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SUBJECT

Test of Model XTBU Radio Transmitting Equipment

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NRL Report No. R-1599
Test of Model XTBU Radio Transmitting Equipment

B

19 March 1940

NRL Report No. R-1599
BuEng Prob. T4-5C

[redacted]

RESTRICTED
Classification changed from
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NAVY DEPARTMENT

Report on Test

of

Model XTBU Radio Transmitting Equipment

Contractor:
Westinghouse Electric and Manufacturing Company

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

Number of Pages: Text - 64 Tables - 50 Plates - 35

Authorization: BuEng let.C-NOs-66593(12-12-DR6) of 18 Dec.1939

Date of Tests: November 9, 1939, to February 25, 1940

Tests conducted by:

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G. J. Butler, Contract Employee

Prepared by:

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Chief of Section

Reviewed by:

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Superintendent, Radio Division

Approved by:

H. G. Bowen, Rear Admiral, U. S. N.
Director

Distribution: BuEng (10)

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Table of Contents

Appendices

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Appendices (continued)

[redacted]

AUTHORIZATION OF TEST

1. The tests herein reported were authorized by reference (a). Other pertinent data are listed as references (b) to (f).

Reference: (a) BuEng.ltr. C-NOs-66593 (12-12-DR6) of 18 December 1939.
(b) BuEng. Specifications RE 13A 422C.
(c) Contract NOs-66593 of 1 March 1939.
(d) Contractor's Descriptive Specification R-1042 of March 1939.
(e) Contractor's Test Report on XTBU Equipment.
(f) Preliminary Instruction Book covering Model XTBU Equipment.

OBJECT OF TESTS

2. The object of the tests was:

(a) To determine the extent to which the equipment complies with contractual requirements and basic specifications and modifications thereto.

(b) To determine the degree of compliance with reference (d) which governs in regard to points not specifically covered by basic specifications, reference (b).

(c) To obtain data to permit submission of recommendations regarding any changes necessary to make the equipment more suitable for Naval use.

(d) To obtain performance data and prepare recommendations for use in the revision of basic specifications required for purchase of additional equipment.

ABSTRACT OF TESTS

3. The tests herein reported were conducted to determine the degree of compliance of the Model XTBU Transmitting Equipment with the mechanical and electrical requirements set forth in the governing contract and specifications.

4. Specifically, tests were conducted to determine the following:

(a) Ability of the equipment to withstand shipment and movement from one location to another.

(b) Check of mechanical and physical construction and assembly, general workmanship, materials employed, corrosion resisting measures used and the adequacy of electrical circuits to withstand operation under Naval Service conditions.

[redacted]

(c) Power output, power input, overall efficiency and flexibility of antenna coupling circuits.

(d) Quality of emitted signals, lilt, undesirable modulation.

(e) Check of dimensions and weights of the various component units.

(f) Determination of frequency overlap, limiting frequencies of various circuits and cycles per division of the master oscillator controls.

(g) Check of the protective circuits employed in the equipment.

(h) Frequency stability and accuracy under the following conditions:

(1) Accuracy of re-set.
(2) Lost motion and back lash.
(3) Operation of Adjust-Tune-Operate control.
(4) Detuning of circuits.
(5) Operation of power output control.
(6) Change of vacuum tubes.
(7) Variation of supply line voltage.
(8) Variation of ambient temperature.
(9) Variation of humidity.
(10) Locked key operation for two hours.
(11) Locked key to intermittently keyed condition.
(12) Continuously keyed to intermittently keyed condition.
(13) Inclination due to roll and pitch of vessel.
(14) Vibration.
(15) Shock.
(16) Effect of dial locks.

5. The operation of the calibration facilities provided were checked and the R.F. voltages available for calibration purposes were measured.

6. The operation of the 4-wire and 6-wire control circuits was investigated to determine their operation under a variety of conditions.

7. The power equipment supplied was tested to determine voltage regulation, percentage of voltage ripple and general performance under various conditions of operation.

[redacted]

Conclusions

(a) The frequency stability and frequency accuracy requirements of the governing specifications have been complied with in practically all respects and the power output obtained on CW and MCW emission conforms with the specification requirements except in the region of 600 kilocycles.

(b) Further study is indicated in connection with the phenomena which tend to generate spurious and unwanted oscillations in the power amplifier circuits and to provide satisfactory keying characteristics, free from arcing, when operating in the region of 300 kilocycles.

(c) While the general construction, arrangement, operating characteristics and appearance of the equipment is good, it was found necessary to modify certain items of the assembly in order to obtain satisfactory operation when the equipment was subjected to vibration. These modifications, performed by representatives of the contractor, proved to be efficacious and no further difficulties were encountered from this source.

(d) The equipment is designed to operate into antennas of the average characteristics which are encountered in the Naval Service but is not designed for operation into antennas whose length may exceed approximately 150 feet.

(e) A number of changes, modifications and corrections of a minor nature are indicated in order to provide greater safety factors, effect greater ease in handling by operating personnel, and to insure safe and continuous operation.

(f) The removable unit construction affords a high degree of accessibility, is easily manipulated and should prove of real value to personnel afloat.

[redacted]

Recommendations

It is recommended:

(a) That the third terminal on the antenna ammeter, which is not used, be eliminated. (See paragraph 33c.)

(b) That, wherever possible, untapped resistors be substituted for tapped resistors and that the location of the static drain resistor be changed for greater accessibility, and that consideration be given to increasing the size of this resistor. (Paragraphs 34a, 34b and 77a.)

(c) That the design and construction of antenna tap switch "J" be modified in order to provide a suitable and serviceable assembly. (Paragraphs 36a, 34b and 77a.)

(d) That all flexible contacts associated with the removable MO/IPA unit be of three leaf construction equipped with backing strips. (Paragraph 36c.)

(e) That care be exercised in the construction and assembly of the Coarse Antenna Coupling Switch "F" to insure proper positioning of the contact plate. (Paragraph 37.)

(f) That the design of plate rheostat R-108 be modified to provide finer adjustment, particularly at the high voltage range. (Paragraph 38.)

(g) That the necessary steps be taken to insure against failure of blocking capacitor C-147. (Paragraphs 40a and 163.)

(h) That the necessary modifications be accomplished to insure satisfactory keying characteristics at 300 kilocycles and to prevent arc overs from occurring. (Paragraphs 45c and 121.)

(i) That the design and construction of all controls be such that satisfactory operation will be assured. (Paragraphs 45e, 45f, 45g and 45h.)

(j) That the Bureau of Engineering determine whether the use of special fuses in the 440 volt circuits is acceptable, or whether standard fuses of 250 volt rating should be substituted in order that special spares will not be required. (Paragraph 46a.)

(k) That overload relays of the modified design be furnished and that the proper precautions be taken to insure the continued and satisfactory operation of these relays when subjected to vibration. (Paragraph 48.)

(l) That the proper precautions be taken to insure that door interlock switches are so positioned that continuous operation is insured even though clearances vary to some extent. (Paragraph 50.)

[redacted]

(m) That the necessary steps be taken to protect personnel against accidental contact with 440 volt potentials. (Paragraph 51.)

(n) That the necessary assurance be obtained to insure safe and satisfactory operation of vacuum tubes in all circuits. (Paragraph 56.)

(o) That the equipment be properly modified to withstand the effects of vibration. (Paragraph 59.)

(p) That all meter leads be of sufficient length to permit removal of meters from front of panel. (Paragraph 67.)

(q) That voltmeter multipliers in accordance with latest revision of specifications RE 13A 590 be supplied with the Model XTBU equipment. (Paragraph 68.)

(r) That the motor starter be equipped with the necessary nameplates and that consideration be given to improved features of design. (Paragraphs 69 and 204.)

(s) That index pointers on all controls be designed to insure ease and accuracy of reading. (Paragraph 74.)

(t) That Control "A" be provided with a stop to limit motion to the readable portion of the dial. (Paragraph 75.)

(u) That further consideration be given to improving accessibility as outlined in paragraph 77.

(v) That a more suitable start-stop switch be provided and that precautions be taken to insure that the wiring of this switch is satisfactory. (Paragraphs 78 and 171(4).)

(w) That unless assurances can be obtained that the stenciling of symbol markings is the equal of the method formerly employed by the contractor, that the use of metallized tags for this purpose be continued; and that the markings applied to tube sockets be of a more legible character. (Paragraphs 82 and 83.)

(x) That panel screws and indicator lamp bezels be finished in a dull finish as required by specifications. (Paragraphs 89 and 92.)

(y) That the antenna coupling circuit be modified to provide a finer degree of adjustment, particularly at the higher frequencies. (Paragraph 101.)

(z) That the Bureau of Engineering consider the advisability of requiring the transmitter to operate into antennas up to 200 feet in length, as indicated in the governing specifications. (Paragraph 103.)

[redacted]

(aa) That the necessary investigation and corrections be made to insure suitable output in the region of 600 kilocycles. (Paragraph 104b.)

(bb) That the degree of modulation obtained on MCW emission be considered satisfactory. (Paragraph 107.)

(cc) That efforts be made to improve the backlash characteristics of the Master Oscillator control in the region of 1000 kilocycles. (Paragraph 110.)

(dd) That the frequency characteristics of the Model XTBU transmitter with respect to vacuum tube changes be considered as satisfactory. (Paragraph 114.)

(ee) That the performance of the Model XTBU with respect to power output under conditions of varying humidity be considered as satisfactory. (Paragraph 117.)

(ff) That further consideration be given to the design of the neutralizing circuits in order to provide satisfactory operation. (Paragraph 127.)

(gg) That the subject of interlocks be reviewed with a view of obtaining improved performance and accessibility. (Paragraph 129(5).)

(hh) That the monitoring circuit be provided with a jack and shield in accordance with the latest Bureau specifications. (Paragraph 139.)

(ii) That a double pole test key be substituted for the single pole test key now furnished. (Paragraph 143.)

(jj) That a suitable means of marking be applied to or near the filament voltmeter to indicate the proper operating potential. (Paragraph 148.)

(kk) That efforts be made to provide more suitable wire for use as flexible leads. (Paragraph 153.)

(ll) That, since the width of the XTBU equipment conforms with original specification requirements, the Bureau consider the advisability of approving the 34" width. (Paragraph 150.)

(mm) That the terminal boards of all transformers be appropriately marked to indicate potentials available and proper manner of making connections. (Paragraph 155.)

(nn) That consideration be given to an improved design of Antenna Terminal. (Paragraph 158(6).)

(oo) That suitable knobs or handles be attached to each section of shielding to facilitate removal of shields. (Paragraph 159.)

[redacted]

(pp) That the nameplate of the master start relay be marked to indicate the proper operating potential. (Paragraph 168.)

(qq) That a more satisfactory type of "Remote-Local" switch be supplied, which contains no "off" position. (Paragraph 175.)

(rr) That the contractor provide assurance that the bias generator is capable of continuous service operation when delivering the load to which it is now subjected. (Paragraph 186.)

(ss) That the Bureau consider the advisability of improving the safety features of the flexible motor generator couplings. (Paragraph 191.)

(tt) That, if possible, manufacturing tolerances be made such that the use of shims for alignment of motor generator be avoided, and that assurances be obtained that the use of hollow motor generator shafts will provide satisfactory and continued service. (Paragraphs 192 and 198.)

(uu) That the fuse ratings be marked on or adjacent to the fuse holders in the motor generator terminal boxes and that care be exercised to insure that all fuse clips are properly spaced. (Paragraph 199.)

(vv) That the finish applied to the motor generator equipment be in accordance with latest specifications. (Paragraph 207.)

(ww) That the instruction books be modified in accordance with the suggestions contained in paragraphs 208 and 209.

(xx) That the use of bakelite knobs as substitutes for the present metal screws used for securing the removable MO/IPA unit be considered. (Paragraph 212.)

(yy) That final decisions be arrived at with respect to the various items discussed in paragraph 220.

(zz) That formal approval of the Model XTBU equipment be held in abeyance until the various items referred to above have been corrected or complied with in a manner meeting the approval of the Bureau of Engineering.

[redacted]

MATERIAL UNDER TEST

8. The material under test consisted of one preliminary Model XTBU Radio Transmitting Equipment and included the following major parts:

1 - Radio Transmitter Unit
Type CAY-52124
Frequency range - 300 to 2000 kilocycles
440 Volt, 3 phase, 60 cycle supply

1 - 3-unit Motor Generator

1 - Motor Starter

9. The Model XTBU equipment was received at the Naval Research Laboratory on 9 November 1939. Transportation was accomplished by means of commercial motor truck from the Baltimore, Maryland plant of the contractor. The equipment was manufactured under Contract NOs-66593 by the Westinghouse Electric & Manufacturing Co., Baltimore, Maryland. The equipment was not packed in wooden packing cases or crates, as would be required for regular rail transportation.

10. The following vacuum tubes accompanied the equipment:

1 - Type CWL-38151, Serial No. 26177
1 - Type CWL-38151, Serial No. 26196
6 - Type 803 Vacuum tubes, as follows:
Serial No. 29739
29789
29792
29796
29477
29738

11. One cable harness for interconnection between transmitter, motor generator and starter units was supplied.

METHOD OF TEST

12. The equipment, when received, was carefully examined to determine whether any damage had been incurred during the process of shipment.

13. The equipment was then wired up and placed into commission.

14. Power output measurements were made by means of suitable dummy antennas composed of essentially non-inductive resistors and low loss capacitors.

15. Frequency changes and drifts were checked by means of a Model LK frequency indicator, the transmitter operating at full

[redacted]

power output whenever the specifications required this method of operation.

16. Frequency range, overlap and calibration of the master oscillator dial were determined by means of a Model LD-2 equipment.

17. The entire equipment was placed in the Naval Research Laboratory test chamber and subjected to variations in ambient temperature between the limits of 50 degrees Centigrade and zero and variations in relative humidity between the limits of approximately 30 per cent and 95 per cent at 40 degrees Centigrade.

18. Measurement of the ripple voltage present in the outputs of the various generators was made by means of an output voltmeter.

19. Model RAA and RAB receivers were employed for determining the quality of the emitted signal.

20. The ability of the equipment to withstand vibration and roll and pitch of a vessel was determined by mounting the entire equipment on the laboratory test stand which is capable of producing the necessary conditions.

21. Shock tests were conducted by subjecting the equipment to blows from a 20-pound weight suspended in the manner prescribed by the governing specifications.

22. The degree of amplitude modulation present in the CW output was determined by coupling a half wave rectifier to the output of the transmitter. The output of rectifier was adjusted to deliver the desired voltage across a load circuit. The d.c. was blocked off by means of a large capacitor and the audio component was measured by means of a suitable voltmeter.

23. The R.F. voltage output of the frequency meter coupling circuit was measured by means of a Ferris Model OF meter used in the substitution method with a General Radio Standard Signal Generator Type 605-B.

24. The degree of modulation on MCW operation was determined by means of an OB audio analyzer.

DATA RECORDED

25. Complete data were recorded during all tests conducted and this information is included in this report as Tables numbers 1 to 50 inclusive and Plates numbers 1 to 35 inclusive.

PROBABLE ERRORS IN RESULTS

26. Precautions were taken to minimize errors in the results obtained during the tests. Where necessary or desirable, duplicate tests were conducted to insure a greater degree of accuracy.

[redacted]

27. The visual frequency indicating equipment employed is capable of measuring beat note frequencies to within one or two cycles. The accuracy of the LD-2 equipment is approximately 0.001 per cent.

28. Radio frequency power measurements are considered accurate to within plus or minus 5 per cent.

29. All meters employed in the tests were of the precision type and were used under conditions to insure maximum accuracy.

RESULTS OF TESTS

30. Inspection of the equipment when received revealed no breakage during transit.

31. In the following report reference is made to the various sections and paragraphs of the governing specifications, RE 13A 422C, under which the equipment was constructed.

32. Section I. The general construction and design of the Model XTBU equipment conforms with the introductory section of the governing specifications. Such defects in operation or design as require further consideration and correction are discussed in detail below, under appropriate paragraph references. The equipment covers the range of 300 to 2000 kilocycles and is designed for CW and MCW emission.

33. Par. 2-2. The component parts which go to make up the complete assembly were examined to the extent possible without resorting to complete disassembly or destruction of the various parts.

(a) The vacuum tubes used in the equipment have received Navy type approval. Types 38151 and 38803 tubes are employed.

(b) Numerous units of standard design are used in the equipment. Special design of parts is resorted to where necessary to provide satisfactory performance and to meet the requirements of the governing specifications.

(c) All meters provided have received Navy type approval and bore Navy type numbers, as listed in Table 1 appended hereto. The various meters were checked to determine their accuracy and were found to comply with the specification requirements. These tests were conducted previous to power output determinations and other tests in order to insure the accuracy of the results obtained. Attention is invited to the Antenna Ammeter, range 0-25 amperes R.F. This meter is equipped with a third terminal which is connected to an internal shield. No connection is made to this third terminal and, in the interests of simplicity, it is recommended that this terminal be dispensed with.

34. Par. 2-2 (Specifications RE 13A 372J) Wire Wound Resistors. Table No. 2 lists the resistors used in the Model XTBU transmitter,

[redacted]

together with the measured values at which the various units operate. Specifications RE 13A 372J list the power dissipation and the maximum voltages which may be employed in connection with each type of resistor, together with the maximum resistance permitted. The majority of the resistors furnished comply with the specifications, as amended by contract Note. Attention, however, is invited to the following instances.

(a) Resistor R-130 is used as a static drain resistor and is connected across the antenna coupling capacitors. This is a Style E resistor and according to Specifications RE 13A 372J should be limited to 6000 ohms. R-130 is a 10,000 ohm resistor and hence does not comply with the specification requirements. Additionally, this resistor is not readily accessible and difficulty is experienced in removing and replacing this unit. This resistor should be moved to a more accessible location, for instance, to the left-hand side of the power amplifier shelf where access could be had through the side shield. During the course of the tests plate by-pass capacitor C-147 failed, permitting the entire P.A. plate potential to be expressed across R-130. This destroyed the resistor. In order to provide maximum protection it is recommended that besides moving the resistor to a new location that a resistor of larger size be substituted for the Style E now employed.

(b) Page 4 of "Contract Notes" and page 3 of reference (a) approves the use of tapped resistors for certain applications in the Model TBU equipment. Reference to Table 2 attached hereto reveals that eight tapped resistors have been supplied, namely, R-102, R-109, R-112, R-113, R-121, R-122, R-124 and R-135. The circumstances under which a portion of these resistors are used indicates that four of these tapped resistors could be replaced by un-tapped resistors.

Resistor R-102. A short circuiting lead has been connected from tap 2 to tap 6, reducing the resistance of the unit from 1969 to 1178 ohms.

Resistor R-109. A short circuiting lead has been connected from tap 3 to tap 9, reducing the resistance of the unit from 512 to 205 ohms.

Resistor R-124. A short circuiting lead has been connected from tap 5 to tap 7, reducing the resistance of this unit from 1973 to 1574 ohms.

Resistor R-135. None of the taps on this unit are employed, the resistor being used in the same manner as an un-tapped unit.

It is recommended, therefore, that untapped resistors be substituted for R-102, R-109, R-124 and R-135.

35. Par. 2-3. In general, aluminum and aluminum alloys have been used in the construction of the transmitting equipment for the purpose of minimizing weight. In certain specific applications, steel or brass has been used where increased strength or resistance to wear is desired. High grade radio frequency insulation has been used in general while the use of bakelite has been confined to such applications as do not violate the spirit of the specifications. Certain items which require further consideration to conform with the requirements of ruggedness, safety and reliability will be discussed below under appropriate paragraph references.

36. Par. 2-3-1. A number of contacts and associated items used in the construction of the Model XTBU equipment require modification or readjustment to insure safe and continuous operation.

(a) During the course of the tests arcing occurred at the contacts of antenna tap switch "J". This arcing was caused due to the lack of sufficient spacing between contacts when the switch was in position 4. The necessary steps should be taken to overcome this difficulty.

(b) During the tests, the micalex shaft which operates antenna tap switch "J" became fractured causing this control to be non-operative. The shaft was removed and repaired at the factory of the contractor. After the repaired switch was reinstalled, it was noted that when the switch was in position 9, arcing at the switch contacts took place when the handle was released. This apparently is caused by a change in the adjustment of the interlock contacts. When the switch handle is released the interlock contacts fail to open soon enough, causing the power contacts to open under load with consequent arcing. The adjustment of this switch should be corrected to overcome this defect.

(c) In the interests of accessibility for servicing operations the design of the equipment is such that the master oscillator may be removed from the transmitter frame as a unit. Connections to this removable unit are made through the medium of flexible finger contacts. Certain of these contacts contain two beryllium copper leaves, while other contacts which carry heavy filament current are provided with three leaves. Additionally, two of these contacts which are in radio frequency circuits are equipped with brass backing strips. In the opinion of the Resident Inspector of Naval Material, Baltimore, Maryland, as expressed in paragraph 38 of enclosure (J) of reference (a), all contact fingers should be provided with three leaves and backing strips. While no trouble could be attributed to the action of these contacts during the course of the tests at the Naval Research Laboratory, it is believed that the recommendations of the Inspector should be complied with. In view of the fact that every effort is being made to improve accessibility and servicing

[redacted]

features of radio transmitters and since the success of this program will be determined by the early models of such equipment placed in service, no effort should be spared in obtaining equipment of a high order of workmanship and design.

37. Par. 2-3-2. All multi-position switches used in the XTBU equipment are of the positive self-positioning type. During the course of the tests no trouble was experienced in connection with these switches, other than that discussed in paragraph 36 above. It was noted, however, in connection with switch "F" which is the coarse antenna coupling control, that the semi-circular contact plate on this switch is so located that the switch arm does not run true. This item should receive corrective action.

38. Par. 2-3-3. The variable resistors used in the Model XTBU equipment are listed in Table No. 2. These resistors are of the wire wound type and functioned satisfactorily during the course of the various tests conducted wherein temperature and humidity were varied over the limits prescribed by the governing specifications. It is pointed out, however, that it is difficult to adjust the power amplifier plate voltage to the desired value by means of Rheostat R-108 due to the coarse graduations or steps provided on this rheostat. A rheostat provided with finer steps should be provided to overcome this difficulty.

39. Par. 2-4. This paragraph of the specifications states that "All workmanship on this equipment must be of the best." Certain items in the Model XTBU equipment fail to meet this requirement and will be discussed under appropriate paragraph references in this report.

40. Par. 2-5. The equipment was subjected to several full power, key locked tests at ambient temperatures ranging between 50 degrees and zero Centigrade and to relative humidities as high as 95 per cent at 40 degrees Centigrade. No failures occurred during the course of these tests which could be attributed directly to the effects of temperature or humidity. However, certain conditions developed which may in part have been the result of operation at high ambient temperatures.

(a) At the conclusion of the tests it was noted that the power amplifier blocking capacitor C-147 showed signs of leakage. A short time thereafter, while operating at normal room temperature (25 degrees Centigrade) this capacitor failed.

(b) During the course of the temperature and humidity tests the following vacuum tubes became inoperative due to loss of emission:

1 - 38803 tube in the Intermediate Amplifier Circuit.
2 - 38851 tubes in the Power Amplifier Circuit.

These failures will be discussed in detail under paragraphs 45(d) and 56 of this report.

[redacted]

41. Par. 2-6. The corrosion resisting measures employed in the equipment proved to be adequate during the course of the tests conducted. Such portions of the equipment as are constructed from materials which may be subject to corrosion have been painted or plated to resist corrosion.

42. Par. 2-7. The use of iron and steel has been kept to a practical minimum. Where steel is employed, such as the cases of rheostats and filter capacitors and frames of contactors, corrosion resisting paint or plating has been provided.

43. Par. 2-8. In general, Isolantite or Micalex insulation has been employed in connection with radio frequency circuits, phenolic insulation being used in such locations as is permitted by the governing specifications.

44. Par. 2-9. Wood has not been used as an electrical insulator in the construction of this equipment.

45. Par. 2-10 (General). This paragraph of the governing specifications states, in part, that "The design of the electrical circuits and controls must be liberal." During the course of the tests various items failed to comply fully with this stipulation, either from the electrical or mechanical viewpoint.

(a) As pointed out in paragraph 36(a) above, lack of sufficient clearance between contacts on control "J" gave rise to arcing when the switch was in position 4.

(b) The mechanical construction of control "J" proved inadequate due to the failure of the micalex drive shaft and after repairs had been effected, the protective interlock on this control failed to function in time to prevent arcing of the radio frequency contacts, particularly when the switch was in position 9.

(c) At various times during the tests it was found impossible to key the transmitter successfully when operating at 300 kilocycles due to arc overs occurring in the P.A. tank condenser, P.A. neutralizing condenser and from conductors to ground. This condition was not in evidence at all times but appears to be caused by a somewhat transient condition which may be caused by the Power Amplifier tube or circuit.

(d) Plate blocking condenser C-147 failed during the tests, which in turn destroyed static drain resistor R-130. The circumstances surrounding this failure are such that it cannot definitely be attributed to a single phenomenon. Operation at high ambient temperatures appears to have been an influencing factor and in addition the failure of P.A. tubes may have been contributory. There also remains the possibility that the capacitor itself may have been originally deficient.

[redacted]

(e) The following controls are equipped with "T" handles:

"B" - M.O. Range Switch
"F" - Coarse Antenna Coupling Switch
"G" - Fine Antenna Coupling Switch

Controls "B" and "F" exhibit undesirable play and looseness. Control "G" is rigid and tight without undue play. The fit and construction of "B" and "F" should be improved.

(f) The following controls are equipped with rectangular knobs:

"C" - Int. Amp. Range Switch
"H" - P.A. Range Switch
Adjust-Tune-Operate Switch

The knobs on the two latter controls exhibit undue play and have a tendency to become loose, requiring frequent tightening. Control "C" remained tight and rigid throughout the tests. The fit and construction of control "H" and the "Adjust-Tune-Operate" switch should be improved.

(g) When received control "K" was not provided with a stop to limit the motion, which endangered the connections of the antenna tuning circuit. Inspection by a representative of the contractor revealed that the stop, in the form of a brass pin, had been sheared off. This stop was replaced by a stainless steel pin, after which the stop functioned satisfactorily.

(h) Control "L" is a continuously variable inductor used for antenna tuning at the higher end of the frequency range. While this control is provided with stops to limit the motion, the inertia of the inductor is great enough to cause screws in the flexible coupling to become loose and the coil shaft slips in the flexible coupling. Additionally, the weight of this inductor is such that it is difficult to operate the control with ease. Greater security should be afforded to prevent this control from slipping and modifications to provide greater ease of operation should be given consideration.

46. Par. 2-10-1. The following fuses are supplied in the equipment, exclusive of the motor generator circuits:

(a) F-103 and F-104. Rated at 6 amperes, 600 volts. These fuses are located in the a.c. line in the transmitter unit, in series with the primary of distribution transformer T-104, and operate at 440 volts. These fuses are 4-15/16" long and are provided with long fuse links. Consideration should be given to the problem of providing replacement links for these fuses, since spares of this nature are probably not standard equipment on board ship.

[redacted]

The positions of these fuses are indicated by nameplates carrying the fuse designations F-103 and F-104 and the ampere and voltage rating of the fuses.

(b) F-101 and F-102. Rated at 6 amperes, 250 volts. These fuses are located in the a.c. control circuit of the transmitter and operate at 115 volts. The positions of these fuses are indicated by nameplates carrying the fuse designations F-101 and F-102 and the ampere and voltage ratings of the fuses.

(c) F-301 and F-302. Rated at 45 amperes, 250 volts. These fuses are located in automatic starter and are in series with two phases of the main line. These fuses operate in the 440 volt circuit. The use of 250 volt fuses in 440 volt shipboard installations is sanctioned by paragraph H-2 of Specifications 17-F-2g. In fact, the requirements of paragraph H-2 appear to be obligatory, and hence it appears that fuses F-103 and F-104, discussed above, should be of the 250 volt rating. The positions of these fuses are indicated by a nameplate bearing the legend:

F.L. - 8 Amps.
Fuse - 45 Amps.

All of the above fuses are of the renewable cartridge type.

47. Par. 2-10-2. A complete discussion of the fuses provided in the generator circuits will be found under paragraph 199 of this report.

48. Par. 2-10-3. Three overload relays are contained in the transmitter unit, as follows:

K-104 - Master Oscillator - Audio Oscillator Overload
K-105 - Power Amplifier Overload
K-106 - Intermediate Amplifier Overload

(a) As originally submitted, these relays were of Westinghouse manufacture, Type SC-1. Difficulty was encountered with these relays, particularly K-105 in the P.A. circuit. If an overload occurred the working parts of the relay became deranged and the contacts would fail to reclose when the relay was re-set, or the contacts would fail to open when the overload mechanism operated. A representative of the contractor readjusted the relays and made some temporary repairs.

(b) When the equipment was subjected to vibration it was found impossible to keep the transmitter in operation due to the frequent and indiscriminate opening of one or more of the overload relays. The relays were set up to the extreme limit of operation but continued to open under the influence of vibration. In order to continue operation it was found necessary to short circuit the contacts of the overload relays.

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(c) This condition was brought to the attention of the contractor and it was decided that replacement relays of a modified design would be furnished. These relays were installed on 5 February 1940. The relays were adjusted to 125 per cent of the normal maximum current which flowed in the relay coil circuit. The following currents were found to exist in the various circuits:

K-104 - 195 M.A. on CW; 230 M.A. on MCW. The relay therefore was adjusted to 125 per cent of 230 M.A. or 288 M.A.

K-105 - 1.11 ampere on CW. The relay was adjusted to 125 per cent value, or 1.39 ampere.

K-106 - 211 M.A. on CW. The relay was adjusted to 125 per cent value, or 264 M.A.

(d) After these adjustments had been made the equipment was operated at full power output and subjected to vibration of varying amplitudes and frequency. The relays functioned satisfactorily, with only a slight tendency on the part of K-105 to open at infrequent intervals. The relay panel, which extends across the bottom of the transmitter is supported only at the extreme ends. It is believed that if an additional support were placed at the top center of the panel, the effect of vibration on this panel and the consequent effect upon the relays themselves, will be reduced to a point where no further difficulty will be experienced. The contractor indicated his intention of providing such a support. If this is done the modified relays should prove acceptable for Naval service use.

(e) The replacement relays are also designated Type SC-1. Markings on the calibration scale are provided as follows:

K-104 - 0.25, 0.30 and 0.50 amp.
K-105 - 1.25, 2.5 and 3.5 amps.
K-106 - 0.25, 0.30 and 0.50 amp.

Adjustment of the relays can readily be made by placing pressure on a small locking lever and rotating the solenoid plunger. The relays use no oil and the calibration was not affected by vibration.

49. Par. 2-11. The subject of plate current overload relays is discussed in paragraph 48 above. In accordance with contractor's descriptive Specification R-1063, and as approved by paragraph 4 of reference (a), the five second protective relay and associated parts have been eliminated from the Model XTBU transmitter. The master oscillator, intermediate amplifier and power amplifier circuits are equipped with individual plate overload relays, as discussed in detail in the previous paragraph of this report.

50. Par. 2-12. The design of the equipment is such that all outside cases and frame members are at ground potential. The access doors in the transmitter are equipped with protective interlock switches which operate at 110-115 volts, a.c. These interlocks operated

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satisfactorily when subjected to vibration, shock and the simulated roll and pitch of a vessel. The interlocks operate in such a manner that the field excitation of the motor generators is removed and the motor generator equipment is shut down. The construction of the interlocks is similar to that furnished on previous equipment provided by the Westinghouse Electric & Mfg. Co. During the course of the tests it was discovered that the clearance of Interlock Switch S-106, used in conjunction with the access door to the main terminal and relay panel at the bottom of the transmitter unit, was inadequate. This switch is mounted too close to the top edge of the door. When the transmitter unit was bolted securely to the vibration test stand, the strain resulting was sufficient to prevent the door from closing due to interference from the interlock. This switch should be moved to provide adequate clearance.

51. Par. 2-12 (continued). This paragraph of the specifications states, in part: "These access doors shall be interlocked with the control system of the power equipment in such a manner that upon opening any access door all potentials in excess of the above specified values (250 v) will be removed." In the Model XTBU equipment 440 volts a.c. is present in the transmitter when the access doors are opened. This 440 volt circuit connects through fuses F-103 and F-104 to the primary of transformer T-104. Two alternatives suggest themselves for protection against accidental contact with this potential:

(a) If transformer T-104 were mounted external to the transmitter unit it would be unnecessary to introduce the 440 volt circuit into the transmitter. For instance, if proper provisions were made, this transformer could be housed in the automatic starter.

(b) If transformer T-104 remains in its present location, it is recommended that insulating cover plates be secured over the 440 volt terminals on the main terminal strip and also over the fuses in the 440 volt circuit. These plates should bear legends indicating the presence of the terminals and fuses so protected.

After the starting and field circuits of the motor generator equipment have been opened, the motor generator coasts to a full stop in approximately 59 to 60 seconds. During this period gradually diminishing residual voltages are present. This condition compares favorably with equipment of similar type.

52. Par. 2-13. Forced ventilation is not used in the Model XTBU equipment. Natural ventilation of the transmitter unit is provided by means of perforated side, rear and top shields and by means of perforated access doors in the various tube compartments. In addition, the horizontal shelf beneath the power amplifier circuits is provided with large sized perforations to assist ventilation. Heat producing resistor elements are mounted against the rear wall of the bottom compartment and the design of the equipment is such that the heat rising from these units has a practically unimpeded path upwards to the top of the transmitter. During the course of the tests no failures

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were noted which could definitely be ascribed to lack of ventilation. In this connection, attention is invited to paragraph 45(d) of this report, which discusses the failure of plate blocking condenser C-147. In the opinion of the Laboratory this failure cannot be ascribed to lack of proper ventilation.

53. Par. 2-14. Aside from the leakage noted from capacitor C-147, as described in paragraph 40(a) above, no leakage of compound from any component part was noted during the course of the various tests, which covered temperature ranges from zero to 50 degrees Centigrade.

54. Par. 2-15. The equipment was subjected to three 2-hour full power key locked tests and in addition to several 8-hour locked key tests without signs of undue heating. However, as discussed under paragraph 56 below, three tube failures occurred which may have been due, in part, to key locked operation. The equipment was keyed at various speeds up to 100 words per minute at various frequencies of operation. In all instances satisfactory performance was obtained, except when keying at 300 kilocycles. At this frequency intermittent arcing was present, as discussed under paragraph 45(c) above.

55. Par. 2-16. The transmitter was tuned to 300, 500, 1000 and 2000 kilocycles, full power output. Then, with the key closed, the antenna circuit was short circuited and open circuited. The results of this test are illustrated in Table No. 3. No damage occurred during the tests; if an overload resulted the plate overload relay operated to protect the equipment, while in other instances, the detuning of the antenna circuit caused the power amplifier plate current to reduce to safe values.

56. Par. 2-17. The design of the equipment is such that the vacuum tubes operate within the current and voltage limitations of Navy tube specifications. This is illustrated in the various tables attached to and forming a part of this report, particularly Tables numbers 6 to 9 inclusive and Tables 21 to 29 inclusive.

(a) However, in spite of operating within specification limitations, three vacuum tubes failed during the course of the tests and subsequent investigation showed that all of these tubes were suffering from a lack of emission. One tube, type 38803, serial No. 29738, failed while being used in the intermediate amplifier circuit. Vacuum tubes type 38851, serial numbers 26177 and 26196 failed while operating in the Power Amplifier circuit. The following tabulation indicates the number of hours of operation which each of these tubes gave while the equipment was being tested at the Naval Research Laboratory. The total hours were obtained from the readings of the filament hour meter and hence include all time during which filaments were lighted and whether the set was unkeyed, intermittently keyed or operated key locked. The history of these tubes, previous to their arrival at the Naval Research Laboratory is not known, but it is reasonable to assume that they were used in the tests at the plant of the contractor and it is possible that they were subjected to overloads during the course of such tests.

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Tube Type No.	Serial No.	Hours of Operation
38803	29738	95.1
38851	26177	117.9
38851	26196	1.1

(b) Type 38803 tube, serial No. 29738 was replaced with tube serial No. 29477. The latter tube has been in operation for 60 hours and is still functioning in a satisfactory manner. After the failure of tube 38851, serial No. 26196, tube No. 26191 was placed into service in the P.A. circuit. This was a new tube which had no previous service. To date this latter tube has been subjected to 36 hours of operation and has continued to function satisfactorily.

(c) From the foregoing it will be seen that no definite conclusions can be drawn as to the cause of the tube failures. But, due to the fact that the tubes are being subjected to no apparent overload, show no signs of serious plate heating and that the new tubes placed in service have functioned satisfactorily for a period of hours, it would appear that the evidence indicates that the tubes which did fail were probably injured due to the type of service to which they were subjected at the plant of the manufacturer. On the other hand, the parasitic and self oscillation conditions which were encountered, as described in paragraphs 104(b) and 127 of this report appear to be closely allied and may have a bearing on the operation of the vacuum tubes.

(d) In an effort to obtain more data in connection with this phase of operation, tests are being continued. The XTBU transmitter is being operated, key locked, full power at 300 kilocycles, and will continue to be operated until a tube failure occurs or until the transmitter is no longer available for use at the Naval Research Laboratory.

(e) It may be of interest to note that tubes 38851, serial numbers 26177 and 26196 were reactivated by being run at a filament potential of 12 volts for two hours without applying voltages to any other tube elements. These tubes were then placed in the P.A. circuit of the XTBU transmitter and operated key locked full power at 300 kilocycles. Tube No. 26177 operated satisfactorily for one hour and 31 minutes after which the output suddenly fell off. Tube No. 26196 operated for a period of one hour and 25 minutes and then failed.

(f) Before the Model XTBU equipment can be considered suitable for Naval service with respect to tube life, definite assurances should be obtained from the contractor that the equipment will be of such design as to comply with the requirements of paragraph 2-17 of the governing specifications.

57. Par. 2-18. This paragraph of the specifications states: "The equipment must be designed so that safe operation and satisfactory performance are assured." During the course of the tests herein discussed a number of items were encountered which failed to comply

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with this requirement of the specifications. Some of these items were corrected during the course of the tests by representatives of the contractor and other items have been taken under advisement by the contractor with a view of correcting and eliminating the difficulties experienced. These various items will be discussed in detail elsewhere in this report under appropriate paragraph references.

58. Par. 2-19. The design of the Model XTBU equipment is such that it fulfills the requirement that the equipment, when secured at the base only, as under service installation conditions, operates successfully and without damage on a moving platform inclining up to 45° from the vertical in any direction. The transmitter is designed to be secured to the deck by means of six bolts, 1/2 inch in diameter, three along the forward edge and three along the rear edge of the foundation pedestal. Several inclination tests were conducted, the equipment being inclined fore and aft and from side to side. No signs of weakness or failure were evident during the course of these tests. For a detailed discussion of the effect of inclination upon the frequency stability of the equipment, see paragraph 122 of this report.

59. Par. 2-20. This paragraph of the governing specifications states, in part, that "The design of the equipment for ship use must be such as to insure freedom from damage and from faulty operation resulting from shock or blast of gunfire or from the most severe vibration encountered on Naval vessels of all types."

(a) When the Model XTBU equipment was subjected to vibration, it was found that numerous factors militated against satisfactory and successful operation. As previously mentioned in paragraph 48 above, the original overload relays had to be shorted out before the transmitter could be maintained in an operative condition. The following is a complete list of the defects noted:

(1) Overload relays K-104, K-105, and K-106 failed to maintain settings and shut down equipment. (See paragraph 48 for details.)

(2) The keying relay vibrated through such a large arc that the leads to the relay were broken.

(3) The mounting of the power amplifier tube (38851) vibrated so badly that the flexible lead connecting to the plate was damaged.

(4) The rear mounting of the Power Amplifier Tank Coil carried away and it was necessary to abandon the tests.

(5) The antenna tuning inductance vibrated badly at certain frequencies and although no definite damage occurred, it was feared that a continuation of the tests would damage this assembly.

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(6) The relay panel vibrated sufficiently to be instrumental in part for the failure of the overload relays.

(7) Various component parts mounted on the power amplifier circuit shelf were subjected to intense vibration which in time may have caused major damage.

(8) The flexibly mounted frame into which the MO/IPA unit slides strikes the side cross member of the transmitter frame at certain frequencies due to inadequate clearance.

(b) The above conditions were called to the attention of the contractor who formulated plans for correcting the various deficiencies noted. The following corrective action was taken:

(1) New overload relays were installed which provided superior performance.

(2) The keying relay was removed from the three Lord mountings originally used and was mounted on a felt pad 3/16 inch thick. After this change was made, the keying relay operated satisfactorily.

(3) A spring buffer clip was mounted between the front supports of the P.A. tube mount and the plate lead was made more flexible. These modifications reduced the vibration to which the P.A. tube was subjected.

(4) New securing brackets of improved design and increased strength were provided for the power amplifier tank coil. These brackets proved to be satisfactory under vibration.

(5) A bakelite brace was placed across the left side of the transmitter to support the bottom of the antenna tuning inductance. This additional support satisfactorily removed the excessive vibration of this unit. In production models, however, the fabrication and mounting of this support should be improved.

(6) No suitable means was found to brace the relay panel while the equipment was at the Naval Research Laboratory. However, the contractor proposes to provide an additional support when the equipment is returned to the factory.

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(7) Two angles were secured, back to back, beneath the power amplifier circuit shelf to give increased rigidity. Additionally, the main transmitter frame was strengthened by incorporating a pair of flat diagonal cross braces at the rear of the main frame. (See Plate 23.) The power amplifier plate choke was modified slightly to provide a more secure mounting and leads of greater flexibility were used. The combined effect of these changes gave improved operating conditions.

(8) No changes have been made in the mounting of the MO/IPA unit and it is recommended that the manufacturer be requested to provide greater clearances between the members mentioned in paragraph 56(a)(8) above.

(c) Lock Washers. Lock washers of the "shakeproof" type are employed throughout the transmitter, while in some locations lock washers of the split type are used. In general, no difficulties were experienced which could be attributed to these washers and the general operation was satisfactory.

(d) Shock. The equipment withstood shocks without derangement of parts or breakage of any kind. Antenna tap switch, Control "J", showed a tendency to open when shocks were applied. This switch requires a thorough study and some revision and should be made proof against shock.

(e) Wiring. The general subject of wiring is discussed in detail in paragraph 153 of this report, and as stated therein, consideration should be given to improving the wiring which involves flexible leads.

60. Par. 2-21. Provision has been made to protect tubes and the master oscillator compartment from the effects of shock and vibration by means of flexible mountings. The key relay, as originally received,was mounted on three Lord mounts. As discussed in detail in paragraph 59 above, vibration tests revealed certain defects and faulty operation which were largely corrected through the medium of modifications effected by representatives of the contractor. The Master Oscillator tube, the Intermediate Amplifier tube, and the Audio Oscillator tube are mounted in rigid sockets. However, the unit to which these tubes are secured is mounted on rubber suspensions, thus giving suitable protection to these tubes.

61. Par. 2-22. The design and control of the circuits of the Model XTBU equipment conform to the spirit of the specifications requiring that operation of the equipment be as simple as possible.

62. Par. 2-23-1. All indicating instruments and controls for the operation and monitoring of the equipment are located on the front panel. A list of all controls and meters appears in Table 1. As illustrated in the attached photographic views, the meters and controls

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have been arranged in a symmetrical and convenient manner. The five meters located just above the door giving access to the main terminal panel have been tilted to insure ease of reading. The test key is well placed at a convenient height near the left hand edge of the panel.

63. Par. 2-23-2. Each control is provided with suitable nameplates to designate its purpose. These plates are of a permanent character and all markings are of such size as to be easily readable at distances in excess of 24 inches. No filling is employed, the plates being prepared by the photo-etched process. In the case of the antenna tuning circuits, which are divided into two ranges, black backgrounds have been supplied for the circuit covering the lower part of the frequency range, while an orange background designates the controls which are operative at the upper end of the frequency range.

64. Par. 2-24. All control shafts are grounded as required by the governing specifications. All knobs and handles are insulated and care has been exercised to sink set screws and taper pins below the insulating surface to protect personnel against shock or burns.

65. Par. 2-25. (General) All electrical indicating instruments provided with the equipment are of the 3.5 inch diameter, flush type with bakelite case. All meters are provided with anti-glare glass of suitable characteristics.

66. Par. 2-25-1. The antenna ammeter is of the external thermocouple type and is connected in the low potential side of the antenna circuit. The meter, however, is not at ground potential but operates above ground by the amount of the r-f potential developed across the antenna coupling capacitors C-156 to C-163 inclusive. As pointed out in paragraph 33(c) above, this meter is equipped with a third terminal for the internal shield. Since the meter does not operate at ground potential, this terminal cannot be grounded.

67. Par. 2-25-2. The mounting and securing facilities for meters have been modified in accordance with contractor's Descriptive Specifications R-1063. The front panels have been drilled and tapped for 6-32 screws for securing the meters to the panel. Screws of non-corrosive steel, with split type lock washers under the head, have been used for securing the meters. The diameters of the meter holes are 2.88 inches which permits sufficient clearance for replacement meters conforming with the requirements of Specifications 17-I-12, where the maximum body size of the meter is limited to 2.8 inches. Sufficient space is allowed in the rear of all meters to accommodate meters of the maximum body depth permitted by the governing specifications. In general, the leads connecting to the meters have been given sufficient slack to permit disconnecting the meters by withdrawing them through the mounting hole. It was noted, however, that one lead to the M.O. Plate Voltage Meter is too short to allow removal from the front and one lead to the Bias voltmeter is too short to permit convenient removal of the meter. In the case of the XTBU transmitter, both of these meters are readily accessible when the MO-IA unit is completely removed from the transmitter frame. However, in the interests of uniformity, it is recommended that proper attention be given to this matter so that all meters may be removed from the front in accordance with specification requirements.

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68. Par. 2-25-2. (Voltmeter Multipliers). All external voltmeter multipliers furnished with the equipment have a sensitivity of 1,000 ohms per volt. Each multiplier is by-passed by capacitors of suitable size and voltage rating. The multipliers supplied with the P.A. Plate and Bias voltage meters are of the old style. The multiplier used in connection with the M.O. Plate voltmeter is of the tubular ferrule type. However, this multiplier does not conform with the requirements of Specifications RE 13A 590A in respect to size and dimensions.

69. Par. 2-26. Nameplates have been affixed to all major units with the exception of the motor starter. The various nameplates appearing on the equipment are listed in Table 4.

70. Par. 2-27. Assembled separate items have been provided with descriptive nameplates as listed in paragraph 69 above.

71. Par. 2-28. The requirements of this paragraph regarding marking do not apply to preliminary models as initially submitted.

72. Par. 2-29. It was not feasible to determine whether the screws and bolts used in the assembly of this equipment are in strict compliance with the provisions of this paragraph without resorting to complete disassembly. During the course of the tests, such items of bolts and screws which were accessible were found to be of suitable characteristics.

