Navy Department - Office of Research and Inventions

NAVAL RESEARCH LABORATORY
Washington, D.C.

* * *

AIRBORNE RADIO DIVISION

FR-2581

13 July 1945

AIRBORNE TELEVISION - RESULTS OF TEST OF TYPE CIX-59AAF CONVERSION UNIT, FOR MODELS ATJ OR ATK TELEVISION EQUIPMENT

By Louis L. George, Assoc. Eng.
and Howard Gordon, Group Leader

- Report R-2581 -

* * *

Approved by:

S. Riccobono - Asst. Section Head

Raymond A. Gordon
Acting Supt. Airborne Radio Division

Rear Adm. A. H. Van Keuren, USN (Ret.)
Director, Naval Research Laboratory

Preliminary Pages . . .	a-c
Numbered Pages	9
Plates	16
Distribution List . . .	d

NRL Problem A(S)74.1T-C(ARN)

ABSTRACT

Engineering tests were conducted on type CIX-59AAF conversion unit, manufactured by Remington Rand, Middletown, Connecticut, for use with Models ATJ or ATK Airborne television equipment. These tests were made to determine equipment suitability for use in Naval aircraft in accordance with reference (a) and compliance with specifications, references (d) and (e). The test results indicate that the subject conversion unit gives satisfactory performance under all service conditions except that of high temperature with a high relative humidity. Specifications were met on all other tests. After modifications herein recommended are made to correct the above mentioned failure, the equipment should give satisfactory performance under these conditions and be in total compliance with specifications. Work previously done on other equipments under the same problem are given in references (b) and (c).

TABLE OF CONTENTS

	Page
1. INTRODUCTION	1
2. RESULTS OF TESTS	2
(m) Temperature and Humidity	3
(s) Altitude	5
(t) Vibration	5
3. CONCLUSIONS	5
4. RECOMMENDATIONS	5
APPENDIX 1	
1. CIX-59AAF Remington-Rand Conversion Unit (Serial No. 5) - Vibration Test of - Report on.	7
2. PLATE 1 - Graph showing transmissibility of mounts.	
REFERENCES	9

Plate 1 Current Consumption
Plate 2 Plate Voltage Regulation
Plate 3 Plate Voltage Regulation
Plate 4 Bias Voltage Regulation
Plate 5 Video Amplifier Response
Plate 6 Photograph of Terminal Strip E102
Plate 7 Photograph of Monitor Screen (+23°C)
Plate 8 Photograph of Monitor Screen (-30°C)
Plate 9 Photograph of Monitor Screen (+50°C)
Plate 10 Photograph of Terminal Strip E-104
Plate 11 Front View of Conversion Unit
Plate 12 Rear View of Conversion Unit
Plate 13 Top View of Conversion Unit
Plate 14 Bottom View of Conversion Unit
Plate 15 Shock Mount
Plate 16 Schematic Diagram

DISTRIBUTION LIST . . . . . d

INTRODUCTION

1. The Type CIX-59AAF Conversion Unit is electrically interchangeable with the Type 59AAE Conversion unit of Model ATJ or ATK television transmitting equipment. The salient features of this unit are as follows:

(a) It employs the two-inch Vericon 2-2 tube, a picture pick-up tube of the low velocity scanning beam type, and has self-contained circuits for generating sweep and synchronizing signals. The unit delivers separate video and synchronizing signals having the characteristics and amplitude required for modulation of the Model ATK transmitter.

(b) The conversion unit is equipped with a high quality lens having a relative aperture of f/1.9, and the lens iris diaphragm is automatically controlled so that the picture contrast is maintained substantially constant under widely varying lighting conditions.

(c) An optical system is included for projecting the image of a compass card on the pick-up tube and thus provides a continuous direction indication during flight.

(d) The video amplifier is separately shock mounted, thus minimizing the possibility of microphonic signals.

(e) Controls for adjustment of the unit before flight are mounted on an inside panel to which access is secured by opening a small door in the dust cover on the right side, looking at the unit from the front.

(f) The conversion unit is provided with a special shock mounting base of the Robinson type.

(g) Internal voltage regulation is provided for tubes and circuits requiring it, gas-tube regulators being provided for this purpose. The unit also contains a negative grid bias supply developed from the horizontal sweep oscillator,

(h) Focus coil current is held close to the design value by a variable resistance type current regulator. In addition to providing the necessary fine control over electrical focus, a special automatic focus compensation circuit is incorporated in the conversion unit.

(i) Both sweep oscillators are of the L-C type. The vertical oscillator operates at a frequency of 80 c.p.s. and the output is fed to a relaxation oscillator whose natural period is adjusted to 40 c.p.s.

(j) Photographs of the conversion unit are shown in Plates 11 through 15. A schematic diagram is shown in Plate 16.

RESULTS OF TESTS

2. The following paragraphs describe the tests conducted and the results obtained:

(a) The Model ATK transmitting equipment draws 28.9 amperes at the nominal d.c. supply potential of 28.6 volts when the Type CIX-59AAF conversion unit is interchanged with the Type CRV-59AAE. When in the standby position the current consumption is 6.85 amperes. These values make the total power consumption 826 and 196 watts respectively. Plate 1 shows a curve of current consumption over a d.c. input range from 25 to 31 volts, when in the standby and transmit positions.

(b) The weight of the conversion unit is 45.7 pounds. The Robinson type shock mount weighs an additional 2.2 pounds.

(c) Plate 2 shows curves of the unregulated plate voltages as a function of the d.c. primary voltage. These voltages were maintained within ±13% of their nominal values between the limits of 25 and 31 volts d.c. supply input. Plate 3 and 4 show similar curves for the regulated plate voltages and for the bias voltage supply respectively. The regulated plate voltages change was within ±3.5% over the same input range. Bias voltage from the horizontal oscillator was maintained within ±12%.

(d) The overall horizontal angle of view was measured using the monitor screen to determine the viewing limits. Two objects were placed at the extreme limits of the viewing range and the distance between them measured. The distance from the lens to a line passing through the two objects was also measured. By use of the law of sines, the total horizontal angle of view for the system was calculated to be 26 degrees.

(e) The effect of primary voltage variation over the range from 25.5 to 31.5 volts upon the vertical and horizontal oscillator frequencies was negligible. The control range for the horizontal oscillator was +300 and -150 c.p.s. or +2.15% and -1.08% of the nominal value of 14 kc/s. The control range for the vertical oscillator was ±3 c.p.s. or ±7.5% of the nominal value of 40 c.p.s.

(f) The peak to peak amplitudes of the vertical and horizontal synchronizing pulses were 2.5 and 1.1 volts respectively. Peak to peak pedestal amplitude with no video signal was 0.5 volts. When the pedestal was filled 80% with a 1 Kc/s signal, the peak to peak amplitude was 0.86 volts. These voltages were measured at the conversion unit video synchronizing pulse jacks terminated in 47 and 220 ohms respectively.

(g) Vertical blanking pulse width at its base was 1700 micro-seconds or 6.8% of the vertical deflection cycle. Horizontal blanking pulse width at its base was 17 micro-seconds or 23.8% of the horizontal deflection cyle.

Vertical synchronizing pulse width at its base was 600 micro-seconds and 400 micro-seconds at 75% of peak amplitude. The value of 400 microseconds is 560% of the horizontal deflection cycle. The horizontal synchronizing pulse width at its base was 8 microseconds or 47% of the horizontal blanking pulse.

(h) All control coverages were found to be satisfactory. The focus control was, however, critical in adjustment. Both vertical and horizontal linearity were checked using a test chart and were found to be satisfactory as observed on the monitor screen.

(i) The resolution of the conversion unit was observed on the monitor screen was at least 300 lines. This measurement was made using the test chart.

(j) The video amplifier frequency response is shown in Plate 5. This measurement was made with the gain control adjusted for 0.1 volt (RMS) noise output. A constant output of 1 volt (RMS) was used as the reference level. The output was measured at the grid of the cathode follower stage. The grid of the blanking inserter stage was also grounded during the test. As seen from the curve, maximum response occurred at 3.3 mc/s. The frequencies at which the response was down 3 db were 2.9 and 4.4 mc/s. The response below 50 Kc/s could not be measured due to the noise level. These tests were conducted with the factory adjustment of the high peaker capacity.

(k) Automatic iris control was observed to function properly when adequate light was present.

(l) Wiring and workmanship is in accordance with good engineering practice except on terminal strip E102 as shown in Plate 6, an exposed plate supply lead on this terminal strip is in danger of being shorted to ground if a long machine screw is used at this point for securing the compass box to the conversion unit.

Temperature and Humidity

(m) Temperature and humidity tests were conducted on the conversion unit as follows:

1. Adjustments were made at room temperature (+23°C) for the best picture on the monitor screen after a fifteen minute warm-up period. The temperature was then decreased to -30°C, with the equipment non-operating and a stabilization period of one hour allowed. After a fifteen minute warm-up, the performance was noted. This procedure was repeated at +50°C and also after a 48 hour storage period at +50°C with a relative humidity of 95 percent. Photographs were taken of the monitor viewing screen, which was located outside the test chamber. Plate 7 is a photograph taken at room temperature at the start of the tests. The light on the test chart was supplied by one #R2 photoflood (500 watts) bulb. The non-linearity of the horizontal sweep is due to the monitor. Highlights shown in the

pictures were due to reflections from and buckling of the paper chart which could not be conveniently avoided.

