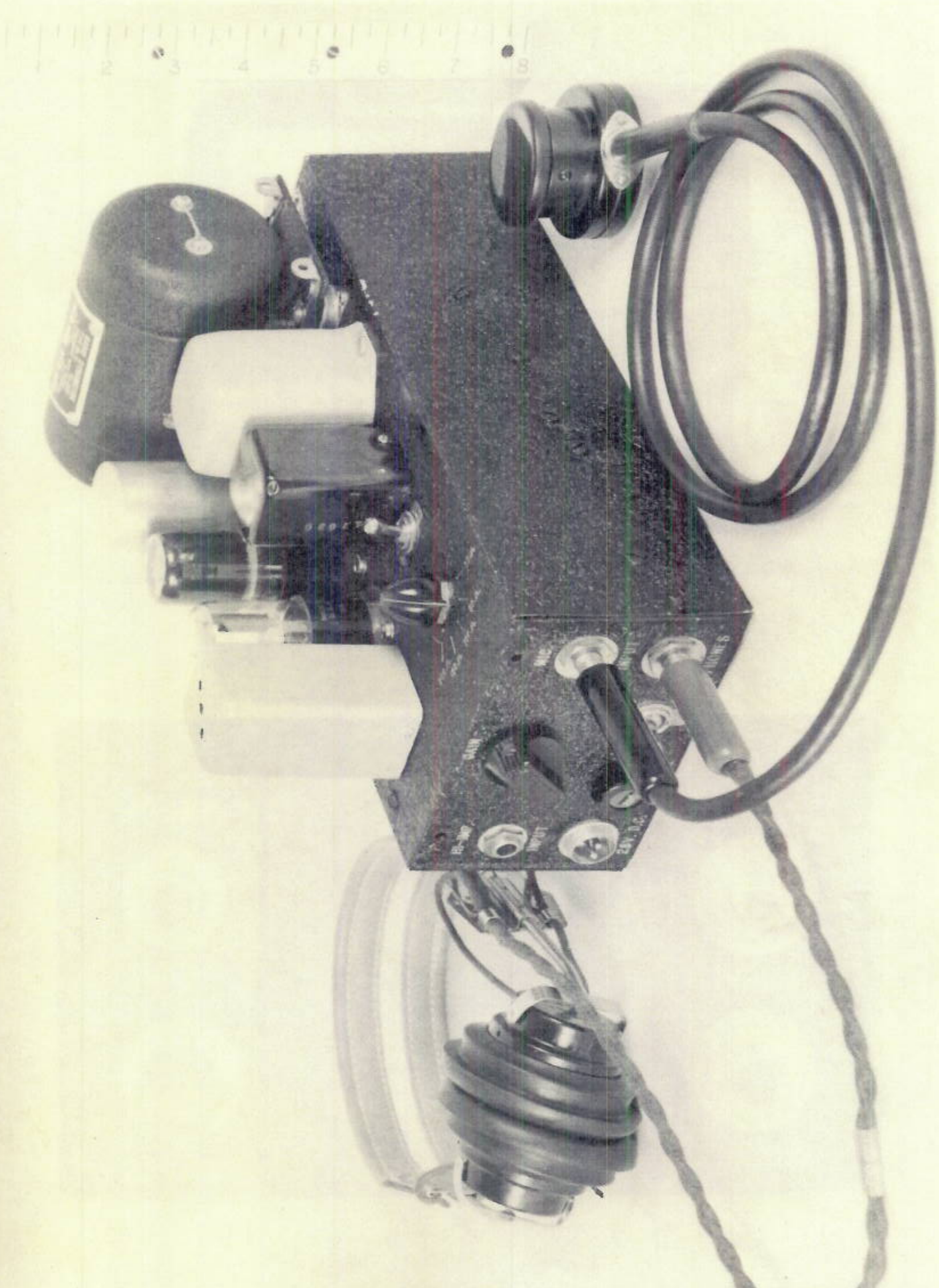

DB
+45
+40
+35
+30
+25
+20
+15
+10
+5
0
-5
-10
-15
OUTPUT
INTERPHONE AMPLIFIER
OVERALL HIGH POWER OUTPUT
RESPONSE CURVE.
PLATE 3.
MAY 24, 1944
NAVAL RESEARCH LABORATORY
1K
FREQUENCY
CPS.



