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SERIAL No. 72

3 August 1944

NRL Report No. R-2330
Problem S482R-S

DECLASSIFIED

Code 2028

Navy Department

Report on

FR-2330

THE DEVELOPMENT AND TEST OF MODEL TEA JAMMING TRANSMITTER

Distribution Unlimited

Approved for Public Release

Naval Research Laboratory
Washington 20, D.C.

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Reviewed by: A. H. Taylor, Supt. of Radio Division

Approved by: A. H. Van Keuren, Rear Admiral, USN Director

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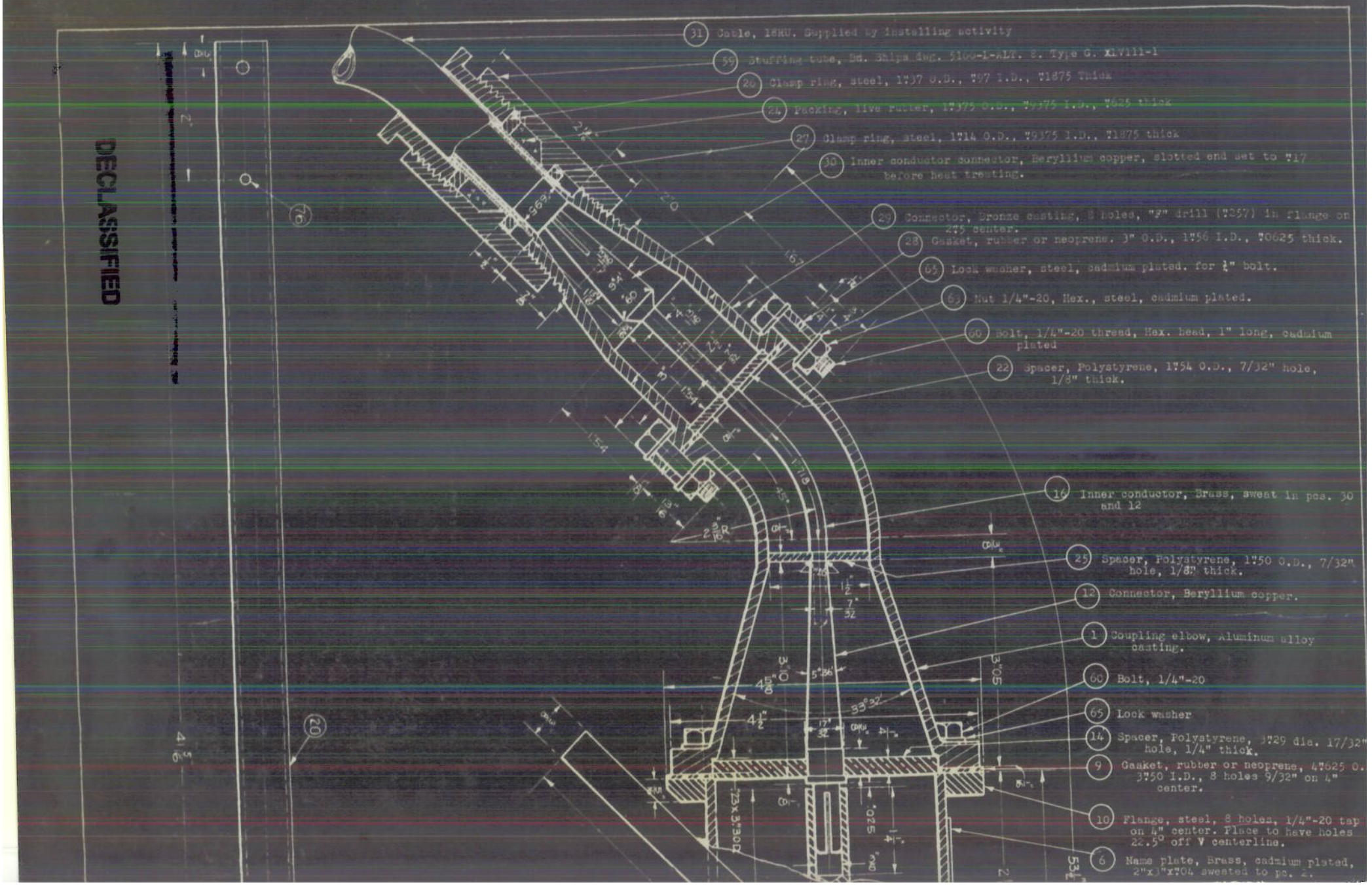
Classification changed from Confidential
To Unclassified
By authority of Lab Memo #117-46
File No. _____ Dated 7-1-46

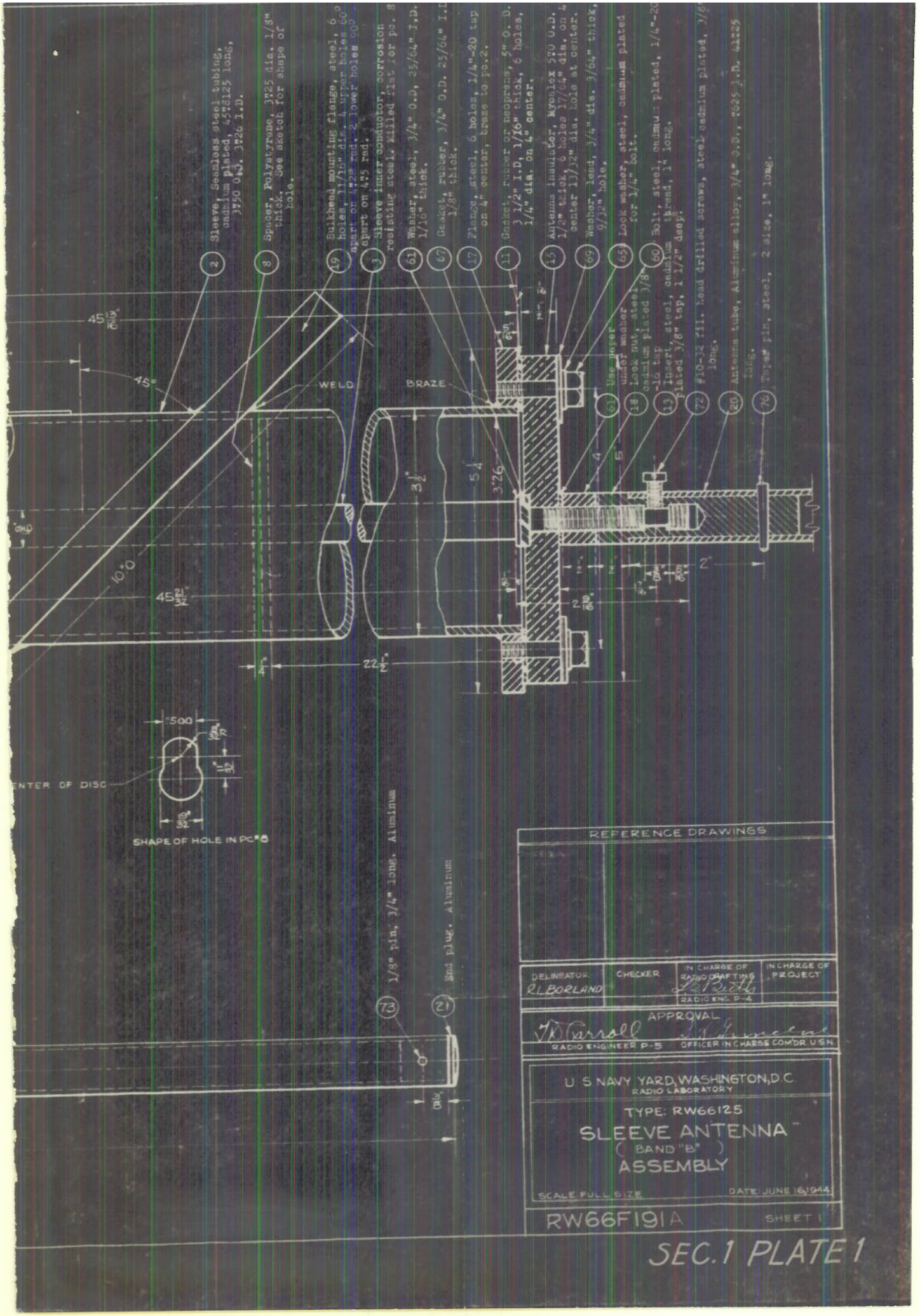
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1	Airborne Instruments Laboratory, Mineola, L. I., New York
1	NDRC, Division 15, 1 River Road, Schanectady, New York
2	OSRD, Liaison Office, Room 724, Dupont Circle Bldg., Washington 25, D. C. (1 copy for transmission to ABL-15, 1 copy retain)

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31 Cable, 15RU. Supplied by installing activity
59 Stuffing tube, Bd. Ships dwg. 5100-1-ALT. 8. Type G. XLV111-1
20 Clamp ring, steel, 1737 O.D., 797 I.D., 71875 Thick
24 Packing, live rubber, 17375 O.D., 79375 I.D., 7625 thick
27 Clamp ring, steel, 1714 O.D., 79375 I.D., 71875 thick
30 Inner conductor connector, Beryllium copper, slotted end set to 717 before heat treating.
29 Connector, Bronze casting, 8 holes, "F" drill (7257) in flange on 275 center.
28 Gasket, rubber or neoprene. 3" O.D., 1756 I.D., 70625 thick.
65 Lock washer, steel, cadmium plated. for ¼" bolt.
63 Nut 1/4"-20, Hex., steel, cadmium plated.
60 Bolt, 1/4"-20 thread, Hex. Head, 1" long, cadmium plated
22 Spacer, Polystyrene, 1754 O.D., 7/32" hole, 1/8" thick.
16 Inner conductor, Brass, sweat in pos. 30 and 12
25 Spacer, Polystyrene, 1750 O.D., 7/32" hole, 1/8" thick.
12 Connector, Beryllium copper.
1 Coupling elbow, Aluminum alloy casting.
60 Bolt, 1/4"-20
65 Lock washer
14 Spacer, Polystyrene, 1729 dia. 17/32" hole, 1/4" thick.
9 Gasket, rubber or neoprene, 47625 O. 3750 I.D., 8 holes 9/32" on 4" center.
10 Flange, steel, 8 holes, 1/4"-20 tap on 4" center. Place to have holes 22.5° off V centerline.
6 Name plate, Brass, cadmium plated, 2"x3"x704 sweated to pc. 2.



REFERENCE DRAWINGS

DELINEATOR	CHECKER	IN CHARGE OF RADIO DRAFTING	IN CHARGE OF PROJECT
R.L. BORLAND		RADIO ENG. P-4	

APPROVAL

RADIO ENGINEER P-5 — OFFICER IN CHARGE COMDR. U.S.N.

U S NAVY YARD, WASHINGTON, D.C.
RADIO LABORATORY

TYPE: RW66125

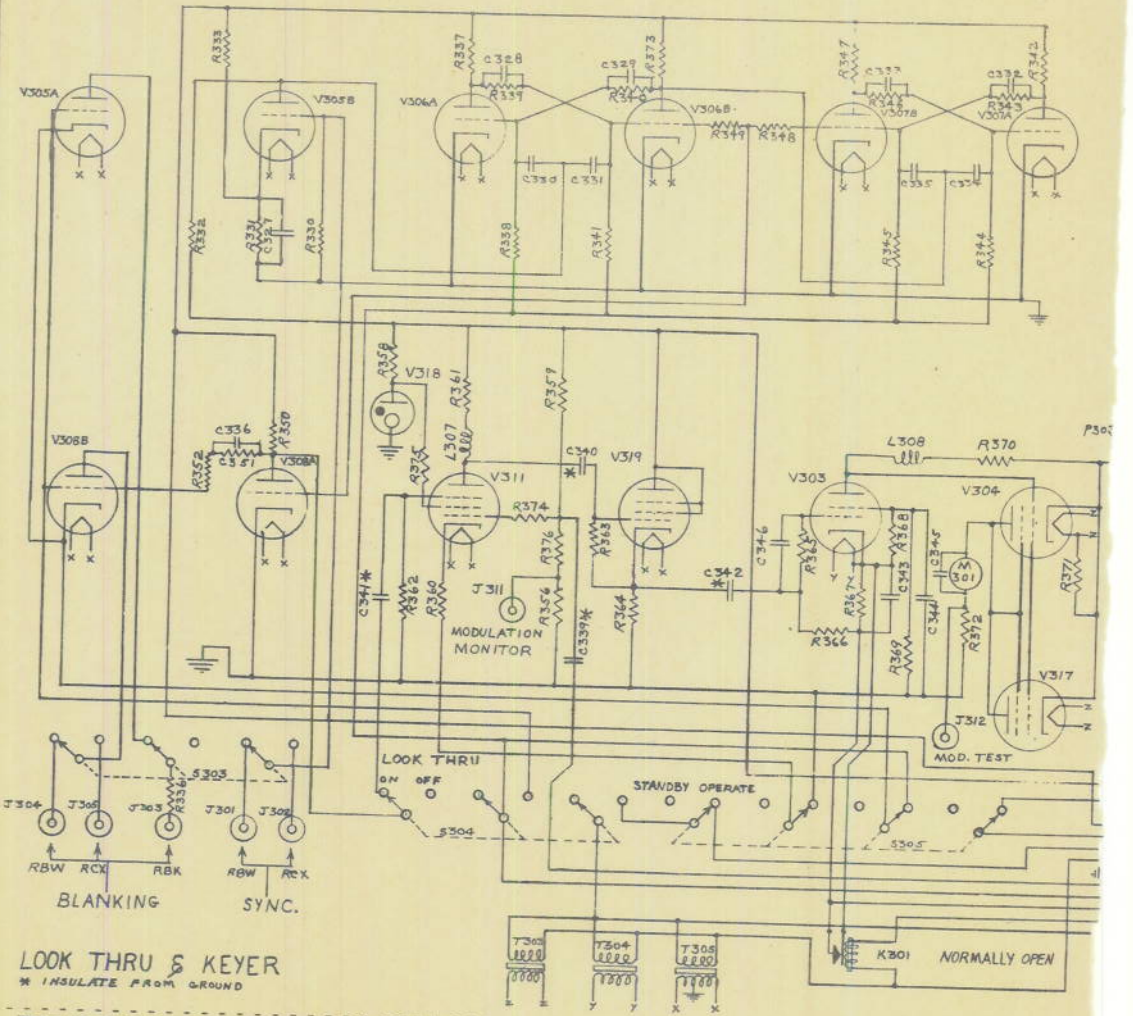
SLEEVE ANTENNA
(BAND "B")
ASSEMBLY

SCALE FULL SIZE — DATE JUNE 16 1944

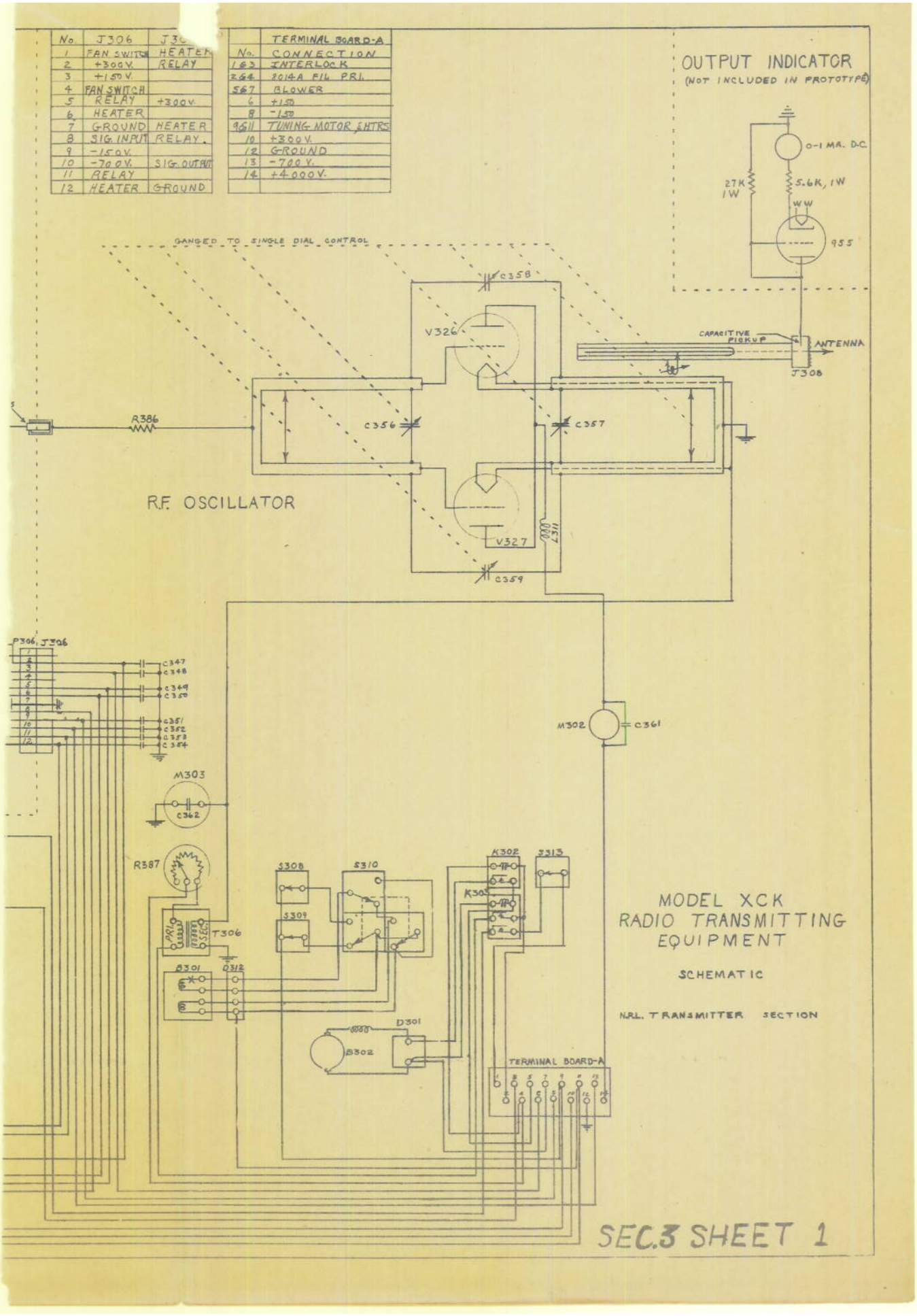
RW66F191A — SHEET 1

SEC. 1 PLATE 1

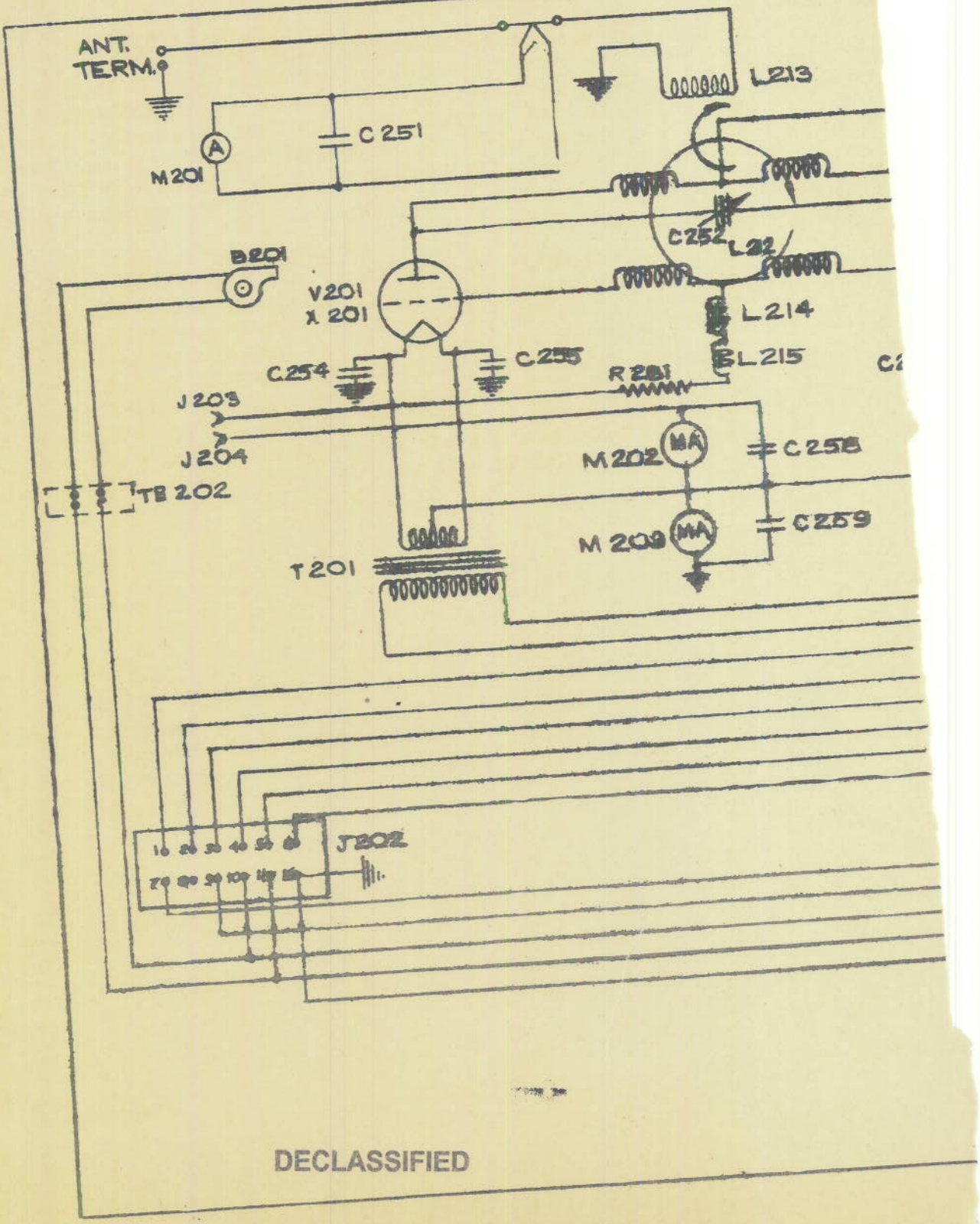
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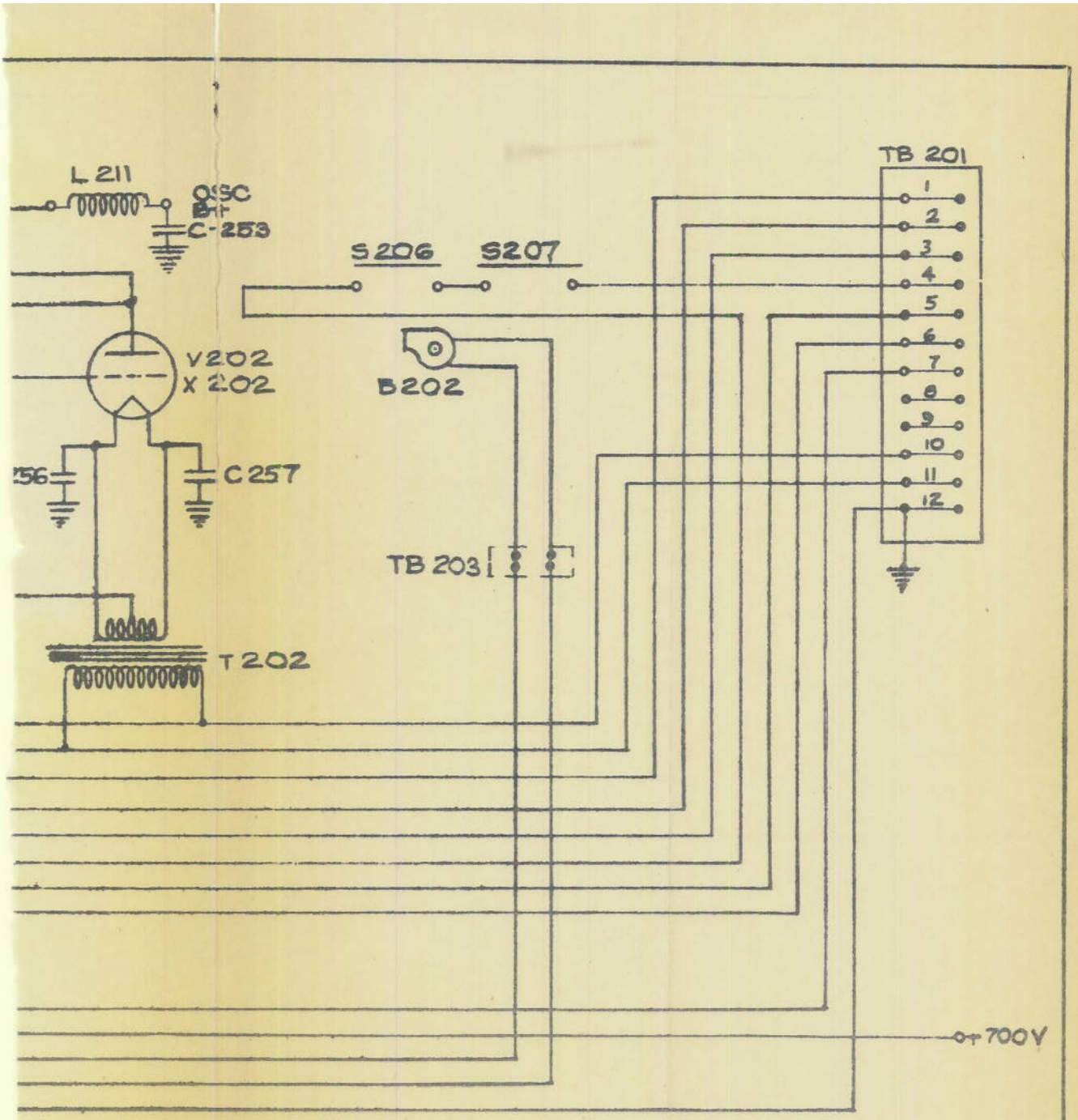
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No. J306 J3
1 FAN SWITCH HEATER
2 +300V. RELAY
3 +150V.
4 FAN SWITCH
5 RELAY +300V.
6 HEATER
7 GROUND HEATER
8 SIG. INPUT RELAY.
9 -150V.
10 -700V. SIG. OUTPUT
11 RELAY
12 HEATER GROUND
No. TERMINAL BOARD-A CONNECTION
1&3 INTERLOCK
2&4 2014A FIL. PRI.
5&7 BLOWER
6 +150
8 -150
9&11 TUNING MOTOR & HTRS
10 +300V.
12 GROUND
13 -700V.
14 +4000V.
OUTPUT INDICATOR
(NOT INCLUDED IN PROTOTYPE)
0-1 MA. D.C.
27K 1W
5.6K, 1W WW
955
GANGED TO SINGLE DIAL CONTROL
C358
V326
CAPACITIVE PICKUP
ANTENNA
J308
R386
C356
C357
R.F. OSCILLATOR
V327
L311
C359
P306, J306
C347
C348
C349
C350
C351
C352
C353
C354
M302
C361
M303
C362
R387
S308
S310
K302
J313
S309
K303
T306
PRI.
SEC.
B301
B312
D301
B302
TERMINAL BOARD-A
MODEL XCK
RADIO TRANSMITTING
EQUIPMENT
SCHEMATIC
N.R.L. TRANSMITTER SECTION
SEC. 3 SHEET 1

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ALTERATION TABLE		
	DRAWN	D.R.C.
	TRACED	
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	APPROVED	
	IN CHARGE OF DESIGN	Supt. Design & Drafting Div.
	CRS.	
	FOR DIRECTOR	
	Comdr. U.S.N.	

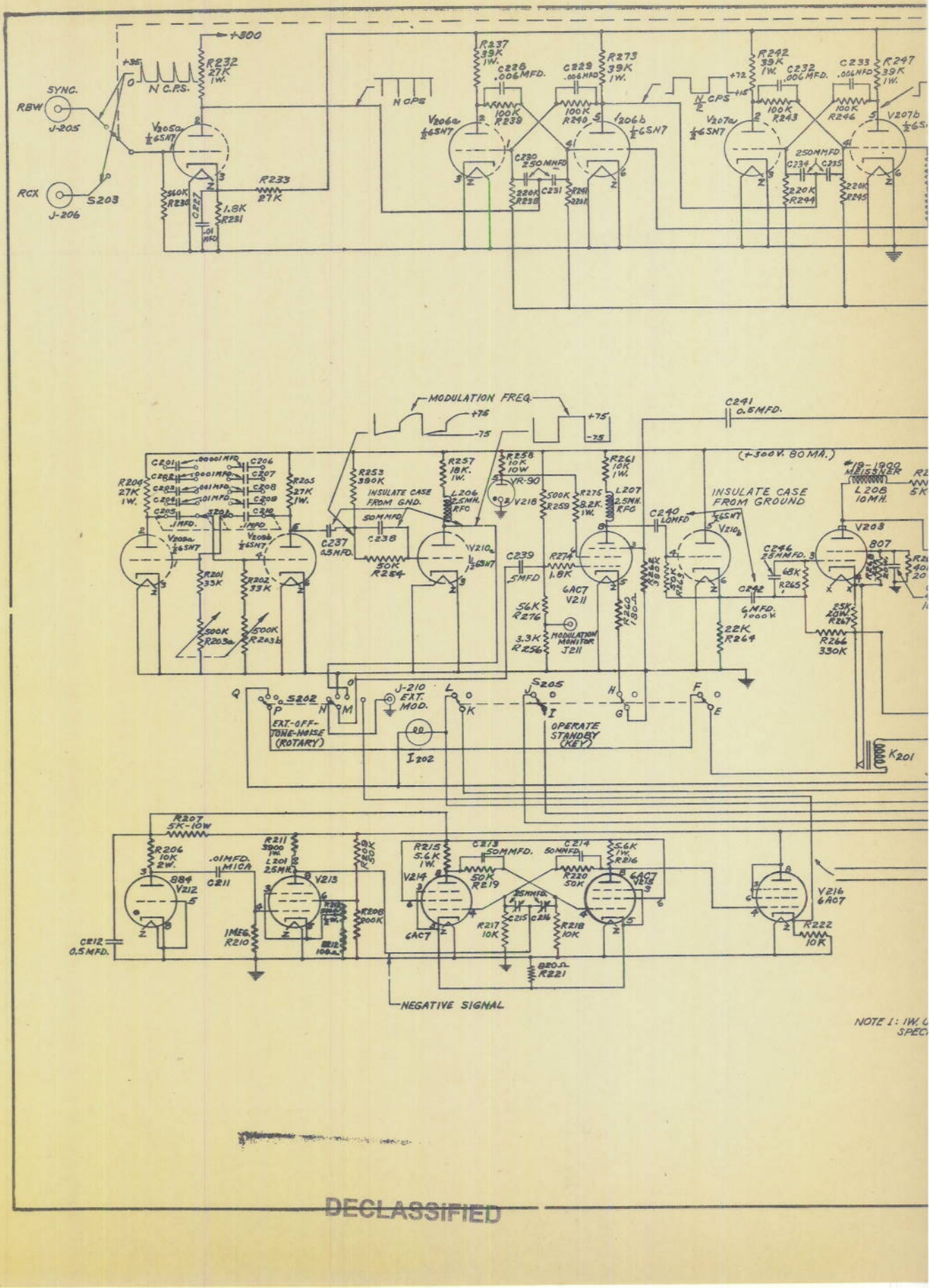
NAVAL RESEARCH LABORATORY
WASHINGTON 20, D. C.