(n) The unit performance at -30°C and +50°C was satisfactory. Plates 8 and 9 show the photographs made at these temperature levels.

(o) After a storage period of 48 hours at +50°C and a relative humidity of 95% the conversion unit failed to operate correctly. There was no vertical synchronization pulse output and no video signal output after a warm-up period of one hour. The test chamber was then turned off and the door opened. Investigation disclosed that the shutter was stuck due to rusting of the wire that actuates it. After remedying this condition, the video output signal showed an enlarged ion spot. Equipment operation was continued for an additional hour, during which time the video signal output improved and the vertical sweep frequency came in at 80 c.p.s. It was later found that a two megohm resistance tied between grid and plate of the vertical oscillator, V124-A, would cause oscillator failure. The same effect was produced when a fine spray of water was directed on the isolantite tube socket. Comparison tests made on a similar socket and one made of bakelite, showed that the isolantite socket (which was not glazed) was porous and absorbed and retained moisture. The bakelite socket was found to be superior in this respect because the moisture accumulated in globules and evaporated. Plate 10 is a photograph showing the bakelite replacement socket. It is to be noted that the accumulation of dust particles on the isolantite socket would aid in holding moisture and maintaining leakage resistance between socket lugs.

(p) Another humidity test was made after replacing the vertical oscillator tube socket with one made of bakelite. The vertical sweep frequency output was 80 c.p.s. but after a 15 minute warm-up time, it changed to approximately 24 c.p.s. The video signal was mostly due to the enlarged ion spot which gradually decreased. However it took one hour for the picture to come in. Subsequent investigation revealed that the low sweep frequency was caused by d.c. leakage of positive supply voltage (+250 volts) to the grid of the synchronized relaxation oscillator, V125, through R225 (1 meg.). The resistor (R225) and d.c. voltage connections are in close proximity on terminal strip E-104. A simulated leakage resistance of 8 megohms between these two points reproduced the low frequency sweep. The terminal strip in question is shown in Plate 10. After R225 and C156 were removed from the strip and reconnected, the vertical sweep frequency remained at 40 c.p.s. during another humidity test.

(q) Loss of the video signal was also traced to faulty terminal strip design. It was found that this was caused by d.c. leakage of positive voltage to the negative bias supply line feeding the video amplifier. It is believed that this occurred in more than one terminal strip so that even though leakage resistance in any single strip might not seriously affect the video signal, a number of leakages in parallel would be sufficient to do so.

(r) Sweep frequency change with temperature variation was ±1 c.p.s. for the vertical oscillator and approximately ±15 c.p.s. for the horizontal oscillator. The humidity test had negligible effect upon the horizontal oscillator frequency.

Altitude

(s) The conversion unit was subjected to altitude tests at a temperature of -30°C and equivalent altitude of 25,000 feet. The available test facilities required the complete transmitting equipment to be installed inside the test chamber and since the transmitter was designed for a limit of 25,000 feet, the test was made at that value. The primary input was adjusted to 31 volts and the equipment turned on and off several times. Continuous operation was checked over a period of 45 minutes with the primary voltage adjusted from 28 to 31 volts. No component breakdown was observed during the tests, although horizontal bars (approximately 12) were noted on the monitor screen. These bars were not present when the equipment was later operated at +23°C at sea level. The bars reappeared when the temperature was reduced to -30°C at sea level. This indicated that possibly an electrolytic capacitor was becoming defective after the altitude test, but since the bars disappeared at room temperature the capacitor was not located. Except for the bars, the picture quality was good.

Vibration

(t) Results of the vibration tests are appended as a separate report.

CONCLUSIONS

3. Based on the results of the tests conducted, the Type CIX-59AAF conversion unit, serial #5 was found to be in accordance with specifications with the following exceptions:

(a) The focus control was found to be critical in adjustment.

(b) The plate supply voltage lead on terminal strip E102 is so placed that if a long screw is used at this point for holding the compass box, a short circuit will result.

(c) Performance of the conversion unit under conditions of high temperature and humidity was poor.

RECOMMENDATIONS

4. Based on the results of Laboratory tests, the Type CIX-59AAF conversion unit is considered to be satisfactory for use in Naval aircraft provided the following modifications are made:

(a) The focus control be made less critical in adjustment.

(b) The plate supply voltage lead on terminal strip E102 be relocated so that a short circuit cannot occur.

(c) Performance of the conversion unit under conditions of high temperature and humidity be improved to meet specifications.

C-L5-2(2)/F42-1(872)

Report No. M165
870-109/45

Appendix 1
13 June 1945

From: Shock & Vibration Division, Code 870

To: Aircraft Section, Code 310

Subj: CIA-59AAF Remington-Rand Conversion Unit (Serial No. 5) - Vibration Test of - Report on.

Ref: (a) BuShips Specification 13A825c.

Encl: (HW)
(A) Graph showing transmissibility of mounts.

INTRODUCTION

1. As requested by Code 310, vibration tests were conducted on a CIA-59AAF Remington-Rand Conversion Unit (Serial No. 5) on 16 May 1945. The tests were conducted in accordance with reference (a). This report presents the data obtained and observations made of the mechanical performance of the equipment during the tests. The electrical performance of the equipment was observed by representatives of the Aircraft Section.

VIBRATION TESTS

2. The equipment, supported on a Robinson Aviation Inc. mount Model RAX 331, Serial No. 9, was secured to the platform of the direct drive vibration machine. The weight of the equipment was 50 pounds.

3. The equipment was subjected to vibration in a vertical direction at an amplitude of approximately 0.03" (total excursion approximately 0.06"). The transmissibility (ratio of unit displacement to table displacement) measurements were made for frequencies between 10 and 55 c.p.s. and are shown plotted in enclosure (A). Resonance occurred below 10 c.p.s. The frequency was slowly changed from 10 to 55 c.p.s. and returned to 10 c.p.s. in one minute. This test was continued for 30 minutes. "Bars" were observed on the scope at 10 c.p.s., indicating slight electrical disturbance. Representatives of the Aircraft Section did not consider this objectionable.

4. The equipment was then subjected to vibration in a horizontal plane in a direction perpendicular to the front of the unit at an amplitude of 0.03". Resonance occurred below 10 c.p.s. The same procedure described in paragraph 3 was followed. "Bars" were observed at 33 c.p.s.

5. The equipment was subjected to vibration in a horizontal plane in a direction parallel to the front of the equipment at an amplitude of approximately 0.03". Resonance was observed below 10 c.p.s. The same procedure described in paragraph 3 was followed, "Bars" were observed at 18 c.p.s. No damage was observed as a result of the vibration tests.

CONCLUSION

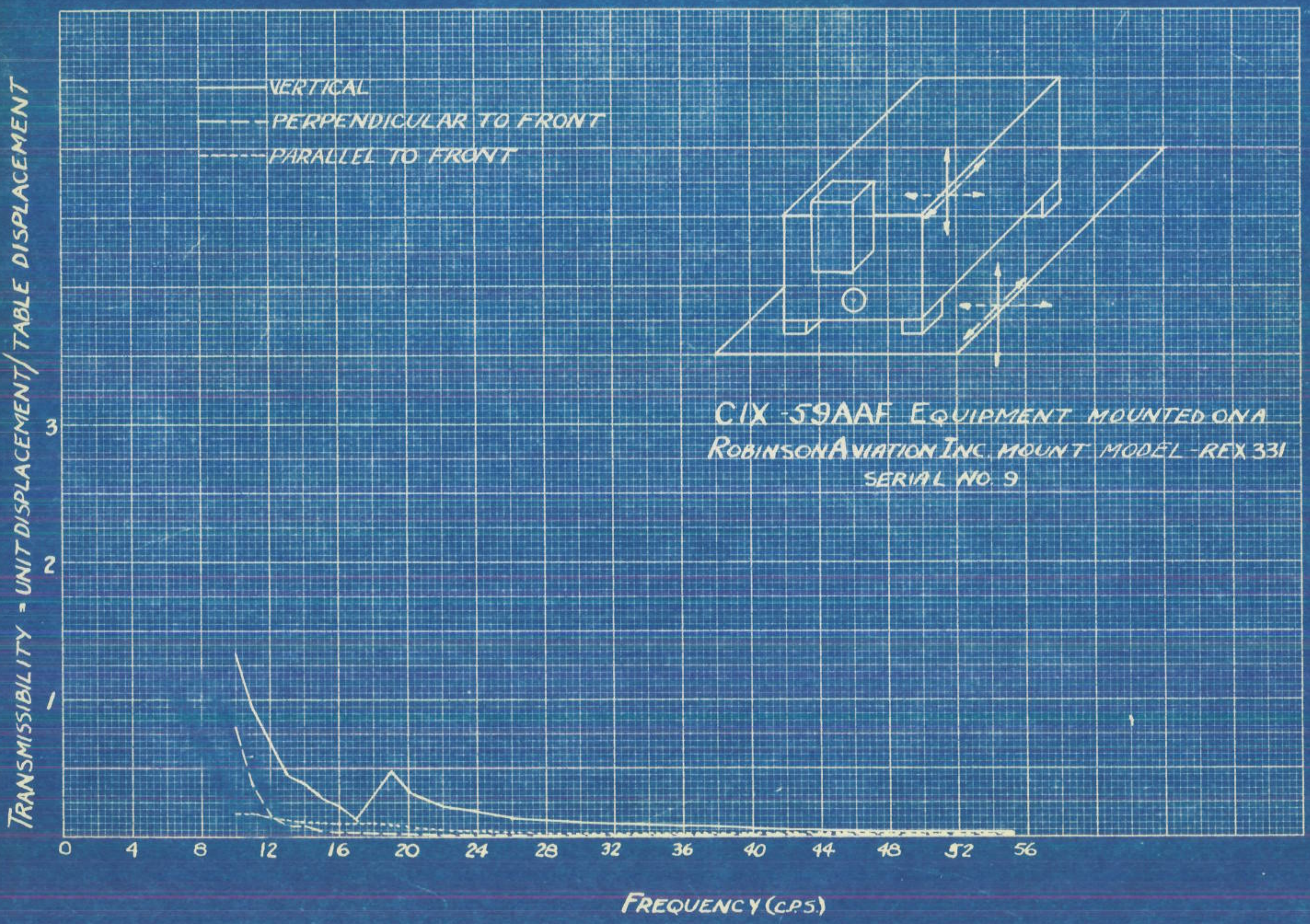
6. Electrical tests which could be made during the vibration tests indicated satisfactory operation of the equipment. Since the equipment also withstood the tests mechanically, it complies with the requirements of reference (a).