DISTORTION
20%
16%
12%
8%
4%
0
1
2
3
4
WATTS OUTPUT.
LOW POWER
HIGH POWER
PLATE 4
MAY 26, 1944
NAVAL RESEARCH LABORATORY


INTERPHONE AMPLIFIER
DISTORTION VS. IMPEDANCE LOAD MISMATCH
HIGH AND LOW POWER
20%
16%
12%
8%
4%
0
DISTORTION
HIGH POWER
4 WATTS AT 30 Ω LOAD
LOW POWER
1.6 WATTS AT 125 Ω LOAD
20Ω 25Ω 30Ω 40Ω 50Ω 60Ω 80Ω 100Ω 125Ω 150Ω 200Ω 250Ω 300Ω
LOAD IMPEDANCE
MAY 26, 1944
NAVAL RESEARCH LABORATOR
PLATE 5


INTERPHONE AMPLIFIER
RESPONSE OF LOW PASS FILTER.
DB
+25
+20
+15
+10
+5
0
-5
-10
-15
-20
-25
-30
-35
-40
OUTPUT
95 MH
253 MH
95 MH
3.3K
.01
.02
.02
.01
3.3K
OUTPUT
INPUT
50 Ω
PLATE 6
MAY 24, 1944
NAVAL RESEARCH LABORATORY.
1K
10K
FREQUENCY
CPS



