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NAVY DEPARTMENT

Report on

# TESTS OF THE MODEL CXBR (SN) RADAR

Contractor - General Electric Co.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, 20, D. C.

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## SECTION I

## REPORT ON THE

## SYSTEMS TEST OF THE MODEL CXBR (SN) RADAR

1-1 INTRODUCTION

1-1-1 During the period 16 November 1942 to 26 December 1942 the CXBR (SN) radar equipment was given a systems test at Chesapeake Bay Annex of the Naval Research Laboratory as described below. For convenience, the results of the test are divided as follows.

1-1-2 Contents (Section 1)



1-1-3 List of Plates







[redacted]

1-2 DESCRIPTION OF EQUIPMENT

1-2-1 The model CXBR (SN) radar equipment is a light-weight, semi-portable, low power S band radar for use on landing barges, beach installations, and as a standby radar for use in emergencies on large naval vessels.

1-2-2 The entire equipment, shown in Plate I, weighs less than 300 pounds and may be carried by three or four men. It consists of the antenna and its assembly (including the reflector), legs and frame for mounting, and one box containing the transmitter, receiver, indicator, and associated circuits. The transmit-receive box is mounted on the frame directly below the antenna, which is coupled to it by a flexible cable. The power supply for the system may be either 115 volts, 60 cycles, or 32 volts, 60 cycles. The power required is about 230 watts. During the tests described below the power was taken from the 115 volt, 60 cycles line of the Naval Research Laboratory's Chesapeake Bay Station.

1-2-3 The transmitter is a GL 464 grounded grid triode, keyed through a pulse transformer by one half of a type 829 tube. The transmitter may be seen in Plate II, which shows a bottom view of the transmit-receive box. The repetition rate is 1000 pulses per second, and is determined by a sine wave generator in the transmit-receive box. The pulse length is approximately 1.5 microseconds.

1-2-4 The receiver is an autodyne using a GL 446 grounded grid triode as the local oscillator-converter. It may be seen in Plate II, next to the transmitter. Following this are four stages of intermediate frequency amplification, the second detector, and video amplifiers. The intermediate frequency is 15 mc. The receiver does not use a duplexer tube, but is protected from the transmitted pulse by a simple bridge circuit using resonant lines. This seems to be satisfactory for the low power and type of receiver used.

[redacted]

1-2-5 The indicator is a five inch cathode ray tube using class "A" presentation. It is shown in Plate III. There are two ranges available of five and twenty five miles, respectively. Range is read from a scale mounted in front of the cathode ray tube screen. Bearing is read from a dial coupled mechanically to the antenna.

1-2-6 The antenna consists of a section of a parabola, 48 by 24½ inches, fed by a vertical half-wave radiator, shown in Plates IV and V, which is coupled to the transmitter through a short length of flexible cable. The vertical radiator remains fixed when the antenna is rotated, and the reflector is rotated around it by means of a hand crank.

1-3 <u>INSTALLATION</u>

1-3-1 The equipment was installed at the Naval Research Laboratory's Chesapeake Bay Station according to the instruction book. The instructions are adequate.

1-4 <u>TUNE-UP</u>

1-4-1 The equipment was tuned up according to the instructions on the transmitter cover. They are clear, and adequate for normal operation.

1-5 <u>DESCRIPTION OF TESTS</u>

1-5-1 The following tests were performed on the CXBR:

System sensitivity
Maximum range
Minimum range
Range accuracy and discrimination
Range drift during warmup.
Bearing accuracy and discrimination
Effect of a ± 10% change in line voltage

1-6 <u>SYSTEM SENSITIVITY</u>

1-6-1 The equipment is not designed for high sensitivity, but rather for simplicity and compactness. Three methods of measuring the sensitivity of the equipment were used. The first

[redacted]

consisted of measuring the signal to noise ratio of the equipment on a number of fixed ehoes around Chesapeake Bay, and comparing this list with a similar one obtained on the 271 equipment, another S band search equipment. The second methods consisted of measuring the limiting range obtained on a 44' wooden motor boat, and comparing this range with that obtained by the 271 on the same target under the same conditions. The third method consisted of measuring the transmitter power and pulse length, the receiver sensitivity and fidelity, and the antenna pattern and gain. These measurements on components were made in the laboratory, and a figure for overall system sensitivity was computed from them and compared with the results obtained by the first two methods.

1-6-2 The list of signal to noise ratios obtained by the first method mentioned above is given in Table I. As would be expected, the CXBR was greatly inferior to the 271.

1-6-3 The 44' wooden boat was followed reliably by the CXBR out to about 5,500 yards. The 271 followed the same target out to 10,500 yards.

1-6-4 The following data were obtained on the system components:

Transmitter Power output------200 to 500 watts
Pulse length---------------1.5 microsecond
Receiver sensitivity-------- -27 db.
I.F. Band Pass-------------down 3 db. at 1.75 mc.
Antenna gain-----------21.5 db over a dipole.

1-6-5 The data of paragraphs 1-5-3 and 1-5-4 can be correlated as follows. The overall sensitivity of one system compared to another can be given by the equation:

$$S = \left(\frac{W_1}{W_2}\right)_{db} + \left(\frac{T_1}{T_2}\right)_{db} + 2G_1 - 2G_2 - R_1 + R_2$$

[redacted]

where $\frac{W_1}{W_2}$ = ratio of output powers, expressed in db.

$\frac{T_1}{T_2}$ = ratio of pulse lengths, expressed in db.

$G_1$ = antenna gain of first radar, (expressed in db. over a dipole)

$G_2$ = antenna gain of second radar (expressed in db. over a dipole)

$R_1$ = receiver sensitivity of first radar in db.

$R_2$ = receiver sensitivity of second radar in db.

If we take as standard a fictitious radar having a power output of 30 kilowatts, a pulse length of 1 microsecond, a receiver sensitivity of 20 db., and an antenna gain of 20 db over a dipole, then we can classify any radar under tests with respect to this standard radar. On this scale, the 271 has and overall sensitivity of 2.8 db., and the CXBR has an overall sensitivity of -20 db. For purposes of comparison, it might be mentioned that the SF has a sensitivity figure of approximately 9.4 db., and the modified SG a figure of 12.5 db.

1-6-6 For surface targets within the optical horizon, the system sensitivity can be related to the limiting range by the equation

$$8\left(\frac{r_1}{r_2}\right) = S_1 - S_2$$

where $\frac{r_1}{r_2}$ = ratio of limiting ranges on the same target, expressed as a power ratio in db.

$S_1$ = System sensitivity of first equipment

$S_2$ = System sensitivity of second equipment

[redacted]

This equation is derived in Naval Research Laboratory report R-2093 on BuShips Problem X-71-S.

1-6-7 Inserting in this equation the figures given in paragraph 1-6-3 and 1-6-5 gives

$$8\left(\frac{r_1}{r_2}\right) \text{db.} = 2.8 + 20$$

or

$$\left(\frac{r_1}{r_2}\right) \text{db.} = 2.85 \text{ db.}$$

$$\frac{r_1}{r_2} = 1.925$$

The actual ratio of the ranges was

$$\frac{10,500}{5,500} = 1.90$$

in good agreement with the calculated value of 1.925.

1-7 <u>MAXIMUM RANGE</u>

1-7-1 The maximum range on land targets was 20 miles, obtained on the Annapolis Radio Towers.

1-7-2 The maximum range on surface targets was obtained on freighters traveling up and down Chesapeake Bay. These could be followed for about 12 miles.

1-7-3 The maximum range on a 44 foot wooden motor boat was 7,000 yards, on one occasion. In general, this target could be followed reliably to only 5,500 yards.

1-8 <u>MINIMUM RANGE</u>

1-8-1 The minimum range observed was about 200 yards.

1-9 <u>RANGE ACCURACY AND DISCRIMINATION</u>

1-9-1 The range accuracy was measured by comparing the radar range with the range on the same target obtained by optical means.

1-9-2 The range accuracy is $\pm$ 100 yards on the 5 mile scale and $\pm$ 500 yards on the 25 mile scale. This is as good as can be expected from the ranging method used. Considering the purpose for which the set is designed, it is considered satisfactory.

1-9-3 The range reset accuracy is of the same order as the range accuracy, namely $\pm$ 100 yards on the 5 mile scale and $\pm$ 500 yards on the 25 mile scale.

1-9-4 The range discrimination is also determined by the method of ranging used, and is about $\pm$ 100 yards on the 5 mile scale, and $\pm$ 500 yards on the 25 mile scale.

1-10 <u>RANGE DRIFT DURING WARM-UP</u>

1-10-1 After a half-minute warm-up period, the set was turned to "operate." About 20 seconds were required for the noise, signal, and position of the sweep to come to normal.

1-10-2 The long range sweep appeared to stabilize immediately within the limits of observational error but the short range sweep required about half an hour to stabilize. During this time the range of a target changed about 200 yards.

1-10-3 Tuning the local oscillator changes the apparent range of a target at 1.75 miles by about 200 yards. The sweep does not appear to move, but the signal moves along the sweep. This same effect was observed on other targets on the five mile scale

1-11 <u>BEARING ACCURACY AND DISCRIMINATION</u>

1-11-1 The bearing accuracy is about $\pm 1^\circ$. The bearing reset accuracy is also about $\pm 1^\circ$.

1-11-2 The bearing discrimination is $\pm 5^\circ$. That is two targets separated by this amount can be distinguished as separate targets.

1-12 <u>EFFECT OF $\pm$ 10% CHANGE IN LINE VOLTAGE</u>

1-12-1 The signal to noise ratio of a given target does not change appreciably when the line voltage is varied from 100 to 127 volts. The range also

[redacted]

does not change appreciably when the voltage is varied by this amount.

1-12-2 When the voltage is changed from 100 to 127 volts, the receiver tuning must be changed to compensate. The changes required are slight, however.

1-13 LIGHTHOUSE TUBE TESTS

1-13-1 A series of tests on the effect of replacing lighthouse tubes in the transmitter and receiver is in progress. The whole problem of lighthouse tube operation is being studied, and in the process a great many tubes are being tested in this and in other equipments. A separate report will be written on this problem when the work is complete.

1-14 DEFECTS AND RECOMMENDATIONS

1-14-1 When the transmit-receive unit is removed from its case and placed on a bench, it is easy to damage the coupling pins of the transmitter and receiver, which project below the rest of the unit. A shield was placed around these pins by a company representative after the systems test was made. This change has not eliminated the trouble completely, however, and it is recommended that further attempts be made to remedy this difficulty.

1-14-2 It is recommended that the change of range with local oscillator tuning, mentioned in paragraph 1-10-3 be corrected.

1-14-3 It is easy to break the type 464 and 446 tubes when trying to insert them in their cavities. It is recommended that the design of the cavities be changed, if possible, to correct this.

1-15 CONCLUSIONS

1-15-1 Considering the purpose for which the CXBR is designed, it is considered satisfactory. However, it is felt that the overall sensitivity is lower than need be. A change to a more sensitive receiver would improve the overall sensitivity greatly, without adding a great deal to the size and weight.

[redacted] 

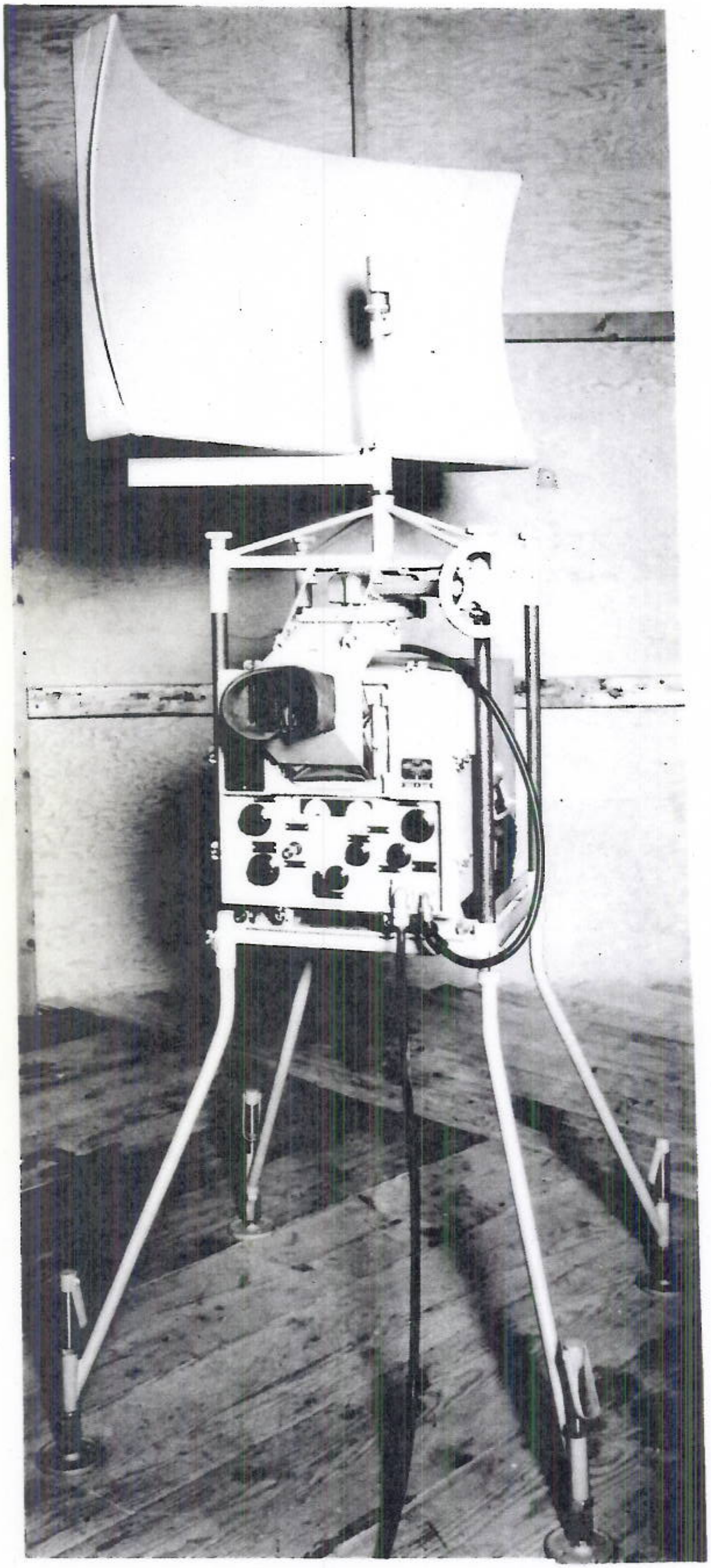



PLATE I SEC. I

[redacted]