Approved

C. E. Crede

Report prepared by

D. H. Eschen



VERTICAL
PERPENDICULAR TO FRONT
PARALLEL TO FRONT
CIX -59AAF EQUIPMENT MOUNTED ON A
ROBINSON AVIATION INC. MOUNT MODEL -REX 331
SERIAL NO. 9
TRANSMISSIBILITY = UNIT DISPLACEMENT/TABLE DISPLACEMENT
1
2
3
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
FREQUENCY (C.P.S.)

FIG. 1

REFERENCES

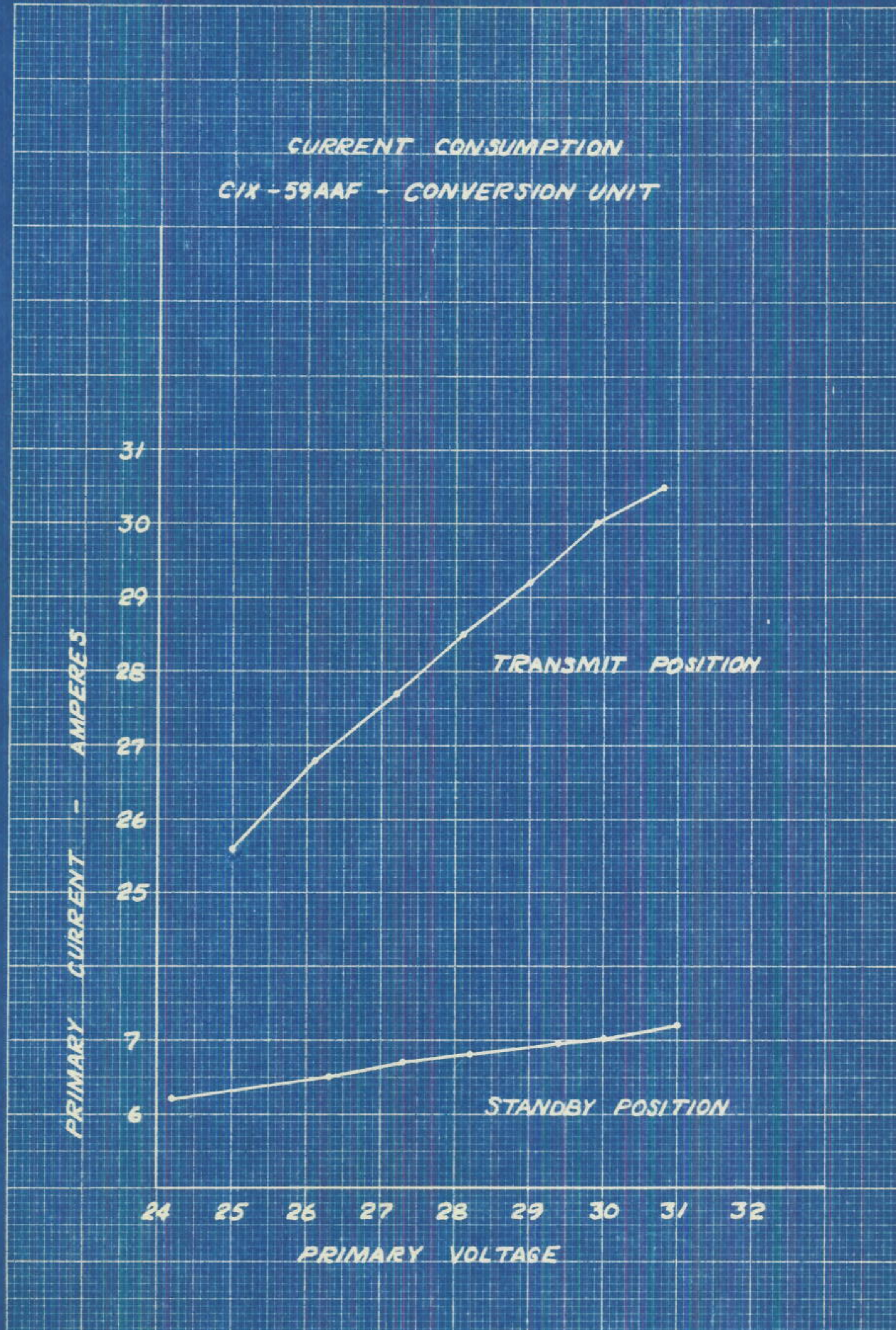
(a) BuShips ltr to NRL 913A - Aer. 2412 913Ah of 3 March 1944.

(b) NRL ltr Report C-F42-1/59(317:HG:LLG) C-310-51/45 dated 23 March 1945.

(c) NRL Report C-F42-1/59(317:HG:LLG) C-310-104/45(amc) NRL Bound Report R-2519 dated 2 June 1945.

(d) Navy Specifications RE13A-585B.

(e) Navy Specifications RE 9078C



CURRENT CONSUMPTION
CIX-59AAF - CONVERSION UNIT
PRIMARY CURRENT - AMPERES
31
30
29
28
27
26
25
7
6
TRANSMIT POSITION
STANDBY POSITION
24
25
26
27
28
29
30
31
32
PRIMARY VOLTAGE

PLATE 1

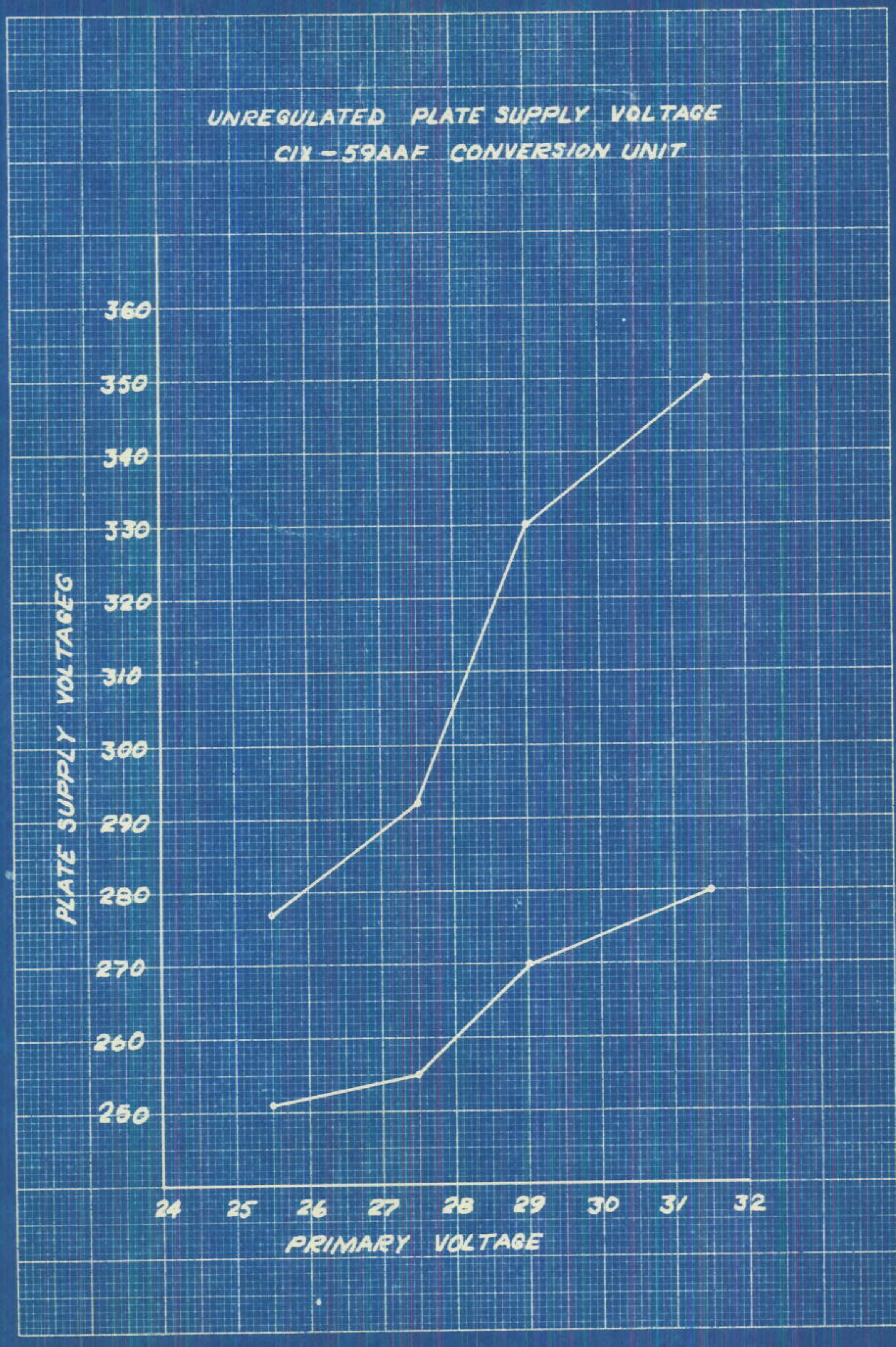

UNREGULATED PLATE SUPPLY VOLTAGE
CIX-59AAF CONVERSION UNIT
PLATE SUPPLY VOLTAGEG
360
350
340
330
320
310
300
290
280
270
260
250
24
25
26
27
28
29
30
31
32
PRIMARY VOLTAGE