DECLASSIFIED

PLATE 7

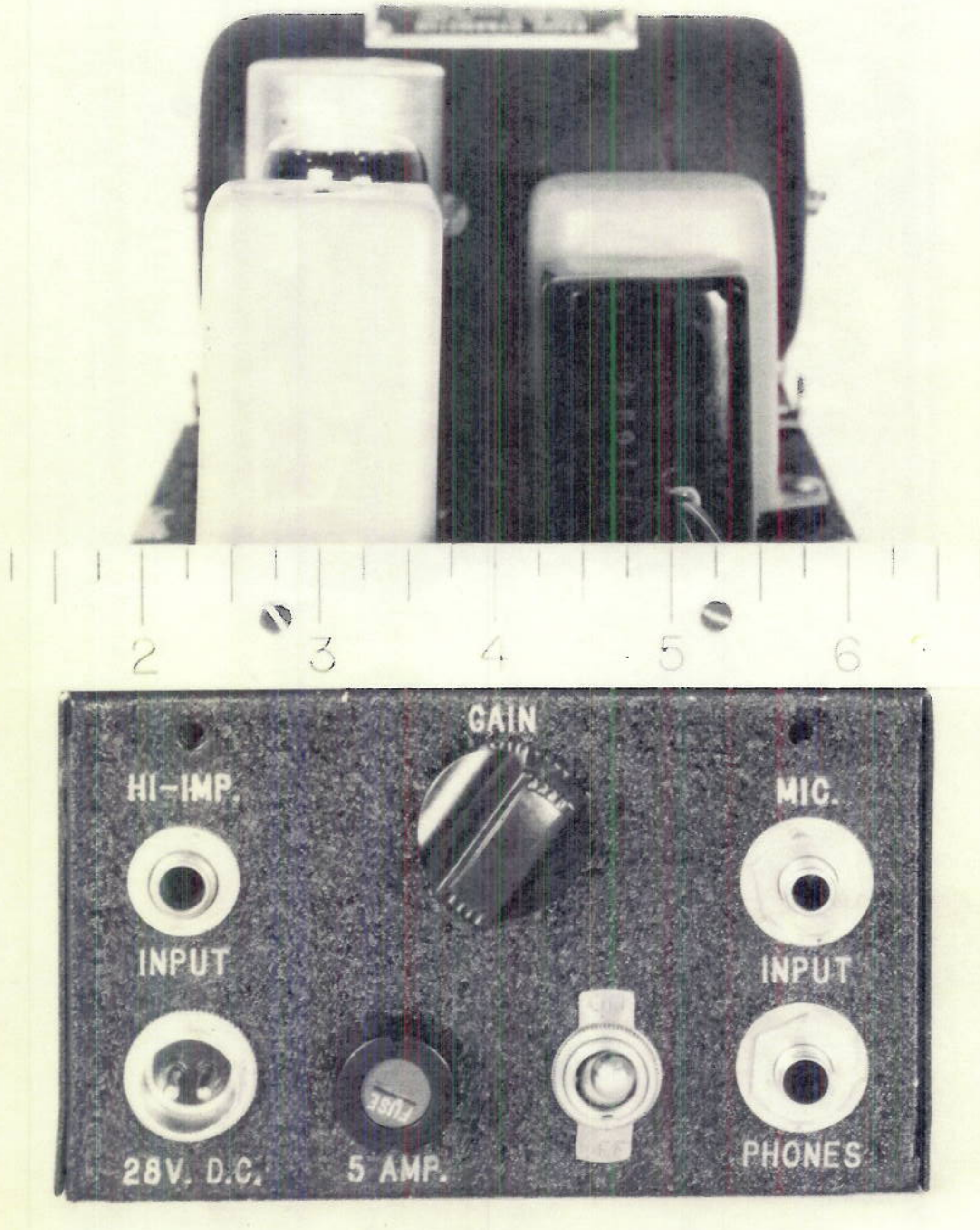


PLATE 8