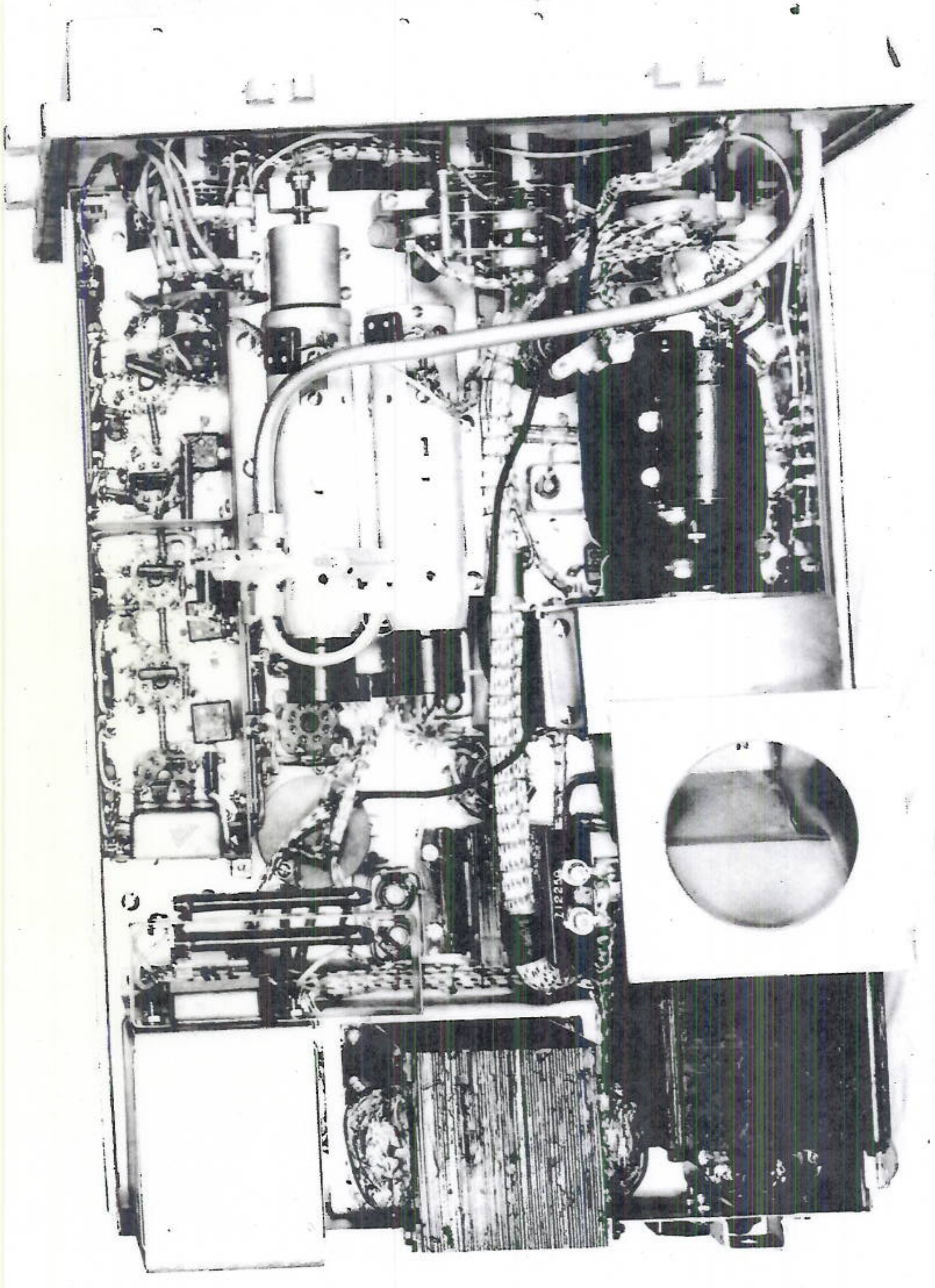

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PLATE 2 SEC.1

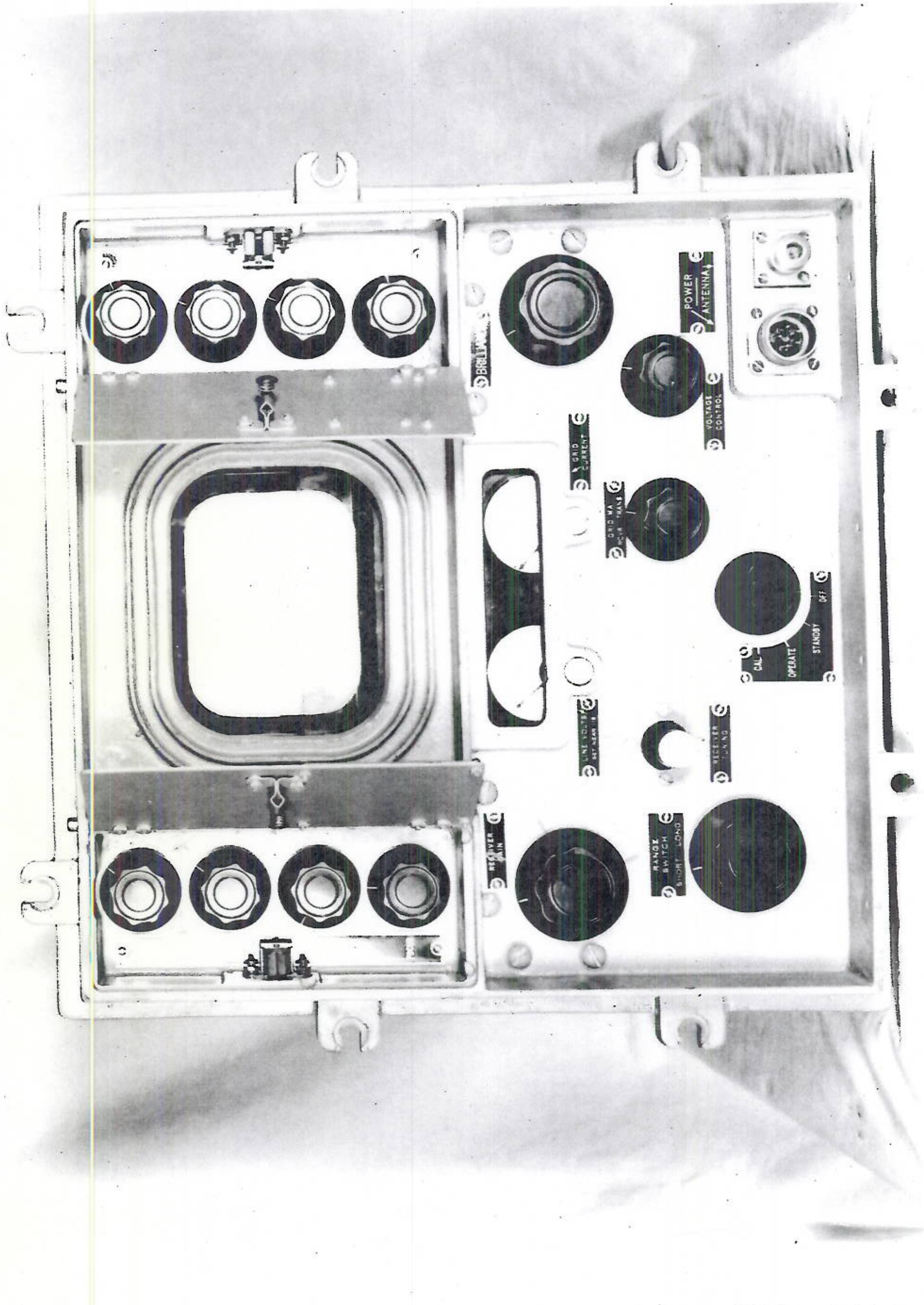


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PLATE 3 SEC. 1

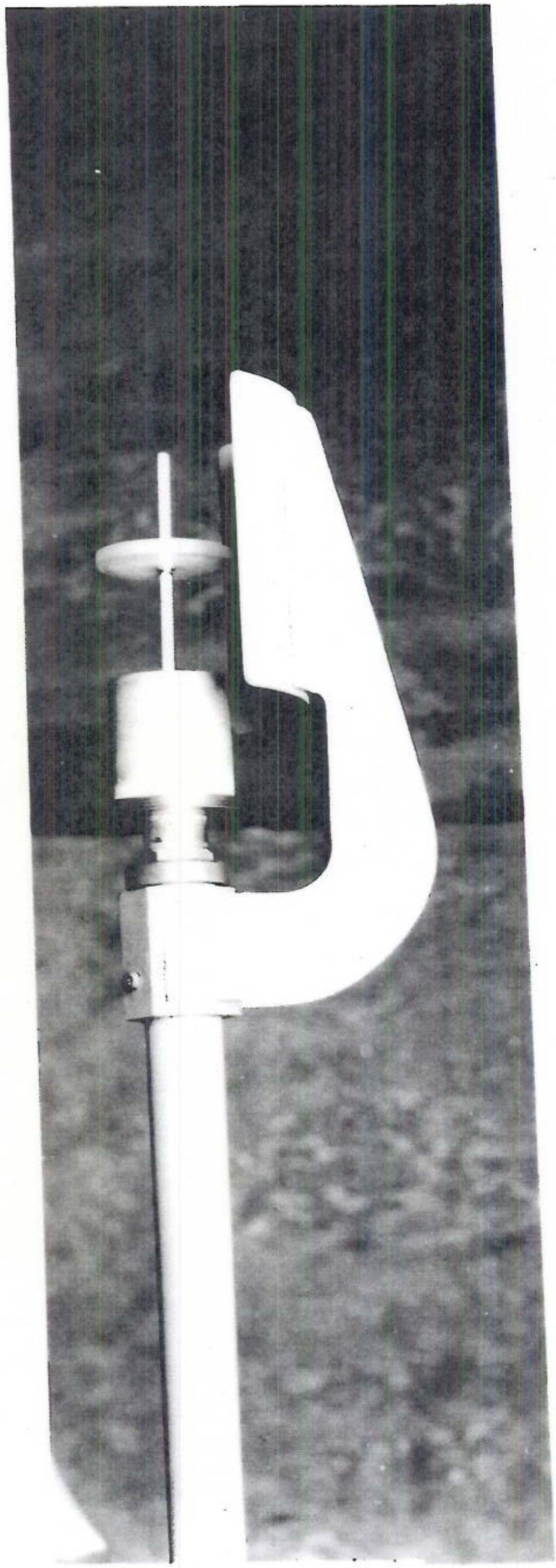

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PLATE 4 SEC. I

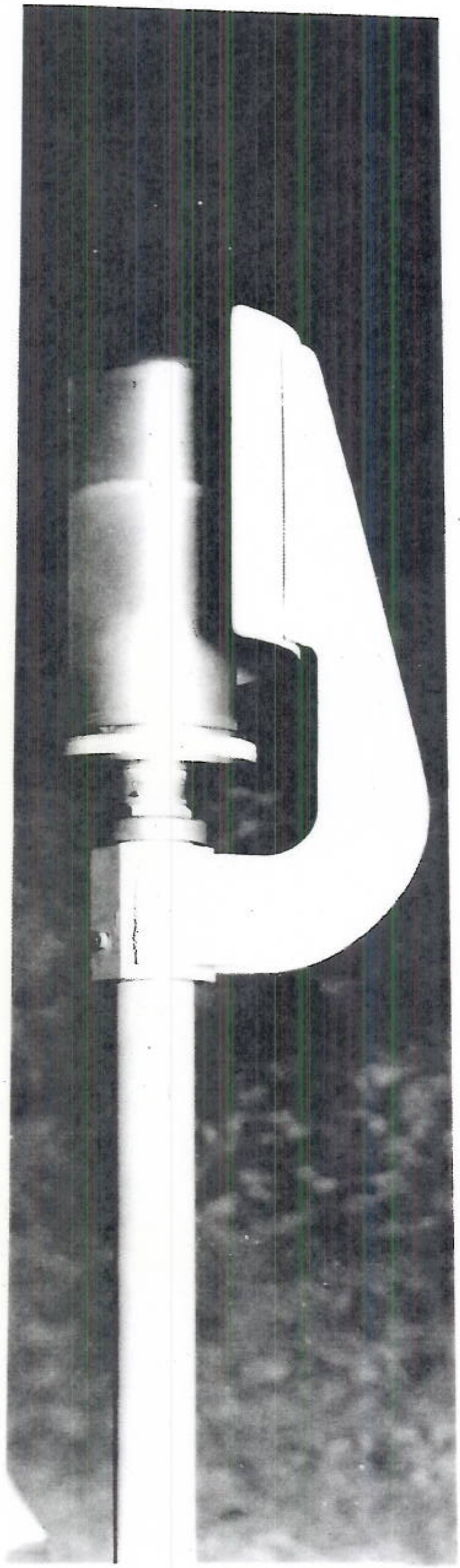

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PLATE 5 SEC.I

## SECTION II

## ELECTRICAL AND MECHANICAL TESTS OF THE MODEL CXBR RADAR TRANSMITTING EQUIPMENT, SERIAL NO. 1

2-1. During the period 12 December 1942, to 1 February 1943, the Model CXBR Transmitting Equipment, Serial No. 1, was subjected to electrical and mechanical tests as discussed below. For convenient reference the results of these tests are divided as follows:



### LIST OF TABLES

## LIST OF TABLES (CONT'D)



## LIST OF PLATES





[redacted]

## LIST OF PLATES (CONT'D)



The tests involved the following units of the Model CXBR Equipment, Serial 1.

| Unit | Type Number |
|---|---|
| Transmitter | CG-X43AAW |
| Antenna Assembly | CG-X66ABU |

### 2-2. EFFECTS OF TEMPERATURE.

A test was performed in order to determine the effects of temperature and temperature variations upon the Model CXBR Equipment. The complete equipment was installed in a temperature test chamber, and was placed in operation. Equipment meters were observed at definite intervals of time through the temperature test chamber windows. The radiated power of the transmitter was received by a reflector and antenna placed adjacent to the Model CXBR Equipment antenna. The absorbed signal was conducted to the exterior of the room where it was coupled to a wavemeter for measurement of wave length. The output of this wavemeter was "zero-beat" with a General Radio Beat-Frequency Oscillator, the beat condition being observed on an RCA Service Oscillograph. By this means the transmitter repetition rate was measured. A measurement of relative power output was obtained by connecting the cable from the receiving antenna and its reflector to a bolometer bridge.

2-2-1. Temperature Variation. The test was started at a temperature of 50°C. During a period of five and one-fourth hours, the temperature was lowered in four discrete steps to 0°C. The relative humidity was held to a value which experience has shown to have no appreciable effect on the results. It was noted that when the transmitter-receiver unit was withdrawn from its cover at 0°C that the rubber gasket between the front panel and the front edge of the steel cover adhered to the steel cover instead of to its specially provided groove in the front panel. Electrical data recorded during this test are compiled in Table 1. These data are graphically presented in Plate 1. Consideration of these data indicate that temperature variations had little effect on the results.

2-2-2. Effect of Low Temperature. An investigation was conducted to determine the ability of the Model CXBR Equipment to start and operate at low temperatures. The equipment was placed in a temperature test chamber and its heater circuits were energized. The temperature was then reduced from 10°C to -31°C during a period of 7-1/2 hours. After the equipment had been subjected to a temperature of -31°C for a period of 1-3/4 hours, all circuits were energized. Data recorded during this test is presented in Table 2. It was noted that the wave length had decreased from its normal value of 11.79 cm to 11.74 cm. This represents a change in frequency of 0.425 per cent or 10.8 megacycles. This should indicate the need of an "echo box" for "tuning up" purposes. A period of 1/2 hour was required for the wave length to stabilize at its normal value. With the exception of a change in wave length, the equipment started and functioned normally.

## 2-3. EFFECTS OF HUMIDITY

Tests were performed to ascertain the effects of humidity on the Model CXBR Radar Equipment. The equipment was installed in a humidity test chamber, and means were provided externally to observe and monitor its operation. Tables 3 and 4 list the data obtained during these tests.

2-3-1. Variation in Relative Humidity. The equipment was subjected to a change in relative humidity from 20 to 97%. For the first hour the equipment was operated in an atmosphere of 40°C and a relative humidity of 20 per cent. At the end of this period the temperature was maintained at 40°C and the relative humidity was raised to 97 per cent. At the end of an hour the humidity was reduced to 20 per cent and the temperature was maintained at 40°C. No deleterious effects due to humidity were observed. The data noted during this test is presented in Table 3 and Plate 2.

2-3-2. Starting Equipment in High Humidity. The equipment was allowed to remain idle for a period of two hours in an atmosphere of 97 per cent relative humidity at a temperature of 40°C. At the end of this period, primary



[redacted]

power was applied. Grid current and power output were present in the GL-464 oscillator circuit two minutes after the application of power. Operation was possible without flashovers or excessive leakage in the high voltage circuits.

2-3-3 Effect of Spray. An investigation was made as to the water-tightness of the equipment by allowing it to remain in a heavy rain over night. Upon removing the transmitter-receiver chassis from its case, the presence of moisture could not be detected in the equipment.

2-4. EFFECT OF VIBRATION.

Tests were made to determine the ability of the equipment to withstand the effects of vibration. The vibration tests were made in two parts. During the first part of the test the transmitter-receiver unit was secured to a vibration test stand which was subjected to periods of vibration of from zero to 2000 cycles per minute for a period of three hours. The second part of the test involved the complete CXBR assembly which was subjected to vibration frequencies of from zero to 2000 cycles per minute for a period of 3/4 hour. The equipment was energized throughout these tests.

2-4-1. Transmitter Removed from Stand. During this test a portion of the transmitter output was absorbed by placing a special antenna and reflector near the transmitting antenna. From the received energy, a measurement of relative power output was obtained by means of a bolometer bridge. The received signal was coupled to a wavemeter for measurement of wave length Repetition rate was obtained in a manner identical to that described in Paragraph 2-2. No significant changes were observed in the repetition rate or peak power output of the transmitter while it was being subjected to vibration. However, the following mechanical effects were observed:

(a) Between 575 and 625 cpm the front and rear ends of the transmitter-unit were displaced longitudinally 1/4 inch with a rocking motion.
(b) At a frequency of 925 cpm, and at frequencies between 1000 and 1100 cpm, the unit was displaced longitudinally 1/8 inch with a rocking motion.

These amplitudes of motion indicate that the design is not such as to insure freedom from damage and faulty operation resulting from the severe vibration encountered



[redacted]

on Naval Vessels.

2-4-2. Transmitter Assembled on Stand. While no serious mechanical breakdown occurred during this test, vibration amplitudes of 1/16 inch to 3/16 inch were present at various points on the transmitter-receiver unit, and on the antenna reflector. The entire supporting structure appeared very limber when the assembly was subjected to vibration. This fact may not be apparent from the measured amplitudes of vibration. The desirability of a stronger and more rigid supporting structure was clearly indicated by the erratic manner in which the unit vibrated. This statement is valid in only those instances where this equipment will be similarly mounted aboard ship. The following amplitudes of vibration were noted:

(a) At a frequency of 625 cpm, the transmitter-receiver unit was displaced transversely a distance of 1/16 inch.
(b) At a frequency of 1050 cpm, the equipment chassis was displaced transversely a distance of 3/16 inch.
(c) At a frequency of 1200 cpm the antenna was displaced transversely a distance of 1/8 inch.

## 2-5. EFFECT OF SHOCK.

A test was conducted to determine the capability of the equipment to withstand the effects of shock such as may be encountered in the Naval Service. This test was performed in two parts. During the first part of the test the transmitter unit was removed from its mounting stand and bolted directly to a shock test stand. The shock mounting provided as part of the equipment was employed. During the second half of the test the equipment was completely assembled as a single unit and the stand bolted to the top of the shock test table. The shock test table is so devised that shocks may be administered to any of its four edges.

2-5-1. Transmitter Removed from Stand. A total of 28 separate shocks, each having a momentary peak acceleration of 250 g were administered in the following order. First, ten were delivered towards the right side, then six towards the rear, six towards the left side and six towards the front. Each shock towards the right side resulted in the unit being displaced towards the left a distance sufficiently far to cause "bottoming" of the shock mounts. During the third shock of this first series the equipment became inoperative. Examination



[redacted]

revealed that the type 6AC7 tube (V113) had developed a grid to cathode short circuit. During the fourth, sixth, and tenth shock of this same series it was necessary to re-insert the type 829A tube in its socket.

During the second shock of the second series administered towards the rear of the transmitter unit, three failures occurred. The type 829A tube developed a grid to cathode short circuit which in turn caused the resistor R156 to decrease in value from 12000 ohms to 4000 ohms. The type GL464 oscillator tube became inoperative. After these items were replaced operation was normal. When the shocks were delivered towards the left side of the transmitter it was deflected towards the right sufficiently far to cause bottoming of the shock mounts. It was also observed during this third series of shocks that the type GL464 tube grid current varied. This was caused by variations in frequency of the receiver, thereby reflecting variations in the load impedance of the type GL464 tube.

The final series of shocks during this part of the test was delivered toward the front of the equipment. After the third and sixth shock in this series it was necessary to retune the transmitter to obtain operation. In each case the oscillator ceased functioning.

2-5-2. <u>Complete Assembly</u>. The equipment was assembled as a complete unit with the transmitter mounted in the stand provided. This assembly represented the manner in which the equipment is normally used when not installed on shipboard. However, tests were conducted to determine the ability of the equipment, when so assembled to withstand shock. The magnitude of the applied shock was increased from 20 to 250 g in six steps. A total of 9 shocks were imparted to the equipment. Of these, the last four had a momentary peak acceleration of 250 g. During each of the last four shocks the antenna assembly was displaced horizontally a distance of approximately six inches. No other deleterious effects were observed.

## 2-6. VARIATION IN LINE VOLTAGE.

The effects of a ±10% variation in line voltage were investigated. The equipment was adjusted for normal operation with the supply line voltage set at 115 volts. The supply line voltage was then reduced to 103.5 volts. The line voltage was then increased



[redacted]

in increments of approximately 3 volts to 126.5 volts. The operation of the equipment was monitored and data recorded after each change in line voltage. These data are presented in Table 5 and Plate 3. Reference to these data reveals that a line voltage reduction of 10% is accompanied by a power reduction of approximately 94%.

2-7. <u>POWER CONTROL AND PROTECTIVE CIRCUITS.</u>

The following items were noted concerning the power control and protective circuits.

2-7-1. <u>Fuse Currents.</u> A measurement was made of all currents through the fuses provided in the Model CXBR Radar Equipment. These values are tabulated in Table 9. Voltage and current ratings of all fuses were satisfactory. No deleterious effects were noted as fuse "blow outs" were simulated by removing fuses from their mounts while the equipment was in operation.

2-8. <u>PLATE VOLTAGE PULSE SHAPE.</u>

The contour of the plate voltage pulse was observed by means of a laboratory oscilloscope with a linear 5 micro-second servo sweep. The shape of this pulse was traced from the screen of the cathode ray tube and is reproduced on Plate 4, Section 2.

2-9. <u>VACUUM TUBES.</u>

An investigation was made to determine the conditions of operation imposed on the vacuum tubes employed in the equipment. Table 6 presents data recorded during this investigation.

2-9-1. <u>Type 829A Vacuum Tube (V114).</u> It is to be noted that the maximum plate voltage recommended by the manufacturer for the type 829A tube is 750 volts. The measured plate to ground potential applied to the type 829A(V114) is 3800 volts. A complete investigation of the ability of this tube to withstand a potential of this order is recommended.

2-9-2. <u>Type GL464 Vacuum Tube (V115).</u> During a test in which all the vacuum tubes employed in the equipment were replaced with stock tubes, it was found that a careful selection of the type GL464 tube (V115) must be made. This tube is used as the oscillator in the transmitter.



[redacted]

Twenty-five tubes (not GL464's) of a similar type (A2199) which comprised a group that was submitted by the RCA Manufacturing Company were tested individually in the transmitter oscillator circuit. Of this group of 25, only 7 performed satisfactorily in the circuit. A tube which drew a grid current of 0.3 milliamperes or more without exhibiting internal arcing was considered satisfactory. The results of this investigation are tabulated in Table 7. This data indicates that specially selected tubes are necessary to insure proper operation of the transmitter oscillator. Suitable steps should be taken to eliminate this difficulty.

2-9-3. There are no labels on the pins of tube socket V114 (829A). This leads to considerable difficulty in identifying the proper pin while servicing.

2-10. <u>CONTROLS</u>.

A list of controls provided on the Model CXBR Transmitting Equipment is presented in Table 11. The mechanical and electrical operation of all controls was found to be satisfactory.

2-11. <u>COMPONENT PARTS</u>.

The following items were noted concerning the component parts used in the equipment.

2-11-1 The 1000 cycle audio frequency grid coil for V109 is unprotected. A suitable protective cover should be installed over this coil.

2-11-2 Navy Specification RE13A372J does not permit the use of the flat type heater resistors that are used in the Model CXBR Equipment. Navy approved resistors should be employed.

2-12. <u>GENERAL PHYSICAL CONSTRUCTION</u>.

An examination of the equipment revealed the following items concerning the general physical construction.

2-12-1 The tuning stubs mounted on the transmitter and receiver oscillators are very lightly constructed, and may be easily bent when the transmitter is removed from its case. It is recommended these stubs be made with a larger cross sectional area, and that a protective cover be provided.



[redacted] 

2-12-2 The placement of the meters in the equipment renders their removal and replacement exceedingly difficult. This difficulty may be eliminated by a more judicious placement of parts.

2-12-3 The BX cable clamp on the blower motor is not satisfactory. An approved type of bushing should be used.

2-12-4 The bend in the metal coaxial transmission line from the antenna coupling stub of the receiver to the output connector on the front of the panel has a crease in the middle of its bend. Better workmanship should be employed in making this bend in future models.

2-12-5 Some means should be provided for handling the unit when it is withdrawn from its cabinet for servicing. A "U" shaped rail mounted on each longitudinal side underneath the chassis would serve this purpose, and would also provide a rest for the unit when it is withdrawn from its case.

2-12-6 The steel partition on the front of the transmitter-receiver panel between the controls and the cathode ray oscilloscope should be in the form of a handle to aid in the withdrawal of the unit from its case.

2-12-7 It is recommended that the external handles provided on the unit be of a type that will remain in their rest position without rattling when not in use and when subjected to vibration.

2-12-8 It is recommended that the antenna rotating handle be moved to a lower position in order to reduce fatigue of the operator.

2-12-9 The breaks in the rubber gasket between the transmitter-receiver unit front panel and its case should be made in the form of a wedge to insure watertightness.

2-12-10 Sixteen holes must be drilled in the deck of a vessel to properly mount the Model CXBR Equipment stand. It is recommended that the mounting be modified so as to require fewer mounting bolts.

2-13. WIRING.

The following items were noted concerning the wiring of the equipment.

2-13-1 The conductors from the blower motor to the a.c. supply



[redacted]

terminals are not properly dressed into a cable with other nearby parallel conductors. The possibility of abrasion, short circuit, and damage to the equipment exists.

2-13-2A number of cables come in contact with rough metallic edges in the equipment. A serious possibility of abrasion of these cables thereby exists.

2-13-3All ground connections in the equipment consist of individual lugs secured directly to the chassis by means of machine screws and nuts without lockwashers. No common bonding, other than the chassis, is present.

2-13-4The insulation of all conductors is pushed back from the soldering terminals without being clamped by the terminal. This practice leads to the fraying of the ends of the insulation and does not provide the additional support offered by this type of terminal..

2-14. CORROSION.

The following items concerning corrosion were noted in the equipment:

2-14-1Corrosion was present on the fan guard of the blower motor.

2-14-2Corrosion was present on the under side of the chassis where the securing screws for the condenser mounting assembly (C156 and C157) pass through the chassis.

2-15 NAMEPLATES AND COMPONENT MARKINGS.

A list of all nameplates of the Model CXBR Radar Equipment is presented in Table 12, Section 2. These nameplates are in accordance with Navy Specification XA8870A.

2-15-1Only a small number of the component parts of the equipment have component markings affixed to them. Location of parts when servicing is thereby made exceedingly difficult.

2-16 SCHEMATIC DRAWING ERRORS.

The following conflicting items were noted between the schematic drawings and the actual wiring of the equipment:

2-16-1The transmitter-receiver schematic drawing shows a



[redacted]

direct connection between the grid of the second half of V110 (6SL7) and resistors R137 and R138. In the actual wiring, there is a network of components between the grid and these resistors.

2-16-2 The plate lead of the second half of V110(6SL7) has a 41000 ohm resistor in series with it that is not indicated on the schematic drawing.

## 2-17 WEIGHTS AND DIMENSIONS.

The various units of the Model CXBR Radar Equipment were weighed and measured. The results are tabulated in Table 10, Section 2.

## 2-18 SUMMARY OF DEFECTS.

A summary of the defects noted during mechanical and electrical tests made on the Model CXBR Radar Transmitting Equipment together with recommendations for corrective action are listed below. The numerals in parenthesis refer to the paragraphs of this report under which these items are discussed in detail. Attention is directed to the fact that items are not necessarily listed in the order of their importance.

2-18-1(2-2-1). The rubber gasket between the front panel and the case of the transmitter-receiver should be securely fastened to the front panel in such a manner as to preclude the possibility of it sticking to the front of the case when the chassis is removed at low temperatures. In addition, there are various types of "anti-seize" compounds obtainable in stick form that have been found to alleviate this condition. U.S. Rubber Co. "Anti-Adhesive" Crayon No. M-6103 has been found satisfactory for this purpose.

2-18-2(2-2-2). It is recommended that an echo box be supplied in order that the receiver may be kept in tune with varying transmitter wave length.

2-18-3(2-4-1). Modification of the shock mounting of the transmitter-receiver unit is indicated in order to prevent excessive amplitudes of vibration.

2-18-4(2-4-2)(2-5-2). A more rigid mechanical design of the complete supporting assembly is indicated to prevent erratic modes of vibration, when the equipment is subjected to vibration, and to prevent excessive amplitudes of displacement when the equipment is



[redacted]

subjected to shock. This recommendation is made with the reservation that only shipboard installation is being considered.

2-18-5(2-5-1). The shock mounting of the transmitter-receiver unit should be suitably modified so as to eliminate the "bottoming" of the shock mounts caused by shock. This recommendation will apply in those cases where this unit is removed from its stand and mounted directly by means of the shock mounts provided.

2-18-6(2-5-1). Vacuum tube V113(6AC7) developed a grid to cathode short when the equipment was subjected to shock.

2-18-7(2-5-1). A suitable clamp should be provided for the type 829A(V114) tube to prevent it from becoming dislodged from its socket when subjected to shock.

2-18-8(2-5-1). The 829A(V114) tube socket should be properly shock mounted to prevent damage to the tube when subjected to shock.

2-18-9(2-6). Suitable steps should be taken to prevent a serious reduction of radio-frequency power output when the equipment is subjected to line voltages 10% below normal.

2-18-10 (2-9). A steady state potential of 3800 volts exists from plate to ground on the second half of tube V114 (829A). A thorough investigation should be made of the ability of this tube to withstand potentials of this order.

2-18-11 (2-9-1). Before the GL464 tubes (V115) can be considered satisfactory for use in the Model CXBR Equipment, it will be necessary to improve their characteristics sufficiently to obviate the necessity for special selection of tubes.

2-18-12 (2-9-2). The pins on the 829A tube (V114) socket should be properly identified.

2-18-13 (2-11-1). A suitable protective cover should be provided for the 1000 cycle audio frequency grid coil.

2-18-14 (2-11-2). The flat type heater resistors should be replaced by resistors of a Navy approved type.

2-18-15 (2-12-1). The tuning stubs on the transmitter and receiver oscillators should be made sturdier, and should





[redacted]

be provided with a protective cover.

2-18-16 (2-12-2). Modifications should be made to expedite the removal and replacement of the panel meters.

2-18-17 (2-12-3). An approved type of bushing should be substituted for the BX cable clamp on the blower motor.

2-18-18 (2-12-4). More careful workmanship should be employed in making the bend in the metal coaxial line from the antenna coupling stub of the receiver to the coaxial output connector on the front panel.

2-18-19 (2-12-5). It is recommended that a "U" shaped rail be mounted on each longitudinal side underneath the chassis to provide a rest for the unit and to expedite handling when the unit is withdrawn from its case.

2-18-20 (2-12-6). A suitable handle should be provided on the front panel of the transmitter-receiver to aid in the withdrawal of the unit from its case.

2-18-21 (2-12-7). Modifications should be made to insure that the handles on the side of the transmitter-receiver unit remain in a fixed position when subjected to vibration.