73. Par. 2-30-1. All scales are arranged so that indications increase numerically with the final controlled effect. However, in the case of controls D, E, K, and L clockwise rotation of the knob results in a decrease in the controlled effect. This is permitted by the specifications if the scale and knob move in opposite directions and the scale moves in a clockwise direction with an increase in the final controlled effect. This is true of the controls mentioned above.

74. Par. 2-30-2. Controls A and L are provided with verniers and continuity of numbering has been provided throughout the dial ranges. The dials and verniers are marked in evenly spaced divisions. On all dials at least two significant figures are always visible. The width of any single division is in excess of 0.05 inch, as listed below:

Control	Space between Divisions
A	0.076"
D	0.058"
E	0.058"
K	0.116"
L	0.116"

In this connection, attention is invited to controls E and L. The index pointers on these controls are long enough to cover up the unit lines on the scales. The unit lines on control D protrude beyond the index pointer and hence it is easier to read the dial setting. Steps should be taken to improve this condition in respect to controls E and L.

75. Par. 2-30-3. Slipping has been noted on control L beyond the point where the stop provided comes into action. This defect is discussed in detail under paragraph 45(h) of this report. Undue play was also noted in various switch handles and knobs, as pointed out under paragraphs 45(e) and 45(f) above. Stops have been provided on all variable controls with the exception of Control "A". It is recommended that this control be provided with stops to limit motion of the dial to the calibrated portion. As mentioned above under paragraph 45(g), the stop on control "K" had become defective and was replaced during the course of the tests.

76. Par. 2-31-1. The construction of the equipment is such that suitable tolerances have been provided for the accommodation of various component parts, such as resistors, vacuum tubes, etc.

77. Par. 2-31-2. In this connection, attention is invited to the fact that paragraph 11-3 of the governing specifications applies to the Model XTBU equipment. This paragraph of the specifications entitled "Proposition #1 - Change in mechanical construction to provide greater accessibility of parts" will be discussed in detail later in this report. (See paragraphs 210 to 217.) The following items should be given consideration with a view of improving accessibility and servicing features:

(a) As previously mentioned under paragraph 34(a) above, static drain resistor R-130 is inaccessible and should be moved to a new location.

(b) Antenna Inductor Assembly, L-116 and L-117, cannot be removed without complete disassembly due to the supports being welded to the frame. If these supports were bolted securely to the frame, it would be possible to remove the assembly as a unit.

(c) The plate and filament rheostats cannot be removed from the transmitter without removing a front panel and five meters. This could be eliminated by reforming the mounting braces so that they fasten to the side angles of the frame instead of the front angles.

(d) Reactor L-113, used in connection with the six-wire keying circuit, is accessible only from the rear of the transmitter unit. Should the transmitter be installed with its back flush against a bulkhead, as provided in the governing specifications, extreme difficulty would be experienced in servicing this unit. It is recommended that the location of this reactor be given consideration with a view of locating it in a more accessible place. It is possible that if tubular multipliers are substituted for the old style multipliers, sufficient space will become available to mount the reactor in a more accessible location.

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78. Par. 2-31-3. All push button and toggle switches may be removed and replaced without the removal of any other component parts. In the case of the M.O. filament stand-by and MCW-CW switches, it is necessary to remove the MO-IPA unit to accomplish removal of these two switches. In this connection it is pointed out that the buttons of the start-stop switches, four-wire control, are flush with or slightly below the surface of the panel when depressed. This causes inconvenience and delays in operation. A more satisfactory switch should be employed. Additionally, the means employed for making connections to the start-stop switches is unsatisfactory. Connections were made by means of Packard cable and small lugs. Due to the tension placed on the lugs by the cable, many of the lugs became broken and had to be replaced. It will be necessary to provide a more secure method of effecting connections to these switches.

79. Par. 2-32. The weights of the various units of the Model XTBU equipment are listed in Table 5. It will be noted that the total weight is 1616 pounds, which is well within the specification limit of 3,000 pounds for equipment supplied with a-c driven motor generators.

80. Par. 2-33. Any single unit of this equipment, when uncrated for installation and without further disassembly, is capable of passing through a door 25 inches wide by 54 inches high and through a hatch 36 inches long by 30 inches wide. Since no spare parts are provided with the preliminary model, the size of spare parts boxes could not be checked for conformity with this requirement.

81. Par. 2-34. The equipment was subjected to sudden and gradual variations of supply line voltage between the limits of ± 5% of normal and additionally between the limits of ± 10% of normal. The results of these tests are illustrated in Tables 19 and 20 appended hereto. No damage occurred during the tests and the equipment functioned normally and satisfactorily during and after the tests, as far as the effect of varying voltages was concerned. No provisions were available for varying the supply line frequency over the limits of ± 5%.

82. Par. 2-35-1. Symbol markings as used in the instruction book and wiring diagrams have been placed adjacent to most of the component parts in the transmitter. It was noted, however, that in a few instances symbol numbers have not been used. For example, door inter-lock switch S-106 has not been marked. Attention is invited to the fact that resistor symbol markings are placed on metal tags which also bear type number and resistor values. This necessitates removing the resistor from the mounting in order to determine the symbol number. Symbol numbers are marked by means of stenciling with red paint or lacquer. While this method results in plainly readable symbols, no information is at hand to determine the wearing qualities of this type of marking. Previously the Westinghouse Electric and Manufacturing Company employed small metallized tags which were securely affixed adjacent to the various component parts. These tags have given excellent service in the past and it is of interest to note that the Model TBL-2 transmitter salvaged from the U.S.S. SQUALUS had the symbol markings intact in the majority of instances. It is recommended, therefore, that unless the

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contractor can give assurance that the new method of marking will prove satisfactory over long periods of time, that consideration be given to the advisability of continuing the use of the former method of marking.

83. Par. 2-35-2. Resistor mountings are marked to indicate the Navy type number and the value of resistance employed. These markings appear on small metal tags secured to one end of the resistor mounting. Tube mountings are marked to indicate the Navy type number of the tube used in each socket. These markings have been cut into adjacent aluminum parts by means of metal stamps. This form of marking does not provide easily readable characters, particularly if lighting conditions are poor. If the stampings were filled in with engraving wax or similar material, greater visibility would result.

84. Par. 2-36. Rubber is employed in the Lord shock mountings used for supporting the tube mounting of the P.A. tube and the MO-IPA unit. Originally, the keying relay was mounted on three Lord mountings but these were later removed and the relay mounted on a piece of felt. Rubber in the form of a gasket is used around the edge of the MO-IPA unit panel. All of these rubber parts are easily replaceable if proper materials are available.

85. Par. 2-37. As discussed in paragraph 81 above, the equipment functioned satisfactorily when line voltage changes of $\pm$ 10% occurred.

86. Par. 2-38. The transmitter unit is provided with four lifting shackles, one on each of the four upper corners of the frame. These shackles fold down below the level of the top shield when not in use. An anti-rattle device is used on each shackle consisting of a flat spring, held in place by two machine screws, which effectively holds the shackle in the closed position. The useful opening in the shackle measures 1-3/8" x 1-1/2". Nameplates are located on the side shields indicating the position of the lifting eyes.

87. Par. 2-39-1. The front panels, access doors, side shields and rear shield are protected by black wrinkle finish similar to samples held by Inspectors of Naval Material. The top shield and the base channels are finished in flat black.

88. Par. 2-39-2. All external surfaces have been finished as described in paragraph 87 above, no plain aluminum finishes being in evidence.

89. Par. 2-39-3. Some of the screws on the front panel are of bright stainless steel, whereas the specifications state dull or black finish shall be used.

90. Par. 2-39-4. All interior surfaces of aluminum or aluminum alloy have been protected against corrosion by the use of Westinghouse "Nasat" finish, which provides a light satin finish. No contact troubles were noted during the course of the tests which would indicate that the finish provided interfered with satisfactory operation.

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91. Par. 2-40-1. All indicating lamps furnished are of Navy Type TS-51 candelabra screw base rated at 18 volts 0.11 ampere.

92. Par. 2-40-2. Each lamp is mounted as a part of a combined receptacle resistor lamp assembly. The part of the assembly protruding through the front panel is rolled to provide a bezel. This bezel is bright metal and is not finished in dull black as required by the specifications. The dimensions of the assembly and the specification requirements are listed below:

	Measured	Specifications
Outside diameter of bezel	1-3/8"	1-3/8"
Projection of globe beyond bezel	1"	1"
Overall length of resistor and housing	5-5/8"	7"

93. Par. 2-40-3. The indicator globes furnished are inside etched and are provided with screw threads. The globes are color coded in accordance with specification requirements as listed in Table 1.

94. Par. 2-41. Capacitors of the electrolytic type have not been used in the construction of the Model XTBU equipment.

95. Par.2-42 to 49. These paragraphs of the specifications cover type tests of component parts. No separate component parts were provided with the preliminary model and it is assumed that such tests have been and will be made at the point of manufacture.

96. Par. 2-50. The control and starting circuits are so designed that filament potentials are applied to the tubes in advance of plate potentials and bias voltage must be available before plate voltage can be applied to the tubes. Filament potentials are available immediately upon closing the start switch. The bias potential, obtained from a self-excited generator, rises to normal value as the motor generator picks up speed and the fields of the plate generators are not energized until full bias voltage is available.

97. Par. 3-1. (General). The design of the Model XTBU transmitter is based on the master oscillator power amplifier principle and covers the frequency range of 300 to 2,000 kilocycles. A discussion of the individual circuits follows.

98. Par. 3-1-1. The master oscillator circuit uses one Type 38803 vacuum tube and functions without the use of a constant temperature compartment. The circuit consists of a standard Colpitts oscillator operating at one-half the output frequency. Frequency variation is accomplished by means of range switch S-101, Control "B" and variable inductor or variometer L-102, Control "A", this latter control providing the fine adjustment of the circuit. Originally, the contractor in Descriptive Specifications R-1042, proposed to supply an Electron Coupled Oscillator. This type of circuit was abandoned for the reasons set forth in paragraph 1 of Westinghouse letter of November 20, 1939,

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to the Resident Inspector of Naval Material, Baltimore, Md. Chief among these reasons was the fact that the 38803 tubes failed to give entirely satisfactory performance when used as electron coupled oscillators. The frequency characteristics of the Model XTBU, using the Colpitts oscillator, is illustrated in the results of tests conducted in conformity with paragraph 3-7 of the governing specifications. From the results of these tests, it is concluded that the oscillator circuit provided is suitable and satisfactory for the needs of the Naval Service. Certain aspects of operation do not comply fully and in detail with the requirements of the governing specifications, as for instance back-lash requirements in accordance with paragraph 3-7-2 at 1,000 kilocycles. Discrepancies of this nature, however, may be attributed to other factors than the fundamental design of the oscillator circuit.

99. Par. 3-1-2. The intermediate amplifier circuit furnished uses a single Type 38803 vacuum tube. This circuit operates as a frequency doubler and covers the nominal range of 300 to 2,000 kilocycles. As pointed out under paragraph 56 of this report, one tube failed in the intermediate amplifier although the evidence which exists does not indicate definitely that the circuit was functioning in an improper manner or was subjecting the tube to undue overloads.

100. Par. 3-1-3. The Power Amplifier circuit provided uses a single 38151 vacuum tube operating as a fundamental amplifier. Contractor's Descriptive Specifications and page 3 of reference (a) indicated that consideration would be given by the Navy to the use of another type of power amplifier tube of improved design and characteristics in lieu of the 38151 tube, provided that the proposed type could be shown in demonstration to offer sufficient advantages to the Navy to warrant its use. No alternative tube was submitted for investigation during the course of the tests herein outlined. In view of the difficulties experienced with the 38151 tubes as discussed in paragraph 56 above and in view of the fact that the 38151 tube has demonstrated a tendency to resist complete and satisfactory neutralization as discussed in paragraph 127 below, it is recommended that the Bureau of Engineering continue in its efforts to obtain a suitable substitute for the 38151 tube in an effort to overcome the difficulties described.

101. Par.3-1-4. The antenna circuit provided in the Model XTBU equipment is of the capacity coupled type. Originally, contractor's Descriptive Specifications R-1042 indicated that this circuit would be of the inductively coupled type. However, in paragraph 5 of the Westinghouse letter of June 1, 1939, to the Inspector of Naval Material, Baltimore, the contractor proposed to submit a capacity coupled circuit. This substitution was approved, subject to demonstration of suitability in connection with test of the preliminary model, in Bureau of Engineering letter C-NOs-66593(6-5-R6) of 19 July 1939 to the Inspector of Naval Material, Baltimore, Md. Basically, the capacity coupled circuit provided is probably to be preferred to inductive coupling, but certain elements of design require further consideration before the circuit submitted can be considered entirely satisfactory. The gradation of coupling is too coarse, particularly at the higher frequencies. The degree of coupling is controlled by controls "F" and "G", control "F" permitting rather large or coarse adjustments while control "G" permits

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finer adjustments in six steps. For example, when operating at 2,000 kilocycles as illustrated in column 2 of Table 9, a coupling adjustment of F-7, G-6 created a loading condition which caused only 800 milliamperes of plate current to flow in the power amplifier tube. In attempting to increase the coupling, it was necessary to set control F on tap 8 and control G on tap 1. This caused the P.A. plate current to rise to a value in excess of 1200 milliamperes, which overloaded the tube. It is recommended, therefore, that the design of the antenna coupling circuit be so modified that the proper variation in coupling can be obtained at the upper end of the frequency range.

102. Par. 3-1-5. An audio oscillator circuit, using a Type 38803 tube, is provided to permit mcw operation. This circuit operates at a frequency of approximately 800 cycles and modulates the suppressor grid of the intermediate amplifier tube. A "CW-MCW" control in the form of a switch is provided for placing the audio oscillator in operation. When the switch is in the "CW" position, a dummy load in the form of resistor R-125 is substituted for the filament load of the audio tube, thus obviating the necessity of readjusting filament potentials.

103. Par. 3-2. This paragraph of the specifications lists various dimensions of antennas and trunks which may be employed in conjunction with the Model XTBU transmitter. It is indicated that the transmitter may be required to work into trunks ranging from zero to 35 feet in length and into antennas 40 feet to 200 feet long, with a probable average length of antenna, outside of trunk or entering insulator, of 80 feet.

(a) The Model XTBU transmitter was connected to several actual outdoor antennas of varying characteristics to determine whether satisfactory adjustment of the output circuits could be obtained.

(b) The first antenna used consisted of a 125 foot vertical element with a 95 foot flat top. The maximum frequency to which the output circuits would resonate was approximately 1080 kilocycles.

(c) An antenna of 95 foot vertical height with a 95 foot flat top was then tried. The maximum frequency of operation was found to be 1250 kilocycles.

(d) The next antenna tried consisted of a 65 foot vertical element and a 95 foot flat top. The maximum frequency at which the antenna circuit could be resonated was found to be 1500 kilocycles.

(e) No trunks were used in connection with any of the foregoing antennas and the lead-in from the transmitter to the insulator at the base of the vertical section of the antenna was approximately 10 feet in length.

(f) The design of the Model XTBU antenna circuit is such that no series capacitors are provided and hence it is impossible to resonate the circuits when an antenna at or above the fundamental is employed. However, this condition will not present itself if antennas of approximately 80 foot length are used.

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104. Par. 3-3. In order to determine the power output of the Model XTBU transmitter at various frequencies within the specified range, the equipment was operated into dummy antennas consisting of essentially non-inductive resistors and low loss capacitors. These dummy antennas were adjusted to values to agree as closely as possible to the values listed under paragraph 3-2 of the governing specifications.

(a) Table 6 attached hereto covers power output tests conducted at 300 and 400 kilocycles. At 400 kilocycles, two different values of antenna resistance were employed. In all instances, the cw power output was in excess of that required by the governing specifications.

(b) Table 7 covers tests conducted at 500, 600, and 750 kilocycles. The specifications require an output of 530 watts at 500 kilocycles and 900 watts at 750 kilocycles. In order to determine the required output at 600 kilocycles, a straight line was drawn between the 500 and 750 kilocycle values, which resulted in a power of 675 watts at 600 kilocycles. During the attempts to obtain power output in the region of 600 kilocycles, trouble was experienced due to parasitic oscillations. The frequency range between the limits of 575 kilocycles and 650 kilocycles was explored in small frequency increments and it was found that the plate overload relays were actuated by overloads. These overloads, in turn, were found to be due to unwanted oscillations in the power amplifier circuit. A 10 ohm resistor was originally supplied in the P.A. grid circuit for the purpose of preventing oscillations of this character. A representative of the contractor investigated this condition and finally replaced the 10 ohm resistor with a resistor of 40 ohms value. This modification had the effect of eliminating the parasitic oscillations, but at the same time decreased the power output to a value below that required by the specifications. Reference to column 2 of Table 7 reveals that a maximum of 603 watts was obtained, whereas the specifications require an output of 675 watts.

(c) Tables 8 and 9 cover tests conducted at 1000, 1250, 1500 and 2000 kilocycles. In all cases the power output obtained was in excess of the specification requirements. Attention is invited to the condition which exists at 2000 kilocycles, where full power operation had to be limited to 800 milliamperes plate current in the P.A. stage. The reasons for this type of operation are discussed in detail in paragraph 101 above.

105. Par. 3-4-1. Determination of the harmonic content in the transmitter output was not undertaken. Paragraph 10-31 of the governing specifications indicates that such measurements will be undertaken, if required, after the equipments have been installed in service afloat. The character of the emitted signals was observed locally and no traces of lilt were observed. The master oscillator tube is completely blocked when the key is open and no radiation is encountered from this source. As mentioned elsewhere in this report, unwanted oscillations were encountered during the course of the tests and the remedial measures applied by the contractor to date to eradicate this condition are not considered wholly satisfactory.

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106. Par. 3-4-2. Tests were conducted at output frequencies of 300, 1000, and 2000 kilocycles to determine the amount of amplitude modulation present in the cw output of the transmitter. The results of these tests are shown in Table 10. It will be noted that in all cases the degree of ripple observed is less than the 2% permitted by the governing specifications.

107. Par. 3-5. The specifications require the transmitter to be capable of emitting a signal modulated not less than 70% at 800 cycles, ± 5% and that the power be reduced to not less than 50% of the cw output. The frequency of modulation was measured as 780 cycles, which conforms to the specification requirements. Tables 6, 7, 8, and 9 attached hereto show the percentage of modulation obtained and the power output in watts when operating so as to produce mcw emission. In all instances the power output was in excess of the specification requirements of 50% of the cw power. At 400 kilocycles, the percentage of modulation as measured is somewhat less than the 70% value specified, but it will be noted that the mcw power is decidedly in excess of the required 50%, and hence the communication range on mcw should not suffer due to the somewhat reduced modulation percentage. It is recommended, therefore, that the mcw characteristics of the Model XTBU transmitter be considered as complying with the specification requirements. Selection of cw or mcw is effected by a switch control located on the front panel of the transmitter. The keyed output of the transmitter was observed on a cathode ray oscillograph and satisfactory keying operation was obtained on mcw up to speeds of 50 words per minute as required by the specifications. Additionally, speeds as high as 70 and 100 words per minute were observed on mcw with satisfactory results.

108. Par. 3-6. The transmitting equipment is so constructed that by means of the front panel controls any frequency within the specified range may be obtained. The number of controls has been kept to a minimum comparable with the specification requirements.

109. Par. 3-7-1. <u>Accuracy of Reset to Previously Calibrated Frequencies.</u> Table 11 shows the results of reset tests conducted at 300, 1000 and 2000 kilocycles. It will be noted that in all cases the accuracy of reset complies with the specification requirements and that all resets were accomplished in less than one man minute.

110. Par. 3-7-2. <u>Test for Lost Motion, Back Lash and Torque Lash.</u> Tests conducted to determine the degree of back lash existing in the frequency establishing controls of the master oscillator are shown in Table 12. At output frequencies of 2000 and 300 kilocycles, the results obtained comply with the specification requirements. At 1000 kilocycles, however, the degree of back lash is somewhat in excess of the specification figure of 0.02% for the average of five trials. A recheck was made at this frequency with the key locked in order to avoid errors due to heating. However, the recheck results essentially duplicate the results obtained in the original test. It is recommended that the further consideration be given to the master oscillator control with a view of reducing back lash deviations in the region of 1000 kilocycles.

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111. Par. 3-7-3. Operation of Adjust-Tune-Operate Control. Reference to Table 13 reveals that the operation of the Adjust-Tune-Operate control produces frequency variations of far less magnitude than permitted by the governing specifications. Tests were conducted at eight different frequencies to insure that uniform results could be obtained throughout the frequency range of the transmitter.

112. Par. 3-7-4. Detuning of Circuits. Table 14 covers tests conducted in conformity with this paragraph of the specifications. The intermediate amplifier, power amplifier and antenna circuits were detuned on either side of resonance to a degree which caused the plate current of the tube affected to vary approximately 25% from the plate current at normal adjustment. In no case were frequency shifts noted of the magnitude permitted by the governing specifications.

113. Par. 3-7-5. Operation of Power Output Control. The variation in frequency resulting from a change in power output from full power operation to operation at reduced power, at any point within the range of the control, does not exceed the specified limit of 0.005%. Tests were conducted at frequencies of 300, 1000 and 2000 kilocycles, as illustrated in Table 15.

114. Par. 3-7-6. Change of Tubes. Table 16 illustrates the results of changing tubes in the various circuits of the Model XTBU transmitter when operating at 300 kilocycles. In no case was the specified frequency tolerance exceeded even though the tubes employed were from different manufactured lots. Table 17 lists similar tests conducted at 1000 kilocycles. Here it will be noted that changing tubes in the master oscillator circuit caused an average variation from the mean frequency in excess of that permitted by the specifications when tubes of different manufacture were used. Table 17 contains a recapitulation of the data wherein the tubes of each manufacturer are considered separately. When this procedure is followed, the requirements of the specifications are easily complied with. Table 18 lists the results of tests conducted at 2000 kilocycles. Here again, as in the case of the tests conducted at 1000 kilocycles, the specification value is exceeded for the master oscillator circuit when tubes of different manufacture are considered in one lot. When Westinghouse tubes alone, or RCA tubes alone, are considered, the average deviation from the mean frequency falls within specification limits. In view of the above results, it is recommended that the Model XTBU equipment be considered as complying in full with the requirements of paragraph 3-7-6 of the governing specifications.

115. Par. 3-7-7. Variation of Supply Line Voltage. The Model XTBU equipment operates from a supply of 440 volts, 3 phase, 60 cycles. Hence, by the terms of this paragraph the equipment should be subjected to a line voltage variation of ± 5%. The results of such tests, conducted at output frequencies of 300, 1000, and 2000 kilocycles, are listed in Table 19. The line voltage was varied in a period of one minute and additionally in a period of five minutes. Under both conditions the frequency variations noted fall within the limits imposed by the governing specifications. Paragraphs 2-37 and 6-3 of the governing specifications require that the equipment withstand 10% line voltage variations without damage to tubes or equipment. While conducting

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tests of this nature, the effect upon frequency was recorded as listed in Table 20. It will be noted that the frequency variations encountered during the 5% and 10% variations are of the same degree, that is, the XTBU equipment produces the same order of frequency stability in both cases. Attention, however, is invited to page 4 of the Contract Note which reads "Ref. Par. 2-37 of CDS: For the purpose of conducting frequency stability tests as per paragraph 3-7-7 of NBS (Navy Basic Specifications) the ± 10% variation of A C Supply, Paragraph 6-3 NBS, may be restricted to ± 5%."

116. Par. 3-7-8. Variations in Ambient Temperature. Tables 21, 22, and 23 cover tests conducted to determine the effect of variations in ambient temperature upon the emitted frequency of the Model XTBU equipment. Reference to the summary of Table 21 reveals that at 300 kilocycles the requirements of the governing specifications have been complied with except in the temperature range of 10 to zero degrees C. However, in this case the results of the tests show that the specifications have been exceeded by a value of only 0.0001%. The governing specifications limit the frequency change per 1° C. to 0.0025% whereas the test result indicated a change of 0.0026%. A difference of this degree may well fall within the limits of observational error and hence it is believed that the equipment should be considered as complying with the specification requirements. Tables 22 and 23 reveal that at 1000 and 2000 kilocycles the variations due to change in ambient temperature are well within the limits imposed by the governing specifications. Plates 1, 2, and 3 attached hereto, show the results of the temperature variation tests in graphic form. The Model XTBU does not employ temperature control for the master oscillator circuit. It is understood that the contractor has selected capacitors of definite temperature characteristics, which when associated with the inductors employed provide a certain degree of temperature/frequency compensation. In this connection it may be of interest to draw a comparison between the Model XTBU transmitter and the Intermediate Frequency unit of the Model XTBN-2 equipment. These transmitters are of similar construction and cover the same frequency range and have the same nominal power output. The XTBN-2 transmitter was tested during the month of August 1935. The following tabulation shows the frequency change, in cycles, per 10° C change in ambient temperature.

	Cycles change per 10° C.			
Temperature	1000 kc		2000 kc	
Range	XTBN-2	XTBU	XTBN-2	XTBU
50 to 40	515	130	495	240
40 to 30	190	95	190	230
30 to 20	411	57	160	50
20 to 10	127	38	275	50
10 to 0	98	60	225	10

It will be observed that, in general, the Model XTBU exhibits a marked degree of improvement over the Model XTBN-2.

DECLASSIFIED

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117. Par. 3-7-9. Variation in Humidity (Ambient Temperature Constant). The complete transmitting equipment, including transmitter, motor generator, starter and dummy antenna, was installed in the temperature-humidity test chamber. Tables 24, 25, and 26 list the results of tests conducted at 300, 1000, and 2000 kilocycles, while Plates 4, 5, and 6 show these data in graphic form. The requirements of the specifications are complied with in all respects except that at 300 kilocycles the power reduction during the test was 6.9% whereas the specifications permit only 5%. The reason for the greater falling off in power at 300 kilocycles as compared with 1000 and 2000 kilocycles is not obvious. Reference to the test data submitted by the contractor in reference (e) shows that during the tests at the point of manufacture a greater falling off in power was experienced at 300 kilocycles than at 1,000 or 2,000 kilocycles, but that the power reduction amounted to only 4.03% at 300 kilocycles. In the tests conducted at the Naval Research Laboratory, the test at 300 kilocycles was started 15 minutes after the transmitter had been placed in operation, while at 1,000 kilocycles the transmitter had been operating for a full hour previous to the humidity run and at 2000 kilocycles the transmitter had been operated for one hour and fifty minutes previous to the humidity test. These differences in preliminary heating may have a bearing on the results. The data in Plates 4, 5, and 6 indicate that the power fell to its lowest value while the humidity was a maximum, but the data also reveal, especially at 300 kilocycles, that a noticeable falling off in power occurred during the first half hour of the test while the humidity was at the low value of about 29%.

118. (Special note on paragraphs 3-7-8 and 3-7-9.) Attention is invited to paragraph 56 of this report, wherein tube failures are discussed. One IPA tube and two PA tubes became defective during the period of the temperature and humidity tests. However, as pointed out under paragraph 56 above, the circumstances surrounding these failures and the data available are such that it is impossible to state definitely that these tube failures were directly or indirectly due to temperature or humidity.

119. Par. 3-7-10. Locked Key Operation for Two Hours. Tables 27, 28, and 29 cover two hour locked key tests conducted at 300, 1000, and 2000 kilocycles. In all instances the frequency variations measured are within the specification limits. The data presented indicate the degree to which plate voltage, plate current, and power output fell off during the course of these tests.

120. Par. 3-7-11. Changed from Key Locked to Intermittently Keyed Condition. The Model XTBU transmitter complies with the requirements of this specification test as illustrated in Table 30.

121. Par. 3-7-12. Change from Continuously Keyed to Intermittently Keyed Condition. Table 31 lists the results of tests conducted in conformity with this paragraph at frequencies of 1000 and 2000 kilocycles. Attempts were made to conduct this test also at 300 kilocycles, but due to frequent arc-overs, particularly in Capacitors C-139 and C-143, it was impossible to complete such a test. The tests referred

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to above were conducted on December 5, 1939. Later, on February 5, 1940, attempts were again made to conduct a test of this nature at 300 kilocycles. Since the previous test, a new 38151 tube had been installed in the power amplifier. However, on February 5, the attempts to key the transmitter for any protracted period of time proved unsuccessful due to arcing which caused the plate overload relay to open. It will be necessary to overcome this difficulty before the Model XTBU transmitter can be considered satisfactory for service use. At the higher frequencies of 1000 and 2000 kilocycles, the equipment complied with the specification requirements as illustrated in Table 31.

122. Par. 3-7-13. Inclination due to Roll and Pitch of Ship. The frequency characteristics of the Model XTBU equipment while being subjected to inclination up to an angle of 45° from the vertical are illustrated in Tables 32, 33, and 34, and these data are shown in graphic form in Plates 7 to 12 inclusive. Table 32 and Plates 7 and 8 cover tests conducted at 300 kilocycles wherein the equipment was inclined from front to back and additionally from side to side. It will be noted that the maximum frequency change from the start to the end of the test was of the order of 0.011% while the frequency change during any one cycle of inclination did not exceed 0.003%. The frequency change of 0.011% cannot be ascribed entirely to the effects of inclination since the transmitter has a certain amount of inherent drift. This drift varies with conditions such as the degree of preheating to which the transmitter was subjected before the test actually got under way. Tests at 1000 and 2000 kilocycles are illustrated in Tables 33 and 34. In all cases the requirements of the governing specifications have not been exceeded. It may be pertinent to note that the inclination tests wherein the equipment was inclined from front to back, were conducted before the transmitter frame was strengthened in an effort to overcome vibration difficulties, as discussed in paragraph 59 above, while the tests wherein the equipment was inclined from side to side were conducted after the frame had been modified. It is considered that the Model XTBU equipment meets the specification requirements as set forth in paragraph 3-7-13.

123. Par. 3-7-14. Vibration. With the complete equipment secured to the vibration test stand, it was subjected to varying degrees of vibration, both in amplitude and frequency. With the equipment in its original state, it was impossible to maintain the transmitter in operation due to the overload relays being affected by vibration. Additionally, mechanical failures occurred, as described under paragraph 59 above, which prevented operation. After these deficiencies had been remedied by representatives of the contractor, complete and successful tests were conducted as indicated in Table 35 and Plates 13, 14, and 15. Tests were conducted at output frequencies of 300, 1000, and 2000 kilocycles and in all instances the maximum set in frequency encountered did not exceed the specification value of 0.005%.

124. Par. 3-7-15. Shock. With the transmitter secured to the deck by means of the regular base fittings, shocks were applied to the equipment in the manner designated by the governing specifications. Tests were conducted at 300, 1000, and 2000 kilocycles, and in all instances the frequency change due to shock remained within the limitations imposed by the governing specifications. Trouble was experienced

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with opening of overload relays and some difficulty was experienced in connection with antenna control "J". The overload relays were the original ones supplied with the equipment. Later these relays were replaced with an improved design. With the improved relays installed, the transmitter could be shocked without affecting the relays. The matter of overload relays is discussed in full under paragraph 48 above while the mechanical effect of shock is treated in paragraph 59 above.

125. Par. 3-7 (General). For purposes of information and comparison, a summary of all frequency stability tests, as outlined in paragraph 3-7 of the governing specifications, is presented in Table 37. The values listed for each specific test are the maximum values obtained during those tests. The totals of columns 2, 3, and 4 are the arithmetical sums of the various tests, no account being taken of whether the variations were plus or minus. Columns 5, 6, and 7 under the heading "Per cent frequency variation of specification allowance" give the percentage values of the actual test results as compared with the values permitted by the specifications. Thus a percentage value of 100% indicates that the test value and the specification value are in exact agreement. A test value of 10% indicates that the frequency variation observed during the test was only 10% of the value permitted by the specifications. A test value in excess of 100% indicates that the specification value was exceeded. Attention is invited to the fact that no test could be conducted at 300 kilocycles for test 3-7-12, hence the totals at 300 kilocycles are not in strict agreement with the totals at 1000 and 2000 kilocycles. Attention is also invited to test 3-7-6 (a). The values here used are for tubes of different manufactured lots; if the tubes of a single manufactured lot were used as the basis of calculation, the specification limit of 0.015% would not be exceeded at any frequency.

126. Par. 3-8. Provision is made for energizing the filament of the master oscillator tube during the periods in which the equipment is shut down. Power for this purpose is obtained from the 440 volt supply line through distribution transformer T-104 and M.O. filament transformer T-102. A suitable switch is provided on the transmitter panel to permit selection of standby operation or to permit the oscillator filament to be extinguished during idle periods. Power is automatically made available for standby operation, when desired, through the medium of contactor K-102. Resistor R-129, of 25 ohms value, is used to adjust the primary voltage applied to transformer T-102 when standby operation is selected, so that the filaments of the M.O. tube operate at a suitable potential. Measurements made at the tube contacts showed that with a line voltage of 438 volts, the M.O. standby filament potential was 9.88 volts.

127. Par. 3-9. A neutralizing circuit, containing variable air capacitor C-136 is provided for the purpose of neutralizing the power amplifier circuit. During the course of the tests conducted, evidence was noted that neutralization was not complete and satisfactory.

(a) As discussed in paragraph 104(b) above, parasitic oscillations were encountered during the power output tests conducted in the region of 600 kilocycles. This condition was alleviated by changing

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the value of resistor R-131, in series with the grid of the P.A. tube, from 10 ohms to approximately 40 ohms. However, this increase in resistance had the effect of reducing the power output. Later, during the tests conducted to determine the effect of varying ambient temperatures and relative humidity, difficulty was again experienced due to self oscillations in the power amplifier circuit. A thorough investigation conducted by representatives of the contractor failed to disclose the exact underlying cause for this faulty operation. The self oscillations disappeared when a new tube was placed in the power amplifier circuit. The 38151 tube which had been in the circuit was tested and found to suffer from a lack of emission. The previous history of the tubes submitted by the contractor is not known and hence no real basic conclusions can be drawn from the phenomena encountered during these tests. In other words, it cannot be stated that faulty operation and the presence of self oscillations was due to defective tubes, or that some fundamental defect in the transmitter circuits caused the tubes to fail.

(b) The phenomena discussed above apparently fall into two separate classes. One is a condition of high frequency parasitics, which can be minimized if not entirely cured, by inserting non-inductive resistance in the grid of the power amplifier tube. The other condition is one in which the power amplifier will continue to oscillate at a frequency determined by the constants of the P.A. tank circuit and hence may be at or close to the frequency established by the master oscillator circuit. This latter condition is closely allied to or may be caused by the characteristics of the vacuum tube being employed in the circuit.

(c) The methods employed to overcome these difficulties were meliorative in character. It is believed that studies should be undertaken to determine the underlying causes and that these causes should be eradicated before the Model XTBU equipment can be considered suitable for Naval service.

128. Par. 3-10. The design of the keying circuit is such that all tubes cease to oscillate when the key is open, including the audio oscillator tube. Satisfactory keying was obtained at speeds up to 100 words per minute.

129. Par. 3-11. The frequency range of the transmitter unit is divided into several ranges as follows:

(1) The Master Oscillator Circuit is provided with a range switch, Control "B". This control is equipped with 10 taps. Table 38 lists the degree of overlap existing between the various taps and it will be noted that in all instacnes the specification value of 3% overlap and end tolerance has been exceeded.

(2) The range of the Intermediate Amplifier Circuit is divided into six steps. As illustrated in Table 39, overlap and end tolerances in excess of 3% are provided in all cases. The limiting frequencies at the low end of the range is determined by the Master Oscillator circuit, hence the end tolerance at this point is in excess of 5.8%. (See Table 38.)

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(3) The range of the power amplifier circuit is divided into six steps. Ample overlap and end tolerances are provided, as illustrated in Table 40.

(4) Table 41 shows the degree of overlap existing in the antenna circuit when operating into antenna constants as indicated. The entire frequency range was covered without hiatus, which is in accord with the terms of the governing specifications, as amended by Contract Note, page 4, since no fixed capacitors are employed in the antenna tuning system.

(5) Interlocks have been provided on the following controls:

Control "H", PA Range Switch, interlock in key circuit
Control "J", Antenna Tap Switch, " " " "
Tune-Operate Switch, interlock opens M.G. fields.

The interlock contacts on the Tune-Operate are practically inaccessible for servicing operations. The interlock on Control "H", while somewhat more accessible, is still difficult to service. The interlock on Control "J" is fairly accessible, but is not reliable, as discussed under paragraph 36(b) above. Controls "F" and "G", Antenna Coupling switches, are not provided with interlocks. If these controls are changed while the transmitter is operating key locked, destructive arcing occurs. The remaining controls are not interlocked and may be operated with power on without injury due to arcing. In general, the interlocks provided are not entirely satisfactory and further consideration should be given to this subject.

130. Par. 3-12. The controls by means of which the transmitter is adjusted have been kept down to a practical minimum. A list of these controls will be found in Table 1.

131. Par. 3-13. Each tuning control is identified by a nameplate located near or on the control, indicating the function of the control. Additionally, each tuning control is given a designating letter, as indicated in Table 1. These nameplates are easily readable and of pleasing appearance.

132. Par. 3-14. Provision is made for mounting on the front panel of the transmitter, under a transparent waterproof shield, a calibration card suitable for recording reset data for 12 frequencies. The visible portion of the card measures 2-5/8" x 5-3/8". Provision is made for four extra cards to be mounted behind the active card.

133. Par. 3-15. Vernier control is provided on the master oscillator circuit by means of positive gearing. Table 42 lists the variation of resonant frequency per division of marking of the master oscillator dial. The average frequency range per division is 0.014%, which complies with specification requirements. The remaining controls permit satisfactory and non-critical adjustment of the circuits.

134. Par. 3-16. Suitable friction type locking devices have been provided on each continuously variable control to prevent accidental movement of the control. These devices are of such a type that they do not adversely affect the calibration of the circuits. The degree of frequency change resulting from the operation of the locking devices is illustrated in Table 43. The design of all locking devices is such that no sharp edges or corners are presented which interfere or which might injure an operator's hand when the controls are manipulated rapidly.

135. Par. 3-17-1. Adjustable positioning devices have not been provided in connection with the Model XTBU controls.

136. Par. 3-17-2. In order to expedite adjustment of the equipment to frequencies for which the equipment has not been previously calibrated, coupling and terminating facilities have been provided to facilitate the use of standard frequency measuring equipment.

137. Par. 3-17-3. A pick-up circuit has been provided in the Model XTBU transmitter, which is connected through shielded leads to a pair of terminals located on a terminal board near the bottom of the transmitter. This pick-up circuit consists of a lead covered cable with a few inches of the lead sheath removed. This exposed portion is located adjacent to the master oscillator tube. In addition, an output jack is located on the front panel of the transmitter which is connected to a pair of terminals on the terminal board near the bottom of the transmitter.

138. Par. 3-17-4. The coupling circuit produces in excess of 100 millivolts output over the frequency range of 150 to 1,000 kilocycles, as illustrated in Table 44 attached hereto. It will be noted that the voltages were measured at the frequency of the master oscillator circuit; i.e., half the frequency of the output circuits. These measurements were made with the Adjust-Tune-Operate switch in the "Adjust" position. Since it is desirable to adjust the frequency of the transmitter without emitting a signal, it will be necessary for the operating personnel to make measurements at half frequency and this procedure should be thoroughly explained in the instructions covering the operation of the Model XTBU equipment.

139. Par. 3-17-5. The output phone jack for the frequency measuring equipment is located at approximately mid-panel height on the left hand side of the transmitter. This jack is not in agreement with Bureau of Engineering Drawing RE 49AA 147A and is not provided with a shield or cup. From the contractor's letter of November 20, 1939, paragraph 4, it is understood that definite plans were not available at the time the Model XTBU equipment was submitted for inspection, but that the necessary changes will be made when approved drawings are available. It is further noted, from paragraph 11 of reference (a), that the suitability of jack and cup arrangement will be determined by the Resident Inspector at the contractor's plant.

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140. Par. 3-17-6. The terminals provided on the terminal board are marked "For Frequency Meter," one pair of terminals being marked "Audio Output" and the other pair "R.F. Coupling." The jack on the panel is marked "Frequency Meter Audio Output."

141. Par. 3-18. The Model XTBU equipment is so designed that when shifting from one frequency to any other frequency, or from one type of emission to another, it is possible to do so without readjusting the filament, plate or bias controls.

142. Par. 3-19. A three position switch is incorporated in the equipment to facilitate tuning and frequency shifting operations. This switch operates in the field circuit of the main plate generator. The voltages available with the switch in its various positions are listed in Table 45 appended hereto.

143. Par. 3-20. A test key arranged for key open, momentary key closed and key locked has been provided. The key provided is of the Gamewell type and is a single pole double throw. From the correspondence submitted with reference (a), it is noted that the Bureau desires the test key to be of the double pole double throw type in order to provide an additional set of contacts and in the interests of standardization. The contractor states that the double pole type of test key will be provided in production equipments. The test key as provided is mounted for vertical operation and provides key locked control in the "up" position, key open in the center position and momentary contact in the "down" position. The key is of rugged and substantial construction and operated in a satisfactory manner during the course of the tests.

144. Par. 3-21. The design of the circuits is such that all oscillations cease when the transmitter key is open. Listening tests on receivers located adjacent to the transmitter indicated no undue interference from the motor generator or other parts of the equipment. The opening and closing of switches causes the usual momentary clicking interference.

145. Par. 3-22. No rotating equipment, other than the motor generator, is used in the Model XTBU equipment.

146. Par. 3-23. By means of the main plate generator field rheostat, it is possible to vary the power output of the transmitter from the maximum value to a minimum value of less than 25%. This variation in power output is illustrated in Table 15 attached hereto. It is possible to adjust the power output while the set is transmitting. In order to obtain finer adjustment of plate voltage, particularly at the higher end of the range, it is recommended that a modified plate rheostat be considered, as discussed in paragraph 38 above.

147. Par. 3-24. Indicator lamps have been provided on the panel of the transmitter to indicate the following functions:

(1) When bias voltage is supplied to the transmitter.

(2) When plate voltage is supplied to the transmitter.

[redacted]

(3) When the starting contactor is energized.

148. Par. 3-25. Meters have been provided to indicate essential functions. A list of meters will be found in Table 1. 10 volt and 11 volt filament potentials are used in the Model XTBU transmitter. The circuit arrangement is such that the filament voltmeter must be adjusted to read 11 volts in order to obtain proper filament potentials. It is recommended that provision be made to indicate the proper setting of the filament voltmeter, since past experience indicates that there is danger of operating the filaments at improper potentials if no definite instructions appear on the panel of the transmitter. It is suggested, therefore, that the proper setting (11 volts) be definitely marked on the filament voltmeter by means of a red line, or that a small nameplate be placed adjacent to the filament voltmeter bearing the legend "Adjust filament voltmeter to 11 volts."

149. Par. 3-26. A tube life meter has been provided to register the tube life of the power amplifier tube. This meter registers up to 10,000 hours by tenths and is of the self starting type rated at 120 volts, 60 cycles.

150. Par. 3-27. The dimensions of the transmitter unit are listed in Table 5. The dimensions conform to the requirements of this paragraph, as amended by paragraph 11-3-10. Contract Note, page 4, indicates the desire that every effort be made to maintain the width of the transmitter within the 32-inch limitation. It will be noted, however, that the Model XTBU transmitter as submitted is 34 inches in width. The transmitter unit consists of a single section with a removable unit containing the M.O. and I.P.A. circuits.

151. Par. 3-28. The dimensions and assembly of the equipment are such that it complies with the specification requirements and will pass through hatches of the size specified in paragraph 2-33 of the specifications.

152. Par. 3-29. The transmitter unit includes, integral with its assembly, all vacuum tubes, radio frequency circuits, meters, filament transformers, relays and filters for the motor generator equipment. These filters are in the form of by-pass capacitors located in the transmitter unit.

153. Par. 3-30. In general, the shielding and wiring of the transmitter are in accordance with the intent of the governing specifications. Certain details require further consideration as discussed below.

(a) The transmitter is shielded on all six sides and the various circuits within the transmitter are shielded from each other. The shields are secured to the transmitter frame by means of non-removable knurled head studs.

(b) Lead sheathed wires are used for non-radio frequency circuits except in such instances where a higher degree of flexibility is required.

[redacted]

The lead sheaths are protected by means of felt buffers at locations where injury might result were no additional protection provided. The lead sheaths are spotted together and grounded.

(c) A number of items of wiring are not up to the usual production standard of the contractor, particularly in appearance, but it is realized that a condition of this nature is likely to occur in connection with preliminary models. The contractor states, in paragraph 65 of his letter of November 20, 1939, that production wiring will be better than exhibited in the Model XTBU since wiring will be bench formed.

(d) The matter of flexible leads or cables in the Model XTBU requires further consideration. In general, the practice is to employ so-called Packard cable for this purpose. The experience of Naval radio personnel indicates that cable of this nature suffers through aging, particularly when the cable is subjected to high temperatures. The cable may deteriorate to such an extent that both the fabric covering and the rubber insulation disappear.. In the case of the Model XTBU equipment, due to the removable unit construction, the use of tapped resistors and the employment of 803 tubes, a far greater number of flexible cables are required and hence a larger amount of Packard cable has been used than was generally the case in previous equipment. During the course of the tests conducted at the Naval Research Laboratory, it was noted that the lugs have a tendency to work loose from the cable thus placing the entire stress on the wire itself where it is soldered to the lug. In the presence of heat the cables become hard, discolored and brittle. This is particularly true of the cables used to make connections to the plates of the 38803 vacuum tubes.

(e) In paragraph 50 of the contractor's letter of November 20, 1939, the Inspector of Naval Material recommends the use of slow burning wire. The contractor recommends the use of #16 26/30 Rockbestos Radio Hookup Wire which has pliofilm and filled asbestos insulation covered by a glass yarn braid. On page 8 of reference (a), the Bureau of Engineering indicates that while the proposed use of Rockbestos wire may be satisfactory, reports received from certain sources indicate that under conditions of high humidity the insulation may not prove to be entirely suitable. There is another type of cable which has been supplied for use under conditions of this character. This cable consists of a stranded wire conductor insulated with numerous layers of varnished cambric and covered with a black woven sleeving or fabric. This fabric covering is not varnished as is the case with Packard cable. The cable is sufficiently flexible and appears to be satisfactory in all other respects. No information is available, however, as to the ability of the cable to withstand aging. The foregoing summary indicates that the solution of this problem may best be arrived at by a joint conference of all interested activities at which time all available information should be submitted and weighed.

154. Par. 3-31. All electrical indicating instruments and external multipliers, except r-f instruments, are protected by by-pass condensers. The meters themselves are by-passed by capacitors of

0.006 microfarad rated at 1,000 volts. The main plate multiplier is by-passed by a 0.005 microfarad 3000 volt condenser and the M.O. voltmeter multiplier by 0.03 microfarad 2500 volt unit.