R. F. OSCILLATOR FOR
X C J-4 TRANSMITTER
SCHEMATIC DIA.

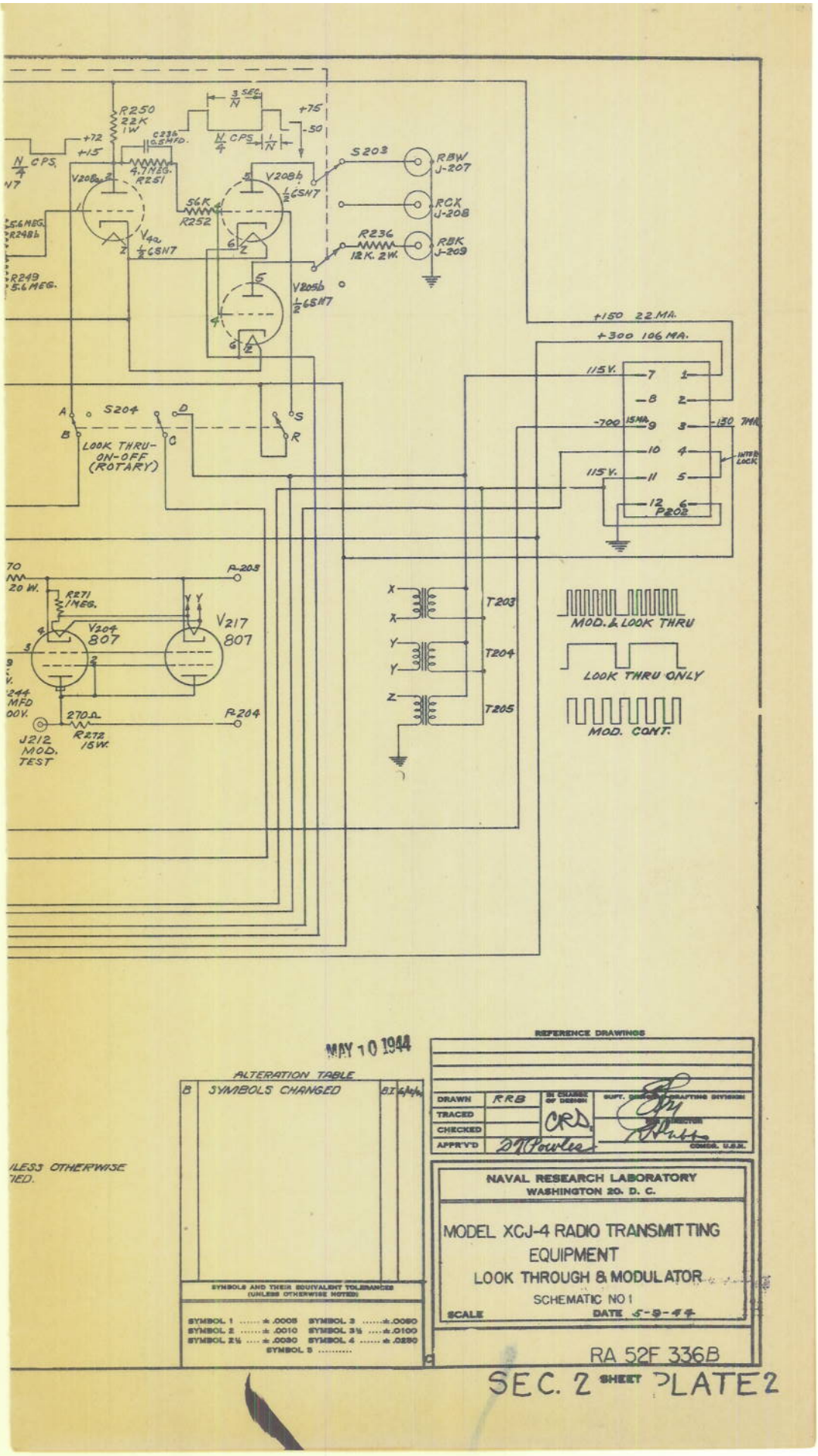
SCALE

DATE JULY 4, 1944

SEC. 2 PLATE 1 RA 35AA 276A



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MAY 10 1944

ALTERATION TABLE

B	SYMBOLS CHANGED	BI 6/4/44

SYMBOLS AND THEIR EQUIVALENT TOLERANCES (UNLESS OTHERWISE NOTED)

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

ILESS OTHERWISE IED.

REFERENCE DRAWINGS

DRAWN	R.R.B.	IN CHARGE OF DESIGN	C.R.D.
TRACED			
CHECKED			
APPR'V'D	D.M. Fowler		

NAVAL RESEARCH LABORATORY
WASHINGTON 20. D. C.

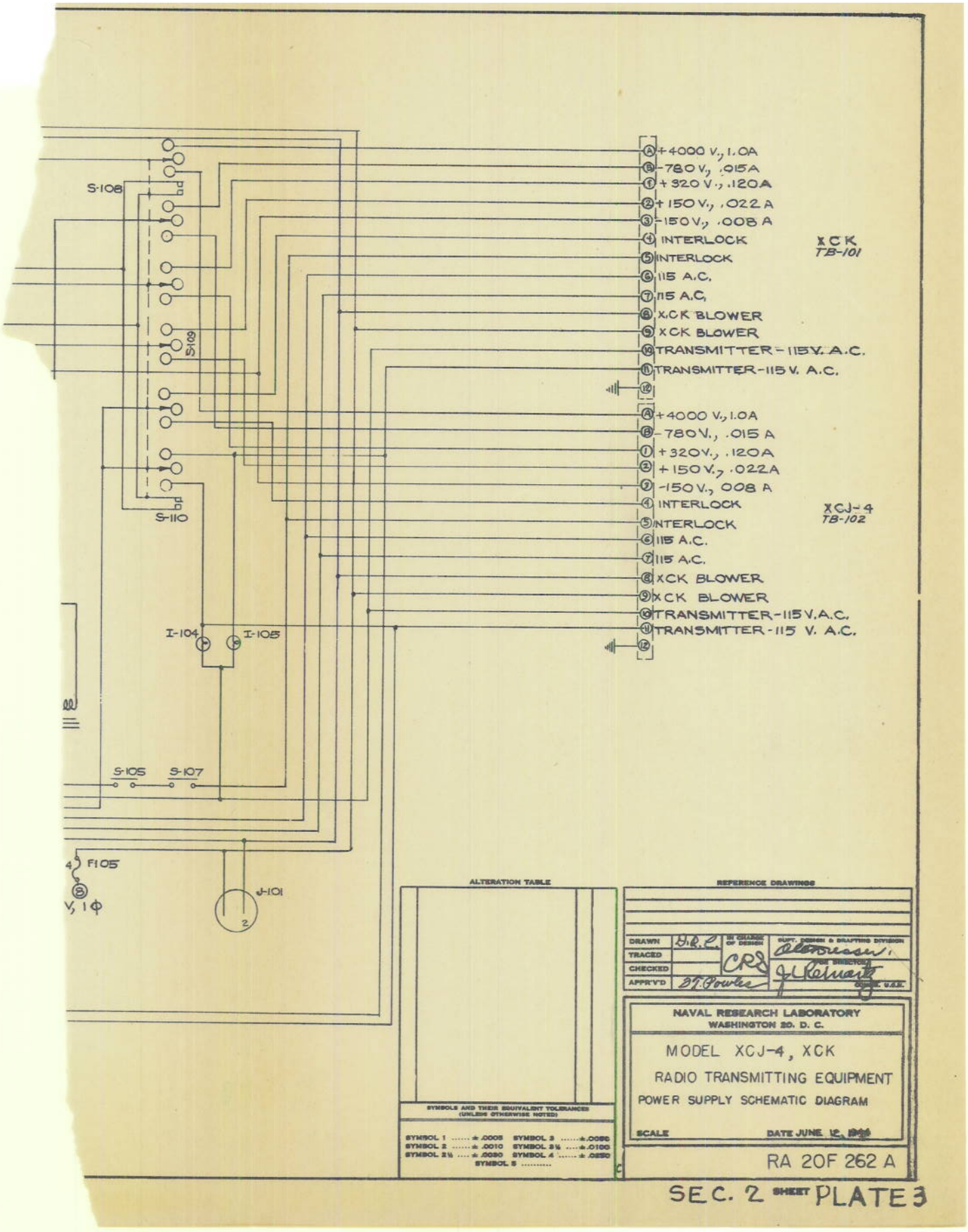
MODEL XCJ-4 RADIO TRANSMITTING EQUIPMENT
LOOK THROUGH & MODULATOR
SCHEMATIC NO 1

SCALE

DATE 5-9-44

RA 52F 336B

SEC. 2 SHEET PLATE 2


S-108
S-109
S-110
S-105
S-107
I-104
I-105
F105
J-101
V, 1 φ
+4000 V., 1.0A
-780 V., .015A
+320 V., .120A
+150 V., .022 A
-150 V., .008 A
INTERLOCK
INTERLOCK
115 A.C.
115 A.C.
XCK BLOWER
XCK BLOWER
TRANSMITTER-115V. A.C.
TRANSMITTER-115 V. A.C.
XCK
TB-101
+4000 V., 1.0A
-780 V., .015 A
+320 V., .120A
+150 V., .022A
-150 V., 008 A
INTERLOCK
INTERLOCK
115 A.C.
115 A.C.
XCK BLOWER
XCK BLOWER
TRANSMITTER-115 V.A.C.
TRANSMITTER-115 V. A.C.
XCJ-4
TB-102
ALTERATION TABLE
SYMBOLS AND THEIR EQUIVALENT TOLERANCES (UNLESS OTHERWISE NOTED)
SYMBOL 1 ..... ± .0005
SYMBOL 2 ..... ± .0010
SYMBOL 2½ .... ± .0030
SYMBOL 3 ..... ± .0050
SYMBOL 3½ .... ± .0100
SYMBOL 4 ..... ± .0250
SYMBOL 5 .....
REFERENCE DRAWINGS
DRAWN D.R.L.
TRACED
CHECKED
APPR'V'D E.T. Fowler
IN CHARGE OF DESIGN C.R.S.
SUPT. DESIGN & DRAFTING DIVISION
NAVAL RESEARCH LABORATORY
WASHINGTON 20. D. C.
MODEL XCJ-4, XCK
RADIO TRANSMITTING EQUIPMENT
POWER SUPPLY SCHEMATIC DIAGRAM
SCALE
DATE JUNE 12, 1944
RA 20F 262 A
SEC. 2 SHEET PLATE 3

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PART I

TEA DEVELOPMENT PROGRAM

References:

(a) BuShips ltr S-S67-5(923-2) S-920-06156 to NRL of 9 Oct 1943
(b) BuShips ltr S-S67-5(920-C) S-920-06336 to NRL of 4 Nov 1943
(c) NRL ltr S-S67-5/RCM(321) Ser. 1957 to BuShips of 18 Oct 1943
(d) BuShips ltr S-S67-5(923-2) S-920-06126 to NRL of 5 Oct 1943
(e) NRL ltr C-S67-5/RCM(362) to BuShips of 7 July 1944
(f) NRL ltr C-F42-1/84/RCM(322) to BuShips of 10 Dec 1943
(g) Navy Specifications RE 13A 924 of 25 May 1944
(h) NRL Report No. R2240
(i) NRL ltr C-F42-1/84/RCM(320) to BuShips of 30 June 1944
(j) BuShips ltr C-S67-1/68(920-Cb) C-920-6080 to NRL of 15 May 1944
(k) NRL ltr C-F42-1/84/RCM(320) to BuShips of 23 May 1944

1. Abstract

1-1 This report covers the development and test of the model TEA jamming transmitter authorized by references (a) and (b). The model TEA transmitter has been designed as a high-powered jamming transmitter for guided missiles countermeasures use and covers the frequency range from 15 to 125 Mc with an average power output in excess of 1 kw. This transmitter also should be useful for communication jamming within its frequency range. The model TEA equipment actually consists of two separate jamming transmitters, either one of which can be operated from a common power supply. The two component transmitters bear the experimental designations, "XCJ-4" (15 to 55 Mc) and "XCK" (40 to 125 Mc).

1-2 This report is divided into three parts; the first, covering the general guided missiles countermeasures jammer program leading to the development of the TEA equipment; the second, being a detailed report on the construction and test of the XCJ-4 transmitter; and the third, being a similar report on the construction and test of the XCK transmitter.

2. General Description of Model TEA Equipment

2-1 The model TEA jamming transmitter is composed of three rectangular units assembled on top of each other to form a complete

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assembly measuring approximately 72 inches high, 48 inches wide, and 24 inches deep. The bottom unit contains the high-voltage rectifier filter and control circuits for both the XCJ-4 and XCK transmitters. Primary power is obtained from the three-phase, 440-volt supply; and auxiliary power is obtained from the three-phase, 110-volt source. The middle unit houses the XCJ-4 oscillator and modulator. The XCJ-4 oscillator employs 833-A tubes in a push-pull tuned plate, self-excited oscillator circuit. This oscillator covers the 15 to 55 Mc range in three bands by means of plug-in coils. The top unit contains the XCK oscillator and modulator circuits. The XCK oscillator employs 8014-A tubes in a push-pull capacitance loaded tuned-grid, tuned-cathode line oscillator circuit, covering the entire 40 to 125 Mc range in a single band. The modulator circuits for the XCJ-4 and XCK units are identical and interchangeable. Modulation is obtained by means of square wave grid keying as described in greater detail in the subsequent sections of this report.

3. Development Responsibility

3-1 This transmitter has been developed jointly by the Special Development Section, the Transmitter Section, and the Communication Security Section of this Laboratory; and the three parts of this report have been prepared independently by these three Sections. The Communication Security Section formulated the general basic design and conducted the preliminary experimental work on both transmitters and prepared Part I of this report. The Special Development Section was responsible for the final development, construction, and test of the XCJ-4 transmitter and power supply and has prepared Part II of this report. The Transmitter Section has been responsible for the final development, construction, and test of the XCK transmitter and has prepared Part III of this report.

4. History of TEA Development

4-1 Work on the development of jamming transmitters for countermeasures against guided missiles was started at the Naval Research Laboratory almost a year prior to the first guided missile attacks by the Germans. This early work had been carried on under low priority but had led to the development of a simple single-dial control jammer of approximately 75 watts output at frequencies up to 45 Mc, with a very flexible system of tone and noise modulation. This jammer has been used successfully in tests against radio control drones.

4-2 The desirability of a much more powerful single dial tuned jammer, capable of operation at higher frequencies, also was recognized at this early date. Work has been started on the development of a condenser loaded line tuned oscillator using 8014-A tubes early in the spring of 1943. This oscillator later became the first laboratory model of the XCK or high-frequency portion of the TEA jammer.

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4-3 Following the first German guided missile attacks, this Laboratory equipped two destroyer escorts with analysis and jamming equipment as reported in reference (c). The only commercial transmitters then available which seemed to have possible application for missile jamming at the frequencies then suspected were the Signal Corps SCR-596T-1 jammer and the GO-5 aircraft transmitter. These transmitters were installed on both ships as the major jamming equipment and the 75 watt Naval Research Laboratory jammer also was installed aboard one ship, even though this jammer had not been constructed for shipboard service. At this time, development of the first experimental XCK had not progressed far enough for it to be installed. After arriving at the scene of operations, the frequency range of the Naval Research Laboratory jammer was extended to 50 Mc and this jammer was used effectively during subsequent attacks. The operating personnel agreed that a simple single dial tuned oscillator was more practical for missile jamming than the other multistage transmitters.

4-4 At the time of the above installations, the need for a simpler jammer of much higher power was recognized. Since it was evident that the development of the experimental XCK could not be completed in a short time, and since there was doubt that its lower frequency limit could be dropped to the 17 Mc frequency then believed to be used by the Germans, work was started on the development of a jammer using push-pull 833-A tubes in a self-excited tuned plate oscillator circuit with plug-in coils. For the lack of any official designation, the above jammer using 833-A tubes was termed, "TX" and the higher frequency jammer using 8014-A tubes was termed, "TY". These unofficial designations appeared in much of the early correspondence and caused some confusion. These designations later were replaced by the Navy experimental designations "XCJ" for the "TX" jammer, "XCK" for the "TY" jammer, and "XCL" for a proposed "TZ" jammer intended to cover 15 to 130 Mc in a single band. The XCL project subsequently has been abandoned.

4-5 Reference (d) requested this Laboratory to construct six XCJ jammers on a crash basis. This problem was assigned to the Special Development Section and all preliminary information obtained by the Communication Security Section was turned over to them, leaving the transmitter group of the Communication Security Section free to continue the XCK development and to start the development of the XCL jammer. During the crash production of XCJ's, additional improvements were incorporated in the subsequent units as the necessary development information became available. Whereas the first two XCJ's were delivered with provisions only for tone modulation, the final units had provision for both tone and noise modulation and were equipped for look-through operation. The noise modulation was added on the possibility that it could be used for barrage jamming of several adjacent missile control channels at short ranges. While this use has not been practical, the noise modulation should be useful for communication jamming. The same packaging was retained for all of these crash units and was much larger than necessary.

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4-6 The XCJ circuit drawings formed the basis for the production of the CXGE jammers described in reference (e). These jammers were conversions of a General Electric one killowatt FM broadcast final amplifier. The cabinet and power supply of these amplifiers were retained and the amplifier was replaced by the XCJ oscillator, modulator and look-through circuits.

4-7 Reference (a) requested the Laboratory to build a manufacturer's prototype of the XCJ. Reference (b) extended the above problem to include prototypes of the XCK and XCL and to develop broad band shipboard antennas covering the frequency range of this equipment. The completion of the XCK development and the construction of its prototype was assigned to the Transmitter Section, leaving the Communication Security Section free to continue the development of the XCL. It was decided that the XCJ and XCK should be so constructed as to operate individually, but not simultaneously, from the same power supply so that both the XCJ and XCK eventually could be assembled into one transmitter. The physical nature of the long line oscillator in the XCK required that this unit be housed in a horizontal case approximately 2' x 2' x 4'. This necessitated repackaging the XCJ and power supply into cabinets of similar dimensions so that all three units could be stacked into a single assembly not exceeding six feet in height. Reference (f) is the tentative specifications for the XCJ and XCK prototypes which were followed by the Special Development and Transmitter Sections in the construction of these prototypes. Reference (g) is the Navy Specifications for the TEA transmitter, which was based upon the above tentative specifications.

5 Broad Band Antennas and Antenna Switches

5-1 The problem, as extended by reference (b), included the development of shipboard broad band antennas covering the 15 to 130 Mc range. Upon the recommendation of antenna engineers of NDRC, Division 15, this Laboratory investigated the suitability of sleeve antennas and was able to cover the above frequency range with three such antennas, each matching a 50 ohm resistance within a 2:1 standing wave ratio over a 2:1 frequency band. Reference (k) is a report of the development of the 15 to 30 Mc and 30 to 60 Mc sleeve antennas and their test aboard a destroyer escort. Plate 1 is an assembly drawing of the 30 to 60 Mc sleeve antenna and Plate 2 is a photograph of the two lower frequency sleeve antennas installed on a cruiser. Reference (i) is a report on the development of the 60 to 130 Mc sleeve antenna which has been designed to be mounted on yardarms.. Plate 3 is a photograph of a laboratory model of this antenna. Plate 4 shows this antenna installed on the yardarm of a destroyer.

5-2 The high average power supplied by these transmitters requires the use of large size antenna cable such as RG-18/U and the above antennas have been designed for use with this cable. No cable fittings or antenna switches were available for use with this size cable. Reference (j)

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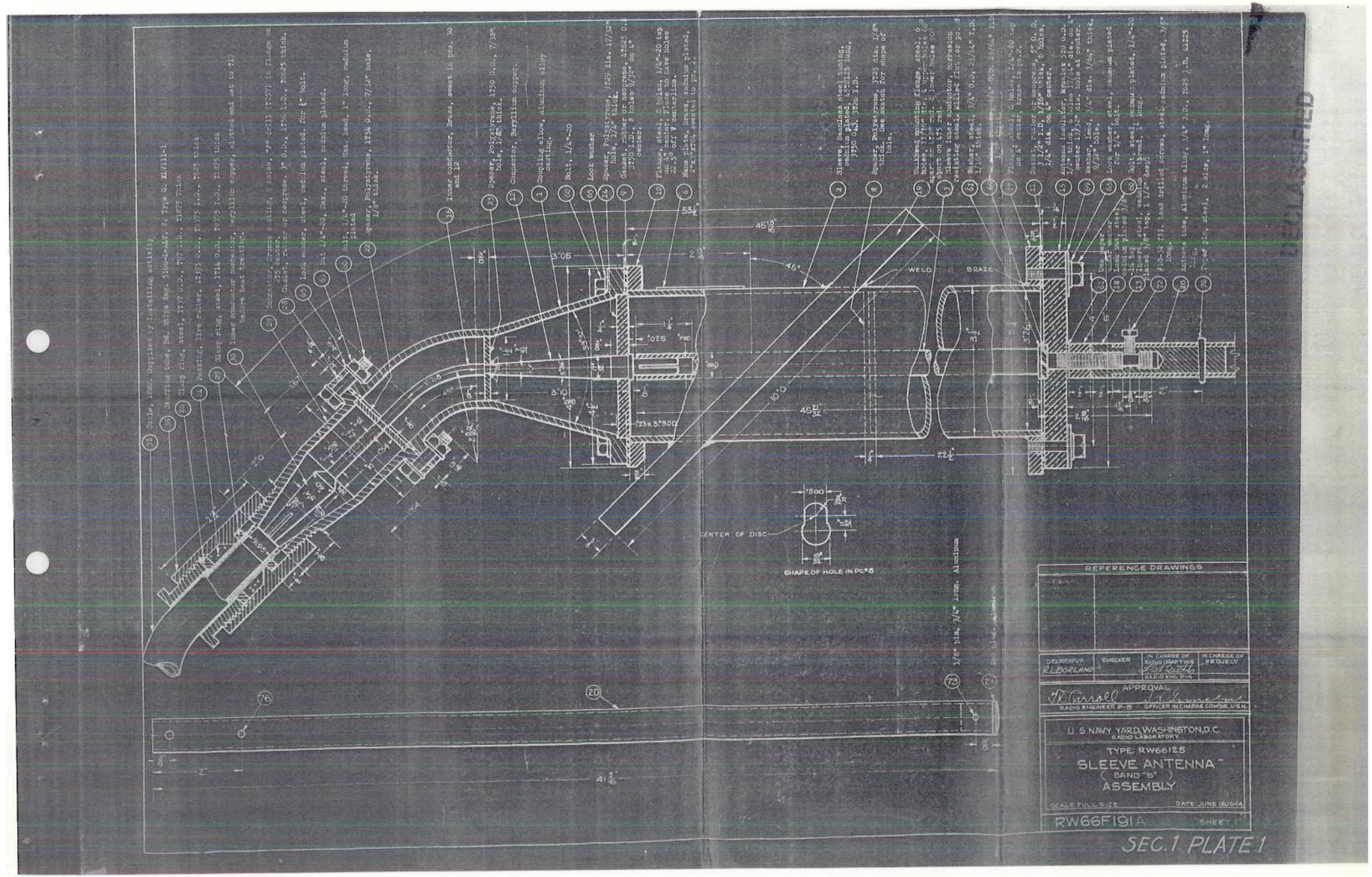
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assigned the problem of developing and testing the antenna switches needed to connect as many as eight antennas to either of the two oscillators. Cable fittings for use with these switches were designed by the Bureau of Ships and tested by this Laboratory as reported in reference (k). A magnetically operated, single-pole, double-throw antenna switch previously designed by the Special Development Section of this Laboratory was modified to take the new cable fittings. This switch will be energized from the TEA power supply and will be used to connect the antenna selector switch to whichever oscillator of the TEA is being used. A single-pole, 8-position rotary coaxial antenna selector switch has been designed by the Airborne Instruments Laboratory with the consultation of the Naval Research Laboratory. It is contemplated that in order to eliminate dead spots in some installations, it may be necessary to install antennas for all three bands on both the port and starboard sides of the ship. This 8-position antenna switch will be capable of selecting any one of the above six antennas with a dummy load connected to the seventh position and the eighth position remaining free for possible future requirements. Plate 5 shows a block schematic of this antenna switching system. No photographs of these antenna switches are available at the present time.

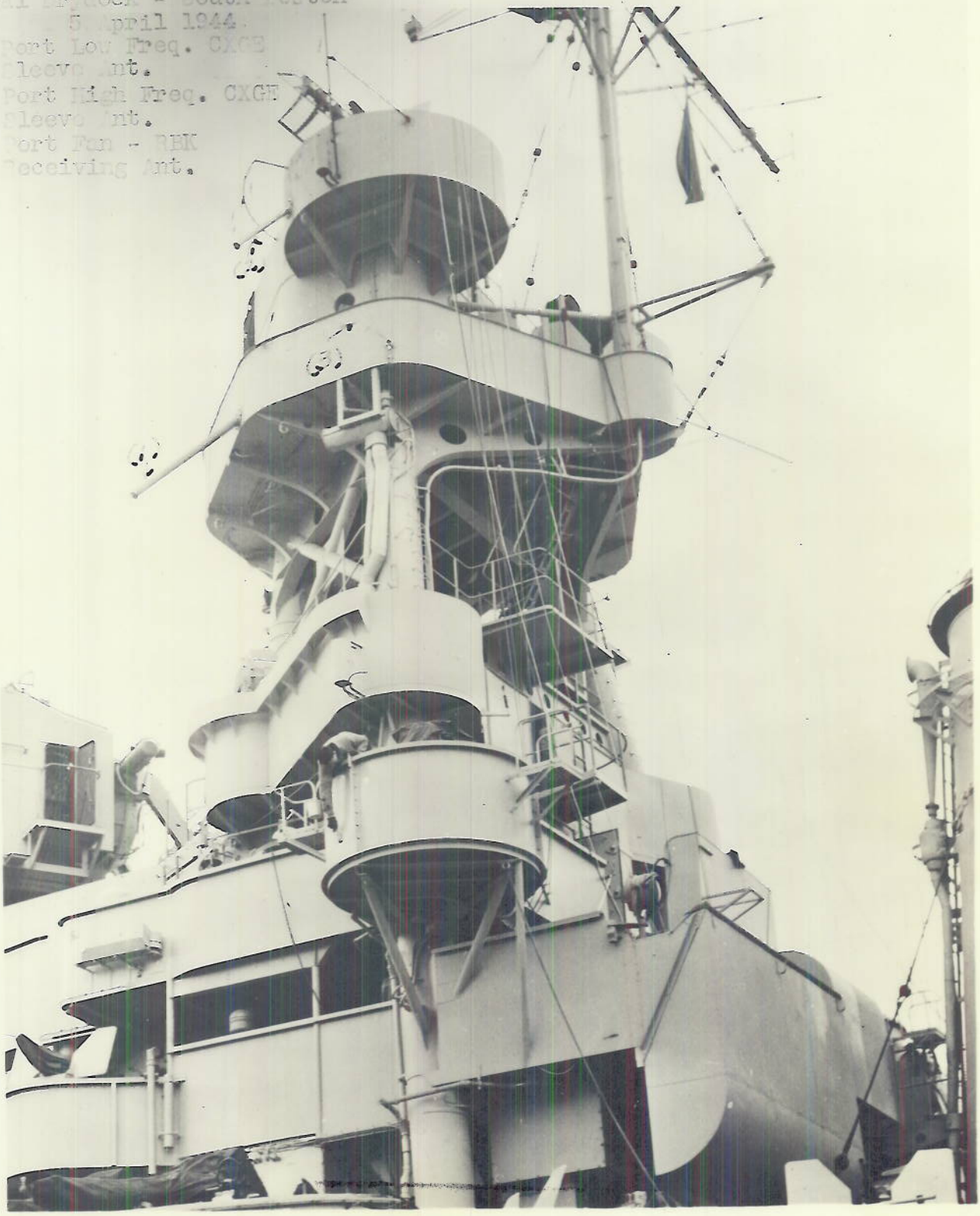
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REFERENCE DRAWINGS
DESIGNATOR R.L.BORLAND
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RADIO ENG. P-4
IN CHARGE OF PROJECT
APPROVAL
RADIO ENGINEER P-5
OFFICER IN CHARGE COMDR. U.S.N.
U. S. NAVY YARD, WASHINGTON, D.C.
RADIO LABORATORY
TYPE: RW66125
SLEEVE ANTENNA
(BAND "B")
ASSEMBLY
SCALE FULL SIZE
DATE: JUNE 16, 1944
RW66F191A
SHEET 1
SEC. 1 PLATE 1
WELD
BRAZE
SHAPE OF HOLE IN PC #5
CENTER OF DISC

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CA-51 CXCH Antenna
Naval Drydock - South Boston
5 April 1944.
(1) Port Low Freq. CXCS
Sleeve Ant.
(2) Port High Freq. CXGH
Sleeve Ant.
(3) Port Fan - REK
Receiving Ant.