2-18-22 (2-12-8). The antenna rotating handle is located in such a position that the operator will tire easily when operating from a seated position. It is recommended that this handle be lowered.

2-18-23 (2-12-9). It is recommended that the breaks in the rubber gasket between the transmitter-receiver unit fron panel and its case be made in the form of a wedge to insure watertightness.

2-18-24 (2-12-10). The method of mounting the assembly to the deck of a vessel should be modified so as to require fewer mounting bolts.

2-18-25 (2-13-1). The conductor from the blower motor to the a-c supply terminal should be properly dressed into a cable.

2-18-26 (2-13-2). Buffers should be provided for all cables in positions where the cables contact rough metallic edges.

2-18-27 (2-13-3). A more suitable method of connection should be provided to connect all ground terminals



[redacted]

to the chassis.

2-18-28 (2-13-4). The insulation of all conductors should be firmly grasped by the soldering terminals.

2-18-29 (2-14-1)(2-14-2). The transmitter-receiver chassis and the blower motor fan guard should be plated in a manner to prevent corrosion.

2-18-30 (2-15-1). All component parts should be properly identified by suitable component markings.

2-18-31 (2-16-1)(2-16-2). The transmitter-receiver schematic drawings should be altered to conform to the actual wiring of the unit.

2-19. CONCLUSIONS.

The Model CXBR Radar Equipment can be assembled and placed in operation within one-half hour. The equipment can be readily transported in its carrying cases and is simple and compact in construction. However, continuous operation cannot be expected of this equipment when it is subjected to shock such as is encountered in the Naval Service. The type of vacuum tube employed as the transmitter oscillator requires a considerable amount of pre-selection. This condition is undesirable. Considerable modifications are necessary before the CXBR can be considered suitable for the Naval Service.



[redacted]

Table 1 - Section 2

Model CXBR Radar Equipment

Variation in Ambient Temperature

Transmitter-Receiver Unit: Type CG-X43AAW

Antenna Assembly Unit: Type CG-X66ABU

| Time | Amb. Temp. (°C) | Rel. Hum. (%) | Wave Length (Cm) | Power Output Aver. (Mw) | Power Output Peak (Watts) | Osc. Grid Cur. (Ma) | Rep. Rate (Pul/Sec) | Duty Cycle (%) | Line Volts | Fil. Pri. Volts | Line Power (Watts) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0900 | 50.0 | 10 | 11.79 | 0.858 | 0.605 | 0.42 | 1028 | 0.142 | 115 | 114 | 191 |
| 0915 | 50.0 | 8 | 11.79 | 0.862 | 0.607 | 0.43 | 1028 | 0.142 | 115 | 114 | 190 |
| 0930 | 50.0 | 8 | 11.79 | 1.010 | 0.710 | 0.44 | 1028 | 0.142 | 115 | 114 | 190 |
| 0945 | 50.0 | 8 | 11.79 | 0.920 | 0.648 | 0.43 | 1028 | 0.142 | 115 | 114 | 190 |
| 1000 | 50.0 | 8 | 11.79 | 0.920 | 0.648 | 0.42 | 1029 | 0.142 | 115 | 114 | 190 |
| 1015 | 35.0 | 12 | 11.79 | 1.770* | 1.250 | 0.42 | 1028 | 0.142 | 115 | 114 | 190 |
| 1030 | 34.5 | 12 | 11.79 | 1.200 | 0.845 | 0.42 | 1029 | 0.142 | 115 | 114 | 193 |
| 1045 | 34.5 | 12 | 11.79 | 1.370 | 0.965 | 0.41 | 1029 | 0.142 | 115 | 114 | 193 |
| 1100 | 34.5 | 12 | 11.79 | 1.250 | 0.880 | 0.41 | 1029 | 0.142 | 115 | 114 | 193 |
| 1115 | 34.0 | 12 | 11.79 | 1.175 | 0.828 | 0.41 | 1029 | 0.142 | 115 | 114 | 192 |
| 1130 | 23.0 | 15 | 11.79 | 1.250 | 0.880 | 0.41 | 1030 | 0.142 | 115 | 114 | 192 |
| 1145 | 20.0 | 15 | 11.79 | 1.250 | 0.880 | 0.41 | 1032 | 0.142 | 115 | 114 | 193 |
| 1200 | 20.0 | 16 | 11.79 | 1.300 | 0.915 | 0.41 | 1033 | 0.143 | 115 | 114 | 193 |
| 1215 | 20.0 | 16 | 11.79 | 1.600 | 1.130 | 0.41 | 1033 | 0.143 | 115 | 114 | 193 |
| 1230 | 20.0 | 16 | 11.79 | 1.420 | 1.000 | 0.41 | 1033 | 0.143 | 115 | 114 | 193 |
| 1245 | 20.0 | 16 | 11.79 | 1.420 | 1.000 | 0.42 | 1033 | 0.143 | 115 | 114 | 193 |
| 1300 | 9.0 | 32 | 11.79 | 1.420 | 1.000 | 0.36 | 1035 | 0.143 | 115 | 114 | 198 |
| 1315 | 0 | — | 11.79 | 1.580 | 1.110 | 0.38 | 1035 | 0.143 | 115 | 114 | 200 |
| 1330 | 0 | — | 11.79 | 0.980 | 0.690 | 0.39 | 1035 | 0.143 | 115 | 114 | 202 |
| 1345 | 0 | — | 11.79 | 1.000 | 0.705 | 0.38 | 1035 | 0.143 | 115 | 114 | 201 |



[redacted]

Table 1 – Section 2 (Contd)

| Time | Amb. Temp. (°C) | Rel. Hum. (%) | Wave Length (Cm) | Power Output Aver. (Mw) | Power Output Peak (Watts) | Osc. Grid Cur. (Ma) | Rep. Rate (Pul/Sec) | Duty Cycle (%) | Line Volts | Fil. Pri. Volts | Line Power (Watts) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1400 | 0 | — | 11.79 | 1.200 | 0.846 | 0.38 | 1035 | 0.143 | 115 | 114 | 202 |
| 1415 | 0 | — | 11.79 | 1.120 | 0.790 | 0.35 | 1035 | 0.143 | 115 | 114 | 200 |

Pulse Length Remained Constant At 1.38 micro seconds.

* Increased Power Due to Change of Impedance Presented by Receiver Oscillator.



[redacted]

Table 2 - Section 2

Model CXBR Radar Equipment

Effect of Low Temperature

Transmitter-Receiver Unit: Type CG-X43AAW

Antenna Assembly Unit: Type CG-X66ABU

| Time | Temp. (°C) | Power On or Off | Power Switch changed to on-off | Wave Length (CM) | Power Output Aver. (Mw) | Power Output Peak (Watts) | Rep. Rate (Pul/Sec) | Duty Cycle (%) | Osc. Grid Cur. (Ma) | Line Cur. (Amps) | Line Volt | Fil Pri Volt | NOTE | Line Power (Watts) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0000 | 10 | Off | (Heaters On) | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0030 | - 8 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0100 | -15 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0130 | -19 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0200 | -21 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0230 | -24 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0300 | -25 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0330 | -26 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0400 | -27 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0430 | -28 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0500 | -29 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0530 | -29 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0600 | -29 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0630 | -29 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0700 | -30 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0730 | -31 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0800 | -31 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |

[redacted]

Table 2 - Section 2 (Contd)

| Time | Temp (°C) | Power On or Off | Power Switch changed to on-Off | Wave Length (CM) | Power Output Aver. (Mw) | Power Output Peak (Watts) | Rep. Rate (Pul/Sec) | Duty Cycle (%) | Osc. Grid Cur. (Ma) | Line Cur. (Amps) | Line Volt | Fil Pri Volt | NOTE | Line Power (Watts) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0830 | -31 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0900 | -31 | | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0915 | -31 | | On | | | | | | | 0.33 | 115 | 0 | | 38 |
| 0917 | -31 | On | | 11.74 | 1.07 | 0.743 | 1040 | 0.144 | 0.2 | 2.0 | 115 | 114 | 1 | 192 |
| 0930 | -31 | On | | 11.75 | 1.07 | 0.743 | 1040 | 0.144 | 0.4 | 2.0 | 115 | 114 | | 192 |
| 0945 | -31 | On | | 11.79 | 1.07 | 0.743 | 1045 | 0.144 | 0.4 | 2.0 | 115 | 114 | | 192 |
| 1000 | -31 | On | | 11.79 | 1.07 | 0.743 | 1045 | 0.144 | 0.4 | 2.0 | 115 | 114 | | 192 |

Pulse length remained constant at 1.38 microseconds.

Note 1: Starting was normal, and general operation was satisfactory; however, the wave length varied from normal and required 1/2 hour to stabilize. Rotation of the hand crank easily broke all ice that could be formed on the antenna bearing.

[redacted]

Table 3 - Section 2

Model CXBR Radar Equipment

Variation in Relative Humidity

Transmitter-Receiver Unit: Type CG-X43AAW

Antenna Assembly Unit: Type CG-X66ABU

| Time | Amb. Temp (°C) | Rel. Hum. (%) | Wave Length (CM) | Power Output Aver. (Mw) | Power Output Peak (Watts) | Osc. Grid Cur. (Ma) | Line Cur. (Amps) | Rep. Rate (Pul/Sec) | Duty Cycle (%) | Line Volts | Fil Prim Volts | Line Power (Watts) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0915 | 40 | 20 | 11.79 | 0.575 | 0.405 | 0.39 | 1.96 | 1032 | 0.142 | 115 | 114 | 190 |
| 0930 | 40 | 22 | 11.79 | 0.742 | 0.524 | 0.39 | 1.96 | 1032 | 0.142 | 115 | 114 | 190 |
| 0945 | 40 | 20 | 11.79 | 0.575 | 0.402 | 0.42 | 1.96 | 1035 | 0.143 | 115 | 114 | 192 |
| 1000 | 40 | 20 | 11.79 | 0.575 | 0.402 | 0.42 | 1.96 | 1034 | 0.143 | 115 | 114 | 190 |
| 1015 | 40 | 22 | 11.79 | 0.608 | 0.425 | 0.42 | 1.96 | 1035 | 0.143 | 115 | 114 | 191 |
| 1030 | 40 | 97 | 11.79 | 0.608 | 0.427 | 0.43 | 1.97 | 1032 | 0.142 | 115 | 114 | 192 |
| 1045 | 40 | 97 | 11.79 | 0.608 | 0.427 | 0.44 | 1.96 | 1032 | 0.142 | 115 | 114 | 191 |
| 1100 | 40 | 97 | 11.79 | 0.608 | 0.425 | 0.42 | 1.96 | 1033 | 0.143 | 115 | 114 | 190 |
| 1115 | 40 | 97 | 11.79 | 0.642 | 0.450 | 0.42 | 1.96 | 1035 | 0.143 | 115 | 114 | 190 |
| 1130 | 40 | 97 | 11.79 | 0.676 | 0.473 | 0.43 | 1.97 | 1035 | 0.143 | 115 | 114 | 192 |
| 1145 | 40 | 43 | 11.79 | 0.742 | 0.520 | 0.43 | 1.96 | 1036 | 0.143 | 115 | 114 | 190 |
| 1200 | 40 | 23 | 11.79 | 0.642 | 0.450 | 0.43 | 1.96 | 1037 | 0.143 | 115 | 114 | 191 |
| 1215 | 40 | 20 | 11.79 | 0.710 | 0.496 | 0.42 | 1.96 | 1035 | 0.143 | 115 | 114 | 191 |
| 1230 | 40 | 20 | 11.79 | 0.710 | 0.496 | 0.42 | 1.96 | 1036 | 0.143 | 115 | 114 | 191 |
| 1245 | 40 | 22 | 11.79 | 0.710 | 0.496 | 0.42 | 1.96 | 1036 | 0.143 | 115 | 114 | 192 |
| 1300 | 40 | 20 | 11.79 | 0.710 | 0.496 | 0.42 | 1.96 | 1036 | 0.143 | 115 | 114 | 192 |
| 1315 | 40 | 20 | 11.79 | 0.710 | 0.496 | 0.42 | 1.96 | 1037 | 0.143 | 115 | 114 | 191 |

Pulse length remained constant at 1.38 microseconds.



[redacted]

Table 4 – Section 2

Model CXBR Radar Equipment

Effect of High Humidity

Transmitter-Receiver Unit: Type CG-X43AAW

Antenna Assembly Unit: Type CG-X66ABU

| Time | Rel. Hum. (%) | Temp. (°C) | Power On or Off | Power Switch changed to on-off | Wave Length (CM) | Power Output Aver. (Mw) | Power Output Peak (Watts) | Rep. Rate (Pul/Sec) | Duty Cycle (%) | Osc. Grid Cur. (Ma) | Line Cur. (Amps) | Line Volt | Fil Pri Volt | NOTE | Line Power (Watts) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1315 | 20 | 40 | On | | 11.79 | 0.710 | 0.496 | 1037 | 0.143 | 0.42 | 1.96 | 115 | 114 | | 191 |
| 1316 | 20 | 40 | | Off | (Heaters On) | | | | | | 0.33 | 115 | 0 | | 38 |
| 1330 | 95 | 40 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 1345 | 95 | 39 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 1400 | 97 | 41 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 1415 | 97 | 41 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 1430 | 97 | 41 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 1445 | 97 | 40 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 1500 | 97 | 40 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 1515 | 97 | 40 | Off | | | | | | | | 0.33 | 115 | 0 | | 38 |
| 1530 | 97 | 40 | | On | | | | | | | 2.12 | 115 | 114 | 1 | 210 |
| 1532 | 97 | 40 | On | | 11.79 | 0.676 | 0.472 | 1037 | 0.143 | 0.37 | 1.96 | 115 | 114 | | 190 |
| 1545 | 97 | 40 | On | | 11.79 | 0.710 | 0.496 | 1038 | 0.143 | 0.42 | 1.96 | 115 | 114 | | 190 |

Pulse length remained constant at 1.38 microseconds.

Note 1: Grid current and power output from the GL-464 appeared two minutes after power was applied. Starting was satisfactory with no indication of leakage or arc over. Operation was normal.

[redacted]

Table 5

Section 2

Model CXBR Radar Equipment

Variation in Line Voltage

| Line Volts | Power Output: Aver. (Mw) | Power Output: Peak (Watts) | Fil. Prim Volts | Osc. Grid Cur. (Ma) | Grid Voltage (Volts) | Line Cur. (Amps) | Power Input (Watts) |
|---|---|---|---|---|---|---|---|
| 103.5 | 4.76 | 3.3 | 104 | 0.05 | - 2 | 1.74 | 162 |
| 106.0 | 20.2 | 14.0 | 107 | 0.10 | -16 | 1.80 | 170 |
| 108.0 | 37.3 | 25.8 | 108 | 0.17 | -23 | 1.85 | 172 |
| 110.0 | 52.8 | 36.6 | 110 | 0.34 | -54 | 1.86 | 182 |
| 112.5 | 68.7 | 47.6 | 112 | 0.48 | -68 | 1.94 | 194 |
| 115.0 | 76.2 | 53.0 | 115 | 0.51 | -72 | 2.00 | 202 |
| 117.5 | 86.0 | 60.0 | 117 | 0.57 | -84 | 2.05 | 212 |
| 120.0 | 91.0 | 63.2 | 118 | 0.58 | -85 | 2.10 | 218 |
| 122.5 | 110.0 | 76.5 | 121 | 0.60 | -85 | 2.15 | 226 |
| 124.0 | 114.0 | 79.0 | 123 | 0.62 | -87 | 2.20 | 232 |
| 126.5 | 115.0 | 80.0 | 124 | 0.62 | -89 | 2.25 | 240 |

The following remained constant during the test.

Repetition Rate - 1040 cycles/sec.
Pulse length - 1.38 microseconds
Duty cycle - 0.144%
Wave length - 11.82 cms

[redacted]

## Table 6

## Section 2

## Model CXBR Radar Equipment

## List of Vacuum Tube Potentials

| Tube Circ. Sym. | Type Tube | Plate Voltage | Cathode Voltage | Grid Voltage | Screen Grid Voltage | Filament Voltage | Where Used |
|---|---|---|---|---|---|---|---|
| V109 | 6SH7 | 250 | 0 | -13.5 | 205 | 6.35 | 1000 cyc.osc. |
| V110* | 6SL7GT | 45 | 0 | -36 | | 6.35 | 1st and 2nd clippers. |
| V110* | | 150 | | -13 | | | |
| V111 | 6SH7 | 74 | 0 | -67 | 74 | 6.35 | Clipper Amp. |
| V112 | 6SH7 | 92 | 0 | - 3.5 | 92 | 6.35 | Clipper Amp. |
| V113 | 6AC7 | 258 | 9.3 | 0 | 258 | 6.35 | Clipper Limiter and Pulse Amp. |
| V114-1* | 829A | 268 | -250 | 300 | 258 | 6.10 | Pulse Driver |
| V114-2* | 829A | 3800 | -250 | 435 | 258 | 6.10 | Pulse Modulator. |
| V115 | GL-464 | Pulsed | 0 | -60 | | 6.32 | Pulsed Osc. |
| V118 | 5U4G | | | | | 4.95 | Low Voltage |
| V119 | 6X5GT | | | | | 6.35 | Power Supply |

* Twin Tube

All voltages measured to ground.

[redacted]

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Table 7

Section 2

Model CXBR Radar Equipment

Check of Transmitter Oscillator Tubes (GL464)

| Ser. NR. | Grid (Ma) | Remarks |
|---|---|---|
| A 9 | 0 | Did not oscillate. |
| A 12 | 0.25 | |
| A 28 | 0.1 | |
| A 29 | 0 | Did not oscillate. |
| A 38 | 0.2 | |
| A 39 | 0 | Did not oscillate. Cathode cold. |
| A 47 | 0.3 | |
| A 60 | 0.15 | |
| A 63 | 0.3 | |
| A 64 | 0.3 | |
| A 65 | 0.3 | Internal arc. |
| A 68 | 0.3 | Decreased to 0.15. |
| A 70 | 0 | Did not oscillate. |
| A 71 | 0.6 | |
| A 78 | 0.35-0.5 | Intermittent internal arc. |
| A 83 | 0 | Did not oscillate. |
| A 85 | 0.6 | |
| A 86 | 0 | Feeble and erratic oscillation. |
| A 89 | 0.75 | |
| A126 | 0.05 | Feeble oscillation. |
| A128 | ---- | Feeble oscillation. |
| A153 | 0 | Oscillated for short time. Gassy. |
| A156 | 0.25 | |
| A172 | 1.25 | Varying. |
| A177 | | Cathode ring too large to fit equipment. |

[redacted]

Table 8

Section 2

Model CXBR Radar Equipment

Power Required from the Supply Line

| Unit(s) | Line Volts | Line Amps. Normal | Line Amps. Surge | Watts Input |
|---|---|---|---|---|
| Transmitter-Receiver | | | | |
| Stand-By | 115 | 1.66 | 1.95 | 173 |
| Operate | 115 | 1.88 | 2.05 | 191 |
| Calibrate | 115 | 1.88 | 1.90 | 191 |
| Heaters (117 Volt Unit) | 115 | 0.33 | 0.33 | 38 |

[redacted]

Table 9

Section 2

Model CXBR Radar Equipment

List of Fuse Currents

| Cir. Symb. | # | Rating on Fuse Amp. | Rating on Fuse Volt | Operating Conditions Volt | Operating Conditions Amps. Surge | Operating Conditions Amps. Nor. | Fuse Circuit |
|---|---|---|---|---|---|---|---|
| F101 | N | 5 | 250 | 115 | 2.55 | 1.85 | Main Line to Transmitter |
| F102 | N | 5 | 250 | 115 | 2.55 | 1.85 | Main Line to Transmitter |
| F103 | N | 0.5 | 250 | 115 | 0.64 | 0.64 | 117 Volt Heater Circuit. |
| F104 | N | 2 | 250 | * | ---- | ---- | 32 Volt Heater Circuit. |

All fuses 1/4" diameter, 1 1/4" long.

* 32 volt supply not available.

#N indicates non-refillable type fuse.

[redacted]

Table 10

Section 2

Model CXBR Radar Equipment

List of Weights and Dimensions

| Unit | Overall Dimensions in Inches Height | Width | Depth | Weight Pounds |
|---|---|---|---|---|
| Antenna Reflector | 24-3/4 | 48 | 15-1/2 | 33.5 |
| Antenna Support | 25 | 33 | 31 | } |
| Transmitter-Receiver Case | 17-3/4 | 16-1/2 | 23-1/2 | } 124 |
| Supporting Stand | 56 | 38-3/4 | 37 | } |
| Transmitter-Receiver Chassis | 17-3/4 | 16-1/2 | 24 | 108.5 |
| Overall-Assembled | 88-3/4 | 52-1/2* | | |
| Total Weight of Equipment | | | | 266 |

* Diameter of reflector circle.

[redacted]

Table 11

Section 2

Model CXBR Radar Equipment

List of Controls

| Cont. let. | Control Marking | Circuit Controlled | Control Calibration or Positions. Type of Control |
|---|---|---|---|
| S101 S105 | {Off, Standby, Operate, Calibrate | Main Power, Heaters, and H.V. Primary | 4 Position Switch |
| S102 | Range Switch | Selects Differentiation Circuit | (Long-Short) 2 Position Switch |
| S103 | Grid Ma | Grid Circuit of GL-464 | (Rec-Trans.) 2 Position Switch |
| S104 | Voltage Control | Primary Tap Position on Transformer T-101 | Multi-Position Switch. |
| | Handwheel | Rotation of Antenna and Reflector | 360° Azimuth Scale |

[redacted]

Table 12

Section 2

Model CXBR Radar Equipment

List of Nameplates

Model CXBR Radar Equipment

Supply 115 V 1Ø 60 ~ Serial 1

Equipment consists of accessories and the following

1 -- CG-X43AAW Radar Transmitter-Receiver
1 -- CG-X66ABU Antenna Assembly

See license notice inside

NAVY DEPARTMENT

BUREAU OF SHIPS

CONTRACTOR

GENERAL ELECTRIC

Schenectady, N.Y. Made in U.S.A.

| Contract Number | Contract Date |
| --- | --- |
| NXs 4753 | May 11, 1942 |

(2-3/4" X 3")

Table 12 (Cont'd)

Type CG-X66ABU

Antenna Assembly

103 Pounds    Serial 1

A Unit of Model CXBR Radar Equipment

Manufactured for

NAVY DEPARTMENT - BUREAU OF SHIPS

By Contractor

General Electric

Schenectady, N.Y.    Made in U.S.A.

Bridgeport Plant

| Contract Number | Contract Date |
|---|---|
| NXs 4753 | May 11, 1942 |

(3" X 2")

Table 12 (Cont'd)

Type CG-X43AAW

Radar Transmitter-Receiver

Input 115/1/60 3.1 Amps. 300 Watts

153 Pounds Serial 1

A Unit of Model CXBR Radar Equipment

Manufactured for

NAVY DEPARTMENT - BUREAU OF SHIPS

By Contractor

General Electric

Schenectady, N.Y. Made in U.S.A.