PLATE 2

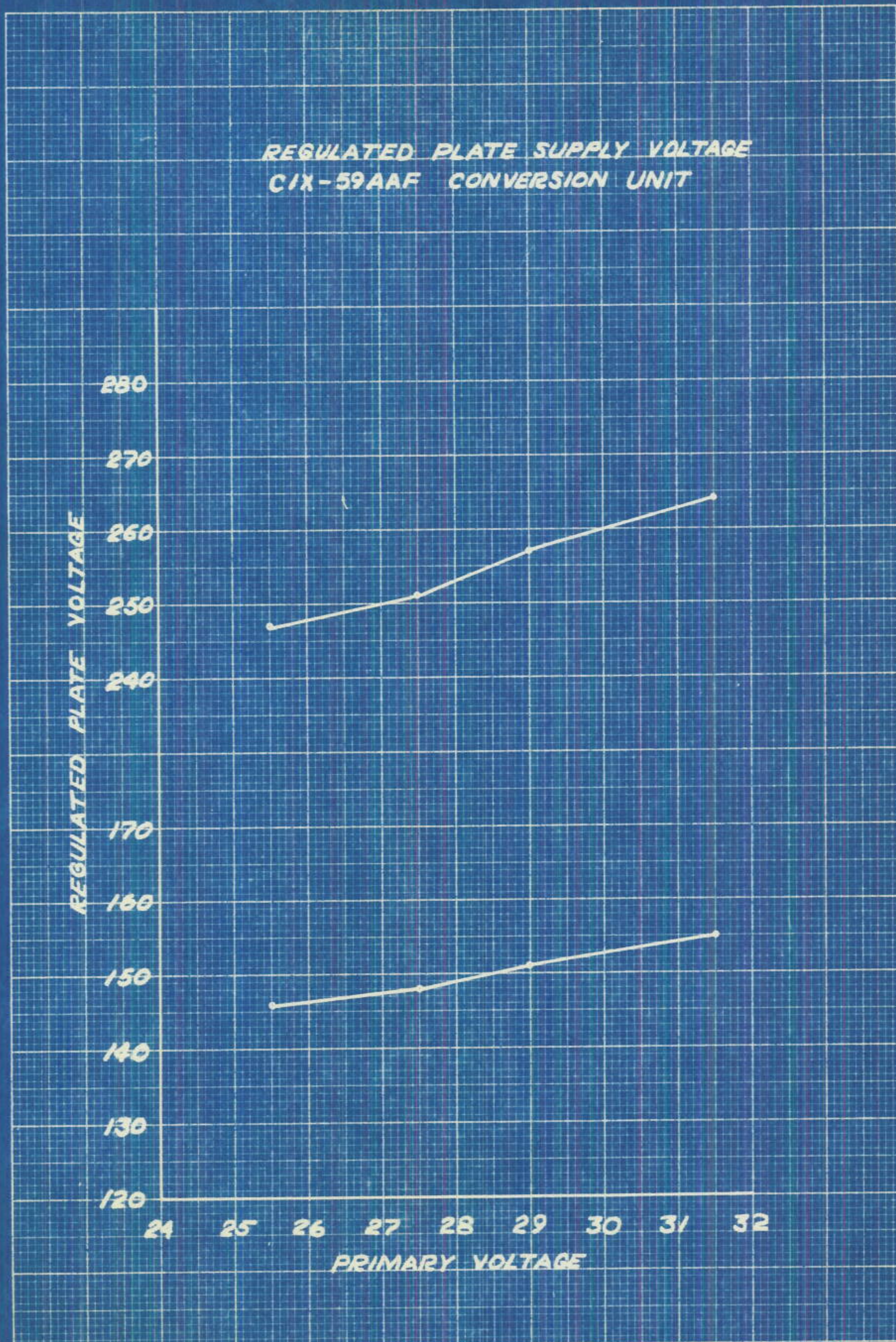

REGULATED PLATE SUPPLY VOLTAGE
C/X-59AAF CONVERSION UNIT
REGULATED PLATE VOLTAGE
280
270
260
250
240
170
160
150
140
130
120
24 25 26 27 28 29 30 31 32
PRIMARY VOLTAGE