155. Par. 3-32. Vacuum tubes are lighted from the main alternating current supply through the medium of the distribution transformer, T-104, and filament transformers, T-102 and T-103. The secondaries of the filament transformers are tapped at their mid-points. The primary windings of the filament transformers are provided with taps connected to terminals having adjustable links to permit operation from three different voltage supplies. As connected in the transmitter, these transformers were operating at approximately 100 volts primary. The primary of transformer T-104 is designed for 220/440 volt operation and the secondary for 110/220 volts. None of the transformer nameplates can be seen without removing the transformers from the transmitter. All terminals on all transformers are marked by designating numerals and in the case of the filament transformers, the secondaries are marked with voltage and current characteristics. The numbered markings, however, are not sufficient to indicate in what manner the various primary and secondary links should be shifted to obtain different voltages, nor is information given to indicate the values of these voltages. It is recommended that the transformer terminal panels be marked in a manner complete enough to give this information.

156. Par. 3-33. The transformers functioned satisfactorily during the complete tests without any signs of undue heating. The transformers are air cooled and are of a compact design. Suitable terminals mounted on terminal panels are provided, but as pointed out in paragraph 155 above, additional markings are required to assist in making the proper connections for the various voltages available.

157. Par. 3-34. Table 46 illustrates the degree of regulation existing in the transformers supplied under a variety of conditions and also contains pertinent data relative to other characteristics of the transformers. It will be observed that the regulation is less than 1% when the transmitter is keyed and that a sufficient range of adjustment is available to maintain the various tubes within their specified working tolerances.

158. Par. 3-35. The transmitter unit is so constructed that:

(1) It can be installed with its back flush against a bulkhead. All parts are accessible from the sides or front when the equipment is so installed, with the exception of Reactor L-113, as discussed in greater detail under paragraph 77 (d) above.

(2) The transmitter foundation or pedestal consists of two 4-inch channels located at the front and rear edges of the unit. This leaves the sides of the base open so that connecting cables may be brought in from either or both sides. Six bolt holes are provided for securing the transmitter to the deck. These holes are 9/16-inch in diameter and three are located in the front channel and three in the rear channel. The foundation fittings proved to be of ample strength during the inclination tests to which the equipment was subjected.

[redacted]

(3) All cable connections can be effected at terminal boards located at the bottom front of the transmitter. Access to these terminal boards is provided through the interlocked bottom door of the transmitter. The lower edges of the panels are 4 inches above the deck while the lower edges of the terminal boards are 4-1/8 inches from the deck. The arrangement is such that all cables may enter the transmitter on the same deck level. Suitable lugs were provided for connection of external wiring. The terminal strips are so disposed and wired that the most accessible terminals are retained for the external wires.

(4) The renewal of vacuum tubes and adjustment of relays and other auxiliaries may be accomplished through access doors in the front panel. Additionally, an even greater degree of accessibility is provided by the removal of the Master Oscillator Intermediate Amplifier Unit.

(5) The keying relay is mounted just inside the top access door and may easily be removed for servicing or replacement. Operation of contacts may be observed through perforations in access door.

(6) The antenna connection is made through a 4 inch diameter hole in the top panel. The panel is reinforced around the edge of the hole by a 5/8-inch wide 5/32-inch thick ring of metal welded to the shield. The edges of the hole are not rounded. Due to the high antenna potentials which are likely to exist under service conditions, efforts should be made to remove sharp points at this location. Connection to the antenna terminal in the interior of the set is provided in the form of a terminal on a corona shield capped isolantite insulator 1-3/4-inches in diameter by 3 inches in length. A special rounded nut is used on this terminal to prevent corona or arcing. The nut is provided with two flat sides. To tighten this nut a 5/8 inch wrench is necessary. However, the ordinary wrench of this size cannot be used in the space available when the top shield of the transmitter is in place. A substantially constructed safety gap is provided between the antenna terminal and ground to prevent excess voltages causing damage to the equipment. This feature should prove of distinct value under conditions of service use. To further improve the antenna connection facilities, it is suggested that the Bureau consider the advisability of providing an antenna connection of the type discussed in paragraph 87(f) and illustrated in Plate 28 of Naval Research Laboratory Report No. R-1553 of 14 August 1939.

159. Par. 3-36. The side, rear, and top shields of the transmitter unit, as well as the tube access doors, are perforated with holes 3/8-inch in diameter and with approximately 440 holes per square foot. Side and rear shields are held in place with knurled head thumb screws. The heads of the screws which are 5/8-inch in diameter are slotted to permit the use of a screw driver if desirable. It is difficult to remove the panel shields under certain circumstances and it is recommended that each shield be provided with two small handles or knobs located near the top of the shield. Knobs of this nature will permit removal of shields without difficulty. The top shield is secured in place by means of round head machine screws. The shields are divided in such a manner that no shield exceeds 38 inches in length.

[redacted]

160. Par. 3-37. No access doors are employed on the sides of the transmitter, all access doors being in the front panel.

161. Par. 3-38. Three access doors are provided in the front panel. These doors are equipped with continuous brass hinges and are equipped with suitable stops to protect the hinges against excessive strain and to hold the doors in the open position. The two upper doors are perforated to permit observation of the vacuum tubes and keying relay. All doors are of the overlapping type, provided with interlocks and are of sufficient size to permit easy access and replacement of vacuum tubes. The dimensions of the door openings are as follows:

P.A. Tube Access: 10-5/8" high by 8-1/2" wide.
M.O., A.O., and IPA Access: 16-1/8" high x 5-5/8" wide.
Terminal Board and Relay Access: 7-5/8" high x 29-5/8" wide.

162. Par. 3-39. Insulated hand rails of sturdy construction are provided at each side of the front panel. Relevant dimensions are as follows:

Diameter of rails: 1-1/8"
Length of rails: 24"
Top of rail to deck: 4', 9-1/4"

163. Par. 3-40. A blocking condenser, C-147, is provided between the P.A. plate and antenna tuning circuits to prevent high potential D.C. from reaching the antenna. This capacitor is rated at 0.005 microfarad, 5000 volts, 11 amperes at 1,000 kilocycles. During the course of the tests, this capacitor failed as described in paragraphs 34(a) and 40 above. A temporary replacement capacitor was provided by the contractor in order that tests could be continued. In order to determine whether this capacitor was being overloaded, the current through this circuit was measured. The maximum currents noted are listed below:

1500 kilocycles - 2.6 amperes
300 kilocycles - 2.0 amperes

Hence it appears that the capacitor was not being subjected to overloads and it must be concluded that the capacitor was originally defective.

164. Section V, Transmitter Control. The requirements of this section of the specifications have been modified in accordance with contractor's Descriptive Specifications R-1063 and associated correspondence originating in the Bureau of Engineering and the Office of Inspector of Naval Material, Baltimore, Md. In general, the 4-wire control circuits have been eliminated in favor of an arrangement which permits the use of either 6-wire or 4-wire controls. In the following paragraphs such items of the original specifications as still apply will first be discussed, after which the modified circuits will be considered.

165. Par. 5-6. The keying relay is an integral part of the transmitter unit and provision is made on the terminal boards of the transmitter for connection of all monitor and remote control lines.

[redacted]

This relay controls the emission of the transmitter for telegraphic signalling. The relay furnished is equipped with additional contacts which are not used and no connections are made to these contacts.

166. Par. 5-7. The keying control circuit is so arranged that the keying relay cannot be energized before the motor generator has attained normal operating speed.

167. Par. 5-8. The keying relay operates satisfactorily at speeds up to 100 words per minute. The coil circuit of the key relay is energized from the 230 volt bias generator through the medium of a potentiometer connected across the output of the bias generator and a 250 ohm series resistor R-107. The actual potential applied to the relay coil and the current through the coil are as follows:

Key relay potential - 92 volts
Key relay current - 120 milliamperes

The control key breaks only the current flowing through the relay coil, or 120 milliamperes.

168. Par. 5-24. The following relays are used in the Model XTBU transmitter:

D-C Operated Relays

Part No.	Function	Relay Coil Voltage
K-101	Keying	92 volts (120 milliamperes)
K-104	MO and AO Overload	
K-105	PA Overload	
K-106	IA Overload	

A-C Operated Relays

K-103	Field Contactor	110 volts (340 ma)
K-102	Master Start	45 volts (93 ma)

The a-c operated relays obtain operating voltage from the Distribution Transformer T-104, which is described in detail in paragraph 155 above. The voltage rating of the master start relay coil is not marked. Due to the special voltage requirements, it is recommended that this information appear on the nameplate to prevent accidental use at 110 volts.

169. Par. 5-25. The relays and contactors incorporated in the Model XTBU equipment operate in a quiet and efficient manner without undue noise or hum.

170. In the following paragraphs, reference is made to the diagrams and memorandum covering 4-wire and 6-wire control circuits referred to in paragraph 4 of reference (a). The numerals listed correspond to the paragraph numbers appearing in the above mentioned memorandum.

[redacted]

171. Requirements for Transmitter Control Circuits - AC and DC Supply: General. The Model XTBU equipment is designed for use with either 4-wire or 6-wire control circuits. The equipment is provided with the necessary switches and facilities to provide this type of operation.

(1) A "Local-Remote" switch is provided on the front panel for use with either 4 or 6-wire control. When on "local", this switch renders the remote control units inoperative. When on "remote", control is available at the remote unit and at the panel of the transmitter, although with 4-wire control the start-stop switch on the transmitter panel must also be in the "start" position for control at the remote station.

(2) An emergency toggle switch is provided which, when thrown to the "Stop" position, removes all power to the equipment with the exception of the 440 volt lines to Transformer T-104 and the 110 volt control voltage obtained from this transformer. In addition, if the MO standby switch is in the "on" position, the MO filament remains lighted irrespective of the position of the emergency switch. The motor generator cannot be restarted with the emergency switch in the "Stop" position.

(3) Terminals have been provided on the transmitter terminal panel for connecting either 4 or 6-wire remote control units. Links are also provided on this panel for use in changing from 6 to 4-wire systems. Numbering of the terminals corresponds to that designated in the governing specifications.

(4) Interchangeable start-stop switches are provided to enable the circuits to be changed from 4-wire to 6-wire control. No change in the switch plate is necessary and the modification can readily be made when necessary. The 4-wire start-stop switch, however, is of such a design that it is necessary to depress the buttons almost beneath the level of the panel. This is an annoying condition which interferes with clean-cut and concise operation. It is recommended, therefore, that a more suitable start-stop switch be provided.

(5) The transmitting equipment under test is designed for operation from a primary source of 440 volts, 3 phase, 60 cycles. Hence keying potential is derived from the bias-exciter generator, which has a nominal output of 230 volts. This voltage is reduced to the required value by means of a potentiometer.

(6) Motor starting relay K-301, master start relay K-102 and field contactor K-103, operate from the 115 volt a.c. supplied by the secondary of transformer T-104. Indicator lamps are of the 18 volt type with series resistors for operation on 115 volts a.c. except for the bias indicator which is supplied from a suitable tap on the potentiometer across the bias generator output. Remote control units are provided with 115 volt a.c. indicator lamp supply.

[redacted]

(7) Keying potential is not available until the motor generator equipment has been started and reaches full operating speed.

172. Requirements for 6-wire remote control circuits - A.C. and D.C. Equipment.

(1) The equipment may be started or stopped locally by means of a two button momentary contact, normally open, switch. This feature is operative when "local-remote" switch is in either the "local" or "remote" position. The equipment may also be keyed locally.

(2) The equipment may be started, stopped, and keyed from any connected remote unit after the "local-remote" switch is placed in the "remote" position.

(3) The local indicator lamp is connected, through a series resistor, in parallel with the master start relay and current limiting reactor L-113.

(4) The remote indicator lamp is connected in parallel with the local indicator lamp when "local-remote" switch is in "remote" position. In order to complete this parallel circuit, however, it is necessary for the emergency switch S-102, interlock switches S-104, S-105 and S-106, and contacts of K-105, K-104 and K-102 to be closed.

173. It is possible to obtain the required operation with more than one remote station; i.e., two or more remote stations in parallel. Under these conditions all remote indicators would be illuminated regardless of the position from which the equipment was started.

174. Requirements for 4-wire remote control circuits - A.C. and D.C. equipments.

(1) The equipment may be started or stopped locally by means of a double push button switch when the "local-remote" switch is on "local." The equipment may be stopped locally when the "local-remote" switch is in the "remote" position or started and keyed locally if the remote starting switch is in the "on" position and the local-remote switch is in the "remote" position.

(2) The equipment may be started, stopped and keyed from a remote unit after the local start switch is placed in the "on" position and the "local-remote" switch is placed in the "remote" position.

(3) The local indicator lamp is connected, through a series resistor, in parallel with the master start relay and current limiting reactor L-113.

(4) The remote indicator lamp is connected in parallel with the local indicator lamp and its series resistor when the "local-remote" switch is placed in the "remote" position. The circuit is completed through switches S-102, S-104, S-105, S-106, and contacts of K-102, K-104, and K-105.

[redacted]

175. Comments on 4-wire and 6-wire control circuits. Below are listed certain conditions under which an operator at a remote station would believe that the transmitter was capable of delivering keyed power, judging by the remote indicator light, but would find that the transmitter was actually inoperative.

(1) If motor thermal overload is open.
(2) If bias generator fuse, F-212 or either of the high voltage fuses F-211 and F-221, were open.
(3) If antenna tap switch "J" is open.
(4) If "Adjust-Tune-Operate" switch is in incorrect position for operation.
(5) If "local-remote" switch is not turned <u>fully</u> to the remote position.
(6) If Intermediate Amplifier overload relay is open. (This relay opens field contactor.)

(Note: Condition (5) above should be corrected by substitution of a more satisfactory switch with positive positioning and no open or center position.)

176. Additional comments on 6-wire control circuit.

(1) Interruption of the supply line voltage to the equipment, or interruption of the interlock circuits due to opening of a door or operation of overload relays K-104 or K-105, will shut down equipment and extinguish local and remote indicator lights. Closing of the circuit will not restart the equipment. Starting must be accomplished by depressing the start button of the "start-stop" switch.

(2) No grounds are present on the A-C control circuit.

177. Additional comments on 4-wire control circuit.

(1) Interruption of the supply line voltage or of the interlock circuits will shut down equipment and extinguish local and remote indicator lights. Reclosing of these circuits starts equipment immediately.

(2) The a-c control circuit is grounded.

178. Concise and satisfactory instructions were submitted for changing from 4-wire to 6-wire, or vice versa, control. Three links are involved in making the changes, two of which are located on the main terminal panel of the transmitter and the other on a small sub-terminal panel located near the start-stop switch.

[redacted]

179. Par. 6-1. The following paragraphs of this report comment in detail upon the operation and performance of the power equipment supplied with the Model XTBU equipment.

180. Par. 6-2. The power equipment supplied is designed for operation from 440 volts, 60 cycle, 3 phase power. The motor is capable of operation from either 220 or 440 volts. The magnetic controlled furnished was designed for 440 volt operation and all tests were conducted at this potential.

181. Par. 6-3. The equipment, including motor generator and starter, was subjected to ± 10% variations in line voltage and the power equipment functioned satisfactorily. No means were available for changing the frequency of the supply voltage.

182. Par. 6-4. The power equipment was subjected to numerous full power key locked tests for varying periods of time ranging up to 8 hours. During these tests the ambient temperature was varied between the limits of zero and 50° C and the relative humidity was varied from a low value to 95% at 40° C. No overheating, breakdowns or unsatisfactory performance were noted during the course of these tests.

183. Par. 6-5. The total power required for operation of the Model XTBU equipment and the power required for various conditions of operation are listed in Table 47 attached hereto. This table also indicates the power required for +10% of normal line voltage. In no case is the specification requirement of 8500 watts exceeded. In general, full power cw operation is obtained with an input of approximately 4500 watts.

184. Par. 6-6. Power for the filament lighting transformers is obtained from the 440 volt 60 cycle line through the medium of a step-down distribution transformer which permits the filament transformers to operate at primary voltages of 110/220 volts.

185. Par. 6-7. The power required for the vacuum tube plate, screen grid and control grid bias circuits is obtained from motor driven generators.

186. Par. 6-8. D-C power required for the excitation of the motor generators involved and for auxiliary use is obtained from the bias generator which has a nominal rating of 230 volts. The nameplate attached to the bias generator indicates that the rating of this generator is 900 milliamperes at 230 volts. Actual measurements of the load on this generator, exclusive of that required for self-excitation, is as follows:

Main generator excitation:	360 milliamperes
MO Plate excitation:	282 milliamperes
Potentiometer, indicators, key relay,etc., in transmitter unit:	418 milliamperes
Total:	1060 milliamperes

[redacted]

No signs of overheating or other trouble were noted from this apparent overload and the generator functioned satisfactorily during the course of the tests. Assurance should be obtained, however, that the contractor considers this type of operation satisfactory for service use over extended periods of time.

187. Par. 6-9. The power equipment as supplied consists of a 6 h.p. 220/440 volt, 3 phase, 60 cycle motor driving a single small commutator main plate generator rated at 2300 volts and a double commutator auxiliary generator which furnishes power at 230 and 1000 volts. The three units are assembled on a common bed plate.

188. Par. 6-10. The motor generator furnished is of 3-unit, 6-bearing construction. Since only an a.c. motor was submitted, it was impossible to determine whether a d.c. motor could be substituted for the a.c. motor without requiring movement of the generators or machining of the bed plate.

189. Par. 6-11. The length of the largest armature assembly furnished with the equipment is 28 inches which is well within the specification limit of 36 inches.

190. Par. 6-14. The design of the power equipment is such that two generators are not connected in series in order to obtain the necessary potentials.

191. Par. 6-15. The couplings furnished are of the 6-bolt type with leather middle section. The overhang on the coupling flanges is not deep enough to adequately shield the bolts. The bolt ends extend beyond the flange overhang limits and present a potential source of danger since it would be possible for clothing, lines, and so forth to catch on these bolts. Couplings providing a greater degree of protection should be employed or substantial guards, proof against vibration and deformation should be fitted over the couplings.

192. Par. 6-16. The motor and generators are mounted on a common bed plate. The bed plate is a casting of substantial design and construction. The bed plate is provided with base slots to permit lifting the entire assembly. Lifting eyes are provided for lifting the individual units. Any individual unit may be removed without disturbing the position of the other units and without removing the bed plate from its normal position. The units are secured to the bed plate by means of 3/8"/16 cap screws, four to a unit, and 5/16" taper pins with 1/4" square heads. These dowels, two per unit, are located on diagonal corners. It is noted that shims are used under the base of the low voltage generator and under the driving motor in order to obtain proper alignment. If possible to do so, it is recommended that manufacturing tolerance be made such that shims are not required, in order to prevent loss or transportation of shims during servicing operations.

193. Par. 6-17. All motor and generator frames are grounded to the main bed plate, which in turn may be secured to the station ground upon installation. All metal cover plates on terminal boxes are of

[redacted]

heavy cast construction and are provided with rubber gaskets to prevent entrance of water. The terminal boxes are of strong construction and will withstand a weight of 250 pounds without bending or deformation.

194. Par. 6-18. Each individual unit of the motor generator assembly is fitted with an eyebolt of sufficient strength to permit hoisting the individual unit, while the bedplate is equipped with lifting slots for hoisting the entire assembly. Warning plates are affixed adjacent to the eyebolts directing that the eyebolt be used for lifting the individual unit and not the entire assembly. For details of this nameplate refer to Table 4.

195. Par. 6-19. The dimensions of the motor generator equipment comply with the requirements of the governing specifications, as listed in Table 5.

196. Par. 6-20. The motor generator is fitted with ball bearings, but the type of bearings could not be ascertained without complete disassembly.

197. Par. 6-21. Suitable nameplates specifying the grade of lubricant to be employed have been provided on each unit. Size and wording of nameplates are listed in Table 4.

198. Par. 6-22. The outboard end of the low voltage generator shaft is not marked in accordance with this requirement of the governing specifications. The outboard end of the high voltage generator shaft is hollow for a distance of 16 inches. The inside diameter of the shaft is 7/8" and the outside diameter is 1-1/16" at point of support at outboard ball bearing. Since this is a type of construction not previously encountered, the contractor should be requested to state the advantages of this design and give assurance that the shaft is of adequate strength to insure uninterrupted operation under service conditions. No difficulties developed on this score during the course of the tests.

199. Par. 6-23. The output terminals of the generators are provided with protective fuses. The fuses are housed in the generator terminal boxes. The interior dimensions of the terminal boxes are:

Width:	8-1/2"
Height:	5-13/16"
Depth:	4-1/4"

These dimensions provide ample clearance around the fuses. The sides of the terminal boxes opposite the fuse ends are lined with insulating fiber to prevent expelled gases from causing short circuits. The fuses in the 1000 volt and 2300 volt circuits are mounted on corrugated isolantite insulators which in turn are secured to a bakelite base panel. The following fuses are provided.

MO Generator, F-211, HV Littelfuse, 5000 V, 1/2 ampere, No. 3024
PA Generator, F-221, HV Littelfuse, 5000 V, 2 amperes, No. 3026.
Bias Generator, F-212, Renewable Cartridge, 250 volts, 3 amperes.

[redacted]

The fuse holders are marked with the part number but are not marked with respect to voltage and current ratings. To conform with the requirements of paragraph 2-10-1 of the governing specifications, voltage and current ratings should be marked. The high voltage Littelfuses may be renewed if proper facilities in the form of a threading needle and proper fuse wire are available. The fuse clips holding the bias generator fuse are not properly spaced and it is difficult to insert the fuse. Precautions should be taken to insure that proper spacings are provided.

200. Par. 6-24. In accordance with past procedure, the generators were not deliberately subjected to short circuit tests.

201. Par. 6-30. The direct current generators supplied have been designed in accordance with the requirements set forth in this paragraph of the specifications as far as could be determined without disassembly or detailed tests of component parts.

202. Par. 6-31. The voltage regulation of the various generators supplied is illustrated in Table 48. In all cases the regulation is well within the 5% specified. The percentage of ripple present in the output of the various generators, both no load and full load condition, is listed in Table 49. In no instance was the specification value of 0.25% exceeded.

203. Par. 6-33. The alternating current motor supplied with this equipment has been designed in accordance with the requirements of this paragraph of the governing specifications as far as could be determined without disassembly or detailed tests of the component parts. The motor performed satisfactorily during the course of the tests conducted.

204. Par. 6-34. The magnetic controller provided is in accordance with the requirements of this paragraph of the specifications and is provided with thermal overload protection of low voltage release type.

(a) In order to check the operation of the protective device one phase of the supply line was opened. Thermal overload relay K-302 opened in 11 seconds with the relay setting adjusted to 100%, if the motor generator set was initially stationary. When the motor generator was running under no load, opening the phase had no effect upon motor speed or thermal overload device. Opening one phase with the generator carrying full key locked transmitter load caused no perceptible change in motor speed. The thermal overload arm moved slowly for about 10 minutes, at which time it apparently reached equilibrium temperature. It did not open after 16 minutes of this type of operation. The temperature of the motor casing did not indicate severe overheating of the motor, although warmer than normal. However, it must be assumed that under continued operation, the motor would overheat.

(b) The control circuit of the starter is protected by fuses F-101 and F-102 in the transmitter unit.

[redacted]

(c) As required by separate correspondence listed in paragraph 3 of reference (a), the magnetic controller is equipped with a 3-pole disconnect switch. This switch is of substantial construction and is capable of opening the circuit under full load. It is impossible to open the door without first opening the switch. However, it is possible to close the switch with the door open. Switches have been submitted which cannot be closed while the door is open and it is recommended that the Bureau consider the advisability of providing this feature in connection with the Model XTBU equipment.

(d) The starter box is constructed of 3/32" sheet steel, while the cover is fabricated from 1/16" sheet. Means for fastening to the bulkhead is obtained by extending the back of the box at top and bottom 1-1/4". These extensions are each provided with two bolt holes for 3/8" bolts. The starter is finished with light gray enamel, which does not correspond to the standard finish for Naval Radio Rotating Power Equipment, Controllers and Accessories as authorized by the Bureau of Engineering.

(e) The dimensions of the starter are within the specification limitations, as illustrated in Table 5.

(f) Page 2 of Bureau of Engineering letter C-NOs-66593(5-20-R6) of 23 May 1939 to Resident Inspector of Naval Material, Westinghouse Electric and Manufacturing Company, Baltimore, Md., requests that a suitable warning plate to indicate the presence of 440 volts be located on the door of the starter. No warning plate was provided with the preliminary model. In this connection the attention of the Bureau is invited to a design of starter wherein precautions are taken to completely shield or cover all parts carrying 440 volt potentials when the door of the starter is open. An insulating cover is placed over the terminals to which the 440 volt line is connected and the live parts of the switch, (jaws) are protected by insulating baffles. In this design accidental contact with 440 volts is practically impossible, unless a deliberate effort is made to circumvent the precautionary measures supplied.

205. Par. 6-35. The high voltage filter capacitors for the motor generators are located within the transmitter unit.

206. Par. 6-36. The door of the starter cabinet is provided with removable hinge pins which are secured to the starter box by means of short lengths of chain.

207. General Comments on Generator Equipment. The general assembly is of substantial construction and presents a neat appearance. The motor generator is finished with a light gray enamel which is not in accordance with the standard finish for rotating power equipment specified by the Bureau of Engineering.

(a) No difficulties were encountered in connection with the power equipment during the course of the tests.

[redacted]

(b) The 230/1000 volt generator is of 2-pole, compound wound, double commutator construction, equipped with salient field poles. Two brush studs are provided on each end mounted on ceramic insulation. Adjustment of brushes for proper commutation is obtained by rotating entire end bell. The commutator of the 230 volt generator is 3/4" wide of 100 bars and is undercut. The brushes (Morganite) are 3/8" thick, 1/2" wide and 7/8" long. The commutator of the 1000 volt generator is of similar construction and uses identical brushes.

(c) The 2300 volt generator is of single commutator construction, 2-pole with interpoles, compound wound provided with salient field poles. The commutator of 154 bars is 13/16" wide and undercut. Brushes (Morganite) are 3/8" thick, 1/2" wide and 7/8" long, 2 brush studs, 1 brush per stud trailing.

(d) Each generator is provided with two 3" x 3-1/2" inspection openings. These openings are closed by means of 1/16" thick flat, rubber gasketed covers held in place by four 10/32 machine screws. No retaining chains are provided on the covers or securing screws. Ventilation is provided by fan and ducts. The covers over the high voltage commutators bear warning nameplates, as listed in Table 4.

(e) All units are of cast construction. Bearings are provided with screw type grease cups. The bearings are mounted from the inside of the end bells on all units. It is necessary that these end bells be removed if access to bearings is desired.

208. Section IX, Drawings and Instruction Books. The preliminary instruction book furnished with the Model XTBU was complete enough to permit placing the equipment in operation. During the course of the tests the following items were noted:

(a) Current limiting reactor in series with master start relay is marked L-104 in schematic diagram and L-113 in transmitter unit.

(b) Audio transformer is marked T-115 in schematic diagram and T-101 in transmitter.

(c) Due to the close spacing of the lines in schematic drawing a connection appears to exist between Capacitor C-146 and Resistor R-129 (filament standby-circuit). Since no connection exists at this point precautions should be taken to correct drawing.

(d) Fuse F-212 (230 volts generator) is shown in the negative lead in schematic diagram; it actually is in plus lead.

(e) Filament transformers T-102 and T-103 are represented with numbered terminals on primaries and lettered secondaries. Since the transformers actually have numbers on all terminals, it is recommended that the diagram be changed to correspond. Letters may be retained in addition to indicate proper tube connections.

(f) Circuit checking would be facilitated if the flexible contacts to the MO-IPA removable unit were indicated on the schematic diagram. They should be lettered to correspond with the lettering on the contact strip in the transmitter.

[redacted]

(g) Instruction book, page 14, paragraph 2-11-2. It would be advisable to state definitely that the proper rotation of the motor generator set is necessary and that this should be checked at this point of the installation.

(h) Instruction book, page 19, paragraph 2-35 and page 23, paragraph 3-21. It is stated that IA plate current should not exceed 130 milliamperes. During the tests, currents up to 145 milliamperes were noted.

209. Since several new items of construction are incorporated in the Model XTBU equipment, mention of such items and complete explanations where required, should be contained in the final instruction books.

(a) Mention of and instructions for the removal of the MO-IPA unit and what precautions should be observed in connection with this operation.

(b) Attention directed to the fact that meters and switches may be removed from the equipment through the front panel.

(c) Attention directed to and instructions given in detail regarding the use and operation of the calibration facilities provided.

(d) Call attention to fact that the locking devices supplied should be used regularly after each change in transmitter setting to prevent accidental movement of controls.

210. Par. 11-3 (General). By the terms of the governing contract proposition #1 applies, which requires mechanical construction of a type to provide greater accessibility of parts. Construction of this type is incorporated in the Model XTBU equipment.

211. Par. 11-3-1. The design and construction of the equipment is such as to facilitate servicing of the transmitter from the front of the unit. The various views presented in Plates 16 to 35 inclusive, illustrate details of construction and assembly.

212. Par. 11-3-2. The Master Oscillator Circuit and the Intermediate Amplifier Circuit are assembled on a separate chassis and associated section of the front panel. This combination of the two circuits is permitted if the total height of the removable panel does not exceed 24". In the case of the Model XTBU equipment the dimensions of the removable unit are as follows:

Panel height of unit: 21-1/8"
Panel width of unit: 29-5/8"
Depth of unit (measured from rear of front panel): 15-3/8"

When the unit is withdrawn from the transmitter frame, but is still resting on its slides and locked in place so that it cannot be accidentally dislodged, the unit extends 15-3/4" from the front panel of the transmitter. The slides on which the unit moves are 20-3/4" long. In order

[redacted]

to remove the unit completely from the transmitter, a clear space of 25" must be available in front of the transmitter. In accordance with the requirements of the specification, the panel and assembled chassis are secured to the transmitter frame by four slotted hex head screws, which are secured to the panel of the removable unit to prevent loss. During the course of the tests, screw drivers were frequently employed to tighten and loosen these screws. The securing screws are 3/4" across the flats and the slots are thus of such size that it would require a screw driver of special proportions to fit the slots. The use of ordinarily available screw drivers with small bits gradually mars the head of the securing screw, destroying its appearance and causing burrs which injure an operator's hand. It is recommended that consideration be given to a type of securing screw which could be operated without resorting to the use of tools. If the present slotted hexagonal head were replaced with a bakelite knob of the same type which is used to control the door latches improved operating qualities would result, appearance would be improved and sufficient pressure could be brought to bear so that no danger would exist due to loosening of the unit under vibration.

213. Par. 11-3-3, 4, 5, and 6. The design of the removable unit is such that automatic disconnection and reconnection are provided through the medium of leaf springs and studs. A total of 18 such contacts are provided, 16 of which are disposed along the bottom rear edge of the unit and 2 at the right hand side of the unit. The latter two contacts are in radio frequency circuits, while the others operate in the a.c. and d.c. supply circuits and the low voltage r-f monitoring circuit. A definite degree of wiping action is obtained when making and breaking contact during the process of removal and replacement. No contact trouble was experienced during the course of the tests when the equipment was subjected to vibration, inclination, temperature changes, and humidity changes. The contacts are mounted on micalex and exhibited no tendency to become loose or lose their resiliency. However, as pointed out in paragraph 36(c) above, it is believed that every effort should be made to provide a maximum of serviceability and hence it is recommended that all contacts be provided with at least three leaves and that backing strips be furnished to afford additional protection. The entire unit is flexibly mounted on Lord mounts and a slide and roller arrangement is provided which permits the unit to be removed with a maximum of ease. The removable unit, with tubes in place, weighs 105 pounds and is easily handled by two men. Two insulated handles of the "T"type are provided for withdrawing the unit and spring operated locking devices prevent the unit from accidentally sliding completely off from its supports. Nameplates are placed adjacent to these spring operated locks giving the necessary instructions for complete removal of the unit.

214. Par. 11-3-7. The removal of the unit from the transmitter frame immediately removes all dangerous potentials by breaking the interlock circuit in series with the master start relay, which causes the motor generator to stop. Power cannot be reapplied until this circuit is reestablished.

215. Par. 11-3-8. Access to the Power Amplifier circuits is through the P.A. tube access door or from the sides of the transmitter after shields are removed. The antenna circuits are accessible only from the sides of the transmitter.

[redacted]

216. Par. 11-3-9. The weight of the transmitter unit is 630 pounds, while the weight of the removable unit is 105 pounds.

217. Par. 11-3-10. The dimensions of the transmitter unit are listed in Table 5 and are in agreement with the specification requirements.

218. The various items referred to in paragraphs 1 to 6 inclusive of reference (a) are discussed under appropriate paragraphs in the foregoing portions of this report. In paragraph 8 of reference (a), the Bureau requested the Naval Research Laboratory to indicate whether the data obtained during the course of the Model XTBU tests are in general agreement with the data obtained during the tests conducted at the plant of the contractor. A comparison of these data will be found in Table 50 appended hereto.

219. Paragraph 9 of reference (a) requests brief comments on the instruction book furnished. Comments of this nature are made in paragraph 208 and 209 of this report.

220. Paragraph 10 of reference (a) requests that the Laboratory comment on the 67 points discussed in enclosures (I) and (J) of reference (a).

Item 1. This subject is discussed in paragraph 98 above.

Item 2. As pointed out in paragraph 68 above, the voltmeter multipliers furnished with the Model XTBU equipment are not in agreement with Specifications RE 13A 590A. It is recommended that multipliers in accordance with the foregoing specifications be furnished in the production equipments.

Item 3. A discussion of the motor starter furnished will be found under paragraph 204 of this report. The dimensions of the starter submitted are in agreement with specification requirements. It is recommended that the modifications discussed in paragraph 204 above be given consideration by the Bureau of Engineering with a view of obtaining an improved type of starter.

Item 4. This subject is discussed in paragraph 139 above.

Item 5. It is recommended that the substitution of Insanol for micarta in the construction of the start-stop switch terminal board be approved. If the Insanol is equal in other respects and superior in the matter of cold flow to the micarta provided in the Model XTBU transmitter, the use of Insanol is recommended.

Item 6. The connection diagrams and instructions contained in contractor's drawing 7707197 are sufficiently clear to permit change from 4 to 6-wire control even in the absence of identifying tags for the leads to S-108 and S-109. It is recommended, however, that these leads be tagged as extra assurance against errors in making connections.

[redacted]

Item 7. This subject is discussed in paragraph 34(b) above.

Item 8. This matter is discussed in paragraph 143 above.

Item 9. This subject is discussed in paragraph 48 above.

Item 10. The MO and IA variometers are single layer wound with insulated wire and painted with insulating varnish. It is recommended that the end turns be secured by linen tape as described by the contractor. The method of construction used in the IA auxiliary coil L-108 is satisfactory.

Item 11. Tests have disclosed no objectionable features to the substitution of a series reactor for the originally specified resistor in the master starting relay coil circuit. It is believed that the additional advantages of the system used in the Model XTBU are sufficient to warrant its retention.

Items 12 and 13. Satisfactory nameplates should be provided as outlined by the contractor.

Item 14. Power transformer T-104 as submitted with Class B glass insulation successfully withstood the ambient temperature tests at 50° C, 95% humidity at 40° C and numerous key locked runs at full power without any indication of overheating or failure.

Item 15. Type numbers should be attached to all parts as required by the governing specifications.

Item 16. Control knobs and couplings. During the tests of the Model XTBU equipment certain objectionable features were noted in the control knobs and couplings employed. The same type of know was used on the tune-operate switch, the IA range switch and the PA range switch. Although these knobs appear to be of adequate size and strength for the load driven, two of them continually loosened during the test period. An improved method of securing these knobs should be used. As submitted, they are fastened by means of a single machine screw and lock washer threaded axially into the end of the control shaft. Any slight play between the knob and shaft will gradually work the securing screw loose. Three of the "T" type handles are also used in the equipment. The handles themselves are well designed and entirely suitable. However, in the case of two of these handles, excessive play was present between switch and shaft. Control "F" became progressively worse until about an entire switch position of play developed. This switch has 8 positions. The control knob for antenna tuning inductance "L" has a very considerable load to drive. It would be advantageous to either reduce the load or increase the size of the crank handle. During the tests, slippage was noted in the coupling of control "L". This is due to the action of the end stops which are on the coil, not on the control end of the coupling. The result is that the shock of striking the end stops is transmitted through the coupling. As stated above, there is quite a load on this control and the end stops are usually struck with considerable force. An unsplined shaft is used on the coil end of this coupling.

[redacted]

It is recommended that the coupling be pinned to the shaft. In addition to the slippage described the machine screws used in the coupling assembly became very loose during the tests resulting in about two divisions back lash and necessitating retightening to avoid probable destructive action. A coupling of more rugged design should be used.

Item 17. Signal Lamp and Resistor Assemblies. No trouble developed in the signal lamps and associated resistor assemblies during the course of the tests at the Laboratory. All tests having been made on a-c equipment, no data are available as to the action of these lamps as compared with the CS-5 lamps originally specified under the d-c condition described by the contractor as especially injurious to the CS-5 lamp. As the Bureau of Engineering has undoubtedly more complete data with respect to signal lamps of various types than are available at the Naval Research Laboratory, final decision on this point is referred to the Bureau of Engineering.

Item 18. The contractor has availed himself of the entire 34 inch width which the specifications permit. The Bureau has expressed the desire to reduce this dimension to 32 inches, but judging from the present design, it is difficult to see how this can successfully be accomplished.

Item 19. The master oscillator is designed to operate over the frequency range 150 to 1,000 kilocycles, and the results obtained during the tests indicate the desirability of this type of operation.

Item 20. Accessibility of Parts in Equipment. With the exception of certain items mentioned in the foregoing portions of this report, accessibility is good with the MO unit in place and excellent with it removed. Since the removable unit weighs but 105 pounds, it may be handled without difficulty by two men.

Item 21. This subject is covered in paragraph 175 above.

Item 22. Total Weight. The actual weight of the combined equipment, as shown in Table 5 attached, is 1616 pounds. The contractor estimated the weight as 1851 pounds and the specification limit is 3000 pounds.

Item 23. Finish of Indicator Lamp Bezels. This subject is covered by paragraph 92 above.

Item 24. Indicator Lamp for Filament. Specification 3-24 does not require the use of an indicator lamp to show that the filaments are energized. In the Model XTBU equipment, the position of the MO tube is such that it is plainly visible from the front of the transmitter. It thus serves as its own indicator when the filament is lighted under standby condition.

Item 25. The Laboratory agrees with the Resident Inspector of Naval Material in recommending the application of high voltage warning plates on the covers of the motor generator terminal boxes. These signs are particularly important in the case of the two generator boxes which contain fuses, since access to these will be required during servicing operations.

[redacted]

Item 26. Marking of Generator Fuse Positions. This subject is discussed in paragraph 199 above.

Item 27. Thumb screws for side shield removal. This subject is discussed in paragraph 159 above. The top section of the rear shield is particularly difficult to handle due to distortion. This apparently is due to the bulge formation over the end of the antenna tap switch. Care should be exercised to avoid distortion of this type.

Item 28. Suitability of Switches. No trouble of any kind developed in the PA range switch, Adjust-Tune-Operate switch, or the Intermediate Amplifier switch during the course of the tests. The PA and Tune-Operate switches are interlocked and the IA switch does not show excessive sparking when operated under load. The many tests involving temperature, humidity, vibration, shock, etc., disclosed no electrical or mechanical weakness in these switches. Difficulty in the control knobs has been discussed under Item 16 above.

Item 29. Soldering of Leads to Switches. The soldering in connection with these switches does not present a workmanlike appearance, but no trouble was experienced from this source during the course of the tests. It is recommended that the improvements suggested by the contractor be carried out.

Item 30. Start-Stop Switch Buttons. This subject is discussed in paragraph 171(4) above.

Item 31. Control "J", Antenna Tap Switch. This control is discussed under paragraphs 36(a), 36(b), and 59(d) above. The conclusion made is that this entire switch assembly requires further thought and modification to produce an acceptable installation. The points raised by the Inspector with respect to the handle and guard are believed well taken and in view of the Inspector's experience afloat his recommendations should be given careful consideration.

Item 32. Plate Connection to MO Tube. In order to protect against short circuiting the MO plate supply, it is recommended that the plate clip be of the wholly insulated type. Attention is also invited to paragraph 153(d) above, wherein the use of Packard cable is discussed.

Item 33. Tube Clamps. While no difficulties were experienced with the tube clamps during the course of the tests, any improvements which the contractor can accomplish to improve security should be incorporated into the design of these clamps.

Item 34. Mounting of Keying Relay. The original mounting of the keying relay proved to be unsuitable when the equipment was subjected to vibration. A more suitable method of mounting was evolved as described in paragraph 59(b)(2) above.

Item 35. Terminal Designating Strips. It is recommended that improved terminal designating strips as outlined by the contractor be approved.

[redacted]

Item 36. Grounding of R-F Monitoring Lead. It is recommended that this lead be grounded in accordance with the method suggested by the Inspector and as agreed to by the contractor.

Item 37. Flexible Finger Contacts. This subject is discussed in paragraph 36(c) above.

Item 38. Wiring of Flexible Contacts. In the opinion of the Naval Research Laboratory, the method of wiring the flexible finger contacts is suitable, although further consideration should be given to providing an improved type of wire, as discussed in paragraph 153 above.

Item 39. Terminal Lugs. It is recommended that the Inspector give careful consideration in the selection of the most suitable type of terminal lugs for the wiring used in production equipments.

Item 40. Start-Stop Switch Terminal Block. See Item 5.

Items 41 and 42. Emergency Switch. It is recommended that the emergency switch be so wired as to open both lines of the 115 volt secondary of transformer T-104, thus removing voltage from the filament circuits.

Item 43. IA Tank Inductors. Since the general color scheme of the Model XTBU transmitter is black and white, it is believed that the color of these inductors may be left to the discretion of the contractor on the basis of availability.

Item 44. Wiring of Antenna Loading Coil. It is recommended that the method of wiring proposed by the Inspector, and concurred in by the contractor, be approved.

Item 45. Micalex shaft of Control J. As pointed out in paragraph 36 above, considerable trouble was experienced in connection with Control J and a more suitable assembly must be developed to provide satisfactory operation. In this process the subject of suitable clearances should be given consideration.

Item 46. Flexible contacts on Control J. See paragraph 36 above.

Item 47. PA Tube Mounting. The thin flexible metallic strips used for filament connections to the PA tube socket have proven satisfactory during the tests and are considered more suitable than Packard cable. It is recommended that the present method of connection be retained. Care should be exercised to insure that the grid clip lock provides proper tension for holding tube in place.

Item 48. Resistor R-125. This resistor proved to be satisfactory during the course of the tests and the type of construction used is authorized by Specifications RE 13A 372J.

[redacted]

Item 49. Resistor R-131. It is recommended that the use of carbon resistors in this location be approved; however, attention is invited to the discussions contained in paragraphs 104(b) and 127 above.

Item 50. Flexible wiring to Resistor Bank. In this connection, attention is invited to paragraphs 34(b) and 153(d) and 153(e) above.

Item 51. Tapped Resistors. As submitted, Resistor R-127 was not of the tapped type. As pointed out in paragraph 34(b) above, it is recommended that Resistors R-102, R-109, R-124 and R-135 be replaced by untapped units. If this recommendation is carried out, the difficulties referred to by the Inspector will be eliminated.

Item 52. Resistor Mounting Panel. The contractor's explanation indicates the necessity for the additional mounting holes if interchangeable AC-DC operation is contemplated.

Item 53. Wiring of Transformer T-103. The method proposed by the contractor will eliminate the objections raised by the Inspector.

Item 54. Wiring Details. The methods proposed by the contractor will eliminate the objections raised by the Inspector.

Item 55. Wiring of Switch S-110. During the course of the tests, no difficulties were experienced with Switch S-110 and observation while equipment was subjected to vibration indicates that this assembly is satisfactory for service use.

Item 56. Warning plate for 4/6 wire controls. No warning plate of the nature referred to was included in the Model XTBU assembly. However, the additional information imparted by such a plate should be helpful to service personnel.

Item 57. Door Hinges. In the opinion of the Naval Research Laboratory, the type of hinges supplied are adequate for the purpose, but in the case of the hinge used on the PA access door, a defective hinge appears to have been used which permits excessive play. Careful inspection should avoid this difficulty.

Item 58. Ground Terminal. Since a longer ground stud may prove to be desirable on board ship, it is recommended that the suggestion of the Inspector be followed.

Item 59. Voltmeter Nameplates. Since the term PA plate voltage would be more descriptive, it is recommended that the nameplate be modified to agree with this designation.

Item 60. Wiring of PA Range Switch. It is recommended that the use of larger wire, as suggested by the contractor, be approved.

Item 61. Symbol Markings. This subject is discussed in paragraph 82 above.

[redacted]

Item 62. M.O. Unit Lock or Catch. The procedure outlined by the contractor should remedy this defect.

Item 63. Condenser Mountings. No difficulties were experienced during the course of the tests due to failure of condenser mountings.

Item 64. Finish of Motor Generator Sets. The action outlined by the contractor is satisfactory.

Item 65. Wiring. The action taken by the contractor is satisfactory.

Item 66. Fuses. Attention is invited to paragraph 51 above.

Item 67. Gaskets. It is suggested that the use of synthetic rubber be considered for this application.

221. A summary of the defects noted in the Model XTBU equipment and such items as do not comply with the requirements of the governing specifications are listed below. The numerals enclosed in parentheses refer to the paragraph of this report under which these items are discussed in detail.

(a) (33c) Third terminal on antenna ammeter not used; should be eliminated.

(b) (34a, 34b, 77a) Resistor R-130 should be repositioned and increased in size; untapped resistors could be substituted for present tapped units R-102, R-109, R-124, and R-135.

(c) (36a, 36b, 59d) Necessary modifications should be incorporated in Antenna Tap Switch "J" in order to improve operation and serviceability.

(d) (36c) Flexible contact fingers on removable unit should be improved by addition of backing strips and making all contacts of 3-leaf construction.

(e) (37) Contact plate on Control "F" not positioned properly.

(f) (38) Adjustment provided by plate rheostat R-108 too coarse.

(g) (40a, 163) Blocking capacitor C-147 failed.

(h) (45c, 121) Impossible to key transmitter at 300 kilocycles due to arc-overs.

(i) (45e, 45f, 45g, 45h) Construction and operation of various controls not satisfactory.

(j) (46a) Use of special fuses in 440 volt circuits requires special consideration with respect to spares.

[redacted]

(k) (48) Overload relays failed to function satisfactorily during the course of the tests.

(l) (50) Interlock switch S-106 not properly located.

(m) (51) Further consideration should be given to the protection of personnel against contact with 440 volt circuits.

(n) (56) One 38803 and two 38851 tubes failed during the course of the tests.

(o) (59) Equipment failed to withstand the effects of vibration and various parts became deranged.

(p) (67) Leads to MO and Bias Voltmeters too short.

(q) (68) Voltmeter multipliers not in accordance with Specifications RE 13A 590A.

(r) (69, 204) Motor starter not equipped with nameplate or warning plate, finish does not conform with latest specifications, and further consideration should be given to overload characteristics and safety features.

(s) (74) Index pointers on Controls "E" and "L" not satisfactory.

(t) (75) Control "A" is not provided with stop to limit motion.

(u) (77) Accessibility and servicing features of certain items require further consideration.

