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16 October 1942

SEARCH RADAR SECTION

Radio Division, U.S. Naval Research Laboratory

NRL Report No. R-1937
BuShips Prob. X75S

NAVY DEPARTMENT

Report On

TEST OF MODEL SC-1 RADAR EQUIPMENT

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Contractor:
General Electric Company

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

Authorization:	BuShips ltr S-S67/36(485) Serial 1667, 5 November 1941.
Date of Test:	4 May 1942 to 5 September 1942.
Section I submitted by:	R. M. Page, Head of Ship & Shore Radar Research Section
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REPORT OF TESTS ON MODEL SC-1 RADAR EQUIPMENT

0-1. INTRODUCTION. The tests on Model SC-1 Radar equipment, serial No. 7, were authorized by a letter from the Bureau of Ships, S-S67/36(485), serial 1667, dated 5 November 1941, and are a part of the work on BuShips problem No. X75S. The object of these tests was to determine the suitability of this equipment for Naval service. The equipment was received on 4 May 1942 and the major tests were completed by 18 August 1942. Tests on the improved model of the duplexer were completed on 5 September 1942.

0-2. CONTENTS. The report of Tests on Model SC-1 Radar Equipment is divided into three parts; the table of contents of each section is given on the first page of each section. These sections are:

(a) Section I: Systems Tests of Model SC-1 Radar Equipment, Par. 1-1 to 1-15-5.

(b) Section II: Electrical and Mechanical Tests of Model SC-1 Radar Transmitting Equipment, Par. 2-1 to 2-23-7.

(c) Section III: Electrical and Mechanical Tests of Model SC-1 Receiver-Indicator Unit, Par. 3-1 to 3-28.

0-3. CONCLUSIONS: SECTION I. The tests and observations given in Section I of this report lead to the following conclusions:

0-3-1. Comparative tests with the XAR-2 Radar system indicate that the overall performance of the SC-1 transmitter, antenna, and duplexer system is satisfactory, but that the SC-1 receiver performance is poorer than it should be for a receiver of this type.

0-3-2. Tests on the SC-1 transmitter indicate that it has satisfactory tuning properties and a pulse power output of over 156 Kw over the entire frequency range under a wide range of loading conditions.

0-3-3. The SC-1 Radar system is a marked improvement over the SC system in many respects. The SC-1 equipment is easier to tune, is less likely to cause r-f interference, and has a larger pulse power output. The SC-1 equipment should observe objects at consistently greater ranges and the improvement should be very marked on the red band. Some of the SC defects have been eliminated and the SC-1 equipment should have less maintenance troubles.

0-3-4. There are still a number of defects in the SC-1 equipment. The failures which were observed during the systems test indicate that the SC-1 performance might not be as reliable as is desired. Careful attention to correcting these defects should decrease maintenance

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difficulties and result in more consistent operation under adverse circumstances.

0-3-5. With a good receiver, or with a lighthouse tube preamplifier for the present receiver, the SC-1 system appears to be capable of equaling the performance of the best of the 200 Mc Radar systems which are in use at the present time.

0-4. CONCLUSIONS: SECTION II. The results of the tests made on the Model SC-1 Transmitting Equipment lead to the following conclusions:

0-4-1. The equipment operated satisfactorily over a wide range of ambient temperatures and relative humidity. In the absence of specifications governing variations in emitted frequency and power output, no conclusions relative to these points are included.

0-4-2. While no damage resulted to the equipment when it was subjected to vibration, parts of the antenna developed a considerable amplitude of motion which, if continued, may prove detrimental. Certain aspects of this vibration may interfere with the radio-frequency operation of the antenna.

0-4-3. The shock tests conducted on the apparatus disclosed a number of difficulties which will require correction before satisfactory operation can be obtained.

0-4-4. The wiring of the transmitter unit, with minor exceptions, is satisfactory. The wiring of the control unit requires improvement.

0-4-5. A number of minor defects were encountered which, in general, appear to be the result of lack of sufficient inspection. A number of improvements and corrections are recommended to improve maintenance and servicing features.

0-4-6. The means provided to adjust the transmitter oscillator and output circuits is considered unsatisfactory, since they afford no definite means of calibration. The use of dial cable in the output circuits presents a difficult problem of servicing.

0-4-7. The Model SC-1 Transmitting Equipment represents an improvement over the Model SC Equipment. A number of the difficulties present in the Model SC Equipment have been overcome. This has been done either by modification of the design or by elimination of the feature in which the difficulty occurred.

0-5. CONCLUSIONS: SECTION III. The general construction, workmanship, and appearance of the receiver and range indicator unit of Model SC-1 radar equipment are good. Certain electrical and

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mechanical defects and recommendations for their improvement are summarized in Par. 0-6-60 to 0-6-94. However, it should be noted that several tests usually required to determine equipment performance under service conditions were not made due to time limitations. Among the more serious defects are the use of non-Navy-approved vacuum tubes, unreliable tube sockets, and the insecure mounting of the range-calibration crystal.

0-6. SUMMARY OF DEFECTS AND RECOMMENDATIONS. The following defects were noted and recommendations made in the three sections of this report. They are roughly grouped by component units and the numerals in parentheses refer to the paragraph under which these items are discussed in detail.

0-6-1. ANTENNA. (1-11-3). The design of the inner conductor of the antenna rotating joint is unsatisfactory.

0-6-2. (2-4-2a). A number of points on the antenna frame were found to resonate and oscillate excessively under the influence of vibration. It is recommended that the Contractor be required to make such modification in the design and construction of the antenna as is necessary to reduce the excessive vibration noted.

0-6-3. (2-4-2b). The open wire transmission lines which connect together the various dipole radiators on the antenna were found to vibrate excessively. The necessary steps should be taken to eliminate this condition.

0-6-4. (2-4-2c). Some of the transmission lines which connect together the various dipole radiators on the antenna were found to have broken loose from the ends of the dipoles. More care should be taken in the workmanship with which the welds holding these lines are made.

0-6-5. (2-16-1). The steel parts of the antenna are rusting badly. It is recommended that the anti-corrosion measures on the antenna be improved.

0-6-6. (2-17-5). Attention is directed to the ease with which the "Sling Here" markings on the antenna can be obscured. These markings have been provided to indicate where ropes are to be placed on the antenna for hoisting or lowering operations.

0-6-7. ANTENNA PEDESTAL. (2-14-5). It is recommended that the excess tubing of the antenna pedestal thermostat be eliminated and that supports be provided for the remaining portion.

0-6-8. (2-15-3). Care should be taken during manufacture to properly assemble the oil gauges which are located on the antenna pedestal.

0-6-9. (2-15-4). The antenna pedestal leaks oil. Definite steps

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should be taken to eliminate this condition.

0-6-10. (2-17-3). The points at which the antenna is filled with or drained of oil and the points at which the antenna is greased should be marked at appropriate points on the antenna pedestal. A nameplate on the antenna drive motor should specify the Navy type of the grease that is to be used with the motor bearings.

0-6-11. (2-17-4). It is recommended that a nameplate be provided adjacent to the antenna interlock plug to indicate its purpose and to warn operators to open the interlock before working on the antenna.

0-6-12. AMPLIDYNE. (2-18-4). Steps should be taken to prevent the amplidyne brushes from arcing and burning.

0-6-13. CONTROL UNIT. (2-14-4). Sufficient clearance should be provided between switches S-107 and S-109 in the control unit to prevent them from touching each other.

0-6-14. (2-14-7). It is recommended that the anti-hunt control on the antenna rotation circuit be modified so that the control, when set correctly, will eliminate hunting at all rotational speeds of the antenna without further adjustment.

0-6-15. (2-14-11). It is recommended that the panel marking and the panel mounting hole for the phase adjustment control be omitted from the front panel of the control unit.

0-6-16. (2-15-5). It is recommended that care be taken during the manufacture of the control unit cabinet so that the panel securing brackets will fit properly.

0-6-17. (2-15-9). The bolts holding capacitor C-102 should be made 1/4 inch longer. This will permit these bolts to extend completely through the nuts which hold them.

0-6-18. (2-16-5). The use of unprotected steel for the gears which connect the differential generator to the slewing motor in the control unit should be abandoned in favor of gears of a suitable corrosion resisting material.

0-6-19. (2-18-1). It is recommended that resistors R-102C, R-105, and R-108 be replaced by resistors that will be more suitable for use in the Naval service.

0-6-20. (2-18-2). It is recommended that the resistors R-111 and R-112 which have tab type terminals be replaced with Navy type resistors having ferrule terminals.

0-6-21. (2-18-3). It is recommended that the present two-position

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RR switch be replaced by a three-position switch. The three-position switch should be provided with a "Lock" position, a "Normal" position, and a "Momentary" position.

0-6-22. TRANSMITTER AND CONTROL UNIT. (2-13). A number of improvements are necessary in the wiring of the control and transmitter units.