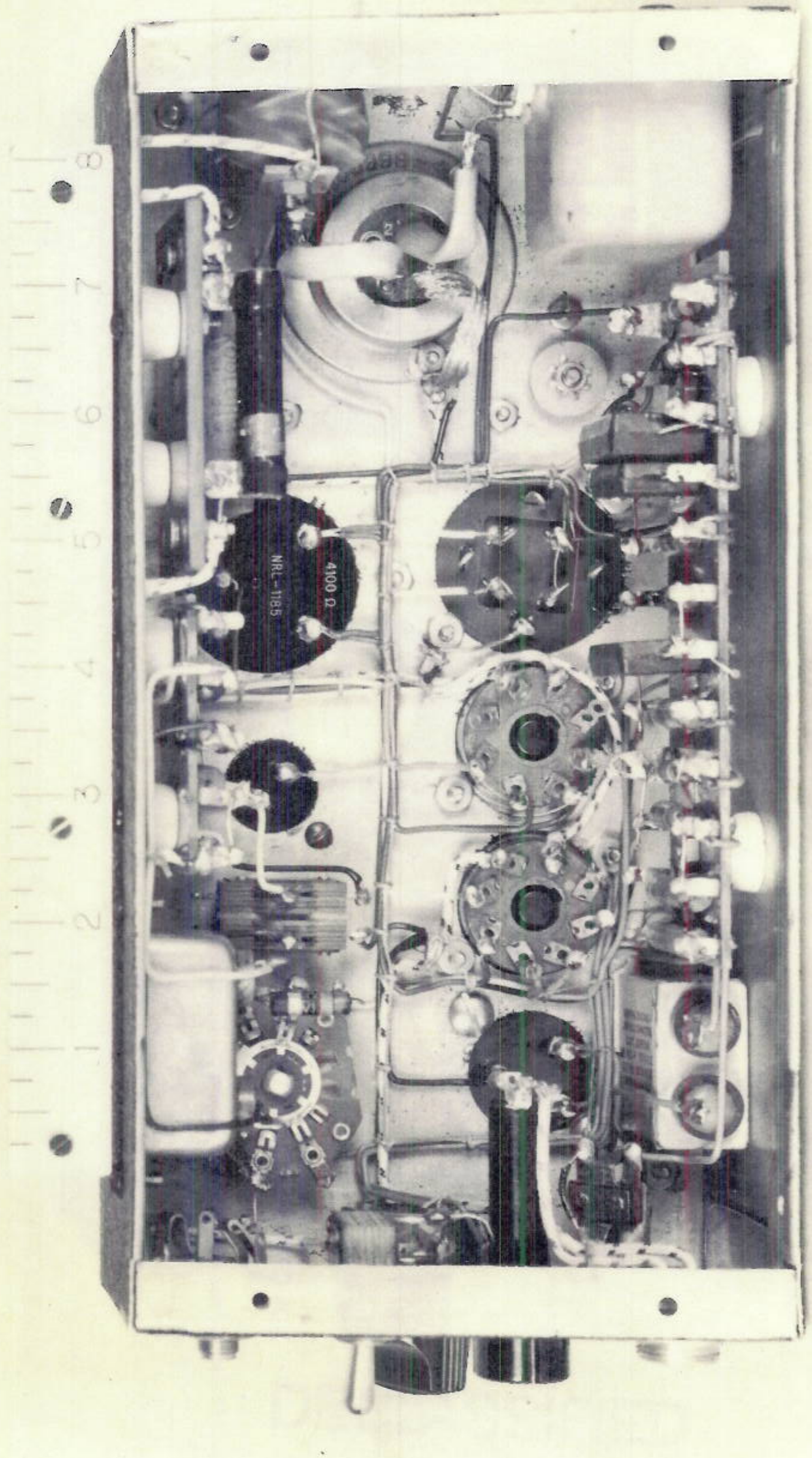


PLATE 9

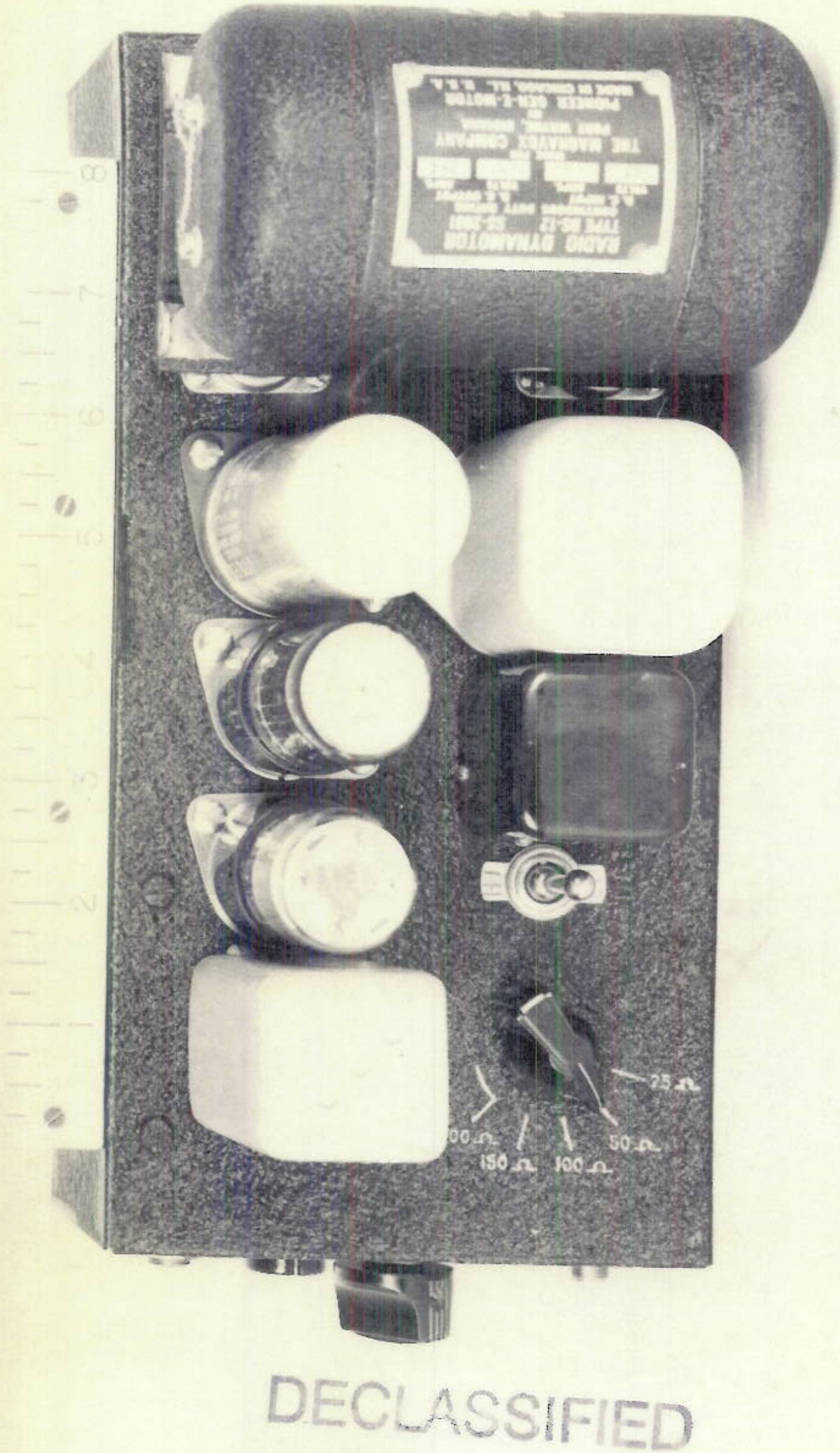


PLATE 10