(v) (78, 171(4)) Four-wire control start-stop switch not satisfactory and wiring of these switches not suitable.

(w) (82, 83) Wearing qualities of symbol markings of stencilled type questionable and tube socket markings should be made more legible.

(x) (89, 92) Bright finish on panel screws and bezels of indicator lamps.

(y) (101) Antenna coupling circuit does not provide satisfactory degree of adjustment at higher frequencies.

(z) (103) Antennas in excess of 150 feet in length cannot be resonated.

(aa) (104b) Power output at 600 kilocycles fails to meet specification requirements.

(bb) (110) Back lash characteristics at 1000 kilocycles fail to meet specification requirements.

[redacted]

(cc) (127) Characteristics of neutralizing circuits did not prove to be entirely satisfactory during the course of tests.

(dd) (129(5)) Further consideration should be given to interlock circuits.

(ee) (148) Filament voltmeter should be marked to indicate proper voltage.

(ff) (153) Flexible cables and leads should be given further consideration.

(gg) (155) Marking of transformers not sufficient to be self-explanatory.

(hh) (159) Removal of shields difficult due to lack of knobs or handles.

(ii) (168) Nameplate of Master Start relay should include operating voltage.

(jj) (175) A more satisfactory type of "Remote-Local" switch should be provided.

(kk) (186) Bias generator operates at apparent overload.

(ll) (191) Further consideration should be given to design of motor generator couplings.

(mm) (199) Fuse ratings in motor generators not indicated and fuse clips in bias generator not properly spaced.

(nn) (207) Finish of motor generator set not in accordance with specifications.

(oo) (208) Instructions furnished contain errors.

(pp) (212) Metal holding screws of MO/IPA unit become marred.

(qq) (220) Comments submitted on various items of construction and design contained in contractor's letter of November 20, 1939.

CONCLUSIONS

222. The frequency stability and frequency accuracy requirements of the governing specifications have been complied with in practically all respects and the power output obtained on cw and mcw emission conforms with the specification requirements except in the region of 600 kilocycles.

[redacted]

223. Further study is indicated in connection with the phenomena which tend to generate spurious and unwanted oscillations in the power amplifier circuits and to provide satisfactory keying characteristics, free from arcing, when operating in the region of 300 kilocycles.

224. While the general construction, arrangement, operating characteristics, and appearance of the equipment are good, it was found necessary to modify certain items of the assembly in order to obtain satisfactory operation when the equipment was subjected to vibration. These modifications, performed by representatives of the contractor, proved to be efficacious and no further difficulties were encountered from this source.

225. The equipment is designed to operate into antennas of the average characteristics which are encountered in the Naval Service, but is not designed for operation into antennas whose length may exceed approximately 150 feet.

226. A number of changes, modifications, and corrections of a minor nature are indicated in order to provide greater safety factors, effect greater ease in handling by operating personnel and to insure safe and continuous operation.

227. The removable unit construction affords a high degree of accessibility, is easily manipulated and should prove of real value to personnel afloat.

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TABLE 1

Model XTBU Transmitting Equipment
List of Controls and Meters

Data as per paragraph 2-23 of Specifications RE 13A 422C

Control Designation	Control Marking	Dial Marking
A	Master Oscillator Tuning	2500 Divisions
B	M. O. Range Selector	10 Positions
C	Int. Amp. Range	6 positions
D	Intermediate Amplifier Tuning	100 Divisions
E	Power Amplifier Tuning	100 Divisions
F	Coarse Antenna Coupling	8 positions
G	Fine Antenna Coupling	6 positions
H	P. A. Range	6 positions
J	Antenna Tap Switch	9 positions
K	Antenna Tuning Inductance	100 divisions
L	Antenna Tuning Inductance	1300 divisions

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Overload Relay Reset - push button
Filament Voltage - Rheostat
Plate Voltage - Rheostat
M.O. Filament Standby, toggle switch, on - off
CW - MCW, Toggle switch
Adjust-Tune-Operate Switch, 3 positions
Local-Remote switch, 2 positions
Start-Stop Switch, push button
Test key, up-lock, center - off, down - momentary
Emergency Switch, Toggle, on-off.
Frequency Meter Audio Output, Jack
Calibration Card Holder
Start Indicator light, Blue
Plate Indicator light, Red
Bias Indicator Light, Green

\- - - -

Meters

Filament Voltage; 15 V. AC, CAY-22080, NA-35
Bias Voltage, 500 V DC, CAY-22198, NX-35, 1000 ohms per volt
M.O. Plate Voltage, 1.5 KV DC, CAY-22227, NX-35, 1000 ohms per V
P.A. Tube Hours, 10,000 hrs by tenths, NH-35
Plate Voltage, 3 KV DC, CAY-22235, NX-35, 1000 ohms per volt
M.O. Plate Current, 100 MA DC, CAY-22059, NX-35
Audio Osc Plate Current, 100 MA DC, CAY-22059, NX-35
Int. Amp. Plate Current, 250 MA DC, CAY-22065, NX-35
P.A. Plate Current, 2 Amp. DC, CAY-22002, NX-35
Antenna Current, 25 Amp. RF, CAY-22228, NT-35, with separate shunt. (This meter has a third terminal which is connected to an internal shield. This terminal is not used.

TABLE 2

Model XTBU Transmitting Equipment
Check of Resistors used in Equipment.

Test as per paragraph 2-2 of Specifications RE 13A 422C

Res. No.	Rated Ohms	Style	Type No.	Permitted by Specs. Watts	Volts	Max. R	Measured Watts	Volts	Resis.
R101	10000	D	63090E	24	625	18000	5.48	235	10070
R102	2000	B	63229E*	60	1200	50000	13.9	128	1969
R103	10000	D	63090E	24	625	18000	6.07	250	10330
R107	250	D	63064E	24	625	18000	2.99	27	244.1
R109	500	B	63227E*	60	1200	50000	28.2	76	512.4
R110	10000	D	63090E	24	625	18000	5.7	240	10090
R111	5000	D	63085E	24	625	18000	1.64	90	4950
R112	5000	A	63238E*	80	1650	75000	97.5	700	5028
R113	5000	A	63238E*	80	1650	75000	54.4	520	4980
R115	1000	D	63076E	24	625	18000	3.58	60	1007
R117	1000	D	63076E	24	625	18000	0.14	12	1007
R119	500	E	63278E	10	350	6000	Key filter		485.6
R121	300	A	63258E*	80	1650	75000	38.1	105	289
R122	300	A	63258E*	80	1650	75000	60.4	130	279.7
R124	2000	B	63229E*	60	1200	50000	18.4	170	1973
R125	2	A	63171E	80	1650	75000	46.8	9.7	2.03
R127	2500	B	63144E	60	1200	50000	29.5	270	2464
R128	500	E	63278E	10	350	6000	0.01	2.5	507
R129	25	D	63050E	24	625	18000	10.5	16	24.9
R130	10000	E	63016E	10	-350	6000	Static Drain		10320
R131			Carbon						40
R135	2000	B	63229E*	60	1200	50000	15.7	180	2059

(*) denotes 10 section tapped resistors used.

Voltages as measured are key closed, full power output conditions, except R113 in which open key voltage is used; condition of greatest dissipation used in each case.

Rheostat R-108, Main Plate Generator field control, is a Westinghouse Type WL Style No. H-66057; 5000 ohms, 0.47-0.042 amps; 230 volts; body of rheostat 6-3/4" dia, 1-3/4" deep, enclosed.

Rheostat R-126, Filament control, Westinghouse Type WL, Style No. H-67502; 10 ohms; 4.5 Amps; 600 volts max; body of rheostat 6-3/4" dia, 1-3/4" deep, enclosed.

TABLE 3.

Model XTBU Transmitting Equipment
Antenna Short Circuited and Open Circuited

Test as per paragraph 2-16 of Specifications RE 13A 422C

Frequency kc	Antenna Condition	Antenna Current	P.A. Plate Current	P.A. Plate Volts
300	Normal	13.2	990	2280
300	Open	P. A. Overload Relay operates		
300	Shorted	P. A. Overload Relay operates		
500	Normal	13.5	960	2260
500	Open	0	50	2310
500	Shorted	0	50	2310
1000	Normal	14.5	960	2250
1000	Open	0	60	2300
1000	Shorted	0	80	2300
2000	Normal	13.4	960	2250
2000	Open	0	100	2300
2000	Shorted	0	170	2300

Antenna Capacity: 998 uuf
Antenna Resistance: 7.66 ohms

TABLE 4

Model XTBU Transmitting Equipment
Name Plate Data

Data as per paragraph 2-26 of Specifications RE 13A 422C

Transmitter Unit

Radio Transmitter Type CAY 52124
Frequency 300 to 2000 kc
440 volts, 60 cycles, A.C.
Weight: 662 Serial: XTBU
Manufactured for Navy Department
Bureau of Engineering
by
Westinghouse Electric & Mfg. Co.
Baltimore, Md.
Contract NOs-66593 Date 9 May 1939
(Size of plate: 2-1/4" x 3-3/8")

Motor Generator Unit

M.O. Plate and Bias Generator

Westinghouse
DC Generator for Model TBU Radio Transmitter

KW - .21	Wound - Comp.
.30	Frame - X 204
Volts - 230	
1000	
Amps -.9	Serial 1-39W232
.3	Mfgrs Type SK
Field	Contract 66593
Volts - 230	Date 1939
Max. Field Amps - .5	
RPM - 1750	

Manufactured for Navy Department
Bureau of Engineering
by
Westinghouse Electric & Mfg. Co.
Baltimore, Md.

(Size of Plate: 3" x 1-7/8")

A. C. Motor

Westinghouse
A. C. Motor for Model TBU Radio Transmitter

6 H.P.	Mfgrs. type CS
220/440 volts	Frame SD 254
3 Phase 60 cycle	Style 1-39W233
13.6/6.8 amps.	Contract 66593
1750 RPM	Date 1939

Manufactured for Navy Department
Bureau of Engineering
by
Westinghouse Electric & Mfg. Co.
Baltimore, Md.

(Size of plate: 3" x 1-7/8")

Plate Generator

Westinghouse
DC Generator for Model TBU Radio Transmitter

KW - 2.65	Wound - Comp.
Volts - 2300	Frame - X 284
Amps - 1.15	Serial 1-39W231
Field Volts 230	Mfgrs. Type SK
Max Fld Amps .5	Contract 66593
RPM - 1750	Date 1939

Manufactured for Navy Department
Bureau of Engineering
by
Westinghouse Electric & Mfg. Co.
Baltimore, Md.

(Size of Plate: 3" x 1-7/8")

Each generator is fitted with two warning plates, red in color, secured to the access covers:

Danger
High Voltage
Do not open covers while
Motor Generator is running.

(Size of Plate: 3" x 1-7/8")

Each generator and the motor is fitted with an eyebolt plate as follows:

This eyebolt must not be used when hoisting the entire motor generator set. Use only for hoisting this individual unit.

(Size of plate: 1" x 1-1/2")

TABLE 4 cont.

Each generator and the motor is fitted with two lubrication plates bearing the following:

For Lubrication
use Navy Grade A Grease

(Size of plate: 1" x 1-1/2")

The motor is fitted with a rotation plate bearing an arrow and legend:

Rotation

(Size of plate: 2-1/2" x 3/4")

The base of the motor generator unit bears the following plate:

Motor and generators of this unit have Class A insulation. Their ratings are based on 40°C rise continuous for 50°C ambient.

(Size of plate: 2" x 3")

The automatic starter is not equipped with a descriptive nameplate.

TABLE 5

Model XTBU Transmitting Equipment
Dimensions and Weights

Test as per paragraphs 2-33 and 3-27 of Specs. RE 13A 422C.

Transmitter Unit	Overall Dimensions	Specification Requirements
Height:	71-3/4"	72"
Width:	34"	34"
Depth:	24"	24"

Weight: 630 pounds

(Weight of removable MO/IPA Unit, with tubes - 105 pounds)

Motor Generator		
Length:	77"	83"
Height:	19-5/8"	27-1/2"
Width:	21-3/16"	24"

Weight: 935 pounds

Starter		
Height:	21-3/8"	25"
Width:	15-1/2"	20"
Depth:	11-3/8"	12"

Weight: 51 pounds

Total weight: 1616 pounds
Permitted by specifications: 3000 pounds

TABLE 6

Model XTBU Transmitting Equipment
Determination of Power Output

Test as per paragraph 3-3 of Specifications RE 13A 422C

Column No:	1	2	3
Control or Meter	300 Kc	400 Kc	400 Kc
A	810.5	1577	1578
B	1	2	2
C	1	2	2
D	31.5	47.5	47.5
E	32	45	46.5
F	1	3	3
G	1	6	2
H	1	2	2
J	1	2	2
K	51	35	35.5
L	-	-	-

	CW	MCW	CW	MCW	CW	MCW
E fil	11	11	11	11	11	11
E bias	232	235	223	228	229	230
E MO plate	1000	1000	990	990	995	990
E PA plate	2100	2100	2230	2250	2250	2260
I MO plate	48	49	38	39	39	40
I Aud Osc Pl	-	28	-	28	-	28
I Int Amp Pl	101	62	104	63	104	65
I Pr Amp	1000	650	1000	755	1010	780
I Ant (Set)	15.4	11.5	16.6	13.8	18.7	15.1
I Ant External	13.08	9.42	14.96	12.18	16.9	13.56
Ant Res. DC	3.332	3.332	3.332	3.332	2.54	2.54
Ant. Res. RF	3.332	3.332	3.332	3.332	2.54	2.54
Ant. Cap. uuf	415	415	415	415	415	415
Watts Out	570	295	745	494	725	467
Watts Required	530	265	530	265	530	265
% MCW/CW Power		51.9		66.4		64.5
% Mod. Neg. Peaks		90		65		58
Pos. Peaks		0		5		5
% Mod req'd by specs:		70		70		70

TABLE 7

Model XTBU Transmitting Equipment
Determination of Power Output

Test as per paragraph 3-3 of Specifications RE 13A 422C

Column No.	1	2	3
Control or Meter	500 Kc	600 Kc	750 Kc
A	1542	1036	1096
B	3	4	5
C	3	3	4
D	39.5	66	51
E	43	76	49
F	4	5	3
G	1	3	4
H	3	3	4
J	3	3	4
K	24	55	-
L	-	-	1180

	CW	MCW	CW	MCW	CW	MCW
E Fil	11	11	11	11	11	11
E Bias	228	228	224	228	228	229
E MO plate	1000	1000	985	990	995	992
E PA plate	2250	2250	2225	2225	2250	2260
I MO plate	42	42	34	33	37	38
I Aud Osc Pl	-	29	-	29	-	29
I Int Amp Pl	109	65	118	71	115	70
I Pr Amp	1000	740	1010	710	996	725
I Ant (Set)	20.4	16.3	20.9	16.5	24.4	20.3
I Ant External	17.9	14.22	17.85	14.3	21.25	17.5
Ant Res DC	1.775	1.775	1.46	1.46	1.8	1.8
Ant Res RF	1.775	1.775	1.89	1.89	2.23**	2.23
Ant Cap uuf	415	415	415	415	475	475
Watts out	568*	358*	603*	387*	1010	682
Watts required	530	265	675	338	900	450
% MCW/CW power		63.1		64.2		67.8
% Mod Neg Peaks		80		86		77
Pos Peaks		10		10		12
% Mod req'd by specs:		70		70		70

(*) denotes measurement made after R-131 was changed to 50 ohms
(**), denotes resistance measured with R.F. bridge

TABLE 8

Model XTBU Transmitting Equipment
Determination of Power Output

Test as per paragraph 3-3 of Specifications RE 13A 422C

Column No:	1	2
Control or Meter	1000 KC	1250 Kc
A	1270	1045
B	6	7
C	5	5
D	42	69
E	35	61
F	5	7
G	4	6
H	5	5
J	7	8
K	-	-
L	360	697

	CW	MCW	CW	MCW
E fil	11	11	11	11
E bias	228	228	228	230
E MO plate	990	990	995	995
E PA Plate	2250	2250	2250	2270
I MO plate	28	28	29	29
I Aud Osc Pl	-	28	-	29
I Int Amp Pl	112	67	117	70
I Pr Amp	950	710	1000	730
I Ant (Set)	23.3	19.4	14.5	12.1
I Ant External	20.9	17.2	13.46	11.02
Ant Res DC	2.387	2.387	7.71	7.71
Ant Res RF	2.5	2.5	8.3	8.3
Ant Cap uuf	609	609	940	940
Watts Out	1090	740	1505	1010
Watts required	1000	500	1000	500
% MCW/CW power		67.9		67.5
% Mod Neg Peaks		78		87
Pos Peaks		13		14
% Mod req'd by specs:		70		70

TABLE 9

Model XTBU Transmitting Equipment
Determination of Power Output

Test as per paragraph 3-3 of Specifications RE 13A 422C

Column No:	1	2
Control or Meter	1500 Kc	2000 Kc
A	1300	1475
B	8	10
C	6	6
D	8.5	88
E	12	57
F	6	7
G	6	6
H	6	6
J	9	9
K	-	-
L	750	1098

	CW	MCW	CW	MCW
E fil	11	11	11	11
E bias	225	225	228	226
E MO Plate	990	990	980	980
E PA Plate	2240	2250	2250	2250
I MO Plate	31	32	38	38
I Aud Osc Pl	-	29	-	29
I Int Amp Pl	118	72	123	75
I Pr Amp	950	650	800	525
I Ant (Set)	12.8	10.3	11.3	9
I Ant External	11.74	9.32	10.92	8.42
Ant Res DC	9.3	9.3	9.3	9.3
Ant Res RF	10.37	10.37	10.37	10.37
Ant Cap uuf	1000	1000	1000	1000
Watts Out	1430	900	1238	735
Watts required	1000	500	1000	500
% MCW/CW power		63		59.3
% Mod Neg Peaks		92		100
Pos Peaks		13		14
% Mod req'd by specs:		70		70

TABLE 10

Model XTBU Transmitting Equipment
Carrier Hum and Ripple

Test as per paragraph 3-4-2 of Specifications RE 13A 422C

Frequency KC	Carrier Volts	Ripple Volts	Per cent Ripple
2000	300	1.1	0.367
1000	300	0.9	0.30
300	300	1.2	0.40

Specification Requirements: 2% max.

Transmitter was operating at full power during above tests

TABLE 11

Model XTBU Transmitting Equipment
Accuracy of Reset to Previously Calibrated Frequencies

Test as per paragraph 3-7-1 of Specifications RE 13A 422C

Trial No	Frequency Kc	Time Seconds	Deviation in Frequency Cycles	Per cent
Original	300.500			
1	473	40	27	0.009
2	473	37	27	0.009
3	475	38	25	0.0083
4	480	33	20	0.0067
5	500	36	0	0
			Average:	0.0066%
Original	1000.663			
1	618	42	45	0.0045
2	637	45	26	0.0026
3	645	46.6	18	0.0018
4	618	34	45	0.0045
5	639	34	24	0.0024
			Average:	0.00316%
Original	2000.480			
1	482	42	2	0.0001
2	501	44	21	0.00105
3	465	46	15	0.00075
4	510	43	30	0.0015
5	470	38	10	0.0005
			Average:	0.00078%

Specification Requirements: 0.01% average
Maximum departure any one trial: 0.015%

TABLE 12

Model XTBU Transmitting Equipment
Test for Lost Motion, Back Lash and Torque Lash

Test as per paragraph 3-7-2 of Specifications RE 13A 422C

Trial No.	Frequency when approached from Clockwise Direction	Counter Clockwise Direction	Backlash Cycles	Per Cent
1	2000.360	2000.573	213	0.0107
2	350	575	225	0.0113
3	320	568	248	0.0124
4	333	568	235	0.0118
5	335	563	228	0.0114
		Average:		0.0115%
		Permitted by Specs:		0.02%
	Maximum departure from initial frequency:			0.0124%
	Permitted by specifications:			0.045%
1	1000.528	1000.783	255	0.0255
2	503	750	247	0.0247
3	508	737	229	0.0229
4	510	725	215	0.0215
5	515	760	245	0.0245
		Average:		0.0238%
		Permitted by Specs:		0.02%
	Maximum departure from initial frequency:			0.0255%
	Permitted by specifications:			0.045%
	Re-Check at 1000 kc.			
1	1000.533	1000.742	209	0.0209
2	490	748	259	0.0259
3	518	748	230	0.0230
4	495	750	255	0.0255
5	480	720	240	0.0240
		Average:		0.0239%
		Permitted by Specs:		0.02%

Note: The re-check test at 1000 kc was made with key locked to avoid any errors due to heating. The original test at 1000 kc was not made with key locked, but one minute was allowed before frequency was read in each case.

Continued

TABLE 12 continued

1	300.165	300.218	53	0.0177
2	165	216	51	0.0170
3	155	217	62	0.0206
4	151	209	58	0.0193
5	158	205	47	0.0157
		Average:		0.0181%
		Permitted by Specs:		0.02%
	Maximum departure from original frequency:			0.0206%
	Permitted by specifications:			0.045 %

TABLE 13

Model XTBU Transmitting Equipment
Operation of Adjust-Tune-Operate Control

Test as per paragraph 3-7-3 of Specifications RE 13A 422C

Step 1 "Adjust"	Step 2 "Tune"	Step 3 "Operate"	Maximum Frequency Change Cycles	Per Cent
2000.448	2000.460	2000.462	14	0.0007
1500.450	1500.486	1500.478	36	0.0024
1300.408	1300.395	1300.415	20	0.0015
1000.456	1000.459	1000.473	17	0.0017
800.449	800.443	800.443	17	0.0023
500.343	500.349	500.350	7	0.0014
400.302	400.320	400.323	21	0.0053
300.426	300.440	300.445	19	0.0063

Specification Requirements: 0.015%

Above measurements were made at the Master Oscillator frequency, i.e., one half the output frequency and were then converted to the output frequency

TABLE 14

Model XTBU Transmitting Equipment
Detuning of Circuits

Test as per paragraph 3-7-4 of Specifications RE 13A 422C

Circuit Detuned	Frequency KC	Change in Frequency Cycles	Per Cent
Normal	2000.390		
IPA "D" - cw	408	18	0.0009
IPA "D" - ccw	370	20	0.001
Normal	458		
PA "E" - cw	448	10	0.0005
PA "E" - ccw	463	5	0.00025
Normal	450		
Ant "L" - cw	458	8	0.0004
Ant "L" - ccw	446	4	0.0002
- - - - - - -			
Normal	1000.473		
IPA "D" - cw	500	27	0.0027
IPA "D" - ccw	428	45	0.0045
Normal	460		
PA "E" - cw	445	15	0.0015
PA "E" - ccw	467	7	0.0007
Normal	460		
Ant "L" - cw	472	12	0.0012
Ant "L" - ccw	449	11	0.0011
- - - - - - -			
Normal	300.490		
IPA "D" - cw	496	6	0.002
IPA "D" - ccw	482	8	0.0026
Normal	485		
PA "E" - cw	483	2	0.00067
PA "E" - ccw	480	5	0.00167
Normal	481		
Ant "K" - cw	481	0	0
Ant "K" - ccw	481	0	0

Specification Requirements: 0.01%

TABLE 15

Model XTBU Transmitting Equipment
Operation of Power Output Control

Test as per Pars. 3-7-5 & 3-23 of Specifications RE 13A 422C

Frequency KC	Frequency Change Cycles	Frequency Change Per Cent	Plate Volts	Per cent voltage	Power Out	Per cent power
2000.419			2250	100	1348	100
410	9	0.00045	2000	88.9	1037	76.9
401	18	0.0009	1730	77	744	55.2
398	22	0.0011	1500	66.7	526	39
390	29	0.00145	1230	54.6	293	21.7
384	35	0.00175	980	43.5	123	9.12
378	41	0.00205	890*	39.6	80	5.9
1000.410			2080	100	1348	100
410	0	0	1760	84.6	945	70.2
406	4	0.0004	1540	74	688	51.1
402	8	0.0008	1260	60.6	423	31.4
400	10	0.001	1210	58.2	378	28.1
399	11	0.0011	900*	43.3	147	10.9
300.570			2240	100	1178	100
566	4	0.00133	2000	89.3	912	77.5
564	6	0.002	1730	77.3	651	55.3
562	8	0.00267	1510	67.5	461	39.2
558	12	0.004	1250	55.8	270	22.9
556	14	0.00467	1070*	47.8	176	14.9

(*) denotes minimum voltage obtainable.

Specification Requirements: Frequency change not to exceed 0.005%
Minimum power not to exceed 25%

TABLE 16

Model XTBU Transmitting Equipment
Change of Tubes

Test as per paragraph 3-7-6 of Specifications RE 13A 422C

Manufacturer and Serial No. of Tube	Frequency KC	Deviation from Mean Frequency Cycles	Per Cent
	Master Oscillator Circuit		
WL 29789	300.321	55	0.0183
WL 29792	310	44	0.0147
WL 29739	295	29	0.0097
WL 28818	267	1	0.0003
WL 28707	288	22	0.0073
RCA 36170	220	46	0.0153
RCA 37362	210	56	0.0187
RCA 36156	221	45	0.0150
RCA 36135	236	30	0.0100
WL 29796	287	21	0.0070
	Mean: 300.266	34.9	0.0116%
	Specification requirements:		0.015%
	Intermediate Amplifier Circuit		
WL 29789	300.277	1	0.0003
WL 29792	276	0	0
WL 29739	282	6	0.0020
WL 28818	275	1	0.0003
WL 28707	255	21	0.007
RCA 36170	290	14	0.0046
RCA 37362	293	17	0.0056
RCA 36156	278	2	0.00067
RCA 36135	270	6	0.0020
WL 29738	265	11	0.00367
	Mean: 300.276	7.9	0.00264%
	Specification Requirements:		0.005%
	Power Amplifier Circuit		
GE 14140	300.264	0.5	0.000167
WL 26196	264	0.5	0.000167
GE 14145	264	0.5	0.000167
WL 26177	262	1.5	0.0005
	Mean: 300.2635	0.75	0.00025
	Specification Requirements:		0.005%

TABLE 17

Model XTBU Transmitting Equipment
Change of Tubes

Test as per paragraph 3-7-6 of Specifications RE 13A 422C

Manufacturer and Serial No. of Tube	Frequency KC	Deviation from Mean Frequency Cycles	Per Cent
	Master Oscillator Circuit		
WL 29789	1000.504	79	0.0079
WL 29792	325	258	0.0258
WL 29739	432	151	0.0151
WL 28818	280	303	0.0303
WL 28707	335	248	0.0248
RCA 36170	790	207	0.0207
RCA 37362	798	215	0.0215
RCA 36156	910	327	0.0327
RCA 36135	962	379	0.0379
WL 29796	492	91	0.0091
	Mean: 1000.583	226	0.0226%
	Specification Requirements:		0.015%
	Intermediate Amplifier Circuit		
WL 29789	1000.468	33	0.0033
WL 29792	411	24	0.0024
WL 29739	470	35	0.0035
WL 28818	440	5	0.0005
WL 28707	470	35	0.0035
RCA 36170	402	33	0.0033
RCA 37362	470	35	0.0035
RCA 36156	354	81	0.0081
RCA 36135	370	65	0.0065
WL 29738	492	57	0.0057
	Mean: 1000.435	40.3	0.004%
	Specification Requirements:		0.005%
	Power Amplifier Stage		
GE 14140	1000.480	2.5	0.00025
WL 26196	480	2.5	0.00025
GE 14145	475	7.5	0.00075
WL 26177	495	12.5	0.00125
	Mean: 1000.482	6	0.0006
	Specification Requirements:		0.005

TABLE 17 Continued

Recapitulation of data wherein the tubes of each manufacturer are considered separately.

	Master Oscillator Circuit Westinghouse Tubes		
WL 29789	1000.504	109	0.0109
WL 29792	325	70	0.007
WL 29739	432	37	0.0037
WL 28818	280	115	0.0115
WL 28707	335	60	0.006
WL 29796	492	97	0.0097
	Mean: 1000.395	81.3	0.0081%
	Specification Requirements:		0.015%
	Master Oscillator Circuit RCA Tubes		
RCA 36170	1000.790	75	0.0075
RCA 37362	798	67	0.0067
RCA 36156	910	45	0.0045
RCA 36135	962	97	0.0097
	Mean: 1000.865	71	0.0071%
	Specification Requirements:		0.015%

TABLE 18

Model XTBU Transmitting Equipment
Change of Tubes

Test as per paragraph 3-7-6 of Specifications RE 13A 422C

Manufacturer and Serial No. of Tube	Frequency KC	Deviation from Mean Frequency Cycles	Per Cent
	Master Oscillator Circuit		
WL 29789	2002.500	1127	0.0564
WL 29792	300	927	0.0464
WL 29739	425	1052	0.0526
WL 28818	090	717	0.0359
WL 28707	225	852	0.0426
RCA 36170	2000.060	1313	0.0657
RCA 37362	150	1223	0.0612
RCA 36156	1999.800	1573	0.0787
RCA 36135	675	1698	0.0849
WL 29796	2002.500	1127	0.0564
Mean:	2001.373	1160.9	0.058%
Specification Requirements:			0.015%
	Intermediate Amplifier Circuit		
WL 29789	2000.495	92	0.0046
WL 29792	450	47	0.0024
WL 29739	475	72	0.0036
WL 28818	400	3	0.0002
WL 28707	475	72	0.0036
RCA 36170	325	78	0.0039
RCA 37362	443	40	0.002
RCA 36156	220	183	0.0092
RCA 36135	255	148	0.0074
WL 29738	495	92	0.0046
Mean:	2000.403	82.7	0.00414%
Specification Requirements:			0.005%
	Power Amplifier Circuit		
GE 14140	2000.495	3	0.00015
WL 26196	495	3	0.00015
GE 14145	498	0	0
WL 26177	503	5	0.00025
Mean:	2000.498	2.75	0.00014%
Specification Requirements:			0.005%

TABLE 18 Continued

Recapitulation of data wherein the tubes of each manufacturer are considered separately.

	Master Oscillator Circuit Westinghouse Tubes		
WL 29789	2002.500	160	0.008
WL 29792	300	40	0.002
WL 29739	425	85	0.0043
WL 28818	090	250	0.0125
WL 28707	225	115	0.0058
WL 29796	500	160	0.0080
	Mean: 2002.340	135	0.0068%
	Specification Requirements:		0.015%
	Master Oscillator Circuit RCA Tubes		
RCA 36170	2000.060	139	0.007
RCA 37362	150	229	0.0115
RCA 36156	1999.800	121	0.0061
RCA 36135	675	246	0.0123
	Mean: 1999.921	184	0.0092%
	Specification Requirements:		0.015%

TABLE 19

Model XTBU Transmitting Equipment
Variation of Supply Line Voltage

Test as per paragraph 3-7-7 of Specifications RE 13A 422C

Line Volts	Plate Volts	Filament Volts	Antenna I (external)	Frequency kc	Frequency Change Cycles	Per Cent
	(Variation from -5% to plus 5% in 5 minutes)					
418	2025	10.7	11.68	300.355		
440	2025	11.2	11.80	300.347		
462	2025	11.9	11.84	300.339	16	0.0053
	(Variation from -5% to plus 5% in 5 minutes)					
418	2225	10.4	12.86	1000.231		
440	2225	11.0	12.86	1000.219		
462	2225	11.6	12.94	1000.212	19	0.0019
	(Variation from -5% to plus 5% in 5 minutes)					
418	2200	10.4	11.64	2000.216		
440	2200	10.9	11.82	2000.195		
462	2200	11.7	12.00	2000.175	41	0.00205

Specification Requirements: 0.006%

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Line Volts	Plate Volts	Filament Volts	Antenna I (external)	Frequency kc	Frequency Change Cycles	Per Cent
	(Variation from-5% to plus 5% in one minute)					
418	2025	10.3	11.64	300.328		
440	2025	10.9	11.68	300.328		
462	2025	11.4	11.80	300.330	2	0.00067
	(Variation from -5% to plus 5% in one minute)					
418	2020	10.3	12.80	1000.230		
440	2020	11.1	12.84	1000.225		
462	2020	11.6	12.94	1000.220	10	0.001
	(Variation from -5% to plus 5% in one minute)					
418	2200	10.3	11.60	2000.217		
440	2200	11.0	11.80	2000.205		
462	2200	11.6	11.94	2000.192	25	0.00125

Specification Requirements: 0.006%

TABLE 20

Model XTBU Transmitting Equipment
Variation of Supply Line Voltage

Test as per paragraphs 3-7-7 & 2-37 of Specifications RE 13A 422C

Line Volts	Plate Volts	Filament Volts	Antenna I (external)	Frequency kc	Frequency Change Cycles	Frequency Change Per Cent
(Variation from -10% to plus 10% in 5 minutes)						
396	2200	9.9	11.80	300.262		
440	2220	11.0	11.96	300.265		
484	2220	12.2	12.06	300.260	5	0.00167
396	2240	9.8	12.86	1000.209		
440	2240	11.0	12.96	1000.195		
484	2250	12.2	13.02	1000.175	34	0.0034
396	2175	9.9	11.02	2000.236		
440	2175	11.0	11.66	2000.217		
484	2200	12.4	11.84	2000.199	37	0.00185

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Line Volts	Plate Volts	Filament Volts	Antenna I (external)	Frequency kc	Frequency Change Cycles	Frequency Change Per Cent
(Variation from -10% to plus 10% in 1 minute)						
396	2200	9.9	11.76	300.249		
440	2220	11.0	11.98	300.257		
484	2220	12.2	12.06	300.258	9	0.003
396	2230	9.8	12.76	1000.283		
440	2240	11.0	12.88	1000.284		
484	2250	12.2	13.00	1000.278	6	0.0006
396	2200	10.0	10.88	2000.231		
440	2200	11.1	11.62	2000.219		
484	2200	12.5	11.80	2000.205	26	0.0013

TABLE 21

Model XTBU Transmitting Equipment
Variations in Ambient Temperature

Test as per paragraph 3-7-8 of Specifications RE 13A 422C

Time	Amb. Temp.	Rel Hum.	Frequency kc	P. A. Ep	P. A. Ip	Ant. Curr.	Line Volts
0900	49	13	300.442	2220	920	12.2	435
15	48	37	352	2200	910	12.0	433
30	51.7	26	320	2200	900	11.9	436
45	51	29	298	2180	890	11.8	435
1000	50.7	29	280	2170	880	11.5	430
15	39.5	35	280	2170	880	11.5	431
30	39.5	33	294	2180	880	11.6	431
45	40.2	30	310	2180	880	11.6	430
1100	40.5	30	322	2190	890	11.7	432
15	40	30	326	2190	890	11.8	432
30	30	40	344	2200	890	11.9	430
45	29.5	39	360	2200	900	12.0	432
1200	30	38	370	2200	900	12.0	436
15	29.5	33	380	2200	900	12.0	437
30	29.5	30	385	2200	900	12.0	434
1245	20	53	392	2220	910	12.1	433
1300	21	35	404	2220	910	12.1	432
15	21	28	420	2220	920	12.2	434
30	21	28	426	2230	920	12.3	434
45	19.5	29	430	2220	920	12.3	434
1400	10	27	448	2240	920	12.4	430
15	10	31	458	2250	930	12.5	433
30	10	25	460	2250	930	12.5	431
45	10.5	31	466	2250	940	12.5	430
1500	9.5	37	470	2250	950	12.5	430
15	0.5	-	500	2250	950	12.6	435
30	1	-	528	2280	950	12.7	438
45	0.5	-	540	2300	960	12.8	438
1600	1	-	550	2290	950	12.7	428
15	1.5	-	550	2290	960	12.8	433

TABLE 21 continued

SUMMARY

Temperature Change Degrees C.	Cycles Change per 10 Degrees C.	Per Cent Change per one Deg. C.
50 to 40	46	0.0015
40 to 30	59	0.0019
30 to 20	45	0.0015
20 to 10	40	0.0013
10 to 0	80	0.0026

Specification Requirements: 0.0025% frequency change per one Degree C change in ambient.

TABLE 22

Model XTBU Transmitting Equipment
Variations in Ambient Temperature

Test as per paragraph 3-7-8 of Specifications RE 13A 422C

Time	Amb Temp	Rel. Hum.	Frequency kc	P. A. Ep	P. A. Ip	Ant. Curr.	Line Volts
0830	51	13	1002.200	1930	1000	13.1	435
45	51	23	175	1900	980	13.0	436
0900	50.7	25	200	1900	970	12.9	438
15	51.2	25	210	1880	960	12.8	437
30	51	26	220	1880	960	12.8	435
45	40.5	34	250	1880	960	12.7	432
1000	41.5	29	270	1880	960	12.7	435
15	41.5	29	325	1880	970	12.9	436
30	41	29	350	1880	970	12.9	434
45	41	29	350	1890	970	12.9	436
1100	29	39	400	1900	970	13.0	437
15	29	39	440	1900	980	13.0	437
30	28.5	36	440	1900	980	13.0	436
45	29	34	445	1900	980	13.0	440
1200	30.5	31	445	1900	980	13.0	441
15	19	48	455	1900	985	13.1	440
30	20.5	42	480	1940	990	13.2	440
45	19.5	37	495	1910	990	13.1	438
1300	19.5	36	490	1910	990	13.1	438
15	21.5	28	502	1920	990	13.1	437
30	10.5	36	610	1950	1000	13.3	440
45	10.5	36	620	1950	1000	13.3	440
1400	9.5	35	610	1950	1000	13.4	438
15	10	36	550	1950	1000	13.4	439
30	10	36	540	1950	1000	13.4	439
45	0	-	600	1950	1000	13.5=	438
1500	1	-	650	1970	1010	13.5	435
15	1	-	600	1980	1010	13.5	433
30	0.5	-	600	1990	1010	13.6	434
45	1	-	600	2000	1010	13.6	436

TABLE 22 continued

SUMMARY

Temperature Change Degrees C	Cycles Change per 10 Degrees C.	Per cent Change per one Deg. C.
50 to 40	130	0.0013
40 to 30	95	0.00095
30 to 20	57	0.00057
20 to 10	38	0.00038
10 to 0	60	0.0006

Specification Requirements: 0.0025% frequency change per one degree C change in ambient.

TABLE 23

Model XTBU Transmitting Equipment
Variations in Ambient Temperature

Test as per paragraph 3-7-8 of Specifications RE 13A 422C

Time	Amb Temp.	Rel. Hum.	Frequency kc	P. A. Ep	P. A. Ip	Ant. Curr.	Line Volts
0830	50	29	2002.090	2250	920	12.5	436
45	50.5	28	030	2220	910	12.4	438
0900	51.7	24	190	2200	900	12.2	439
15	51	25	250	2200	900	12.1	440
30	51	26	280	2190	900	12.0	440
45	38.5	34	410	2190	890	12.0	430
1000	38	36	480	2180	890	12.0	432
15	40.2	33	510	2180	880	12.0	430
30	39.2	35	520	2180	880	12.0	425
45	40.5	33	520	2180	880	12.0	428
1100	29.7	37	640	2190	880	12.0	430
15	29.5	35	680	2200	890	12.1	434
30	29	35	700	2200	890	12.1	438
45	30.7	26	720	2200	890	12.2	436
1200	29	26	750	2200	900	12.3	432
15	19	39	800	2210	900	12.4	440
30	20	29	820	2220	900	12.5	438
45	19	26	830	2230	900	12.5	437
1300	19	30	840	2240	900	12.5	436
15	19.5	34	800	2250	910	12.5	438
30	10.5	27	900	2250	910	12.5	436
45	10.7	27	900	2250	920	12.7	435
1400	10	29	870	2250	920	12.7	436
15	10	29	870	2270	920	12.7	434
30	9.5	28	850	2270	920	12.8	435
45	0.7	-	920	2270	920	12.8	434
1500	1	-	950	2280	920	12.9	434
15	1	-	900	2290	920	13.0	435
30	1	-	860	2290	930	13.0	430
45	0	-	860	2290	930	13.0	430

TABLE 23 continued

SUMMARY

Temperature Change Degrees C.	Cycles Change per 10 Degrees C.	Per cent Change per one Deg. C.
50 to 40	240	0.0012
40 to 30	230	0.00115
30 to 20	50	0.00025
20 to 10	50	0.00025
10 to 0	10	0.00005

Specification Requirements: 0.0025% frequency change per one degree C change in ambient.

TABLE 24

Model XTBU Transmitting Equipment
Variations in Humidity

Test as per paragraph 3-7-9 of Specifications RE 13A 422C

Time	Amb. Temp.	Rel. Humid.	Frequency kc	P. A. Ep	P. A. Ip	Watts Output	Line Volts
0900	41.5	27	300.609	2210	960	950	434
15	41.2	29	579	2200	950	942	435
30	42.0	28	556	2190	940	933	435
45	39.0	80	532	2180	930	910	440
1000	40.5	90	516	2180	930	903	440
15	42.5	97	498	2180	920	869	440
30	41.0	96	497	2180	920	869	440
45	41.2	93	500	2180	920	869	438
1100	41.5	93	499	2180	920	869	432
15	41.5	97	498	2180	920	869	432
30	38.5	66	510	2180	920	869	438
45	40.7	36	515	2180	920	869	436
1200	40.0	29	520	2180	920	869	440
15	41.0	27	528	2180	930	874	442
30	40.2	32	530	2180	920	874	440
45	41.0	29	532	2190	930	883	440
1300	40.0	30	534	2190	930	887	438

Transmitter operated at full power output 15 minutes previous to starting of test.

Frequency at end of 1st test period: 300.556 kc
Frequency of greatest subsequent change: 300.497
Maximum frequency change: 59 cycles; 0.0197%
Specification Requirements: 0.05%

Greatest variation of power output from end of first test period: 6.9%
Specification requirements: 5%

Transmitter operating into 1500 watt, 110 volt Lamp with 998 uuf in series.

TABLE 25

Model XTBU Transmitting Equipment
Variations in Humidity

Test as per paragraph 3-7-9 of Specifications RE 13A 422C

Time	Amb. Temp.	Rel. Humid.	Frequency kc	P. A. Ep	P. A. Ip	Watts Output	Line Volts
0900	41.7	30	1000.745	1910	1000	1300	438
15	41.7	28	780	1910	1000	1295	442
30	42.0	28	795	1900	1000	1285	440
45	39.5	86	682	1900	1000	1285	439
1000	41.7	93	490	1900	1000	1280	440
15	42.5	97	323	1900	1000	1270	440
30	40.7	90	320	1900	1000	1265	432
45	41.0	93	300	1900	1000	1265	437
1100	39.7	93	408	1900	1000	1270	437
15	39.7	41	607	1900	1000	1265	438
30	40.5	30	702	1900	1000	1270	438
45	42.0	25	750	1900	1000	1270	439
1200	42.0	24	772	1900	1000	1270	442
15	42.0	24	780	1900	1000	1270	442
30	42.0	24	790	1900	1000	1270	440

Transmitter operated at full power output one hour previous to starting of test.

Frequency at end of 1st test period: 1000.795 kc
Frequency of greatest subsequent change: 1000.300 kc
Maximum frequency change: 495 cycles, 0.0495%
Specification Requirements: 0.05%

Greatest variation of power output from end of first test period: 1.56%
Specification requirements: 5%

Transmitter operating into 1500 watt, 110 volt lamp with 998 uuf in series.

TABLE 26

Model XTBU Transmitting Equipment
Variations in Humidity

Test as per paragraph 3-7-9 of Specifications RE 13A 422C

Time	Amb. Temp.	Rel. Humid.	Frequency kc	P. A. Ep	P. A. Ip	WATTS Output	Line Volts
1000	39.7	29	2000.888	2250	950	1300	434
15	40.5	31	930	2250	950	1300	438
30	41.5	29	960	2250	950	1300	437
45	41.5	87	500	2250	950	1300	436
1100	42.0	97	253	2250	950	1290	438
15	41.5	93	235	2250	950	1290	440
30	41.5	93	228	2250	950	1285	439
45	41.5	93	222	2250	950	1290	441
1200	41.7	93	209	2250	950	1290	440
15	40.2	60	479	2250	950	1290	442
30	42.5	28	700	2250	930	1290	444
45	41.2	31	804	2250	930	1290	437
1300	40.5	30	855	2250	930	1290	442
15	40.2	32	894	2250	930	1290	440
30	40.5	32	918	2250	930	1290	440

Transmitter operated at full power output one hour and 50 min. previous to starting of test.

Frequency at end of 1st test period: 2000.960 kc
Frequency of greatest subsequent change: 2000.209 kc
Maximum frequency change: 751 cycles; 0.038%
Specification requirements: 0.05%

Greatest variation of power output from end of first test period: 1.15%
Specification requirements: 5%

Transmitter operating into 1500 watt, 110 volt lamp with 998 uuf in series.

TABLE 27

Model XTBU Transmitting Equipment
Locked Key Operation for Two Hours

Test as per paragraph 3-7-10 of Specifications RE 13A 422C

Time	Temp °C	Frequency kc	Plate Volts	Plate Curr.	Output Watts	Line Volts
1:15	22.8	Filaments on				
20	22.8	300.250	2050	980	979	437
25	22.8	230	2025	980	982	438
30	22.6	221	2020	980	979	438
35	22.6	216	2020	980	979	438
40	22.8	211	2020	980	979	440
45	22.6	208	2020	980	979	439
50	22.8	204	2020	980	979	440
55	22.6	200	2010	980	975	439
2:00	23.0	198	2010	980	975	439
05	23.0	196	2010	980	972	439
10	23.0	194	2010	980	972	440
15	23.4	190	2010	960	972	438
20	23.8	188	2000	960	968	438
25	23.4	186	2000	960	965	438
30	23.4	185	2000	950	968	440
35	23.1	182	2000	950	951	431
40	22.9	180	2000	950	951	434
45	22.7	179	2000	950	955	430
50	22.8	178	2000	950	951	434
55	22.6	176	2000	950	948	435
3:00	22.8	175	2000	950	941	430
05	22.9	175	2000	950	941	434
10	23.2	175	2000	950	941	436
15	23.6	175	2000	950	945	436
20	23.8	175	2000	950	941	437

Frequency change in first five minutes: 20 cycles; 0.0067%
Specification Requirements - 0.015%

Maximum frequency change during remainder of test
from frequency at end of first five minutes: 55 cycles; 0.0183%
Specification Requirements: 0.03%

TABLE 28

Model XTBU Transmitting Equipment
Locked Key Operation for Two Hours

Test as per paragraph 3-7-10 of Specifications RE 13A 422C

Time	Temp. °C	Frequency KC	Plate Volts	Plate Curr.	Output Watts	Line Volts
10:45	23.0	Filaments	on			
50	22.6	1000.238	2245	970	1075	438
55	22.8	185	2240	960	1075	438
11:00	22.9	167	2240	950	1055	439
05	22.7	161	2240	950	1050	439
10	22.6	165	2240	950	1050	440
15	22.2	166	2240	945	1040	438
20	22.6	172	2225	945	1030	439
25	23.0	175	2225	945	1026	440
30	24.3	180	2225	940	1026	440
35	24.8	183	2225	940	1026	440
40	25.2	185	2225	940	1026	440
45	25.2	190	2210	940	1026	440
50	25.1	192	2210	940	1026	440
55	25.0	194	2210	940	1026	440
12:00	24.9	204	2210	940	1026	440
05	24.4	209	2200	930	1026	440
10	24.4	212	2200	930	1026	440
15	24.4	220	2200	930	1015	441
20	24.0	225	2210	930	1020	442
25	23.9	230	2210	930	1026	442
30	23.7	234	2210	925	1015	434
35	23.5	238	2210	925	1015	434
40	23.8	242	2210	925	1010	435
45	24.0	244	2210	925	1010	434
50	24.8	246	2210	925	1000	438

Frequency change in first five minutes: 53 cycles, 0.0053%
Specification Requirements: 0.015%

Maximum frequency change during remainder of test
from frequency at end of first five minutes: 61 cycles; 0.0061%
Specification Requirements: 0.03%

TABLE 29

Model XTBU Transmitting Equipment
Locked key operation for Two Hours.