PLATE 3

BIAS VOLTAGE (FROM HORIZ. OSC.)
C/X-59 AAF CONVERSION UNIT

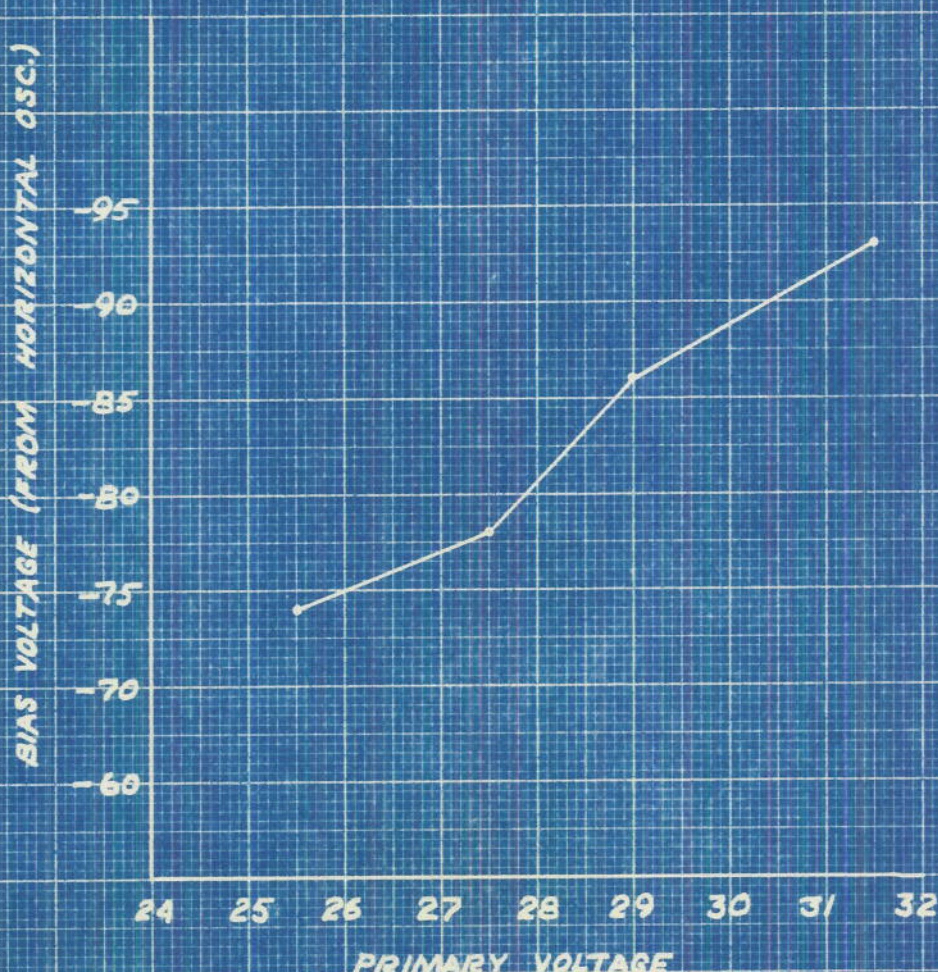


PLATE 4

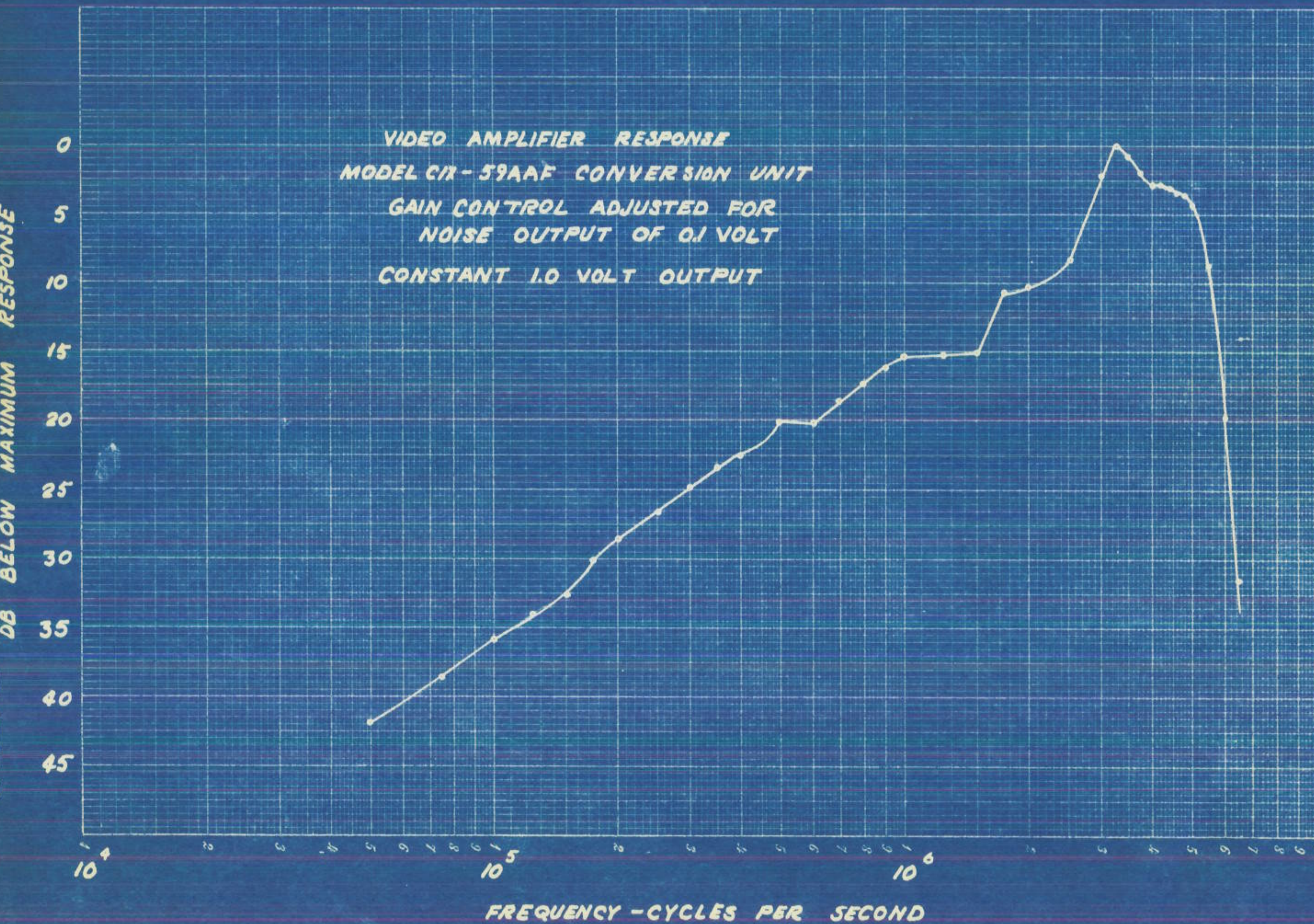
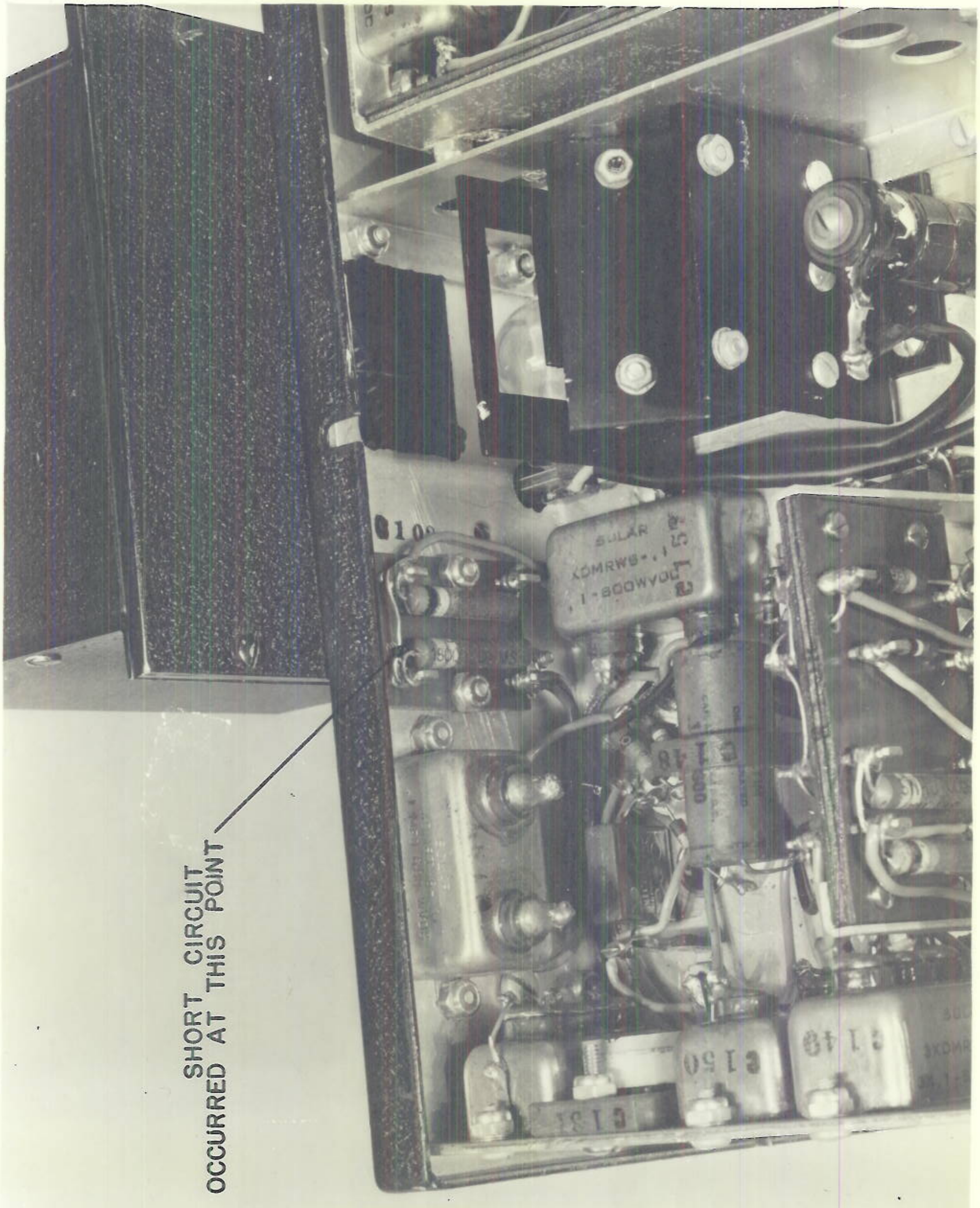
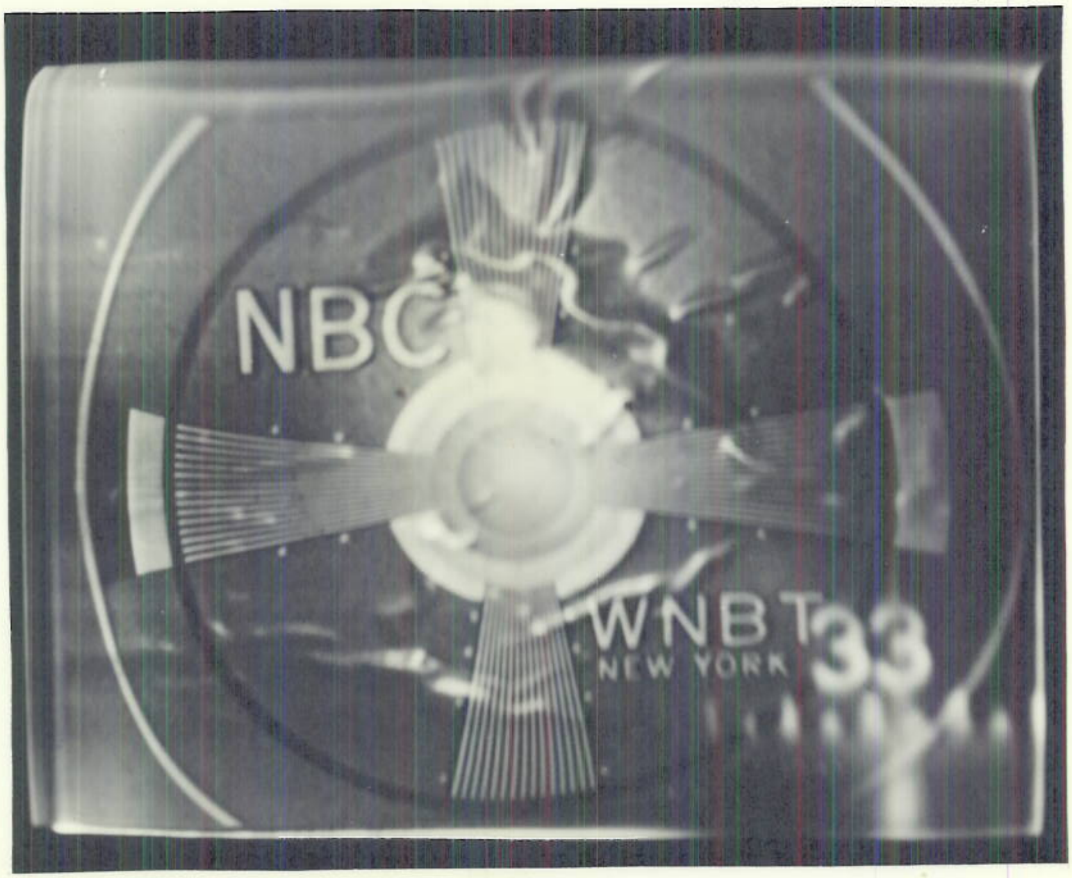