0-6-23. (2-14-6). The marking on a number of the controls on the transmitter and control units is incomplete. It is recommended that the additional markings suggested in Table 19 of Section II be added to these controls.

0-6-24. TRANSMITTER. (1-8-8). The top cover of the transmitter should be securely fastened and bonded to the piece which supports the transmission line where it leaves the cabinet.

0-6-25. (1-8-10). Sparking was sometimes observed in the transmitter grid-current meter.

0-6-26. (1-8-11). The transmitter overload relay circuit should be improved so that it will give good protection to the oscillator and still pass the high starting current. Until such an improvement has been worked out, it is recommended that the overload relay be set to trip at 100 to 150 ma. See Par. 0-7-3.

0-6-27. (1-8-12). An oscillator filament voltmeter should be used which measures the actual filament voltage instead of the input voltage to the filament transformer.

0-6-28. (2-5-1a). The top of the cabinet of the transmitter unit deflects a considerable amount under the influence of shock. The instruction book should indicate the amount of clearance to be left around the unit to prevent it from striking against adjacent objects.

0-6-29. (2-10-1). The oscillator plate variac rotor slips on its shaft. It is recommended that the set screws holding this rotor be retained and that in addition the variac rotor be fastened to its control shaft by means of a taper pin of non-magnetic corrosion resisting steel.

0-6-30. (2-15-1). It is recommended that the hex head bolts on the back and side shields of the transmitter unit be eliminated and that the thumb screws provided to secure these shields be changed to a type that will hold the shields securely without the assistance of extra bolts.

0-6-31. (2-15-10). It is recommended that nuts and bolts holding capacitors C-303 and C-304 be made more accessible.

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0-6-32. (2-16-2). It is recommended that a more durable finish be used on the outside of the transmitter unit.

0-6-33. (2-16-3). It is recommended that a more durable finish be used on the high-voltage plate transformer in the transmitter unit.

0-6-34. (2-16-4). Care should be taken during manufacture to prevent the bracket supports for resistors R-312 and R-305 from being scratched.

0-6-35. (2-16-6). It is recommended that the use of steel for the two braces which connect the oscillator cathode tuning shield box to the transmitter frame be abandoned and that these braces be made of aluminum.

0-6-36. (2-17-1). A nameplate should be provided on the transmitter unit to indicate the function and method of use of the oscillator-plate-current meter push-to-read switch.

0-6-37. (2-17-2). A nameplate should be provided on the transmitter unit near the Filament Primary Voltmeter to indicate to what value the voltage indicated by this meter is to be adjusted.

0-6-38. (2-18-7). The resistance of resistors R-335 and R-336 exceed their specified tolerance. These resistors should be replaced by ones of the proper value.

0-6-39. TRANSMITTING OSCILLATOR. (1-8-2). Careful factory inspection is necessary to insure that the oscillator grid connectors have neither too tight nor too loose a fit on the tube pins. An improved design is desirable. See Par. 0-7-1.

0-6-40. (1-8-3). The oscillator filament connectors should be properly heat treated to insure the proper spring properties. They should be carefully inspected to insure a proper fit on the filament terminals. The circular spring should be made heavier. An improved design is desirable.

0-6-41. (1-8-4). The edges of the holes through the filament by-pass capacitor plates should be rounded off. A high grade of clear mica should be used.

0-6-42. (1-8-5). The oscillator filament tuning vane should have an edge at least 3/8" thick and this edge should be carefully rounded off and polished.

0-6-43. (1-8-6). The screw-driver access holes on the blue-, green-, and yellow-coded stub-line extension inserts should be properly spaced so that the set screws on the inner conductor can be properly tightened.

0-6-44. (1-8-7). The stub-line shorting bar should be made from

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beryllium-copper so that it will always make a good contact with both the inner and outer conductors.

0-6-45. (1-8-9). Suitable means should be used to prevent corona from the bronze dial cables which are used to adjust the output coupling of the oscillator.

0-6-46. (2-14-1). It is recommended that the present cable drive on the "Output Coupling" and "Output Matching" controls in the transmitter unit be abandoned in favor of some method of driving these controls which will be mechanically more durable and positive.

0-6-47. (2-14-2). The mechanical construction of the "Oscillator Tuning" control should be improved to permit this control to be moved smoothly both clockwise and counter-clockwise with a minimum amount of backlash.

0-6-48. (2-14-3). It is recommended that the "Output Coupling" and "Output Matching" control dials of the transmitter unit be calibrated only to the useful limits of their motion.

0-6-49. (2-4-1). A method should be provided to prevent the "Output Coupling" tuning-control-cable pulley from vibrating excessively.

0-6-50. (2-5-1d). One of the oscillator tubes in the transmitter unit developed a broken plate seal as a result of shock.

0-6-51. KEYING MONITOR. (1-9-1). The keying monitor design should be modified so that the tubes can be more easily replaced.

0-6-52. (2-15-6). The transmitter unit chassis should be provided with guides for the keying monitor chassis.

0-6-53. (2-15-7). The keying monitor connector-plug board located in the tuning compartment of the transmitter should be moved 1/4 inch toward the front of the transmitter.

0-6-54. (2-15-8). The round-head screws which interfere with the keying monitor when it is being inserted into the transmitter unit should be replaced by countersunk flat-head screws.

0-6-55. ALIGNMENT SECTION. (2-19). The results of tests made on the alignment section, which connects the transmitter unit to the transmission line, indicate that it is subject to too rapid wear to be suitable for the Naval Service in its present form. It is recommended that steps be taken to reduce the wear on the moving parts and provide positive contact between its various elements.

0-6-56. DUPLEXER. (1-10-1 to 1-10-7). Several serious defects were noted in the duplexer which was supplied for the systems test. Most of these defects were corrected in the revised model of the duplexer, tests on which are given in Par. 1-13 to 1-13-3. The design

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of the tuning capacitors in the revised model of the duplexer should be improved; the very close spacing and critical alignment of these capacitors are regarded as a very likely source of trouble.

O-6-57. (1-12-3). The cable connector in the line from the duplexer to the receiver is unsatisfactory. A method must be found which permits secure clamping to the cable shield without causing a short-circuit to the inner conductor and which prevents the cable from making a sharp bend just as it leaves the connector.

O-6-58. RECEIVER-INDICATOR UNIT. (1-6-2). Comparison with the XAR-2 system shows that the SC-1 receiver does not give the desired performance.

O-6-59. (1-12-2). The design of the socket for the first detector tube in the receiver is unsatisfactory. The clips easily get out of line and it is difficult to insert the tube.

O-6-60. (3-10-1(a)). The dials provided with locks should be so arranged or constructed that the lock knobs do not interfere with dial operation.

O-6-61. (3-10-1(b)). The most frequently used controls should be grouped together.

O-6-62. (3-10-1(c)). The Receiver-Calibrate "CC" and Dial Light "DD" control should be moved away from the often used cathode-ray tube controls.

O-6-63. (3-10-1(d)). All dial knobs should possess two set screws.

O-6-64. (3-10-1(e)). Different shaped knobs should be used on the calibration dials than on the most frequently used controls.

O-6-65. (3-10-2). A long insulated screw driver should be supplied with the spare parts if the present method of adjustment of the range calibration resistors is not to be altered.

O-6-66. (3-10-3). A Navy-approved type of potentiometer should be furnished to provide dependable gain control.

O-6-67. (3-10-6). All brass gears should be treated to improve their corrosion resistance.

O-6-68. (3-11-1). Inasmuch as the voltages of the type 6J5 marker tubes are unusual, operational reports from units in service might be studied to determine whether this practice results in the required reliability.

O-6-69. (3-11-2). The loctal tubes and sockets should be replaced by types approved by the Bureau.

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0-6-70. (3-11-2). Spare acorn sockets should be furnished with more dependable by-pass condensers.

0-6-71. (3-11-3). Tube clamps should be provided where practicable.

0-6-72. (3-11-4). Tube sockets should be identified on both sides of the chassis and no designations should be obscured by other components or fittings.

0-6-73. (3-13-2). Color coding and tracers should be used more extensively.

0-6-74. (3-13-3). No switch shafts should be used as cabling supports.

0-6-75. (3-13-4). The internal tooth type terminal lugs should be replaced with a more permanently useful type.

0-6-76. (3-13-4). The paper terminal markers should be replaced by a more durable kind. They should be used on the rear as well as the side terminal board.

0-6-77. (3-14-1). An interlock should be provided to operate with the indicator unit in addition to the one provided with the receiver unit.

0-6-78. (3-14-2). The pilot lamp should be so mounted as not to require adhesive material to assure reliable operation.

0-6-79. (3-15-1). Holes should be provided in the base of the shock mount plate to facilitate the removal of the three screws on the under side of the receiver chassis.

0-6-80. (3-15-3). A clamp should be provided to hold the 164 Kc crystal more securely to insure good contact under all operating conditions.