Test as per paragraph 3-7-10 of Specifications RE 13A 422C

Time	Temp °C	Frequency Kc	Plate Volts	Plate Curr.	Output Watts	Line Volts
8:40	22.5	Filaments on				
45	22.7	2000.510	2230	990	1563	438
50	23.2	395	2225	990	1553	438
55	22.0	355	2225	990	1540	437
9:00	22.0	352	2225	990	1540	437
05	22.0	353	2225	990	1520	436
10	22.1	378	2225	990	1515	438
15	21.8	396	2220	990	1510	436
20	21.6	418	2220	980	1505	439
25	21.4	438	2225	990	1505	440
30	21.2	458	2220	980	1497	438
35	21.2	480	2220	960	1487	438
40	21.3	500	2220	960	1487	436
45	21.4	518	2220	960	1487	440
50	21.8	531	2210	960	1468	438
55	22.0	546	2220	955	1468	438
10:00	22.1	565	2220	950	1458	437
05	22.2	580	2210	955	1443	438
10	22.2	590	2210	955	1443	439
15	22.2	600	2210	950	1425	438
20	22.2	618	2210	950	1420	437
25	22.0	630	2210	940	1402	438
30	22.0	640	2210	940	1383	438
35	22.2	655	2210	940	1380	439
40	22.2	662	2210	930	1373	438
45	22.6	670	2210	930	1348	438

Frequency change in first five minutes: 115 cycles; 0.0058%
Specification requirements: 0.015%

Maximum frequency change during remainder of test
from frequency at end of first five minutes: 275 cycles; 0.0138%
Specification requirements: 0.03%

TABLE 30

Model XTBU Transmitting Equipment
Change from Key Locked to Intermittently Keyed Condition

Test as per paragraph 3-7-11 of Specifications RE 13A 422C

Test Condition	Frequency at end of 10 min. key locked period (kc)	Frequency at end of 10 sec. dash 20 min. later (kc)	Change in Frequency Cycles	Per cent
M.O. Fil. not lighted	1000.225	1000.356	131	0.0131
M.O. Fil. lighted	1000.272	1000.307	35	0.0035
M.O. Fil. not lighted	2000.389	2000.575	186	0.0093
M.O. Fil. lighted	2000.382	2000.424	42	0.0021
M.O. Fil. not lighted	300.312	300.354	42	0.014
M.O. Fil lighted	300.322	300.338	16	0.0053

Specification Requirements:

Master Oscillator Filaments Lighted:	0.01%
Master Oscillator Filaments not Lighted	0.02%

TABLE 31

Model XTBU Transmitting Equipment
Change from Continuously Keyed Condition
to Intermittently Keyed Condition.

Test as per paragraph 3-7-12 of Specifications RE 13A 422C

Test Condition	Frequency at end of 30 min. continuous keying (kc)	Frequency at end of 10 sec. dash after 20 min. pause	Change in Frequency Cycles	Per cent
All fils. lighted	1000.209	1000.248	39	0.0039
All fils. lighted	2000.745	2000.785	40	0.002
All fils. lighted	300*			

(*) It was found impossible to conduct this test at 300 kc, due to the fact that when the transmitter was keyed arc overs occurred in Capacitors C-139 and C-143 (variable air condensers) and also to ground from the conductor between C-139 and C-147, where the conductor passes through the P.A. deck. The arc overs caused the overload relays to operate, prohibiting continuation of the test. No trouble was encountered during the locked key condition; hence it appears that insufficient spacing is provided to prevent breakdown by keying transients. It was observed that when the transmitter had been heated up due to previous operation, the arc overs appeared to occur more readily than when the equipment was cold.

Specification Requirements: 0.01%

TABLE 32

Model XTBU Transmitting Equipment
Inclination Test

Test as per paragraph 3-7-13 of Specifications RE 13A 422C

Time	Maximum Frequency	Difference Cycles	Minimum Frequency	Test Condition
		Inclination: Front to Back		
1:34	300.543			Stationary
35	535	4	300.539	Inclination
40	532	5	537	"
45	525	5	530	"
50	521	5	526	"
55	516	5	521	"
2:00	512	5	517	"
05	508	5	513	"
06	513			Stationary

Maximum frequency change during test from frequency at start of test: 35 cycles; 0.011%
Maximum frequency change at any two points in inclination cycle (max to min): 5 cycles; 0.0016%.

Time	Maximum Frequency	Difference Cycles	Minimum Frequency	Test Condition
		Inclination: Side to Side		
9:25	300.209			Stationary
25	198	5	300.203	Inclination
30	195	7	202	"
35	190	8	198	"
40	185	9	194	"
45	181	8	189	"
50	176	8	184	"
55	174	7	181	"
55	182			Stationary

Maximum frequency change during test from frequency at start of test: 35 cycles; 0.011%
Maximum frequency change at any two points in inclination cycle (max to min): 9 cycles; 0.003%

Inclination at rate of 5 complete cycles per minute

Specification requirements: 0.005%

TABLE 33

Model XTBU Transmitting Equipment
Inclination Test

Test as per paragraph 3-7-13 of Specifications RE 13A 422C

Time	Maximum Frequency	Difference Cycles	Minimum Frequency	Test Condition
		Inclination: Front to Back		
2:15	1000.520			Stationary
15	520	10	1000.530	Inclination
20	532	14	546	"
25	543	12	555	"
30	547	13	560	"
35	550	15	565	"
40	553	15	568	"
45	555	15	570	"
45	567			Stationary

Maximum frequency change during test from frequency at start of test: 50 cycles; 0.005%
Maximum frequency change at any two points in inclination cycle (max to min); 15 cycles; 0.0015%

Time	Maximum Frequency	Difference Cycles	Minimum Frequency	Test Condition
		Inclination: Side to Side		
11:10	1000.215			Stationary
10	215	13	1000.228	Inclination
15	220	12	232	"
20	221	14	235	"
25	224	11	235	"
30	226	13	239	"
35	225	16	241	"
40	227	15	242	"
40	232			Stationary

Maximum frequency change during test from frequency at start of test: 27 cycles; 0.0027%
Maximum frequency change at any two points in inclination cycle (max to min); 16 cycles; 0.0016%

Inclination at rate of 5 complete cycles per minute

Specification requirements: 0.005%

TABLE 34

Model XTBU Transmitting Equipment
Inclination Test.

Test as per paragraph 3-7-13 of Specifications RE 13A 422C

Time	Maximum Frequency	Difference Cycles	Minimum Frequency	Test Condition
		Inclination: Front to Back		
3:10	2000.543			Stationary
10	535	25	2000.560	Inclination
15	535	13	548	"
20	515	30	545	"
25	522	23	545	"
30	535	17	552	"
35	540	15	555	"
40	542	16	558	"
40	558			Stationary

Maximum frequency change during test from frequency at start of test: 28 cycles; 0.0014%
Maximum frequency change at any two points in inclination cycle (max to min): 30 cycles; 0.0015%

Time	Maximum Frequency	Difference Cycles	Minimum Frequency	Test Condition
		Inclination: Side to Side		
12:55	2000.206			Stationary
55	210	10	2000.220	Inclination
1:00	219	15	234	"
05	224	18	242	"
10	223	19	242	"
15	231	18	249	"
20	231	19	240	"
25	235	20	245	"
25	235			Stationary

Maximum frequency change during test from frequency at start of test: 43 cycles; 0.0021%
Maximum frequency change at any two points in inclination cycle (max to min): 20 cycles; 0.001%

Inclination at rate of 5 complete cycles per minute.

Specification requirements: 0.005%

TABLE 35

Model XTBU Transmitting Equipment
Vibration

Test as per paragraph 3-7-14 of Specifications RE 13A 422C

Time	Frequency kc	P. A. Ep	P. A. Ip	Antenna Current	Test Condition
3:30	300.402	2210	1000	13.0	No vibration
30	400	2210	1000	13.0	Vibration
35	398	2200	1000	13.0	"
40	392	2210	1000	13.0	"
45	392	2210	1000	13.0	"
50	390	2200	1000	12.9	"
55	390	2200	990	12.8	"
4:00	388	2210	1000	12.8	"
00	388	2210	1000	12.9	No vibration

Maximum set in frequency (difference between start and end of test): 14 cycles; 0.0046%

Time	Frequency kc	P. A. Ep	P. A. Ip	Antenna Current	Test Condition
2:40	1000.410	1900	1000	12.6	No vibration
40	396	1900	1000	12.6	Vibration
45	400	1900	990	12.8	"
50	400	1890	990	12.5	"
55	388	1890	980	12.5	"
3:00	390	1900	990	12.8	"
05	380	1890	975	12.5	"
10	382	1890	990	12.5	"
10	386	1900	990	12.4	No vibration

Maximum set in frequency (difference between start and end of test): 24 cycles; 0.0024%

Time	Frequency kc	P. A. Ep	P. A. Ip	Antenna Current	Test Condition
1:20	2000.518	2225	960	12.5	No vibration
25	530	2225	960	12.5	Vibration
30	544	2210	950	12.3	"
35	553	2210	950	12.4	"
40	570	2210	950	12.5	"
45	582	2210	950	12.4	"
50	592	2205	950	12.4	"
50	596	2210	950	12.5	No vibration

Maximum set in frequency (difference between start and end of test): 78 cycles; 0.0039%

Specification Requirements: 0.005%

TABLE 36

Model XTBU Transmitting Equipment
Shock Test

Test as per paragraph 3-7-15 of Specifications RE 13A 422C

Shock applied to :	Frequency before shock	Frequency after shock	Frequency Difference Cycles	Per cent
Front*	2000.343	2000.354	11	0.00055
Back	351	358	7	0.00035
Right Side	373	360	13	0.00065
Left Side	323	308	15	0.00075

* Plate overload and control "J" opened under shock.

Front	1000.316	1000.341	25	0.0025
Back*	303	297	6	0.0006
Right Side	301	305	4	0.0004
Left Side	306	306	0	0

* Plate overload relay opened.

Front	300.226	300.225	1	0.0003
Back	238	227	11	0.0036
Right side	230	230	0	0
Left Side	225	225	0	0

Specification requirements: 0.005%

TABLE 37

Model XTBU Transmitting Equipment

Summary of frequency Stability tests.

Tests as per paragraph 3-7 of Specifications RE 13A 422C.

	Maximum Frequency Variation (%)			Percent Frequency Variation of Specification allowance			Spec. Limits
Test No.	300	1000	2000	300	1000	2000	
3-7-1 (a)	0.0066	0.00316	0.00078	66%	32%	8%	0.01
(b)	0.009	0.0045	0.0015	60	30	10	0.015
3-7-2 (a)	0.0181	0.0239	0.0115	91	120	57	0.02
(b)	0.0206	0.0259	0.0124	45	57.	27	0.045
3-7-3	0.0063	0.0017	0.0007	42	11	5	0.015
3-7-4	0.0026	0.0045	0.001	26	45	10	0.01
3-7-5	0.00467	0.0011	0.00205	93	22	41	0.005
3-7-6 (a)	0.0116	0.0226	0.058	77#	151#	387#	0.015
(b)	0.00264	0.004	0.00414	53	80	83	0.005
3-7-7	0.0053	0.0019	0.00205	88	32	34	0.006
3-7-8	0.0026	0.0013	0.0012	104	52	48	0.0025
3-7-9	0.0197	0.0495	0.038	39	99	76	0.05
3-7-10(a)	0.0067	0.0053	0.0058	45	35	39	0.015
(b)	0.0183	0.0061	0.0138	61	20	46	0.03
3-7-11(a)	0.0053	0.0035	0.0021	53	35	21	0.01
(b)	0.014	0.0131	0.0093	70	65	47	0.02
3-7-12	- *	0.0039	0.002	- *	39	20	0.01
3-7-13	0.003	0.0016	0.0015	60	32	30	0.005
3-7-14	0.0046	0.0024	0.0039	92	48	78	0.005
3-7-15	0.0036	0.0025	0.00075	72	50	15	0.005
Totals	0.16521*	0.18246	0.17247	Avg. 65*	Avg. 53	Avg. 54	0.2985 (total)

* and # - see par. 125 of text.

TABLE 38

Model XTBU Transmitting Equipment
Overlap and Limiting Frequency of Master Oscillator.

Test as per paragraph 3-11-1 of Specifications RE 13A 422C

Control "A"	Control "B"	Frequency KC	Overlap KC	Mean Freq. KC	Per Cent Overlap
Specification limit:		150	8.49	145.76	5.83
0	1	141.51			
2500	1	187.43			
			20.57	177.15	11.63
0	2	166.86			
2500	2	219.83	22.61	208.52	10.85
0	3	197.22			
2500	3	293.60	29.32	278.94	10.50
0	4	264.28			
2500	4	408.80	78.65	369.48	21.3
0	5	330.15			
2500	5	535.25	118.22	476.14	24.8
0	6	417.03			
2500	6	643.50	53.86	616.57	8.73
0	7	589.64			
2500	7	762.50	93.22	715.89	13.0
0	8	669.28			
2500	8	929.42	130.97	863.94	15.18
0	9	798.45			
2500	9	1030.72	115.29	973.08	11.87
0	10	915.43			
2500	10	1123.90	123.9	1061.95	11.68

Specification limit: 1000.00

Specification Requirements: 3% overlap

A-1

TABLE 39

Model XTBU Transmitting Equipment
Limiting Frequencies and Overlap of Intermediate Amplifier Circui[t]

Test as per paragraph 3-11-1 of Specifications RE 13A 422C

Column: Limiting) Stage)	1 MO	2 IA	3 IA PA	4 IA	5 I A	6 IA	7 IA PA	8 IA	9 I P
Controls									
A	0	1356	819	1400	970	1781	1205	1366	148
B	1	2	2	3	3	4	4	6	
C	1	1	2	2	3	3	4	4	
D	5.5	100	0	100	0	100	0	100	
E	8	89	0	88	9	39	0	90	
F	3	6	3	6	4	5	4	7	
G	1	1	1	1	4	6	1	3	
H	1	1	2	2	3	4	4	4	
J	2	2	3	3	3	6	5	8	
K	40	83	26	73	62	-	-	-	
L	-	-	-	-	-	837	1064	244	5:
Freq:	279.26	379.07	352.78	484.32	440.31	728.57	620.17	999.71	8.
KC Overlap:			26.29		44.01		108.4		1
Mean Freq:			365.93		462.31		674.37		9
% Overlap:			7.19		9. 53		16.1		

Specification Requirements: 3% min. Overlap

A-2

TABLE 39

Model XTBU Transmitting Equipment
.ting Frequencies and Overlap of Intermediate Amplifier Circuit

›ecifications RE 13A 422C

	4	5	6	7	8	9	10	11	12
A A	IA	I A	IA	IA PA	IA	IA PA	IA	IA	IA
9	1400	970	1781	1205	1266	1482	1155	1307	1948
2	3	3	4	4	6	5	9	8	10
2	2	3	3	4	4	5	5	6	6
0	100	0	100	0	100	0	100	0	100
0	88	9	39	0	90	0	84	13	63
3	6	4	5	4	7	5	8	6	8
1	1	4	6	1	3	6	4	5	1
2	2	3	4	4	4	5	5	6	6
3	3	3	6	5	8	7	9	9	9
6	73	62	-	-	-	-	-	-	-
-	-	-	837	1064	244	532	783	736	1115
2.78	484.32	440.31	728.57	620.17	999.71	845.11	1719.6	1500.0	2137.5
6.29		44.01		108.4		154.6		219. 6	137.5
5.93		462.31		674.37		922.41		1609.8	2068.75
7.19		9. 53		16.1		16.78		13.63	6.68

›n Requirements: 3% min. Overlap

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B-1

TABLE 40

Model XTBU Transmitting Equipment
Limiting Frequencies and Overlap of Power Amplifier Circu

Test as per paragraph 3-11-1 of Specifications RE 13A 422C

Column: Limiting) Stage)	1 MO	2 PA	3 IA PA	4 PA	5 PA	6 PA	7 IA PA	8 PA
Controls								
A	–	1464	819	1503	837	1630	1205	1350
B	–	2	2	3	3	4	4	6
C	–	2	2	3	2	3	4	5
D		42	0	38	61	88	0	45
E	8	100	0	100	0	100	0	10C
F	–	6	3	6	4	7	4	7
G	–	3	1	3	3	4	1	4
H	–	1	2	2	3	3	4	4
J	–	2	3	3	3	6	5	8
K	–	85	26	76	58	–	–	–
L	–	–	–	–	–	394	1064	293
Freq:	279.26	392.15	353.78	496.91	428.95	699.52	620.17	102C
KC Overlap			39.37		67.96		79.35	
Mean Freq.			372 .47		462.93		659.85	
% Overlap			10.58		14.7		12.03	

Note: The M.O. and IA circuits limited the end frequencies of columns 1 and 12; he Power Amp circuits, even though capable of reaching lower and higher freque respectively, could not be tuned.

B-2

TABLE 40

Model XTBU Transmitting Equipment

quencies and Overlap of Power Amplifier Circuit

tions RE 13A 422C

4 PA	5 PA	6 PA	7 IA PA	8 PA	9 IA PA	10 PA	11 PA	12 IA
1503	837	1630	1205	1350	1482	1828	927	-
.3	3	4	4	6	5	10	8	-
3	2	3	4	5	5	6	5	-
38	61	88	0	45	0	94	79	100
100	0	100	0	100	0	100	0	63
6	4	7	4	7	5	8	6	-
3	3	4	1	4	6	6	1	-
2	3	3	4	4	5	5	6	6
3	3	6	5	8	7	9	9	-
76	58	-	-	-	-	-	-	-
-	-	394	1064	293	532	937	654	-
496.91	428.95	699.52	620.17	1020.94	845.11	2100.69	1416.27	2137.5
	67.96		79.35		175.83		684.42	
	462.93		659.85		933.03		1758.48	
	14.7		12.03		18.87		38.9	

ted the end frequencies of columns 1 and 12; hence the
gh capable of reaching lower and higher frequencies
ned.

Specification Requirements : 3% min. Overlap

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TABLE 39

Model XTBU Transmitting Equipment
Limiting Frequencies and Overlap of Intermediate Amplifie

Test as per paragraph 3-11-1 of Specifications RE 13A 422C

Column:	1	2	3	4	5	6	7	8
Limiting Stage	MO	IA	IA PA	IA	I A	IA	IA PA	IA
Controls								
A	0	1356	819	1400	970	1781	1205	1366
B	1	2	2	3	3	4	4	6
C	1	1	2	2	3	3	4	4
D	5.5	100	0	100	0	100	0	100
E	8	89	0	88	9	39	0	90
F	3	6	3	6	4	5	4	7
G	1	1	1	1	4	6	1	3
H	1	1	2	2	3	4	4	4
J	2	2	3	3	3	6	5	8
K	40	83	26	73	62	-	-	-
L	-	-	-	-	-	837	1064	244
Freq:	279.26	379.07	352.78	484.32	440.31	728.57	620.17	999.71
KC Overlap:			26.29		44.01		108.4	
Mean Freq:			365.93		462.31		674.37	
% Overlap:			7.19		9. 53		16.1	

Specification Requirements: 3% min. Overlap

12
IA
1948
10
6
100
63
8
1
6
9
-
1115
2137.5
137.5
2068.75
6.68

TABLE 40

Model XTBU Transmitting Equipment
Limiting Frequencies and Overlap of Power Amplifier Circu[illegible]

Test as per paragraph 3-11-1 of Specifications RE 13A 422C

Column: Limiting) Stage)	1 MO	2 PA	3 IA PA	4 PA	5 PA	6 PA	7 IA PA	8 PA	12 IA
Controls									
A	-	1464	819	1503	837	1630	1205	1350	-
B	-	2	2	3	3	4	4	6	-
C	-	2	2	3	2	3	4	5	-
D		42	0	38	61	88	0	45	100
E	8	100	0	100	0	100	0	100	63
F	-	6	3	6	4	7	4	7	-
G	-	3	1	3	3	4	1	4	-
H	-	1	2	2	3	3	4	4	6
J	-	2	3	3	3	6	5	8	-
K	-	85	26	76	58	-	-	-	-
L	-	-	-	-	-	394	1064	293	-
Freq:	279.26	392.15	353.78	496.91	428.95	699.52	620.17	1020.94	8[illegible]
KC Overlap			39.37		67.96		79.35		1[illegible]
Mean Freq.			372 .47		462.93		659.85		93.[illegible]
% Overlap			10.58		14.7		12.03		18[illegible]

2137.5

Note: The M.O. and IA circuits limited the end frequencies of columns 1 and 12; hence the Power Amp circuits, even though capable of reaching lower and higher frequencies respectively, could not be tuned.

3% min. Overlap

TABLE 41

Model XTBU Transmitting Equipment
Limiting Frequencies and Overlap of Antenna Circuits

Test as per paragraph 3-11-1 of Specifications RE 13A 422C

Column	1	2	3	4	5	6	7	8	9
Limiting) Circuit)	MO	MO	MO	ANT	ANT	ANT	ANT	ANT	ANT
Controls									
A	-	1240	1510	1575	175	1875	1435	2025	1965
B	-	2	1	2	2	3	3	3	3
C	-	1	1	1	1	3	3	3	3
D	-	86	59	47	58	53	34	57	55
E	-	85	60	41	58	57	75	62	62
F	-	6	5	5	5	6	5	6	6
G	-	3	5	1	1	4	3	3	3
H	-	1	1	2	1	3	3	3	3
J	1	1	2	2	3	3	4	4	5
K	0	98	0	98	0	98	-	-	-
L	-	-	-	-	-	-	0	1385	0
Freq:	279.26	377.01	337.7	400.47	334.07	544.68	488.78	560.5	554.75
KC Overlap:			39.31		66.40		55.90		5.75
Mean Freq:			357.36		367 .27		516.73		557.63
% Overlap:			11.0		18.1		10.8		1.03

Columns 1, 2 and 3, Antenna Resistance 7.66 ohms
Antenna Capacity 500 uuf

Columns 4 to 18 incl., Antenna Resistance 7.66 ohms
Antenna Capacity 998 uuf

TABLE 41 Continued

Model XTBU Transmitting Equipment
Limiting Frequencies and Overlap of Antenna Circuits

Test as per paragraph 3-11-1 of Specifications RE 13A 422C

Column Limiting) Circuit)	10 ANT	11 ANT	12 ANT	13 ANT	14 ANT	15 ANT	16 ANT	17 ANT	18 IA
Controls									
A	1435	1375	2100	1870	2100	1700	1650	1325	-
B	4	4	4	4	5	5	8	6	-
C	3	3	4	4	5	5	5	5	-
D	78	76	57	50	43	23	91	44	-
E	88	86	55	45	33	14	80	36	-
F	7	7	6	5	6	6	8	6	-
G	2	2	1	6	6	2	3	6	-
H	3	3	4	4	5	5	5	5	-
J	5	6	6	7	7	8	8	9	9
K	-	-	-	-	-	-	-	-	-
L	1385	0	1385	0	1385	0	1385	0	-
Freq:	663.1	652.75	783.33	746.43	1008.7	902.18	1608.48	1014.95	
KC Overlap:		10.35		36.9		106. 52		593.53	
Mean Freq:		657.93		764.88		955.44		1311.72	
% Overlap:		1.57		4.83		11.15		45.2	

TABLE 42

Model XTBU Transmitting Equipment
Calibration of Master Oscillator Dial - KC per Division

Test as per paragraph 3-15 of Specifications RE 13A 422C.

Control "A"	Control "B"	Frequency KC	Divisions Change	KC Change	KC per Division	% per Division
0	1	141.51				
802	1	150	802	8.49	0.0106	0.007
1215	1	160	413	10	0.0242	0.015
1553	1	170	338	10	0.0296	0.017
1905	1	180	352	10	0.0284	0.015
2500	1	187.4	595	7.43	0.0125	0.007
0	2	166.86				
746	2	175	764	8.14	0.0106	0.006
1286	2	190	522	15	0.0287	0.015
1569	2	200	283	10	0.0354	0.017
1868	2	210	299	10	0.0334	0.016
2500	2	219.83	632	9.83	0.0155	0.007
0	3	197.22				
1084	3	225	1084	27.78	0.0256	0.011
1526	3	250	442	25	0.0565	0.022
1923	3	275	397	25	0.0630	0.023
2500	3	293.6	577	18.6	0.0322	0.011
0	4	264.28				
735	4	280	735	15.72	0.0214	0.007
1025	4	300	290	20	0.0690	0.023
1360	4	325	335	25	0.0746	0.023
1630	4	350	270	25	0.0926	0.026
1890	4	375	260	25	0.0962	0.025
2500	4	408.8	610	33.8	0.0555	0.013
0	5	330.15				
618	5	350	618	10.85	0.0176	0.005
1278	5	400	660	50	0.0758	0.019
1694	5	450	416	50	0.120	0.026
2064	5	500	370	50	0.135	0.027
2500	5	535.25	436	35.25	0.0808	0.015
0	6	417				
780	6	450	789	32.97	0.0423	0.009
1265	6	500	485	50	0.103	0.021
1620	6	550	355	50	0.141	0.025
1960	6	600	340	50	0.147	0.024
2500	6	643.5	540	43.5	0.0805	0.012

TABLE 42 Continued

0	7	589.64				
635	7	600	635	10.36	0.0163	0.003
1310	7	650	675	50	0.0740	0.011
1740	7	700	430	50	0.1162	0.016
2217	7	750	477	50	0.1048	0.014
2500	7	762.5	283	12.5	0.0442	0.006
0	8	669.28				
847	8	700	847	30.72	0.0363	0.005
1308	8	750	461	50	0.1083	0.014
1626	8	800	318	50	0.1572	0.020
1887	8	850	261	50	0.1917	0.022
2185	8	900	298	50	0.1678	0.017
2500	8	929.42	315	29.42	0.0934	0.01
0	9	798.45				
1057	9	850	1057	51.55	0.0487	0.005
1505	9	900	448	50	0.1117	0.012
1820	9	950	315	50	0.1588	0.016
2148	9	1000	328	50	0.1525	0.015
2500	9	1030.72	352	30.72	0.0872	0.008
0	10	915.43				
914	10	950	914	34.57	0.0379	0.004
1467	10	1000	553	50	0.0905	0.009
1826	10	1050	359	50	0.1393	0.013
2195	10	1100	369	50	0.1355	0.012
2500	10	1123.9	305	23.9	0.0783	0.007
				Average:		0.014%

Specification Requirements: Average not to be less than 0.01%

TABLE 43

Model XTBU Transmitting Equipment
Effect of Dial Locks

Test as per paragraph 3-16 of Specifications RE 13A 422C

Control	Direction of approach	Frequency KC Not Locked	Locked	Frequency Change Cycles	Per cent
MO "A"	Clockwise	2000.247	2000.243	4	0.0002
MO "A"	Ctr Clock	380	355	25	0.00125
IPA "D"	Clockwise	242	238	4	0.0002
IPA "D"	Ctr Clock	245	242	3	0.00015
PA "E"	Clockwise	249	245	4	0.0002
PA "E"	Ctr Clock	247	244	3	0.00015
Ant "K"	Clockwise	252	250	2	0.0001
Ant "K"	Ctr Clock	252	249	3	0.00015
MO "A"	Clockwise	1000.255	1000.252	3	0.0003
MO "A"	Ctr Clock	475	460	15	0.0015
IPA "D"	Clockwise	255	255	0	0
IPA "D"	Ctr Clock	259	260	1	0.0001
PA "E"	Clockwise	260	260	0	0
PA "E"	Ctr Clock	264	263	1	0.0001
Ant "L"	Clockwise	266	266	0	0
Ant "L"	Ctr Clock	266	266	0	0
MO "A"	Clockwise	300.215	300.220	5	0.00167
MO "A"	Ctr Clock	218	221	3	0.001
IPA "D"	Clockwise	395	395	0	0
IPA "D"	Ctr Clock	358	358	0	0
PA "E"	Clockwise	356	356	0	0
PA "E"	Ctr Clock	352	352	0	0
Ant "L"	Clockwise	353	351	2	0.00067
Ant "L"	Ctr Clock	353	352	1	0.00033

TABLE 44

Model XTBU Transmitting Equipment
R.F. Voltage Output from Frequency Meter Coupling Circuit.

Test as per paragraph 3-17-4 of Specifications RE 13A 422C

Measurements of voltage made at Master Oscillator Frequency; i.e., one half the output frequency of the Transmitter.

M. O. Frequency KC	Millivolts Output
150	100 plus
200	100 "
250	100 "
300	100 "
350	100 "
550	100 "
600	100 "
700	100 "
800	100 "
900	100 "
1000	100 "

Note: The maximum voltage measurable with the equipment used was 100 millivolts. Voltages measured with Ferris OF Field Strength Meter at the end of 3 feet of lead covered cable. OF equipment calibrated with GR Standard Signal Generator 605-B.

TABLE 45

Model XTBU Transmitting Equipment
Operation of Tune-Operate Switch

Test as per paragraph 3-19 of Specifications RE 13A 422C

	Tuning Step 1	Tuning Step 2	Operate Step 3
Bias Voltage:	240	237	233
M. O. Plate Voltage:	1040	1030	1010
P. A. Plate Voltage:	0	1225	2250

Voltages measured with key closed when operating at full power at 1000 KC.

TABLE 46

Model XTBU Transmitting Equipment
Voltage Regulation of Filament Circuits

Test as per paragraph 3-34 of Specifications RE 13A 422C

Circuit	Volts Key Open	Volts Key Closed	Per cent Regulation
Sec. of Trans. T-104	111.9	111.5	0.36
Pri. of Trans. T-102	98.8	98.1	0.71
M.O. Tube at socket	9.73	9.71	0.26
IPA Tube at Socket	9.8	9.75	0.51
PA Tube at Socket	10.87*	10.80	0.65
Aud Osc Tube at Socket	9.68	9.62	0.62

Stand - by Condition

Sec of T-104	118.7
Pri of T-102	98.1
MO tube at socket	9.88

Line volts 438

(*) Filament voltmeter on panel read 11.1 volts

Above key closed readings were obtained with transmitter operating at full power at 300 KC.

Note: Mfgr's data sheets for vacuum tubes specify filament voltages must be within plus or minus 5% of rated voltage.

Limits for P.A. Tube: 10.45 to 11.55
Limits for others: 9.5 to 10.5

All measured filament voltages fall within these limits.

- - o 0 o - -

Range of Filament Rheostat

Line Volts	Key Condition	Max. Fil. Volts	Min. Fil. Volts
484	Open	-	10.0
396	Closed	11.1	-

TABLE 47

Model XTBU Transmitting Equipment
Power Required From Supply Lines

Test as per paragraph 6-5 of Specifications RE 13A 422C

Condition	Frequency KC	Antenna I (external)	Watts Out	Line Volts	Line Curr.	Watts Input
Starting	-			420	50	24000 approx.
Running Idle	-			436	3.05	1320
CW Key Down	2000	12.10	1395	434	6.46	4400
MCW Key Down	2000	9.00	773	436	4.94	3200
CW Key Down	1000	13.04	1363	434	6.28	4335
MCW Key Down	1000	10.60	900	435	5.15	3425
CW Key Down	300	12.22	1143	432	6.57	4525
MCW Key Down	300	10.42	830	432	5.65	3825

Specification limits input to 8500 watts

The transmitter was adjusted for full power at 440 volts line voltage. No change in controls was made during the time the line voltage was varied from minus 10% to plus 10% of normal line voltage. The results obtained were as follows:

CW Key Down	300	11.92	1088	396	6.87	4400
CW Key Down	300	12.02	1108	439	6.42	4515
CW Key Down	300	12.22	1143	484	6.18	4660

Antenna Constants: R = 7.66 ohms (DC)
C = 998 uuf

TABLE 48

Model XTBU Transmitting Equipment
Regulation of Generators

Test as per paragraph 6-31 of Specifications RE 13A 422C

Generator	Voltage No Load	Voltage Full Load	Per cent Regulation
Main Plate	2290	2260	1.3
M.O. Plate	1040	1010	2.97
Bias	235	232	1.29

Specification Requirements: 5%

Transmitter adjusted for full power operation at 300 KC

TABLE 49

Model XTBU Transmitting Equipment
Measurement of Generator Ripple

Test as per paragraph 6-31 of Specifications RE 13A 422C

Generator	Key Position	DC Voltage	Ripple Voltage	Per cent Ripple
M.O. Plate	Open	1020	0.505	0.0495
M.O. Plate	Closed	1000	0.505	0.0505
Bias	Open	233	0.35	0.15
Bias	Closed	233	0.35	0.15
Main Plate	Open	2220	0.62	0.0278
Main Plate	Closed	2260	2.38	0.1053

Specification Requirements: 0.25%

Transmitter adjusted for full power operation at 300 KC

TABLE 50

Model XTBU Transmitting Equipment
Comparison of results obtained at Naval Research Laboratory
and at plant of Contractor

In the following comparisons the specification requirements are listed as 100% and the actual results obtained at NRL or by the Contractor are referred to this basis. Thus a value of less than 100% indicates that the results obtained are superior to those required by the specifications and a value in excess of 100% indicates that the specification limits have been exceeded, where the comparison is made on the basis of frequency. Where power outputs are compared a value in excess of 100% indicates that the equipment delivers more power than required by the terms of the governing specifications.

DETERMINATION OF POWER OUTPUT - CW
(NRL tables 6, 7, 8 & 9)

Frequency kc	Watts Output Required by Specifications	Watts Output obtained at NRL	Watts Output obtained at WEMCO	Percentage of Specifications NRL	Percentage of Specifications WEMCO
300	530	570	765	107.6	144.3
400	530	725	No data	136.8	-
500	530	568	645	107.2	121.7
600	675	603	No data	89.5	-
750	900	1010	950	112.2	105.5
1000	1000	1090	1140	109	114
1250	1000	1505	No data	150.5	-
1500	1000	1430	No data	143	-
2000	1000	1238	1550	123.8	155

DETERMINATION OF POWER OUTPUT - MCW

Frequency kc	Watts Output Required by Specifications	Watts Output obtained at NRL	Watts Output obtained at WEMCO	Percentage of Specifications NRL	Percentage of Specifications WEMCO
300	265	295	435	111.3	164.1
400	265	467	No data	176.3	-
500	265	358	410	135	154.8
600	338	387	No data	114.4	-
750	450	682	665	151.5	147.8
1000	500	740	755	148	151
1250	500	1010	No data	202	-
1500	500	900	No data	180	-
2000	500	735	1010	147	202

WEMCO obtained % modulation at 300 kc only; result 90%
NRL % of modulation at 300 kc - 90%

TABLE 50 - Continued

CARRIER HUM AND RIPPLE (Spec. 3-4-2)
(NRL Table 10)

Frequency KC	Percentage of Ripple NRL	WEMCO	SPEC.
2000	0.367	No data	2%
1000	0.3	0.061	2
300	0.4	No data	2

ACCURACY OF RESET TO PREVIOUSLY CALIBRATED FREQUENCIES
(Spec 3-7-1(a) 0.01%) NRL Table 11 - Average Deviation

	300 KC % Avg.Dev. Freq.	% of Spec	1000 KC % Avg. Dev. Freq.	% of Spec	2000 KC % Avg. Dev. Freq.	% of Spec
NRL	0.0066	66	0.00316	31.6	0.00078	7.8
WEMCO	0.0066	66	0.0094	94	0.0027	27

(Spec 3-7-1(b) 0.015%) NRL Table 11 - Maximum deviation

NRL	0.009	60	0.0045	30	0.0015	10
WEMCO	0.011	73.3	0.015	100	0.00425	28.3

LOST MOTION, BACK LASH AND TORQUE LASH
NRL Table 12. Spec 3-7-2 (a) Avg departure (Spec. 0.02%)

	300 KC % Avg.Dep. Freq.	% of Spec	1000 KC % Avg Dep Freq	% of Spec	2000 KC % Avg Dep Freq.	% of Spec
NRL	0.0181	90.5	0.0238	119.5	0.0115	57.5
WEMCO	0.0122	61	0.0158	79	0.00658	32.9

NRL Table 12. Spec. 3-7-2 (b) Max. Departure (Spec. 0.045%)

NRL	0.0206	45.8	0.0255	57.5	0.0124	27.6
WEMCO	0.0167	37	0.013	28.9	0.0085	18.9

OPERATION OF ADJUST-TUNE-OPERATE CONTROL
NRL Table 13 Spec 3-7-3 (Spec 0.015% max)

	300 KC Max. Freq. Change %	% of Spec	1000 KC Max Freq Change %	% of Spec	2000KC Max Freq Change %	% of Spec
NRL	0.0063	42	0.0017	11.3	0.0007	4.7
WEMCO	0.006	40	0.003	20	0.0021	14

(This data was also taken at NRL on 400, 500, 800, 1300 & 1500 KC)

TABLE 50 - Continued

DETUNING OF CIRCUITS
NRL Table 14 - Spec. 3-7-4 (Spec. 0.01%)

	300 KC		1000 KC		2000 KC	
	Frequency Change %	% of Spec.	Frequency Change %	% of Spec.	Frequency Change %	% of Spec
			Intermediate Amplifier Circuit			
NRL	0.0026	26	0.0045	45	0.001	10
WEMCO	0.01	100	0.002	20	0.00005	0.5
			Power Amplifier Circuit			
NRL	0.00167	16.7	0.0015	15	0.0005	5
WEMCO	0.002	20	0.0005	5	0.0001	1
			Antenna Circuit			
NRL	0	0	0.0012	12	0.0004	4
WEMCO	0.003	30	0.0004	4	0.0003	3

OPERATION OF POWER OUTPUT CONTROL
NRL TABLE 15 - Spec. 3-7-5 (Spec. 0.005% max)

	300 KC		1000 KC		2000 KC	
	Frequency Change %	% of Spec	Frequency Change %	% of Spec.	Frequency Change %	% of Spec.
NRL	0.00467	93.4	0.0011	22	0.00205	41
WEMCO	0.00267	53.3	0.0012	24	0.0005	10

MINIMUM POWER
NRL Table 15 - Spec 3-23 (Spec 25% of Max)

	300 KC		1000 KC		2000 KC	
	Per cent Power	% of Spec.	Per Cent Power	% of Spec.	Per cent Power	% of Spec.
NRL	14.9	59.6	10.9	43.6	5.9	23.6
WEMCO	13.6	54.4	20	80	19.6	78.4

CHANGE OF TUBES
NRL Tables 16, 17 & 18. Spec. 3-7-6

	300 KC		1000 KC		2000 KC	
	Frequency Change %	% of Spec.	Frequency Change %	% of Spec.	Frequency Change %	% of Spec
			Master Oscillator Stage (Spec. 0.015%)			
NRL *	0.0116	77.3	0.0226	150	0.058	387
WEMCO	0.00578	38.5	0.0123	82.3	0.0119	79

Note: * Data also re-grouped in Tables 17 & 18.

TABLE 50 - continued

CHANGE OF TUBES (Continued)

Intermediate Amplifier Stage (Specs 0.005%)

NRL	0.00264	52.8	0.004	80	0.00414	82.8
WEMCO	0.002	40	0.00171	34.2	0.00148	29.6

Power Amplifier Stage (Specs 0.005%)

NRL	0.00025	5	0.0006	12	0.00014	2.8
WEMCO	0.00116	23.3	0.00044	8.8	0.00021	4.1

VARIATION OF SUPPLY LINE VOLTAGE

NRL Table 19 - Spec. 3-7-7

	300 KC		1000 KC		2000 KC	
	Frequency Change %	% of Spec.	Frequency Change %	% of Spec.	Frequency Change %	% of Spec.
			5 Minute change (Spec 0.006%)			
NRL	0.0053	88.4	0.0019	31.7	0.00205	34.2
WEMCO	0.00067	11.1	0.0006	10	0.0003	5
			1 Minute Change (Spec 0.006%)			
NRL	0.00067	11.2	0.001	16.7	0.00125	20.8
WEMCO	0.00333	55.5	0.0006	10	0.001	16.7

VARIATIONS IN AMBIENT TEMPERATURE

NRL Tables 21, 22 & 23 - Spec 3-7-8 (Spec 0.0025% per Deg. C)

	300 KC		1000 KC		2000 KC	
	% Freq Change °C	% of Spec	% Freq. Change °C	% of Spec	% Freq. Change °C	% of Spec
			50 Deg to 40 Deg			
NRL	0.0015	60	0.0013	52	0.0012	48
WEMCO	0.0004	16	0.00125	50	0.00123	49
			40 Deg to 30 Deg.			
NRL	0.0019	76	0.00095	38	0.00115	46
WEMCO	0.0017	68	0.00092	36.8	0.00103	41.2
			30 Deg to 20 Deg.			
NRL	0.0015	60	0.00057	22.8	0.00025	10
WEMCO	0.0017	68	0.0007	28	0.00115	46
			20 Deg to 10 Deg.			
NRL	0.0013	52	0.00038	15.2	0.00025	10
WEMCO	0.00177	70.8	0.00042	16.8	0.0004	16
			10 Deg. to 0 Deg.			
NRL.	0.0026	104	0.0006	24	0.00005	2
WEMCO	0.00193	77.3	0.00021	8.4	0.0004	16

VARIATIONS OF HUMIDITY

NRL Tables 24, 25 & 26. Spec 3-7-9 (a) Frequency variation

Specs: 0.05%.

	300 KC		1000 KC		2000 KC	
	Frequency Change %	% of Spec.	Frequency Change %	% of Spec.	Frequency Change %	% of Spec.
NRL	0.0197	39.4	0.0495	99	0.038	76
WEMCO	0.029	58	0.05	100	0.0255	51

Spec 3-7-9 (b) Power Variation (Spec. 5%)

	300 KC		1000 KC		2000 KC	
	Power Var %	% of Spec	Power Var %	% of Spec.	Power Var %	% of Spec.
NRL	6.9	138	1.56	31.2	1.15	23
WEMCO	4.03	80.6	2.04	40.8	2.46	49.2

LOCKED KEY OPERATION FOR TWO HOURS

NRL Tables 27, 28 and 29 Spec 3-7-10

	300 KC		1000 KC		2000 KC	
	Frequency Change %	% of Spec	Frequency Change %	% of Spec.	Frequency Change %	% of Spec.
	Drift in 1st five minutes (Spec 0.015%)					
NRL	0.0067	44.6	0.0053	35.3	0.0058	38.6
WEMCO	0.00467	31.1	0.004	26.7	0.00475	31.6
	Drift during remainder of test (Specs 0.03%)					
NRL	0.0183	61	0.0061	20.3	0.0138	46
WEMCO	0.0163	54.3	0.003	10	0.007	23.3

CHANGE FROM KEY LOCKED TO INTERMITTENTLY KEYED CONDITION

NRL Table 30 - Spec 3-7-11

	300 KC		1000 KC		2000 KC	
	Frequency Change %	% of Spec	Frequency Change %	% of Spec	Frequency Change %	% of Spec
	M O Filament lighted (Spec 0.01%)					
NRL	0.0053	53	0.0035	35	0.0021	21
WEMCO	0.00633	63.3	0.0008	8	0.00835	83.5
	M.O. Filament not lighted (Spec 0.02%)					
NRL	0.014	70	0.0131	65.5	0.0093	46.5
WEMCO	0.009	45	0.0125	62.5	0.00825	41.3

CHANGE FROM CONTINUOUSLY KEYED TO INTERMITTENTLY KEYED CONDITION
NRL Table 31 - Spec 3-7-12 (Spec: 0.01%)

	300 kc		1000 kc		2000 kc	
	Frequency Change %	% of Spec	Frequency Change %	% of Spec	Frequency Change %	% of Spec
NRL*	No data	-	0.0039	39	0.002	20
WEMCO	0.002	20	0.0021	21	0.0033	33

* Impossible to key transmitter on account of arcing.

SHOCK TEST
NRL Table 36 - Spec 3-7-15 (Spec 0.005%)

	300 kc		1000 kc		2000 kc	
	Frequency Change %	% of Spec	Frequency Change %	% of Spec	Frequency Change %	% of Spec
			Front			
NRL	0.0003	6	0.0025	50	0.00055	11
WEMCO	0.00167	33.4	0.001	20	0.0004	8
			Back			
NRL	0.0036	72	0.0006	12	0.00035	7
WEMCO	0.00133	26.6	0.0003	6	0.00025	5
			Right Side			
NRL	0	0	0.0004	8	0.00065	13
WEMCO	0.00167	33.4	0.0005	10	0.0005	10
			Left Side			
NRL	0	-	0	-	0.00075	15
WEMCO	0.00167	33.4	0.0007	14	0.0001	2

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The contractor had no facilities for conducting vibration and inclination tests; hence no data submitted

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OVERLAP AND LIMITING FREQUENCIES
NRL Tables 38, 39, 40 & 41 - Spec 3-11-1 (Specs 3% min)

A comparison of the NRL and WEMCO data reveals close agreement and in all cases the specification requirements have been met.

CALIBRATION OF MASTER OSCILLATOR
NRL Table 42 - Spec. 0.01% min - 0.025% Max.