Bridgeport Plant

Contract Number Contract Date

NXs 4753 May 11, 1942

(2" X 1-1/2")

Accepted by Navy ____________ Placed in Service ____________

See Instruction Book Regarding Guarantee

(2-1/4" X 3/8")

[redacted]

Table 13 - Section 2

Model CXBR Radar Equipment

List of Meters

| Circ. | Meter Range | Meter Circuit | Meter Dial Marking |
|---|---|---|---|
| M101 | 0-2 MA. D.C. | Grid Circuit of transmitter and receiver oscillators | 0-2 Milliamperes, General Electric, Type DW41 Model 8DW41 |
| M102 | 0-150 Volts A.C. | Line voltage across transformer primary | 0-150 A.C. volts, General Electric, Type AW41 Model 8AW41. |



[redacted]

Table 14 - Section 2

Model CXBR Radar Equipment

Check of Capacitors used in Equipment

| Symbol | Capacity Mfs. (Instr. Book) | Capacity Mfs. (Marked) | Rated Working Voltage (Instr. Book) | Actual D.C. Working Voltage (Measured) | Type (Instr. Book) | Type (Actual) |
|---|---|---|---|---|---|---|
| C102 | 0.01 | 0.01 | 300 | Negligible | Mica | Mica |
| C127 | 0.1 | 0.1 | 600 | 150 | Paper | Paper |
| C128 | 0.001 | 0.001 | 500 | 12 | Mica | Mica |
| C129 | 0.003 | 0.003 | 500 | 30 | Mica | Mica |
| C130 | 0.0033 | 0.0033 | 500 | 60 | Mica | Mica |
| C131 | 0.00033 | 0.00033 | 500 | 150 | Mica | Mica |
| C132 | 0.0033 | 0.0033 | 500 | 45 | Mica | Mica |
| C133 | 0.0056 | 0.0056 | 400 | 87 | Mica | Mica |
| C134 | 2.0 | 2.0 | 600 | 260 | Pyranol | Pyranol |
| C135 | 0.00001 | 0.00001 | 500 | 95 | Mica | Mica |
| C136 | 0.0056 | 0.0056 | 400 | 150 | Mica | Mica |
| C137 | 0.0033 | 0.0033 | 500 | 11 | Mica | Mica |
| C138 | 0.0033 | 0.0033 | 800 | 220 | Mica | Mica |
| C139 | 0.00043 | *----- | 500 | 450 | Mica | Mica |



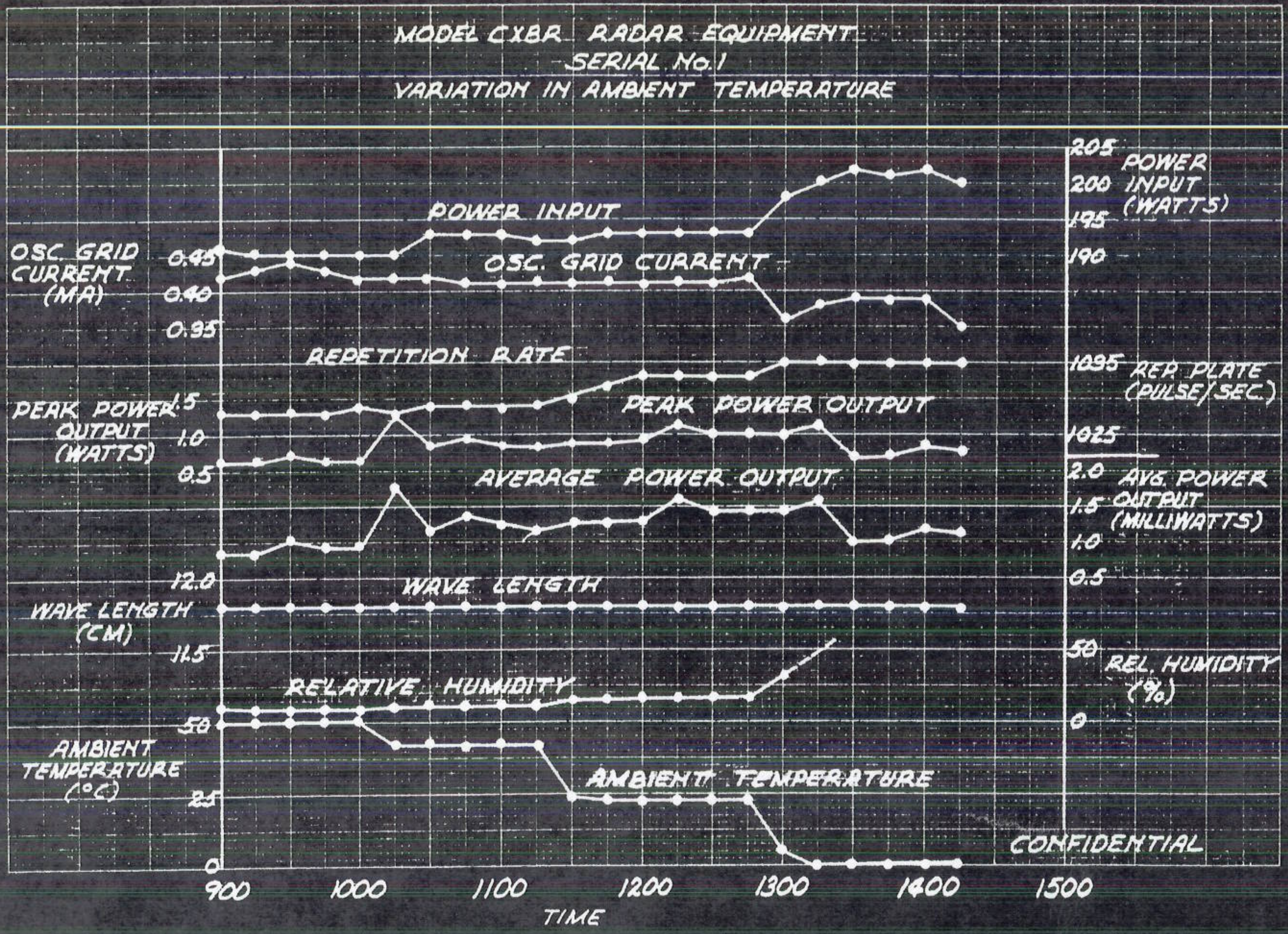
[redacted]

Table 14 (Contd)

| Symbol | Capacity Mfs. (Instr. Book) | Capacity Mfs. (Marked) | Rated Working Voltage (Instr. Book) | Actual D.C. Working Voltage (Measured) | Type (Instr. Book) | Type (Actual) |
|---|---|---|---|---|---|---|
| C140 | 0.1 | 0.1 | 600 | 270 | Paper | Paper |
| C141 | 0.01 | *--- | 5000 | 3750 | Pyranol | Pyranol |
| C142 | 0.01 | 0.01 | 300 | 64 | Mica | Mica |
| C143 | 0.0012 | *--- | 500 | 0 | Mica | Mica |
| C153 | 15.0 | 15.0 | 600 | 316 | Pyranol | Pyranol |
| C154 | 10.0 | 10.0 | 600 | 310 | Pyranol | Pyranol |
| C155 | 2.0 | 2.0 | 600 | 360 | Pyranol | Pyranol |
| C156 | 0.1 | 0.1 | **7500 | 3750 | Pyranol | Pyranol |
| C157 | 0.1 | 0.1 | **7500 | | Pyranol | Pyranol |

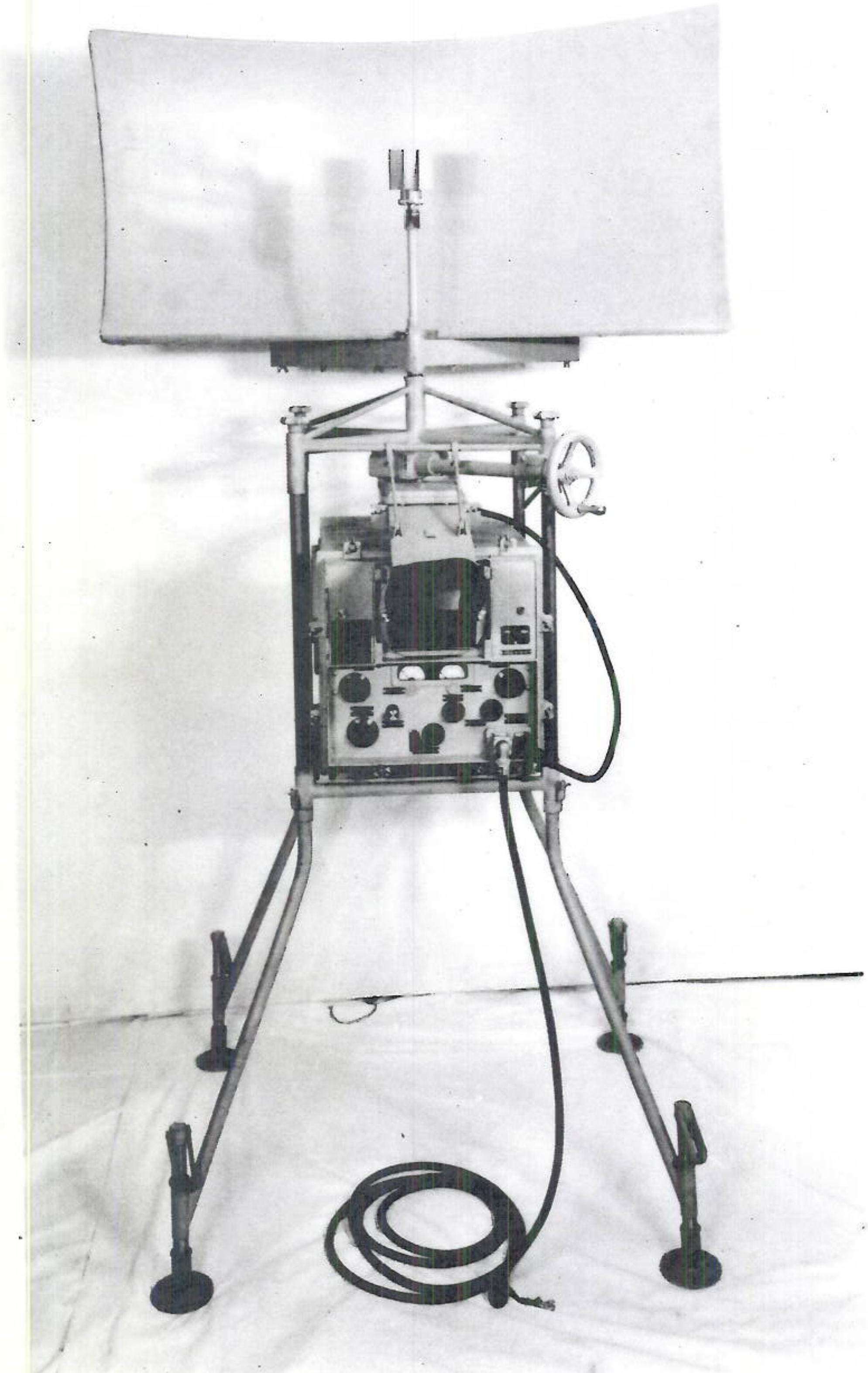
* Unable to check because of physical location.

**The rating of this capacitor in Instruction Book is 7500 volts. The marking on the capacitors case is 6000 volts.



MODEL CXBR RADAR EQUIPMENT
SERIAL No. 1
VARIATION IN AMBIENT TEMPERATURE
POWER INPUT
OSC. GRID CURRENT
REPETITION RATE
PEAK POWER OUTPUT
AVERAGE POWER OUTPUT
WAVE LENGTH
RELATIVE HUMIDITY
AMBIENT TEMPERATURE
OSC. GRID CURRENT (MA)
0.45
0.40
0.35
PEAK POWER OUTPUT (WATTS)
1.5
1.0
0.5
WAVE LENGTH (CM)
12.0
11.5
AMBIENT TEMPERATURE (°C)
50
25
0
205
200
195
190
POWER INPUT (WATTS)
1035
1025
REP. RATE (PULSE/SEC.)
2.0
1.5
1.0
0.5
AVG. POWER OUTPUT (MILLIWATTS)
50
0
REL. HUMIDITY (%)
900
1000
1100
1200
1300
1400
1500
TIME
CONFIDENTIAL


PLATE 1, SEC. 2



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[redacted]

PLATE 5 SEC 2

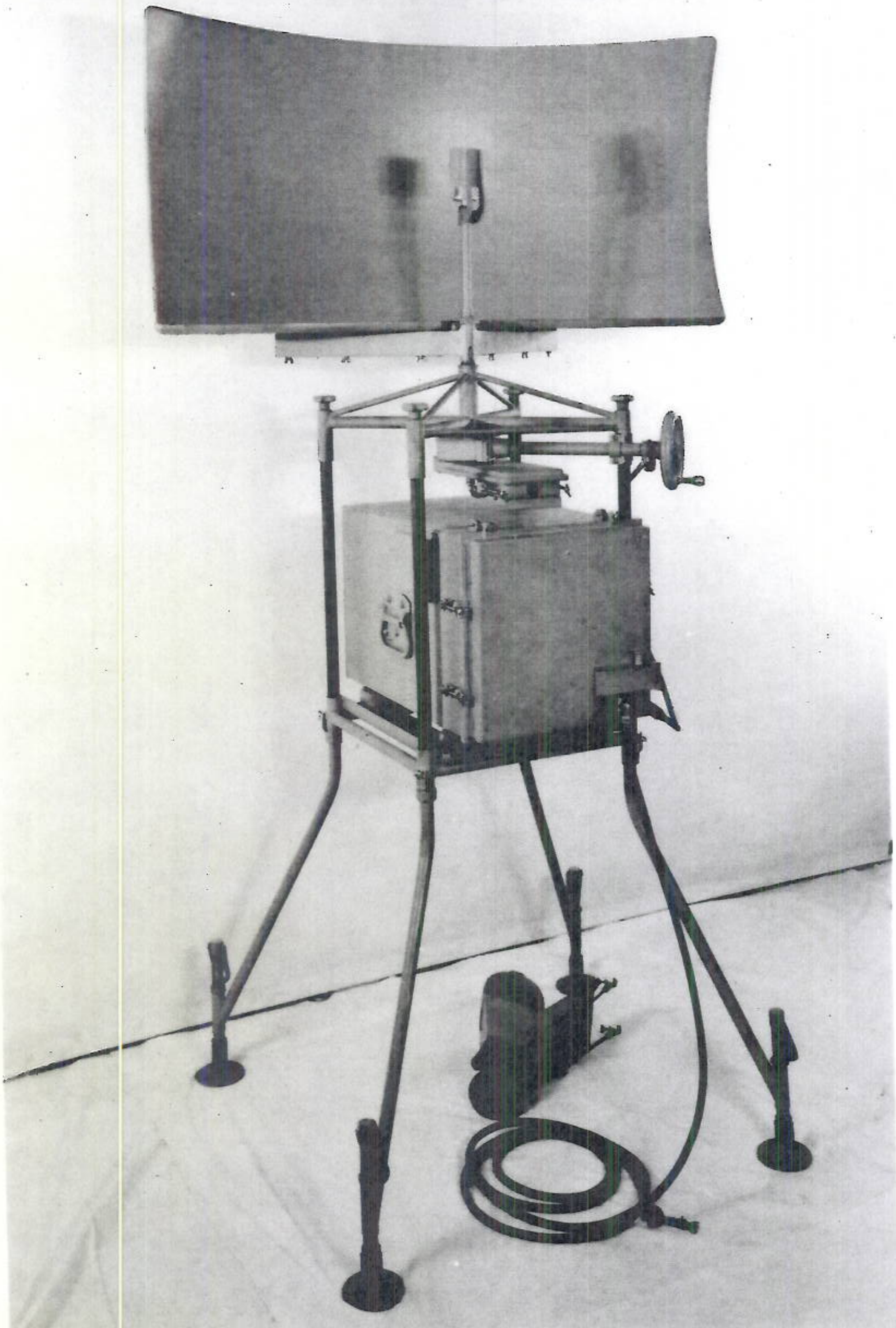

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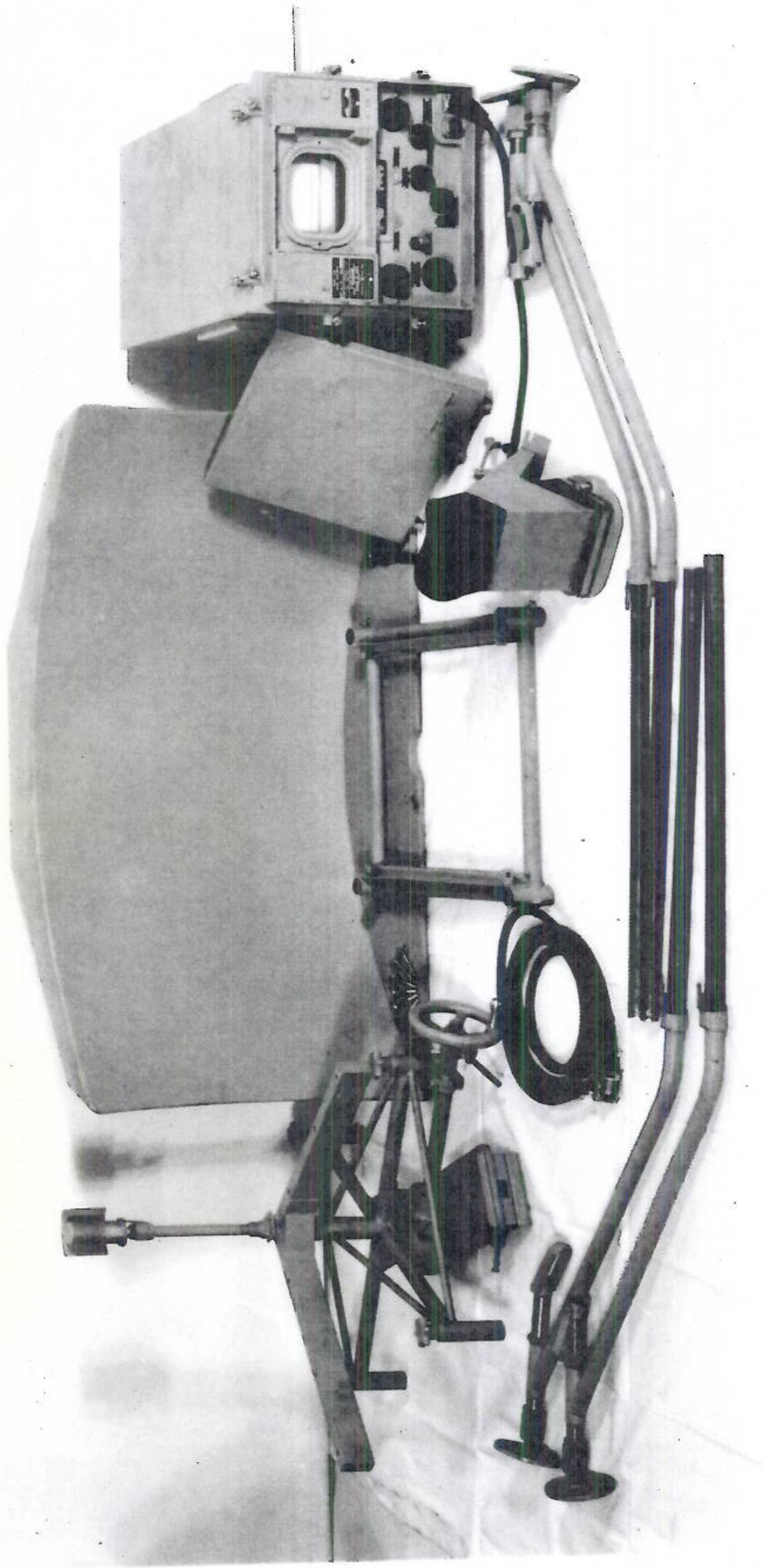
PLATE 6 SEC.2



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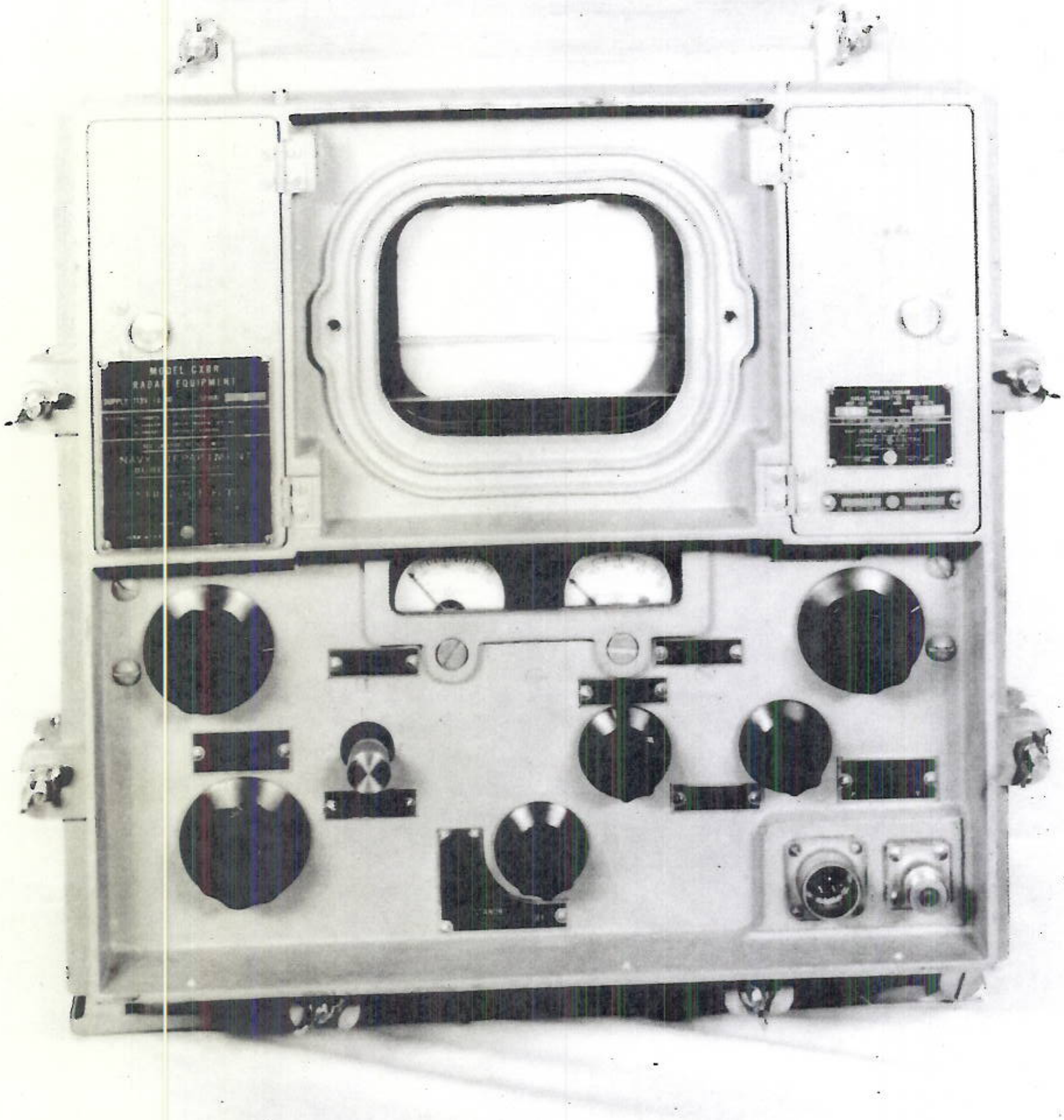