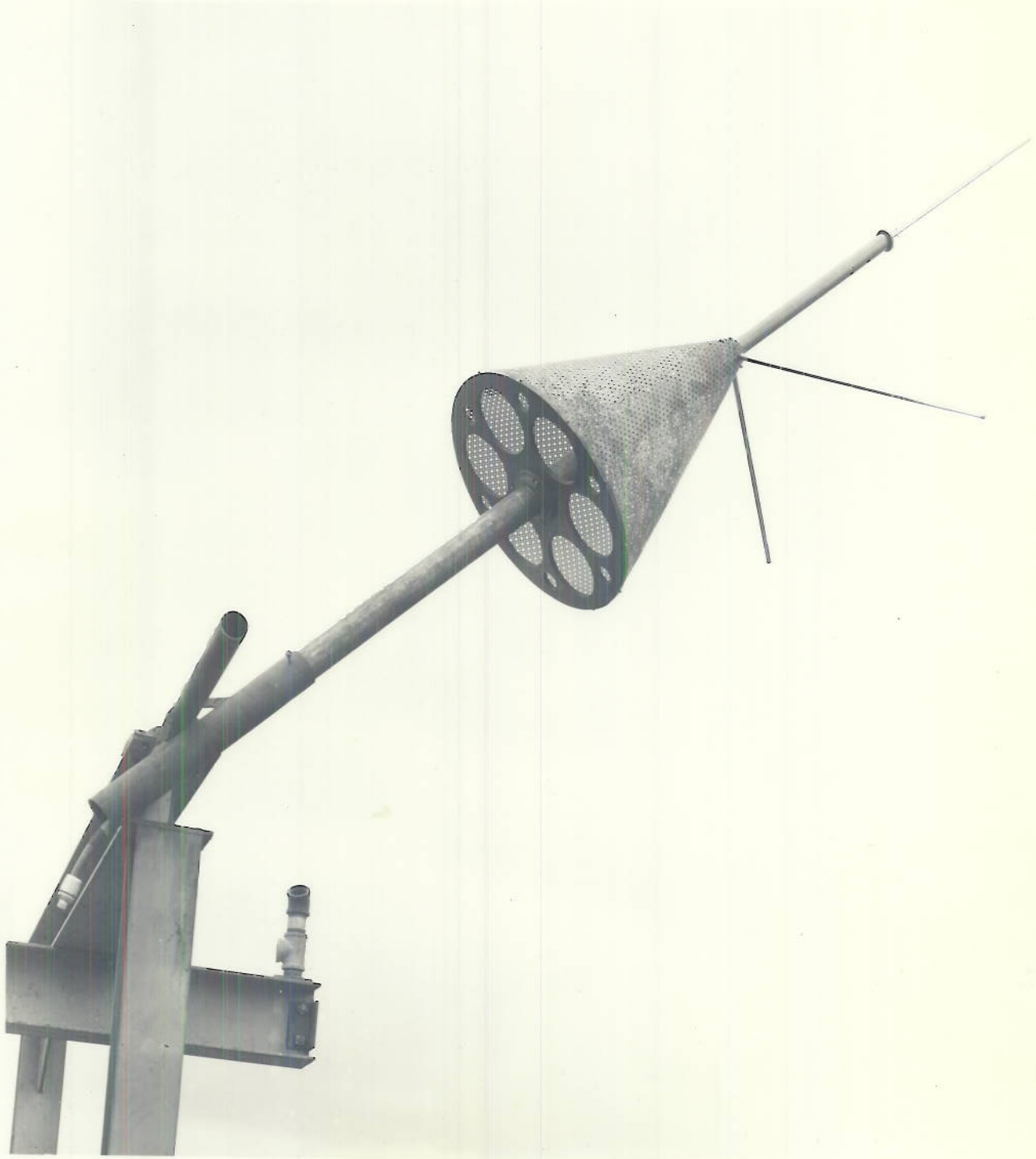


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PLATE 2 SEC. I

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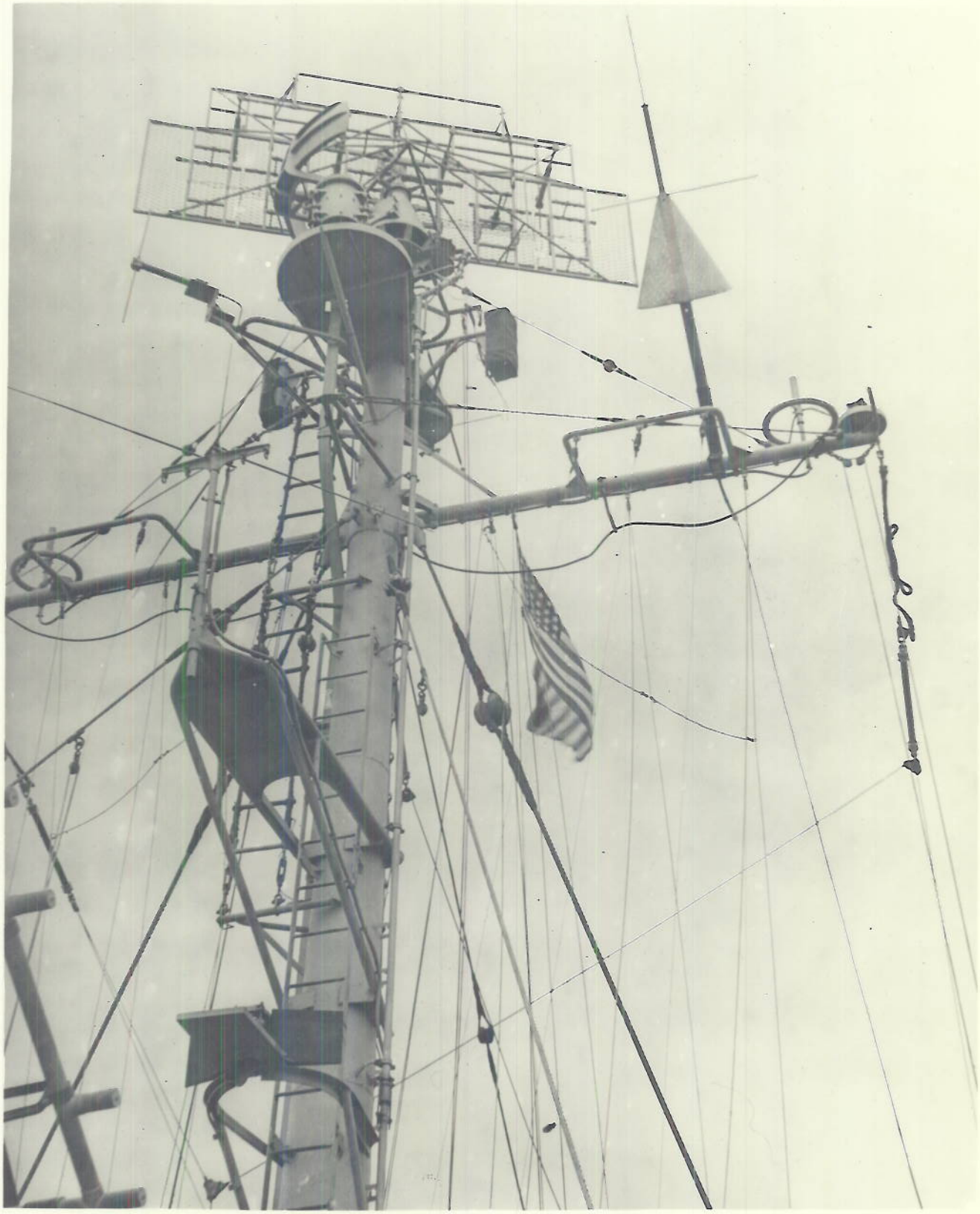


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PLATE 3 SEC. 1

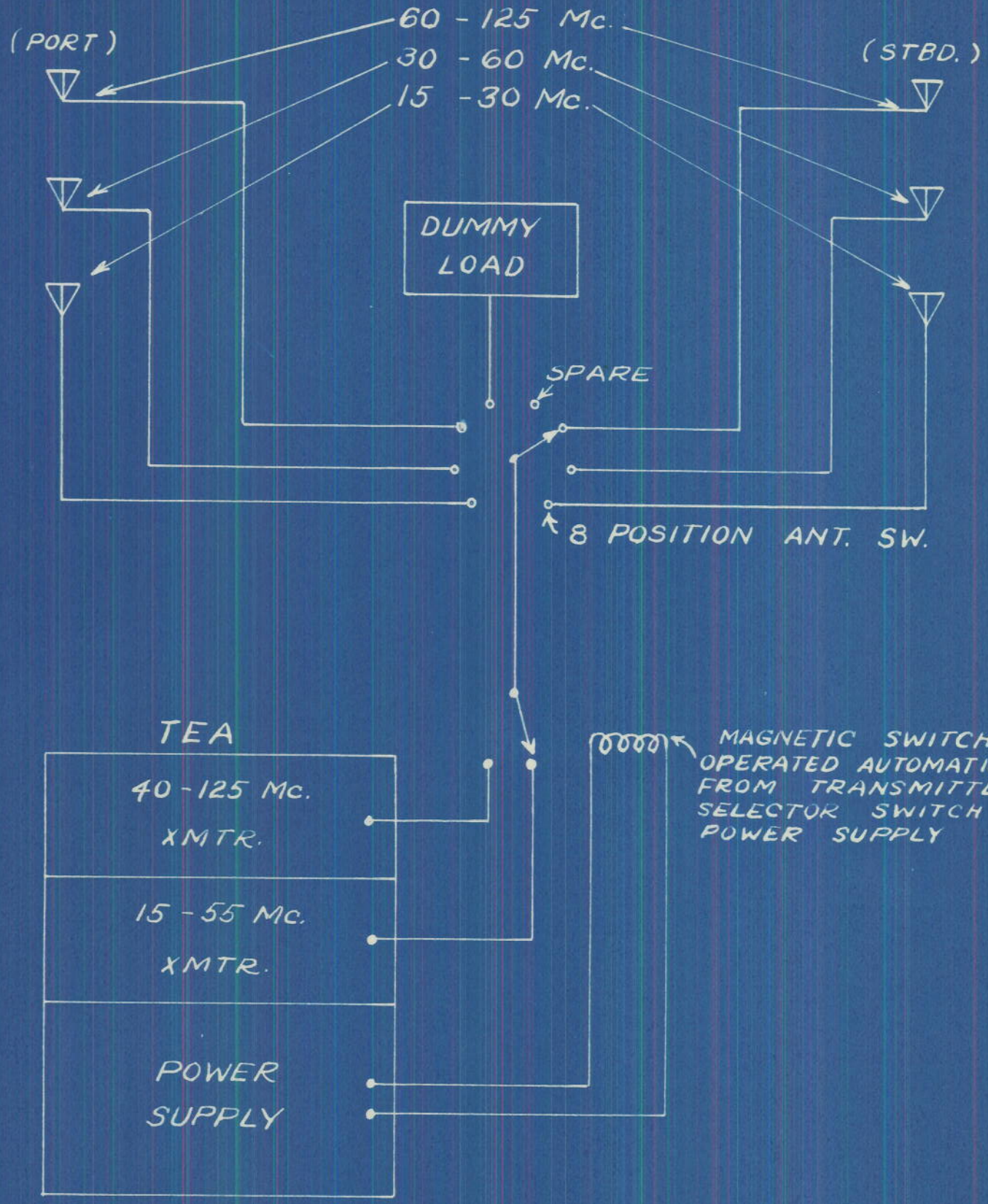
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PLATE 4 SEC. I



ANTENNA SYSTEM FOR TEA EQUIPMENT

SEC. 1 PLATE 5

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PART II

CONSTRUCTION AND TESTING OF

MODEL XCJ-4 TRANSMITTER (15 to 55 Mc)

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PART II

CONSTRUCTION AND TESTING OF

MODEL XCJ-4 TRANSMITTER (15 to 55 Mc)

1. Abstract

1-1 This section of the report covers the construction and testing of the model XCJ-4 transmitter which will be the manufacturer's prototype for the power supply and low-frequency portion of the model TEA transmitter. The tests herein reported were conducted to determine the potentialities of the equipment under Naval conditions of operation and included the results of power output, temperature, humidity, shock, and vibration tests.

2. General Description of the XCJ-4 Transmitter

2-1 The model XCJ-4 transmitter is a self-excited oscillator which employs push-pull 833-A tubes in a tuned plate circuit. Three plug-in tank coils are provided to cover the operating range of 15 to 55 Mc. The power output is in excess of 1000 watts at all frequencies below 52 Mc and rises as high as 2000 watts at certain low frequencies. A wide frequency range of variable tone modulation, as well as noise modulation, is available. Incorporated in the modulator is a "look-through" circuit, provided to enable observation of the victim signal during jamming and to aid in tuning the jammer to the victim's frequency by matching pips on associated panoramic receivers. Single dial control of the r.f. oscillator facilitates rapid adjustment of the jammer frequency to that of the victim signal.

2-2 The model XCJ-4 equipment includes a high-voltage power supply which is a separate unit from the XCJ-4 transmitting oscillator unit. This power supply also is to be used with the XCK transmitter when assembled to form the complete TEA transmitter

3. R.F. Oscillator

3-1 The right hand half of the top frame, as shown on Plates 4 and 5, houses the radio frequency oscillator. Plate 6 shows the back view of the oscillator in the upper left quarter. Two type 833-A triode tubes are used in a push-pull reversed feedback circuit shown in the schematic diagram on Plate 1. Forced air cooling is used to obtain maximum output and tube life. Three plug-in type of coils are used to cover the range with adequate overlapping. These coils are pictured on Plate 8. The split stator tuning condenser was of a special design having a very low minimum capacity to achieve the maximum possible frequency coverage. The keying and modulation of the oscillator are accomplished in the grid circuit.

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4. Keyer-modulator and Look-through

4-1 The upper half of the section adjacent to the r.f. oscillator is occupied by the plug-in chassis of the keyer-modulator. To facilitate servicing of tubes and components, this unit was made to slide out after loosening the four panel thumb screws. A multi-vibrator circuit provides any desired square wave modulation from 5 cps to 300,000 cps. Noise modulation is derived from a type 884 gas tube source, which supplies jamming noise components as high as 200 kilocycles. The modulation switch provides selection of the tone, noise or external modulation, or pure cw output.

4-2 The look-through feature operates at will in conjunction with the external Model RBW or Model RCX Panoramic adapters. The adapter supplies a triggering pulse to the XCJ-4, where it is amplified and formed into a square wave pulse with a blanking ratio of 1 to 3. This pulse is mixed into the amplifier and modulator, where it acts as a keyer to the r.f. oscillator, allowing it to operate for three-fourths of the look-through cycle, and biasing it beyond cut-off for the remaining one-fourth cycle. This provides a "hole" through which the panoramic adapters are able to make one sweep of the spectrum and observe the frequency and character of the enemy signals. The look-through cycle is determined by the sweep rate of the panoramic adapter being used. A counter circuit allows three low sensitivity panoramic traces of the XCJ-4 signal to appear on the analyzer screen, followed by one trace of the panoramic adapters operating at high sensitivity to observe the "victim" signals. A four to one reduction of the repetition rates of synchronizing pulse to look-through pulse is thus obtained and although a 30 cycle synchronizing signal has been used in the tests to obtain a 7.5 cycle look-through rate, it is possible to use a 60 cycle synchronizing signal to provide a 15 cycle look-through rate. Although look-through operation is provided, it is well to use it only for brief intervals to adjust transmitter frequency, and to employ the full modulated power as much as possible while jamming a signal.

4-3 The schematic diagram of the keyer-modulator is given on Plate 2. A view of the top of the chassis is presented on Plate 9. The sub-chassis view showing the arrangement of components and interconnections may be seen on Plate 10.

5. Power Supply

5-1 The entire lower frame in the front views of Plates 4 and 5, and in rear view Plate 6, is utilized by the power supply. The schematic wiring diagram and terminal board arrangement are presented on Plate 3. Three 872-A mercury vapor rectifier tubes in a three phase half wave circuit supply plate voltages up to 4000 volts D.C. at 1 ampere. A three phase Variac in the transformer primary circuit provides a means of controlling the plate voltage from the front panel. Thus the input

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to the r.f. oscillator may be set to the optimum value. A thermostatically operated heater maintains a safe minumum operating temperature about the mercury vapor tubes. The plate voltage can be applied only after a time delay circuit has allowed the rectifier filaments to preheat. Two bias supplies and one low voltage power supply for the keyer-modulator are alos located in this frame. The Transmitter Selector switch at the right end of the front panel directs power to either the XCJ-4 or the XCK transmitters. Provision is made to supply power to an XAZ type antenna changeover relay which may be used to change antenna transmission line connections from the XCJ-4 and XCK.

6. Electrical and Mechanical Tests

6-1 A power output run using a tuned water cooled resistor load was taken at 22 locations throughout the frequency band. The results are tabulated in Appendix A. Tests covering shock and vibration, and wide variations in temperature and humidity such as are met in Naval service have been made. These are listed in Appendix B.

7. Conclusions

7-1 Serial Number 1 of the Model XCJ-4 radio transmitting equipment has been delivered to the Transmitter Equipment Manufacturing Co, of New York, N. Y. It is being used as a prototype in the manufacture of the Model TEA radio transmitting equipment. Tests are in progress on Serial No 2, which will subsequently be used in the training of personnel who are to be assigned to ships on which the Model TEA will be installed. Minor modifications have been made in the design of Serial No 2, and some further changes will be noted in the production Model TEA. Being of a minor nature, they do not affect the basic principle or method of operation.

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8. Appendix A

8.1 Power Output Run with Tuned Water Cooled Resistor Load

Freq. Mcs	P_{out} Watts	E_p Volts	I_p Ma.	I_g Ma.	Ant.Coup. Setting	Line Input Watts	Osc. P_{input} Watts	Eff. Percent
14.4	1860	4000	840	55		5000	3360	55.4
20.0	2040	4000	810	90	66	4850	3240	63.0
25.0	2200	4000	840	124	78	5000	3360	65.4
27.3	1570	4000	640	170	83	4000	2560	61.4
25.3	1110	4000	860	60	61	5100	3440	32.3
26.0	1100	4000	800	65	60	4800	3200	34.4
30.0	1340	4000	850	96	60	5050	3400	39.4
33.0	1710	4000	850	115	62	5050	3400	50.3
36.0	1680	4000	820	175	62	4880	3280	51.2
40.0	1620	3500	860	215	66	4570	3010	53.8
43.5	1200	2700	880	205	73	3800	2380	50.4
47.0	750	1900	840	200	77	2880	1600	46.9
48.0	650	1800	890	220	74	2880	1600	40.6
48.75	540	1700	880	210	74	2760	1500	36.0
44.0	970	4000	800	55	63	4800	3200	30.3
48.0	1240	4000	840	120	65	5000	3360	36.9
49.0	1300	3900	860	145	65	5000	3350	38.8
50.0	1340	4000	860	195	64	5100	3440	39.0
51.0	1300	4000	900	215	65	5300	3600	36.1
53.0	840	3250	870	215	67	4350	2830	29.7
54.0	650	2900	890	215	68	4050	2580	25.2
55.0	340	2300	690	220	66	2870	1590	21.4

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9. Appendix B

9-1 Miscellaneous Tests:

(a) Frequency Range and Coil Overlap

The frequency range of the equipment is covered by the use of three plug-in coils in the oscillator. These coils cover the three ranges of 14.4 to 27 mcs, 27 to 45 mcs and 45 to 55 mcs. The actual coverage is greater than this in the overlapping region between coils, but it is recommended that these limits be observed in order to obtain optimum power output. A tabulation of the frequency calibration appears in Appendix A.

(b) R. F. Output

A power output of 1000 watts or more is obtained at all frequencies below 52 mcs. Above this frequency the output decreased to a minimum of 340 watts at 55 mcs. The maximum output obtained is 2200 watts at 25 mcs. A complete tabulation appears in Appendix A.

(c) Variation of Ambient Temperature

The operation of the equipment over the range from 0°C to 50°C was satisfactory. The oscillator frequency shift was 0.14% at the low end of the frequency range and 0.20% at the high end. The power output was not appreciably affected.

(d) Variation of Relative Humidity

The operation of the equipment over the range from 30% to 95% was satisfactory. The oscillator frequency shift was of the order of 0.013%. The power output remained constant.

(e) Operation Under Shock, Vibration and Roll

The equipment was subjected to a total of 16 shocks at the maximum available acceleration. The average frequency shift as a result of six shocks from front to back was 0.036% and of 10 applied side to side was 0.049%.

Vibration of the equipment at rates from 5 to 30 cycles per second was maintained for one hour. The most severe vibration occurred between 14 and 15 cycles per second, and the frequency modulation was 0.03% for this condition. No appreciable frequency change occurred during the run.

A roll of 45° each side of vertical caused a frequency shift of 0.13% when applied front to back and no appreciable change from side to side.

Operation in general was satisfactory for all of these tests.

(f) Change of Line Voltage

The operation was satisfactory for changes in line voltage of ±10% from the normal value.

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(g) Change of Plate Voltage

Variation of plate voltage from 1000 volts to 3500 volts resulted in a maximum frequency shift of .12% measured at either end of the band.

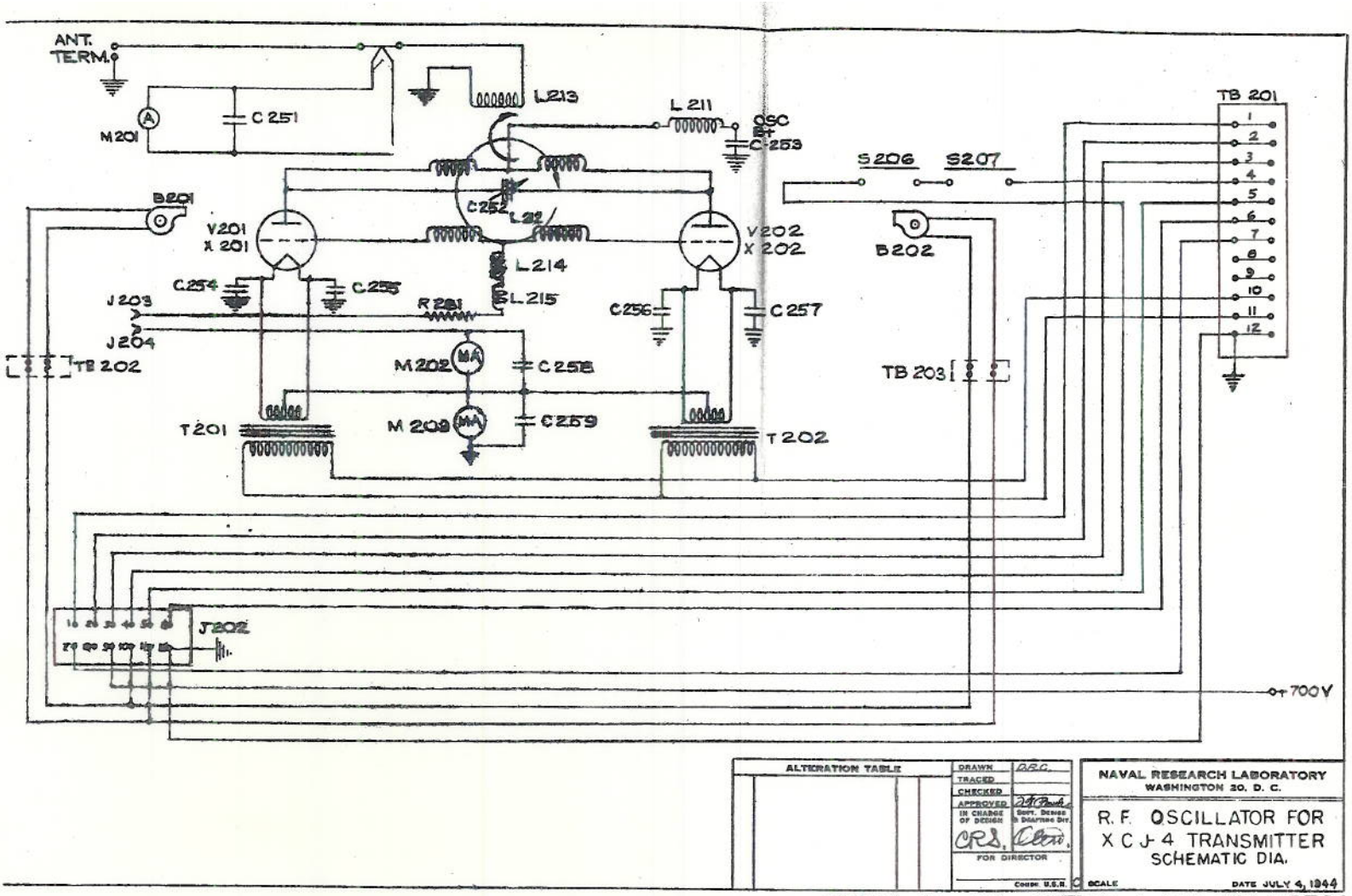
(h) Modulation and Keying

Observation of oscilloscope patterns using different combinations of modulation gave satisfactory results. The variable tone oscillator covers a frequency range of 5 to 300,000 cycles per second in five steps with 30% to 50% duty cycle. The noise bandwidth is continuously variable from 50 kc to 200 kc measured at modulation test jack with oscillator plate voltage off. A duty cycle of 30% to 50% is obtained.

(i) Input Power Factor

The supply line input power measurements showed that the power factor was of the order of 50% which caused the current rating of the plate voltage Variac to be exceeded with full power output. Capacitors of 20 mfd each were placed across each of the phases to the primaries of the high voltage plate transformers which increased the power factor to 65%. The measurements of line input power given in Appendix A are the sums of the powers in the 440 volt 3 phase line and the 115 volt 3 phase line, but are normally both taken from the 440 volt line through external step down transformers.

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ALTERATION TABLE		
	DRAWN	D.R.C.
	TRACED	
	CHECKED	
	APPROVED IN CHARGE OF DESIGN	Head, Design & Drafting Div.
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Comm. U.S.N.

NAVAL RESEARCH LABORATORY
WASHINGTON 20, D. C.

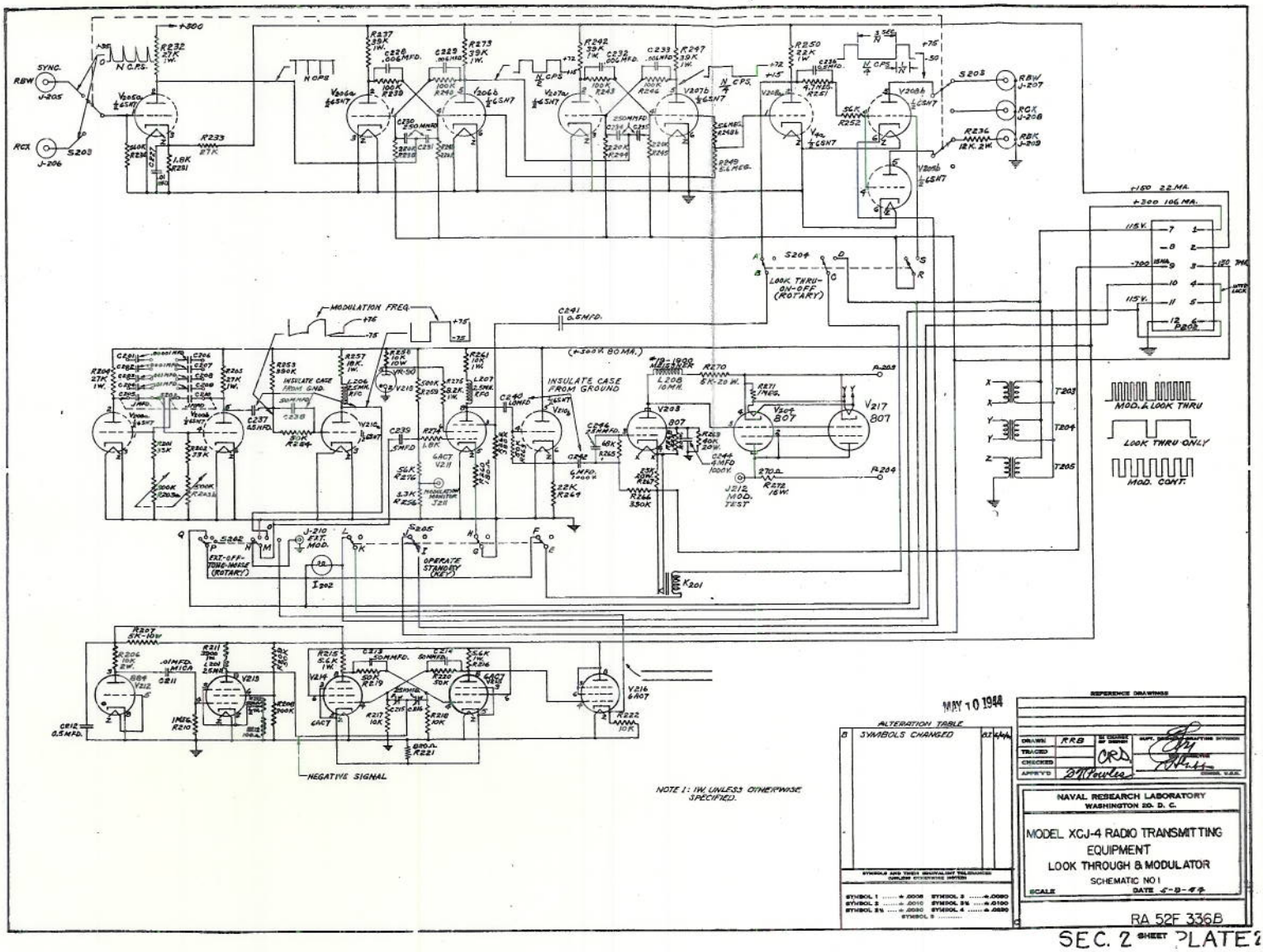
R. F. OSCILLATOR FOR
X C J-4 TRANSMITTER
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SCALE

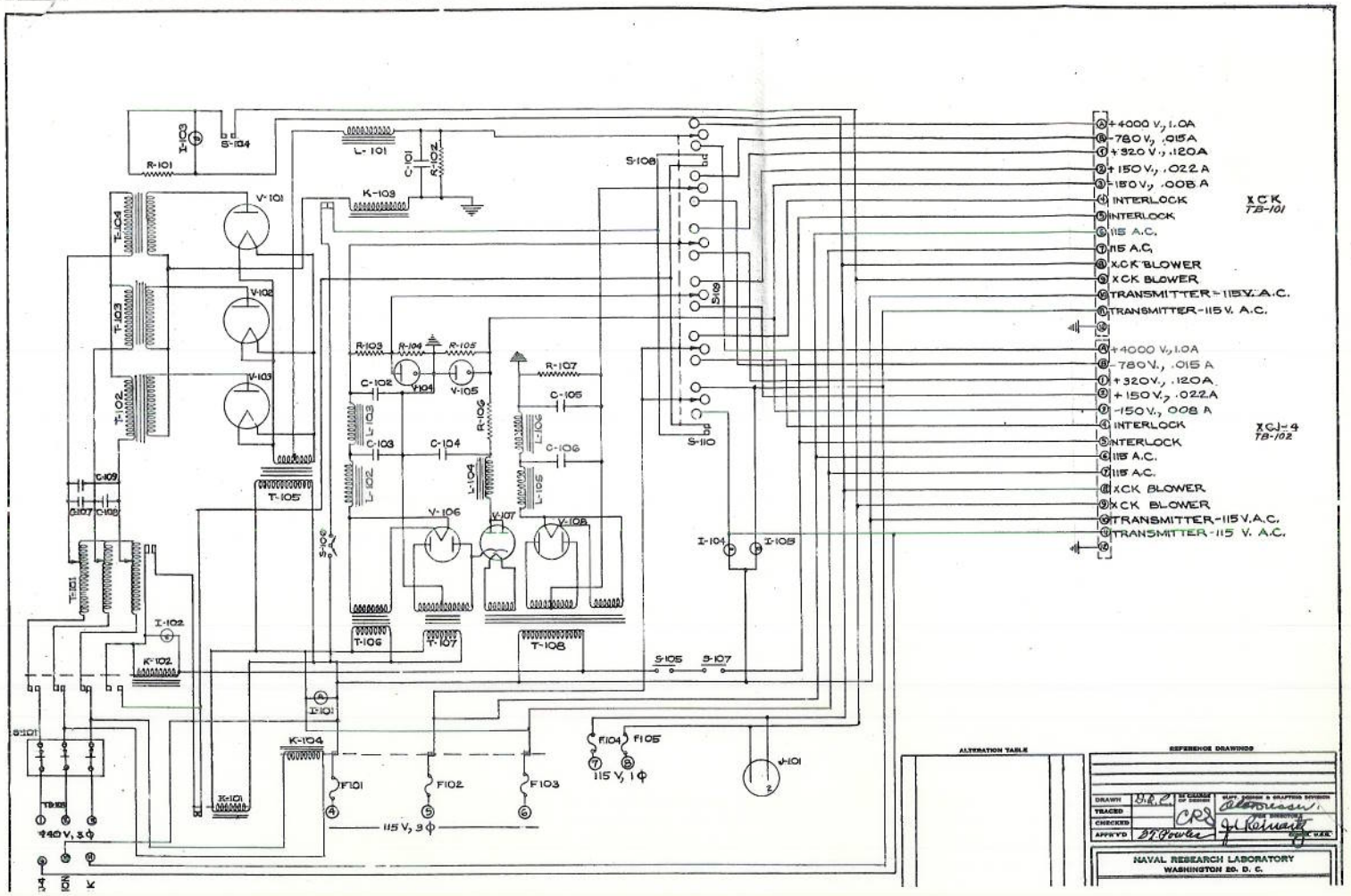
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SEC. 2 PLATE 1 RA 35AA 276A

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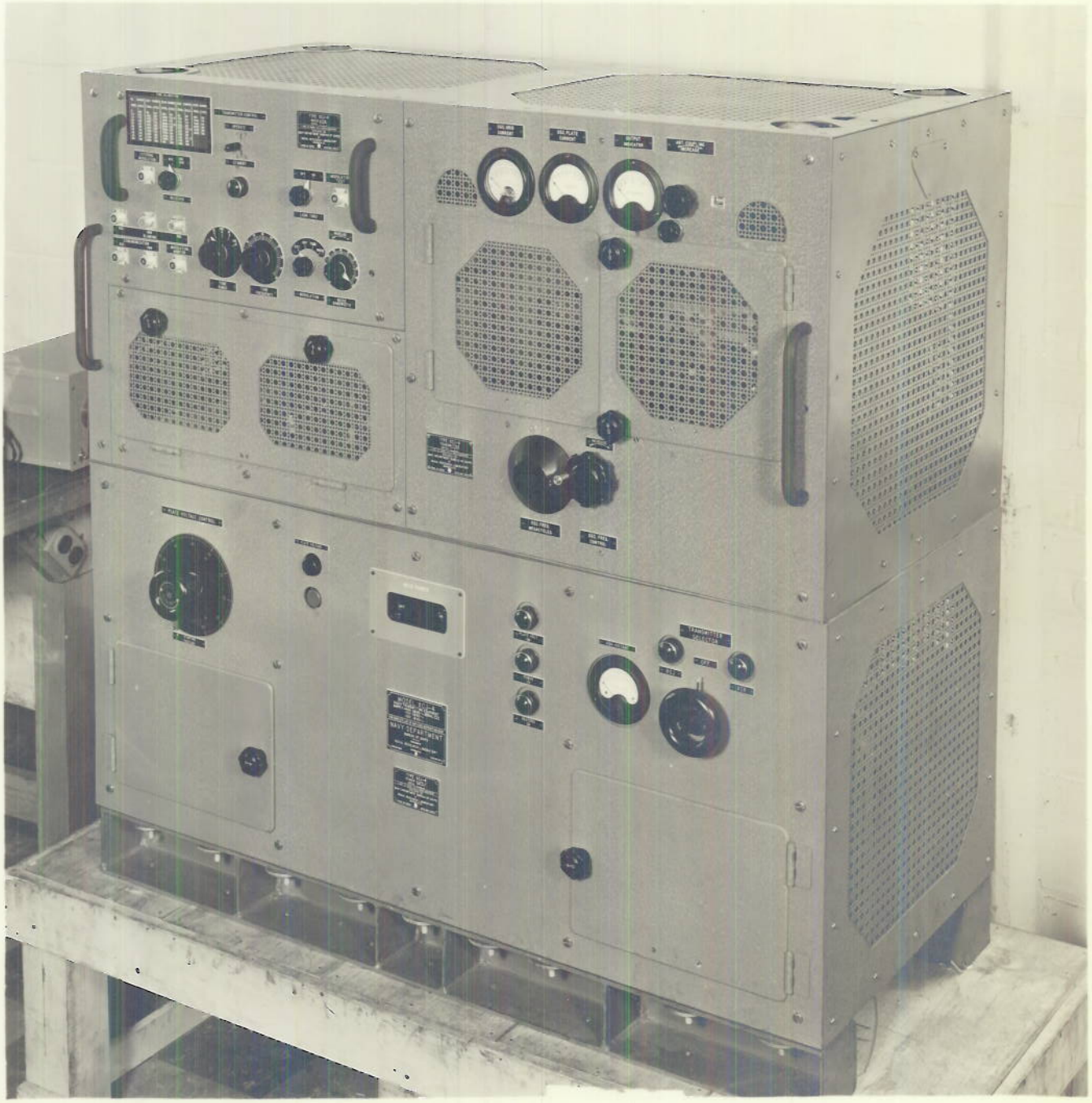