VIDEO AMPLIFIER RESPONSE
MODEL CIX-59AAF CONVERSION UNIT
GAIN CONTROL ADJUSTED FOR
NOISE OUTPUT OF 0.1 VOLT
CONSTANT 1.0 VOLT OUTPUT
DB BELOW MAXIMUM RESPONSE
0
5
10
15
20
25
30
35
40
45
10^4
10^5
10^6
FREQUENCY - CYCLES PER SECOND

PLATE 5



TERMINAL STRIP E-102



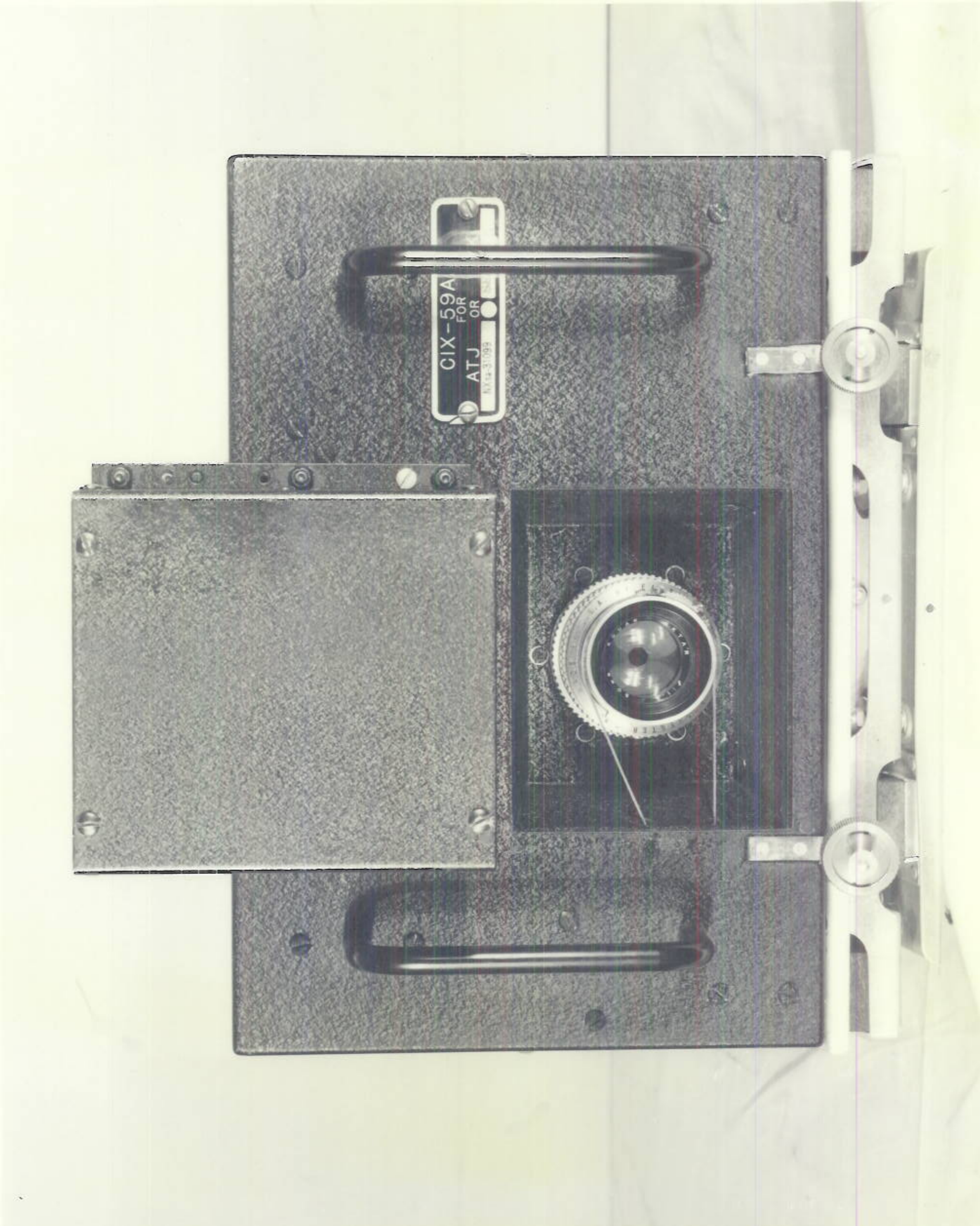