0-6-81. (3-15-4). All internal-tooth lock washers should be replaced by Navy-approved split-ring lock washers. See Par. 0-7-4.

0-6-82. (3-15-7). The heads on the captive thumb screws on the cathode-ray tube bezel should be larger in diameter and wider.

0-6-83. (3-15-8). The transformer plate at the rear of the chassis should be made independent of bowing pressure for support.

0-6-84. (3-17-2). A complete, distinct, and permanent component marking system should be adhered to.

0-6-85. (3-18-1). All condensers and heavy iron core chokes

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should be potted.

0-6-86. (3-18-2). The tank coils L703 and L704 should be wax coated.

0-6-87. (3-18-3). All condensers and resistors should be wax dipped.

0-6-88. (3-18-4). No condenser or resistor leads should be bent or soldered close enough to their shells to endanger their seals.

0-6-89. (3-18-5). No side plates should be secured by wedging.

0-6-90. (3-18-6). No useless parts should be included.

0-6-91. (3-18-7). All permanent parts requiring firm support should be bolted to the chassis rather than being temporarily clamped.

0-6-92. (3-18-8). Soldering technique and procedures should be improved to avoid burning of insulation on wires.

0-6-93. (3-18-9). The intermediate-frequency coil assemblies should be designed to prevent the possibility of the trimming slug contacting the transformer windings under any service conditions.

0-6-94. (3-27-35). Each mica condenser in the subject equipment should be considered with respect to replacement by other types. The recommendation is submitted in view of the current mica shortage.

0-6-95. Most of these defects and failures have already been called to the attention of representatives of the Bureau of Ships and of the General Electric Company. In many cases remedial action has already been taken.

0-7. GENERAL COMMENTS AND CORRECTIONS. There are a few conflicting recommendations and some which have been superseded by decisions in more recent conferences. These are as follows:

0-7-1. In Par. 2-5-1b and 2-26-6 it is recommended that the grid connectors be improved to grip the prong more firmly. This is correct, but it must be added that the connector must not be too tight or tubes will be broken when the connectors are put on the tube. See Par. 0-6-39 and 1-8-2.

0-7-2. In Par. 2-15-2 and 2-22-19 it is recommended that the transmitter unit be provided with lifting eyes to facilitate hoisting. It was decided in a conference, at which representative of the Bureau of Ships and the General Electric Company were present, that such lifting eyes need not be supplied on the SC-1 equipments.

0-7-3. In Par. 2-5-1c it is recommended that the overload relay in the transmitter be adjusted to cause removal of the plate voltage

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whenever the plate current rises to 1.5 times its normal value. This is desirable, but if the relay were adjusted to this value there would be frequent throw-outs and the equipment would be impossible to start unless extensive circuit changes were to be made. Consequently, the recommendation in Par. 0-6-26 and 1-8-11 is given. (It is understood that the SC-2 overload relay circuit has been so designed that it will pass the high starting current and still give good protection to the oscillator circuit once it has started to oscillate.)

0-7-4. In Par. 0-6-81 and 3-15-4 it is recommended that all internal-tooth lockwashers be replaced by Navy-approved split-ring lockwashers. This is true in general, but at a conference attended by representatives of both the Bureau of Ships and the General Electric Company, the General Electric Company was permitted to use internal-tooth lockwashers for flat-head screws in blind holes in lieu of staking the heads of such screws.

0-7-5. The last sentence in Par. 2-3-3 is incorrect and should be deleted.

0-7-6. With regard to the comments on the receiver, it is to be noted that the receiver covered by these tests will soon be replaced by a completely new receiver.

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SECTION I

SYSTEMS TEST OF MODEL SC-1 RADAR EQUIPMENT

1-1. INTRODUCTION. Model SC-1 Radar equipment, serial No. 7, was received at NRL for systems test on 4 May 1942 on Bureau of Ships problem X75S. It was set up and operated as a system at the Chesapeake Bay Annex from 4 May to 13 May 1942. Further electrical tests on the transmitter were made at Bellevue from 14 May to 13 June 1942. Electrical tests were also made on the antenna, on the Keying Monitor which arrived on 9 July 1942, and on an improved duplexer which arrived on 10 August 1942. In addition to the tests outlined in Section I of this report, further detailed electrical and mechanical tests of the components are covered in Section II and Section III of this report. Subsequently the equipment was turned over to the Radio Materiel School at NRL for instructional use.

1-2. TABLE OF CONTENTS FOR SECTION I.

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1-3. DESCRIPTION OF EQUIPMENT. The SC-1 Radar equipment is a high-power general-purpose search Radar for shipboard installation on destroyers and larger craft. The equipment is intended for use in long-range aircraft detection, moderate-range surface-craft detection, detection of land and other objects for navigational purposes, and to furnish sufficiently accurate range and bearing data to put fire-control Radar on a target. The transmitter pulse power output is over 150 Kw with a 3 to 5 microsecond pulse, a repetition rate of 60 per second, and a frequency range from 175 to 225 mc. A single antenna is used for both transmitting and receiving. Each antenna and duplexer is

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designed to cover a band of ± 5 mc. There are four such bands: Red (175 to 185 mc), Green (185 to 195 mc), Yellow (195 to 205 mc), and Blue (215 to 225mc). The antenna and duplexer furnished with this equipment were for the yellow band from 195 to 205 mc. Three range scales are provided on the indicator, the maximum ranges being 15, 75, and 375 nautical miles respectively. The bearing indicator gives both relative and true bearing. Plate 1 of Section I shows the installation at the Chesapeake Bay Annex. Plates 1 to 30 of Section II and Plates 1 to 10 of Section III are photographs of the various components of the SC-1 system.

1-4. INSTALLATION. The equipment was installed at the Chesapeake Bay Annex according to the Installation Instruction Book and the equipment operated satisfactorily. Neither the SC-1 Instruction Book nor the circuit diagram was available for these tests.

1-5. OBSERVATIONS ON MISCELLANEOUS TARGETS. Random observations were made on various fixed and moving targets. For example, an echo from an aeroplane was observed at a range of 54 miles and an echo was observed from a target raft at 800 yards. However, no quantitative controlled tests were made to determine maximum or minimum ranges obtainable with this equipment.

1-6. COMPARISON TESTS. Most of the systems tests at the Chesapeake Bay Annex were made by comparing the SC-1 performance with that of the XAR-2 using echoes from fixed landscape objects at 7 to 20 mile ranges, taking echo signal-to-noise ratio estimates as the criterion of comparison. In most cases the SC-1 design followed the NRL designs which were incorporated in the XAR-2; both equipments operated on the same frequency band and the XAR-2 used an SC antenna. Because of the similarities, it was to be expected that both equipments would give comparable performances. However, the echoes observed on the SC-1 equipment were considerably poorer than those observed on the XAR-2. The following comparison and interchange tests were made to find the cause for this difference in performance.

1-6-1. EFFECT OF DUPLEXER GAPS. Two spark gaps in parallel were provided in the duplexer protector tank. It was observed that only one operated at any one time. One of the gaps was removed and this had no observable adverse effect on either the performance of the equipment or the receiver protection. The protector and decoupler spark gaps furnished with the SC-1 equipment were the GL-471 butt-type gaps. The performance of the equipment became poorer after only a couple of hours' use and there was a considerable improvement in performance when new GL-471 gaps were put into the duplexer. These gaps were replaced by WL-532 enclosed-type coaxial gaps which are similar to the GL-471A gaps. The use of WL-532 gaps resulted in a slight improvement in performance as compared to new GL-471 gaps and a very marked improvement as compared to GL-471 gaps which had been used a few hours. The

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WL-532 gaps were replaced by open-air spark gaps and this resulted in a small further improvement in performance; the performance, however, was still considerably inferior to that of the XAR-2 system.

1-6-2. RECEIVER INTERCHANGE. When the XAR-2 receiver was used with the SC-1 transmitter, antenna and duplexer (using WL-532 gaps), the performance was almost as good as that of the XAR-2 system. Using the SC-1 receiver with the XAR-2 transmitter, antenna, and duplexer, the performance was only slightly better than with the complete SC-1 system, but considerably inferior to that of the complete XAR-2 system. It is to be noted that both the SC-1 and the XAR-2 receiver used "acorn" tubes in the receiver input stage. These tests showed that the overall transmitter-antenna-duplexer systems of the XAR-2 and of the SC-1 were almost equivalent. They also showed that the SC-1 receiver was definitely inferior to the XAR-2 receiver; this conclusion was corroborated by subsequent receiver tests which are given in Section III of this report.