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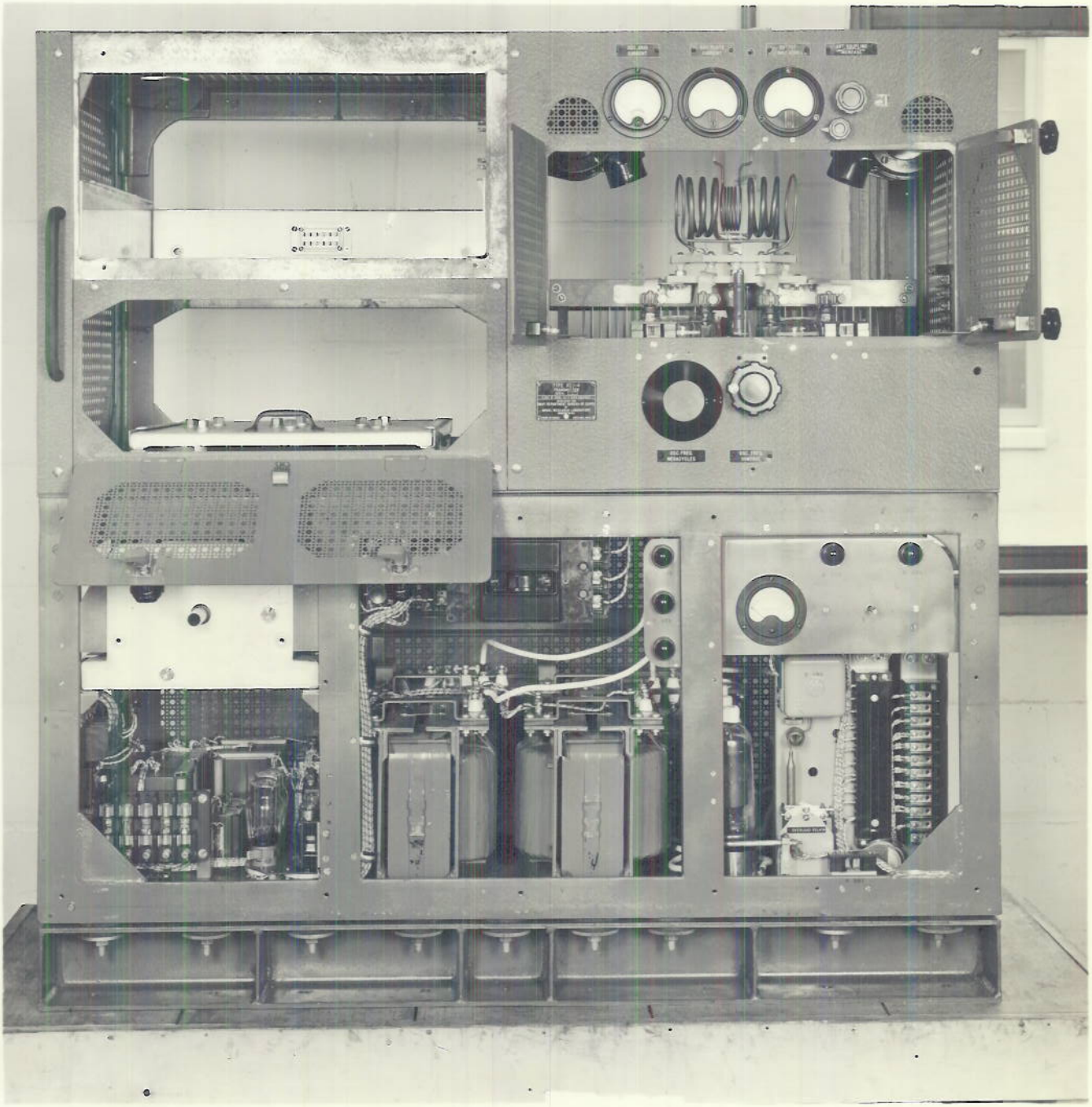


RADIO TRANSMITTING EQUIPMENT MODEL XCJ-4

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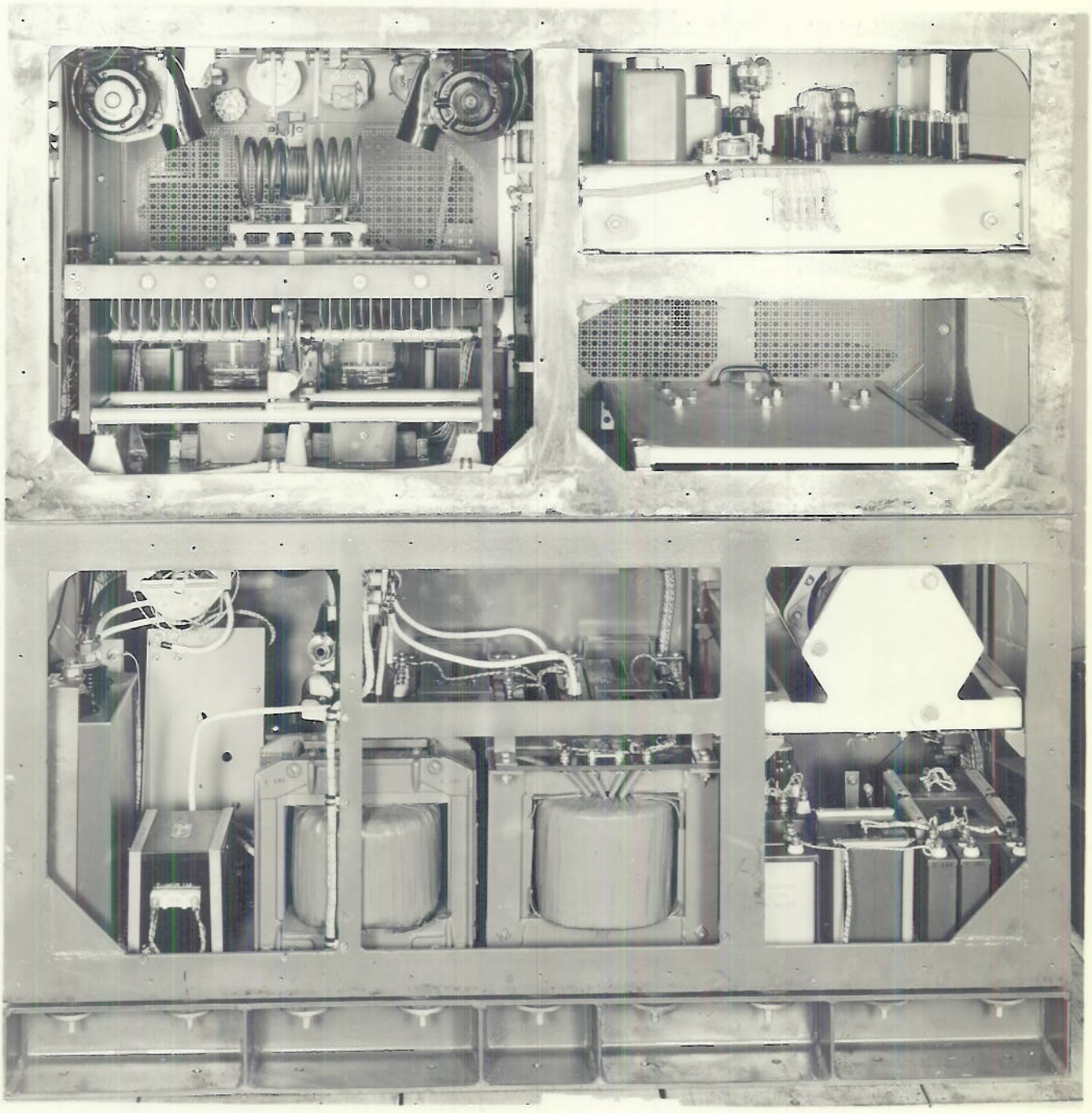
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RADIO TRANSMITTING EQUIPMENT MODEL XCJ-4

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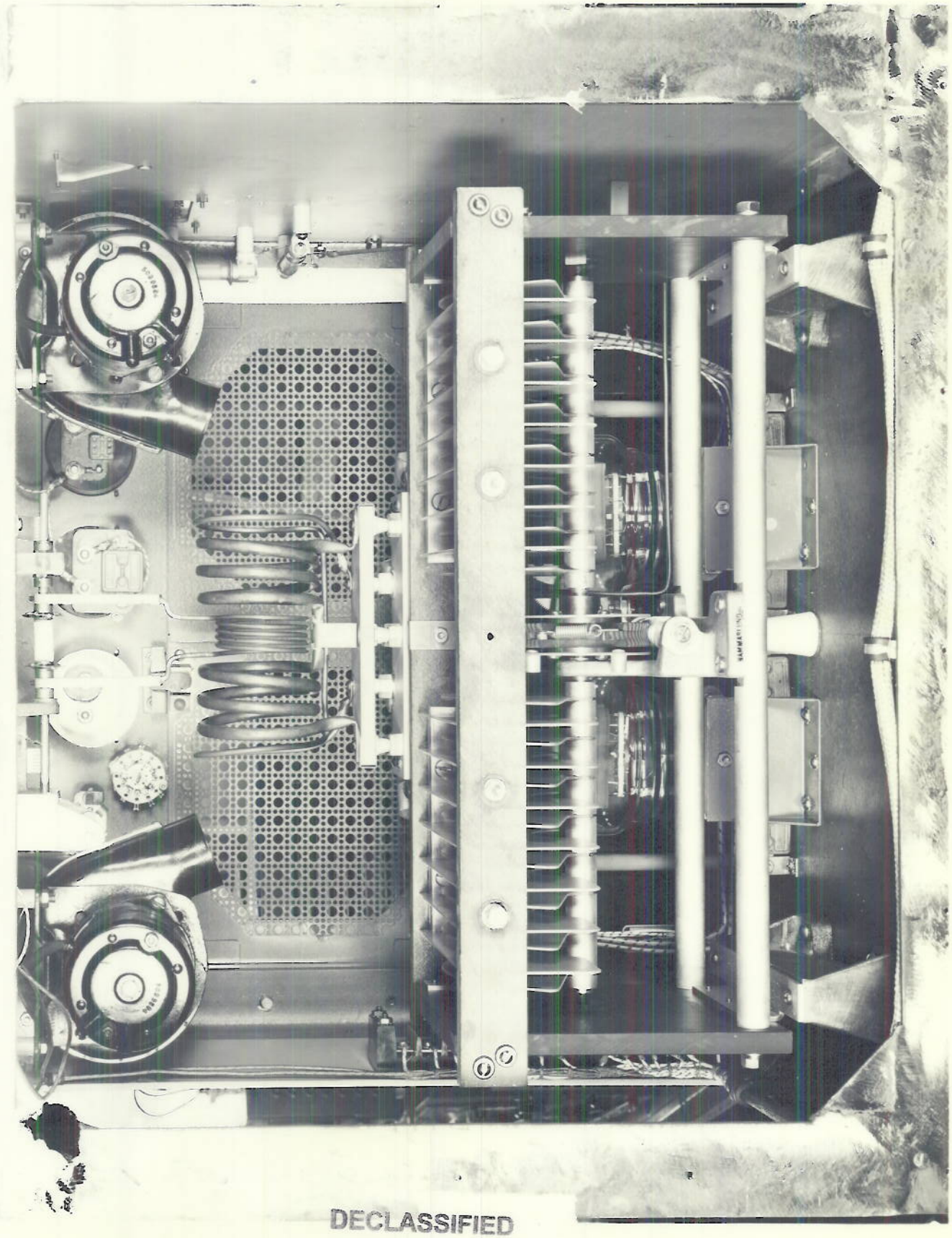


RADIO TRANSMITTING EQUIPMENT MODEL XCJ-4

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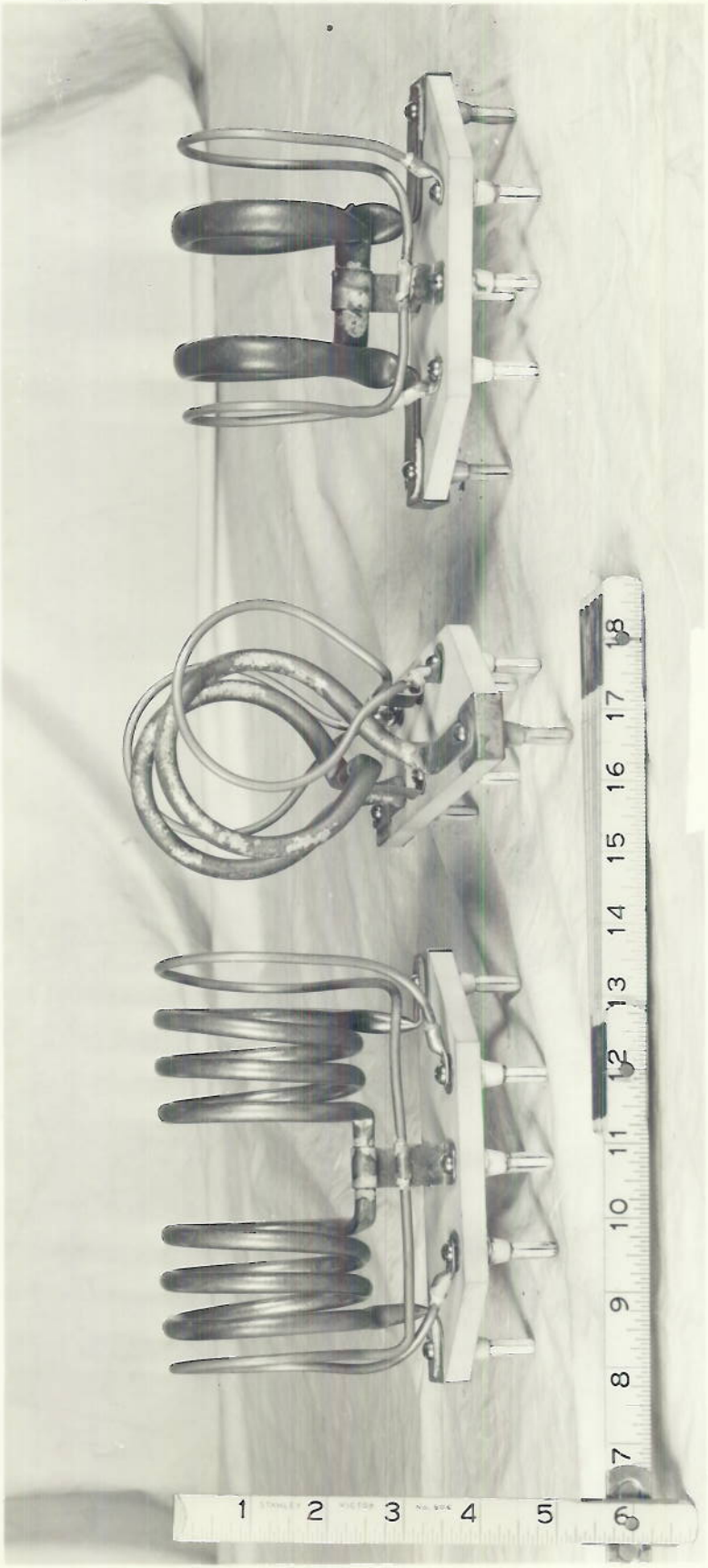
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PLATE 7 SEC.2

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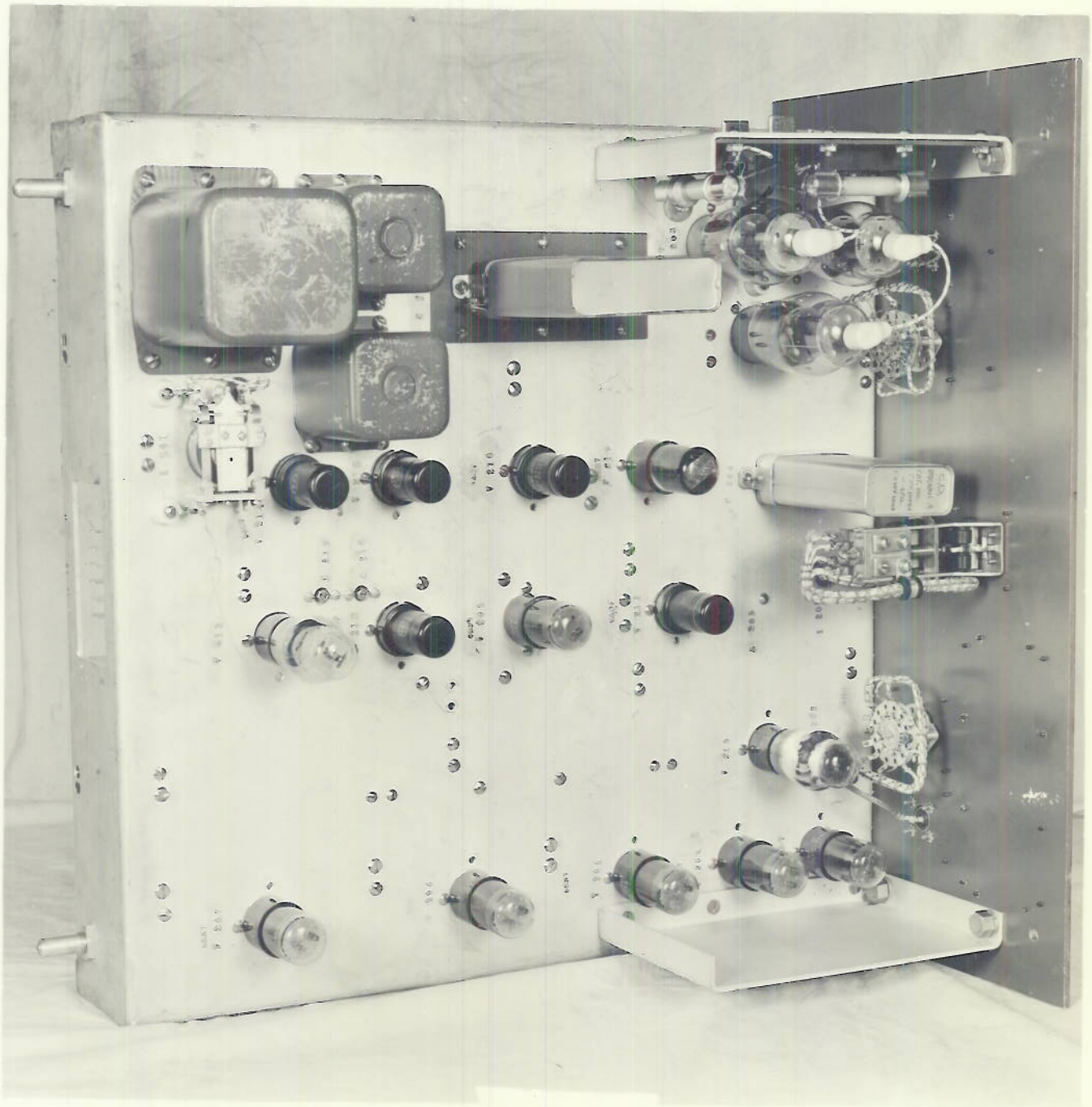
RADIO TRANSMITTING EQUIPMENT MODEL XCJ-4

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PLATE 8 SEC. 2

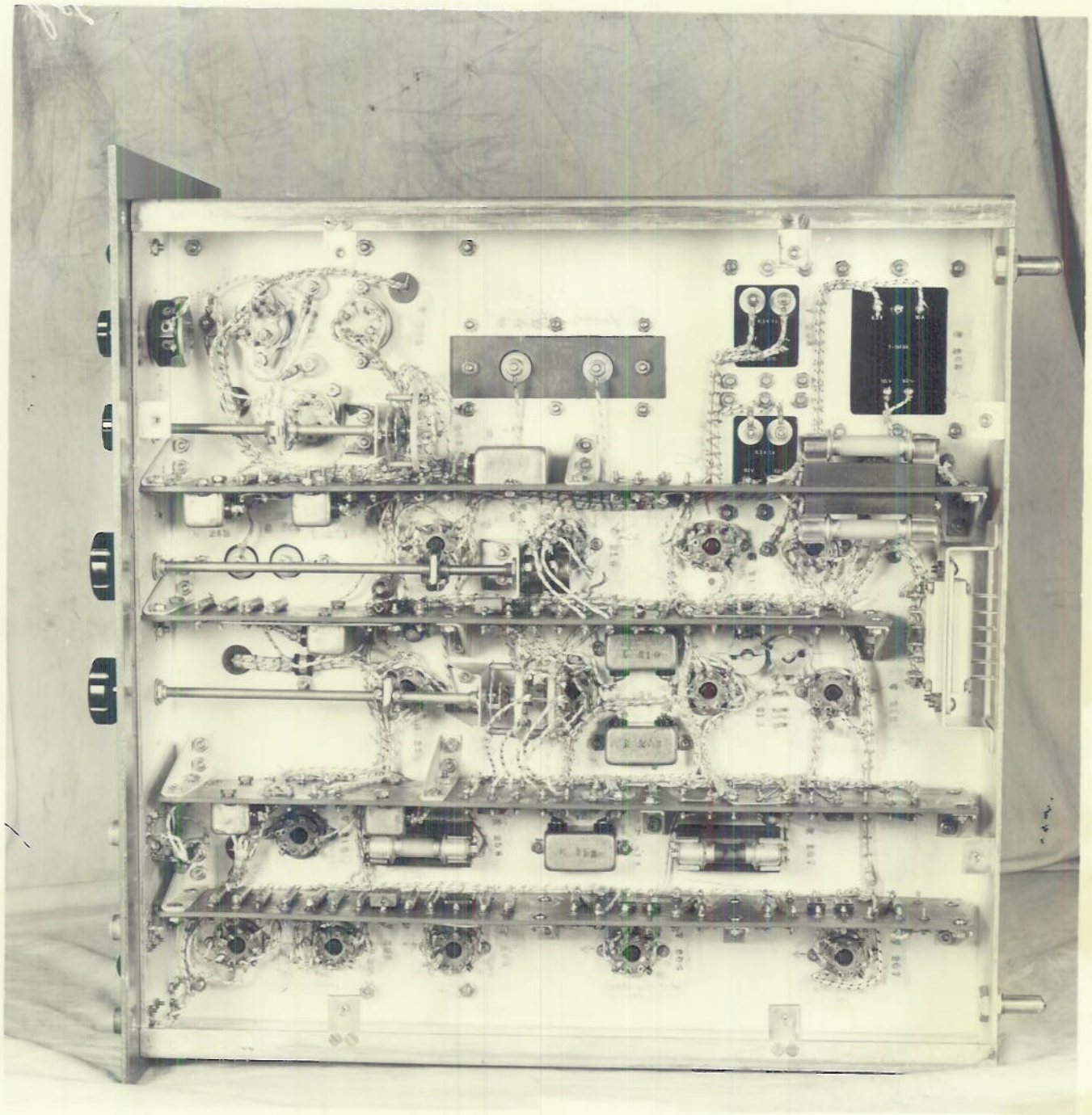
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PART III

CONSTRUCTION AND TESTING OF

MODEL KCK TRANSMITTER (40 to 125 Mc)

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Supplements:

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Photographs, Plates 1 to 16, inclusive
Graphs, Figures 1 to 5, inclusive
Schematic Diagram, Sheet 1

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PART III

CONSTRUCTION AND TESTING OF

MODEL XCK TRANSMITTER (40 to 125 Mc)

REFERENCES

(a) NRL ltr C-S67-5/RCM(382) of 12 May 1944 to BuShips
(b) NRL ltr C-S67-5/RCM(382) of 29 June 1944 to BuShips

ABSTRACT

1. This section of the report covers the construction and testing of the model XCK transmitter which will be the manufacturer's prototype for the high-frequency portion of the TEA transmitter. The tests herein reported were conducted to determine the potentialities of the equipment under Naval conditions of operation and included the results of power output, temperature, humidity, shock, and vibration tests.

GENERAL DESCRIPTION OF THE MODEL XCK TRANSMITTER

2. The model XCK transmitter is a self-excited oscillator which employs push-pull 8014-A tubes in a tuned-cathode, tuned-grid, line circuit with its tuning range extended by end loading the lines with ganged variable condensers to cover a frequency range of approximately 40 to 125 Mc. The transmitter is tuned over its frequency range by means of a single control, which is arranged for both manual and motor drive. The transmitter is grid keyed by an electronic keying circuit providing essentially square wave modulation for look-through, tone, and noise modulation. No power supply is included in the model XCK as it is intended to operate with the power supply of the model XCJ-4 transmitter when assembled with it to form the complete model TEA transmitter.

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SUMMARY

3. The facts herein reported may be summarized as follows.

(a) The apparatus is constructed and fabricated in a manner to satisfactorily withstand shock, vibration, and temperature conditions incident to shipboard use. Prolonged exposure to high humidity, when inoperative, causes temporary failure of modulation circuits; however, this condition may be corrected in production models.

(b) The power output in certain parts of the frequency range is below the desired value of 1 kilowatt, but it is believed that as much power has been obtained as is compatible with the oscillator tube complement, the type of radio-frequency oscillating circuit, single-dial frequency control, and other conditions which must be met to allow fulfillment of the intended function.

(c) A reasonably high degree of frequency stability is afforded and no large fluctuation in power output results during variation in temperature and humidity.

(d) The modulation characteristics depart somewhat from the type desired, but the performance given is of a nature that serious impairment in operation will not result.

(e) The overall performance and operation of the equipment, while not fulfilling all desired objectives, is as satisfactory as can be attained without extensive further investigation.

MATERIAL UNDER TEST

4. The material under test consisted of the Model XCK transmitter, which was constructed at this Laboratory and which is intended for use as companion equipment with the Model XCJ transmitter and power supply unit. The transmitter is a tuned-cathode, tuned-grid, line push-pull oscillator which employs two type 8014-A tubes, the tubes being cooled by a forced air draft. The tuning lines are end loaded with variable condensers to extent the frequency range. Variable condensers are connected between the grid and cathode lines to provide feedback. The cathode and grid lines are provided with adjustable shorting bars which are moved along the lines

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by means of lead screws. The antenna is coupled to the cathode line by means of a coupling loop which is moved along the line by means of a lead screw, as the frequency is changed. The end loading condensers, feed-back condensers, grid line shorting bar, cathode line shorting bar, and antenna coupling loop are ganged to a single frequency control knob which may be operated either manually or by means of a motor. In addition to the frequency control knob, another control knob provides trimming adjustment of the antenna coupling loop. Refer to Plates 1 to 16, enclosure (b), for photographs of the equipment.

5. The transmitter is grid keyed by an electronic keying circuit arranged as shown in the schematic diagram, sheet 1, enclosure (D). The keying circuit provides essentially square wave modulation of the carrier frequency over a wide range of modulation frequencies. The transmitter may be operated c.w., tone modulated, or noise modulated. The equipment may be operated under any of these conditions with or without look-through. The modulation circuits are located in two removable chassis as shown on Plates 1, 3, 4, 5, 6, 7, 8, and 9, the look-through/keyer circuits being in the upper chassis while the tone-noise generator circuits are in the lower chassis.

6. Under normal conditions of operation the transmitter would be used with a panoramic receiver such as the Model RBK-RBW combination. The panoramic receiver provides a synchronizing pulse of "N" c.p.s. This pulse is fed into a pulse sharpening tube, V305b, sheet 1, enclosure (D), which provides a sharp negative pulse of "N" c.p.s. This negative pulse is used to trigger the first frequency dividing tubes, V306a and V306b, which produces a square wave whose frequency is "N/2" c.p.s. This square wave is then used to trigger the second frequency dividing tubes, V307a and V307b, which produces a square wave whose frequency is "N/4" c.p.s. The grid voltages of the first and second frequency dividing tubes are then combined and fed into tube V308a, the output of which will be a square wave pulse whose frequency will be "N/4" c.p.s. and whose duty cycle will be 25 per cent. This 25 per cent duty cycle pulse is then used to accomplish two results: first, to key the transmitter "off"; second, to key the receiver blanking control "off" so the receiver will be operating at normal sensitivity. This pulse goes to the keyer tubes V303, V304, and V317 by way of the mixer tube V311 and

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the amplifier tube V319. This pulse also goes to the receiver blanking control by way of either amplifier tube V308b or by way of amplifier tube V305a, depending on the position of the receiver switch, S303. The end result of this circuit arrangement is to produce normal look-through action which cuts the transmitter "off" and puts the receiver "on" for 25 per cent of the time at regular intervals.

7. Tone modulation is produced by means of a multivibrator circuit using the two halves of a 6SN7 tube, V309a and V309b. The output of the multivibrator is amplified by tube V310 and fed to the cathode follower tube V316 by way of switch S302. The output of the cathode follower is then fed into the mixer tube V311 and on to the keyer tubes as in the case of the look-through signal. Noise modulation is produced by means of an 884 gas tube, V312, which produces pulses of random frequency and amplitude. These pulses are amplified by the band width control tube, V313, the output of which is fed into the electronic switching tubes V314 and V315. The output of the electronic switch will be a random-frequency square wave pulse. This pulse is fed to the cathode follower tube V316 by way of switch S302. The output of the cathode follower is then fed to the mixer tube, V311, and on to the keyer tubes as in the case of tone modulation.

8. All controls for the transmitter are located on the front of the equipment as shown by the photographs, Plates 1, 3, and 6. The look-through/keyer unit and the tone-noise generator unit were designed so that they would be electrically identical to the corresponding units used with the Model XCJ transmitter. At present, it is necessary to use two panoramic receivers, the RCX-RAO and the RBW-RBK panoramic adapter-receiver combination, with the Model XCJ transmitter. Therefore, the look-through circuit on the Model XCK transmitter is provided with synchronization and blanking outlets (see Plate 6) for the two panoramic receivers even though the Model XCK transmitter would normally be used with only the RBW-RBK panoramic adapter-receiver combination.

9. There are three control switches located on the look-through/keyer chassis as shown in Plate 6. The left-hand control switches the synchronization and blanking connections between the transmitter and the two panoramic receivers and provides for the selection of either receiver. The middle

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control switches the look-through "on" and "off." The right-hand control switches the transmitter between "stand-by" and "operate" conditions. Under normal conditions of operation, switching to stand-by simply keys the transmitter "off" by placing sufficient negative voltage on the oscillator grids. This switch is also wired to control the blowers when used with the Model XCJ transmitter. The modulation monitor outlet has provision for connecting an oscilloscope to observe the character of the modulation impressed on the grid of the mixer tube V311. The modulation test outlet provides a place to connect an oscilloscope to observe the character of the modulation at the output of the keyer tubes V304 and V317. The oscillator grid current meter is connected in the plate circuit of the keyer tubes V304 and V317 and provides approximate oscillator grid current indication.

10. There are four controls located on the tone-noise generator chassis as shown by the photograph, Plate 3. The left-hand control is the noise band width control. This control changes the gain of the amplifier tube V313, thereby allowing the switching tubes V314 and V315 to be operated by lower voltage pulses, from the 884 gas tube, as the control is advanced in a clockwise direction. The dial for this control is graduated in arbitrary units. The next control to the right is the modulation selector switch. This control switches the input circuit of the cathode follower tube V316 to the noise generator, tone generator, "off" (ground) and the external modulation outlet which provides for external sources of modulation. The next control to the right is the tone generator frequency range switch and provides for the selection of different frequency ranges for the tone generator. The right-hand control is the tone generator frequency control and provides for the operation of the tone generator at any frequency within the limits indicated by the tone generator range switch setting. The tone generator frequency control dial is graduated to indicate the approximate tone generator frequency in c.p.s. Both the noise band width control and the tone generator frequency control are provided with locking devices to insure against accidentally changing the dial settings.

11. The trimming adjustment for the antenna coupling loop is located on the right-hand side of the small panel between the look-through/keyer and noise-tone generator chassis. The r-f power outlet and the output indicator meter are also

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located on this panel. The output indicator meter and associated components were not installed in the Model XCK transmitter; however, a suitable design has been worked out and is shown on the schematic diagram, sheet 1, enclosure (D). The oscillator plate current meter, the oscillator filament voltage meter, the oscillator filament voltage control rheostat, the calibrated frequency dial, the manual frequency control, and the motor-driven frequency control are located on the large control panel as shown by the photograph, Plate 1.