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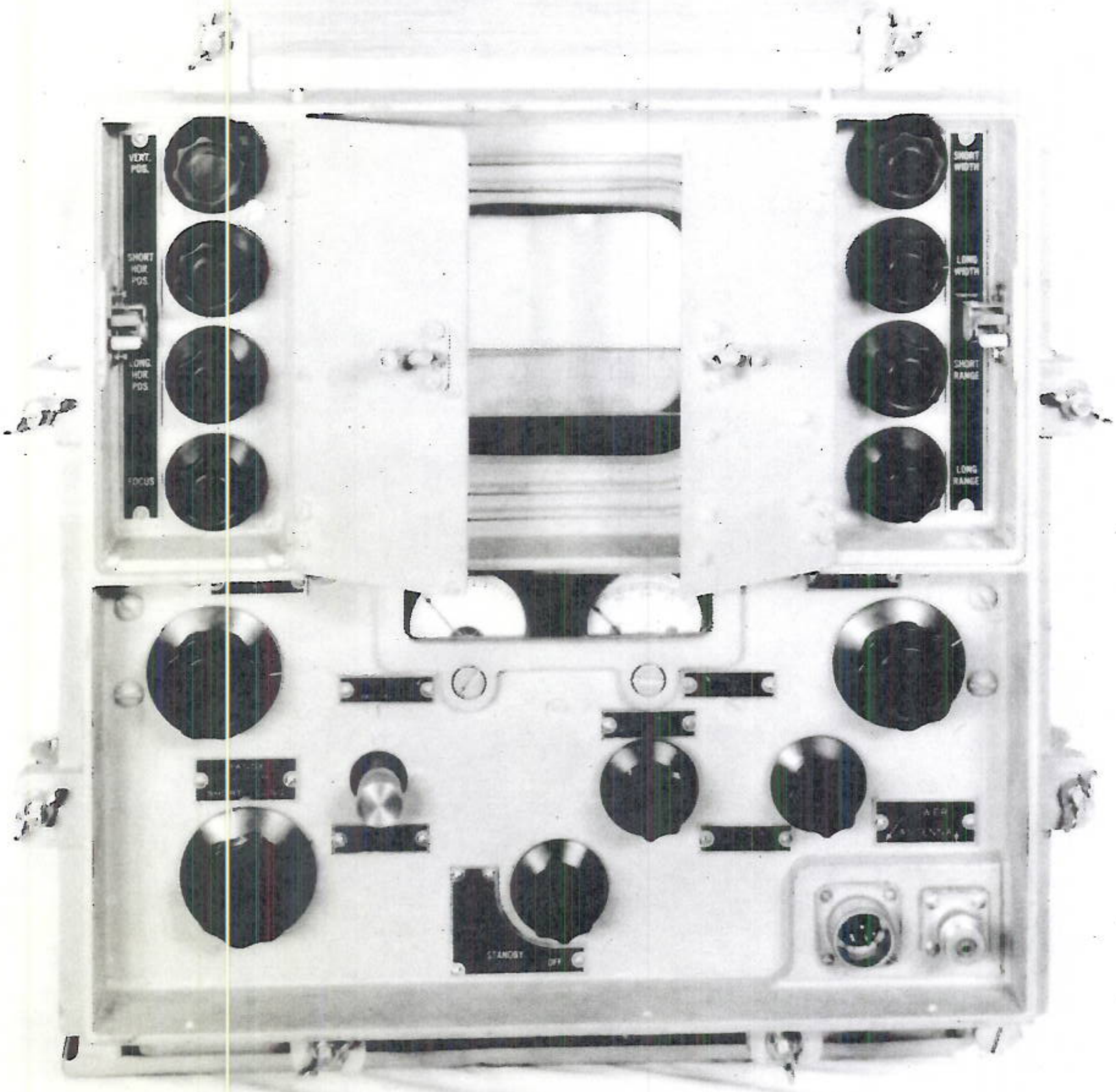




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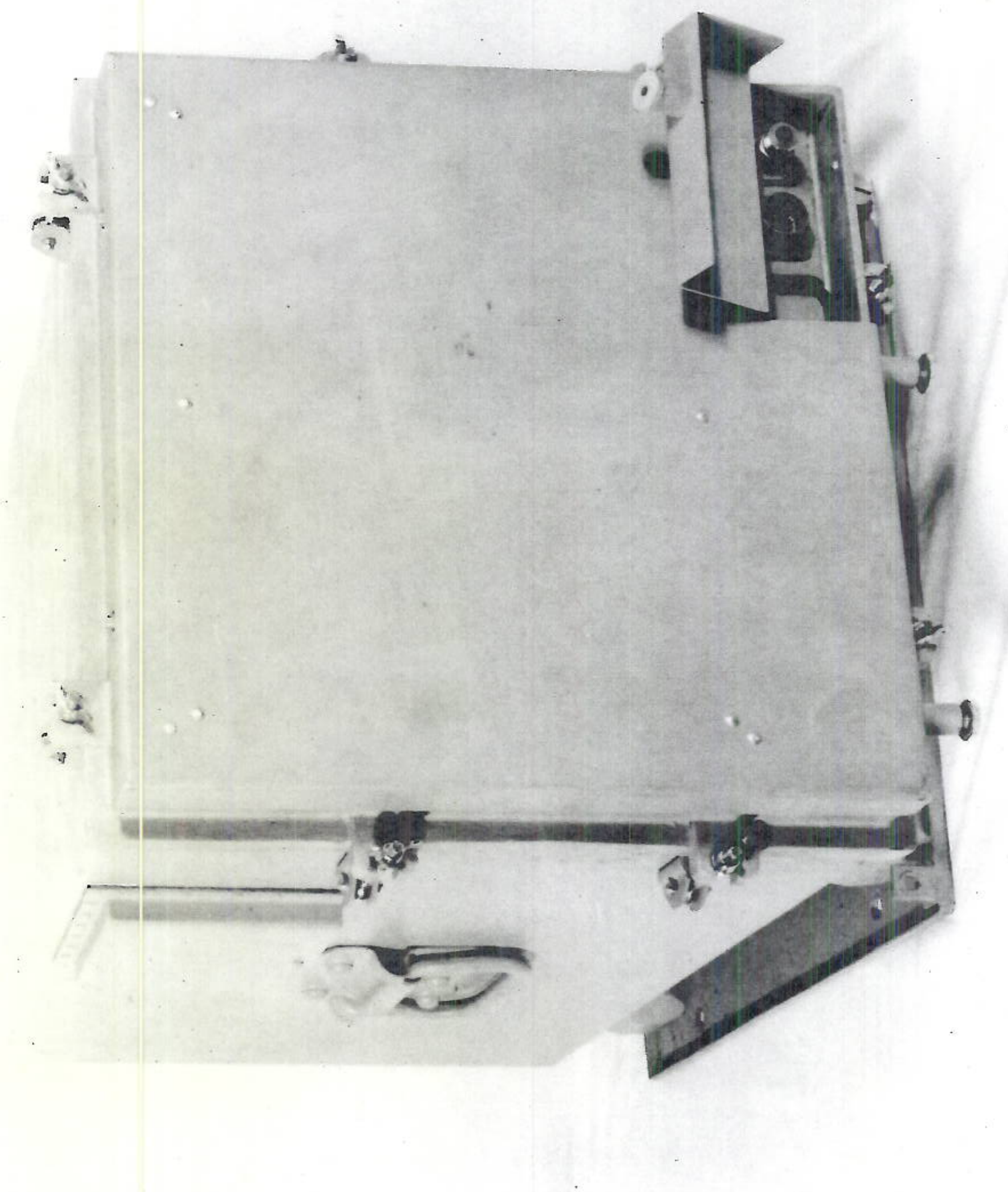
PLATE 9 SEC. 2





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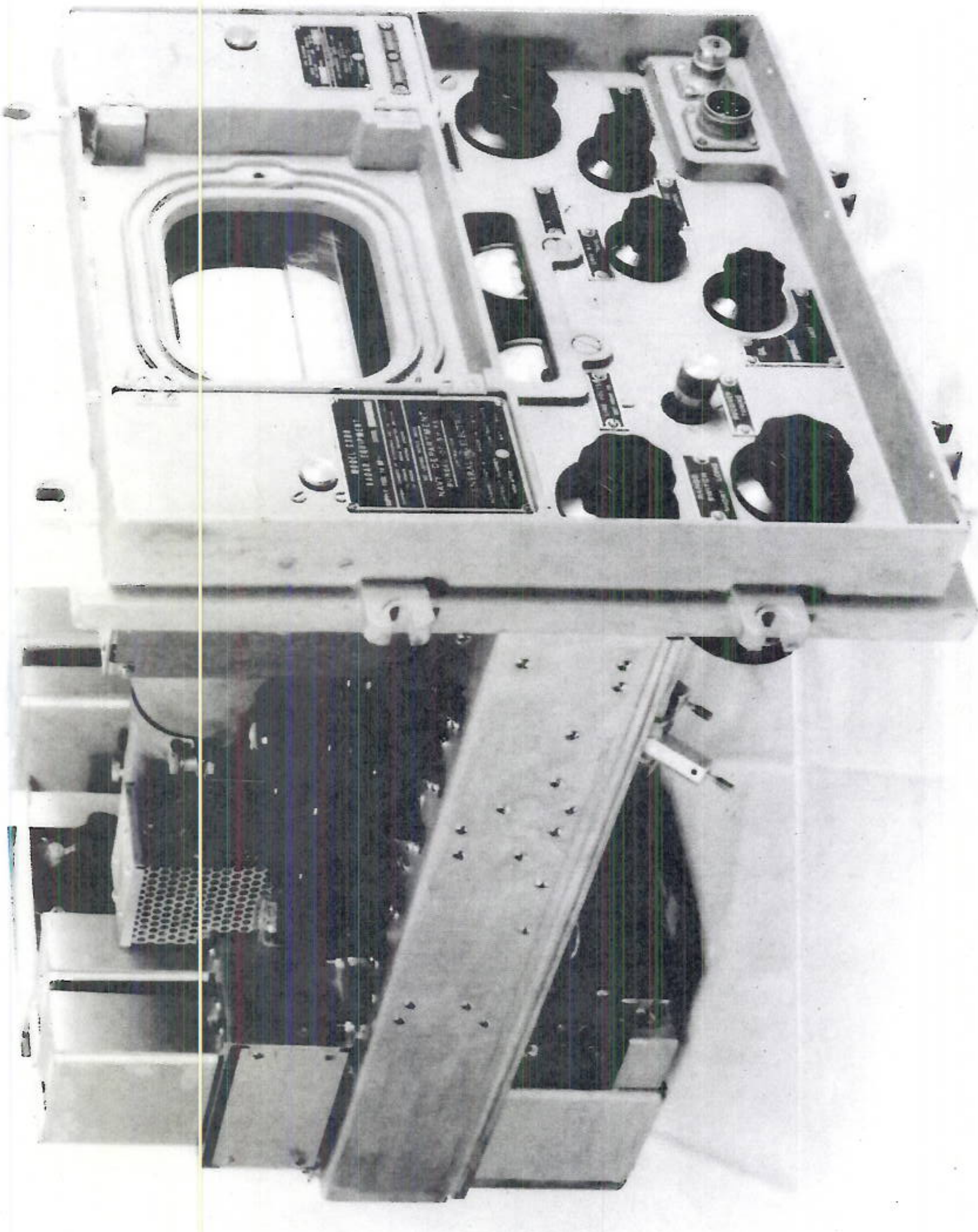

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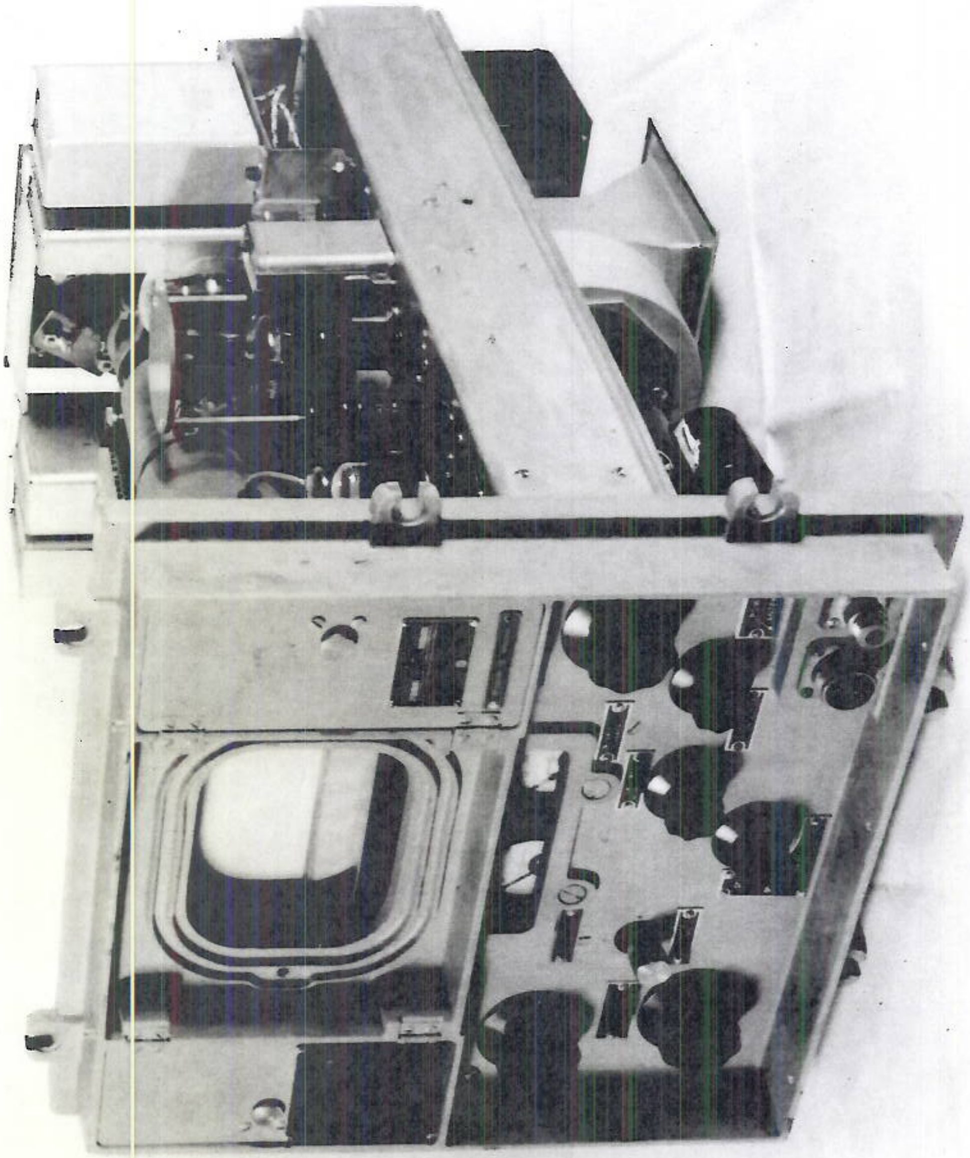
PLATE II SEC.2