MONITOR SCREEN - CONVERSION UNIT 23°C

MONITOR SCREEN - CONVERSION UNIT 30°C

PLATE 8

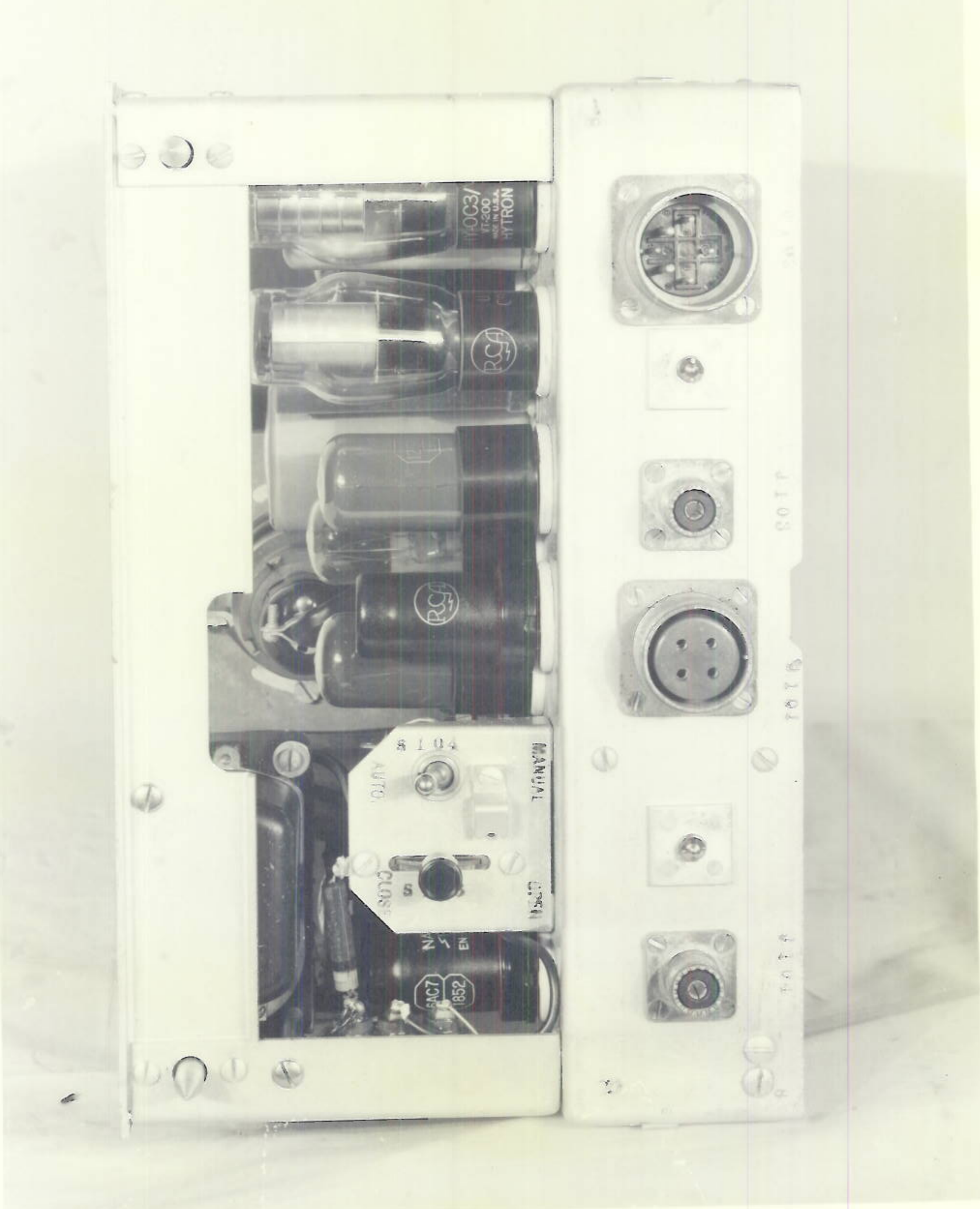
MONITOR SCREEN - CONVERSION UNIT 50°C

TERMINAL STRIP E-104



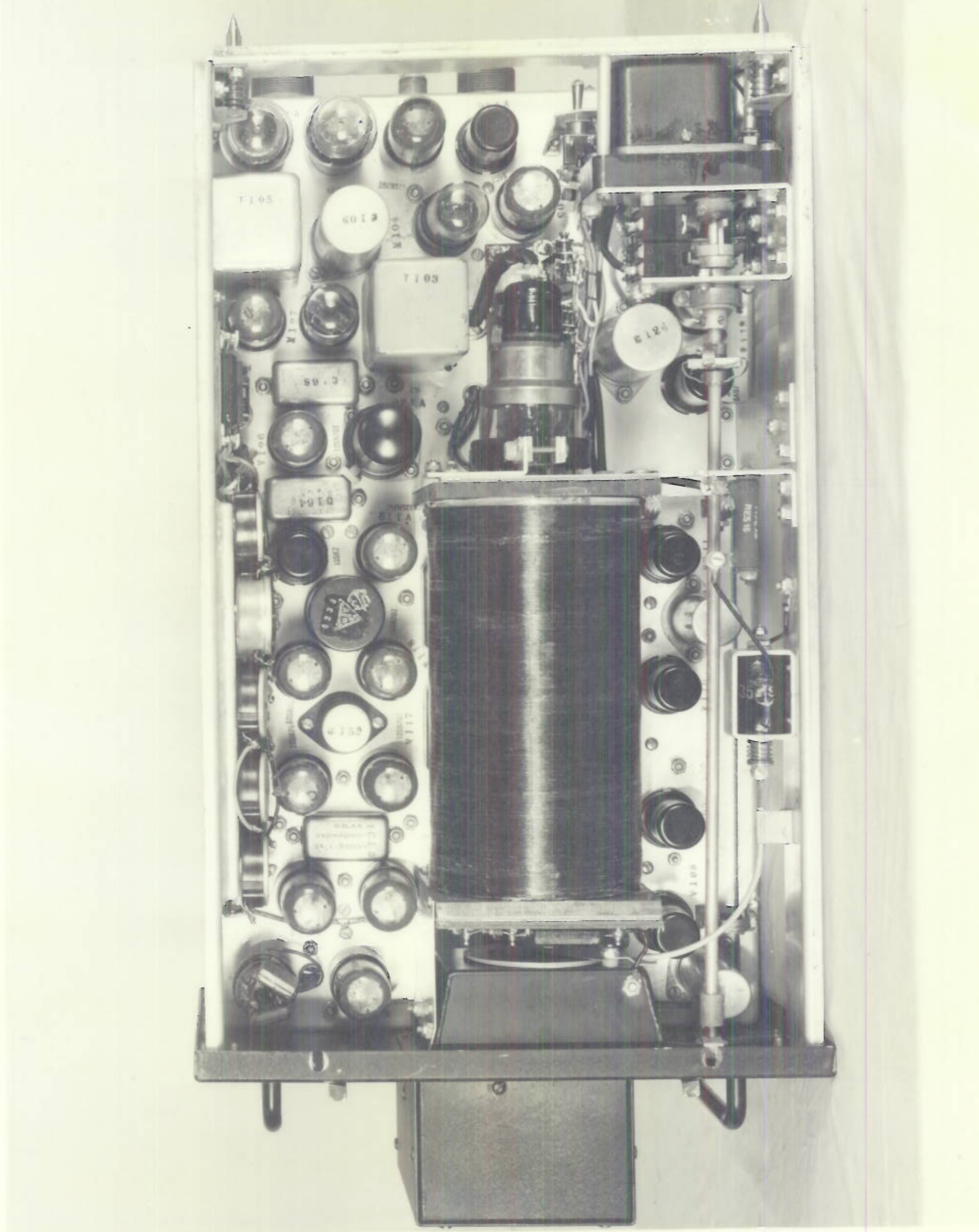
FRONT VIEW

PLATE II



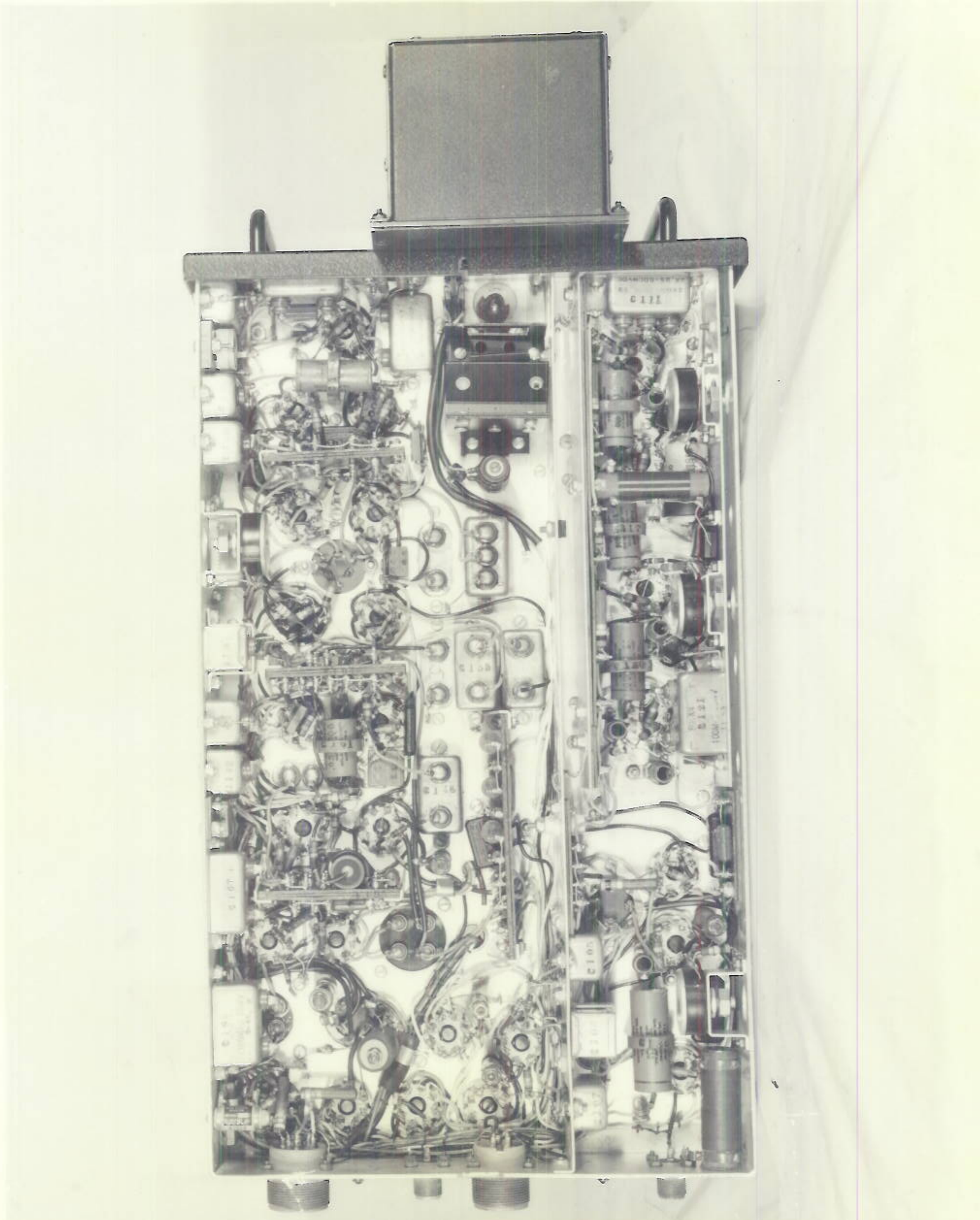