12. By means of the motor-driven frequency control, the oscillator frequency may be changed from its lower limit to its upper limit in approximately 20 seconds. The access door to the oscillator tube compartment is located at the upper right-hand side of the front panel. Directly below this door is located a cover plate which may be removed for access to the main terminal board. Two relays, K302 and K303, see schematic diagram, sheet 1, are located just inside the access door to the oscillator tube compartment. Relay K302 is a time delay relay connected in the circuit in such a manner that the blower which furnishes the forced draft cooling for the 8014-A tubes remains "on" for about four minutes after the filament power has been turned "off." Relay K303 is connected in the circuit in such a manner that it is impossible to apply filament voltage or plate voltage to the 8014-A tubes without adequate voltage on the forced draft blower motor circuit. The 8014-A tubes must have forced draft cooling when filament voltage is applied to the tubes, regardless of whether plate potential is present.

13. Lead-covered cable is used for all wiring in the main transmitter unit. The look-through/keyer chassis and the noise-tone generator chassis are wired with "Gencaseal" type wire. The transmitter is equipped with interlocks so that it is impossible to open the oscillator tube compartment access door or remove either of the two removable chassis without opening the interlock circuit, which in turn removes the 4000-volt, the -700-volt, and the -150-volt power potentials. A "Battle Switch" is included in the main power supply unit which makes it possible to short out all of the interlocks in both the XCJ and the XCK transmitters.

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14. Aluminum alloy is used throughout in the construction of cabinet framework, panels, chassis, internal shields, etc. The total weight of the transmitter is 336 pounds. The dimensions of the transmitter measured over the external panels are as follows:

Length--48"
Height--24"
Depth --22"

All external panels, excepting the base panel, are held in position by means of binder-head screws with shakeproof lock washers. Knobs, etc. extent beyond the front panel. The overall dimensions of the transmitter therefore are:

Length--48-3/8"
Height--24-3/16"
Depth --23-5/8"

The transmitter should be installed with at least 18 inches clearance from the back and each side in order to allow sufficient space for servicing. Provision is made to bolt the XCK transmitter to either the XCJ transmitter or the power supply unit.

15. In order to place the Model XCK transmitter in c-w operation, turn the look-through control switch "off," the modulation selector switch "off," and the transmitter control switch to "operate." Turn the power supply "on"; then adjust the oscillator filament voltage to 15 volts and the oscillator plate voltage to 1000 volts. Set the transmitter on the desired frequency by means of either the manual frequency control or the motor-driven frequency control. Adjust the antenna coupling control to maximum indication on the output indicator meter. Increase the plate voltage sufficiently to secure the desired power output, but do not increase the plate voltage beyond a value that gives a grid current of 250 ma and/or a plate current of 1000 ma. These values of grid and plate current are maximum values for safe operation of the equipment and should never be exceeded under c-w conditions. The output can then be modulated by the noise or tone generator and any available type of modulation, as well as c.w., can be had with or without look-through by selecting the desired modulation setup. Under conditions of modulation, the oscillator plate and grid current will

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drop considerably below the values for c-w operation and it is then possible to increase the plate voltage to a value (not exceeding 4000 volts) whereby the grid current does not exceed 200 ma and/or the plate current does not exceed 800 ma under modulated conditions. Attention is invited to the fact that the limiting values of plate and grid currents depend upon whether the carrier is modulated or unmodulated.

16. WARNING. It is not safe to change the mode of operation, either carrier frequency or type of modulation, without first lowering the plate voltage to approximately 1000 volts. After the new mode of operation has been established, the plate voltage may be increased to the limiting values as previously indicated. Tube life will be considerably increased by operating the equipment at lower values of plate voltage.

17. The tube complement for the Model XCK equipment is as follows: two type 8014A's, three 807's, five 6SN7's, seven 6AC7's, one 884, and one OB3/VR90.

18. For the list of controls on the front panel refer to Table 9.

TESTS ON MODEL XCK EQUIPMENT

Power Output

19. Power output was determined by loading the transmitter into a 50-ohm coaxial cable, 130 feet long, terminated in a suitable water-cooled load. A slotted line for determining the standing wave ratio and power output was inserted between the output jack and the transmission line. Adjustments were made on the load to obtain as good a standing wave ratio as possible. It should be understood that data presented refer to the power output delivered at the terminal of the transmitter and is not that appearing at the end of the coaxial line. All data furnished were made on c-w output. Since no tube ratings are available on the type 8014A tube, when operating as a c-w oscillator, the following practice was followed. After the equipment had been adjusted to deliver optimum output at a relatively low value of plate potential, i.e., approximately 1000 volts, the plate potential was advanced. Care was exercised to insure that the grid current of the two oscillator tubes did not exceed 250 ma, or the plate current did not exceed 1 ampere, both limits being

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concurrently applicable. Data obtained under these conditions were considered to be the maximum power output available. In one instance the plate current was observed to have risen to a value slightly in excess of 1 ampere; however, such a practice is not recommended for long periods of operation.

20. Power output data over the frequency range are shown in Table 1 and a portion of the data are shown graphically in Figure 1. Generally speaking, the power output falls between the limits of 800 and 1100 watts, but in some instances lower outputs are obtained. In two cases the available power is between 500 and 600 watts. It is also noted at certain points of relatively great output that apparent plate circuit efficiencies are high and this causes some of the output measurements to be regarded as optimistic. The design objective was to provide an output not less than 1000 watts at any point over the range; however, it is believed that as much power has been realized as is consistent with the tube complement and the circuit, when operated under conditions offering reasonable tube life, especially when it is considered that the apparatus concerned is a single dial-controlled transmitter.

21. Attention is invited to the fact that most of the data were made under fairly favorable standing wave ratio conditions and should the antenna system selected for use with the transmitter present more adverse relationships, proportionally less power will be realized. Limited time on the project did not permit a study of power output under unfavorable standing wave ratio conditions.

Modulation Characteristics

22. The equipment is designed to provide three types of emission; namely, continuous wave, square wave keyed (also referred to as tone modulated), and noise modulated outputs. The type of modulation may be selected by means of controls on the front panel. The square wave keying device covers a range from 5 cycles to 450 kilocycles, which is somewhat greater than the required range from 20 cycles to 200 kilocycles. The character of keying at frequencies below 100 cycles is not highly acceptable, since an appreciable 60-cycle component appears in the rectified grid current of the oscillator tubes, which reacts on the keying circuit in a manner to disturb its normal functioning. The lack of a center tap on the

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filament transformer secondary is believed to be the principal cause of this unwanted component in oscillator grid current. Attention is invited to the fact that the oscillator r-f circuit does not lend itself to use of a center-tapped filament transformer; thus the condition noted must be accepted as an inherent penalty imposed by the circuit. Acceptable keying is attained over a range from 100 cycles to 250 kilocycles, but at the higher part of the range the keyed characters are appreciably "clipped," and at 200 kilocycles the characters have about one-half the length which would be found under ideal conditions. At frequencies much in excess of 250 kilocycles, the characters are greatly shortened. It is anticipated that from 250 to 450 kilocycles the emitted signals will not be very useful. It is believed that the character of keying, generally speaking, is as good as can be obtained from the circuit used and that efforts to extend the keying range down to 20 cycles will run into extensive further investigative work. It is therefore suggested that no further efforts be made to improve the character of keying at this time.

(a) At constant plate voltage, perfect square wave tone or 50% duty cycle noise modulation should reduce the average r-f power output by 50%; with a corresponding reduction in the plate dissipation. The plate voltage therefore may be raised, with modulated operation, to a value limited either by the plate dissipation or, possibly, by voltage break-down, thus bringing the power output back nearly to its c-w value. The use of look-through keying will produce an additional 25% reduction in average power output but this is not significant since the look-through keying should be switched off after tuning the TEA to its victim signal. Further measurements of the power output with modulated operation are being conducted.

(b) The range of the keying oscillator, by bands, is shown in Table 2.

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Variation in Ambient Temperature

23. The equipment was subjected to ambient temperature variation between limits of 50°C and 0°C. Temperatures were changed in steps of 10 degrees, each temperature being maintained for one hour. During these tests efforts were made to keep the relative humidity below 35 per cent. Throughout the test the equipment was in operation; however, the type of emission was shifted at regular intervals. During each 15-minute period the transmitter was operated on continuous wave five minutes, square wave keyed with look-through on for five minutes, and with noise modulation and look-through on for the remaining five minutes. Such tests were conducted both at 40 and 120 megacycles. The data observed in these tests are shown in Tables 3 and 4 and in Figures 2 and 3. It may be noted that good frequency stability characteristics are evidenced and that no large variation in power output occurred. At the extreme values of temperature all controls and other mechanical devices operated freely and no malfunctioning was noted in any parts of the equipment excepting the time limit relay, K-302. It was found that this relay after once being energized would not open even for periods as long as 20 minutes. Had it been functioning normally it should have opened in approximately four minutes. After removal of the equipment from the temperature chamber it was noted that the relay still would not function normally, but after readjustment of the time limiting mechanism the relay operated satisfactorily thereafter. Hence, it is concluded that there is no evidence to show that the relay is not capable of satisfactory operation over the temperature range and that the difficulties noted were due to the fact that prior to the test it was improperly adjusted.

Variation in Humidity

24. The equipment was subjected to variation in relative humidity as follows. The equipment was operated for 30 minutes at a humidity of approximately 30 per cent, following which the humidity was raised to a value in excess of 95 per cent and maintained for one hour, after which the humidity was again lowered to around 30 per cent for one hour, the temperature being maintained at approximately 40°C during the entire test. The transmitter was operated alternately on continuous wave, square wave keyed and noise modulation, according to the same cycle described in the preceding

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paragraph. Tests were conducted at output frequencies of 40 and 120 megacycles. Data observed during the test are presented in Tables 5 and 6 and Figures 4 and 5. A reasonably high degree of frequency stability was indicated during humidity variation, and no undue fluctuation in power output was noted.

Wet-Start Test

25. The equipment, unenergized, was placed in an enclosed chamber for 40 hours and a relatively high value of humidity was maintained. Temperatures and humidities were not under precise control for most of this period, but temperatures were generally held between the limits of 30° and 40°C and the relative humidity ranged between 85 and 98 per cent. During the last two hours of the period, the temperature and humidity were controlled and held at 40°C and above 95 per cent, respectively. The equipment was then energized. Data collected are shown in the upper portion of Table 7. It may be seen that initially under c-w conditions, operation was normal but that no output could be obtained under square wave keyed condition or noise modulation. After 15 minutes some power output was delivered under the two latter conditions; however, it was approximately one-half that obtained when the equipment is in normal dry condition. The humidity was then lowered to a value around 30 per cent, keeping the temperature at the same value, and observations on the operation of the equipment were continued. Data taken are shown in the lower part of Table 7. No appreciable increase in the output was shown over a 40-minute period. Thus, it is evident that a period longer than 40 minutes will be required to thoroughly dry out the equipment.

26. The failure of the equipment to function normally after a "wet-start" will impair the usefulness under Naval service conditions, and the improper functioning may be corrected or at least minimized by the placing of suitable heaters underneath each chassis to lessen the concentration of moisture around various components. Each heater should have a dissipation of approximately 35 watts, should remain energized at all times when the equipment is inoperative, and provision should be included to automatically de-energize these heaters when the equipment is placed in operation. Attention is invited to the fact that a recommendation to this effect has already been made in paragraph 13 of reference (c).

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Operating Power

27. Data appear in the following table relative to current consumption by the two auxiliary chassis from the various supplies.

Condition	Current Drain from Indicated Source +300 V (ma)	+150 V (ma)	-700 V (ma)	-150 V (ma)
(Keyer/Look-Through Unit)				
C-W	45	15	6	18
Keyed--Look-Through On	45	15	22	12
Noise--Look-Through On	45	15	34	12
(Tone-Noise Unit)				
C-W	75	--	--	--
Keyed--Look-Through On	89	--	--	--
Noise--Look-Through On	80	--	--	--

In addition, operation of these chassis requires 1 ampere from a 115-volt, 60-cycle source.

28. Referring to the Model XCK equipment, exclusive of auxiliary chassis, the following a-c power is required for operation. The filament supply and control circuits require 4.5 amperes at 115 volts, 60 cycles, and the blower requires 3.4 amperes from a supply at the same potential. Attention is invited to the fact that the latter device is operated from an auxiliary supply line.

Backlash

29. The backlash in the main frequency control, when varied back and forth over a range as great as 3 megacycles, is found to be 600 kilocycles at a carrier frequency of 40 megacycles, 1000 kilocycles at 70 megacycles, and 250 kilocycles at 100 megacycles. However, if the variation in tuning is restricted to about one-tenth of the value given above, the backlash is no greater than approximately 35 kilocycles. The difference in backlash under the two conditions is due to the following reasons. When varying over a narrow frequency range, the mechanical backlash in the tuning condenser is of small, if any, moment, for the

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condenser shafts undergo practically no rotation and the principal cause of the observed backlash in frequency is due to the mechanical backlash in the tuning frame mechanism. However, if the tuning control is varied over a much wider range, the mechanical backlash in the tuning condenser, which is relatively high (approximately 4°) comes into play and causes a relatively high backlash in output frequency. No ready means can be offered for reducing frequency backlash over small tuning ranges, but the value found over wide ranges may be reduced by spring loading the front variable tuning condenser shaft. Recommendations concerning backlash in the equipment have already been presented in paragraph 18 of reference (c).

Plate Dissipation of Oscillator Tubes

30. The adequacy of cooling provided by the tube blower was investigated in the following manner. Steps were taken to render the r-f circuit non-oscillatory and plate potential was applied to either oscillator tube, the value of plate current being noted, making it possible to determine the power being dissipated. Since no oscillations were being produced, all power delivered was being dissipated within the tube. The magnitude of the temperature rise of the tubes in the region of their seals was noted by use of temperature indicating paints. The test was started at a relatively low value of plate potential and current and progressively the potential was gradually raised until the tube seals approached the critical temperature of 180°C, this being the maximum value allowable. It was found that the tubes were capable of safely dissipating 1100 watts each without excessive heating. This value of dissipation is adequate for equipments of this power output and character.

Shock

31. The entire equipment, including the companion Model XCJ transmitter and power supply, was bolted to a test platform in a manner simulating a shipboard installation. Approximately 60 shocks were applied to the test platform in a direction toward the front of the transmitter and approximately 30 additional in a direction toward the right end. Each shock imparted a momentary peak acceleration of approximately 250 g to the test platform. During one half of each series of shocks the Model XCK equipment was energized.

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No damage or other malfunctioning of the equipment was noted to result from the shock tests.

Vibration

32. The equipment with the companion transmitting apparatus and power supply was placed on a vibration testing platform and subjected to four hours vibration at various frequencies up to 1500 cycles per minute. The Model XCK equipment was energized for about one-half of the vibration period. No damage was encountered during the test and no undue vibratory motion of any parts or components was observed.

Tube Life

33. During the course of the tests of the equipment, several oscillator tube failures were encountered. On one occasion a puncture resulted in the glass envelope near the upper seal. Several tubes became gassy, one tube lost emission, and an open filament resulted in another. From the relatively limited experience gained during the test of the equipment, it is not possible to definitely state what tube life may be anticipated; however, it is believed that under Naval service conditions oscillator tubes may not be expected to last more than approximately 50 hours under full power output conditions.

34. Table 8 contains data relative to the electrode potentials and currents of the tubes employed in the equipment.

Frequency Coverage

35. The extreme range covered by the transmitter is 37.7 to 126 megacycles, whereas the desired range was from 40 to 130 megacycles. Efforts to extend the range were unavailing without the introduction of points in the range where only feeble power output could be obtained. Thus it is believed that the actual range covered by the equipment should be regarded as acceptable and that no further efforts should be made to extend the frequency coverage at this time.

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36. The equipment was shipped to the Transmitter Equipment Manufacturing Company, New York City on 22 June 1944, to serve as a guide for producing apparatus of this character for the Navy. Attention is invited to the fact that lists of exceptions to be taken in the manufacture of the equipment have been presented to the Bureau of Ships in references (b) and (c).

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TABLE 1

MODEL XCK TRANSMITTING EQUIPMENT

POWER OUTPUT

Dial (°)	Freq. (Mc)	Plate Voltage (Volts)	Plate Cur. (ma)	Grid Cur. (ma)	Power Output (Watts)	Standing Wave Ratio	Ant. Coup. (Div.)
0	37.7	2500	800	247	890	1.15	14
10	38.2	2500	850	234	1040	1.10	14
20	39.3	2500	850	198	1040	1.08	14
30	40.4	2500	910	170	890	1.08	14
40	41.7	2500	920	190	921	1.17	14
50	42.1	2500	920	170	965	1.10	14
60	44.4	2500	850	172	1010	1.07	14
70	46.0	2500	800	188	1120	1.00	12
80	47.5	2500	825	154	1010	1.00	14
90	48.8	2500	750	160	532	1.13	10
100	50.4	3000	890	186	980	1.10	8
110	52.3	3000	1100	100	1130	1.20	11
120	54.5	2500	800	90	978	1.14	10
130	56.0	2500	710	86	725	1.12	10
140	59.5	2750	750	90	1380	1.11	9
150	61.7	2750	680	86	1000	1.20	9
160	64.3	2750	670	75	900	1.25	10
170	66.7	2750	780	94	925	1.25	10
180	70.0	3000	550	87	840	1.25	8
190	72.5	3000	490	90	880	1.18	7
200	75.1	3000	475	87	920	1.24	6
210	78.1	3100	550	65	875	1.22	10
220	80.7	3000	500	80	990	1.48	9
230	82.8	3000	510	90	1105	1.15	7
240	85.5	3000	650	68	1120	1.18	11
250	87.8	3000	560	106	1020	1.18	8
260	90.8	3000	650	114	1130	1.20	9
270	93.6	3000	700	127	1390	1.40	7
280	97.0	3000	700	140	1220	1.18	8
290	101.2	2500	810	88	585	1.05	9
300	104.8	2500	810	180	1000	1.30	6
310	109.0	2250	800	190	1160	1.27	5
320	114.2	2250	900	228	1030	1.34	7
330	120.0	2000	850	238	860	1.77	9
340	126.0	1600	900	244	725	1.82	7

Note: The transmitter was loaded into a 50-ohm, water-cooled load through a 130-foot length of cable and a 50-ohm slotted line.

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TABLE 2

MODEL XCK TRANSMITTING EQUIPMENT

FREQUENCY CALIBRATION OF KEYING OSCILLATOR

Tone Range	Dial Setting (Degrees)	Frequency (C.P.S.)
A	0	4
	20	4
	40	4
	60	4
	80	5
	100	5.5
	120	6
	140	7
	160	9
	180	11
	200	14.5
	220	23
	240	50
	260	80
10A	0	44
	20	44
	40	47
	60	51
	80	56
	100	64
	120	75
	140	90
	160	110
	180	140
	200	195
	220	305
	240	640
	260	1,000
100A	0	355
	20	355
	40	380
	60	410
	80	455
	100	510
	120	600
	140	720
	160	890
100A	180	1,150
	200	1,550
	220	2,500
	240	5,000
	260	8,000
1KA	0	3,150
	20	3,150
	40	3,500
	60	3,800
	80	4,150
	100	4,630
	120	5,500
	140	6,600
	160	8,000
	180	10,300
	200	14,000
	220	22,000
	240	45,000
	260	68,000
10KB	0	24,000
	20	24,000
	40	26,000
	60	28,500
	80	30,800
	100	35,500
	120	42,000
	140	49,000
	160	60,000
	180	73,000
	200	95,000
	220	140,000
	230	175,000
	236	250,000
	237	328,000
	240	360,000
	242	380,000
	244	450,000

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TABLE 3

MODEL XCK TRANSMITTING EQUIPMENT

VARIATION IN AMBIENT TEMPERATURE
FREQUENCY - 40.13 Mc

Time	Temp. (°C)	Hum. (%)	Beat Freq. (Kc)	Mod. Freq. (Kc)	Oscillator Plate Current (ma)	Oscillator Grid Current (ma)	Keyer Plate Current (ma)	Modulator Plate Current (ma)	Look-Through Bias Current (ma)	Power Output (Watts)	Type Modulation
0845	50	23	260	--	820	207	6	120	18	1159	CW
0850	50	23	--	3.95	280	80	22	134	12	360	Tone--Look-Through
0855	50	23	--	--	160	42	32	125	12	144	Noise--Look-Through
0900	50	23	240	--	760	180	6	120	18	957	CW
0905	50	23	--	3.95	260	78	22	132	12	341	Tone--Look-Through
0910	50	23	--	--	170	42	32	125	12	127	Noise--Look-Through
0915	50	23	253	--	760	180	6	120	12	957	CW
0920	50	23	--	3.95	230	74	22	135	8	324	Tone--Look-Through
0925	50	23	--	--	160	41	32	125	10	113	Noise--Look-Through
0930	50	23	256	--	750	175	6	118	12	934	CW
0935	50	23	--	3.95	230	73	22	130	8	324	Tone--Look-Through
0940	50	23	--	--	140	40	35	122	7	113	Noise--Look-Through
0945	50	23	260	--	740	167	6	118	12	935	CW
0950	39	23	--	3.95	270	78	22	130	8	341	Tone--Look-Through
0955	40	23	--	--	150	41	35	122	7	104	Noise--Look-Through
1000	40	23	275	--	730	165	6	117	12	935	CW
1005	40	23	--	3.97	270	77	22	130	8	341	Tone--Look-Through
1010	40	23	--	--	150	40	35	122	7	127	Noise--Look-Through
1015	40	23	275	--	770	177	6	117	12	957	CW
1020	40	23	--	3.99	280	80	22	130	8	378	Tone--Look-Through
1025	40	23	--	--	160	41	34	125	7	127	Noise--Look-Through
1030	40	23	273	--	790	180	6	117	12	937	CW
1035	40	23	--	3.99	270	79	22	130	8	378	Tone--Look-Through
1040	40	23	--	--	160	42	34	122	8	127	Noise--Look-Through
1045	40	23	272	--	770	175	6	117	12	990	CW
1050	40	23	--	4.00	270	77	22	130	8	341	Tone--Look-Through

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TABLE 3 (CONT'D)

Time	Temp. (°C)	Hum. (%)	Beat Freq. (Kc)	Mod. Freq. (Kc)	Oscillator Plate Current (ma)	Oscillator Grid Current (ma)	Keyer Plate Current (ma)	Modulator Plate Current (ma)	Look-Through Bias Current (ma)	Power Output (Watts)	Type Modulation
1055	29	23	--	--	160	40	34	121	7	127	Noise--Look-Through
1100	30	23	290	--	770	175	6	117	12	1015	CW
1105	30	23	--	4.00	280	77	22	131	7	378	Tone--Look-Through
1110	28	24	--	--	160	41	34	122	7	127	Noise--Look-Through
1115	27	29	297	--	770	174	6	117	12	1015	CW
1120	29	25	--	4.00	250	70	22	131	8	301	Tone--Look-Through
1125	30	28	--	--	170	42	34	122	7	127	Noise--Look-Through
1130	30	28	296	--	760	175	6	117	12	1025	CW
1135	30	26	--	4.00	240	70	22	131	8	301	Tone--Look-Through
1140	30	26	--	--	170	42	34	122	8	127	Noise--Look-Through
1145	30	26	294	--	760	177	6	117	13	1005	CW
1150	30	26	--	4.00	275	72	22	130	8	292	Tone--Look-Through
1155	30	26	--	--	175	42	34	122	8	127	Noise--Look-Through
1200	20	34	300	--	800	189	6	117	14	1029	CW
1205	21	26	--	4.00	275	70	22	130	8	301	Tone--Look-Through
1210	20	31	--	--	200	42	34	122	8	127	Noise--Look-Through
1215	20	31	302	--	790	184	6	117	14	1010	CW
1220	20	31	--	4.00	260	72	22	131	8	341	Tone--Look-Through
1225	20	31	--	--	180	42	32	122	8	134	Noise--Look-Through
1230	20	31	300	--	780	185	7	117	12	1115	CW
1235	20	31	--	4.00	260	70	22	131	8	301	Tone--Look-Through
1240	20	31	--	--	190	42	33	122	8	145	Noise--Look-Through
1245	20	31	308	--	760	185	7	116	12	1055	CW
1250	20	31	--	4.00	270	69	22	130	8	301	Tone--Look-Through
1255	20	31	--	--	190	43	33	122	8	145	Noise--Look-Through
1300	20	31	307	--	770	184	7	117	12	1115	CW
1305	11	36	--	4.00	260	70	22	130	8	324	Tone--Look-Through
1310	10	36	--	--	200	44	33	122	8	145	Noise--Look-Through

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TABLE 3 (CONT'D)

Time	Temp. (°C)	Hum. (%)	Beat Freq. (Kc)	Mod. Freq. (Kc)	Oscillator Plate Current (ma)	Oscillator Grid Current (ma)	Keyer Plate Current (ma)	Modulator Plate Current (ma)	Look-Through Bias Current (ma)	Power Output (Watts)	Type Modulation
1315	10	36	308	--	780	190	7	117	13	1140	CW
1320	10	36	--	4.00	260	72	22	130	8	341	Tone--Look-Through
1325	11	36	--	--	200	44	33	122	8	145	Noise--Look-Through
1330	10	36	303	--	780	194	7	117	12	1175	CW
1335	10	36	--	4.00	260	72	22	130	8	341	Tone--Look-Through
1340	10	36	--	--	210	46	33	122	8	168	Noise--Look-Through
1345	10	27	300	--	780	195	6	117	12	1205	CW
1350	10	27	--	4.00	275	72	22	130	8	341	Tone--Look-Through
1355	10	27	--	--	210	47	32	122	8	168	Noise--Look-Through
1400	10	27	305	--	790	197	7	117	12	1238	CW
1405	10	27	--	4.00	270	72	22	130	8	341	Tone--Look-Through
1410	5	--	--	--	210	46	32	122	8	168	Noise--Look-Through
1415	1	--	295	--	780	200	7	117	12	1238	CW
1420	0	--	--	4.00	270	75	22	131	8	341	Tone--Look-Through
1425	0	--	--	--	220	48	32	122	8	193	Noise--Look-Through
1430	0	--	293	--	800	210	7	117	12	1300	CW
1435	0	--	--	4.00	270	73	22	130	8	341	Tone--Look-Through
1440	0	--	--	--	220	50	32	122	8	193	Noise--Look-Through
1445	-1	--	290	--	800	215	7	116	13	1330	CW
1450	-1	--	--	4.00	280	77	23	130	8	377	Tone--Look-Through
1455	0	--	--	--	222	50	33	122	8	193	Noise--Look-Through
1500	0	--	292	--	800	210	7	117	13	1300	CW
1505	0	--	--	4.00	290	78	23	130	8	395	Tone--Look-Through
1510	0	--	--	--	222	50	33	122	8	193	Noise--Look-Through
1515	0	--	293	--	800	213	7	117	13	1330	CW

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TABLE 3 (CONT'D)

Note: R-f frequency drift was measured at twice the transmitter output frequency, or at 80.26 Mc. The actual frequency drift, therefore, is half of what is shown in the above table.

An increase in beat frequency indicates an increase in transmitter output frequency.

The following potentials were held constant throughout the test: [illegible] plate, 2500 volts; osc. bias, -700 volts; modulator plate, 300 volts; look-through plate, 150 volts; look-through bias, -150 volts.

SUMMARY (TEMPERATURE RUN @ 40.13 Mc)

Temperature Change (^{o}C)	Change in Frequency per 10^{o}C (Kc)	Change in Frequency per 1^{o}C (%)
50 - 40	6.0	0.001497
40 - 30	11.0	0.002741
30 - 20	6.5	0.001622
20 - 10	1.0	0.000250
10 - 0	6.0	0.001497
Average	6.1	0.001522

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TABLE 4

MODEL XCK TRANSMITTING EQUIPMENT

VARIATION IN AMBIENT TEMPERATURE
FREQUENCY - 120.25 Mc

Time	Temp. (°C)	Hum. (%)	Beat Freq. (Kc)	Mod. Freq. (Kc)	Oscillator Plate Current (ma)	Oscillator Grid Current (ma)	Keyer Plate Current (ma)	Modulator Plate Current (ma)	Look-Through Bias Current (ma)	Power Output (Watts)	Type Modulation
0845	50	32	200	--	660	130	6	117	12	645	CW
0850	50	32	--	38.0	100	30	23	130	8	40	Tone--Look-Through
0855	50	32	--	--	100	36	34	122	7	18	Noise-Look-Through
0900	50	24	205	--	670	134	6	116	14	592	CW
0905	50	24	--	38.5	100	35	22	130	8	28	Tone--Look-Through
0910	50	24	--	--	100	36	34	121	8	28	Noise--Look-Through
0915	50	24	196	--	660	131	6	117	12	645	CW
0920	50	24	--	38.5	100	27	24	130	8	28	Tone--Look-Through
0925	50	24	--	--	100	35	34	122	8	18	Noise--Look-Through
0930	50	24	204	--	670	125	6	117	12	618	CW
0935	50	24	--	38.8	100	25	24	130	8	28	Tone--Look-Through
0940	50	24	--	--	100	36	35	122	7	18	Noise--Look-Through
0945	50	24	205	--	660	132	6	117	12	645	CW
0950	40	23	--	39.0	100	25	24	130	8	28	Tone--Look-Through
0955	39	23	--	--	100	35	35	122	7	28	Noise--Look-Through
1000	40	23	214	--	660	124	6	116	12	645	CW
1005	40	23	--	39.2	100	25	24	130	8	28	Tone--Look-Through
1010	40	23	--	--	100	36	35	121	7	28	Noise--Look-Through
1015	40	25	194	--	660	124	6	116	12	635	CW
1020	40	25	--	39.2	100	25	24	130	7	28	Tone--Look-Through
1025	40	25	--	--	100	34	34	121	7	28	Noise--Look-Through
1030	40	25	190	--	650	115	6	117	12	592	CW
1035	40	25	--	39.5	100	28	24	130	8	40	Tone--Look-Through
1040	40	25	--	--	100	35	34	121	7	40	Noise--Look-Through

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TABLE 4 (CONT'D)

Time	Temp. (°C)	Hum. (%)	Beat Freq. (Kc)	Mod. Freq. (Kc)	Oscillator Plate Current (ma)	Oscillator Grid Current (ma)	Keyer Plate Current (ma)	Modulator Plate Current (ma)	Look-Through Bias Current (ma)	Power Output (Watts)	Type Modulation
1045	40	25	193	--	640	115	6	117	12	592	CW
1050	40	25	--	39.3	100	26	24	130	7	28	Tone--Look-Through
										18	Noise--Look-Through
1055	31	26	--	--	100	33	36	121	7	542	CW
1100	30	28	183	--	640	110	6	116	12	28	Tone--Look-Through
1105	30	28	--	39.6	100	28	23	130	8	28	Noise--Look-Through
1110	30	28	--	--	100	33	35	121	7	492	CW
1115	30	28	190	--	610	100	6	116	12	40	Tone--Look-Through
1120	30	28	--	39.7	100	30	23	130	7	28	Noise--Look-Through
1125	30	28	--	--	100	35	36	121	7	542	CW
1130	30	28	192	--	644	110	6	116	12	40	Tone--Look-Through
1135	30	28	--	40.0	100	30	23	130	7	28	Noise--Look-Through
1140	30	28	--	--	100	35	36	121	7	590	CW
1145	30	28	198	--	640	114	6	116	12	40	Tone--Look-Through
1150	30	28	--	40.0	100	28	23	130	7	28	Noise--Look-Through
1155	30	28	--	--	100	35	35	121	7		
1200	23	28	197	--	640	112	6	116	12	592	CW
1205	20	31	--	40.1	100	30	24	130	7	40	Tone--Look-Through
1210	20	31	--	--	100	35	35	121	7	28	Noise--Look-Through
1215	20	31	200	--	650	108	6	117	13	542	CW
1220	20	31	--	40.3	100	32	22	130	8	90	Tone--Look-Through
1225	20	31	--	--	100	35	35	121	7	4.4	Noise--Look-Through
1230	20	31	210	--	610	105	6	117	12	542	CW
1235	20	31	--	40.8	100	30	24	129	8	110	Tone--Look-Through
1240	20	31	--	--	100	35	36	121	7	18	Noise--Look-Through
1245	20	31	205	--	610	105	6	117	12	542	CW

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TABLE 4 (CONT'D)

Time	Temp. (°C)	Hum. (%)	Beat Freq. (Kc)	Mod. Freq. (Kc)	Oscillator Plate Current (ma)	Oscillator Grid Current (ma)	Keyer Plate Current (ma)	Modulator Plate Current (ma)	Look-Through Bias Current (ma)	Power Output (Watts)	Type Modulation
1250	20	31	--	40.8	100	30	24	130	8	110	Tone--Look-Through
1255	20	31	--	--	100	35	36	121	7	18	Noise--Look-Through
1300	20	31	200	--	610	102	6	116	12	542	CW
1305	11	46	--	40.8	120	31	23	130	8	110	Tone--Look-Through
1310	11	40	--	--	100	35	36	121	7	18	Noise--Look-Through
1315	10	38	215	--	610	105	6	116	12	542	CW
1320	10	38	--	40.9	140	34	23	130	7	110	Tone--Look-Through
1325	10	38	--	--	100	34	36	121	7	4.4	Noise--Look-Through
1330	10	32	220	--	640	110	6	116	16	542	CW
1335	10	32	--	40.9	100	35	24	130	10	72	Tone--Look-Through
1340	10	32	--	--	100	36	36	121	7	4.4	Noise--Look-Through
1345	10	32	217	--	614	105	6	116	14	492	CW
1350	10	32	--	40.9	100	30	24	129	7	72	Tone--Look-Through
1355	10	32	--	--	100	33	36	121	8	28	Noise--Look-Through
1400	10	32	218	--	630	104	6	117	14	492	CW
1405	10	32	--	41.0	110	35	24	130	8	72	Tone--Look-Through
1410	2	--	--	--	100	36	35	121	8	28	Noise--Look-Through
1415	0	--	235	--	650	110	6	116	14	492	CW
1420	0	--	--	41.3	130	36	24	129	8	110	Tone--Look-Through
1425	0	--	--	--	100	36	36	121	8	28	Noise--Look-Through
1430	0	--	228	--	640	100	6	118	14	566	CW
1435	0	--	--	41.3	150	36	24	129	8	110	Tone--Look-Through
1440	0	--	--	--	100	36	35	121	8	18	Noise--Look-Through
1445	0	--	240	--	650	111	6	116	14	592	CW
1450	0	--	--	41.3	150	40	24	130	8	110	Tone--Look-Through

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TABLE 4 (CONT'D)

Time	Temp. (°C)	Hum. (%)	Beat Freq. (Kc)	Mod. Freq. (Kc)	Oscillator Plate Current (ma)	Oscillator Grid Current (ma)	Keyer Plate Current (ma)	Modulator Plate Current (ma)	Look-Through Bias Current (ma)	Power Output (Watts)	Type Modulation
1455	0	--	--	--	100	35	36	121	8	28	Noise--Look-Through
1500	0	--	223	--	640	105	6	118	13	592	CW
1505	0	--	--	41.3	150	38	24	130	8	110	Tone--Look-Through
1510	0	--	--	--	100	34	36	122	8	10	Noise--Look-Through

Note: An increase in beat frequency indicates an increase in transmitter output frequency.