1-7. TRANSMITTER POWER OUTPUT. Power output and other electrical measurements were made on the transmitting oscillator using a water-cooled load resistor which was fed through a 1.5" 50 ohm concentric transmission line. Along a part of the line, the outer conductor was slotted to permit measurements of the standing-wave ratio on the line. The standing-wave ratio could be varied at will by adjusting a reactive stub connected to the line near the load. The lead normally used to supply a synchronizing pulse to the indicator was connected to an external keying monitor. A Duty Cyclometer was used to measure the pulse length. The transmitter pulse power output was calculated from the ratio of the average power in the water-cooled load and the duty cycle. Servil sweep observations of the pulse shape indicated that the pulse was sufficiently rectangular to give accurate pulse power readings by this method. An external voltmeter was connected across the plate supply to give the plate voltage. Unless otherwise stated, the load stub was adjusted to give a standing-wave ratio of unity ("flat line"), the plate voltage was 15 Kv and the filament voltage 10.5 volts (110.0 volts on the "filament voltmeter").

1-7-1. PULSE POWER OUTPUT VS. PLATE VOLTAGE. Measurements of pulse power output at various plate voltages were made with the recommended filament voltage of 10.5 volts. The yellow-band grid coils were used and the transmitter adjusted for maximum power output at a frequency of 200 mc. The results are given on Table 1, Section I. The pulse power output was 191 Kw at 15 Kv.

1-7-2. PULSE POWER OUTPUT VS. FILAMENT VOLTAGE. Measurements of pulse power output at a plate voltage of 15 Kv were also made with a filament voltage of 11.0 volts. The power output was 238 Kw at 200 mc. This is 25% greater than the pulse power output obtained with the recommended filament voltage of 10.5 volts.

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1-7-3. MAXIMUM PULSE POWER OUTPUT OF TRANSMITTER. Measurements were made with a plate voltage of 18 Kv and a filament voltage of 11.5 volts using an external step-up transformer in the plate transformer primary circuit. A pulse power output of 360 Kw was obtained. The oscillator will operate at these high voltages without circuit flash-over only when it is fully loaded. Although the SC-1 transmitter should never be operated at such high voltages, the fact that it can be operated at these voltages and give such a large pulse power output indicates that the normal operation level of 15 Kv on the plates, 10.5 volts on the filament, and a pulse power output of 150 to 200 Kw is conservative.

1-7-4. PULSE POWER OUTPUT VS. FREQUENCY. Measurements were made of the power output at each end and at the middle of each of the four 10 Mc frequency bands. The oscillator output coupling and output matching controls were readjusted to give the maximum pulse power output for each setting of the main oscillator tuning dial. The pulse power output was somewhat down at the lower end of the red (175 to 185 mc) band, relatively uniform over the yellow (195-205 mc) band, and somewhat down at the higher end of the blue (205-215 mc) band. In all cases, however, the pulse power output was at least 156 Kw, and over 190 Kw for the yellow band. In all cases, the oscillator could be tuned to the required upper and lower frequency limits of each band.

1-7-5. PULSE POWER OUTPUT INTO REACTIVE LOADS. Pulse power measurements were made at the mid-frequency of each of the four bands using reactive loads. The load termination of the transmission line was varied from a pure resistance of 50 ohms, giving a standing-wave ratio of 1:1, to partially reactive impedances, both inductive and capacitive, giving standing wave ratios as high as 2:1. This range of load impedances is larger than would usually be encountered in actual service. On each of the four bands the maximum variation in pulse power output over this range of load impedance was less than 16% and in all cases the pulse power output was over 159 Kw. These tests indicate that the transmitter output is quite satisfactory even if the standing-wave ratio on the line to the antenna is as high as 2:1. It was, however, observed that the tendency for spark-over in the oscillator was increased and it was sometimes difficult to operate the oscillator at a plate voltage of 15 Kw when the standing-wave ratio was 2:1.

1-7-6. PULSE LENGTH. The transmitter is provided with a two-position front-panel switch for selecting either a short or long pulse; when changing from one pulse length to the other it is necessary to readjust the oscillator grid resistance to keep a 60 cycle repetition rate. When the switch is in the "High" position the measured pulse length varies from 2.5 to 5 microseconds. This variation in pulse length occurs with variations of transmitter loading,

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plate voltage, and filament voltage; the pulse length tends to become shorter as the pulse power output increases. When the switch is in the "Low" position, the pulse length is about 2/3 as long as when the switch is in the "High" position under the same voltage and loading conditions. The pulse power output is the same for both "High" and "Low" positions.

1-7-7. BAND-WIDTH OF TRANSMITTED PULSE. The band-width of the transmitted pulse was measured using a Hallicrafter NS-27C receiver whose audio output was observed on an oscilloscope with a 60 cycle linear sweep. The band-width was taken from the variation in receiver tuning required to tune from half maximum amplitude indications (6 db below maximum) on one side of the maximum to half-amplitude indication on the other side of the maximum. The average band-width of the transmitted pulse, measured in this manner, was 280 Kc for a 3 to 5 microsecond pulse; no correction was made for the receiver i.f. pass band which was 160 Kc. The theoretical band-width of the signal, assuming no frequency modulation, is a function of the pulse length and agrees approximately with the measured uncorrected band-width of 280 Kc. It therefore appears that the frequency modulation of the transmitter is negligible.

1-7-8. COMPARISON OF SC-1 AND XAR-2 TRANSMITTERS. When the foregoing measurements are compared with similar measurements on the XAR-2 transmitter, it is seen that the pulse power outputs, coupling characteristics, band-width of transmitted pulse, etc. are essentially the same for the two transmitters, indicating that the XAR-2 oscillator is successfully duplicated in the SC-1 equipment.

1-7-9. X-RAY RADIATION FROM TRANSMITTER. Measurements were made of the X-Ray radiation from the transmitter. At the point of maximum intensity, just opposite the oscillator tube compartment on the side of the transmitter, the X-Ray radiation was 0.042 Roentgens per 8 hour day 5" from the transmitter with a plate voltage of 13.5 Kv. Although this approaches a figure that is not considered safe, under normal operating conditions the operating personnel should not be exposed to excessive X-Ray radiation.

1-8. TRANSMITTER DEFECTS. During the system and power tests of the transmitter, the following observations and defects were noted:

1-8-1. REMOVAL OF OSCILLATOR TUBES. It was found that the tubes can be removed from the oscillator circuit through the front access door of the cabinet, and replaced in the same way, without removing the side or back panels. The entire procedure of making a complete change of oscillator tubes (4 tubes) required about eight minutes and was moderately difficult. Considerable care is required to prevent breakage of tubes and of the grid coil center-support tabs. It was found that the plate-pin set screws must not be tightened, when the

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tubes are being inserted, until after the grid coils are in position; also, in removing the tubes, the plate pin set-screws must be loosened before the grid coils are removed. If these precautions are not observed, breakage of the tube plate seal is likely to occur.

1-8-2. GRID CONNECTORS. On one of the blue band grid coils, the grid connectors were much too tight a fit and could not be put on the tube-pins without grave danger of glass breakage due to the excessive pressure required. The connectors on the other coils were a much looser fit. The one which was too tight was made looser by prying the fingers open slightly, using a thin-bladed screw-driver. However, in later tests described in Par. 2-5-16, it was noted that one of the grid connectors was too loose to stay on when the equipment was shock tested. Careful factory inspection will be necessary to insure that these connectors are neither too tight nor too loose. An improved design is desirable.

1-8-3. FILAMENT CONNECTORS. Considerable trouble was experienced with faulty connections between the filament connectors and the filament pins on the oscillator tubes. In some cases there was a complete open circuit. Inspection showed that the connectors were made from beryllium-copper, but they did not appear to be properly heat treated for the best spring properties. More care should be taken in the heat treatment and in inspecting the connectors. The circular spring around the top of the connector should be made heavier in order to provide a more positive spring action. An improved design is desirable.

1-8-4. FILAMENT BYPASS CAPACITORS. One of the bypass capacitors, which are a part of the oscillator filament socket assembly, was dismantled. The edges of the holes through the brass plates were sharp and a potential source of sparking. A blackened spot on the mica indicated that sparking had occurred from one of these edges. The edges of these holes should be slightly beveled and polished off. The insulation which was used in this capacitor appeared to be a poor-quality built-up mica plate. It is recommended that a high grade of clear mica be used.

1-8-5. FILAMENT TUNING VANE. Sparking was observed in the oscillator between the plate on the filament capacitor and the filament tuning vane. This vane was only 1/4" thick. It is recommended that a 3/8" vane be used and that the edge be rounded off and polished.