[redacted] DECLASSIFIED

PLATE 12 SEC. 2

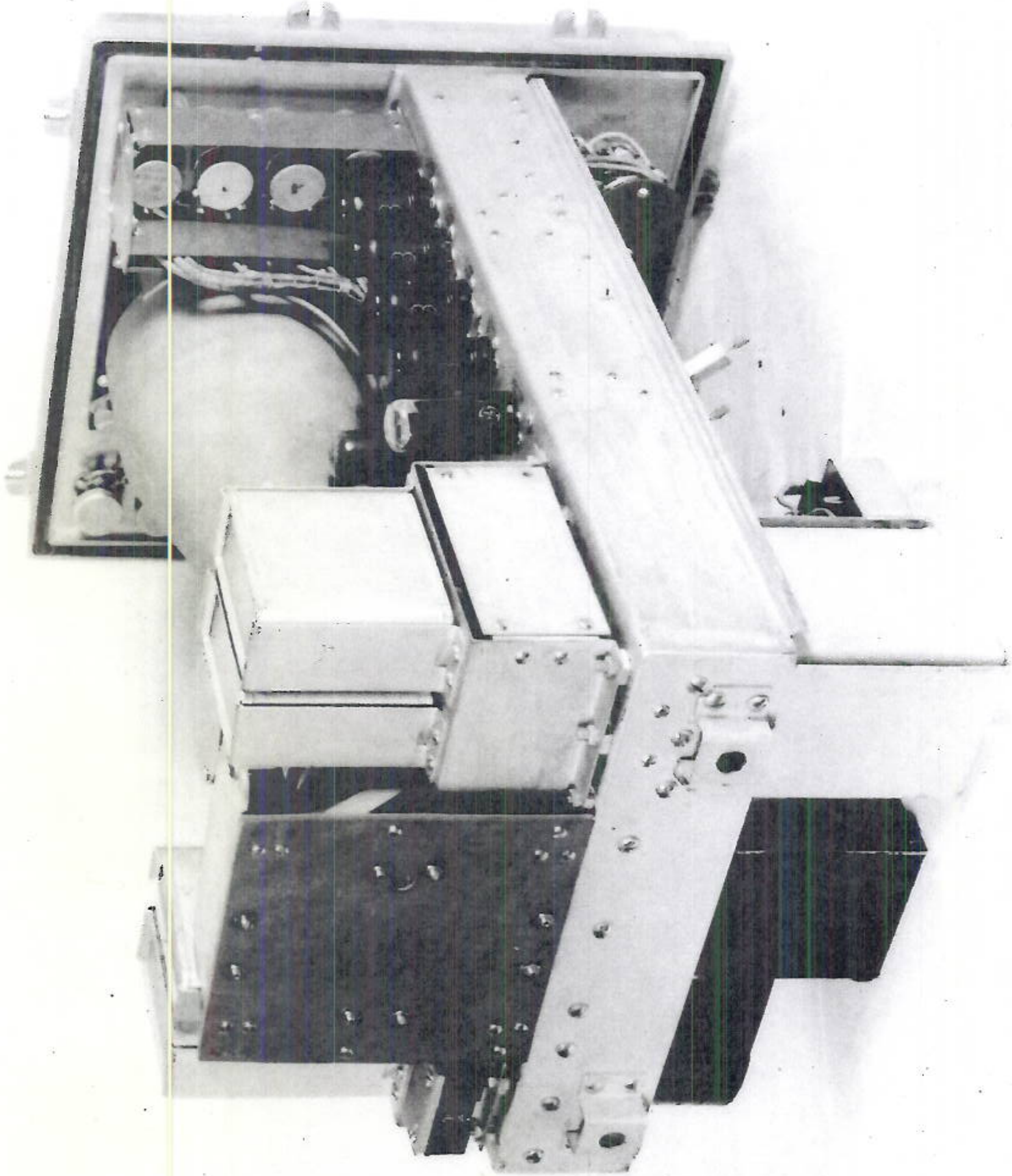


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PLATE 13 SEC. 2

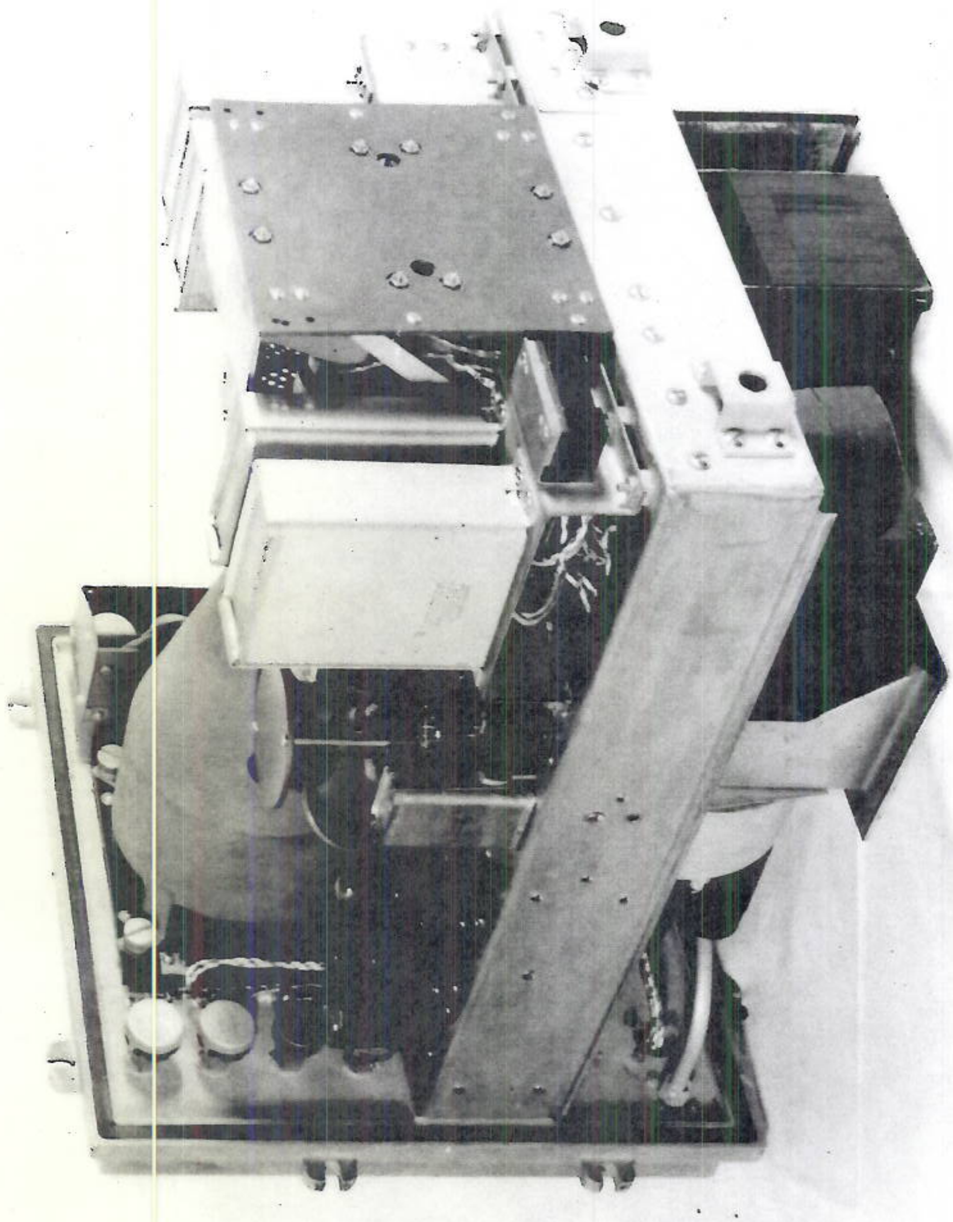

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PLATE 14 SEC. 2

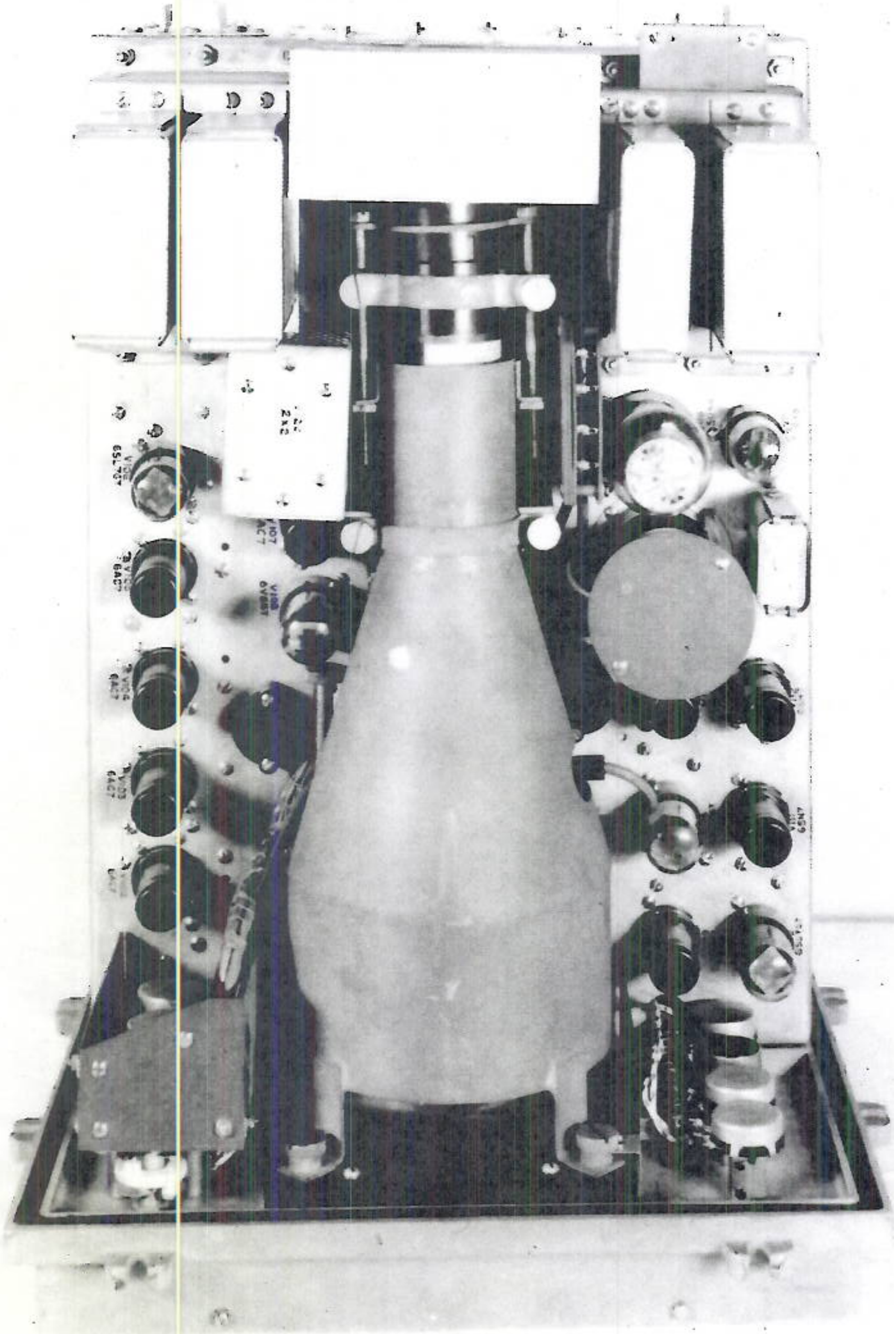
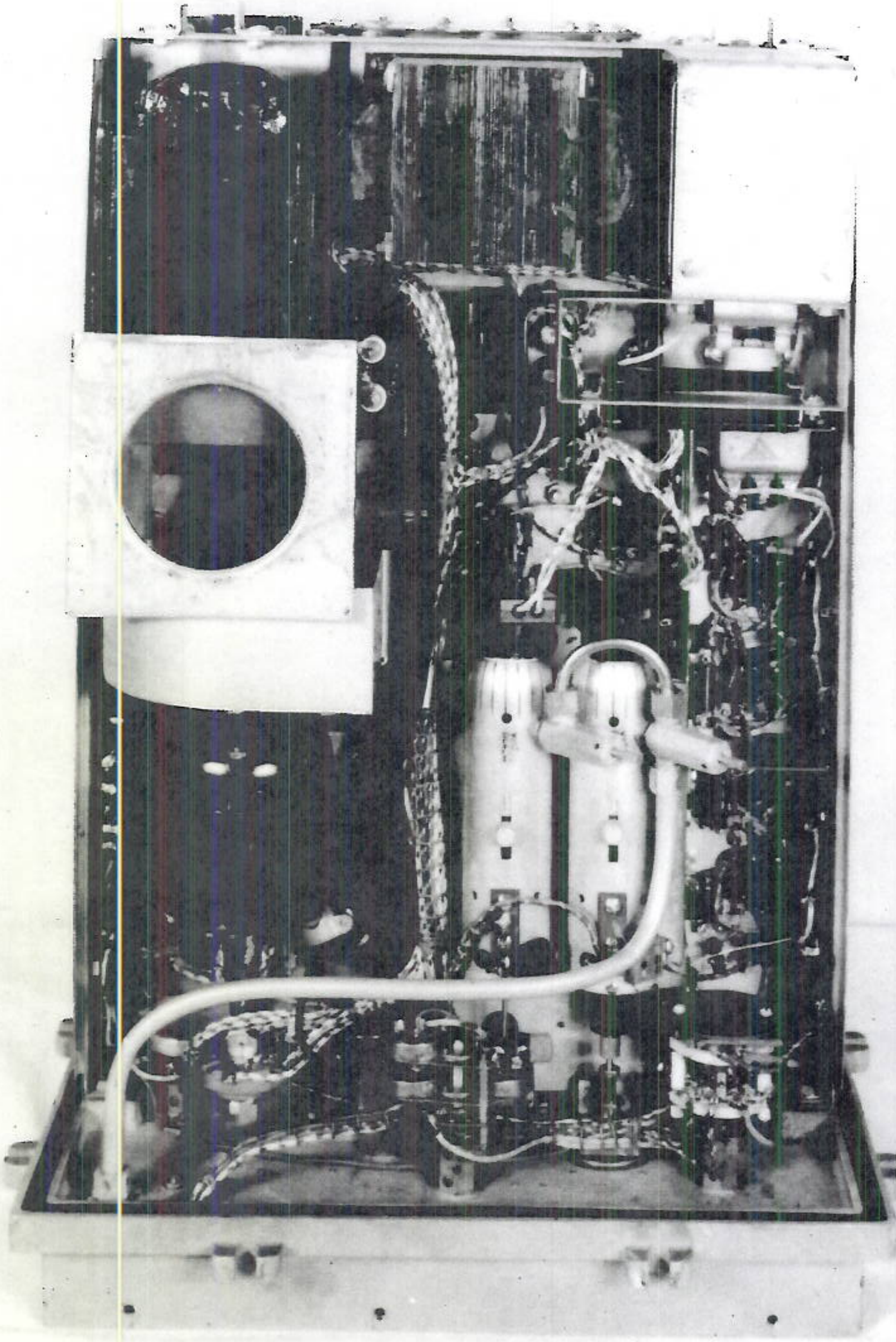




PLATE 15 SEC. 2



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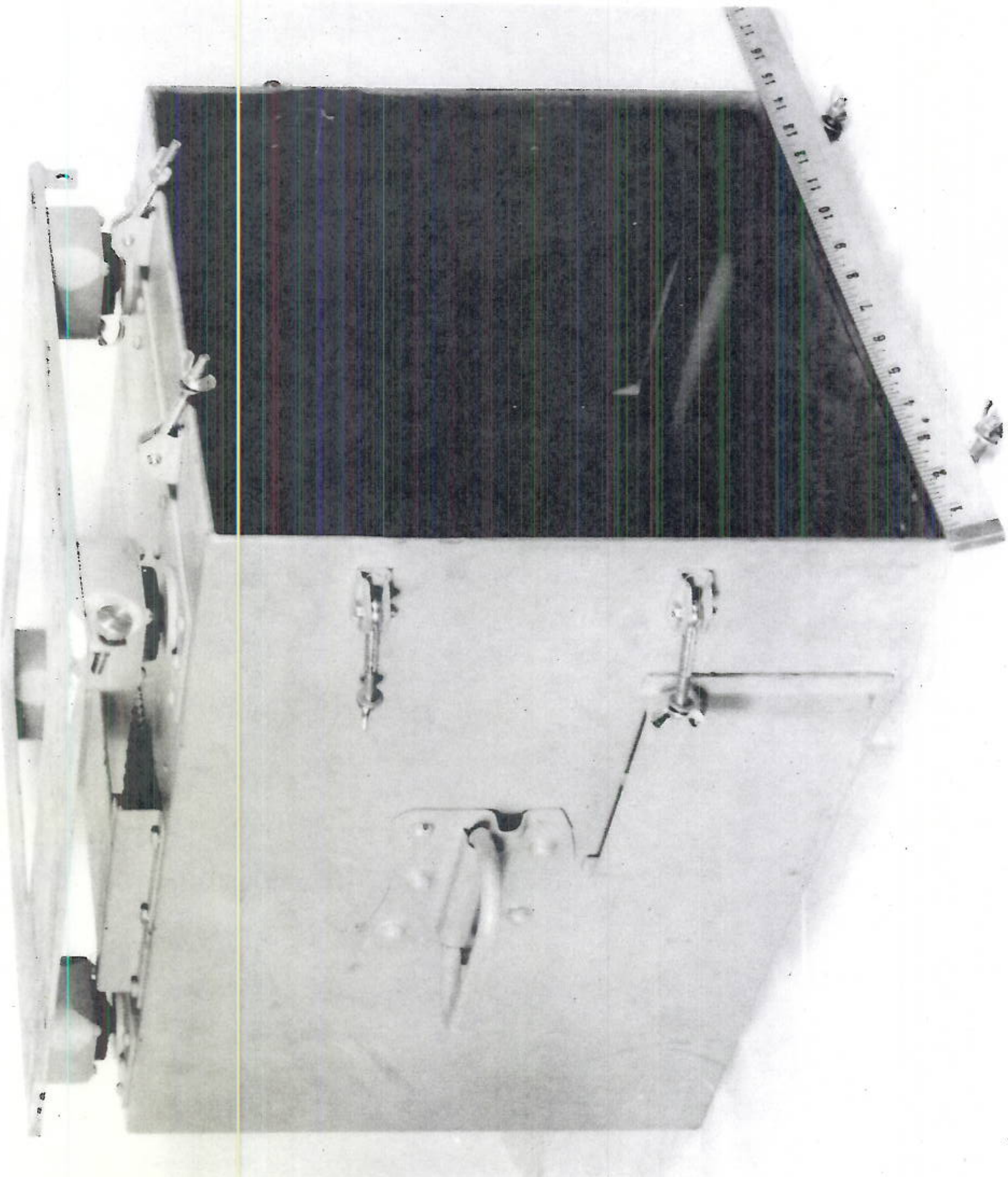

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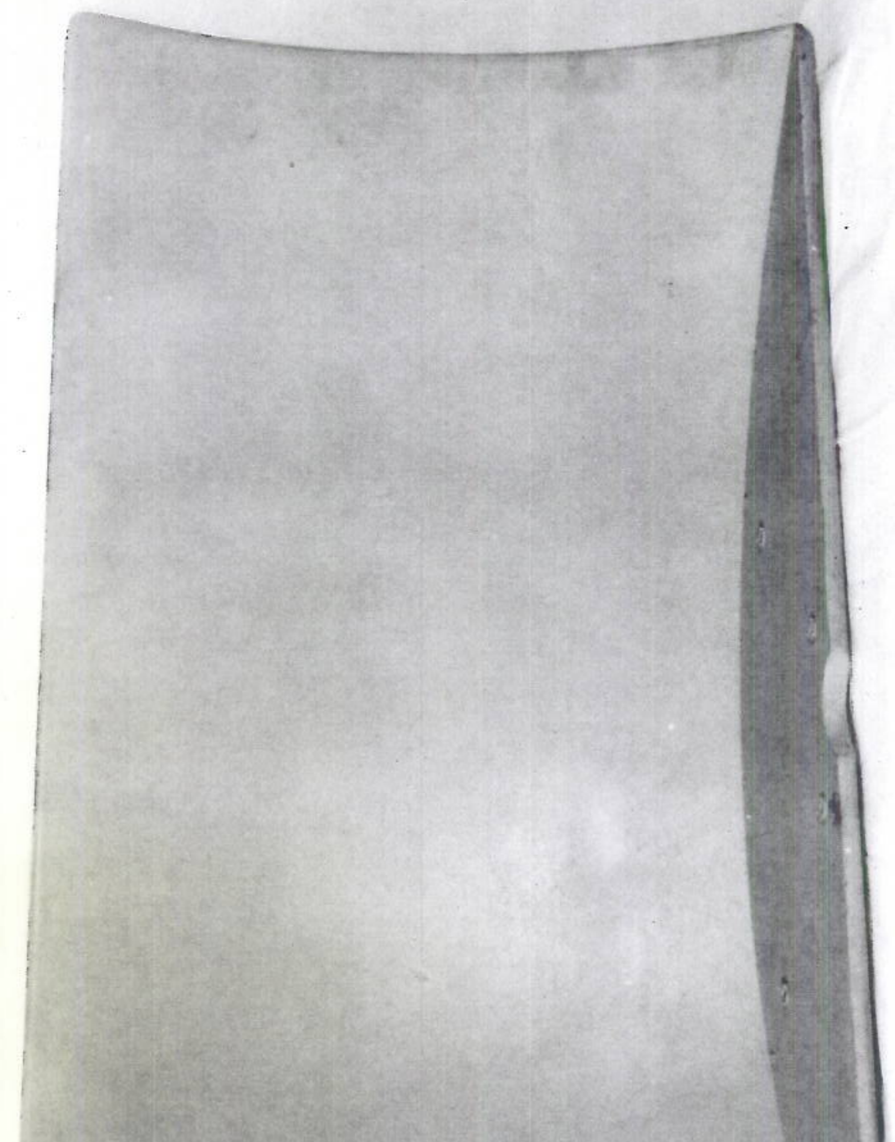
PLATE 17 SEC. 2