When reduced to the same basis the average value obtained by NRL is 0.0133%; by WEMCO 0.0135%

POWER REQUIRED FROM SUPPLY LINES
NRL Table 47 - Spec. 6-5 (Spec: 8500 watts max)

	Starting	Key Closed		Key Open	
	Input Watts	Watts	% Spec	Watts	% Spec.
NRL	24000	4525	53.3	1320	15.5
WEMCO	19560	4450	52.4	1430	16.8

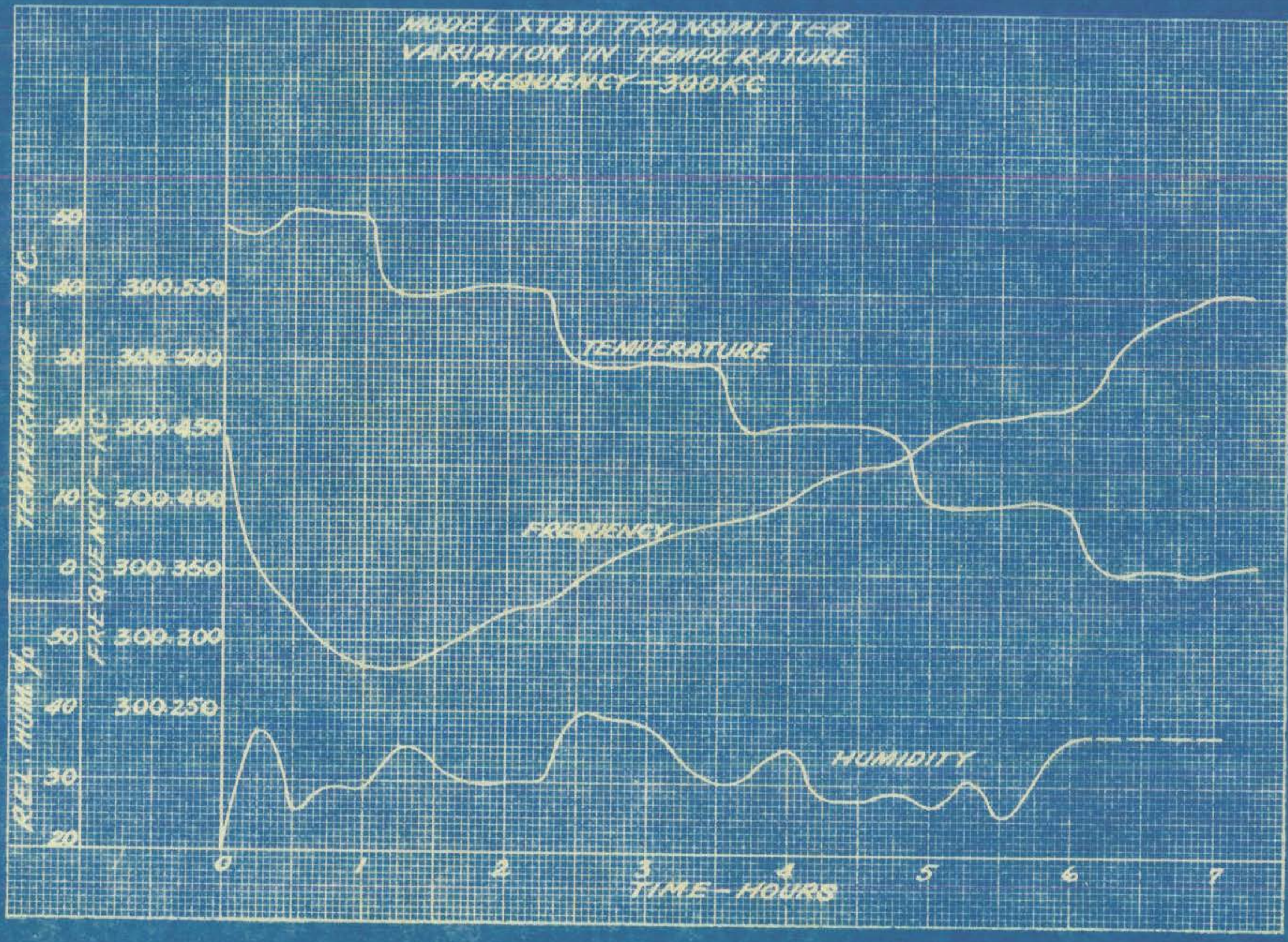
Above data taken at 300 kc; NRL also obtained data at 1000 and 2000 kc and 300 kc power input was measured at plus and minus 10% of normal line voltage.

MEASUREMENT OF GENERATOR RIPPLE
NRL Table 49 - Spec 6-31 (Spec: 0.25%)

	2300 volt Gen.		1000 volt Gen		230 volt Gen.	
	Percent Ripple	% of Specs	Percent Ripple	% of Spec	Percent Ripple	% of Spec
			Full load			
NRL	0.1053	42.1	0.0505	20.2	0.15	60
WEMCO	0.1043	41.7	0.08	32	0.228	91.2
			No load			
NRL	0.0278	11.1	0.0495	19.8	0.15	60
WEMCO	0.0326	13.0	0.085	34.0	0.206	82.4

REGULATION OF GENERATORS
NRL Table 48 - Spec 6-31 (Spec 5%)

	2300 volt Gen		1000 volt Gen		230 volt Gen	
	Percent Regulation	% of Spec	Percent Regulation	% of Spec	Percent Regulation	% of Spec
NRL	1.3	26	2.97	59.4	1.29	25.8
WEMCO	2.1	42	3.7	74	0	-



MODEL XTBU TRANSMITTER
VARIATION IN TEMPERATURE
FREQUENCY — 300KC
TEMPERATURE - °C.
REL. HUM. %
FREQUENCY - KC
50
40
30
20
10
0
50
40
30
20
300.550
300.500
300.450
300.400
300.350
300.300
300.250
TEMPERATURE
FREQUENCY
HUMIDITY
0
1
2
3
4
5
6
7
TIME — HOURS

PLATE-1

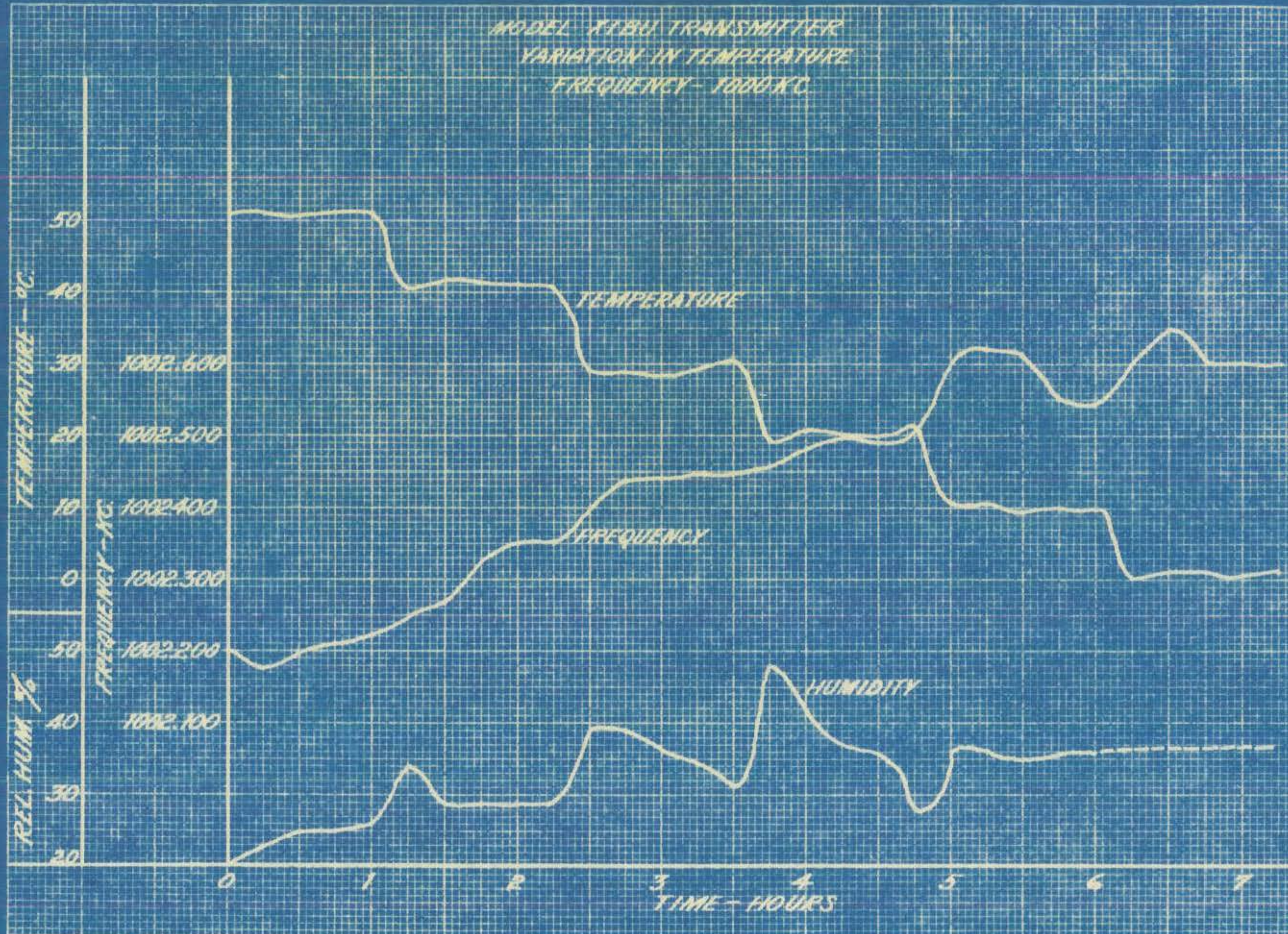

MODEL TRANSMITTER
VARIATION IN TEMPERATURE
FREQUENCY - 1000 KC.
TEMPERATURE - °C.
50
40
30
20
10
0
REL. HUM. %
50
40
30
20
FREQUENCY - KC.
1002.600
1002.500
1002.400
1002.300
1002.200
1002.100
TEMPERATURE
FREQUENCY
HUMIDITY
0
1
2
3
4
5
6
7
TIME - HOURS

PLATE 2

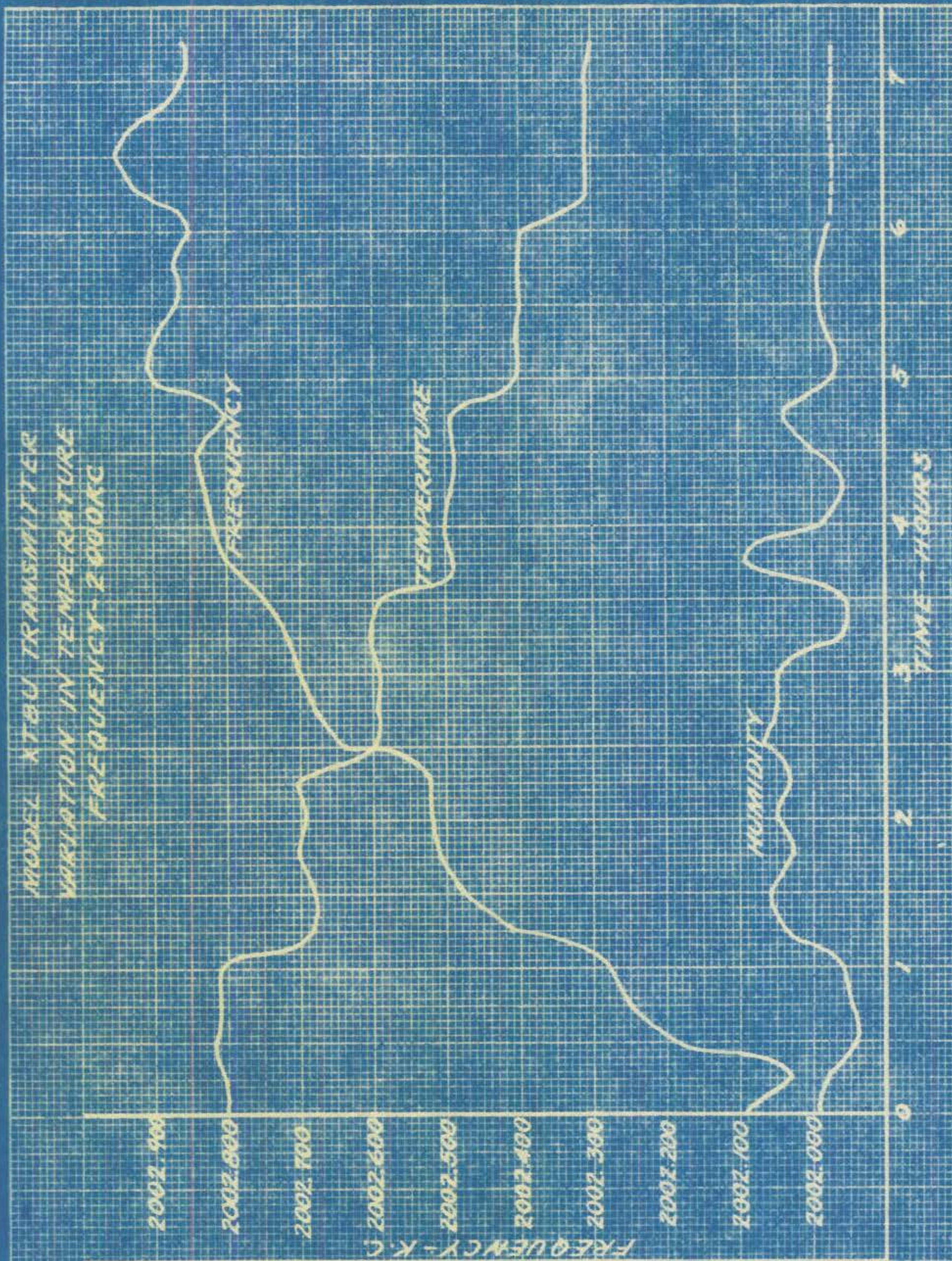

MODEL XTBU TRANSMITTER
VARIATION IN TEMPERATURE
FREQUENCY-2000KC
FREQUENCY
TEMPERATURE
HUMIDITY
TIME-HOURS
0
1
2
3
4
5
6
7
2002.900
2002.800
2002.700
2002.600
2002.500
2002.400
2002.300
2002.200
2002.100
2002.000
FREQUENCY-K.C.
50
40
30
20
10
0
50
40
30
20
TEMPERATURE - °C
REL. HUM %

PLATE 3

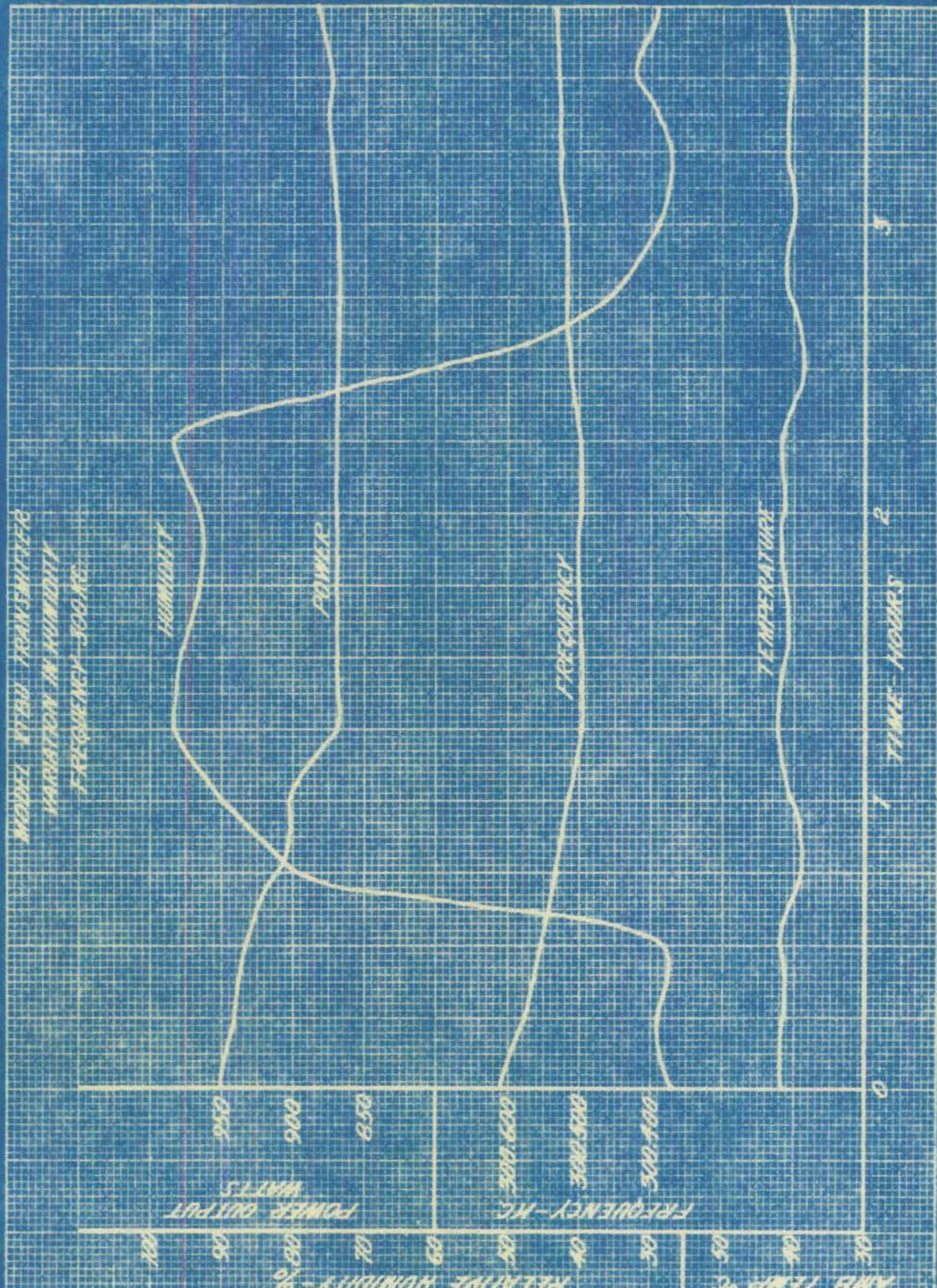
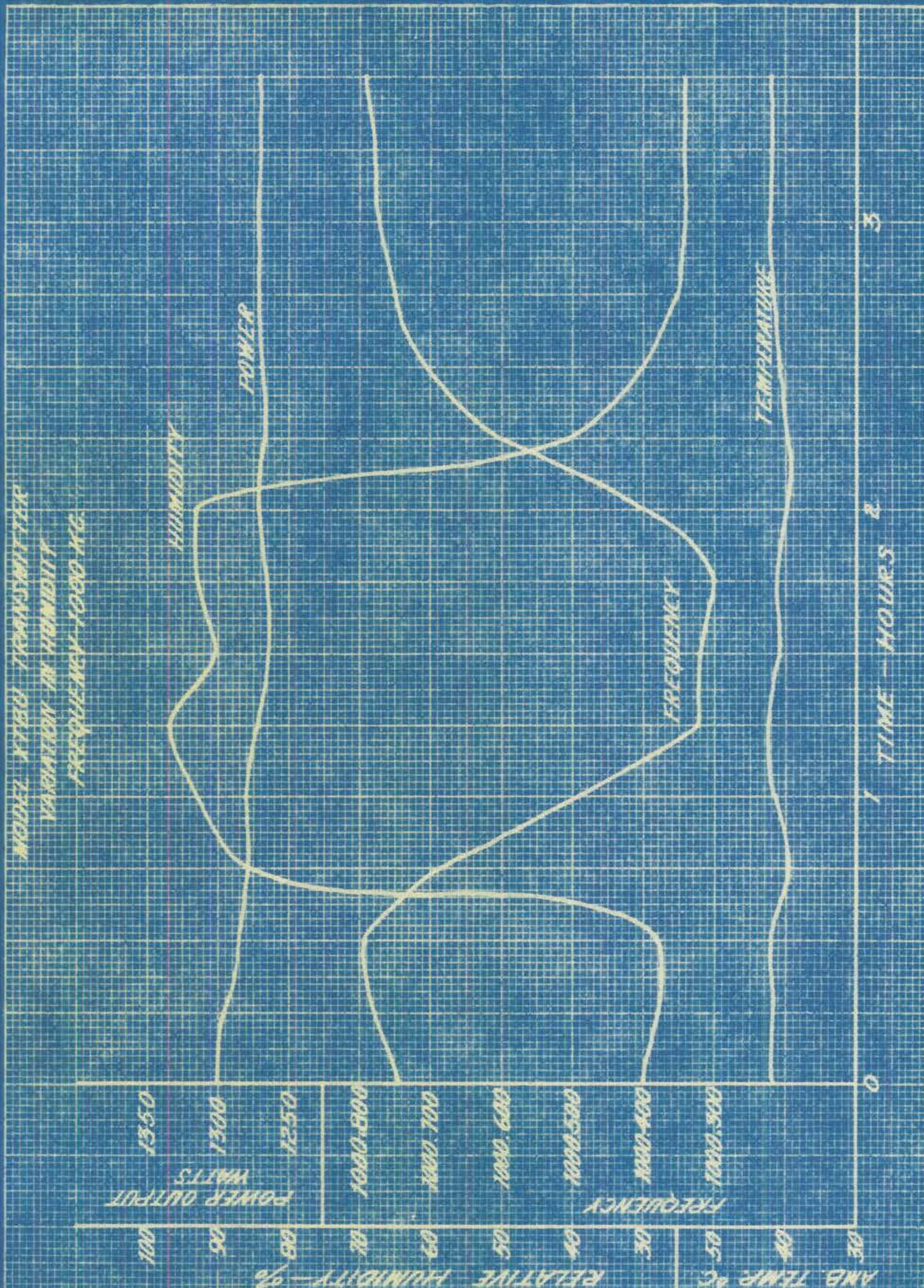

VARIATION IN HUMIDITY
FREQUENCY 300 KC
HUMIDITY
POWER
FREQUENCY
TEMPERATURE
TIME HOURS
0
1
2
3
RELATIVE HUMIDITY-%
100
90
80
70
60
50
40
30
AMB TEMP °C
50
40
30
POWER OUTPUT WATTS
950
900
850
FREQUENCY-KC
300.600
300.500
300.400

PLATE 4



VARIATION IN HUMIDITY
FREQUENCY 1080 KC.
HUMIDITY
POWER
FREQUENCY
TEMPERATURE
POWER OUTPUT WATTS
1350
1300
1250
FREQUENCY
1080.800
1080.700
1080.600
1080.500
1080.400
1080.300
RELATIVE HUMIDITY—%
100
90
80
70
60
50
40
30
AMB. TEMP °C
50
40
30
TIME—HOURS
0
1
2
3

PLATE 5

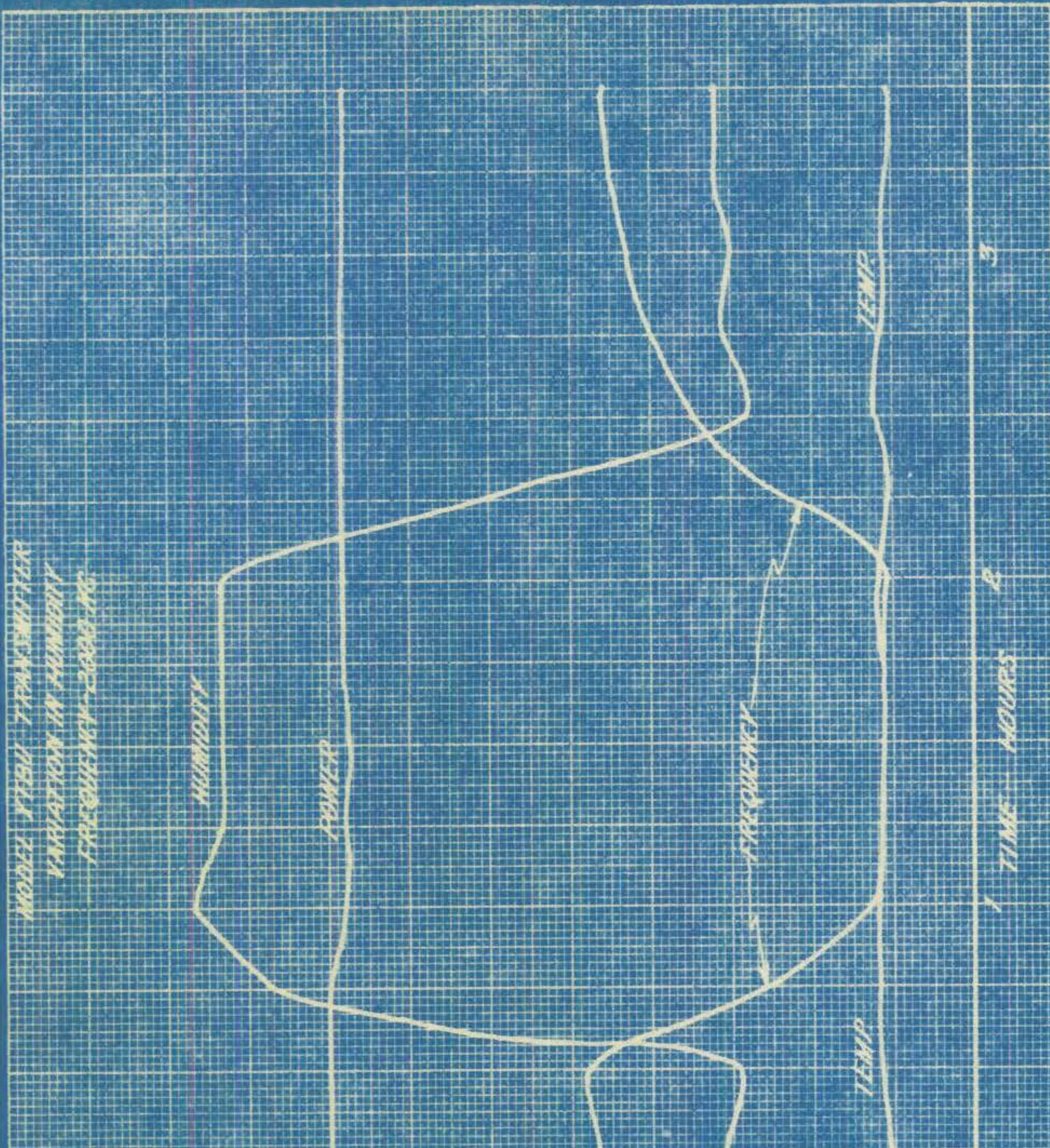
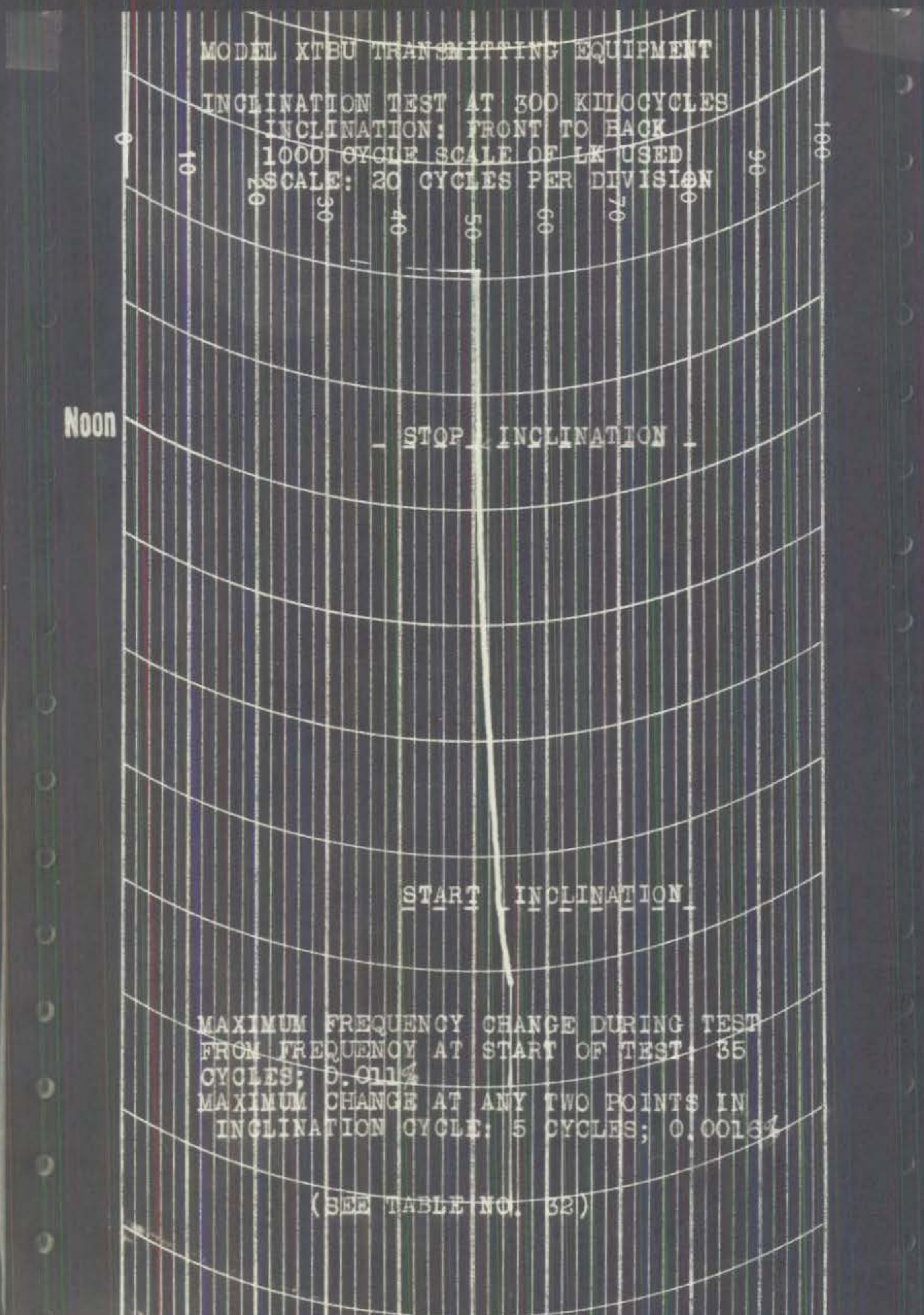

MODEL XTBU TRANSMITTER
VARIATION IN HUMIDITY
FREQUENCY—2000 MC
HUMIDITY
POWER
FREQUENCY
TEMP
TEMP
TIME—HOURS
0
1
2
3
RELATIVE HUMIDITY %
POWER OUTPUT WATTS
1350
1300
1250
FREQUENCY—MC
2001.000
2000.800
2000.600
2000.400
2000.200
AMB. TEMP °C
30
40
50

PLATE 6



MODEL XTBU TRANSMITTING EQUIPMENT
INCLINATION TEST AT 300 KILOCYCLES
INCLINATION: FRONT TO BACK
1000 CYCLE SCALE OF LK USED
SCALE: 20 CYCLES PER DIVISION
0
10
20
30
40
50
60
70
80
90
100
Noon
STOP INCLINATION
START INCLINATION
MAXIMUM FREQUENCY CHANGE DURING TEST
FROM FREQUENCY AT START OF TEST: 35
CYCLES; 0.011%
MAXIMUM CHANGE AT ANY TWO POINTS IN
INCLINATION CYCLE: 5 CYCLES; 0.0016%
(SEE TABLE NO. 32)

Plate 7

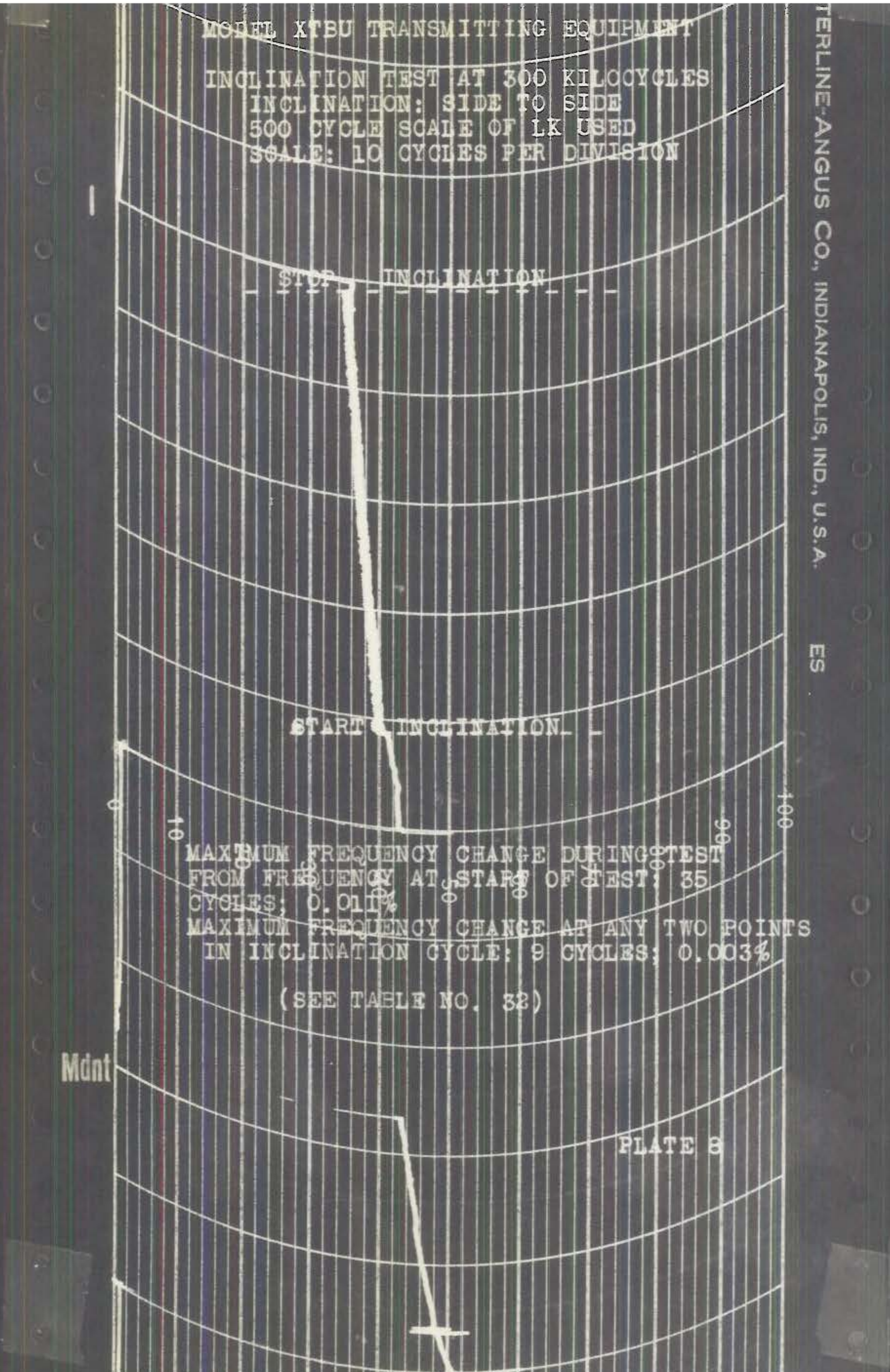

MODEL XTBU TRANSMITTING EQUIPMENT
INCLINATION TEST AT 300 KILOCYCLES
INCLINATION: SIDE TO SIDE
500 CYCLE SCALE OF LK USED
SCALE: 10 CYCLES PER DIVISION
STOP INCLINATION
START INCLINATION
0
10
90
100
MAXIMUM FREQUENCY CHANGE DURING TEST
FROM FREQUENCY AT START OF TEST: 35
CYCLES; 0.011%
MAXIMUM FREQUENCY CHANGE AT ANY TWO POINTS
IN INCLINATION CYCLE: 9 CYCLES; 0.003%
(SEE TABLE NO. 32)
Mdnt
PLATE 8
TERLINE-ANGUS CO., INDIANAPOLIS, IND., U.S.A.
ES

Plate 8

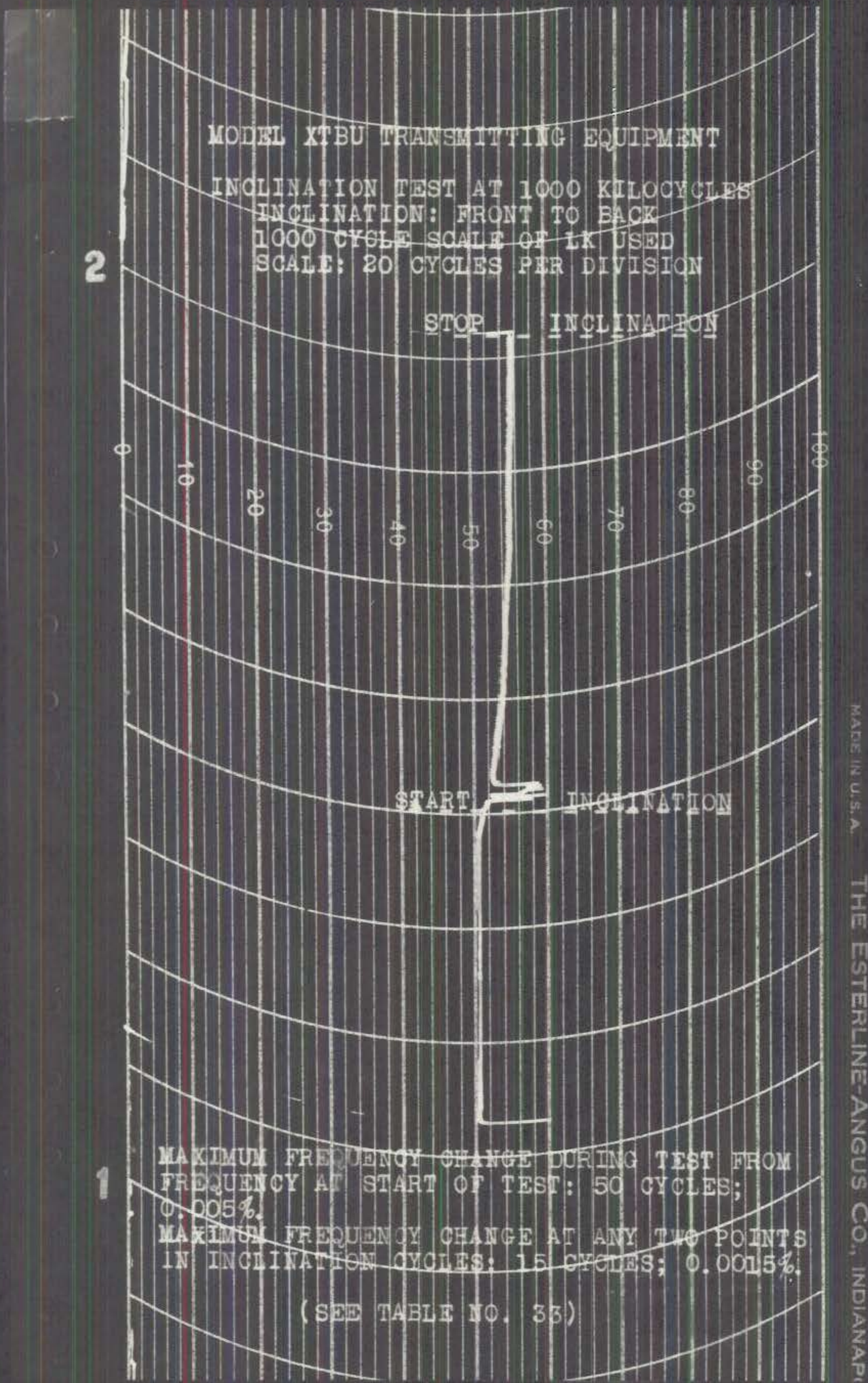

MODEL XTBU TRANSMITTING EQUIPMENT
INCLINATION TEST AT 1000 KILOCYCLES
INCLINATION: FRONT TO BACK
1000 CYCLE SCALE OF LK USED
SCALE: 20 CYCLES PER DIVISION
STOP INCLINATION
START INCLINATION
MAXIMUM FREQUENCY CHANGE DURING TEST FROM FREQUENCY AT START OF TEST: 50 CYCLES; 0.005%.
MAXIMUM FREQUENCY CHANGE AT ANY TWO POINTS IN INCLINATION CYCLES: 15 CYCLES; 0.0015%.
(SEE TABLE NO. 33)
0
10
20
30
40
50
60
70
80
90
100
2
1
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Plate 9

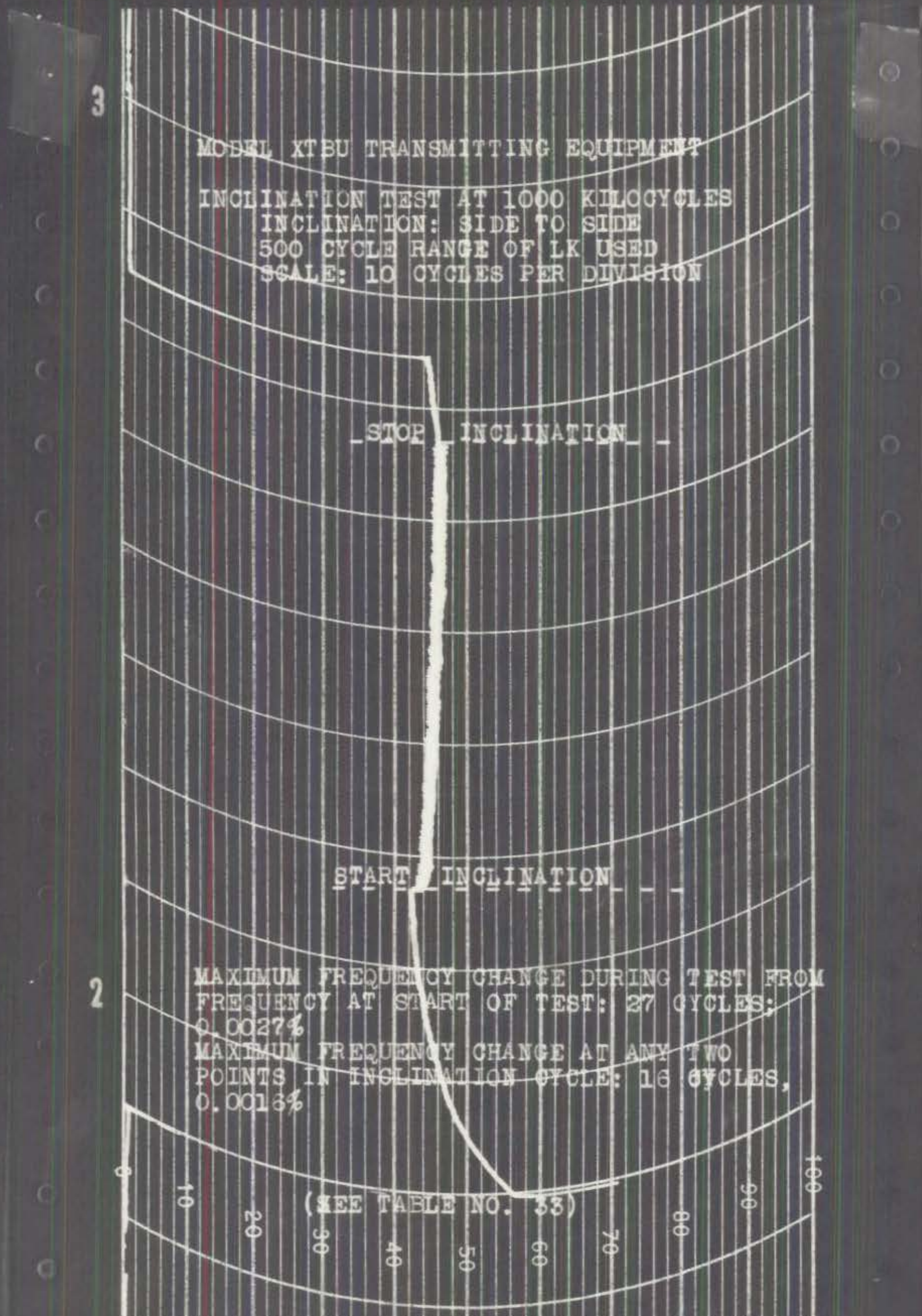
3
MODEL XTBU TRANSMITTING EQUIPMENT
INCLINATION TEST AT 1000 KILOCYCLES
INCLINATION: SIDE TO SIDE
500 CYCLE RANGE OF LK USED
SCALE: 10 CYCLES PER DIVISION
STOP INCLINATION
START INCLINATION
2
MAXIMUM FREQUENCY CHANGE DURING TEST FROM FREQUENCY AT START OF TEST: 27 CYCLES; 0.0027%
MAXIMUM FREQUENCY CHANGE AT ANY TWO POINTS IN INCLINATION CYCLE: 16 CYCLES, 0.0016%
(SEE TABLE NO. 33)
0
10
20
30
40
50
60
70
80
90
100

Plate 10

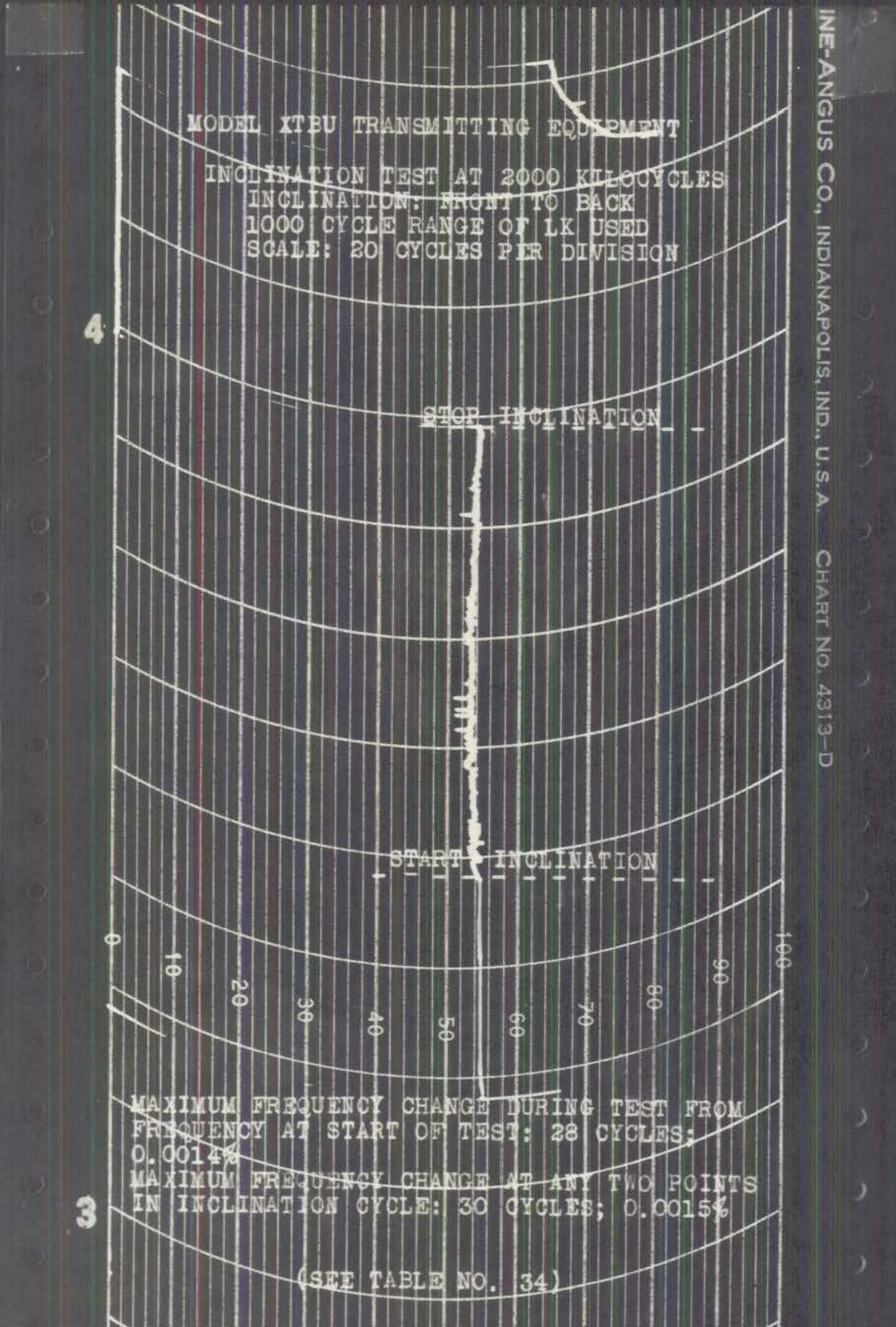
MODEL XTBU TRANSMITTING EQUIPMENT
INCLINATION TEST AT 2000 KILOCYCLES
INCLINATION: FRONT TO BACK
1000 CYCLE RANGE OF LK USED
SCALE: 20 CYCLES PER DIVISION
STOP INCLINATION
START INCLINATION
0
10
20
30
40
50
60
70
80
90
100
4
3
MAXIMUM FREQUENCY CHANGE DURING TEST FROM FREQUENCY AT START OF TEST: 28 CYCLES; 0.0014%
MAXIMUM FREQUENCY CHANGE AT ANY TWO POINTS IN INCLINATION CYCLE: 30 CYCLES; 0.0015%
(SEE TABLE NO. 34)
INE-ANGUS CO., INDIANAPOLIS, IND., U.S.A. CHART No. 4313-D