1-8-6. STUB LINE EXTENSION. When grid coils are changed to change the frequency range of the oscillator, it is also necessary to change the total length of the output matching stub; this is done by inserting a short color-coded section of inner and outer conductor in this line, the inserted pieces having been cut to the correct length for the range covered by the corresponding set of grid coils. The inner conductors of the inserted sections are held in place by set-screws which must be tightened through screw-driver access holes

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in the outer conductor sections. It was found that these access holes were not spaced the correct distance from the ends of the conductor sections on the blue-, green-, and yellow-coded inserts. It was necessary to enlarge the holes to allow tightening the above-mentioned set-screws. The red-coded piece had holes properly positioned with the hole centers 5/8" from ends. The hole-center-to-end spacing on the blue, green, and yellow pieces was 3/4"; although the set screw could be tightened somewhat through the holes, it was necessary to insert the screw driver at such an angle that the inner conductor could not be dependably secured. The yellow-coded pieces, when removed after the tests were made on this band, were found to have burnt spots caused by arcing. The inner conductor was not centered inside the outer conductor, and the burnt spots were at points where the conductor spacing was too close due to this eccentricity, which was in turn due to insufficient tightening of the set-screws. It is recommended that the screw-driver access holes be properly spaced on the blue-, green-, and yellow-coded inserts in the outer conductor extensions for the stub line.

1-8-7. STUB-LINE SHORTING BAR. It was observed that the transmitter output sometimes fluttered when the Output Matching control was adjusted; apparently the shorting bar in the output matching stub line was not always making a good contact. A sample of the shorting bar was inspected and it was found to be made from brass, being turned from a solid cylinder of metal. The fingers making contact with the inner conductor were very thin and had practically no springiness; these fingers would not make a satisfactory contact once they had been bent out slightly. To a lesser degree, the same is also true of the fingers making contact with the outer conductor. This shorting bar should be made from beryllium-copper or the design changed so that the shorting bar will always make a satisfactory contact with both inner and outer conductors.

1-8-8. R.F. OUTPUT LINE. Sparking was observed where the 1.5" coaxial transmission line passes through the top of the transmitter cabinet. The transmitter top cover should be securely fastened and bonded to the piece under the cover which supports the transmission line at the point of exit.

1-8-9. BRONZE DIAL CABLES. Under some conditions of oscillator adjustment, severe corona was observed from one of the bronze dial cables running to the output coupling bar, presumably due to resonance of the cable at the frequency of oscillation. This corona could be avoided by changing the tuning of the oscillator, principally by changing either the frequency or the position of the coupling bar, without any serious loss in pulse power output. However, suitable means should be provided to prevent this corona at any tuning adjustment.

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1-8-10. GRID CURRENT METER. On one occasion when the transmitter oscillator was accidentally so adjusted that "30 cycle" keying occurred, tiny sparks were noticed in the movement of the grid current meter. These were observed through the glass front of the meter and were occurring in the space between the meter coil and the magnet poles. This meter is provided with a mica by-pass condenser, but is not shielded. The General Electric Co. engineers report that this sparking was not caused by r.f. voltage, but by keying transients, and that the trouble has been corrected in the production equipments.

1-8-11. OVERLOAD RELAY. The starting current often trips the overload relay. When the oscillator is adjusted for maximum output, it is often necessary to detune the oscillator before it can be started without tripping the overload relay. It is desirable that this circuit be improved so that it will give good protection to the oscillator and still pass the high starting current. Until such an improvement has been worked out, it is recommended that the overload relay be set to trip at 100 to 150 ma.

1-8-12. FILAMENT VOLTMETER. The "filament voltmeter" for the transmitter oscillator gives the input voltage to the filament transformer, and does not give the actual filament voltage. The relation between filament voltage and "filament voltmeter" reading is given in Table 2, Section I. The actual filament voltage for a given reading on the "filament voltmeter" depends on variations in transformers and on the regulation of the transformer. Since there is a considerable variation in the filament current from tube to tube, and with the same tube as the tube ages, the transformer regulation is not an insignificant factor. Therefore, it is recommended that a filament voltmeter be used which actually measures the filament voltage and which is connected at the terminal board near the filament tuning frame.

1-9. KEYING MONITOR. The SC-1 Keying Monitor was not received until after the rest of the tests had been completed. It was given preliminary inspection and test on July 10, 1942. The unit is satisfactory electrically in that the trace appearing on the oscilloscope screen is of proper brilliance and sharpness, and of correct form. The focus, intensity, and centering controls function properly. The unit provides visual monitoring of the pulsing action of the transmitter, notifying the operator immediately if irregular keying occurs. It also gives an indication of the oscillator peak plate current.

1-9-1. REPLACEMENT OF TUBES. Several mechanical design features which are unsatisfactory were noted. On the keying indicator unit itself, it is necessary to remove 20 machine screws in order to gain access to the tubes. Some of the screws will not screw in all the way, the holes on cover at right of 5U4-G rectifier tube being placed too close to an inside corner bend in the metal. The design should

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be modified so that it will be possible to more easily replace tubes. Other undesirable conditions involving the insertion of the unit into the transmitter cabinet are discussed in Section II of this report, paragraphs 2-15-6, 2-15-7, and 2-15-8.

1-10. DUPLEXER. The following observations and defects were noted on the duplexer which was furnished with the SC-1 system.

1-10-1. DUPLEXER CAPACITORS. The tuning capacitors in both the protector and decoupler tanks are of the concentric cylinder type with very close spacing between the inner and outer cylinders. There was a largeramount of side-play or wobble in the tuning shaft supporting the inner cylinder than there was spacing between the cylinders. As a result of this, the condensers short-circuited at times, or so nearly touched that arc-over across the condenser electrodes occurred at a lower voltage than did break-down of the gap tubes. The tendency to spark over was aggravated by the sharp edge on the cylindrical capacitor slug. Sparking sometimes occurred intermittently, resulting in intermittent operation of the gap tube, and in as much as a 5:1 fluttering of the echo signals. More care should be observed in machining these capacitors and the sharp edges should be rounded off. The thread on the adjusting screw is rather coarse, about 1/4 x 20. This bears on a threaded washer only 1/8" thick, while there is about 1/2" of available bearing surface that is not tapped. A finer thread should be used and the piece through which the screw passes should be modified so that there is a longer threaded surface bearing on the screw.

1-10-2. SPARK GAPS. It has already been noted in Par. 1-6-1 that the best performance was observed when open-air gaps were used in the protector and decoupler tanks. It is recommended that open-air gaps be used. These gaps should be so constructed that they can be used interchangeably with the GL-471 gaps. The gap itself should have flat tungsten faces about 1/8" in diameter. Provision should be made so that the gap spacing can be readily adjusted.

1-10-3. PARALLEL GAPS. It was noted in Par. 1-6-1 that the use of parallel gaps in the protector tank did not improve the performance of the equipment or the receiver protection. It is recommended that only one gap be used in the protector tank. The second gap should be replaced by a support insulator, the ends of which are suitably threaded and shaped so that it will replace a GL-471 gap. As a temporary expedient, an evacuated GL-471 gap could be used for this support insulator.

1-10-4. SUPPORT IN DECOUPLER TANK. If the open-air spark gap is used, it will be necessary to place insulators in the decoupler tank to prevent vibration of the inner conductor.

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1-10-5. POOR CONTACTS. There was a poor contact between the inner conductor of the protector tank and one of the end plates. The actual connection was from the inner conductor through the screw to the outside of the end plate. This was indicated by severe sparking between the screw head and its lock-washer to the end plate. The screw was not loose, but there were signs of corrosion on the screw threads. Since it was difficult to disassemble the tank, the cause was not determined, but this poor contact was probably the result of an inner conductor which was too short to seat against the end plates at both ends and of some corrosion which made the contact even worse. It is essential that the inner conductor make a good contact with the inside of both end plates.

1-10-6. SILVER PLATING. Only some of the protector and decoupler tank parts were silver plated. The inside surface of the outer conductors was not plated, but this probably does not adversely affect the performance. However, the spark-gap mounting plates and the plates holding the duplexer tuning capacitors should be plated. Since the duplexer parts had not been properly cleaned after fabrication, the surfaces which were not plated were corroded. All parts should be properly cleaned after fabrication.

1-10-7. CABLE RECEPTACLE CONNECTION. Some difficulty was experienced with the connection between the Receiver Cable receptacle on the protector tank and the inner conductor. A slight jiggling of the receptacle caused erratic fluctuations of the observed echoes. It was found that the receptacle was not in line with the slotted stub connection to the inner conductor. The fingers on this stub had to be spread excessively to permit insertion of the receptacle and even then the resulting contact was not satisfactory. The design should be improved to insure proper connection between the receptacle and the inner conductor.

1-10-8. Many of the above defects were corrected in the revised model of the duplexer. The results of tests on this unit are given in Par. 1-13.

1-11. ANTENNA. The following tests were made on the antenna:

1-11-1. TWO-BAZOOKA FEED SYSTEM. Tests were made to determine if the two-bazooka feed system would introduce additional beam deflection with frequency change or sharpen the match characteristics.

(a) In the frequency range from 188 mc to 205 mc the beam shifts about one degree in bearing. This is satisfactory since the accuracy of bearing setting is approximately 4 or 5 degrees.

(b) The band-width of the antenna for an introduction of 2:1 standing waves in the coaxial feed is 20 mc centered at 200 mc. This is satisfactory.