[redacted] DECLASSIFIED



PLATE 19 SEC. 2

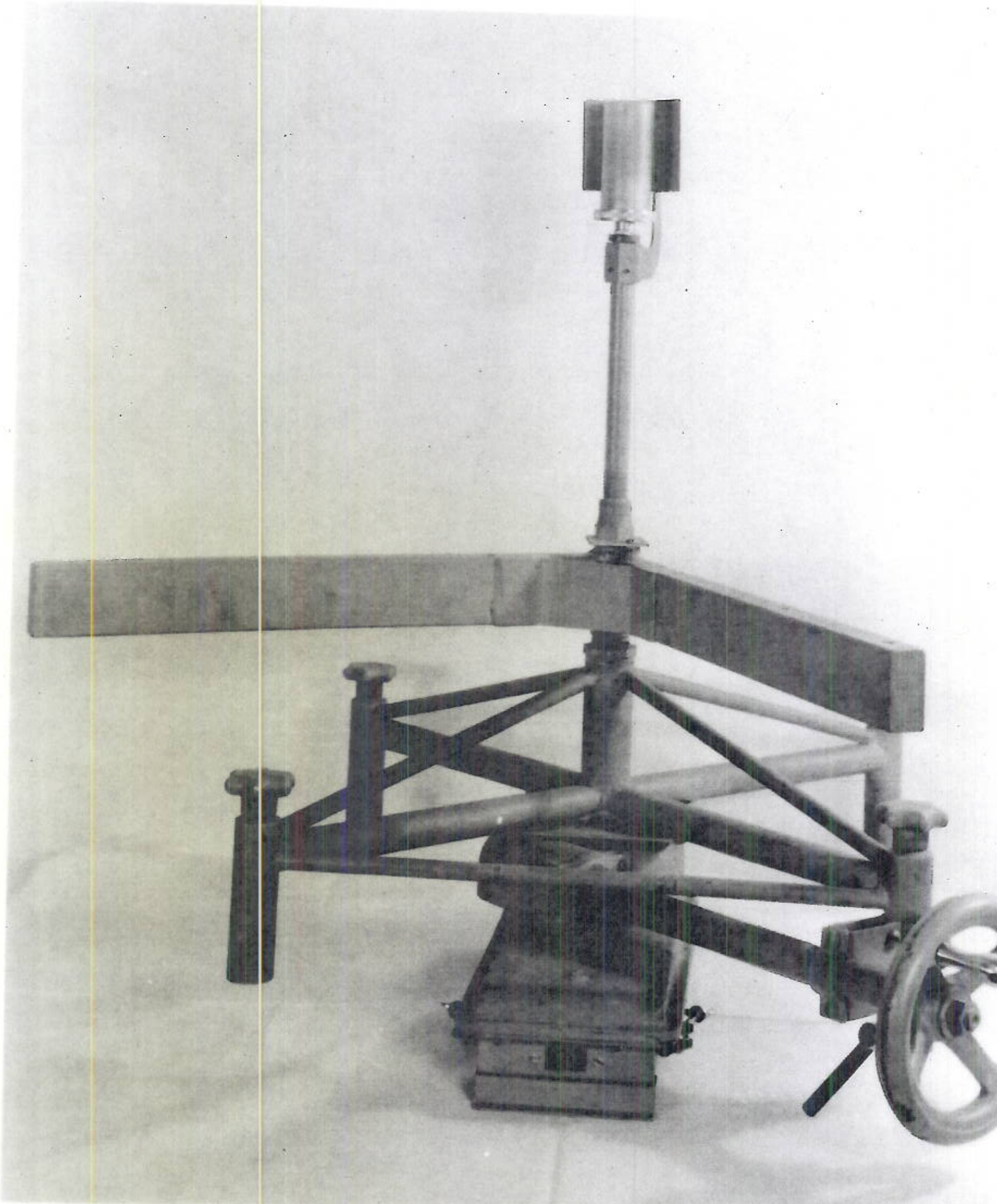


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PLATE 20 SEC. 2

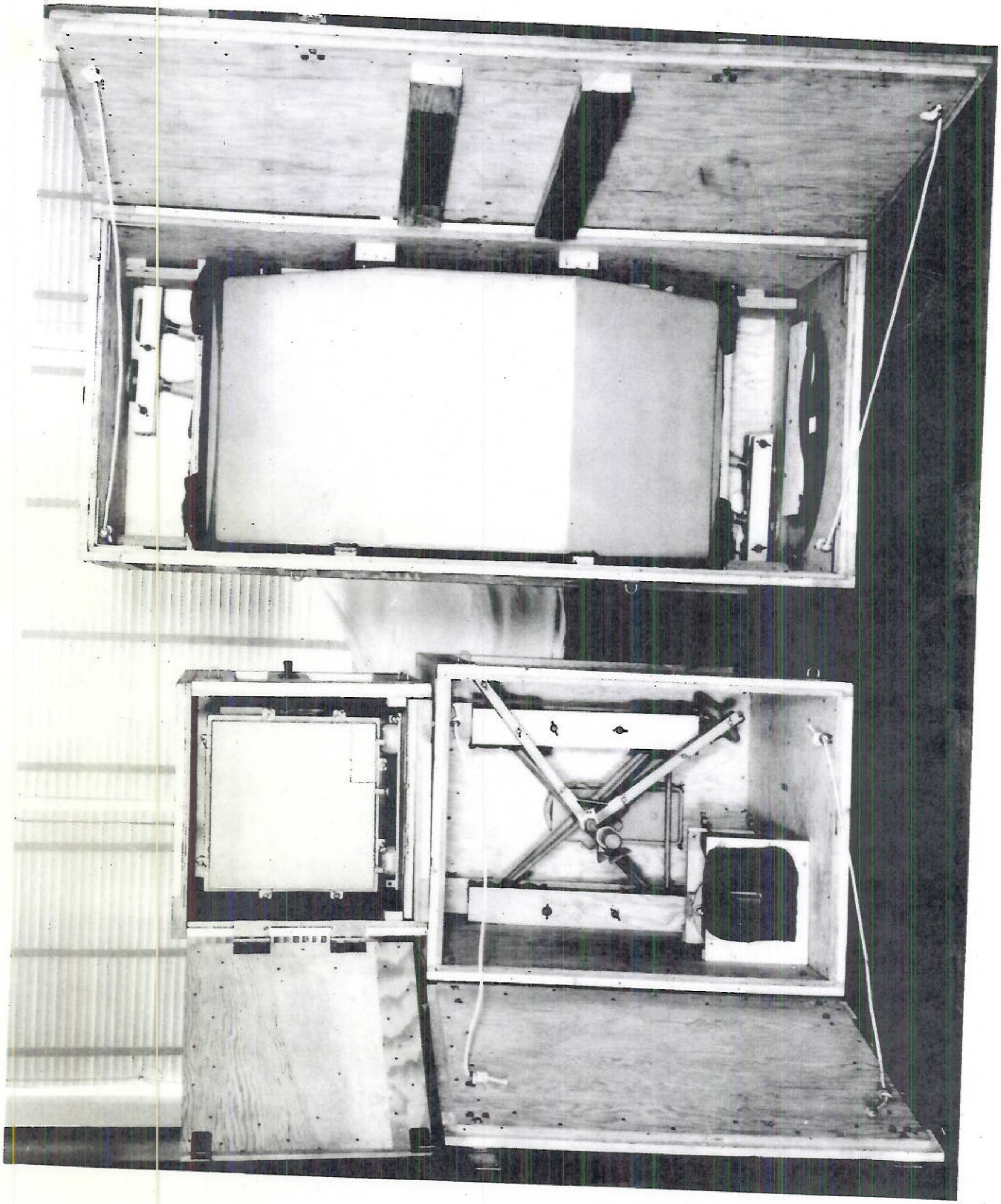



PLATE 21 SEC.2

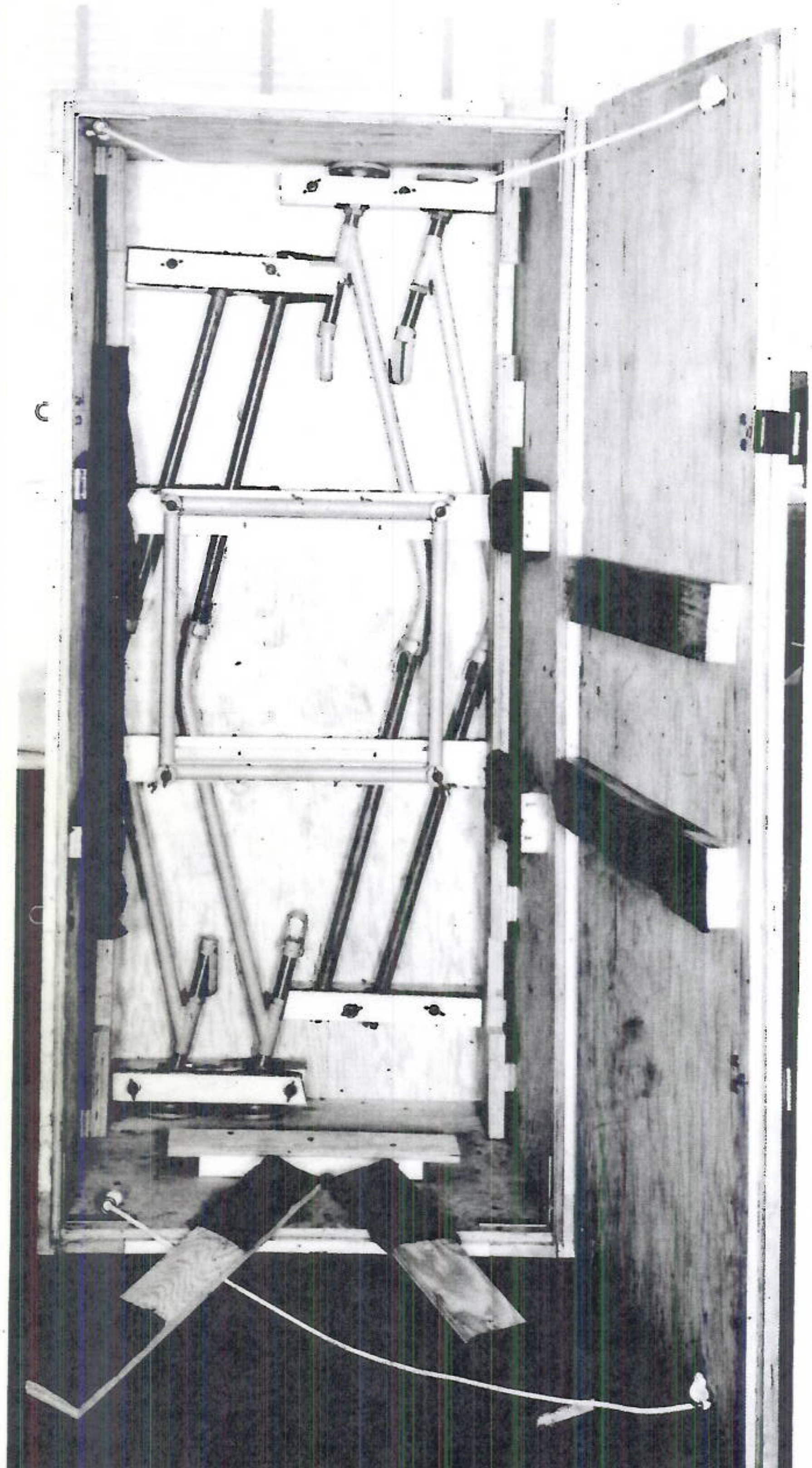

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PLATE 22 SEC.2

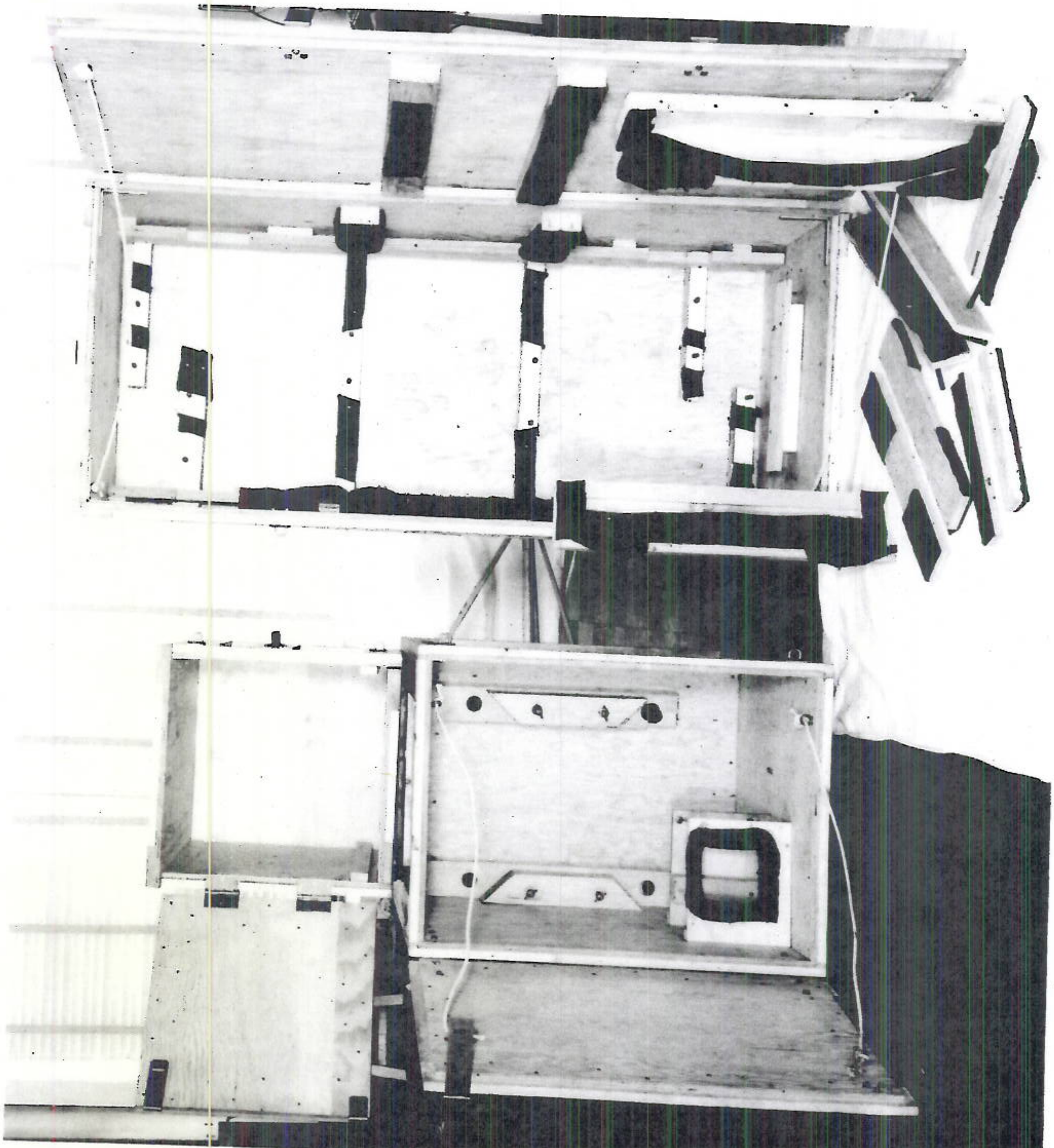

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PLATE 23 SEC.2

## SECTION 3

### REPORT ON ELECTRICAL AND MECHANICAL TEST OF MODEL CXBR (SN) RADAR, RECEIVER-INDICATOR EQUIPMENT.

Enclosure: Table 1, and Figures 101 to 105.

3-1. The Model CXBR Microwave Radar is a low-power, short range S band radio detection equipment. It may be used to locate surface vessles or partially submerged submarines. With certain modifications the equipment could prove invaluable as a navigation aid for small craft, landing boats, etc. Great versatility in application is afforded by the equipments portability and compact physical construction. Satisfactory operation can be obtained wherever 90-130 V a-c is available.

3-1-1. The Model CXBR Radar, Serial No. 1 was manufactured under contract NXs-4753 with the General Electric Co., Schenectady, N.Y. The tests described herein were performed during the period from January 4 to February 16, 1943. The tests conducted include the following:

| | Paragraph No. |
|---|---|
| Sensitivity | 3-2 |
| Selectivity | 3-3 |
| Video Fidelity | 3-4 |
| Resonant Overload | 3-5 |
| Image Rejection Ratio | 3-6 |
| Frequency Coverage of Tuning Control | 3-7 |
| Test of Suitability for use as Navigation Aid | 3-8 |
| Receiver Oscillator Warm-up Drift | 3-9 |
| Vacuum Tubes | 3-10 |
| Effects of Line-voltage Variation | 3-11 |
| Effects of Temperature Variation | 3-12 |
| Effects of Humidity Variation | 3-13 |
| Effects of Vibration | 3-14 |
| Effects of Shock | 3-15 |
| General Physical Construction | 3-16 |
| Weights and Dimensions | 3-17 |
| Power Requirement | 3-18 |

3-2. Sensitivity

The sensitivity of the CXBR (in db below an ideal receiver) was determined. Reference Fig. 101. The Signal + Noise curve was obtained by connecting the output cable of the NRL S-band Generator, No. 1 directly to the antenna input jack of the transmitter-receiver unit and recording the diode (second detector) load voltage for various values of c-w input. The true signal curve was obtained by subtracting (vectorially) the zero-input noise (0.3 v) from the signal + noise output values. The equivalent noise input was determined graphically as shown and its ratio to the



[redacted]

thermal noise, in the input circuit, was computed. The receiver sensitivity obtained as described above was 31 db.

3-3. Selectivity

To determine the receiver's i-f pass-band characteristic the output of the Measurements Corp. Model 65-B, No. 108 signal generator was inserted in series with the grid resistor for the type GL 446 autodyne detector tube. The generator output was adjusted to produce a 2/1 signal/noise ratio of second detector load voltage with the generator tuned to the resonant intermediate frequency (approximately 15 Mc). For increased values of input the generator frequency was varied above and below the resonant frequency to the points where the constant resonant output was obtained. A curve of input ratio vs. frequency in Mc was thus obtained. (Reference Fig. 102).

3-3-1. The i-f channel band width, determined as described above, was found to be 1.8 Mc at the half-power point with the receiver gain in the maximum position. With the receiver gain reduced 3 db below maximum the band width was 1.7 Mc and the band center shifted about -50 kc.

3-4. Video Fidelity

Two signal sources were employed to determine the frequency response of the video amplifier system of the CXBR Radar: the General Radio Company model 713-B beat-frequency oscillator, No. 766 for the 100 c.p.s. - 7 kc range and the General Radio Company model LN signal generator No. 42 for the 10 kc - 8 Mc range. The input was connected to the second detector load resistor (R120) through a 0.1 microfarad paper condenser and was held constant at 0.15 V. The output was taken from the plate of the final video (V108) through a 0.002 microfarad condenser. The input frequency was varied and the output voltage was read on the General Radio Company model 726-A vacuum tube voltmeter, serial No. 149. A curve (Fig. 103) of output referred to the 1-Mc response vs. input frequency was thus obtained.

3-5. Resonant Overload

The output cable of the S-band generator was connected directly to the antenna input jack on the CXBR transmitter-receiver unit. Diode (second detector) load voltages were recorded for increased r-f c-w input values, a plot of second detector output vs. r-f input thus being obtained. During this test the a-c power switch was in the "stand-by" position - i.e., the transmitter and cathode-ray oscilloscope were inoperative. The r-f gain control was in the maximum position, the noise output being 0.3 v for that condition.

3-5-1. As will be noted in Fig. 104, the maximum diode load voltage (6.6 v) is realized at an input of 3 mv and the output falls to 3 db below the maximum at an input of 6.8 mv.



[redacted]

3-6. Image Rejection Ratio

With the output cable of the S-band generator connected directly to the antenna input jack of the CXBR equipment, the generator frequency was adjusted to the image frequency (i.f. - 30 Mc). The r-f c-w input was then adjusted to produce a 2/1 signal/noise ratio of diode load voltage with the gain control in the maximum psotion. The ratio of this input to the input for a 2/1 signal/noise ratio at the nominal signal frequency was determined.

3-6-1. The image-frequency rejection ratio as determined above was 4.6 db. No provision is made for image-frequency rejection.

3-7. Frequency Coverage of Tuning Control.

By use of the wave-meter incorporated in the S-band generator it was determined that the CXBR receiver was capable of operation throughout the range of minus .08 cm. and plus .58 cm referred to the base wave length. The receiver sensitivity varies quite widely within the tuning range.

3-8. Test of Suitability for Use as Navigation Aid.

To investigate the possibilities of using the Model CXBR Radar as an aid to navigation of small craft the equipment was installed temporarily and operated on the bridge of the PYc-7 (Aquamarine) during a round trip from NRL to Quantica, Va. Good operation was obtained. The PYc-7's entire officer personnel (no radio training) quickly learned to operate the unit proficiently, demonstrating the equipment's ease of operation. Saturation echoes from large buildings were received at a maximum 12-mile range. Channel-marker buoys and small boats were distinguishable at 1 mile and produced saturation echoes at 1/2 mile on the Radar.

3-8-1. The test served to prove that a Radar unit similar to the CXBR would be an invaluable aid in the navigation of small craft, landing boats, etc. if the bearing indicator were synchronized with a gyro-compass repeater so as to give all bearings directly as gyro readings. The corrections and calculations necessary to navigate with bearings given relative to a ship's bow render such a method too cumbersome to be practicable.

3-9. Receiver Oscillator Warm-up Drift (Reference Fig. 105).

To determine the time required for the receiver to approximate stable operation, line voltage was applied after having allowed the receiver to stand idle several hours. The wavelength of the receiver oscillator was monitored during the warm-up period by means of the NRL Calibrated Wavemeter, these wave-length values being converted to Mc drift to obtain the plot shown in Fig. 105.



[redacted]

3-9-1. The first reading of local oscillator wave-length was obtained one minute after applying the line voltage. Subsequent readings showed that the oscillator drifted a maximum 3.6 Mc (twice the receiver pass-band width) above the initial frequency, twenty (20) minutes being required to approximate stable operation.

3-10. Vacuum Tubes (Reference, Table 1)

All vacuum tube types employed in the receiver-indicator appear on the Army-Navy Preferred List of Vacuum Tubes as of March 1, 1943. The tube electrode potentials are listed in Table 1. None of the electrode potentials appear to be higher than the manufacturer's recommended maximum values.

3-10-1. The tube accessibility for replacement is considered, in general to be good. However, it is desired that the tube sockets be kept reasonably clear of components to facilitate socket replacement when necessary. Further, sockets with Grade G (or better) ceramic insulation would be preferred in lieu of the fiber-insulation wafer sockets now used in the i-f channel.

3-10-2. Several type GL446 tubes were substituted in the autodyne detector circuit. The cavity tuning was adjusted for maximum echo response with each tube and the sensitivity (2/1 signal/noise ratio) was determined. The maximum variation in sensitivity for the tubes thus tested was approximately 10 db. This variation is apparently not prohibitive; however, it is not definitely known that the tubes used are representative.

3-11. Effects of Line-voltage Variation

The a-c supply voltage was varied from 100 - 130 v and determinations were made of sensitivity, receiver oscillator frequency drift, and change in range calibration.

3-11-1. The receiver was inoperative with input voltages of 100 v and 103 v; however, operation was obtained for inputs of 107 - 130 v. The sensitivity did not vary appreciably for the range of input voltage, 107 - 130 v. The receiver oscillator frequency drifted a maximum of +3.9 Mc at 107 v to -2.0 Mc at 130 v. The range calibration (on the "Long" or 25-mile scale) changed a maximum of -2-1/2 miles at 107 v to +1-1/2 miles at 130 v.

3-12. Effects of Temperature Variation

The subject equipment was operated in the ambient temperatures of +50° C, +35° C, +20° C, and 0° C for a one-hour period at each temperature, total time required for the test being 5 hours and 15 minutes. The ambient relative humidity was maintained below 20% for the entire test.

3-12-1. The range calibration did not appear to change during the temperature cycle, but the receiver oscillator did not function at temperature of +20° C and lower. At these temperatures it was impossible to obtain oscillation at any frequency within the entire range.



[redacted]

3-13. Effects of Humidity Variation

The equipment was subjected to a variation in ambient relative humidity of 20-97-20%, total time for the cycle being 4 hours and 15 minutes. The ambient temperature was maintained at +40° C during the test.

3-13-1. The receiver oscillator frequency did not change appreciably during the humidity cycle, but the range calibration changed +1-1/2 miles on the 25-mile scale at 97% humidity.

3-14. Effects of Vibration

The transmitter-receiver unit was bolted to the vibration table and subjected to vibration at frequencies from 400 - 1800 cpm while the equipment was operating. The unit resonated at 550, 925, and 1050 cpm with amplitudes of vibration from 1/16" to 1/4".

3-14-1. Continued vibration for a period of 1/2 hour to 1 hour at each of the three resonant frequencies did not produce any undesirable effects on the receiver indicator operation.

3-15. Effects of Shock

Six (6) shocks were delivered toward each of the four faces of the transmitter-receiver unit. The approximate equivalent acceleration is 250 g. Several shocks were also given the equipment with the transmitter-receiver unit in place on the four-legged support provided for operation.

3-15-1. The operation of the receiver-indicator did not appear to be affected by the shocks delivered to it. However, on several shocks during the test, one or both of the hinged covers on the calibration and oscilloscope controls on the front panel came open. No other effects were noted.

3-16. General Physical Construction

In general, the construction of the subject unit, due to its portability, is of a compact nature. However, the equipment does not present as neat an appearance as is desirable with regard to wiring and physical construction. Specifically, the following construction practices are considered worthy of consideration for modification:

3-16-1. Wafer-type switches do not have ceramic insulation and the plating on the contacts does not appear to be of sufficient thickness to afford positive contact for long periods of service.

3-16-2. Some terminal strips are mounted flush with the chassis.

3-16-3. Many components are inaccessible for replacement without extensive disassembly.



[redacted]

3-16-4. Fuses are clip-mounted at rear of chassis. To replace a fuse requires withdrawal of chassis from cabinet and placing chassis on its side.

3-16-5. Some of the cabled leads are subjected to chafing by being bent sharply around corners of the transformers.

3-16-6. The mounting holes on some of the solder lugs are provided with internal teeth - no separate washers are provided.

3-16-7. The power transformers and filter chokes are not potted and sealed.

3-16-8. Many soldered joints are not clean and show evidence of excess solder.

3-16-9. The type of hook-up wire employed does not have a homogeneous insulation for protection against the effects of moisture.

3-16-10. The adjustment screw on the antenna-coupling capacitor does not appear to be of sufficient diameter to preclude the possibility of being easily bent when withdrawing or replacing the chassis in the cabinet.

3-16-11. The inductors employed in the i-f amplifiers have bakelite insulating forms which are not waxed or otherwise adequately protected against the effects of moisture.

3-16-12. Not all leads are crimped at their soldered joints.

3-16-13. In some instances, more than three leads (counting component as one) terminate at a single soldered joint.

3-16-14. No provision is made for reducing the dust content of the air intake to the blower-fan.

3-16-15. Not all components (resistors, condensers, etc.) are mounted on terminal boards.

3-16-16. Some components with pig-tail leads do not have between 1/8" and 1/2" clearance between the edge of the component and soldered joints.

3-16-17. The pig-tail leads on some components do not extend axially at least 1/8" before being bent.

3-16-18. The part numbers (as designated on the circuit diagram) are not provided adjacent to components on the chassis.

3-16-19. Many long sections of cabled leads are not securely anchored in place.



[redacted]

3-16-20. The meter ports are not provided with non-glare glass.

3-16-21. The design of the front panel is such as to render the electrical indicating meters invisible from many normal operator positions.

3-16-22. The numerals and markings on the bearing indicator are not suitably illuminated.

3-16-23. The size of the power supply components does not appear to be commensurate with the current-drain requirements of the equipment. It is believed that smaller components could be safely employed.

3-16-24. Replacement of many mica capacitors with approved ceramic capacitors appears to be feasible.

3-16-25. The 1/16" thickness of the circular plate connection to the type GL446 vacuum tube does not appear to afford sufficient surface contact to properly conduct heat from the plate.

3-16-26. The silver plating on the inductance-tuning sleeve on the type GL446 vacuum tube has worn off completely during the course of the tests at this Laboratory.

3-16-27. The soldering lugs employed on the terminal boards are not as sturdy as would be desired.

3-16-28. No Allen-head wrench is provided to fit the control-knob set screws.

3-16-29. Not all of the mounting screws are of sufficient length to extend 1-1/2 threads beyond the retaining device.

3-16-30. Some paper capacitors are employed that are not sealed in metal containers.

3-16-31. Spaghetti tubing has been used for insulation in some instances.

3-16-32. The connector provided on the antenna cable does not appear to afford positive contact for the ground connection.

3-16-33. Several of the bakelite forms for the i-f coils were split by screws securing them to the chassis. These screws were threaded into the forms which were apparently not of adequate thickness and strength to permit of this type of mounting.

3-17. <u>Weights and Dimensions</u>

The gross weight of the Model CXBR transmitter receiver unit is 155 pounds. The overall dimensions of this unit are as follows:



[redacted]

height - 15-3/4"
width - 16-1/2"
depth - 23-1/2"

3-18. Power Requirement

The power requirement for 115 - v, a-c operation is shown below for the three positions of the power switch:

| Power Switch Position | Volts | Amps. | Watts | Power Factor |
|---|---|---|---|---|
| "Stand-by" | 115 | 1.74 | 180 | 0.90 |
| "Operate" | 115 | 2.06 | 205 | .865 |
| "Calibrate" | 115 | 2.06 | 205 | .865 |

3-19. Summary of Defects and Recommendations

It is recommended that consideration be given to the incorporation of the following changes or improvements in subsequent units of the CXBR equipment.

3-19-1. It is believed that the receiver sensitivity could be made considerably better than the present 31-db value without entailing too much difficulty. This improvement in sensitivity would be very desirable. (Ref. Par. 3-2 and Fig. 101).

3-19-2. An improvement in the 4.6-db image-rejection ratio would be desirable. (Ref., Par. 3-6).

3-19-3. The subject equipment could be used to better advantage as a navigation aid for small craft if the PPI type of presentation were employed. (Ref., Par. 3-8).

3-19-4. The receiver oscillator should be operative at temperatures in the 50-0° C range. In its present condition receiver operation is impossible at +20° C and lower. The most apparent means of improvement is the provision of more suitable heaters on the transmitter-receiver chassis. (Ref., Par. 3-12).

3-19-5. A more suitable type of locking catch should be used on the hinged covers on the calibration and oscilloscope controls to prevent the covers swinging open under conditions of shock. (Ref., Par. 3-15).

3-19-6. Preferably, the insulation on the wafer-type switches should have ceramic insulation and Elkonium Type 18 or Oak "Solid Silver" contacts. (Ref., Par. 3-16-1).

3-19-7. It is desirable that all terminal boards be mounted with at least 1/4" clearance from the chassis. (Ref., Par. 3-16-2).



[redacted]

3-19-8. All components should be so mounted as to be easily replaceable without disassembly or disturbance of other circuits. (Ref., Par. 3-16-3).

3-19-9. The cartridge-type fuse, replaceable from the front panel of the equipment, is preferred to the clip-mounted type. (Ref., Par. 3-16-4).

3-19-10. Cabled leads should not be bent around sharp corners of components. (Ref., Par. 3-16-5).

3-19-11. The use of internal teeth on solder-lug mounting holes is not considered satisfactory. Separate lock washers should be provided. (Ref., Par. 3-16-6).

3-19-12. Power transformers and filter reactors should be potted and sealed by approved means. (Ref., Par. 3-16-7).

3-19-13. All soldered joints should be clean and all excess solder removed. (Ref., Par. 3-16-8).

3-19-14. Hook-up wire with homogeneous insulating covering is preferred. (Ref., Par. 3-16-9).

3-19-15. A sturdier screw-adjustment should be provided on the antenna coupling capacitor. (Ref., Par. 3-16-10).

3-19-16. The inductors used in the i-f amplifier channel should have wax-treated ceramic insulating forms. (Ref., Par. 3-16-11).

3-19-17. All leads should be properly crimped at soldered joints so that the mechanical strength of the joint does not depend on the solder. (Ref. Par. 3-16-12).

3-19-18. No more than three leads (counting components) should terminate in a single soldered joint. (Ref., Par. 3-16-13).

3-19-19. A dust filter on the blower fan air intake would be desirable. (Ref., Par. 3-16-14).

3-19-20. Except where electrically impracticable, all small components should be mounted on terminal boards. (Ref., Par. 3-16-5).

3-19-21. At least 1/8" and not greater than 1/2" clearance should be provided between edges of components and soldered joints where pig-tail leads are used. (Ref., Par. 3-16-16).

3-19-22. All pig-tail leads should extend axially at least 1/8" before being bent. (Ref., Par. 3-16-17).

3-19-23. Components should have their part designation numbers clearly and permanently marked adjacent to them on the chassis. (Ref., Par. 3-16-18).



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3-19-24. All lengths of cabled leads should be properly anchored to the chassis. (Ref., Par. 3-16-19).

3-19-25. All meter ports should be provided with non-glare glass. (Ref., Par. 3-16-20).

3-19-26. Consideration should be given to locating the electrical meters so as to make them visible from more varied operator positions. (Ref., Par. 3-16-21).

3-19-27. The numerals and markings on the bearing indicator should be clearly visible from the operating position. (Ref., Par. 3-16-22).

3-19-28. It is believed that smaller power-supply components could be used satisfactorily. (Ref., Par. 3-16-23).

3-19-29. In view of the current shortage of suitable types of mica, consideration should be given the substitution of approved substitute capacitors where practicable. (Ref., Par. 3-16-24).

3-19-30. To more satisfactorily conduct heat from the type GL446 anode, more surface contact should be provided on the plate connection. (Ref., Par. 3-16-25).

3-19-31. Thicker silver-plating of better adherence is desired on the parts of the tuned-cavity assembly. (Ref., Par. 3-16-26).

3-19-32. A sturdier, approved type of soldering lug should be employed on the terminal boards. (Ref., Par. 3-16-27).