The following potentials were held constant throughout the test: plate, 1750 volts; osc. bias, -700 volts; modulator plate, 300 volts; look-through plate, 150 volts; look-through bias, -150 volts.

SUMMARY (TEMPERATURE RUN @ 120.25 Mc)

Temperature Change (°C)	Change in Frequency per 10°C (Kc)	Change in Frequency per 1°C (%)
50 - 40	12.0	0.000998
40 - 30	5.0	0.000416
30 - 20	2.0	0.000163
20 - 10	18.0	0.001498
10 - 0	5.0	0.000416
Average	8.4	0.000698

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TABLE 5

MODEL XCK TRANSMITTING EQUIPMENT

VARIATION IN RELATIVE HUMIDITY
FREQUENCY - 40.13 Mc

Time	Hum. (%)	Temp. (°C)	Beat Freq. (Kc)	Mod. Freq. (Cycles)	Oscillator Plate Current (ma)	Oscillator Grid Current (ma)	Keyer Plate Current (ma)	Modulator Plate Current (ma)	Look-Through Bias Current (ma)	Power Output (Watts)	Type Modulation
1315	27	40	240	--	750	182	6	120	12	1040	CW
1320	27	40	--	870	310	88	17	135	8	399	Tone--Look-Through
1325	27	40	--	870	220	46	20	125	7	162	Noise--Look-Through
1330	23	40	230	--	780	197	6	120	12	1000	CW
1335	23	40	--	870	320	92	17	135	8	421	Tone--Look-Through
1340	23	40	--	--	225	47	20	125	8	220	Noise--Look-Through
1345	23	40	230	--	770	195	6	120	12	954	CW
1350	66	39	--	870	300	90	17	135	8	435	Tone--Look-Through
1355	90	40	--	--	210	45	19	125	8	173	Noise--Look-Through
1400	93	40	227	--	780	195	6	120	12	1010	CW
1405	97	40	--	870	310	95	17	135	8	437	Tone-Look-Through
1410	97	40	--	--	220	50	24	125	7	186	Noise--Look-Through
1415	97	40	217	--	790	196	6	120	12	1010	CW
1420	97	40	--	870	320	93	17	135	8	437	Tone--Look-Through
1425	97	40	--	--	250	50	24	125	7	186	Noise--Look-Through
1430	97	40	223	--	790	195	6	120	12	1010	CW
1435	97	41	--	870	320	92	17	135	8	423	Tone--Look-Through
1440	97	40	--	--	230	50	23	125	11	197	Noise--Look-Through
1445	97	41	225	--	790	194	6	120	18	980	CW
1450	97	41	--	875	320	95	18	134	12	421	Tone--Look-Through
1455	97	41	--	--	220	48	19	125	12	186	Noise--Look-Through
1500	97	40	220	--	790	192	6	120	18	1010	CW

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TABLE 5 (CONT'D)

Time	Hum. (%)	Temp. (°C)	Beat Freq. (Kc)	Mod. Freq. (Cycles)	Oscillator Plate Current (ma)	Oscillator Grid Current (ma)	Keyer Plate Current (ma)	Modulator Plate Current (ma)	Look-Through Bias Current (ma)	Power Output (Watts)	Type Modulation
1505	58	40	--	875	310	88	17	132	12	399	Tone--Look-Through
1510	35	40	--	--	220	50	24	125	11	220	Noise--Look-Through
1515	27	40	230	--	790	195	6	120	18	1000	CW
1520	27	40	--	860	320	93	17	134	12	437	Tone--Look-Through
1525	27	40	--	--	230	50	19	125	12	186	Noise--Look-Through
1530	27	40	240	--	790	195	7	120	18	1010	CW
1535	27	40	--	870	330	94	17	133	12	445	Tone--Look-Through
1540	27	40	--	--	230	50	19	125	12	197	Noise--Look-Through
1545	27	40	235	--	780	195	6	120	18	1010	CW
1550	23	40	--	875	330	93	19	133	12	435	Tone--Look-Through
1555	23	40	--	--	240	50	25	125	12	186	Noise--Look-Through
1600	23	40	240	--	790	196	6	120	18	1010	CW
1605	23	40	--	875	320	93	19	132	12	435	Tone--Look-Through
1610	23	40	--	--	230	50	25	125	12	186	Noise--Look-Through
1615	23	40	235	--	780	195	6	120	18	1010	CW

SUMMARY (HUMIDITY RUN @ 40.13 Mc)

Average Relative Humidity (%)	Average Beat Frequency (Kc)	Change in Frequency Kc	Change in Frequency %
24.7	266.0	----	----
97.0	222.4	21.8	0.000593
28.0	236.0	15.0	0.000374

Note: R-f frequency drift was measured at twice the transmitter output frequency or at 80.26 Mc. The actual frequency drift, therefore, is half of the difference in beat frequencies. An increase in beat frequency indicates an increase in transmitter frequency. The following potentials were held constant throughout the test: plate, 2500 volts; osc. bias, -700 volts; modulator plate, 300 volts; look-through plate, 150 volts; look-through bias, -150 volts.

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TABLE 6

MODEL XCK TRANSMITTING EQUIPMENT

VARIATION IN RELATIVE HUMIDITY
FREQUENCY - 120.25 Mc

Time	Hum. (%)	Temp. (°C)	Beat Freq. (Kc)	Mod. Freq. (Kc)	Oscillator Plate Current (ma)	Oscillator Grid Current (ma)	Keyer Plate Current (ma)	Modulator Plate Current (ma)	Look-Through Bias Current (ma)	Power Output (Watts)	Type Modulation
1230	25	40	80	--	800	220	6	116	12	816	CW
1235	25	40	--	36.6	100	30	24	127	8	28	Tone--Look-Through
1240	25	40	--	--	100	40	34	121	7	28	Noise--Look-Through
1245	25	40	81	--	750	200	6	116	18	786	CW
1250	25	40	--	37.0	100	30	24	129	8	28	Tone--Look-Through
1255	25	40	--	--	100	40	35	121	7	17	Noise--Look-Through
1300	25	40	80	--	750	195	6	116	13	786	CW
1305	74	40	--	36.8	100	30	24	128	8	28	Tone--Look-Through
1310	80	40	--	--	100	40	35	121	7	28	Noise--Look-Through
1315	87	40	61	--	750	205	6	116	12	757	CW
1320	90	40	--	35.6	100	30	24	129	8	28	Tone--Look-Through
1325	97	40	--	--	100	40	35	121	7	28	Noise--Look-Through
1330	93	42	55	--	750	203	6	116	12	757	CW
1335	93	42	--	35	100	30	24	129	8	28	Tone--Look-Through
1340	93	42	--	--	100	40	35	121	7	28	Noise--Look-Through
1345	93	42	54	--	750	200	6	116	12	757	CW
1350	97	41	--	34.8	100	30	24	129	8	28	Tone--Look-Through
1355	97	41	--	--	100	40	35	121	7	28	Noise--Look-Through
1400	97	41	57.5	--	750	203	6	116	12	757	CW
1405	97	41	--	35.0	100	30	24	129	8	18	Tone--Look-Through
1410	97	41	--	--	100	40	35	121	7	18	Noise--Look-Through
1415	97	41	71	--	750	200	6	116	12	786	CW

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TABLE 6 (CONT'D)

Time	Hum. (%)	Temp. (C)	Beat Freq. (Kc)	Mod. Freq. (Kc)	Oscillator Plate Current (ma)	Oscillator Grid Current (ma)	Keyer Plate Current (ma)	Modulator Plate Current (ma)	Look-Through Bias Current (ma)	Power Output (Watts)	Type Modulation
1420	31	40	--	36.0	100	30	24	129	8	28	Tone--Look-Through
1425	29	40	--	--	100	40	35	121	7	28	Noise--Look-Through
1430	27	40	80	--	750	205	6	116	12	786	CW
1435	27	40	--	36.8	100	30	24	129	8	28	Tone--Look-Through
1440	27	40	--	--	100	40	36	121	7	28	Noise--Look-Through
1445	25	40	76	--	750	208	6	116	12	816	CW
1450	25	40	--	37.0	100	30	24	129	8	28	Tone--Look-Through
1455	25	40	--	--	100	40	36	121	7	28	Noise--Look-Through
1500	25	40	82	--	760	210	6	116	12	816	CW
1505	25	40	--	37.2	100	30	24	129	8	28	Tone--Look-Through
1510	25	40	--	--	100	40	36	121	7	28	Noise--Look-Thro ugh
1515	25	40	83	--	750	205	6	116	12	786	CW
1520	25	40	--	37.2	100	30	24	129	8	28	Tone--Look-Through

SUMMARY (HUMIDITY RUN @ 120.25 Mc)

Average Relative Humidity (%)	Average Beat Frequency (Kc)	Change in Frequency Kc	Change in Frequency %
25.0	80.3	--	--
92.1	59.7	20.6	0.000172
23.9	80.3	0.0	0.000000

Note: An increase in beat frequency indicates an increase in transmitter output frequency. The following potentials were held constant throughout the test: plate, 1750 volts; osc. bias, -700 volts; modulator plate, 300 volts; look-through plate, 150 volts; look-through bias, -150 volts.

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TABLE 7

MODEL XCK TRANSMITTING EQUIPMENT

WET START TEST
FREQUENCY - 120.25 Mc

Time	Hum. (%)	Temp. (°C)	Beat Freq. (Kc)	Mod. Freq. (Kc)	Oscillator Plate Current (ma)	Oscillator Grid Current (ma)	Keyer Plate Current (ma)	Modulator Plate Current (ma)	Look-Through Bias Current (ma)	Power Output (Watts)	Type Modulation
1035	98	40	125	--	600	98	9	120	17	440	CW
1040	98	40	--	30.2	0	0	32	135	17	0	Tone--Look-Through
1045	98	40	--	--	0	0	31	128	16	0	Noise--Look-Through
1050	98	40	90	--	600	95	7	129	13	440	CW
1055	98	40	--	27.2	120	30	23	132	11	28	Tone--Look-Through
1100	98	40	--	--	50	32	38	124	10	7	Noise--Look-Through
1105	98	40	100	--	610	108	7	119	13	492	CW
1110	38	40	--	26.2	50	20	22	130	9	7	Tone--Look-Through
1115	34	40	--	--	90	34	36	123	8	7	Noise--Look-Through
1120	28	40	105	--	600	104	6	118	13	492	CW
1125	28	40	--	31.0	100	25	23	130	8	18	Tone--Look-Through
1130	28	40	--	--	80	35	37	122	7	10	Noise--Look-Through
1135	28	40	130	--	600	100	36	118	12	492	CW
1140	28	40	--	33.1	100	25	24	130	8	7	Tone--Look-Through
1145	28	40	--	--	70	28	36	122	8	7	Noise--Look-Through
1150	28	40	135	--	600	108	6	118	12	492	CW

Note: An increase in beat frequency indicates an increase in transmitter output frequency. The following potentials were held constant throughout the test: plate, 1750 volts; osc. bias, -700 volts; modulator plate, 300 volts; look-through plate, 150 volts; look-through bias, -150 volts.

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TABLE 8

MODEL XCK TRANSMITTING EQUIPMENT

OPERATING DATA ON TUBES

Tube Symbol	Type	Ek (Volts)	E_{g_1-k} (Volts)	E_{g_2} (Volts)	E_{g_3} (Volts)	Eb (Volts)	Ik (ma)	I_{g_1} (ma)	I_{g_2} (ma)	I_{g_3} (ma)	Ib (ma)
V303	807	-700			---						
V304	807				---	-85	125			---	125
V305A	6SN7		-150	---	---	0			---	---	
V305B	6SN7	12	5	---	---	270	12	2	---	---	10
V306A	6SN7	0		---	---	70			---	---	
V306B	6SN7	0		---	---	70			---	---	
V307A	6SN7	0		---	---	70			---	---	
V307B	6SN7	0		---	---	70			---	---	
V308A	6SN7	0		---	---	75			---	---	
V308B	6SN7			---	---	0			---	---	
V309A	6SN7	0	-35	---	---	193			---	---	
V309B	6SN7	0	-42	---	---	195			---	---	
V310	6AC7	0	-54	196	196	196	13.5	0			
V311	6AC7	0		56		175	16		3		13
V312	884	0	0	---		14.6			---	---	
V313	6AC7	4.6	-8.0	210	0	280					
V314	6AC7	21	-8.0	123	0	90					
V315	6AC7	20	-8.0	125	0	79					
V316	6AC7	82	-7.0	300	300	300	20		5.5	2.2	12.3
V317	807				---	-85	125			---	125
V318	OB3/VR90	0	---	---	---	88	19	---	---	---	19
V319	6AC7	150		300	300	300	11				7.5
V326/V327	8014-A	0		---	---	4000	1250*	250*	---	---	1000*

Note: Data are for most severe operation. Voltages are measured with respect to ground, unless specified.
*Currents are totals for two tubes in push-pull.

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TABLE 9

MODEL XCK TRANSMITTING EQUIPMENT

LIST OF CONTROLS AND METERS, ETC. ON FRONT PANEL

Transmitter

Frequency control knob.
Frequency indicating dial, calibrated 37-126 Mc.
Tuning motor control: up, increase frequency; down, decrease frequency.
Plate current meter: 0-2 amps., d.c.
Filament voltmeter: 0-25 volts a.c.
Antenna coupling control knob.
Output indicator: 0-1 ma d-c milliammeter.
R-f output jack: for RG18U cable fitting.

Look-Through and Keyer Chassis

Receiver switch: RCX - RBW/RBK (two-position rotary).
Look-through switch: off-on (two-position rotary).
Transmitter control switch: standby-operate (two-position rotary).
Oscillator grid current meter: 0-300 ma d.c.
Synchronization jacks (2): RCX, RBW.
Blanking jacks (3): RCX, RBW, RBK.
Modulation monitor jack.
Modulation test jack.

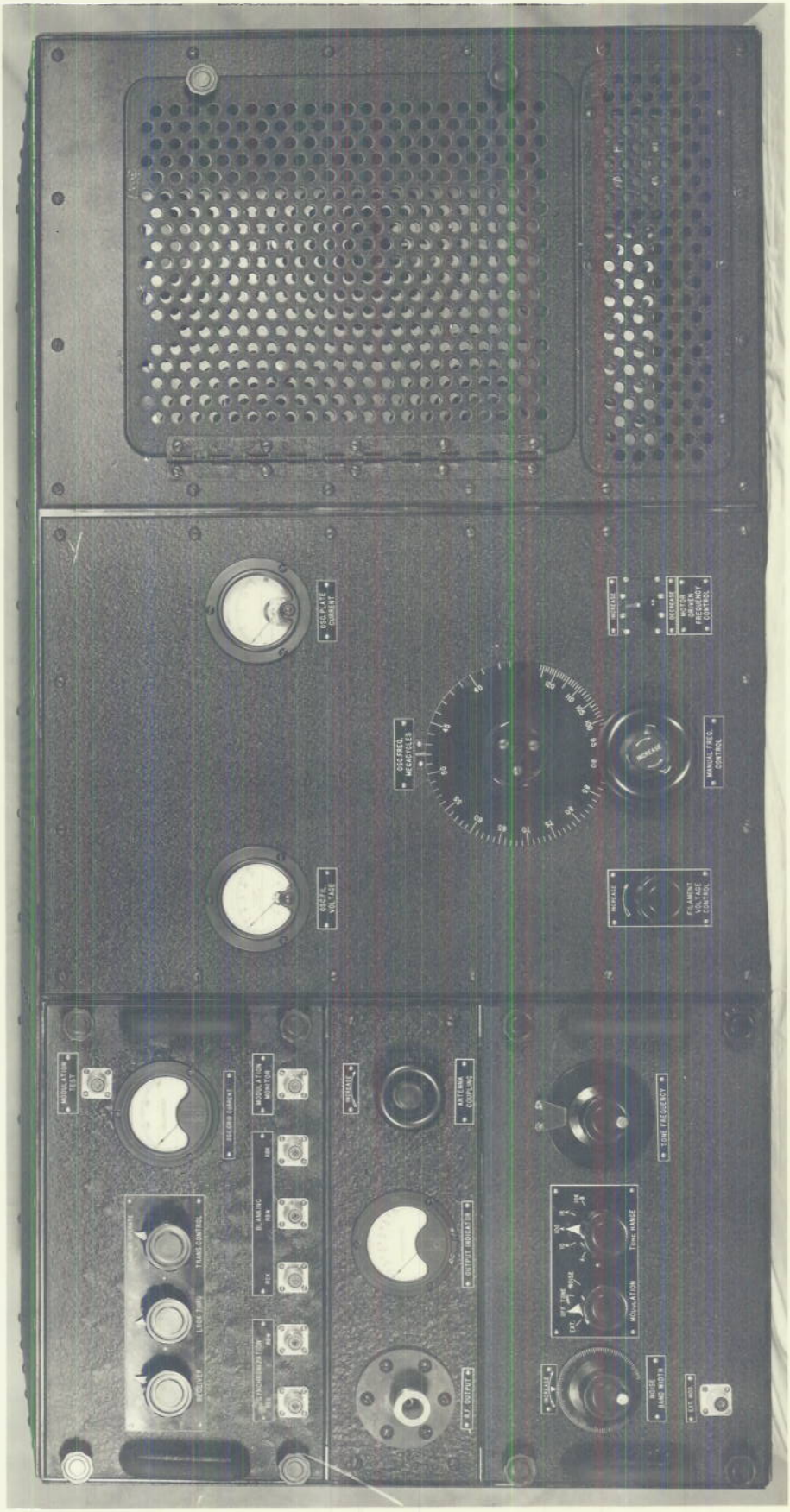
Tone and Noise Chassis

Modulation switch: ext., off, tone, noise (four-position rotary).
Tone range switch: A, 10A, 100A, 1KA, 10KB (five-position rotary.
Tone frequency control: two scales, A and B, directly calibrated.
Noise bandwidth control: 0-100 divisions.
External modulation jack.

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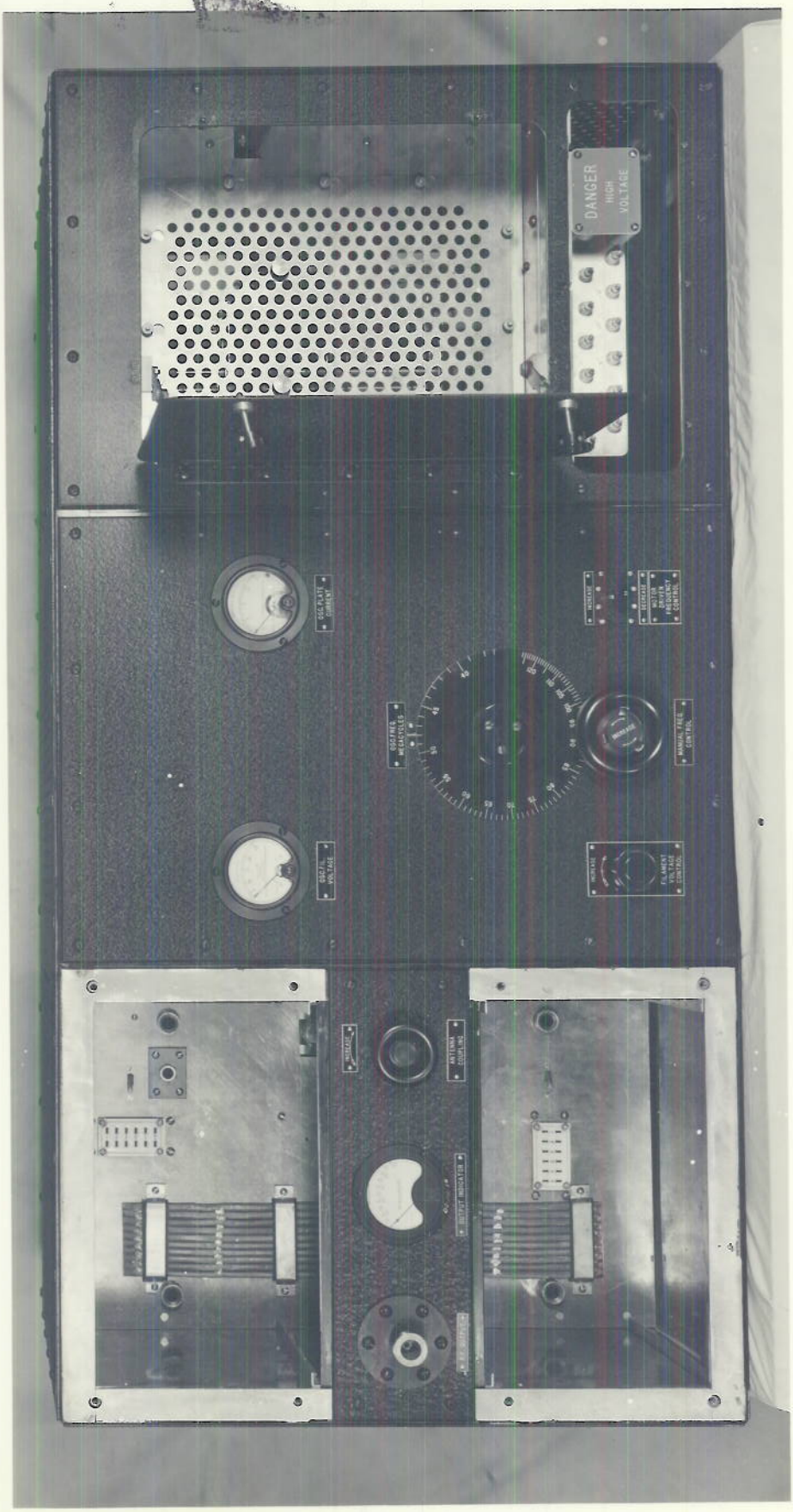


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PLATE I SEC. 3

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PLATE 2 SEC. 3

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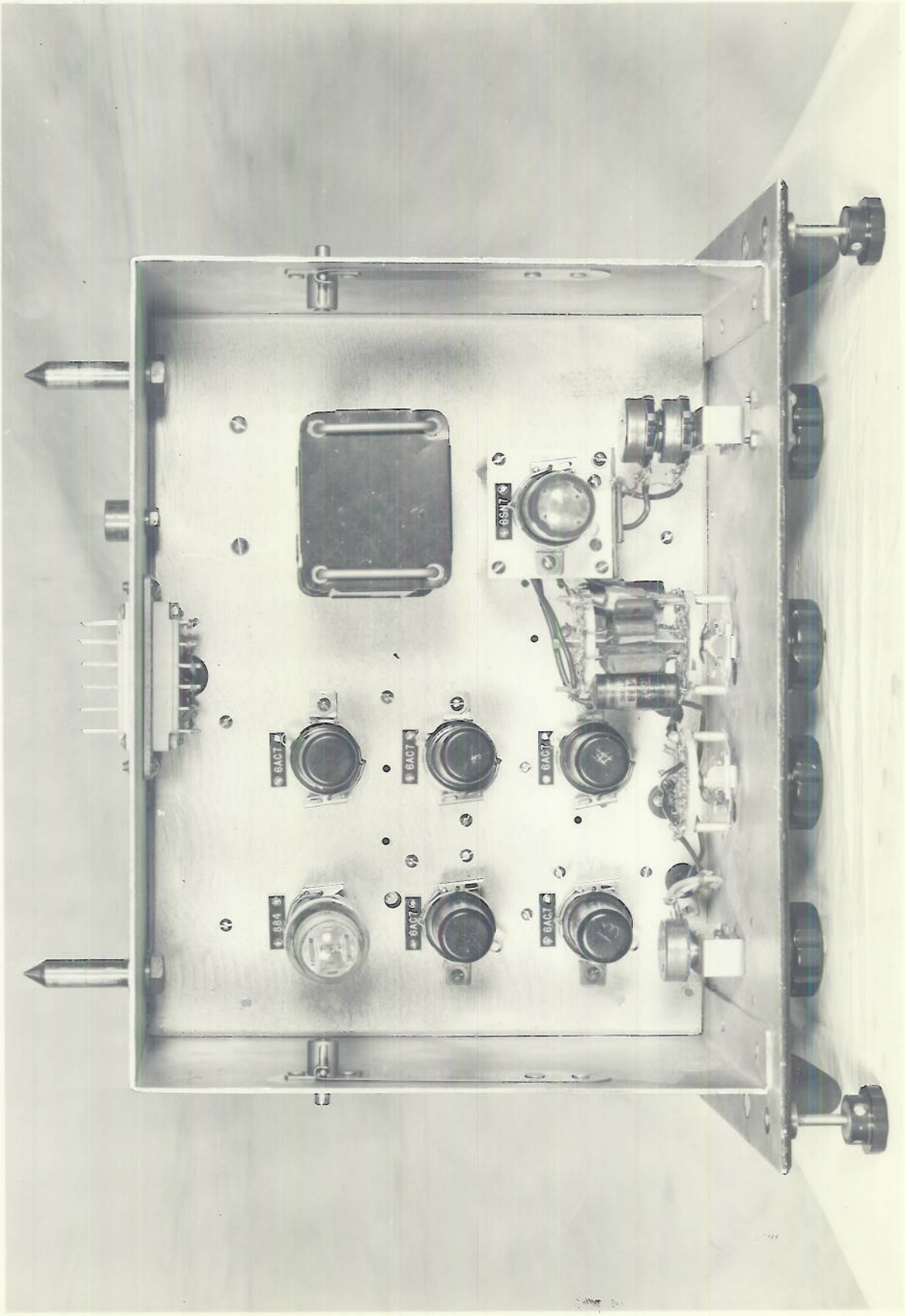


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PLATE 3 SEC. 3

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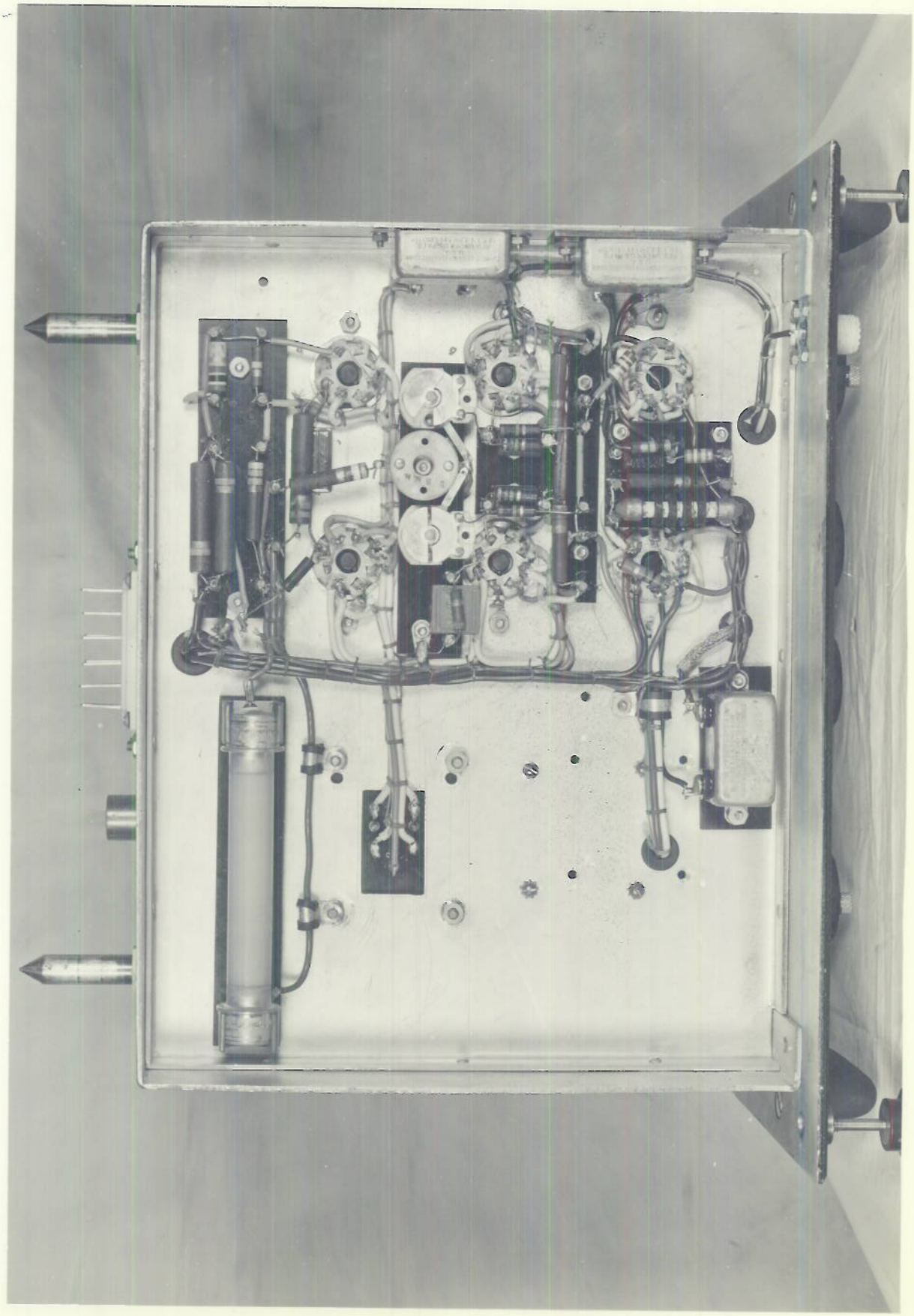