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1-11-2. ANTENNA PATTERN. The antenna pattern for the SC-1 antenna is given in Plate 2, Section I. It is to be noted that no extraneous lobes over 4% of the amplitude of the main lobe were observed. This is satisfactory.

1-11-3. ROTATING JOINT. Although the rotating joint in the SC-1 antenna pedestal gave no trouble during the systems tests, other tests were made on a sample of the inner-conductor rotating joint. After 150,000 rotations there were marked evidences of cutting and the resistance was as high as 0.5 ohms. If the contact fingers were to be sprung in enough to give a good contact, the cutting would be excessive. The design of the inner conductor of this rotating joint is unsatisfactory.

1-12. RECEIVER-INDICATOR. The following defects and failures in the Receiver-Indicator unit were observed during the systems tests.

1-12-1. A defective 7E6 tube was found in the i.f. amplifier. This tube was replaced and operation was satisfactory.

1-12-2. The first detector socket clips were badly out of line with the pins of the 954 tube. It was very difficult to insert the tube in the socket even after the clips had been bent into position. The design of this socket should be improved.

1-12-3. CABLE CONNECTOR. The cable from the duplexer to the receiver developed a short circuit between the inner conductor and the shield at the point where it was clamped to the cable connector. This occurred at least seven times during the tests and each time a short piece of the cable was cut off and the cable re-connected to the connector. The present connector is unsatisfactory when used with the PT-5 cable. A method must be found which permits secure clamping to the cable shield without causing a short-circuit to the inner conductor; this could probably be accomplished by placing a metal ring under the shield braid and clamping the shield between this ring and the connector clamp. It is also necessary that means be found to prevent the cable from making a sharp bend as it leaves the connector; it is possible that a "flat-iron" type of spring would be suitable.

1-13. REVISED DUPLEXING SYSTEM. On 10 August 1942, a revised duplexing system, using open-air gaps, was received for test. Since the rest of the SC-1 systems tests had been completed, this duplexer was not tested on the system. Measurements of power loss, i.e. system insertion loss, were made for both transmitting and receiving conditions. The method of measurement consisted of coupling the input of the duplexer to a test oscillator by means of tuned loops and the output of the duplexer to a vacuum tube voltmeter by means of similar loops. Coupling was adjusted for maximum power

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transfer. Readings thus obtained were compared with direct coupling between the generator and the voltmeter.

1-13-1. TRANSMITTING LOSSES. The spark gaps were short circuited for this measurement. This gives somewhat lower losses than would actually be obtained, but the difference is negligibly small. The loss figure obtained was -0.25 db. This is appreciably higher than has been obtained with comparable duplexers constructed at this laboratory, but is regarded as adequately low when open-air spark gaps are used.

1-13-2. RECEIVING LOSSES. The end of the transmission line normally going to the transmitter was terminated in a short circuit approximately a quarter wave length from the decoupler junction, this representing the worst possible case. The loss figure obtained was -0.81 db. This is satisfactory. The loss in the protector tank alone was measured as -0.26 db which is very nearly the same as with the NRL prototype.

1-13-3. MECHANICAL CONSTRUCTION. The mechanical design and construction is adjudged very good with the exception of the concentric tuning condensers. The very close spacing and critical alignment of these condensers are regarded as a very likely source of trouble even though an adequate bearing has been provided for the movable element.

1-13-4. This revised duplexer is considered to be satisfactory for use with the SC-1 equipment and is an improvement over the original duplexer furnished with the SC-1 system; the design of the tuning capacitors, however, should be improved.

1-14. SUMMARY OF DEFECTS AND RECOMMENDATIONS. A summary of the defects and failures noted during tests covered in Section I, together with the recommendations for corrective action is listed below. The numerals in parentheses refer to the paragraph of Section I of this report under which these items are discussed in detail. These defects are listed in the order in which they appear in the main body of the report and are not in the order of their importance.

1-14-1. (1-6-2) Comparison with the XAR-2 system shows that the SC-1 receiver does not give the desired performance.

1-14-2. (1-8-2) Careful factory inspection is necessary to insure that the oscillator grid connectors have neither too tight nor too loose a fit on the tube pins. An improved design is desirable.

1-14-3. (1-8-3) The oscillator filament connectors should be properly heat treated to insure the proper spring properties. They should be carefully inspected to insure a proper fit on the filament

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terminals. The circular spring should be made heavier. An improved design is desirable.

1-14-4. (1-8-4) The edges of the holes through the filament by-pass capacitor plates should be rounded off. A high grade of clear mica should be used.

1-14-5. (1-8-5) The oscillator filament tuning vane should have an edge at least 3/8" thick and this edge should be carefully rounded off and polished.

1-14-6. (1-8-6) The screw-driver access holes on the blue-, green-, and yellow-coded stub-line extension inserts should be properly spaced so that the set screws on the inner conductor can be properly tightened.

1-14-7. (1-8-7) The stub-line shorting bar should be made from beryllium-copper so that it will always make a good contact with both the inner and outer conductors.

1-14-8. (1-8-8) The top cover of the transmitter should be securely fastened and bonded to the piece which supports the transmission line where it leaves the cabinet.

1-14-9. (1-8-9) Suitable means should be used to prevent corona from the bronze dial cables which are used to adjust the output coupling of the oscillator.

1-14-10. (1-8-10) Sparking was sometimes observed in the transmitter grid-current meter.

1-14-11. (1-8-11) The transmitter overload relay circuit should be improved so that it will give good protection to the oscillator and still pass the high starting current. Until such an improvement has been worked out, it is recommended that the overload relay be set to trip at 100 to 150 ma.

1-14-12. (1-8-12) An oscillator filament voltmeter should be used which measures the actual filament voltage instead of the input voltage to the filament transformer.

1-14-13. (1-9-1) The keying monitor design should be modified so that the tubes can be more easily replaced.

1-14-14. (1-10-1 to 1-10-7) Several serious defects were noted in the duplexer which was supplied for the systems test. These defects were mostly corrected in the revised model of the duplexer, tests on which are given in Par. 1-13 to 1-13-3. The design of the tuning capacitors in the revised model of the duplexer should be

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improved; the very close spacing and critical alignment of these capacitors are regarded as a very likely source of trouble.

1-14-15. (1-11-3) The design of the inner conductor of the antenna rotating joint is unsatisfactory.

1-14-16. (1-12-2) The design of the socket for the first detector tube in the receiver is unsatisfactory. The clips easily get out of line and it is difficult to insert the tube.

1-14-17. (1-12-3) The cable connector in the line from the duplexer to the receiver is unsatisfactory. A method must be found which permits secure clamping to the cable shield without causing a short-circuit to the inner conductor and which prevents the cable from making a sharp bend just as it leaves the connector.

1-14-18. These defects and failures have already been called to the attention of representatives of the Bureau of Ships and of the General Electric Company. In many cases remedial action has already been taken.

1-15. CONCLUSIONS. The tests and observations given in Section I of this report lead to the following conclusions:

1-15-1. Comparative tests with the XAR-2 indicate that the overall performance of the SC-1 transmitter, antenna, and duplexer system is satisfactory, but that the SC-1 receiver performance is poorer than it should be for a receiver of this type.

1-15-2. Tests on the SC-1 transmitter indicate that it has satisfactory tuning properties and a pulse power output of over 156 Kw over the entire frequency range under a wide range of loading conditions.

1-15-3. The SC-1 radar system is a marked improvement over the SC system in many respects. The SC-1 equipment is easier to tune, is less likely to cause r.f. interference, and has a larger pulse power output. The SC-1 equipment should observe objects at consistently greater ranges and the improvement should be very marked on the red band. Some of the SC defects have been eliminated and the SC-1 equipment should have less maintenance troubles.

1-15-4. There are still a number of defects in the SC-1 equipment. The failures which were observed during the systems test indicate that the SC-1 performance might not be as reliable as is desired. Careful attention to correcting these defects should decrease maintenance difficulties and result in more consistent operation under adverse circumstances.

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1-15-5. With a good receiver, or with a light-house tube preamplifier for the present receiver, the SC-1 system appears to be capable of equalling the performance of the best of the 200 mc Radar systems which are in use at the present time.