REAR VIEW

PLATE 12



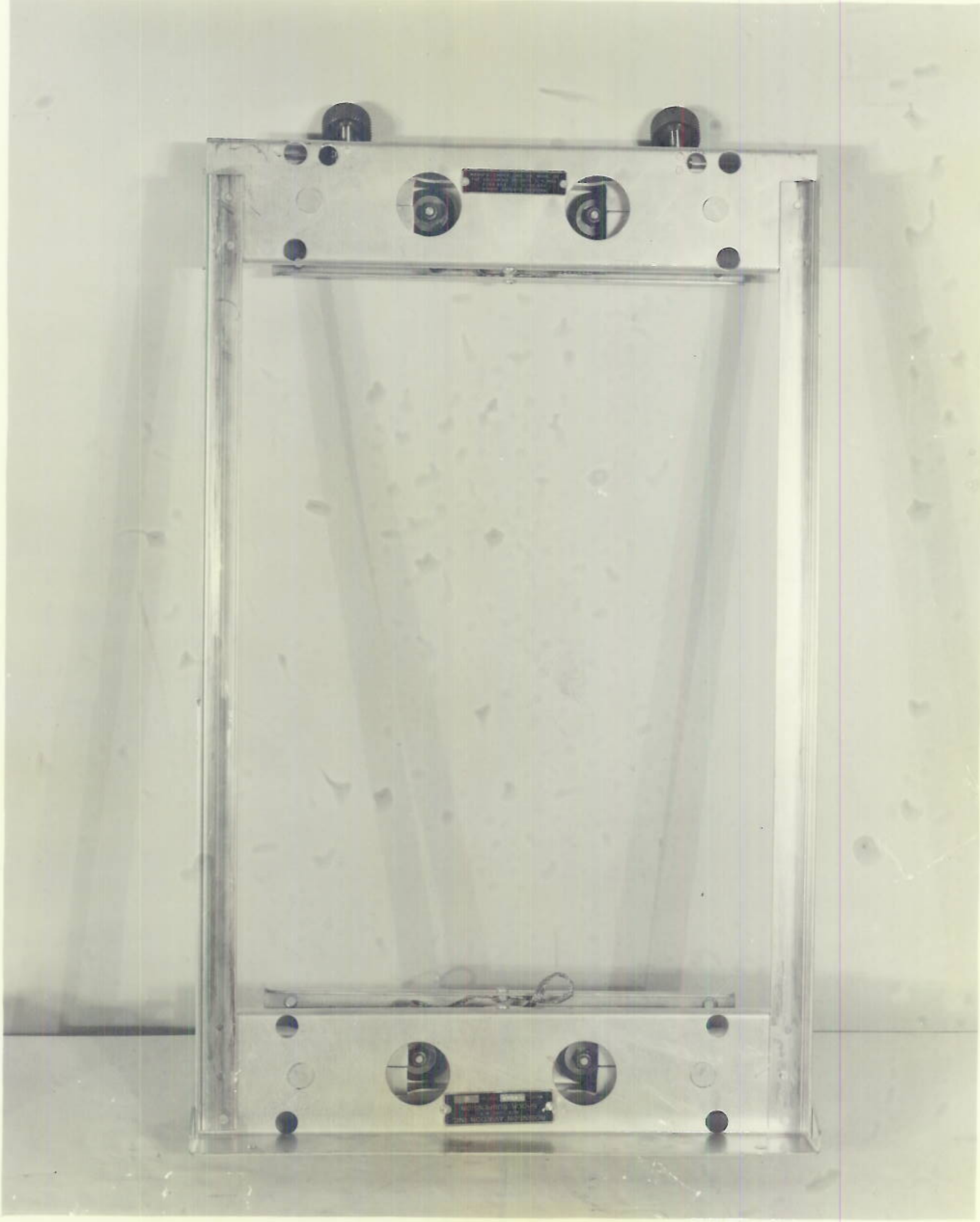
TOP VIEW

PLATE 13



BOTTOM VIEW

PLATE 14



SHOCK MOUNT

PLATE 15

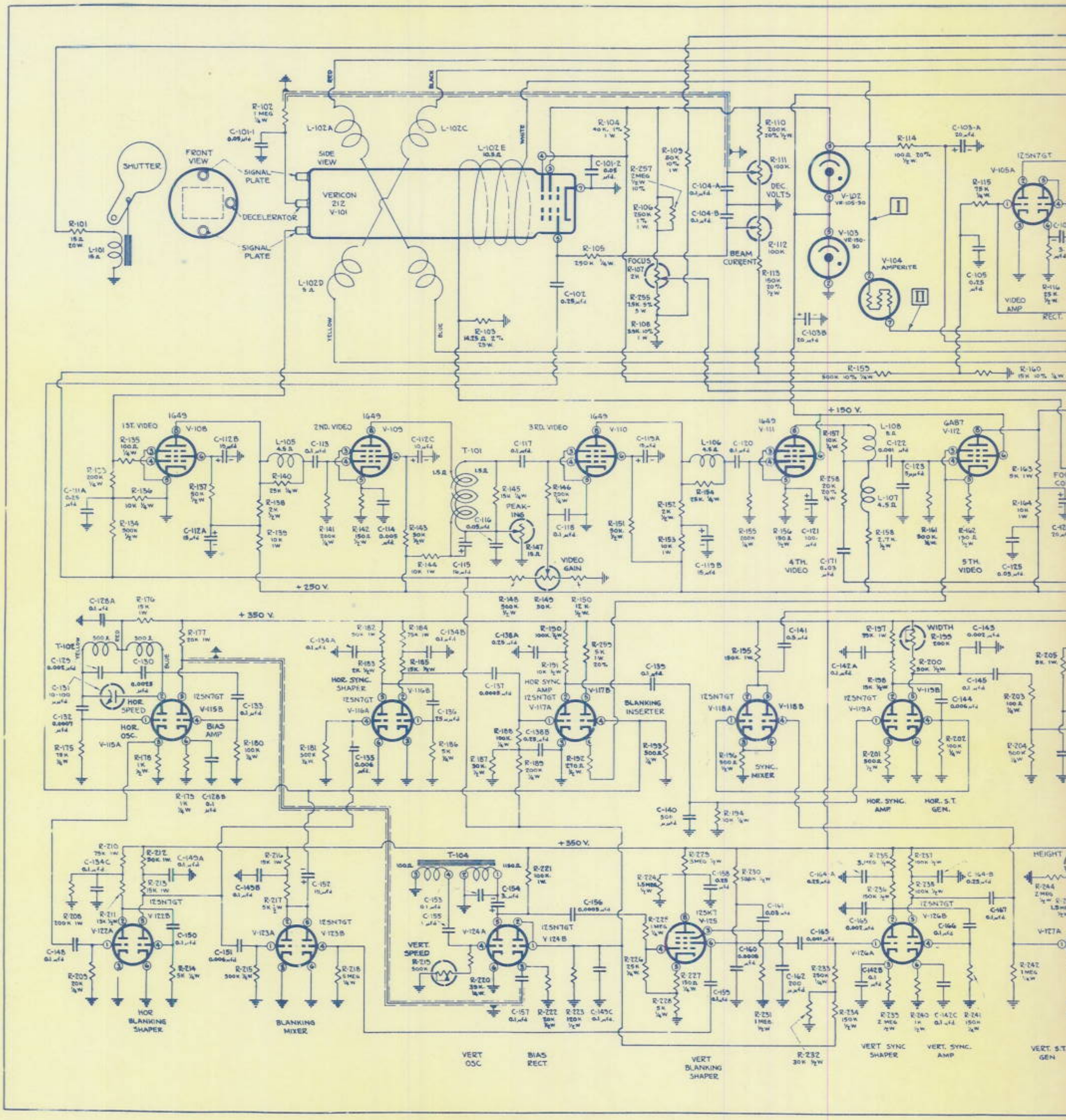
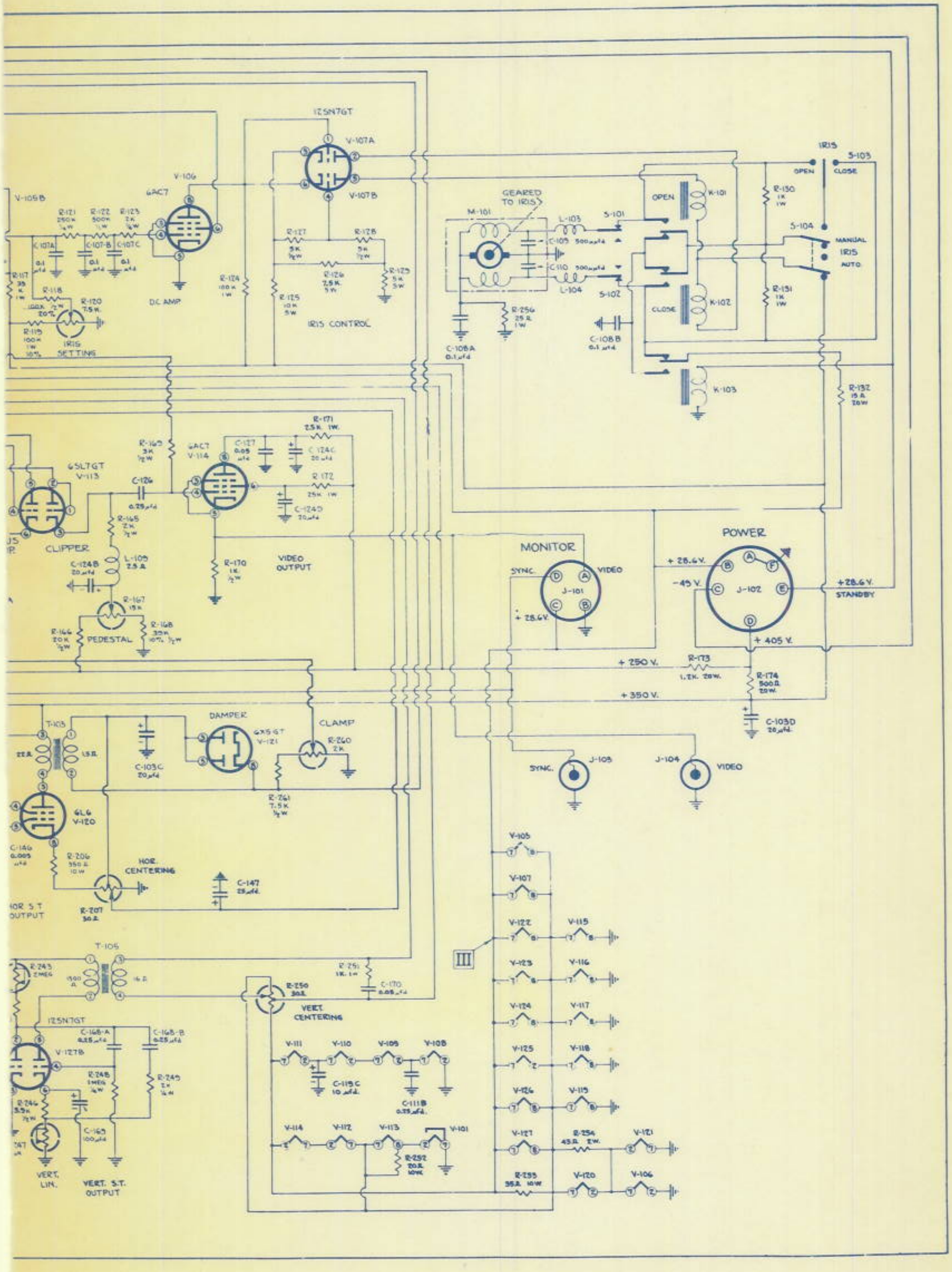


Fig. 25 - Conversion Unit CIX-59AAF, Schema



tic Wiring Diagram

PLATE 16