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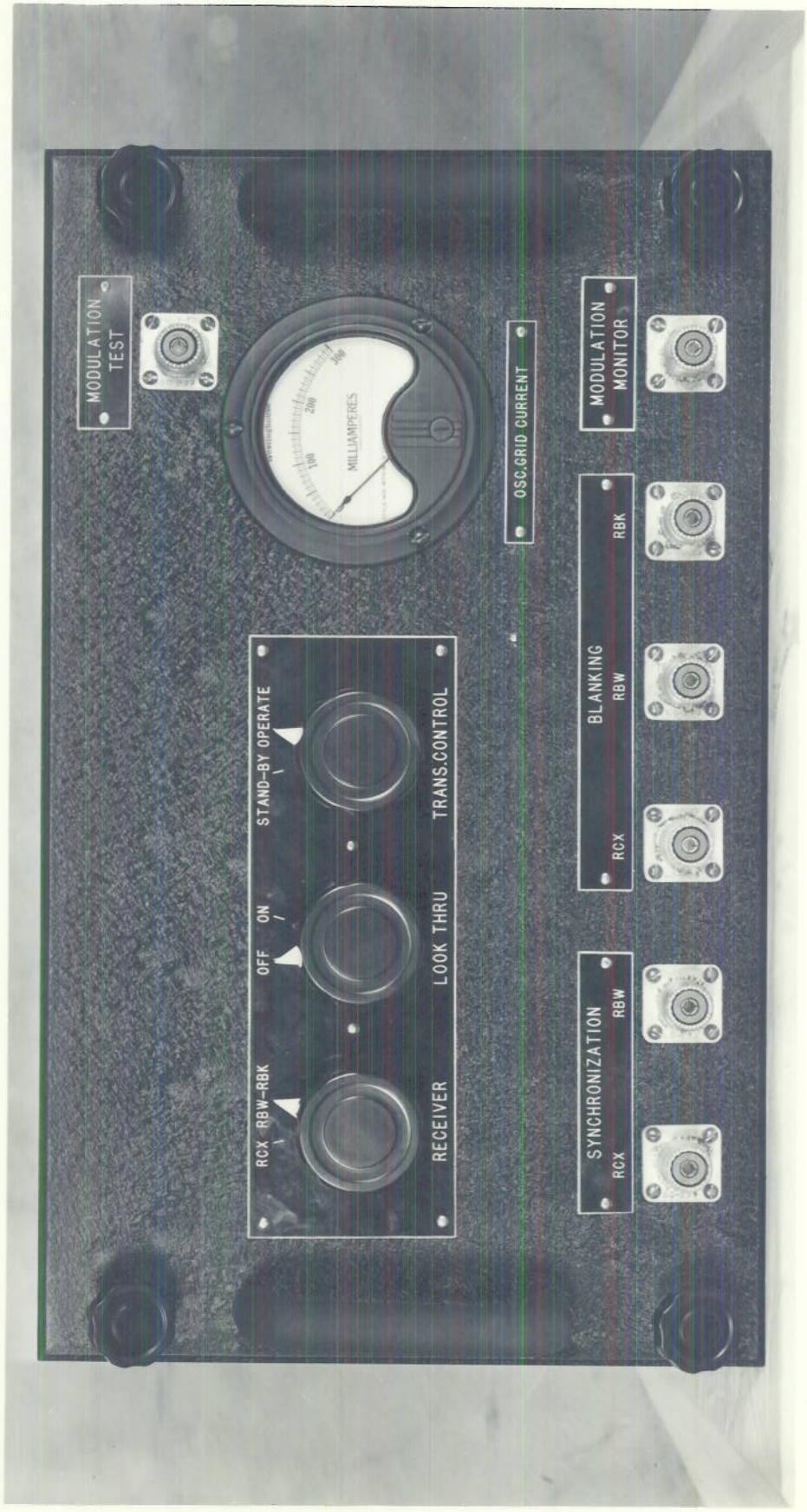


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PLATE 5 SEC. 3

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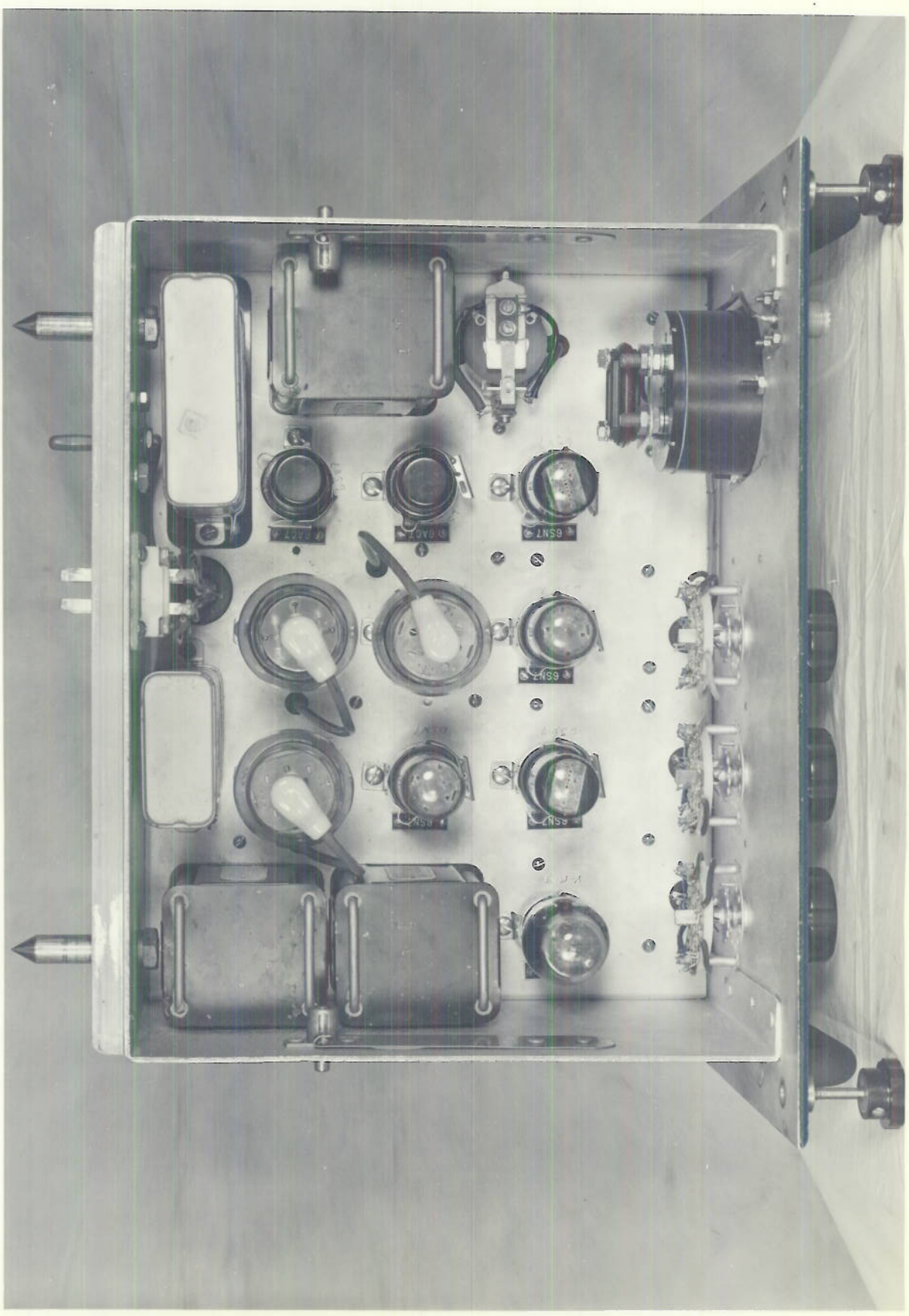


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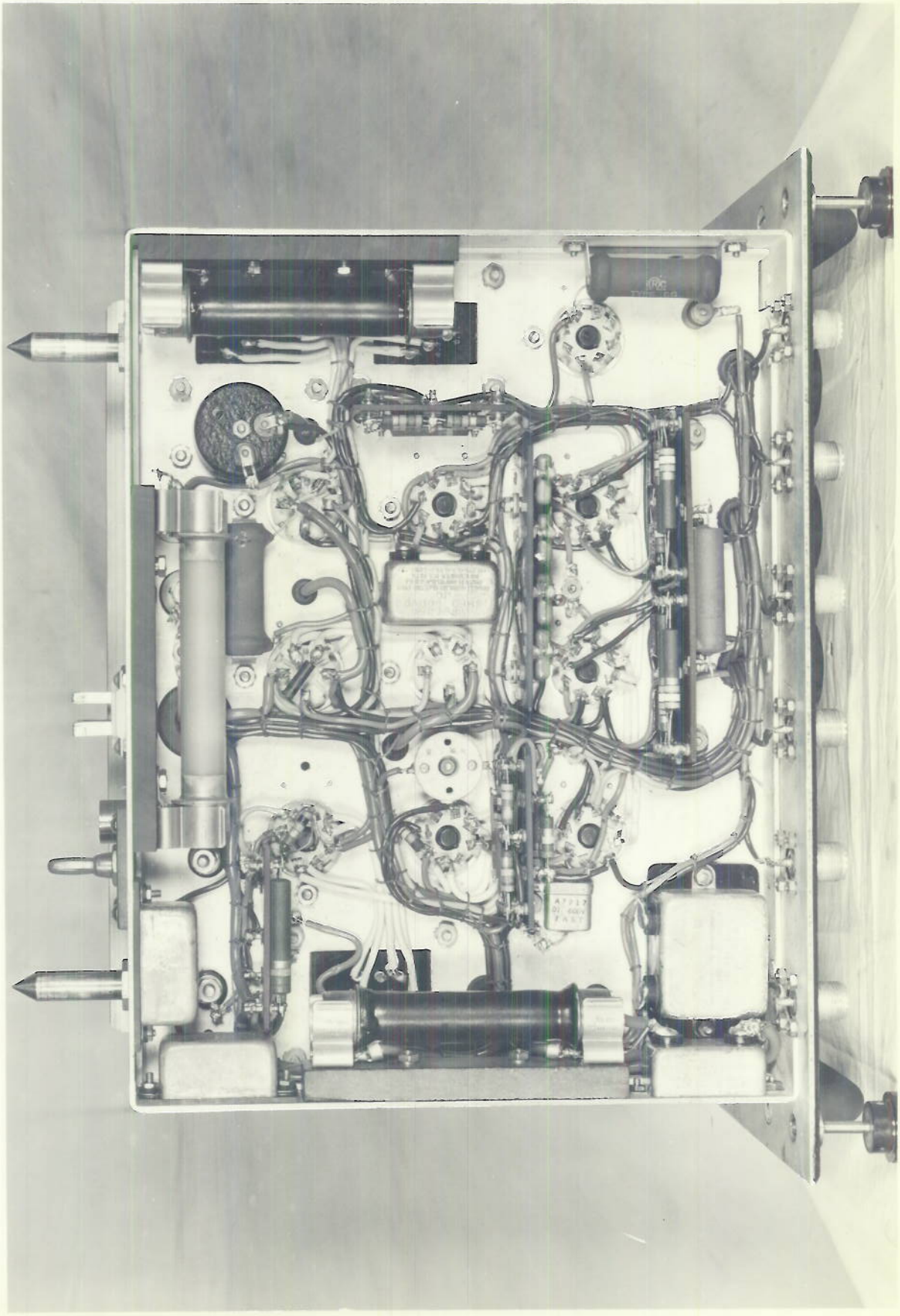


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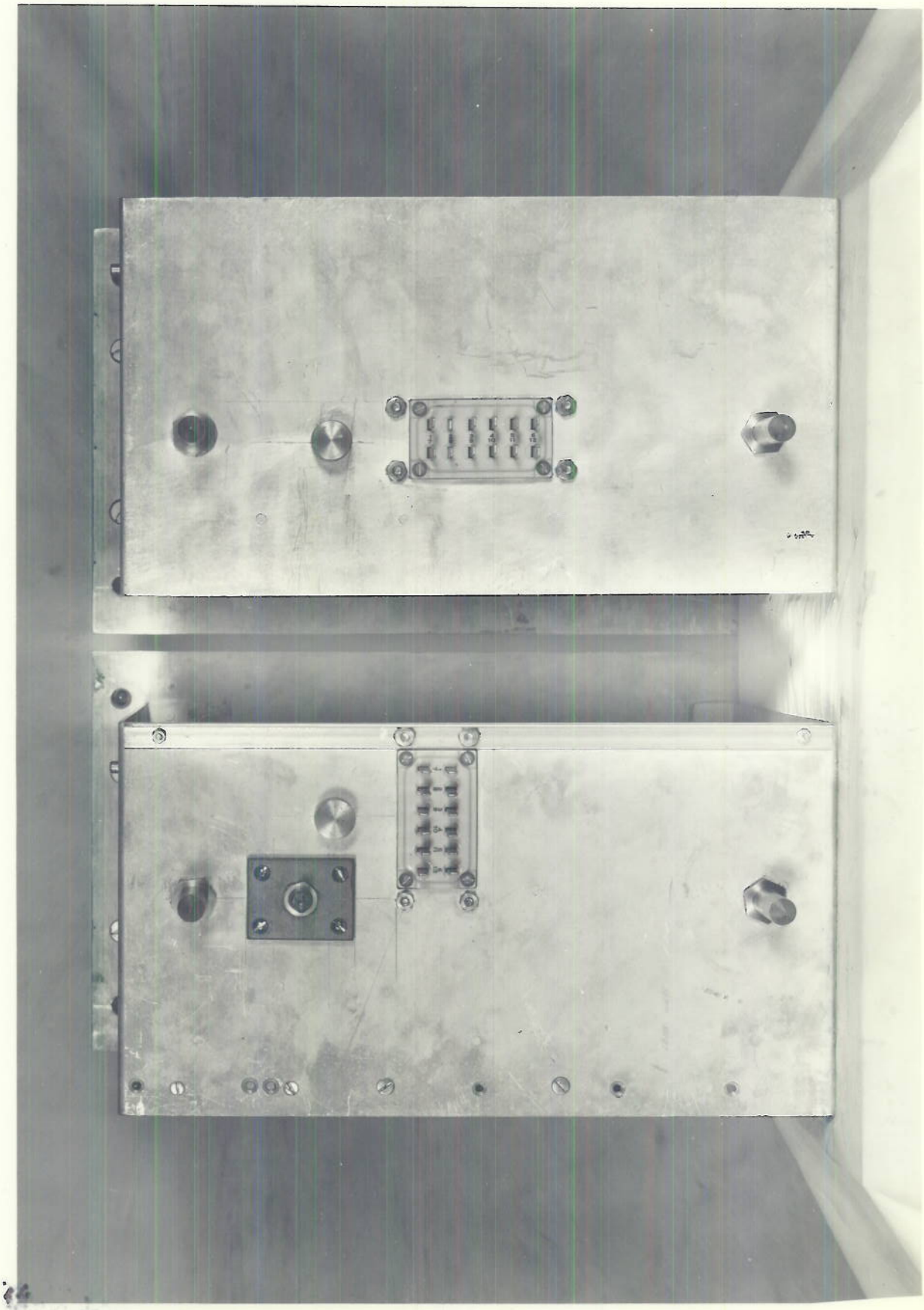


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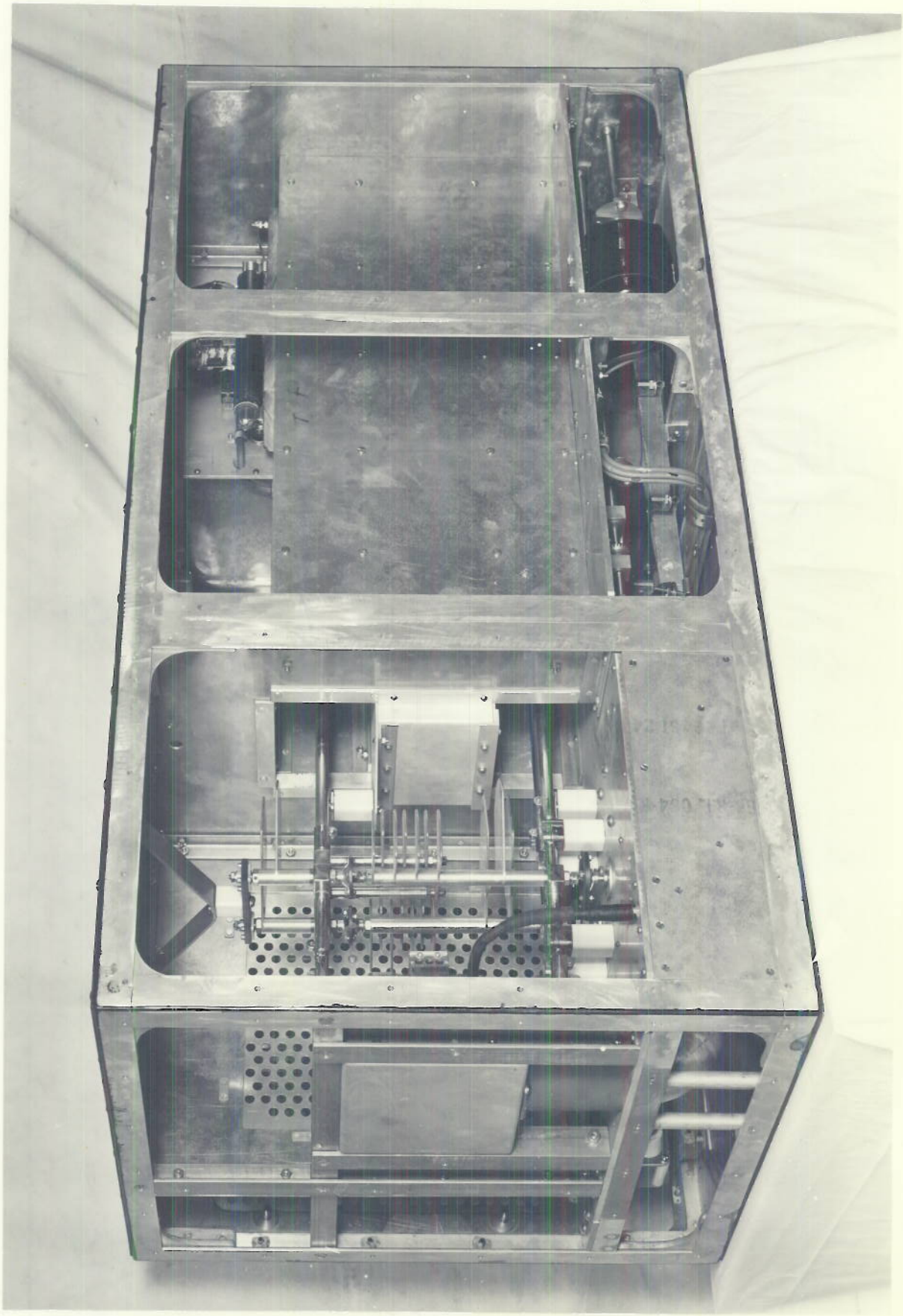


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PLATE 9 SEC. 3

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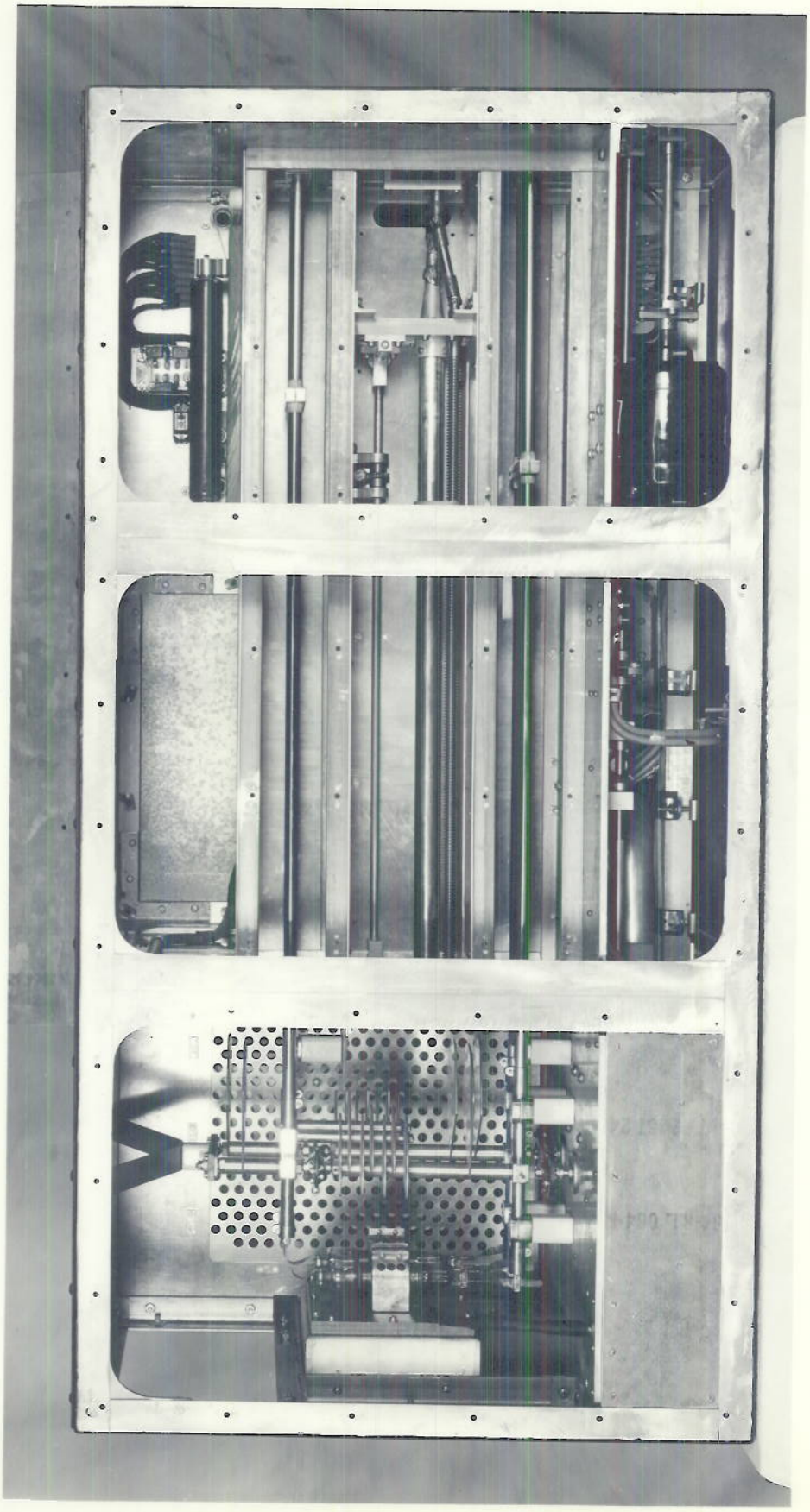


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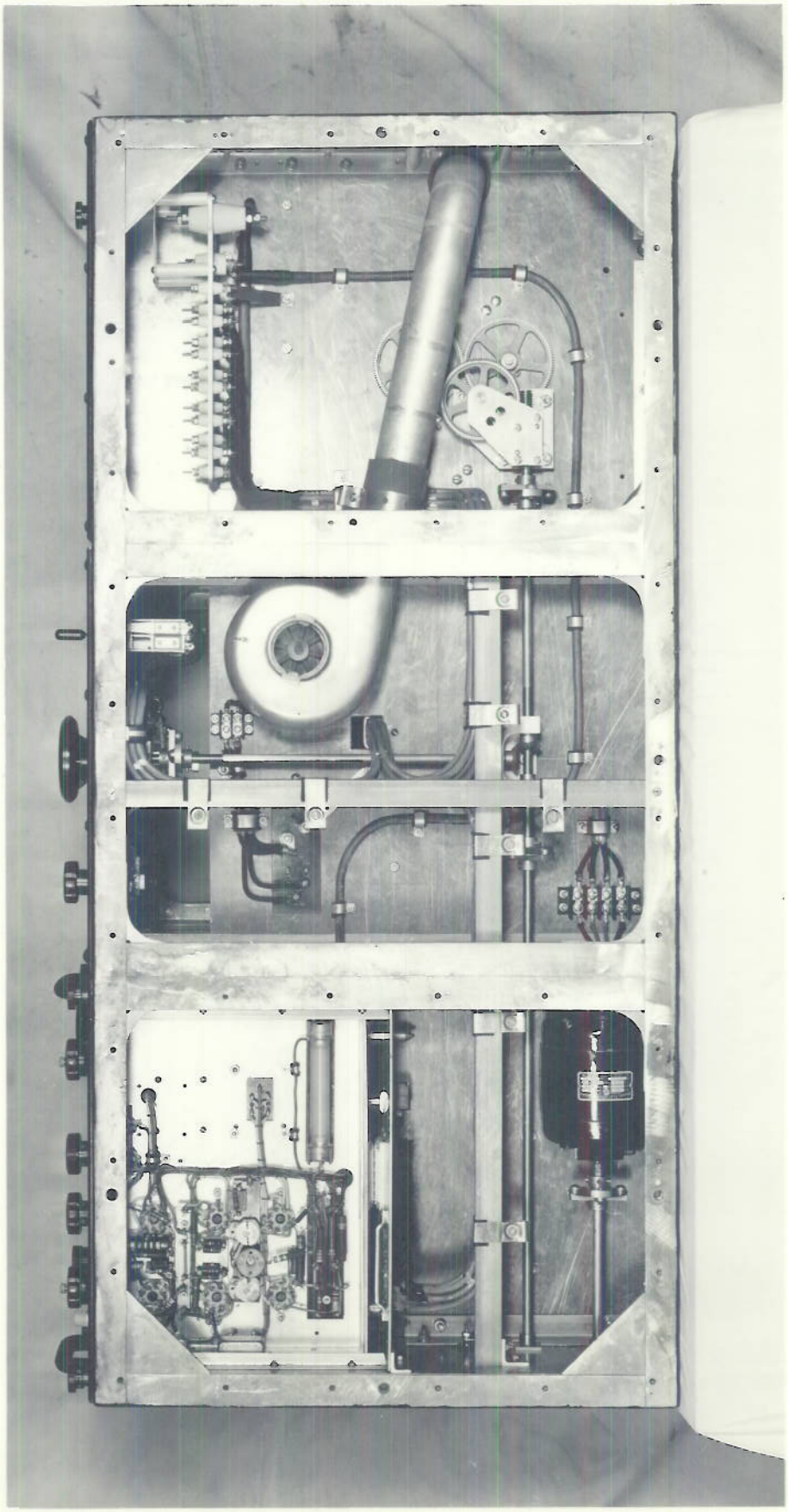


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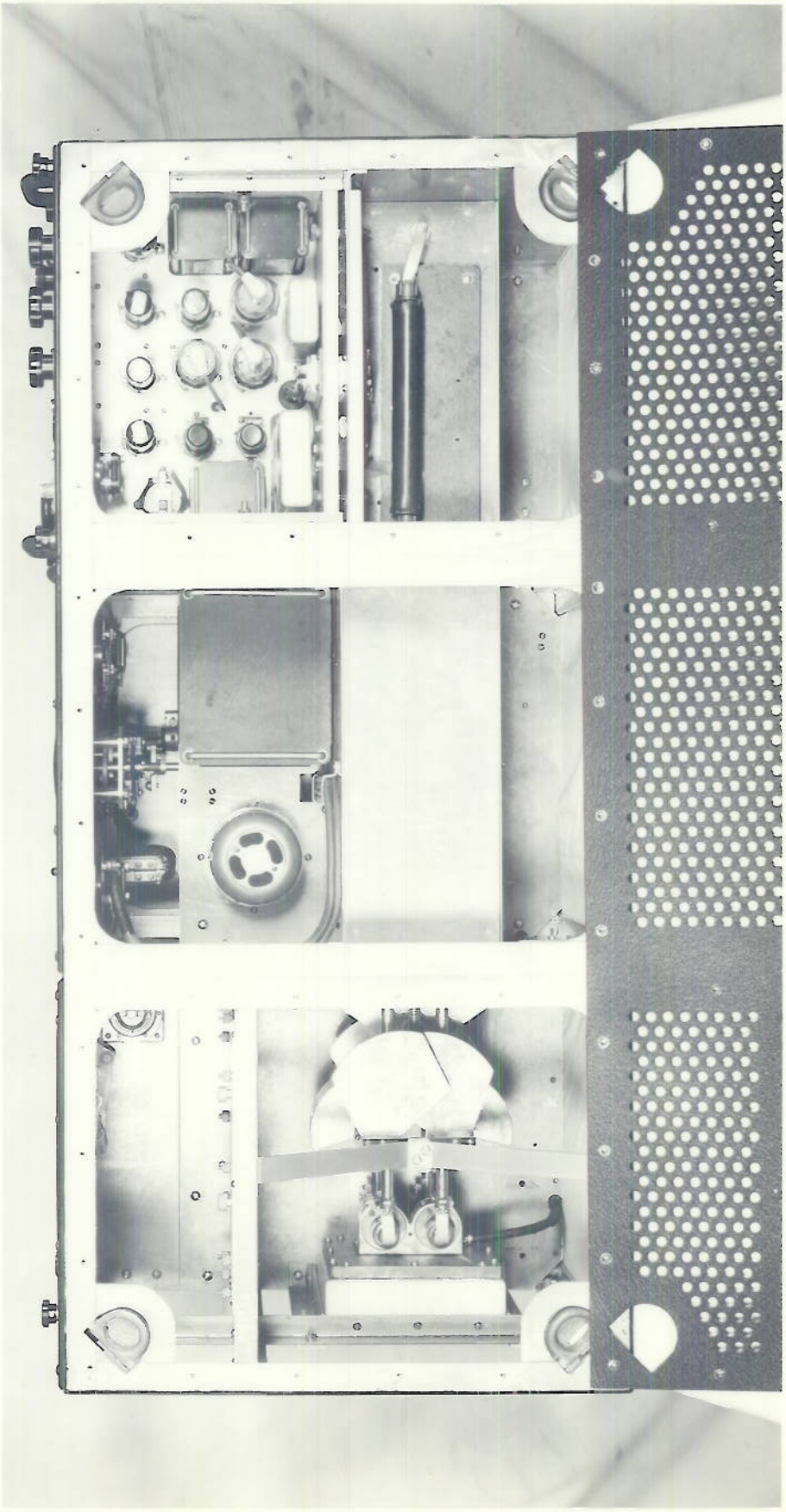


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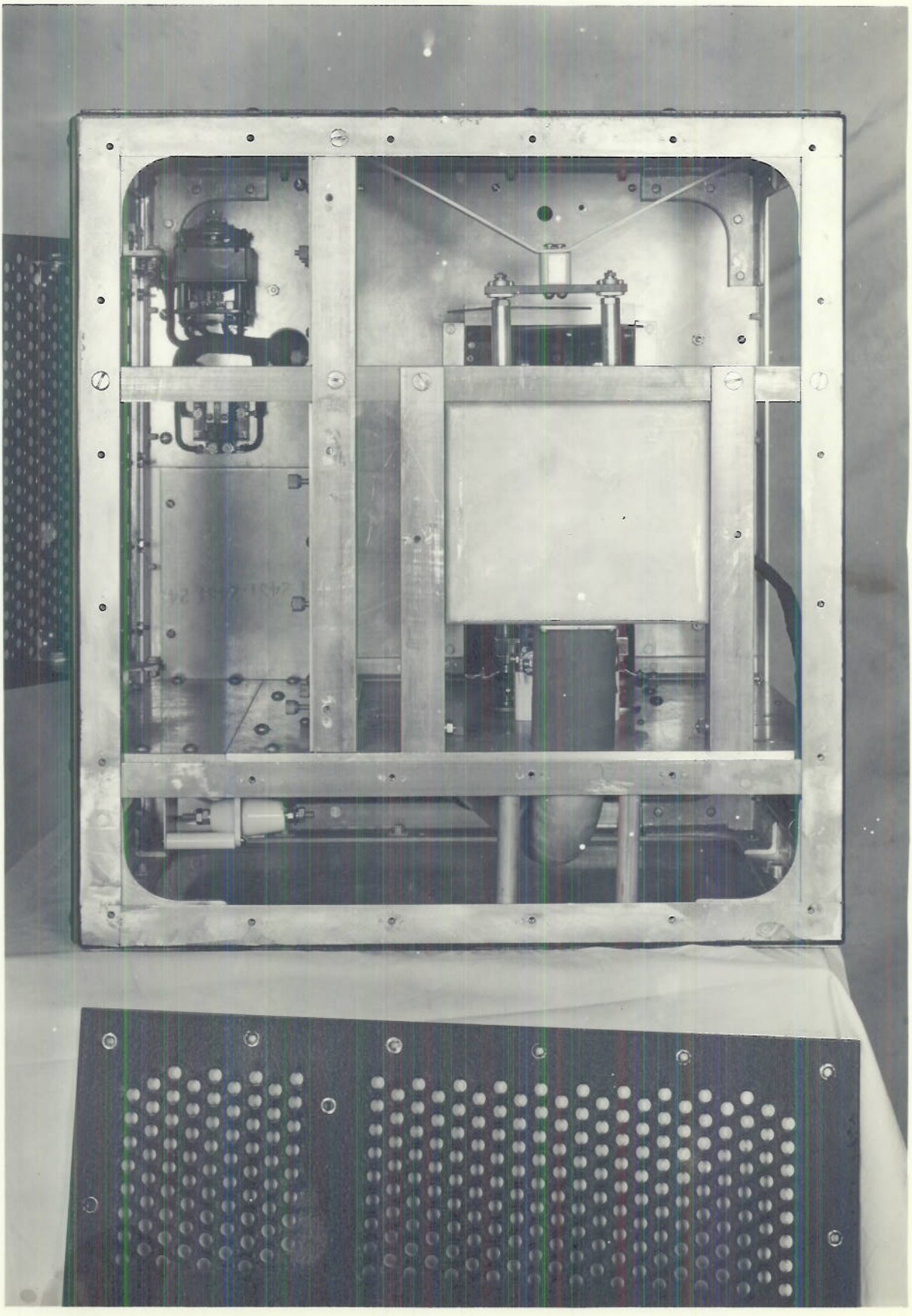