Submitted:

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Associate Engineer

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TABLE 1 -- SECTION I

PULSE POWER OUTPUT WITH PLATE VOLTAGE VARIATION

Frequency -- 200 mc
Filament voltage -- 10.5 volts
"Flat line" loading conditions

Plate Voltage in Kv	Pulse Power Output in Kw
10	105
11	127
12	139
13	162
14	172
15	191

TABLE 2 -- SECTION I

CALIBRATION OF FILAMENT VOLTMETER

Voltmeter Reading	Actual Voltage at Oscillator Tube Filament Terminals
104.5	10.0
110.0	10.5
114.5	11.0
120.5	11.5

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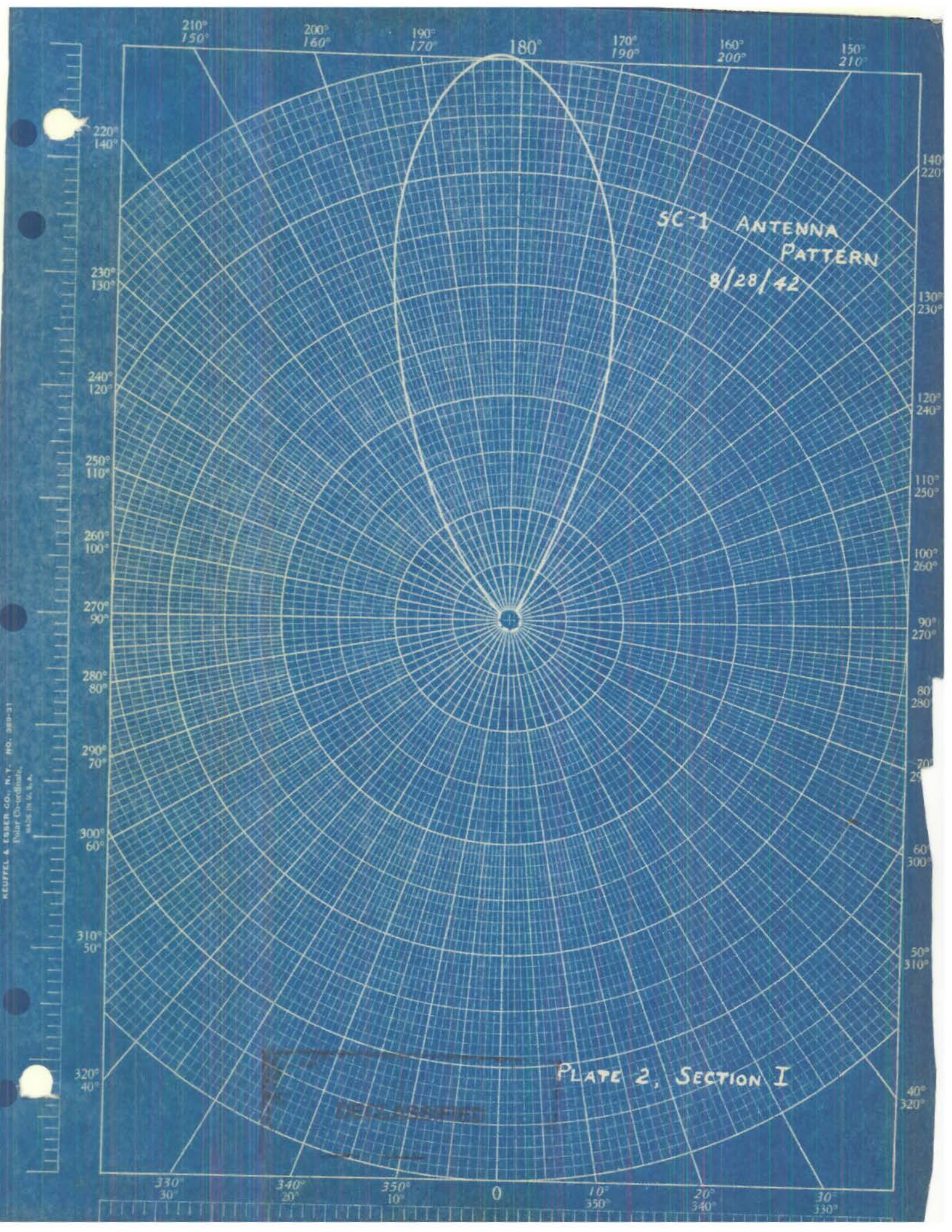
SEC.I PLATE I


SC-1 ANTENNA PATTERN
8/28/42
PLATE 2, SECTION I
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180°
0
210° 150°
200° 160°
190° 170°
170° 190°
160° 200°
150° 210°
220° 140°
230° 130°
240° 120°
250° 110°
260° 100°
270° 90°
280° 80°
290° 70°
300° 60°
310° 50°
320° 40°
330° 30°
340° 20°
350° 10°
10° 350°
20° 340°
30° 330°
140° 220°
130° 230°
120° 240°
110° 250°
100° 260°
90° 270°
80° 280°
70° 290°
60° 300°
50° 310°
40° 320°
KEUFFEL & ESSER CO., N.Y. NO. 389-21
Polar Co-ordinate.
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These tests involve the following units of the Model SC-1 Equipment:

Unit	Type No.	Serial No.
Transmitter	CG-52AK	7
Motor Amplidyne	CG-21AAE	208
Antenna	CG-66ABA	22
Control	CG-23AAF	110
Remote Control	--	--
Reprod	CG-50AAR	55
Transmission Line Alignment Section	--	--
Pulse Indicator	--	--

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2-2. Effect of Temperature. A test was made to determine the ability of the equipment to operate over a wide range of ambient temperatures. The equipment was installed in a temperature test chamber and the temperature therein was varied over the range 50 degrees C. to zero degrees C. in discrete steps. The operation of the equipment was observed and measurements of the emitted power and frequency were taken at intervals as well as readings of the currents and voltages in the various transmitter circuits. A dummy antenna consisting of a load lamp was used during this test and the power in this load lamp was measured by means of a calibrated photocell. Table 1 and Plate 31 contain data obtained during this test. Reference to this table reveals the following:

(a) The test was conducted at a frequency of 200 megacycles. The maximum variation in frequency during the test amounted to 250 kilocycles or 0.125 per cent. No definite correlation was noted between the direction of temperature change and the direction of the frequency change.

(b) The peak power varied during the test from a minimum of 135.5 to a maximum of 160 kilowatts. This amounts to a 24.5-kilowatt or 18 per cent change. The peak power increased as the temperature decreased.

2-3. Effects of Humidity. Tests were made to determine the ability of the Transmitter Unit to operate over wide ranges of relative humidity. The tests were as follows:

2-3-1. Variation in Humidity. The equipment was installed in a humidity test chamber and the relative humidity therein was varied over a range of 25 to 93 per cent with the ambient temperature maintained approximately at 40 degrees C. The operation of the equipment was observed and measurements of the emitted power and frequency were recorded at intervals as well as readings of the current and voltage in various transmitter circuits. A dummy antenna consisting of a load lamp was used during this test and the r-f power in this load lamp was measured by means of a calibrated photocell. Table 2 and Plate 32 contain data obtained during this test. Reference to this table will reveal the following:

(a) The test was conducted at a frequency of 200 megacycles. The maximum variation in frequency during the test was from 200.53 to 200.72 megacycles. This amounts to a change of 190 kilocycles or 0.095 per cent. No definite correlation between humidity and frequency was obtained.

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(b) The maximum change in peak power output during the test was from 134.5 to 141.0 kilowatts. This amounts to a change of 6.5 kilowatts or 4.8 per cent.

2-3-2. Starting at High Humidity. Tests were made to determine the ability of the equipment to start promptly and satisfactorily after it had been allowed to remain idle for a period at a high ambient humidity. At the conclusion of the humidity test described in subparagraph 2-3-1, the transmitter power was removed and the humidity of the test chamber was raised to approximately 95 per cent at a temperature of approximately 42 degrees C. These conditions were maintained for two hours. Power was then applied and the transmitter plate variac setting was increased immediately from the zero to the 15-kilovolt setting. No flashovers occurred; however, there was indication of current leakage in the high-voltage circuits. The plate voltage was then reduced to 10 kilovolts. The plate current meter indicated 12.2 milliamperes and the grid current meter 2.0 milliamperes. These currents gradually assumed the normal values of 10.1 milliamperes for the plate current and 2.6 milliamperes for the grid current in a period of two and one-half minutes. Table 3 shows the results of a further test. At the conclusion of the above test, the transmitter power was again removed. The temperature of the test chamber was lowered from 40 degrees C. to 35 degrees C. in order to cause a slight amount of moisture to precipitate upon the equipment. Power was then reapplied to the transmitter and the variac setting rapidly advanced from zero to the 10-kilovolt point. The data listed in Table 3 were then taken. Reference to this table will show that stabilized operation was obtained in three minutes after the transmitter was energized.

2-3-3. Starting at High Humidity. Comparison of Model SC and Model SC-1 Equipments. Reference to NRL letter C-S67/36 of 30 December 1941 to BuShips will reveal that difficulties were encountered when an attempt was made to operate the Model SC Equipment after it had been allowed to remain idle at high humidities. As indicated in paragraph 4 of the reference, 19 minutes were required before normal operation of the equipment could be obtained. Since under similar conditions the Model SC-1 could be started in three minutes, it is apparent that this equipment represents a considerable improvement. This improvement is no doubt due to the substitution of a voltage doubling rectifier circuit, thereby permitting only half voltage across the capacitor insulators.