Plate 11

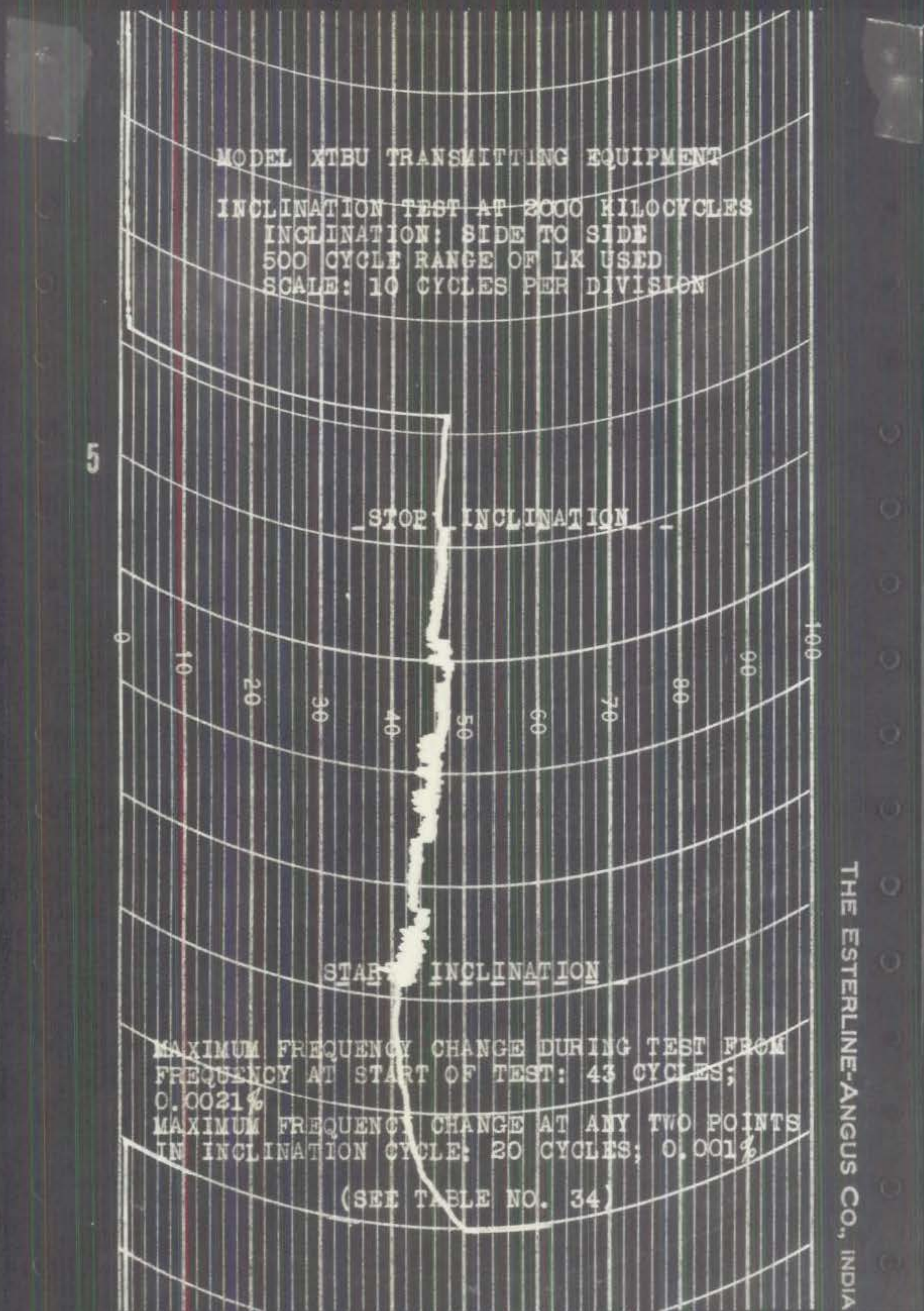
MODEL XTBU TRANSMITTING EQUIPMENT
INCLINATION TEST AT 2000 KILOCYCLES
INCLINATION: SIDE TO SIDE
500 CYCLE RANGE OF LK USED
SCALE: 10 CYCLES PER DIVISION
STOP INCLINATION
START INCLINATION
MAXIMUM FREQUENCY CHANGE DURING TEST FROM FREQUENCY AT START OF TEST: 43 CYCLES; 0.0021%
MAXIMUM FREQUENCY CHANGE AT ANY TWO POINTS IN INCLINATION CYCLE: 20 CYCLES; 0.001%
(SEE TABLE NO. 34)
0
10
20
30
40
50
60
70
80
90
100
5
THE ESTERLINE-ANGUS CO., INDIA

Plate 12

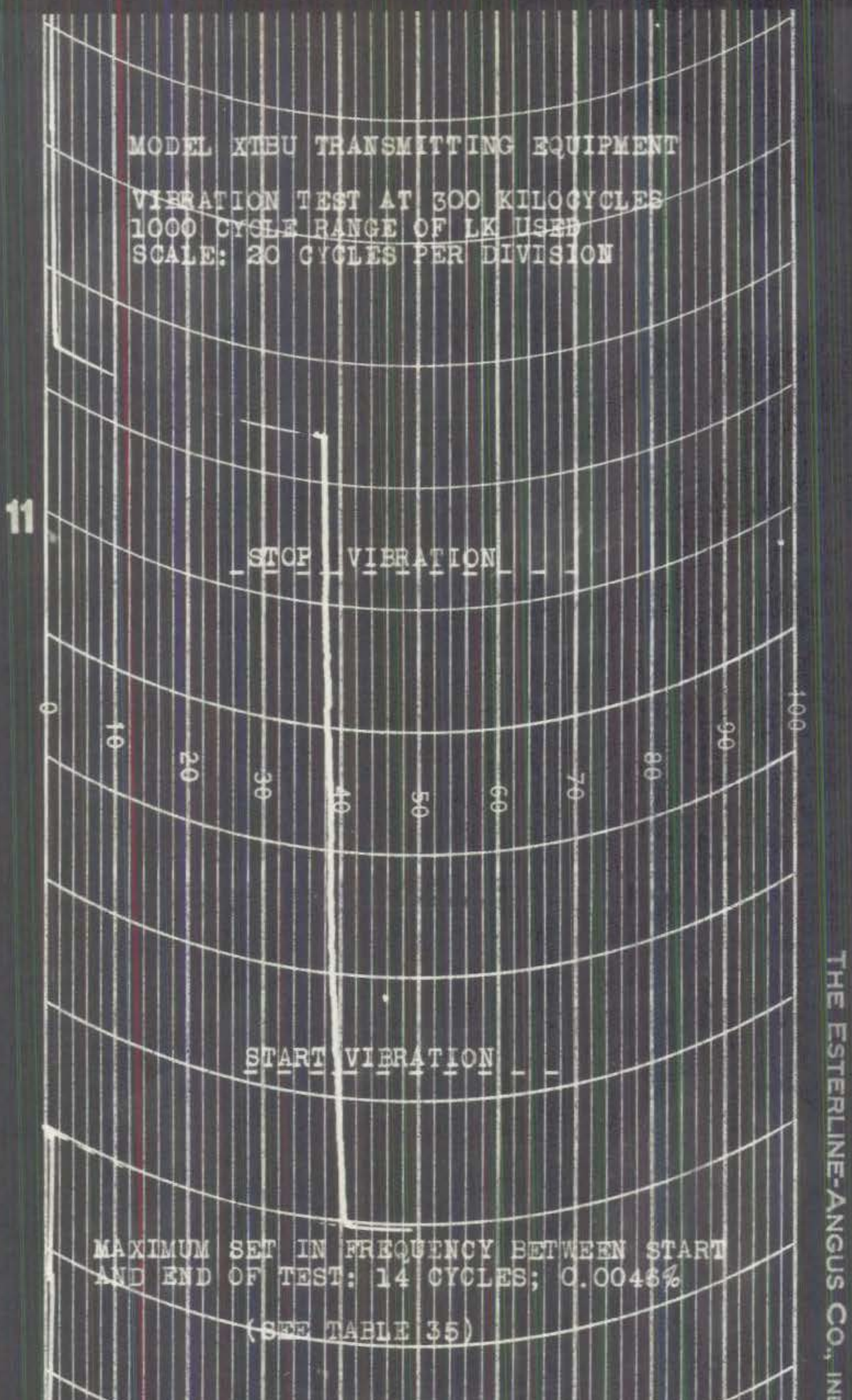
MODEL XTBU TRANSMITTING EQUIPMENT
VIBRATION TEST AT 300 KILOCYCLES
1000 CYCLE RANGE OF LK USED
SCALE: 20 CYCLES PER DIVISION
STOP VIBRATION
0 10 20 30 40 50 60 70 80 90 100
START VIBRATION
MAXIMUM SET IN FREQUENCY BETWEEN START
AND END OF TEST: 14 CYCLES; 0.0046%
(SEE TABLE 35)
THE ESTERLINE-ANGUS CO., INC

Plate 13

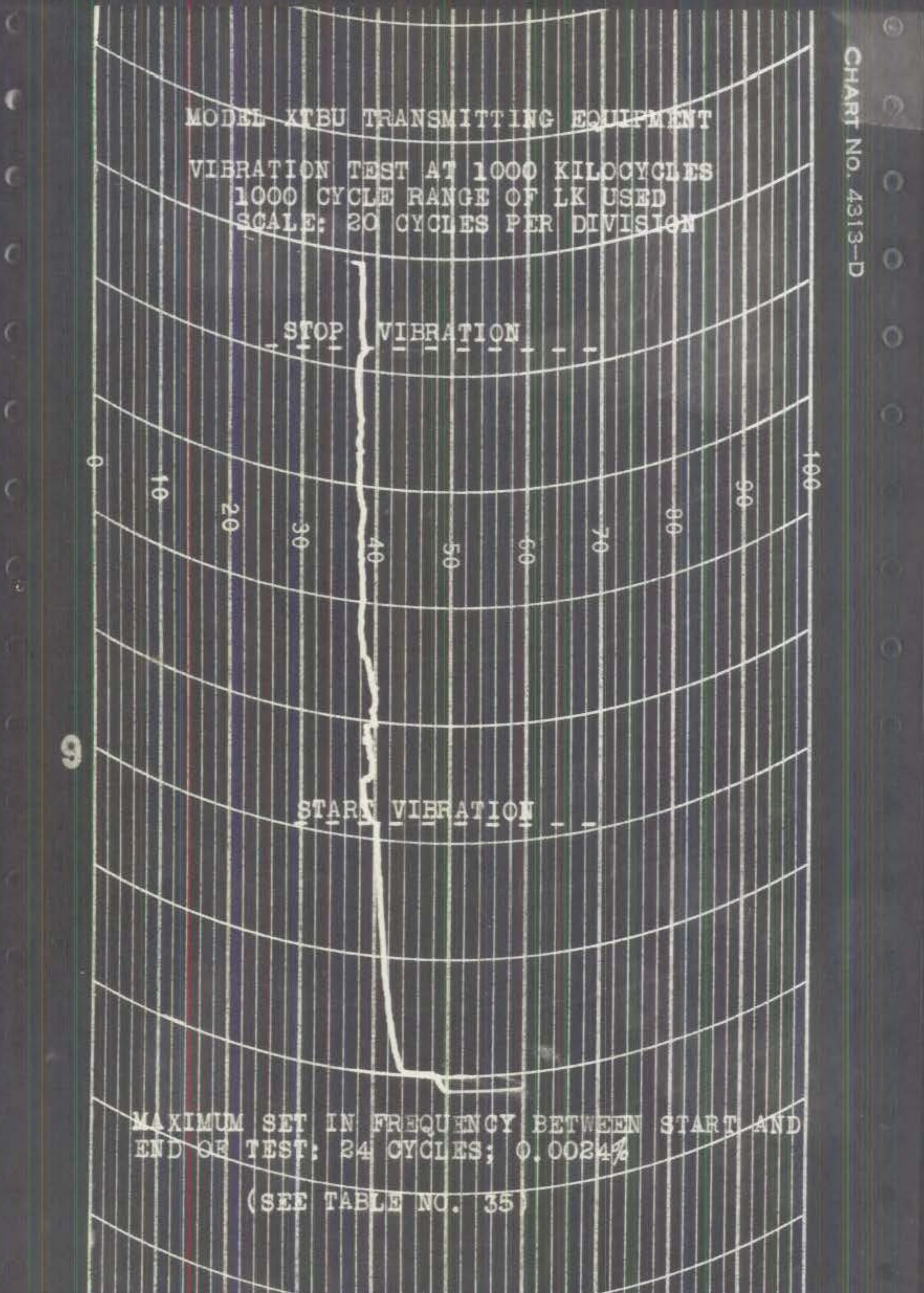

CHART No. 4313-D
MODEL XTBU TRANSMITTING EQUIPMENT
VIBRATION TEST AT 1000 KILOCYCLES
1000 CYCLE RANGE OF LK USED
SCALE: 20 CYCLES PER DIVISION
STOP VIBRATION
0
10
20
30
40
50
60
70
80
90
100
9
START VIBRATION
MAXIMUM SET IN FREQUENCY BETWEEN START AND END OF TEST: 24 CYCLES; 0.0024%
(SEE TABLE NO. 35)

Plate 14

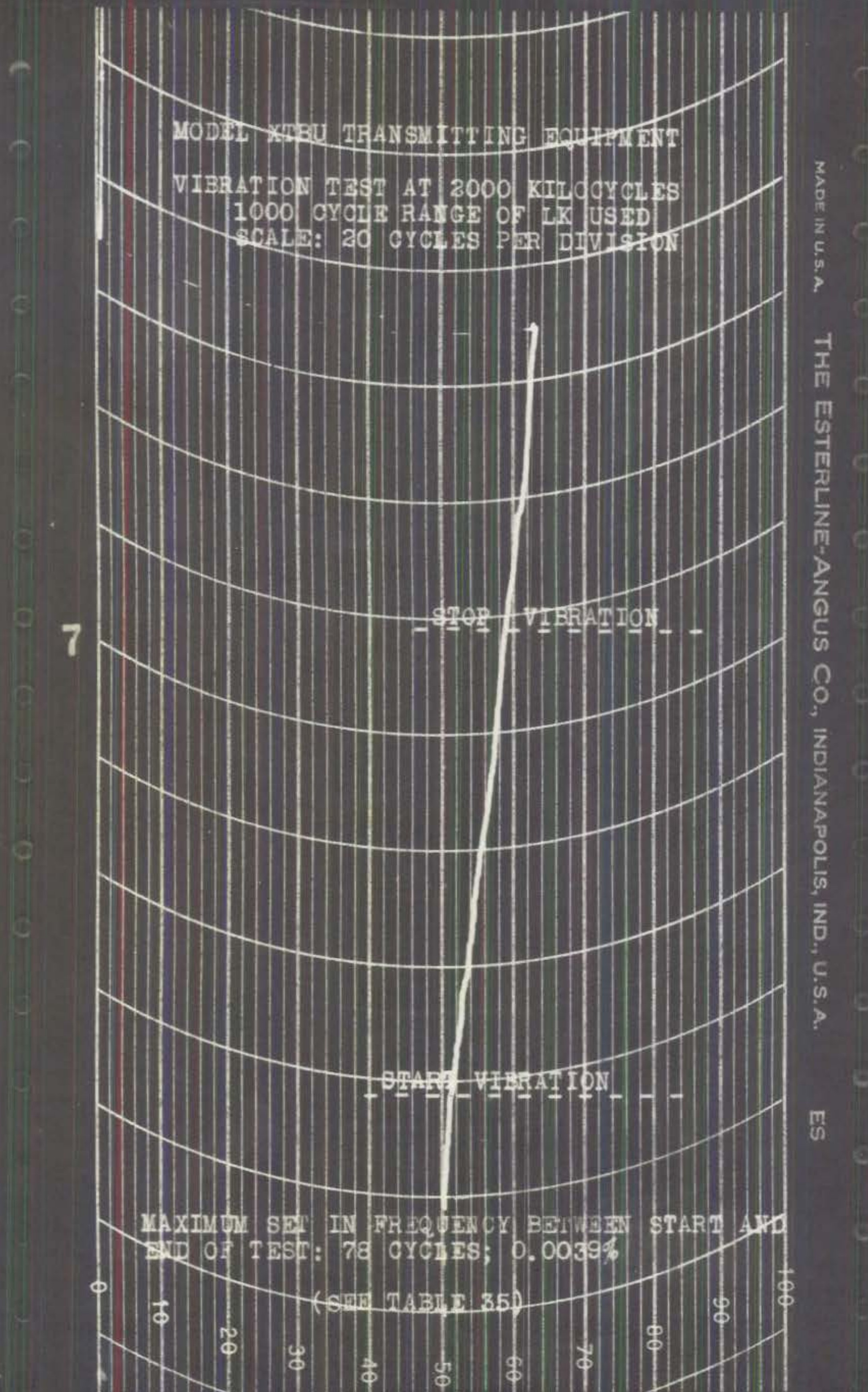
MODEL XTBU TRANSMITTING EQUIPMENT
VIBRATION TEST AT 2000 KILOCYCLES
1000 CYCLE RANGE OF LK USED
SCALE: 20 CYCLES PER DIVISION
STOP VIBRATION
START VIBRATION
MAXIMUM SET IN FREQUENCY BETWEEN START AND END OF TEST: 78 CYCLES; 0.0039%
(SEE TABLE 35)
0
10
20
30
40
50
60
70
80
90
100
7
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Plate 15