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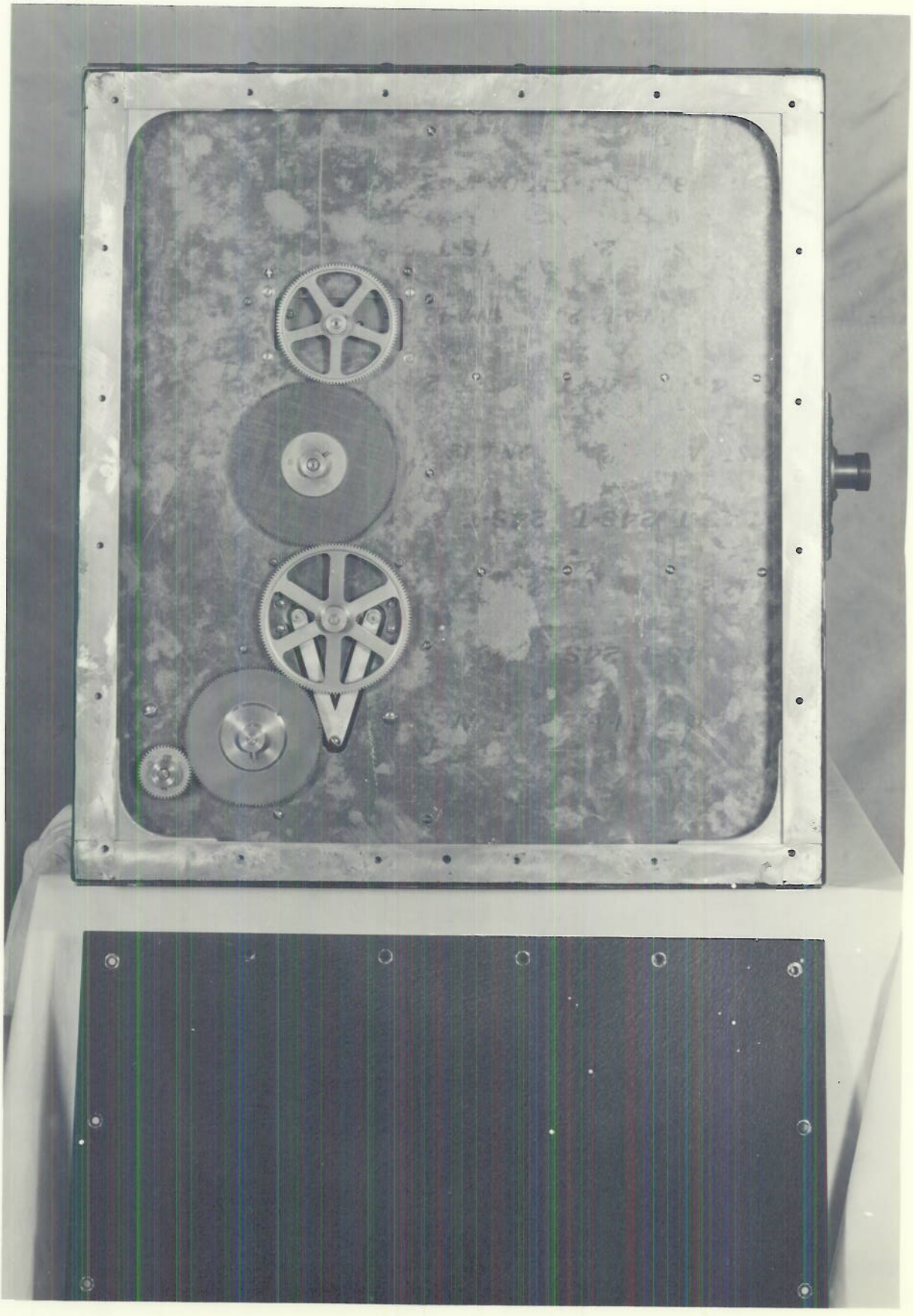


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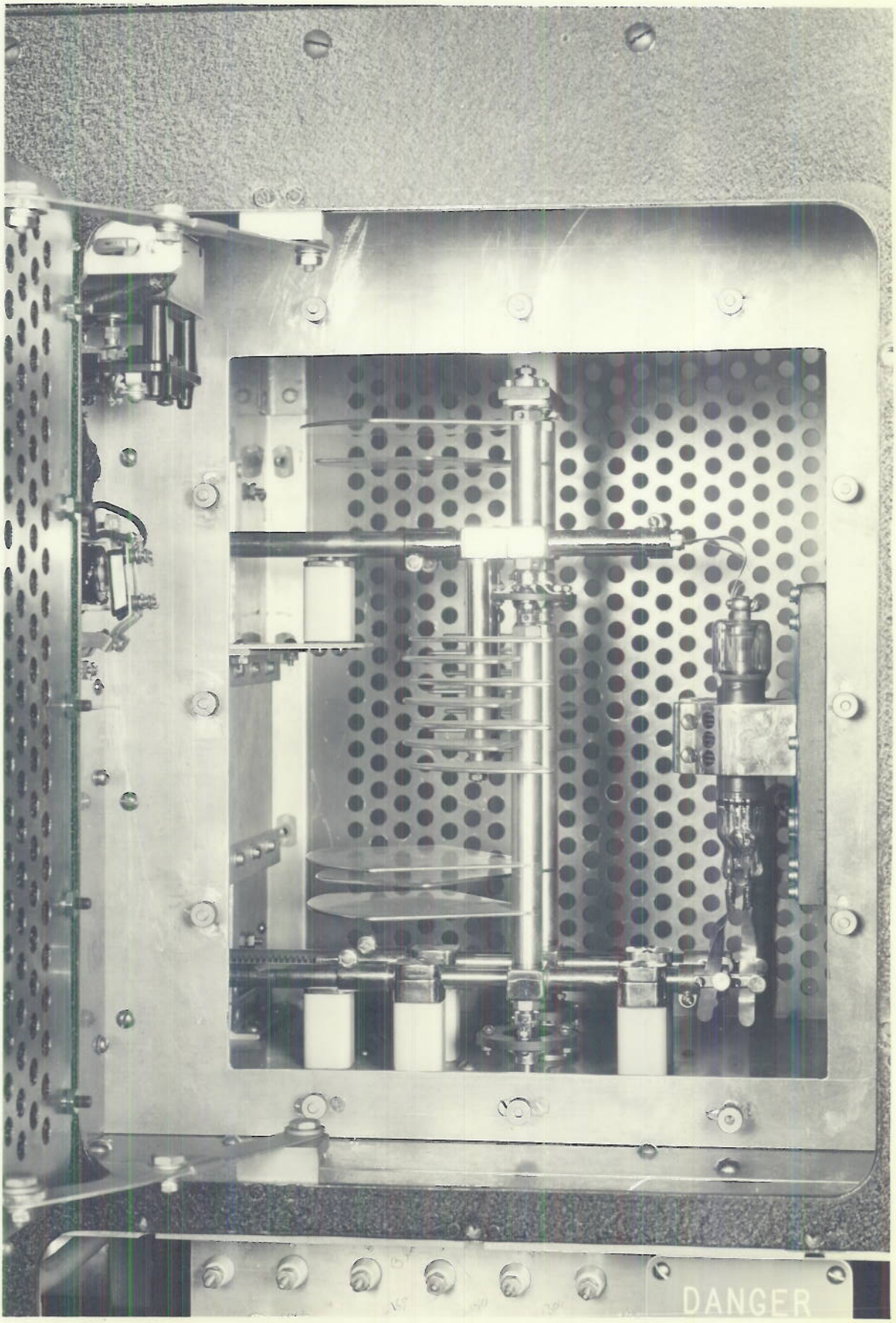


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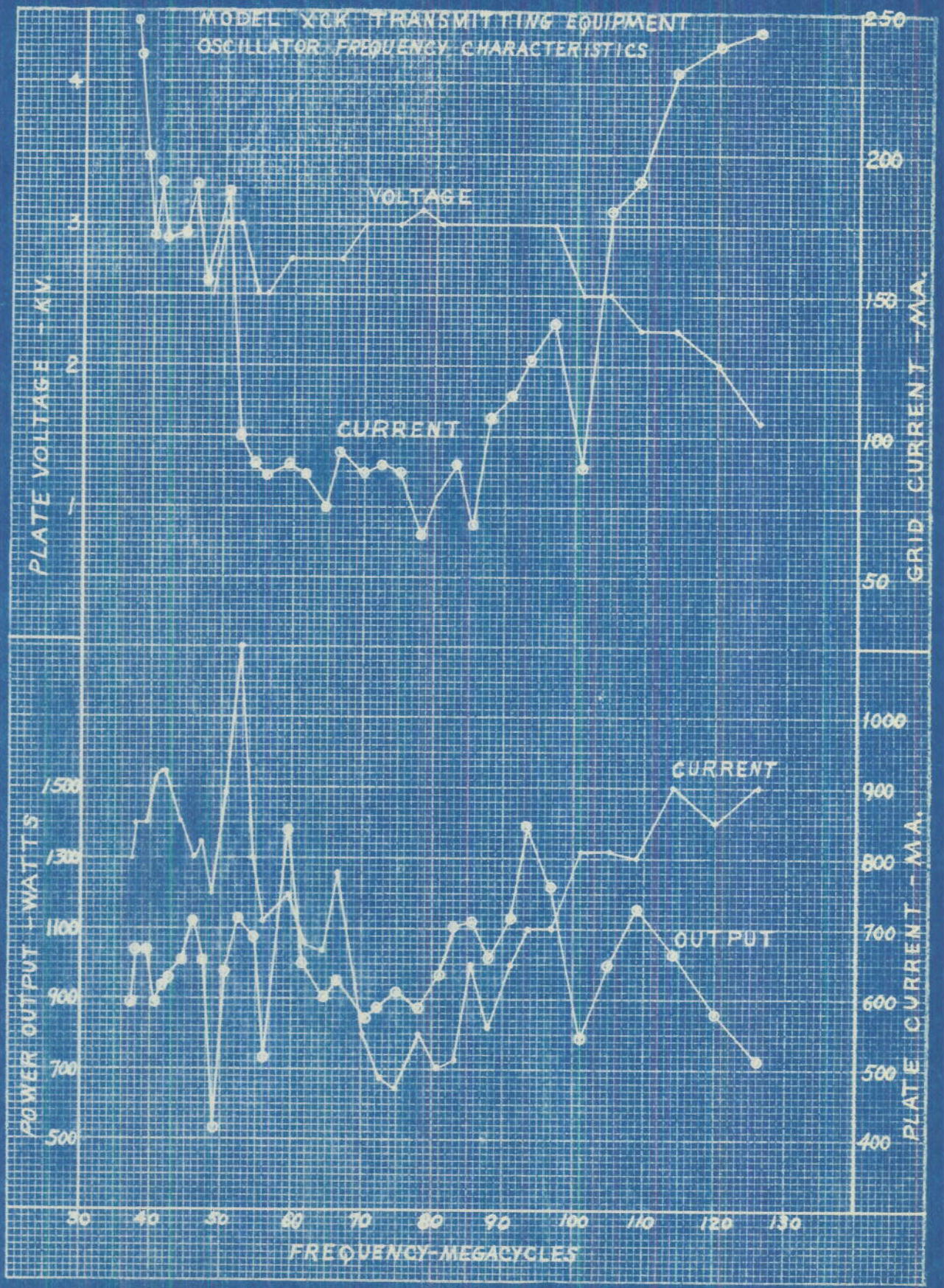
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IF SHEET IS READ THIS WAY (HORIZONTALLY) THIS MUST BE TOP. IF SHEET IS READ THE OTHER WAY (VERTICALLY) THIS MUST BE LEFT-HAND SIDE

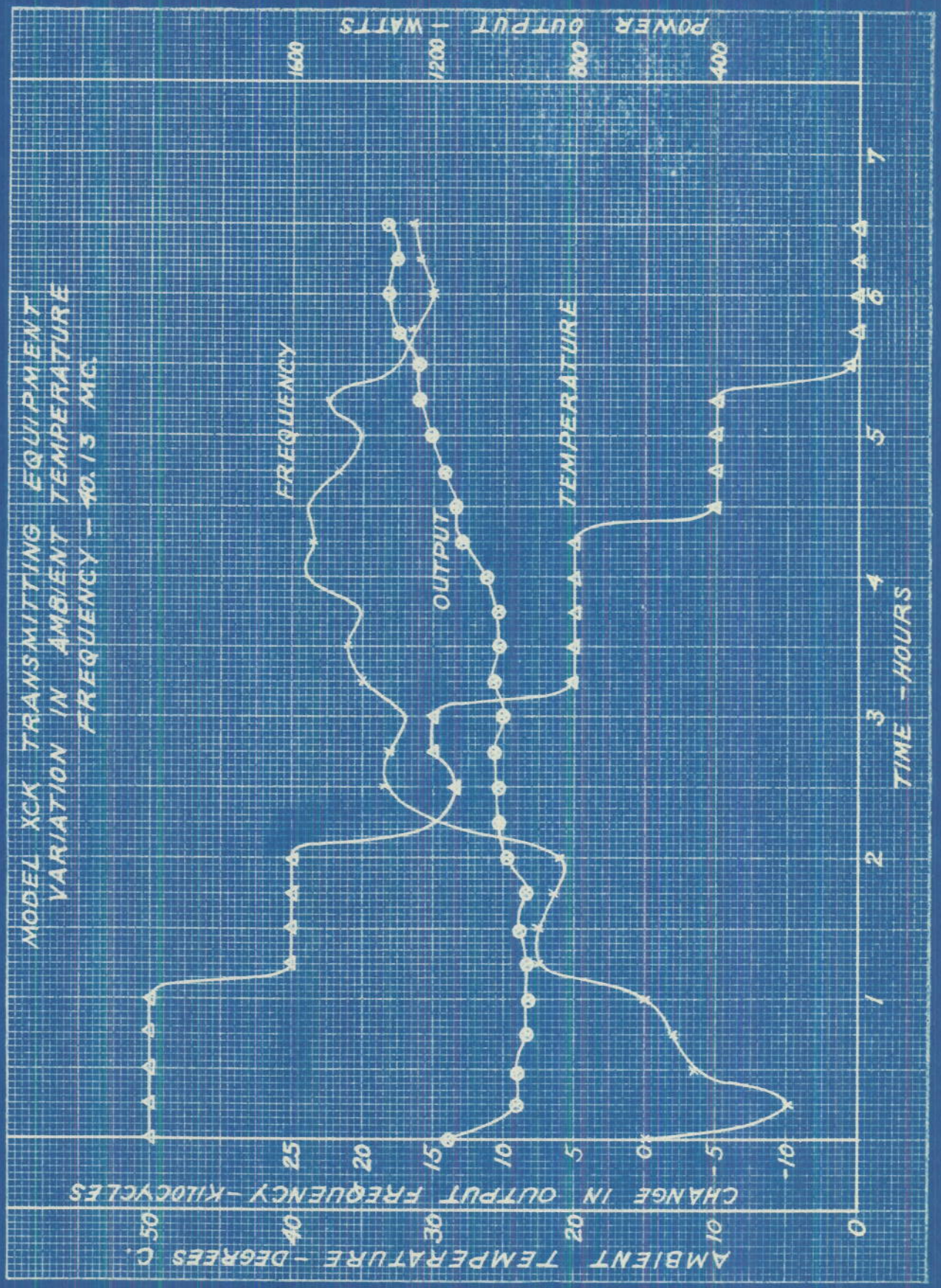
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SEC. 3 FIG. 1

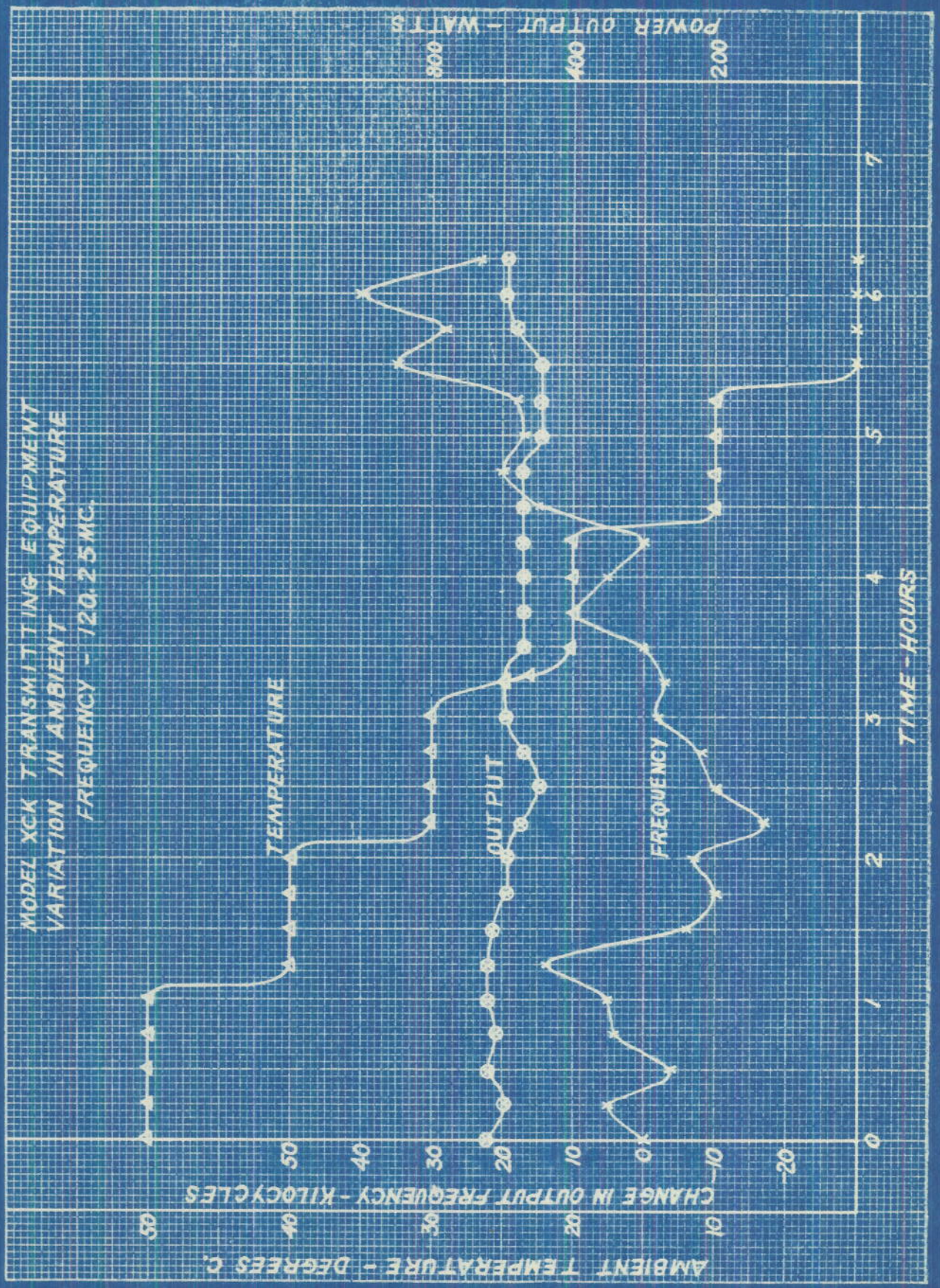
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SEC. 3 FIG. 2

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IF SHEET IS READ THIS WAY (HORIZONTALLY) THIS MUST BE TOP. IF SHEET IS READ THE OTHER WAY (VERTICALLY) THIS MUST BE LEFT-HAND SIDE

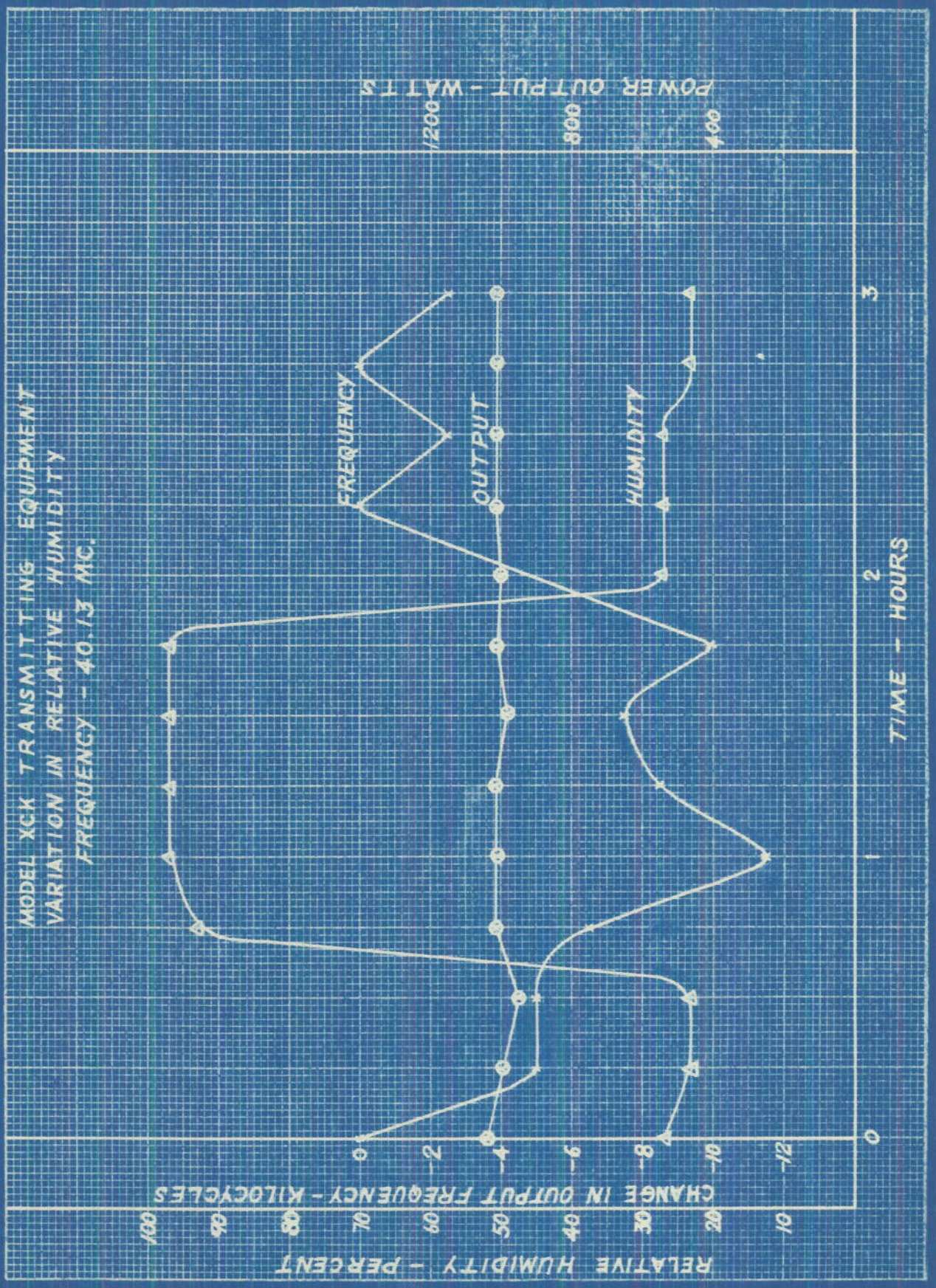
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SEC. 3 FIG. 3

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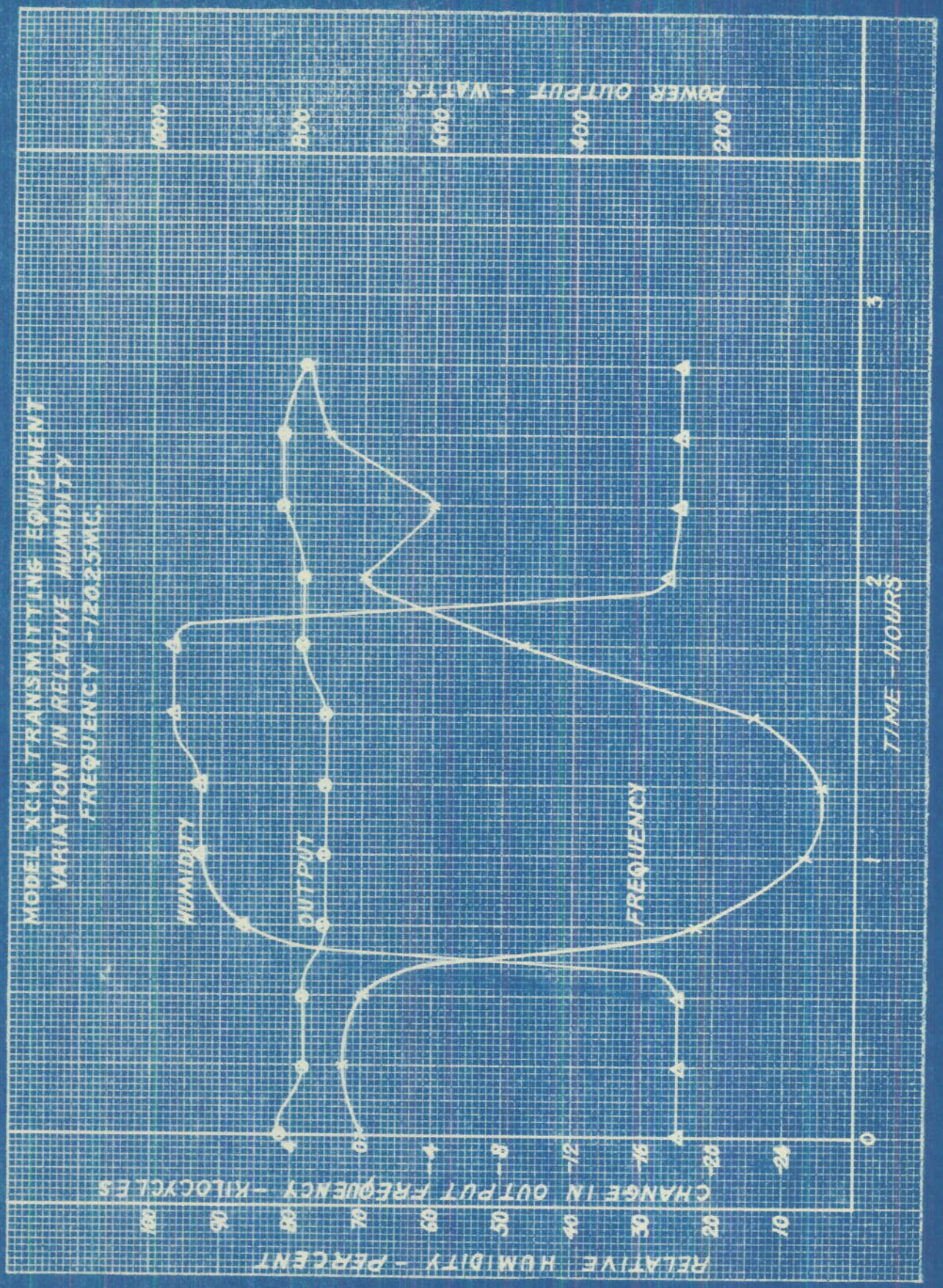


IF SHEET IS READ THIS WAY (HORIZONTALLY) THIS MUST BE TOP. IF SHEET IS READ THE OTHER WAY (VERTICALLY) THIS MUST BE LEFT-HAND SIDE
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SEC. 3 FIG. 4

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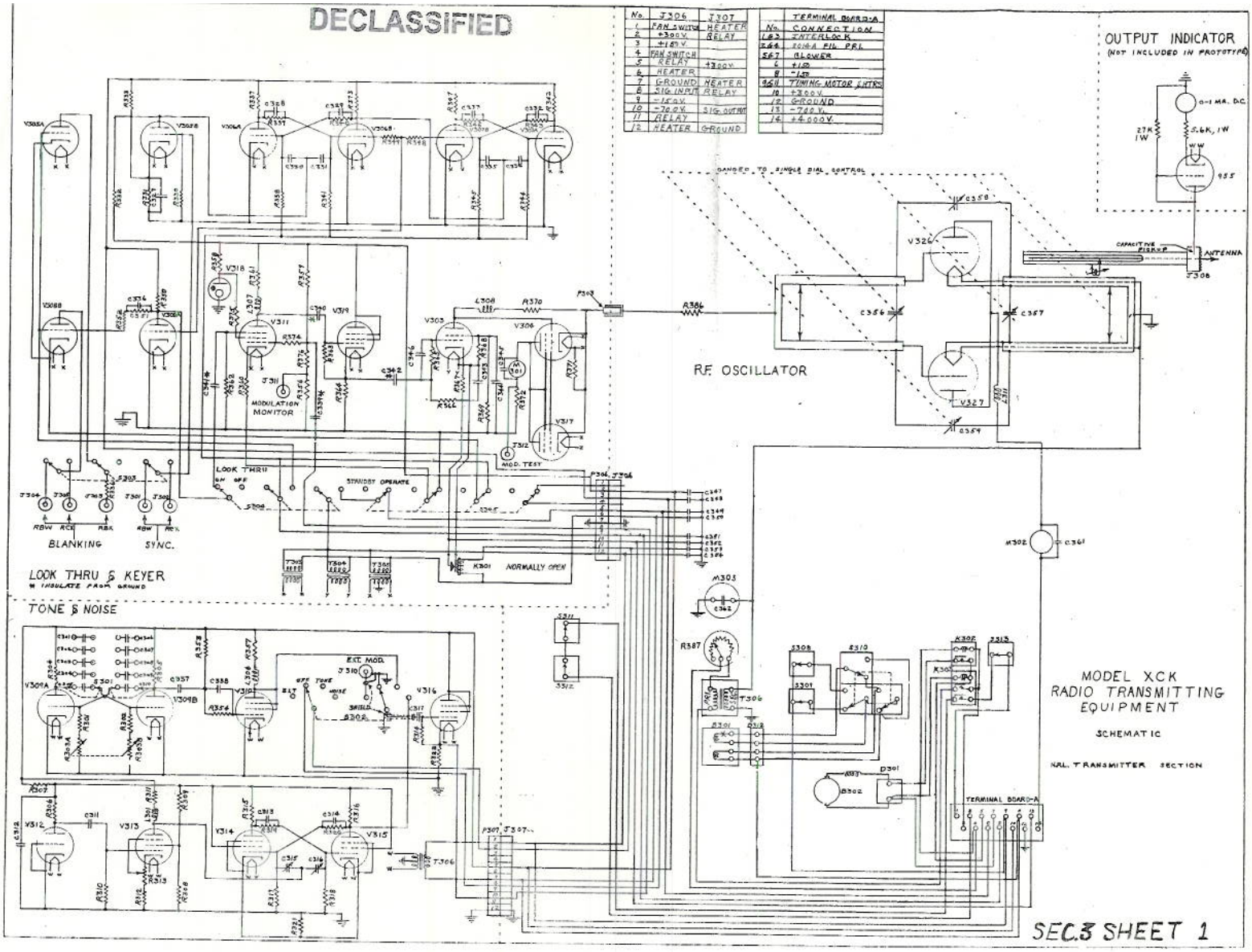
IF SHEET IS READ THIS WAY (HORIZONTALLY) THIS MUST BE TOP. IF SHEET IS READ THE OTHER WAY (VERTICALLY) THIS MUST BE LEFT-HAND SIDE



SEC. 3 FIG. 5

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