3-19-33. An Allen-head wrench to fit the control-knob set-screws should be provided, mounted in an easily accessible position on the chassis. (Ref., Par. 3-16-28).

3-19-34. All mounting screws should be of sufficient length to extend at least 1-1/2 threads beyond the retaining device. (Ref., Par. 3-16-29).

3-19-35. Paper capacitors should be sealed in metal containers in an approved manner. (Ref., Par. 3-16-30).

3-19-36. Spaghetti tubing is not considered a satisfactory means of insulation. (Ref., Par. 3-16-31).

3-19-37. A more suitable, approved concentric-cable connector should be provided on the antenna cable.(Ref., 3-16-32).



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3-20. <u>CONCLUSIONS</u>

The subject equipment does not appear to fulfill the contract requirements that: (1) the design shall be such as to permit easy and rapid replacement of component parts, servicing, and repair, and (2) the equipment shall utilize Navy-approved components and materials. Further, satisfactory operation should be afforded at ambient temperatures of 50-0° C, whereas the receiver is inoperative, in its present condition, at temperatures below 20° C. Greater care should be taken with the electrical and mechanical construction of the units. While Radar equipment of the type tested could undoubtedly prove to be of great value in the Naval service, numerous improvements should be made to insure satisfactory continued operation.

______________________________
Section Head, Receiver Section.



[redacted]

## TABLE 1

## ABOVE-GROUND TUBE ELECTRODE POTENTIALS

Model CXBR

Radar Receiver
Ser. No. 1

G. E. Co., Schnectady, N. Y.

Voltmeter: R.C.A. "Voltohmyst, Jr.", No. 1986.
Gain control: Maximum gain position.

| Circuit Diagram Designation | Tube Type | Function | Heater (V.a-c) | Cathode (V. d-c) | Grid (V.d-c) | Screen (v.d-c) | Suppres-sor (v.d-c) | Plate (V.d-c |
|---|---|---|---|---|---|---|---|---|
| V101 | GL446 | Autodyne Detector | 5.9 | 0.0 | -4.5 | - | - | 171 |
| V102 | 6AC7 | 1st i-f Amplifier | 5.9 | 1.42 | 0.0 | 113 | 0.0 | 236 |
| V103 | 6AC7 | 2nd i-f Amplifier | 5.85 | 1.61 | 0.0 | 140 | 0.0 | 247 |
| V104 | 6AC7 | 3rd i-f Amplifier | 5.85 | 1.7 | 0.0 | 125 | 0.0 | 237 |
| V105 | 6AC7 | 4th i-f Amplifier | 6.0 | 1.75 | 0.0 | 127 | 0.0 | 215 |
| V106 | 6SL7GT | 2nd Detec- | | 1.5 | 0.0 | - | - | 0.0 |
| | | tor 1st Video | 6.0 | 1.5 | 1.5 | - | - | 164 |
| V107 | 6AC7 | 2nd Video | 5.9 | 0.0 | -1.15 | 58 | 0.0 | 252 |
| V108 | 6V6GT | Final Video | 5.9 | 21.2 | 0.0 | 264 | - | 250 |
| V109 | 6SH7 | 1000-cps Oscillator | 5.9 | 0.0 | -25 | 238 | 0.0 | 270 |
| V110 | 6SL7GT | 1st & 2nd | 5.9 | 0.0 | -20 | - | - | 40 |
| | | Clipper-amp. | | 0.0 | -15 | - | - | 160 |
| V111 | 6SH7 | 3rd Clipper amplifier | 5.95 | 0.0 | -65 | 73 | 0.0 | 73 |
| V112 | 6SH7 | 4th clipper amplifier | 5.95 | 0.0 | -3.6 | 85 | 0.0 | 85 |
| V116 | 6SN7GT | Push-pull | 5.9 | 0.0 | -4.2 | - | - | 110 |
| | | Sweep Amp. | | 0.0 | -3.9 | - | - | 110 |
| V118 | 5U4G | Low-voltage Rectifier | 4.85 | 273 | - | - | - | 250v, a-c (each plate) |

NOTE: Shells of all metal tubes at ground potential.

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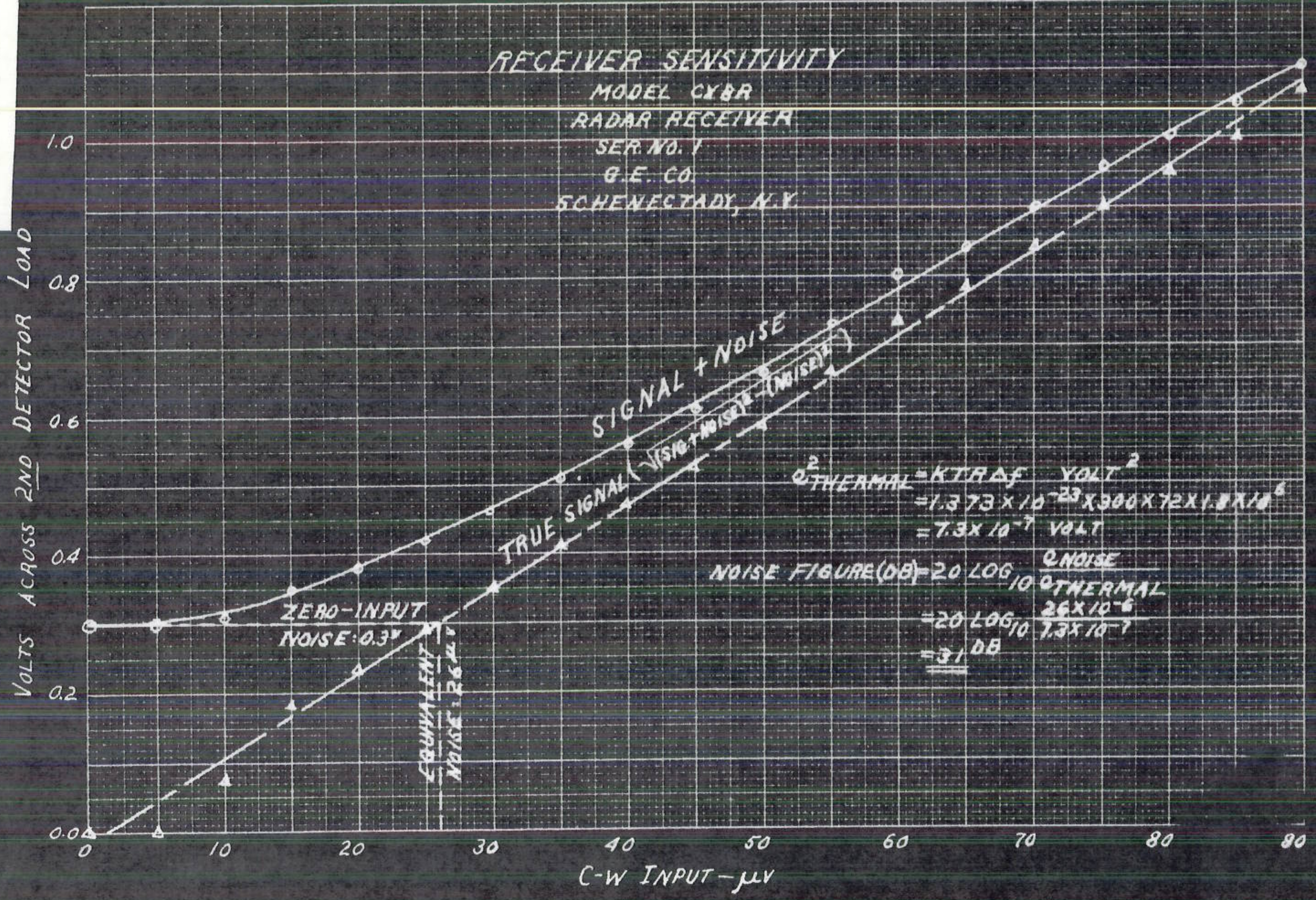
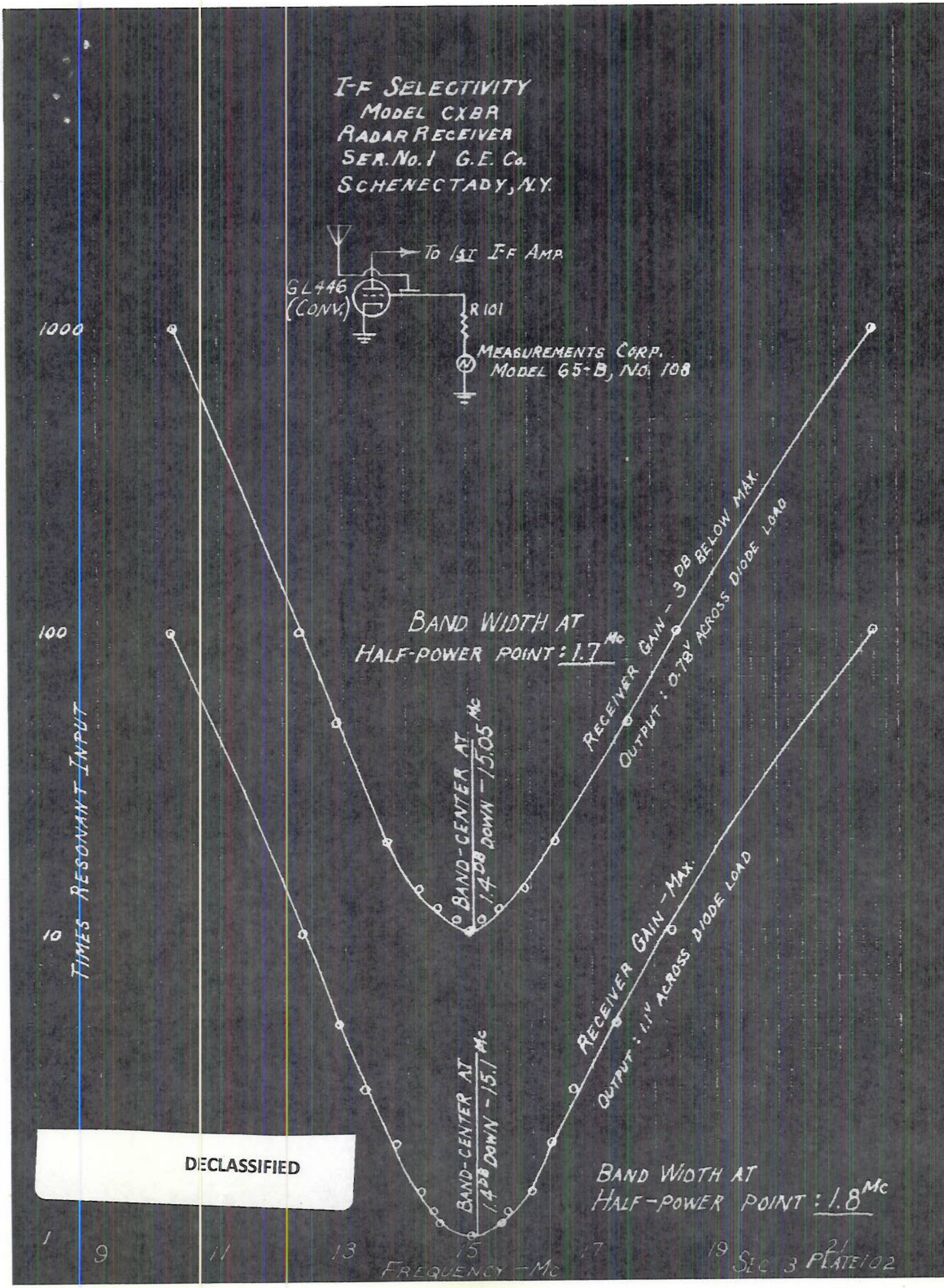





SEC. 3-PLATE 101

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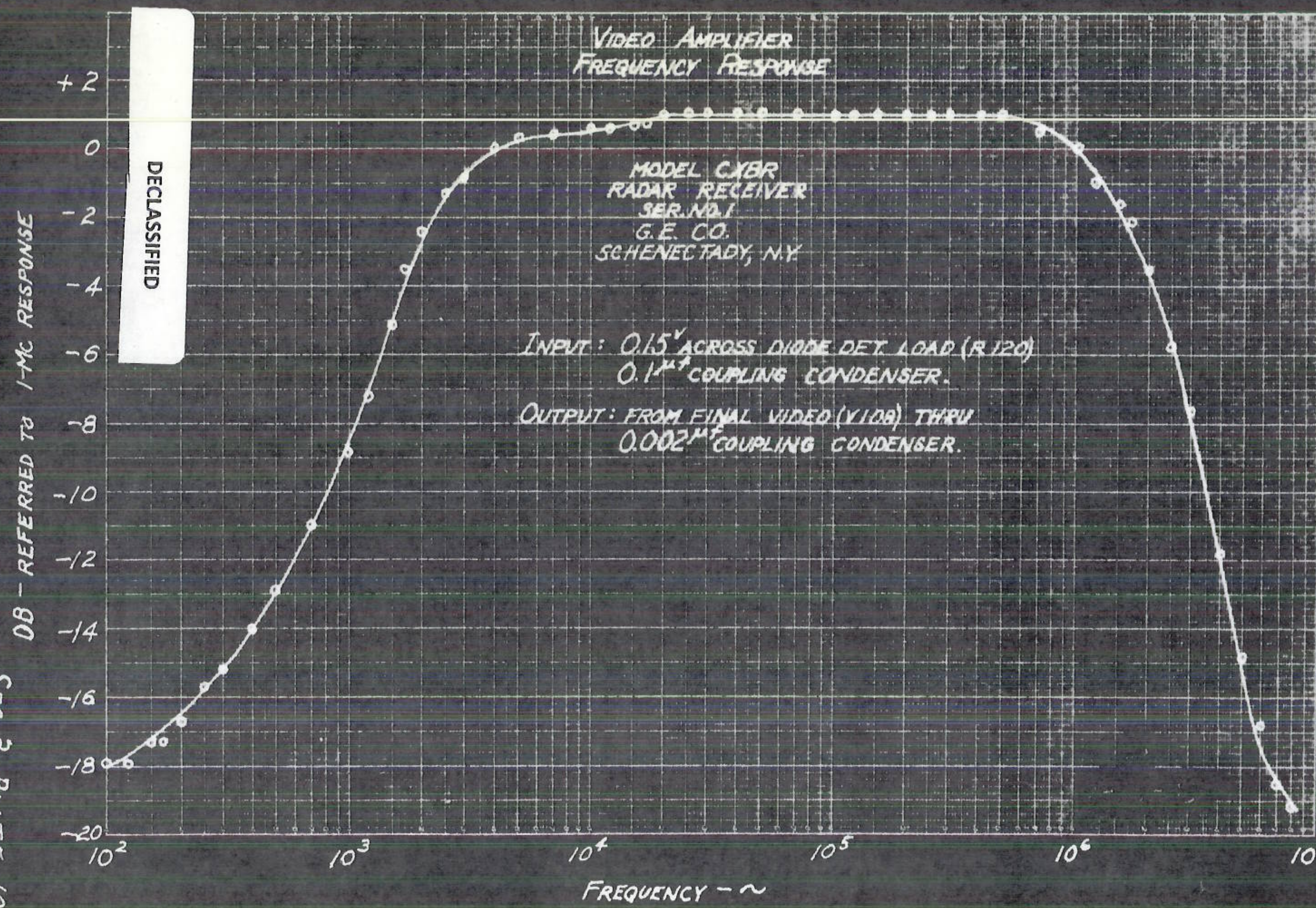
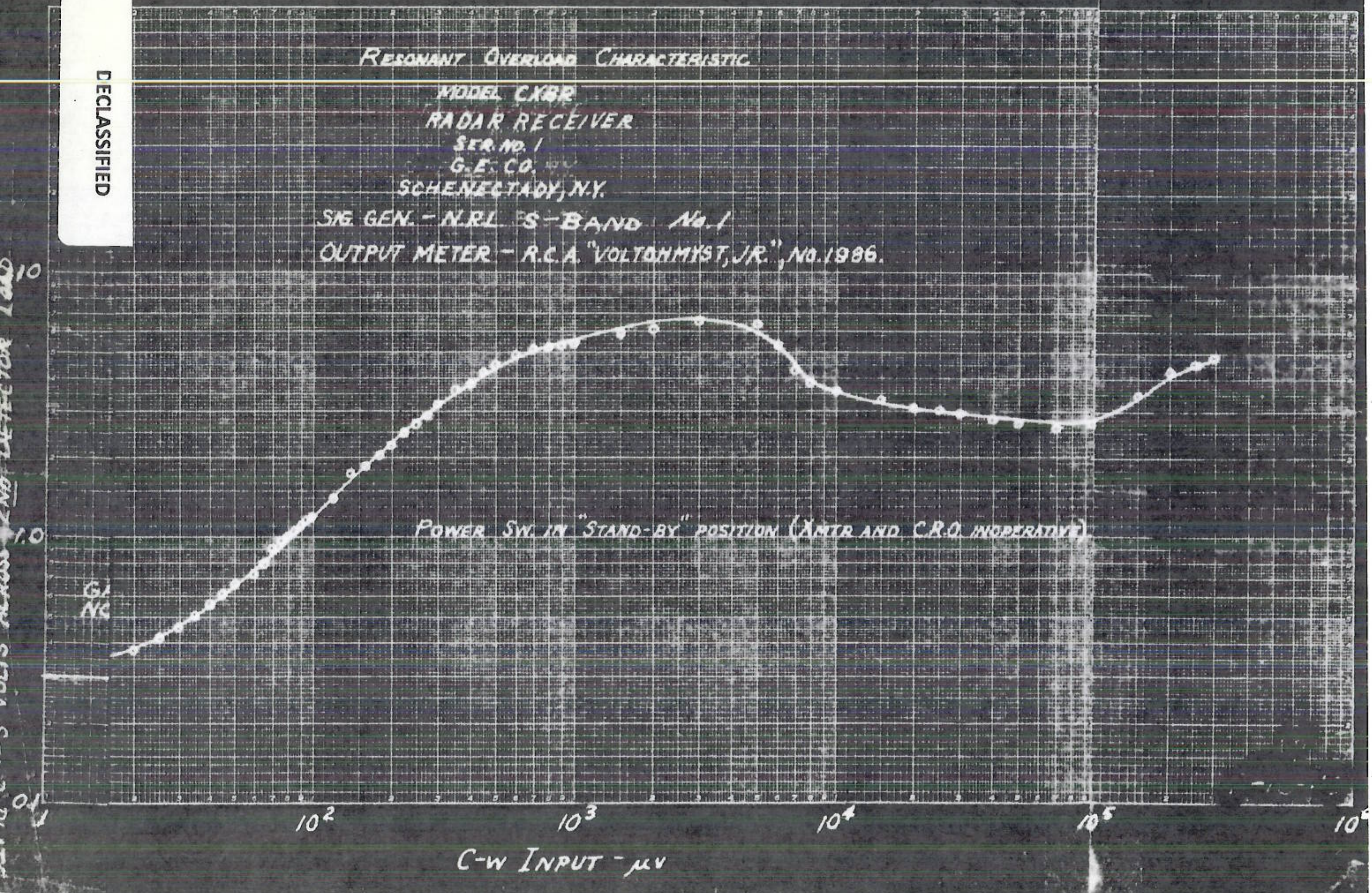
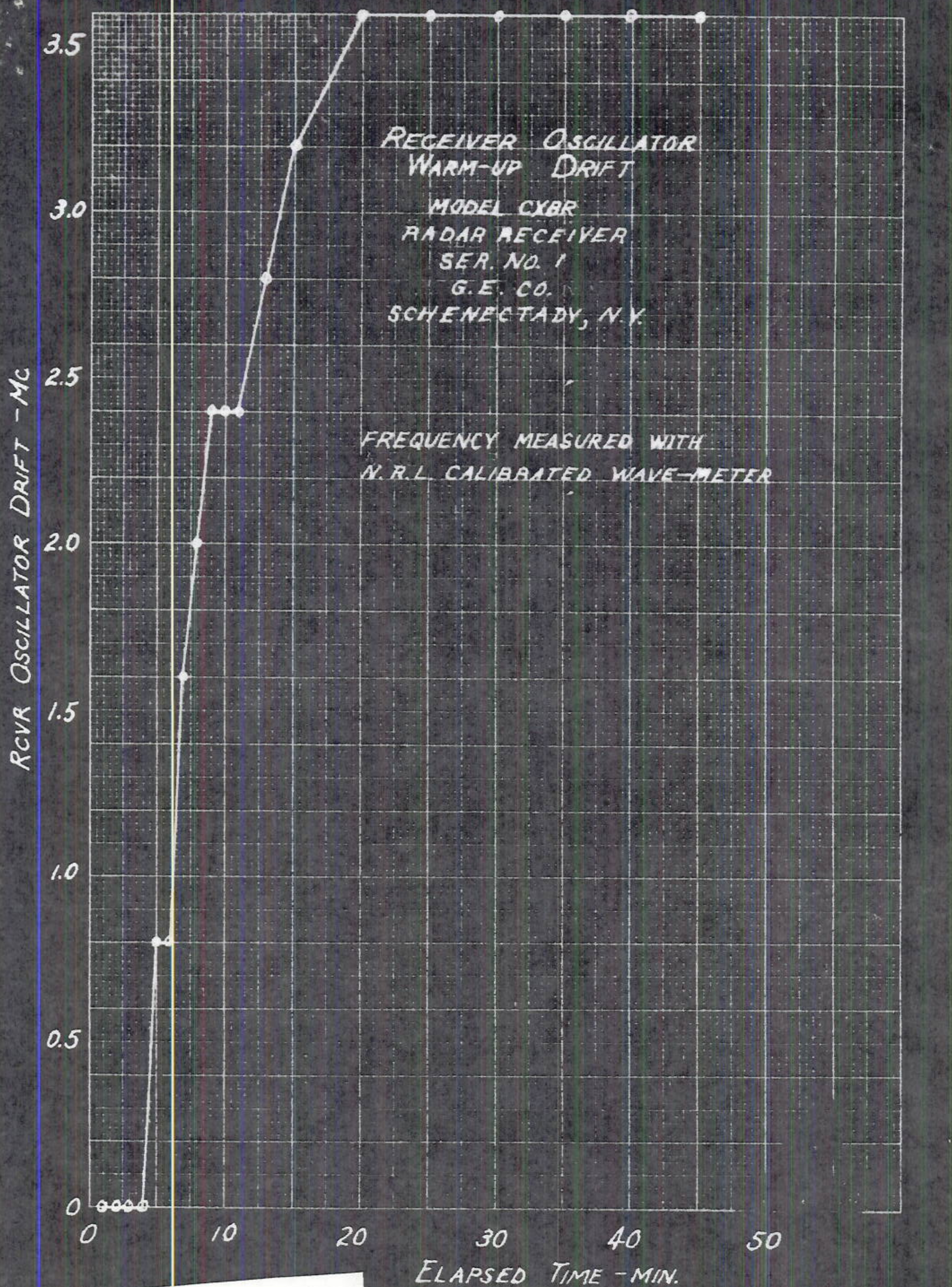

VIDEO AMPLIFIER
FREQUENCY RESPONSE
MODEL CXBR
RADAR RECEIVER
SER. NO. 1
G.E. CO.
SCHENECTADY, N.Y.
INPUT: 0.15V ACROSS DIODE DET. LOAD (R 120)
0.1μf COUPLING CONDENSER.
OUTPUT: FROM FINAL VIDEO (V108) THRU
0.002μf COUPLING CONDENSER.
DB - REFERRED TO 1-MC RESPONSE
+2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
$10^2$
$10^3$
$10^4$
$10^5$
$10^6$
$10^7$
FREQUENCY - ~




SEC. 3-PLATE 104

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