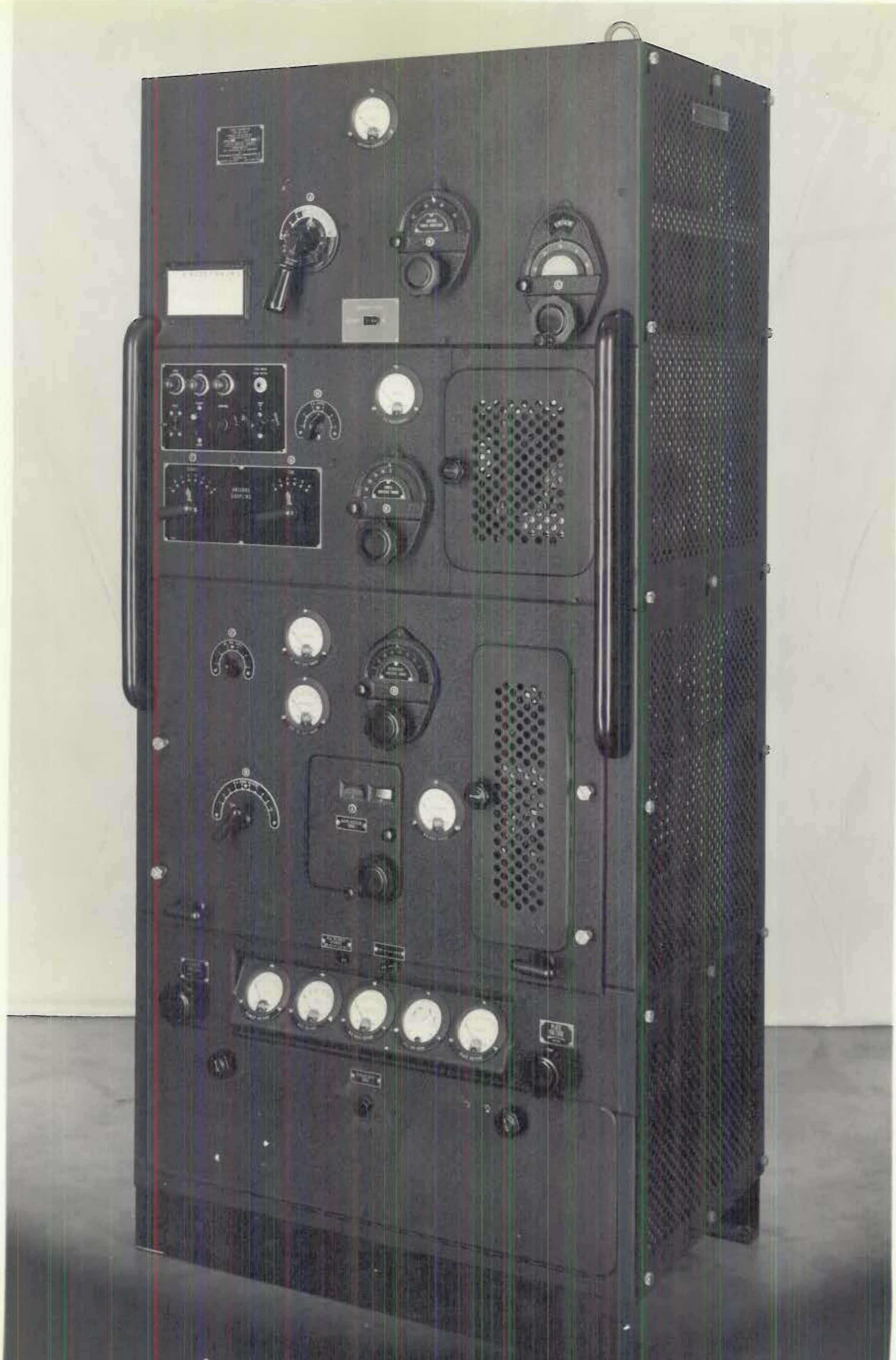

Plate 16

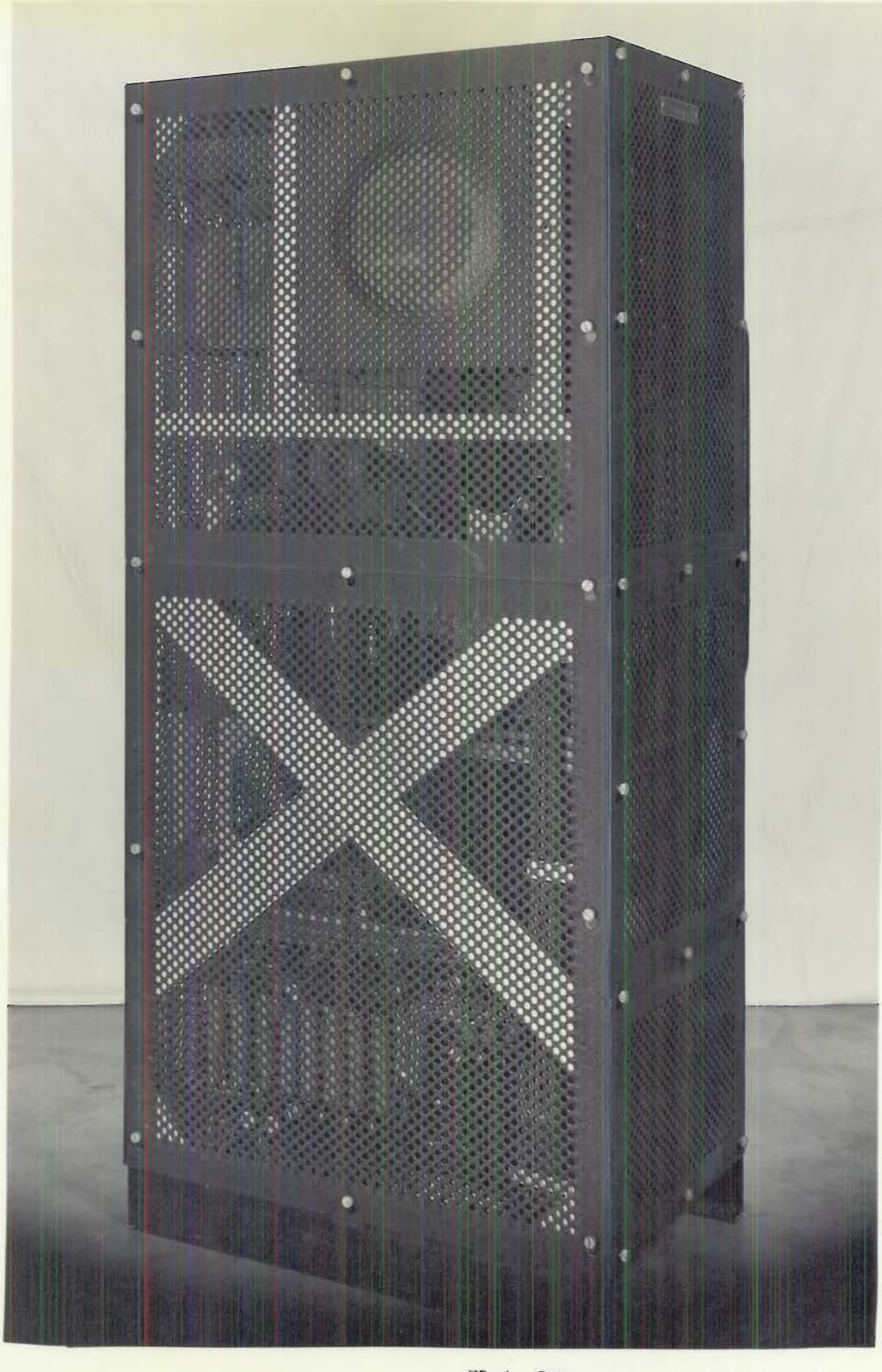

Plate 17

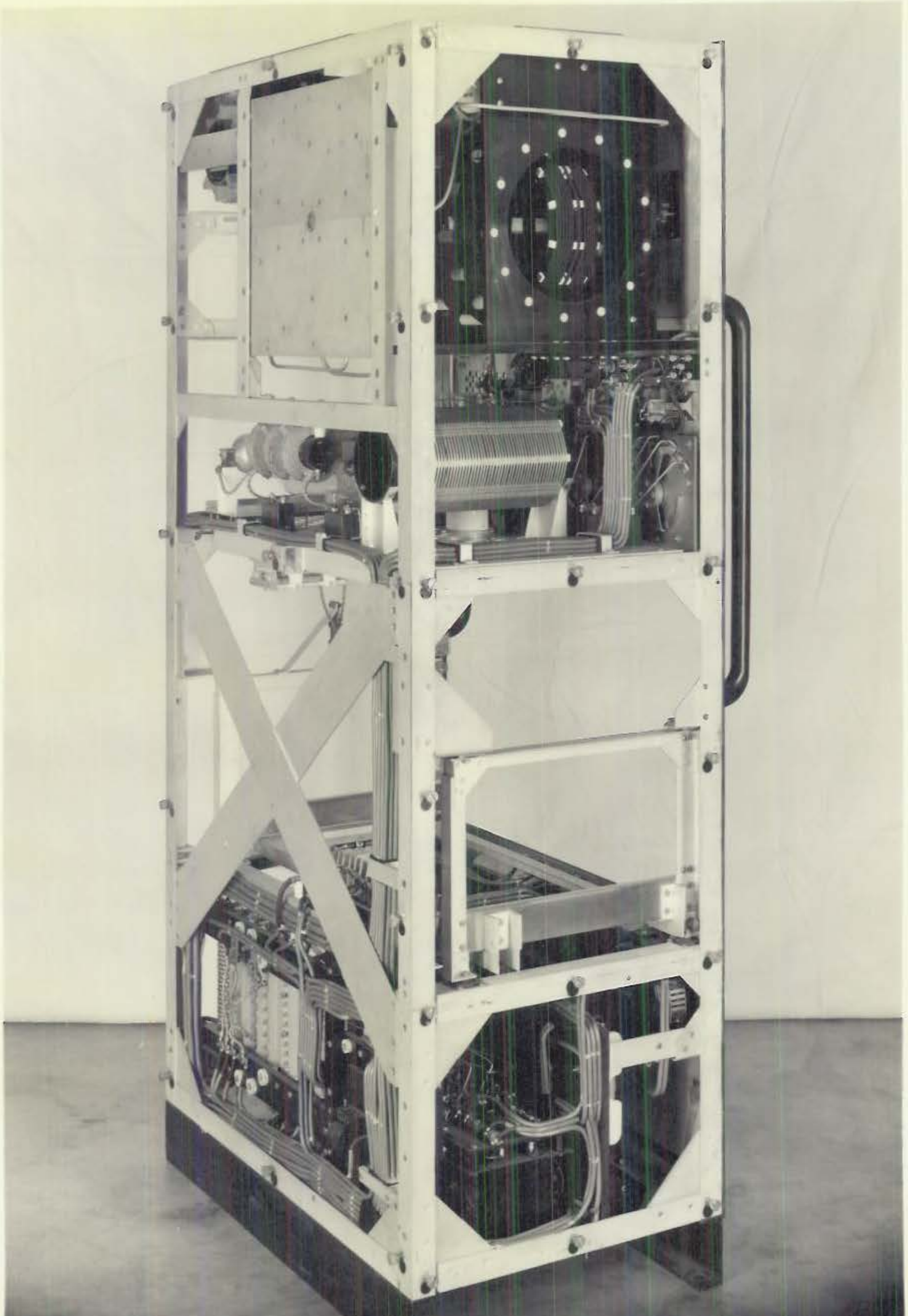

Plate 18

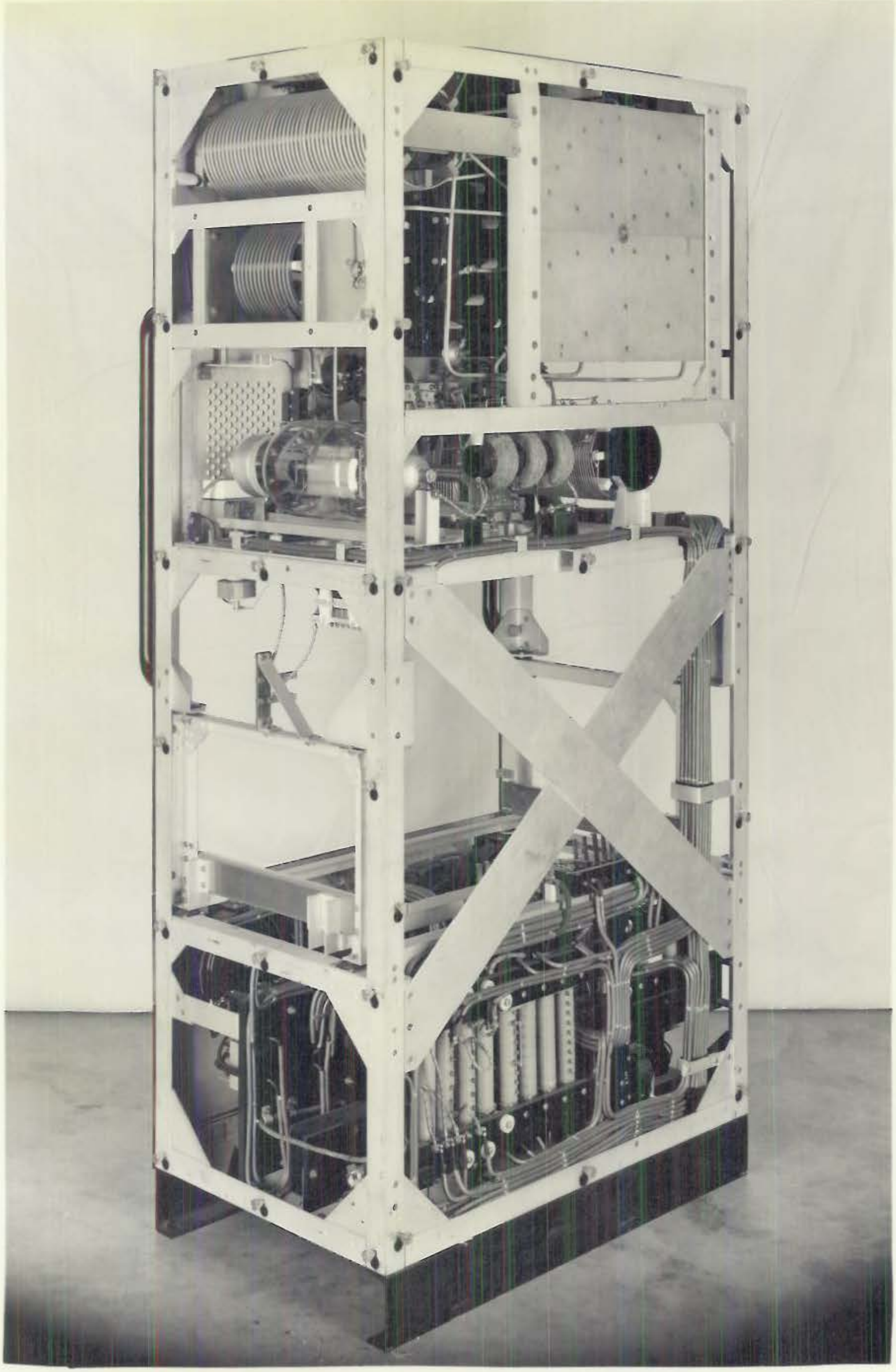

Plate 19

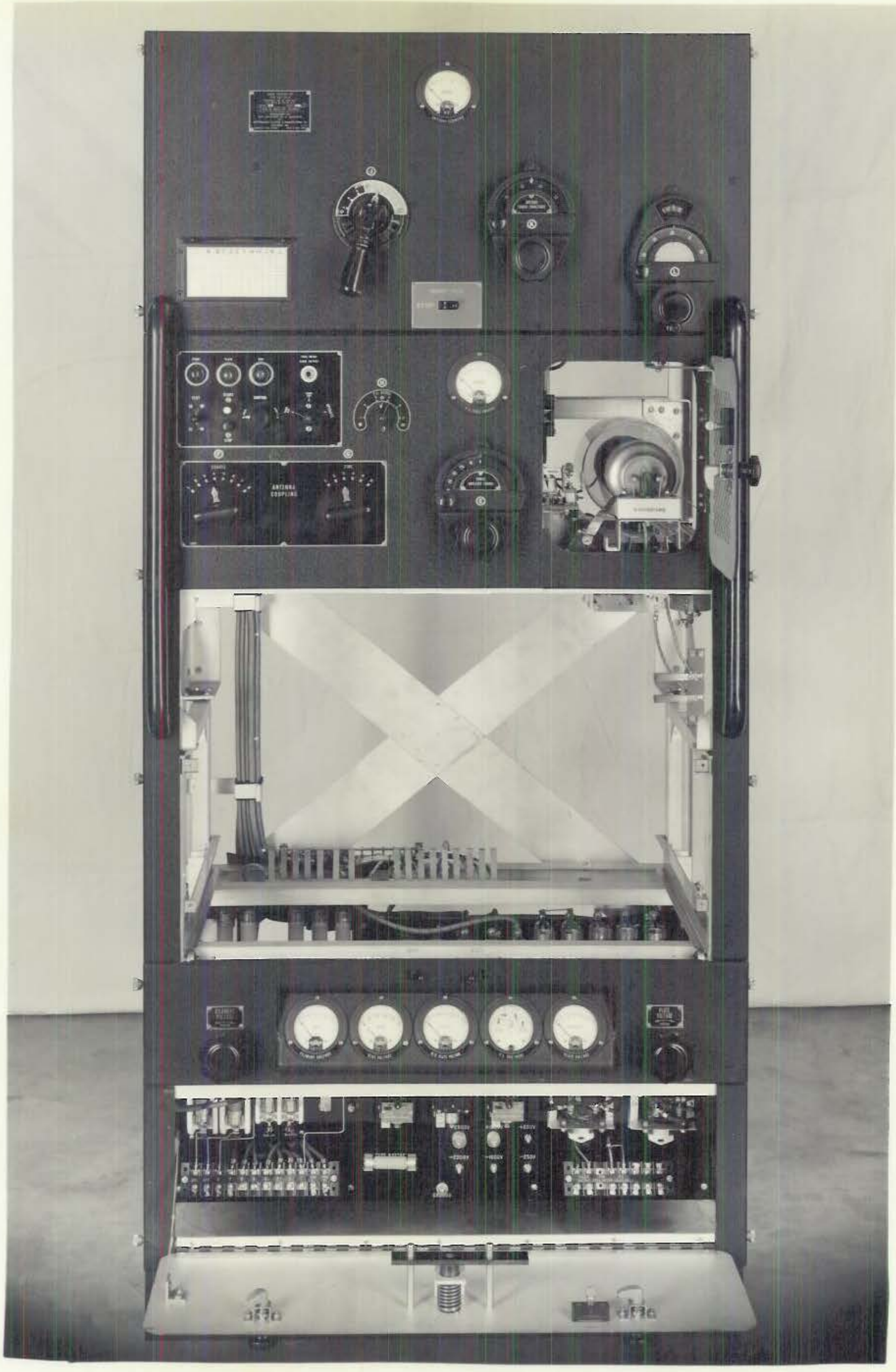

Plate 20

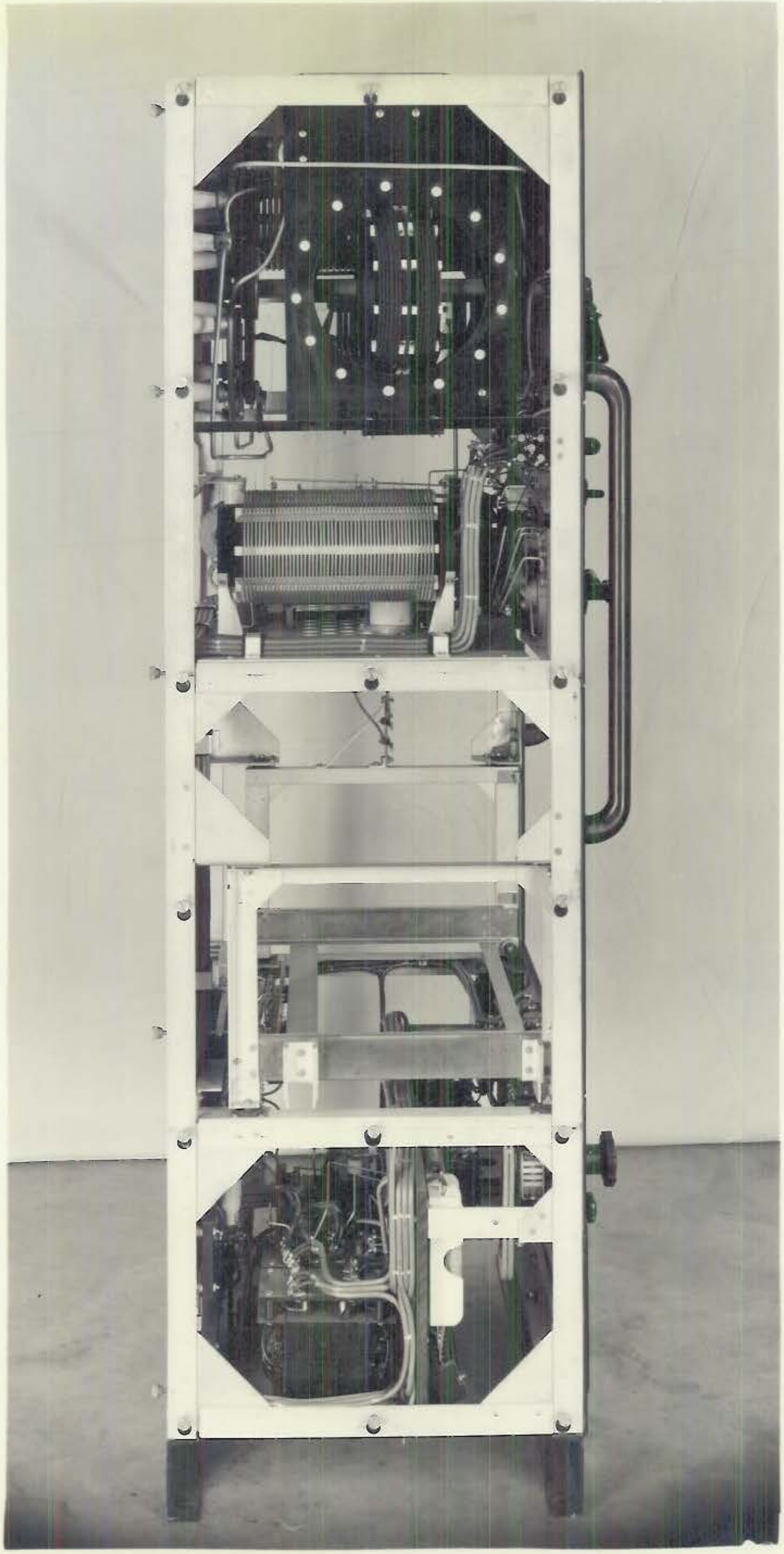

Plate 21

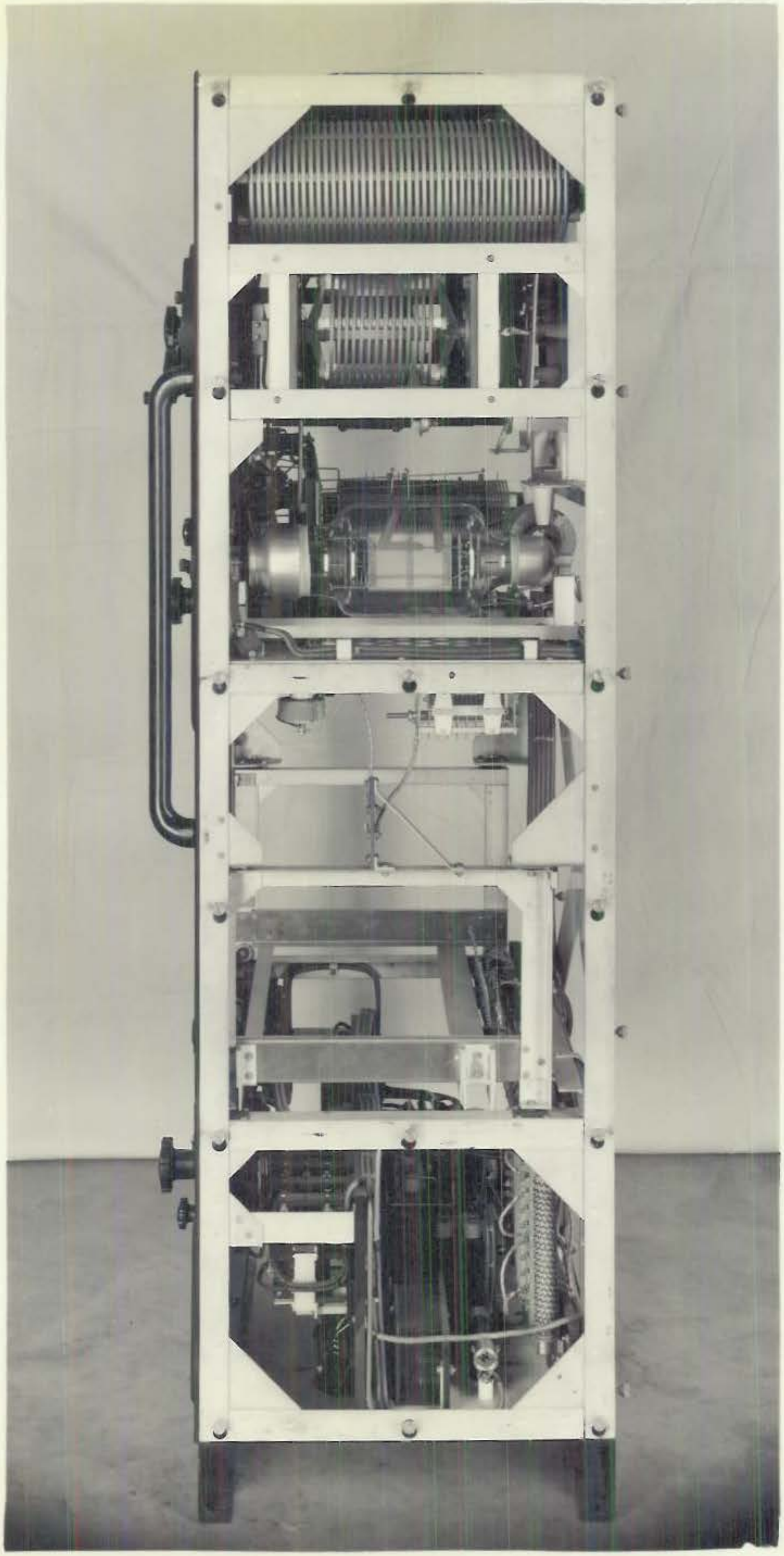

Plate 22

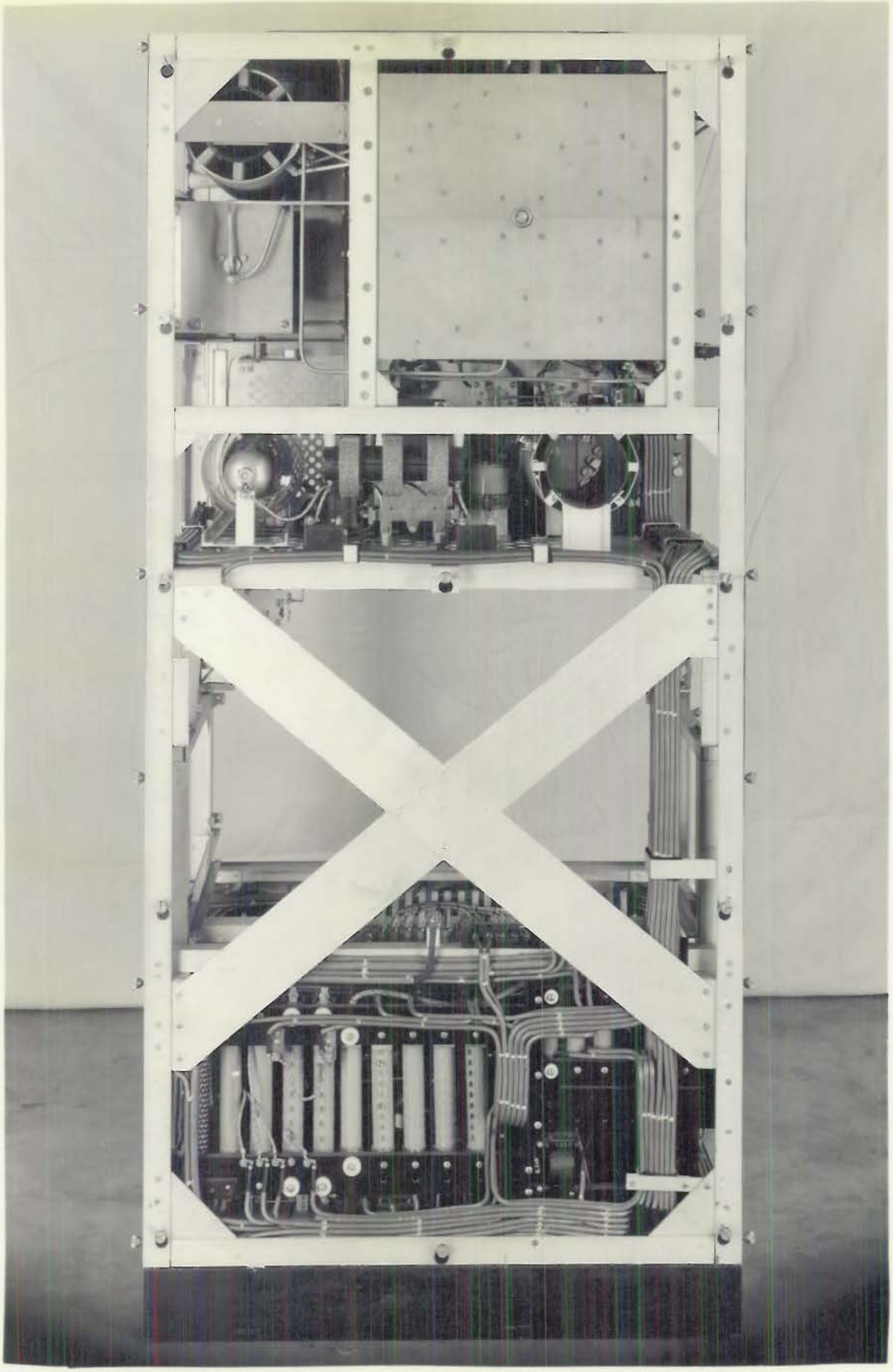

Plate 23

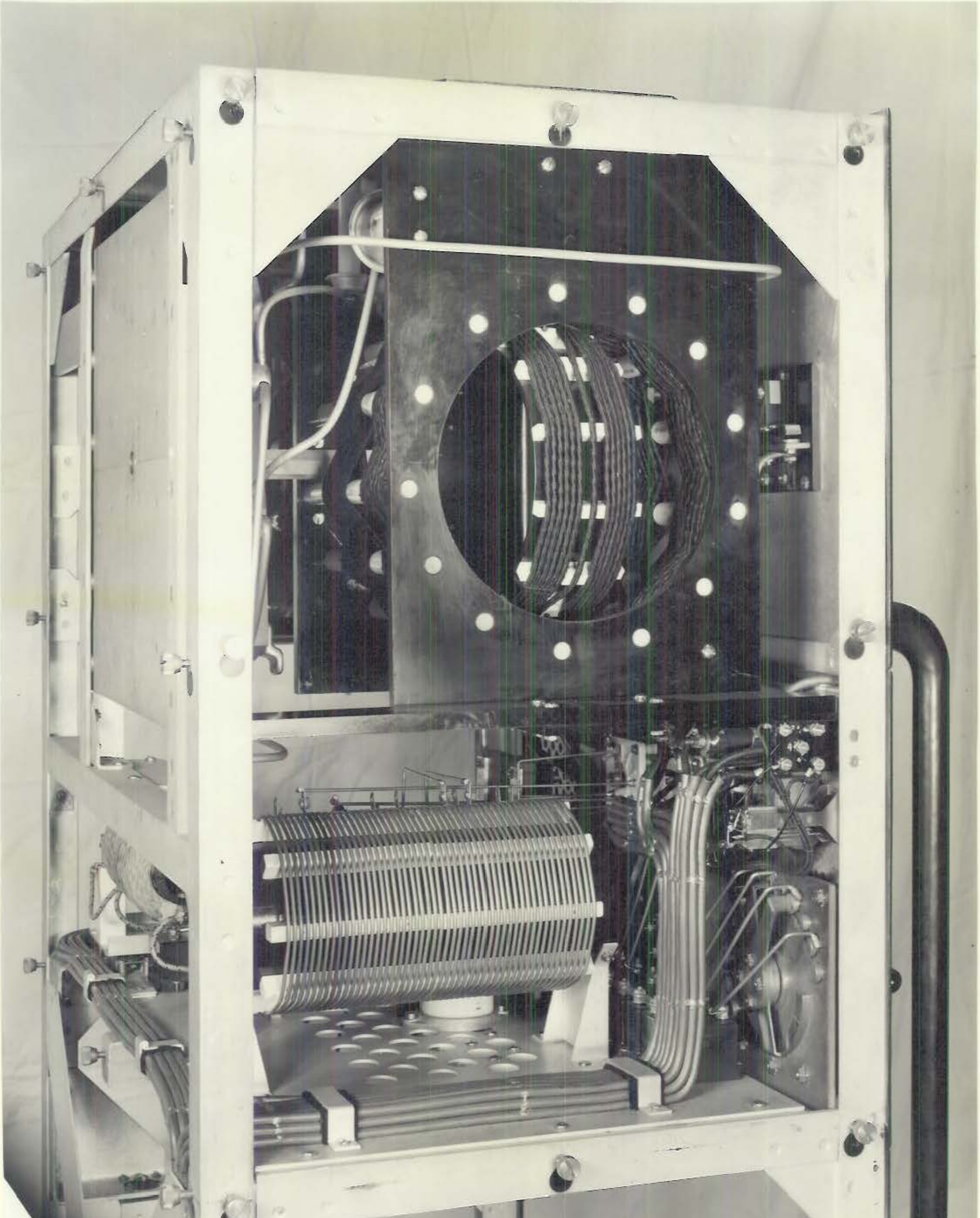

Plate 24

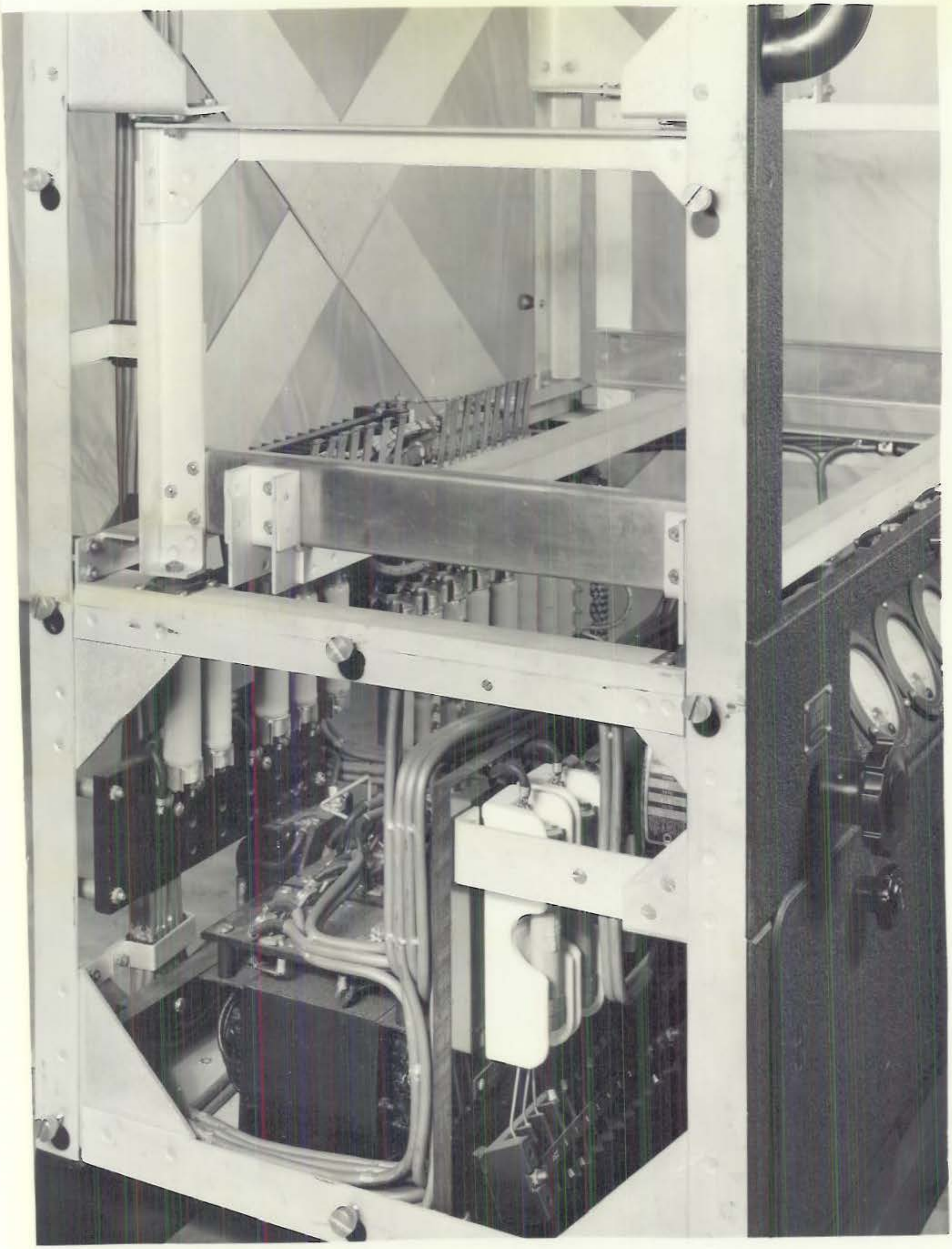

Plate 25

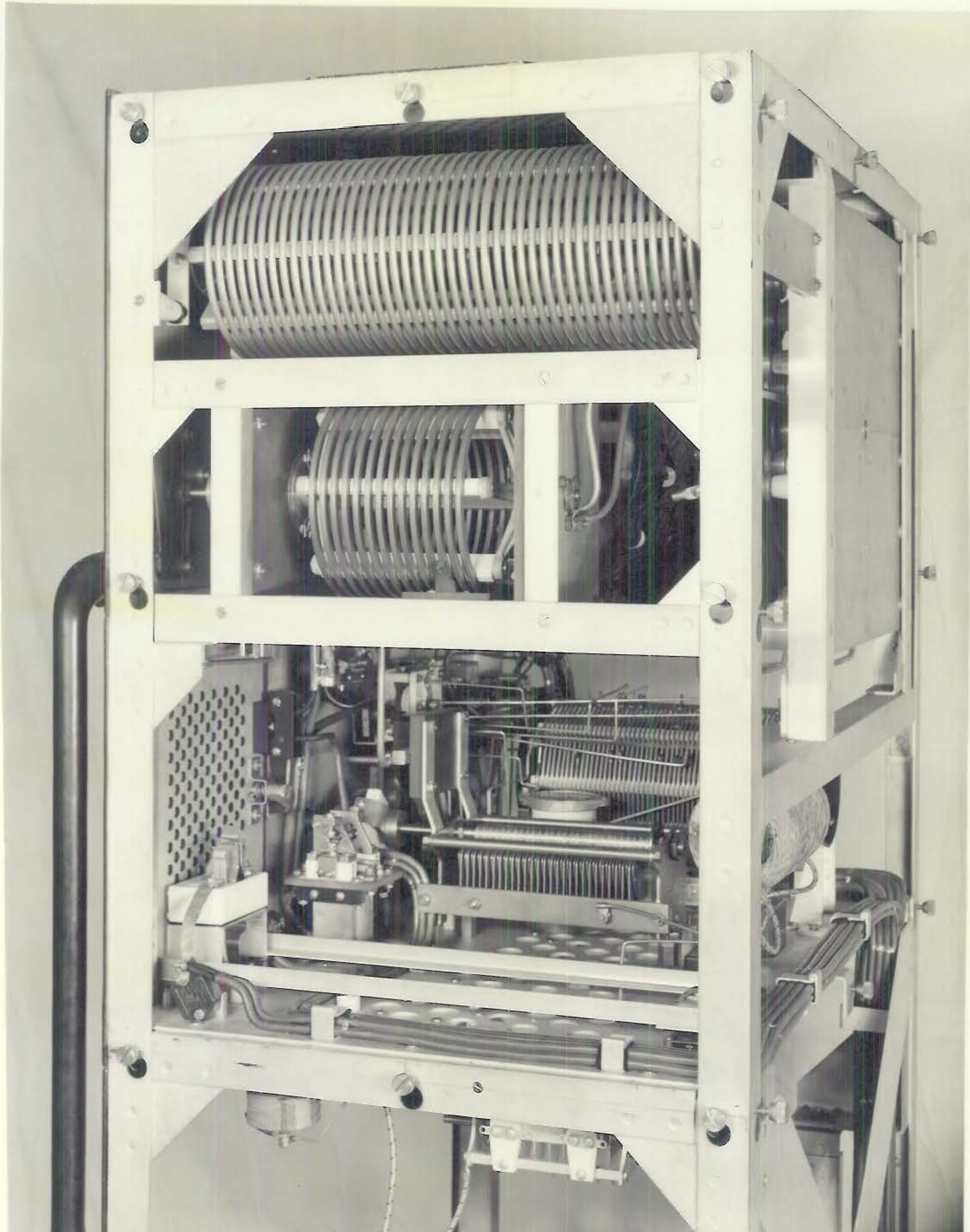

Plate 26

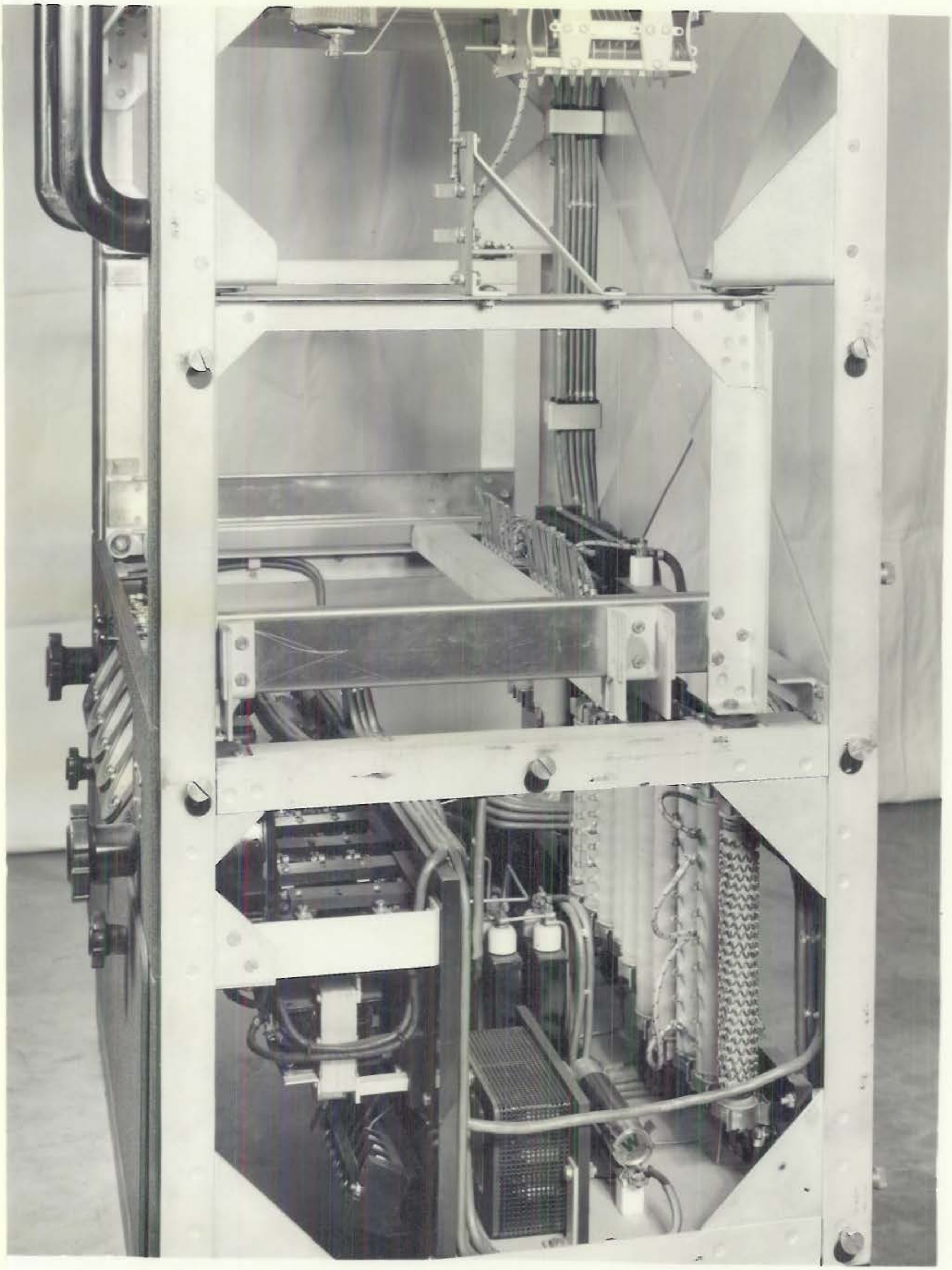

Plate 27

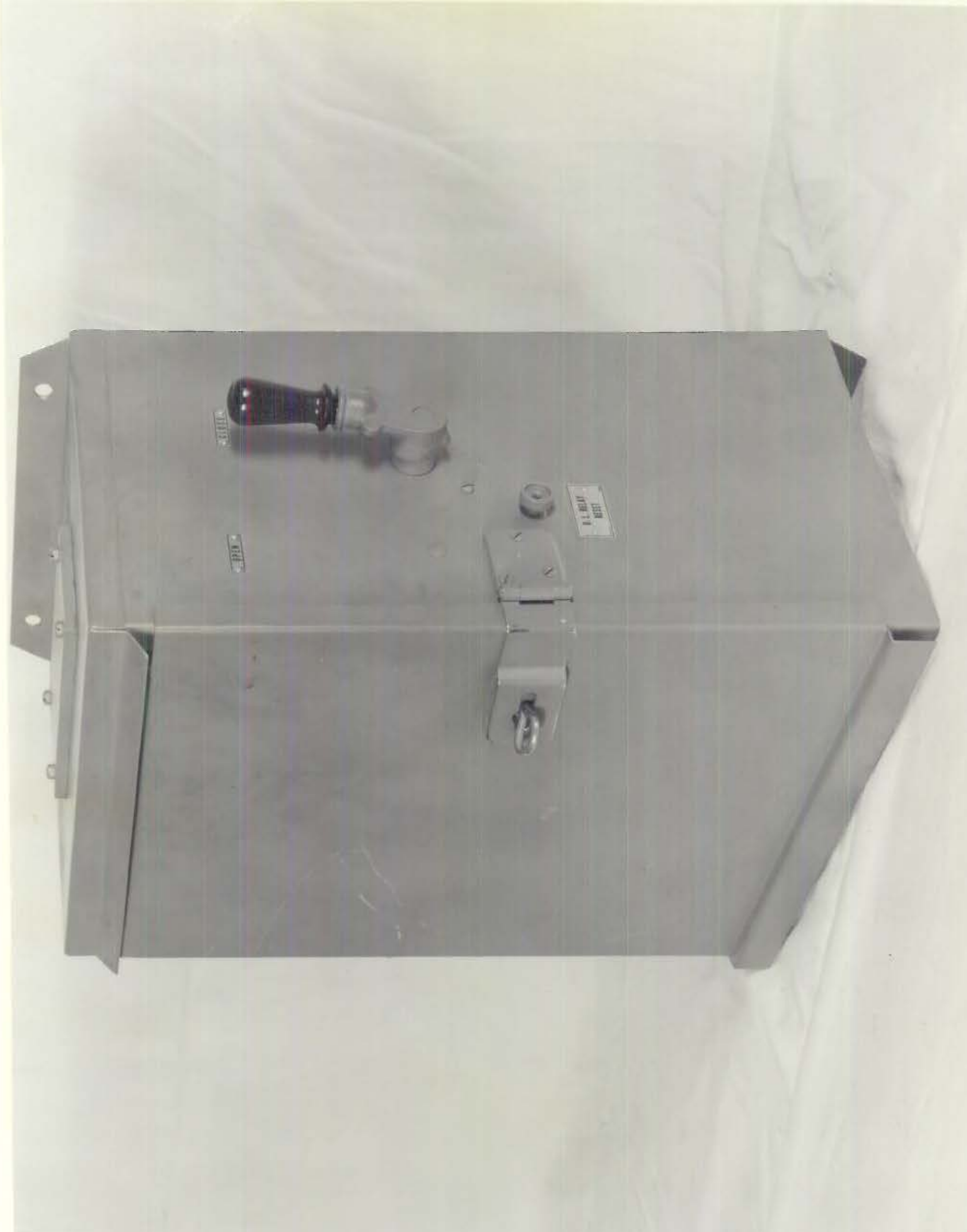

Plate 28

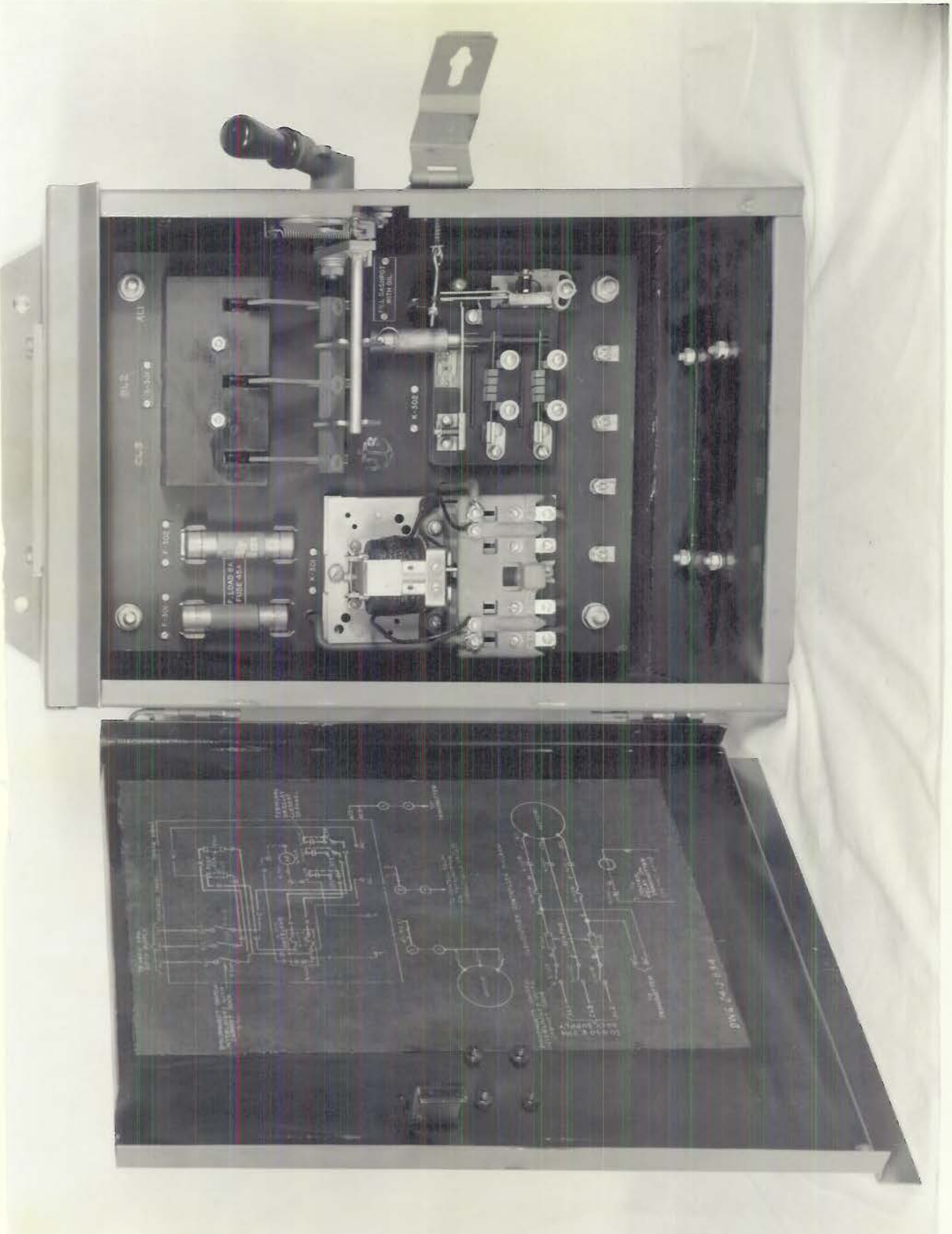

Plate 29

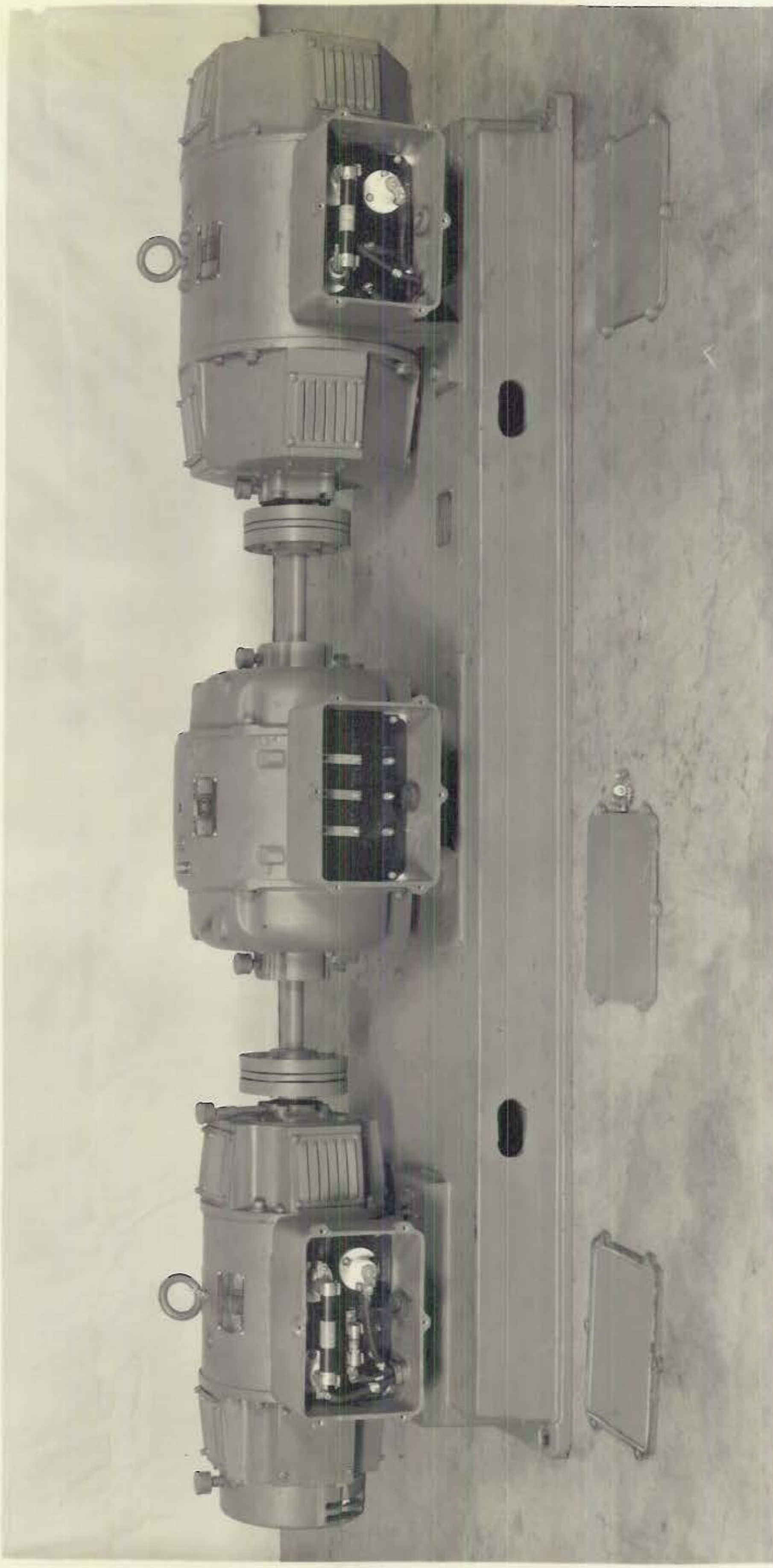

Plate 30

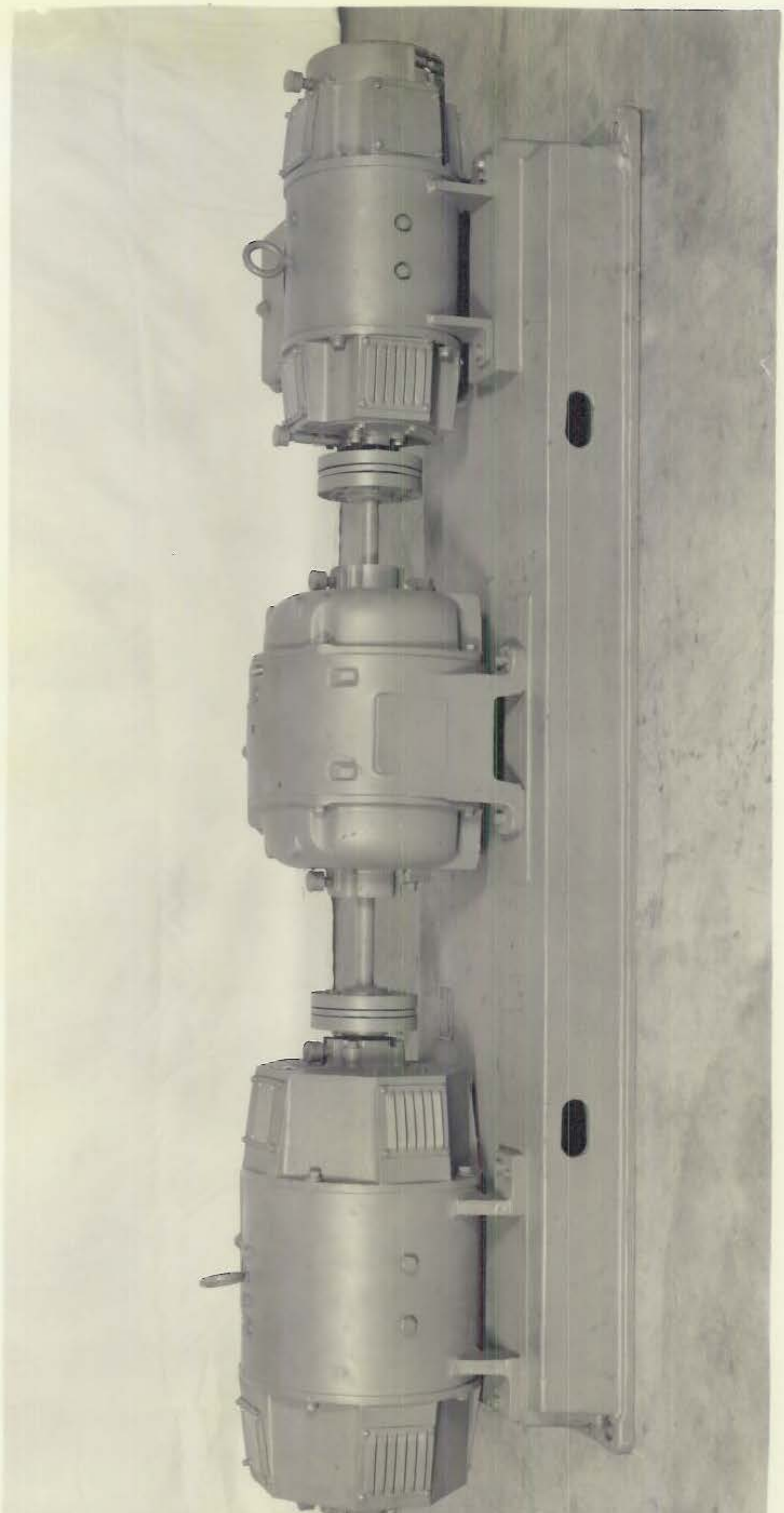

Plate 31

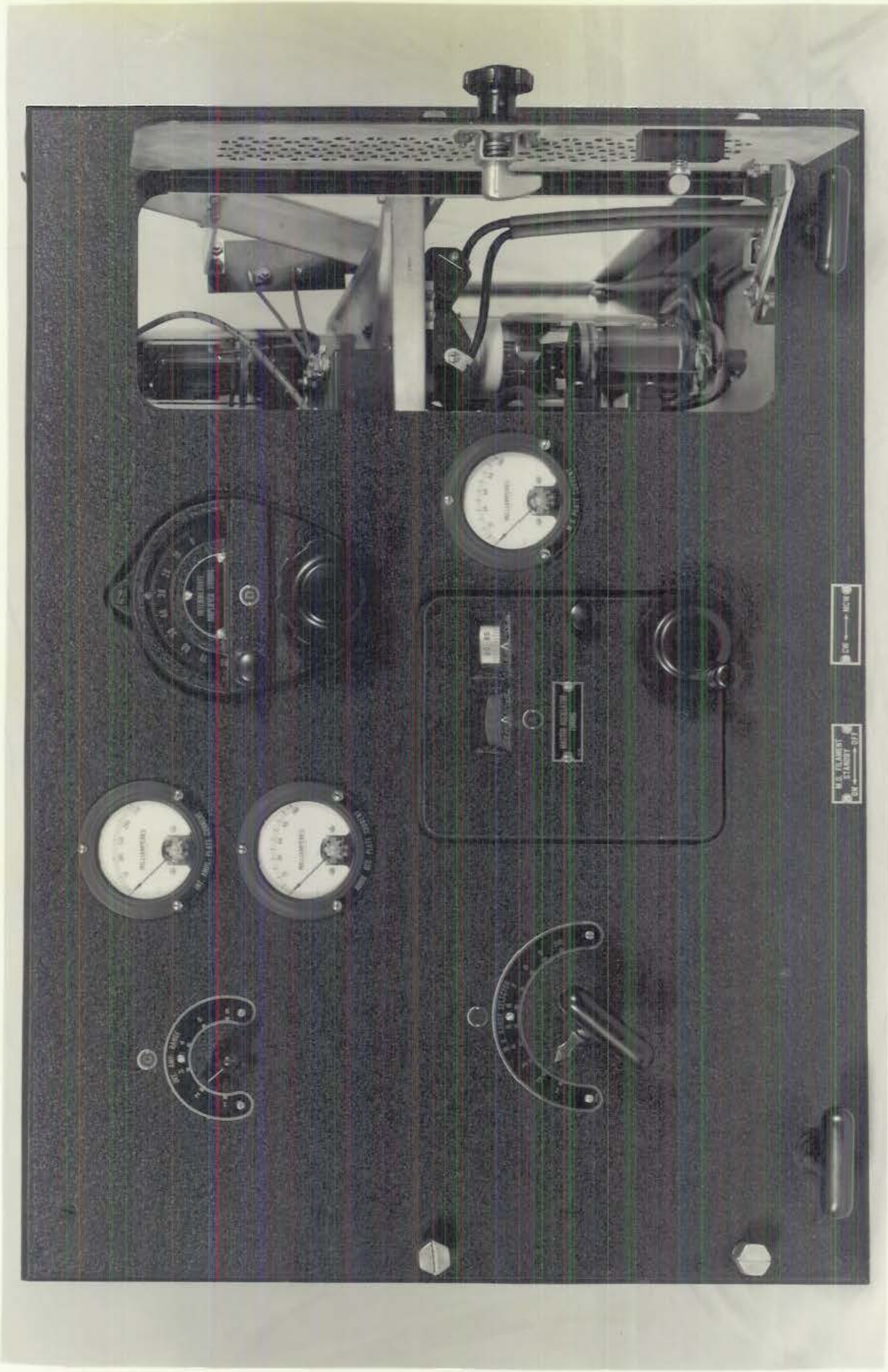

Plate 32

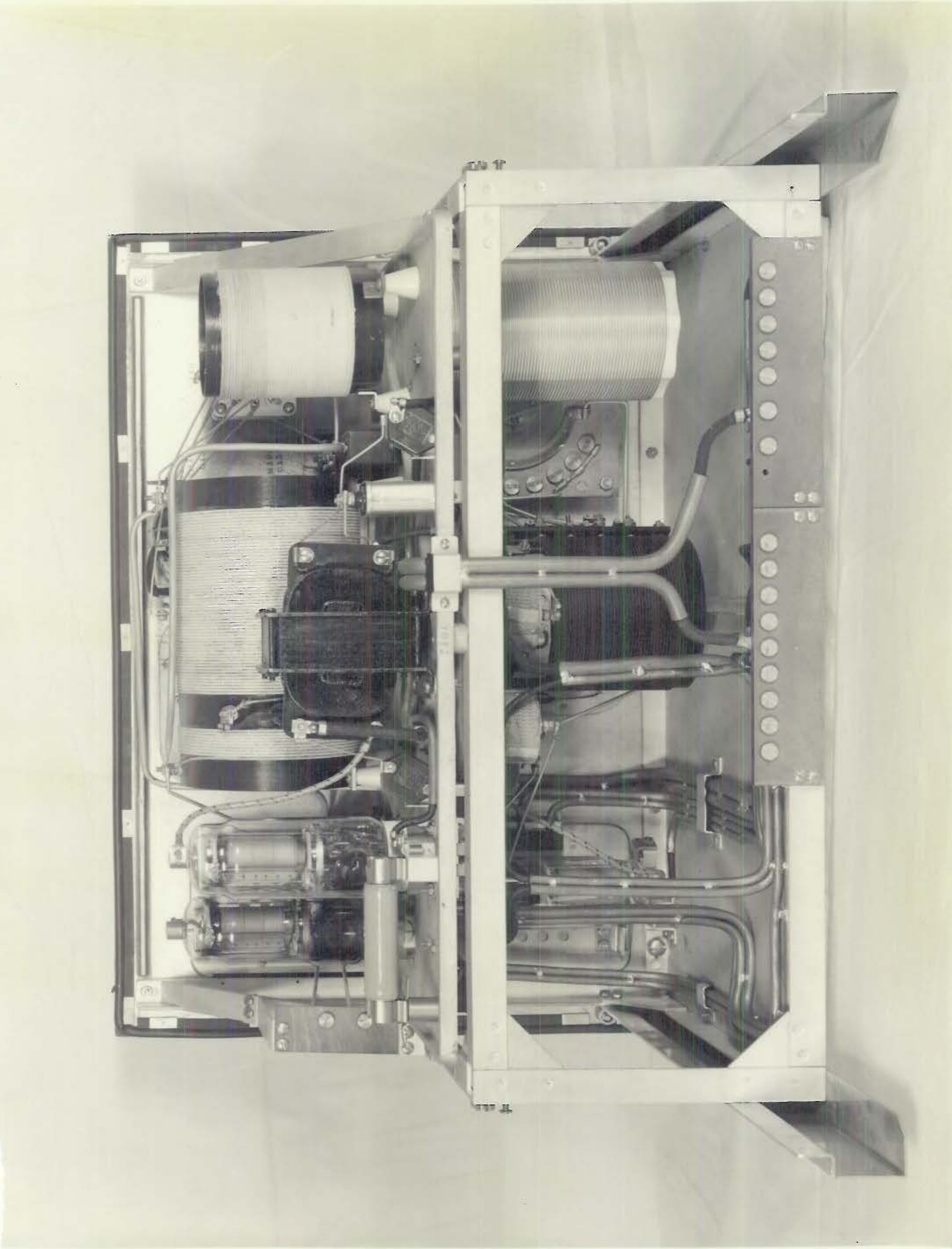

Plate 33

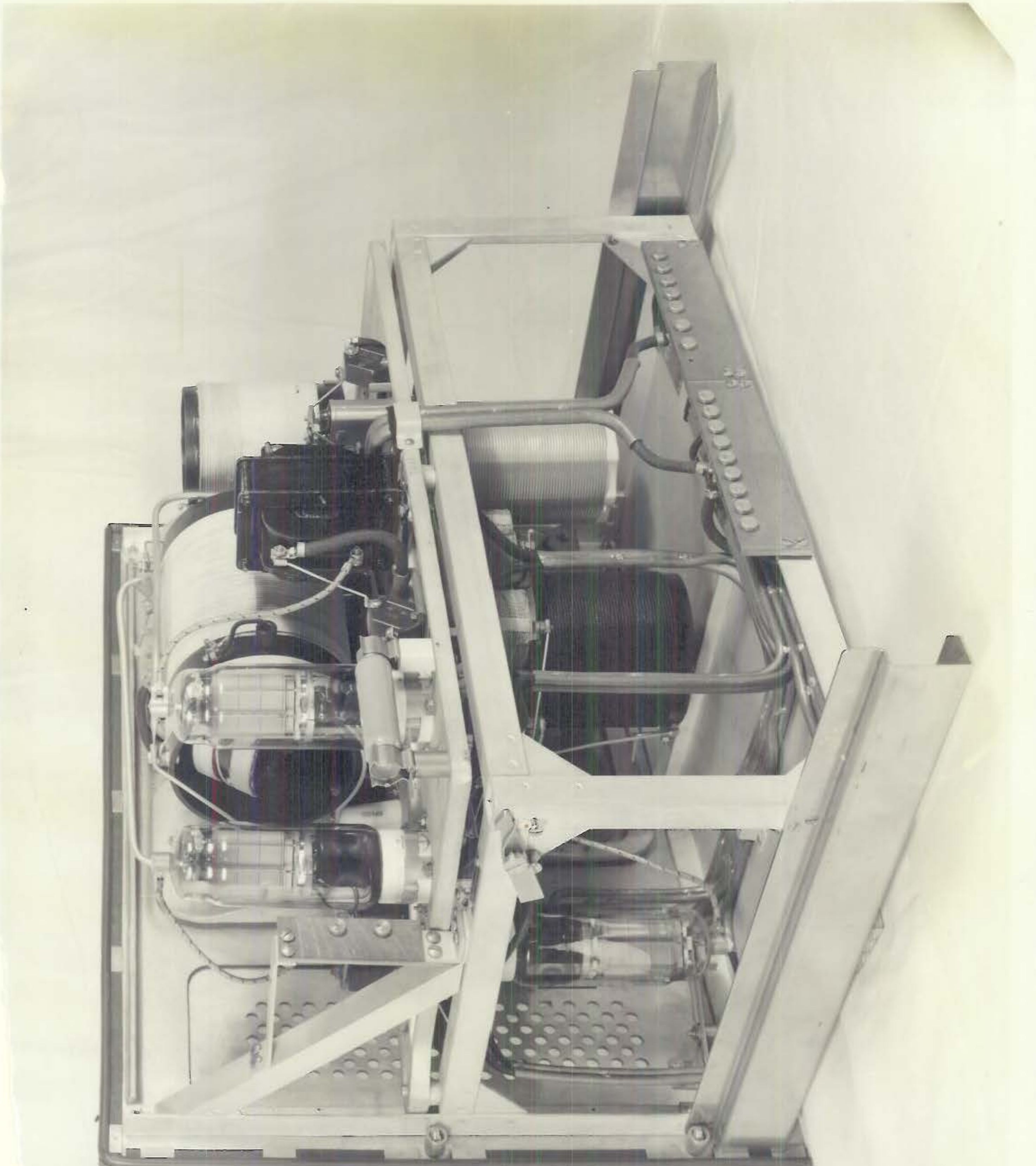

Plate 34

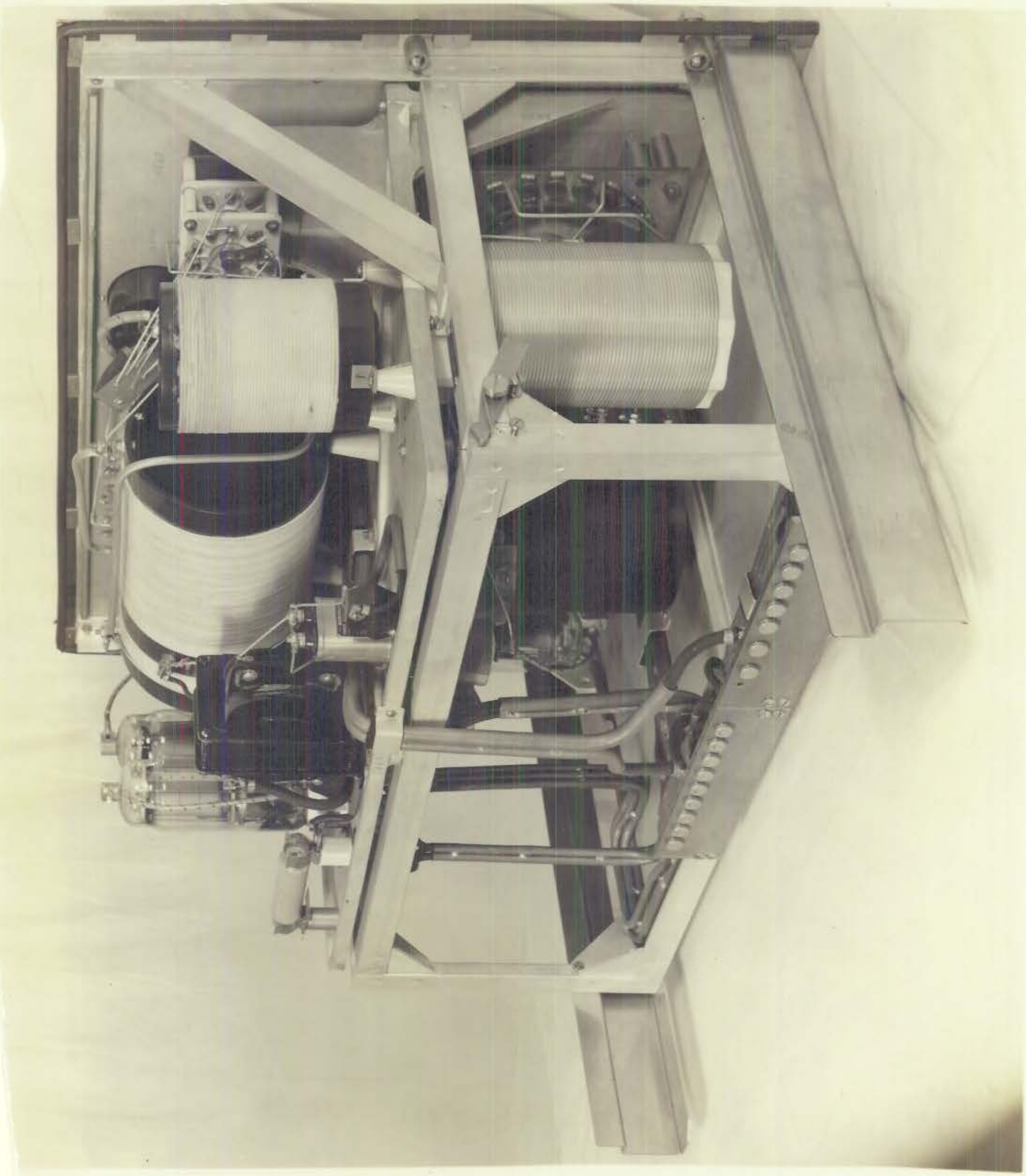

Plate 35