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2-4. Effect of Vibration. Tests were made to determine the ability of the equipment to withstand vibration. In these tests the equipment was secured to a vibration test stand by its normal hold-down fittings and was then subjected to vibration at frequencies between 600 and 2000 cycles per minute. Care was taken to provide a rigid support for the upper shock mount assembly on the transmitter unit. Vibration tests of the transmitter unit and the antenna were conducted separately. The tests were as follows:

2-4-1. Transmitter Unit. The data taken during the vibration test on the transmitter unit are listed in Table 4. Reference to this table will show that the test was made in two parts. Previous to the start of part one, two insulating supports were placed in the transmitter in such a manner as to fasten the aluminum plate under the oscillator tubes to the floor of the oscillator tube compartment. These supports were provided for experimental purposes, since preliminary tests indicated that the tube supporting structure might be insufficiently rigid. Plate 7 shows the construction in the oscillator compartment; the extra supports were removed previous to taking the photograph and therefore do not appear. Part two of the test was made with the transmitter in its normal condition; viz., without the insulating supports in place. No damage occurred in the transmitter during either part of the test and the extra supports under the oscillator tube assembly proved to be unnecessary in so far as vibration is concerned. As indicated in the notes to Table 4, a number of points were found which resonated at certain vibration frequencies and developed a noticeable amplitude of vibration. The "Output Coupling" tuning-control-cable pulley is fastened to the cathode-tuning-compartment floor but is not mounted rigidly and vibrated excessively, striking against the left rear corner of the cathode-tuning-section shield box. A method of securing this pulley should be provided such as will prevent this excessive vibration.

2-4-2. Antenna. The data taken during the vibration test on the antenna are listed in Table 5. The following items were noted during the tests:

(a) A number of points on the antenna were found which resonated at certain of the vibration frequencies and developed considerable amplitude of motion. The maximum amplitudes obtained at these points were measured and are listed in the table. Reference to Plates 25 and 26 will reveal the exact location of these various points. The amplitudes developed

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at the points marked A, B, C, and D (3/8 to 1/2 inch) is considered sufficient to cause eventual fatigue and breakage of the antenna framework. No test was made to determine whether the antenna vibration had an effect on the radiation pattern, but it is possible that the amount of vibration noted would cause a variation in the pattern sufficient to interfere seriously with the use of the equipment. During the course of the tests rods were run experimentally between points A to P and B to Q (Plate 26) in an effort to reduce the amplitude of vibration. These rods reduced the vibration at point D considerably and the vibration at other points appreciably. It is recommended that appropriate steps be taken to reduce the vibration of this antenna.

(b) It was noted that the feed lines between the ends of the dipole radiators resonated at certain frequencies and developed sufficient amplitude of motion to cause considerable variation in the spacing between the two rods composing these lines. In the case of one set of these lines, the amplitude of motion was sufficient to cause the rods to strike against each other (at the points marked J and I on Plate 25). It is probable that the variation in spacing of the feed lines alone will cause an undesirable change in the radiation characteristics of the antenna and it is certain that the intermittent contact between the points J and I will interfere with the operation of the equipment. It is recommended that some means be provided to prevent these lines from vibrating.

(c) At the conclusion of the vibration tests, there was some evidence noted of fractures at the welds by which the transmission lines are joined to the dipole radiators. Some of these lines were loose at the points at which they entered the ends of the dipole and it is possible that vibration had caused the welds at these points to break. More care should be taken in the workmanship with which these welds are made.

The construction of the antenna of the Model SC-1 Equipment is similar to that of the Model SC Equipment. The available reports

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from installations afloat on the operation of the Model SC Equipment have been examined, but no comment has been discovered in them relative to difficulties caused by excessive vibration of the SC antenna. It is suggested that the Bureau furnish the Laboratory with such information on this subject as may be available in order that future equipment of a similar nature may be examined with a greater knowledge of the critical features.

2-5. Effect of Shock. Tests were made to determine the ability of the equipment to withstand shock. The equipment was secured to a horizontal shock test table by its regular hold-down fittings and subjected to a series of blows delivered by a pneumatic shock device. A framework supported on the shock table and rigidly braced was provided to support the upper shock mount assembly on the transmitter unit. The operation of the shock device is such that it delivers a blow against the edge of the table to which the base of the apparatus under test is secured and thereby causes the top of the table to move suddenly in the horizontal plane. The momentary peak acceleration produced at the base of the apparatus was measured by means of a set of accelerometer cells. Separate shock tests were made of the transmitter unit and the antenna. The data from these tests are listed in Tables 6 to 12. As indicated in these tables, shocks were applied to the transmitter unit from several directions. An air pressure of 150 pounds per square inch was used in the shock device for most of the shocks and this produced a momentary peak acceleration at the base of the apparatus of 250 g. The shock tests were made as follows:

2-5-1. Transmitter Unit. Six sets of shocks were applied to the transmitter unit. Three of these sets were delivered with the transmitter in its normal condition. Previous to the other three sets of shocks, two insulating supports were placed in the transmitter in such a manner as to fasten the aluminum plate, at the bottom of the oscillator tube assembly, to the floor of the oscillator tube compartment. The supports were provided for experimental purposes, since preliminary tests indicated that the tube supporting structure might be insufficiently rigid. The results of the tests did not indicate that the supports were necessary. A total of 53 shocks were delivered to the transmitter unit. During the course of these shocks the following was noted:

(a) It was noted that the shocks delivered to the front and rear of the transmitter caused a considerable horizontal movement of the top of the transmitter cabinet with respect to the support to which the upper shock mount assembly was fastened. As indicated

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in Note 3 to Table 7, this displacement was measured and found to amount to 2-1/4 inches overall. From this, it will be seen that precautions must be taken to provide a clear space around the unit when it is installed on shipboard so that the displacement caused by the shock of gunfire will not cause the unit to strike adjacent objects.

(b) The left rear grid connector on the left front oscillator tube (type 327-A) came off of the grid prong during one of the shocks. It is recommended that the design of the grid connectors be improved to grip the grid prong more firmly.

(c) When the grid connector came off as indicated in subparagraph (b) above, the oscillator plate current rose to 1.8 times its normal value. This rise in plate current did not cause the plate current overload relay to open. It is recommended that the overload relay provided on the equipment be adjusted to cause removal of the plate voltage whenever the plate current rises to 1-1/2 times its normal value. Suitable precautions should be taken to prevent this relay, if provided, from opening under the influence of shock or vibration.

(d) The grid connector, which came off as indicated in subparagraph (b), was replaced on the tube immediately and normal operation of the equipment was obtained. Power was then removed and preparations were made for further shock tests. At the conclusion of these preparations, the transmitter was energized and the left front oscillator tube (type 327-A) arced over internally. This was found to be due to a broken seal at the point at which the plate lead enters the tube. It is probable that this seal was cracked by the last shock listed in Table 10 and that air leaked into the tube gradually while the preparations for the tests listed in Table 11 were being made. The result of this test indicates that the oscillator tubes are not completely protected against shock.

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(e) During one of the shocks applied to the transmitter unit, the peak acceleration near the top of the unit was measured. The usual measurement of the peak acceleration at the base was also made. It was found that, during this shock, the peak acceleration imparted to the test stand was 196 g while the peak acceleration near the top of the transmitter was less than 18 g.

2-5-2. Antenna. The antenna was subjected to 20 shocks. These shocks caused no immediate damage. One set of the feed lines between the dipole radiators (I and J, Plate 25) was found to vibrate momentarily as a result of the shocks. The need for better support of these lines has already been commented upon in connection with the vibration tests. It was also noted that the shocks caused the antenna framework to rock. This rocking or vibration occurred in two directions; from side to side about the vertical axis "C" to "D" (Plate 25) and from front to back about the rotary joint. This motion is probably the result of loose fits in the drive gears of the antenna and in the bearings. The data obtained during this test are listed in Table 12.

2-6. Effects of Inclination. Tests were made to determine the ability of the transmitter to withstand inclination simulating the roll and pitch of a vessel. The transmitter was mounted on the inclination test stand by means of the regular mounts provided. Care was taken to insure that the top mounting was adequately braced. The transmitter was inclined from front to back for a period of thirty minutes and additionally from side to side for another period of thirty minutes. The inclination occurred at the rate of five cycles per minute and carried the transmitter to 45 degrees each side of the vertical. Tables 13 and 14 list the data taken during these tests. Reference to these tables shows that no damage resulted from these tests. As will be seen from the tables, the power output and frequency of the transmitter were measured before and after each test, with the transmitter in a stationary position. Measurements were made with the transmitter vertical, and also when it was inclined 45 degrees to each side of the vertical. It was noted during the course of one set of these measurements (Table 13) that the emitted frequency changed from 197.90 megacycles with the transmitter stationary and vertical, to 193.70 megacycles with the transmitter stationary and inclined 45 degrees to the rear. This is a change of 2.2 megacycles or 1.1 per cent. The exact reason for this large change was not found, but it is presumed to be the result of movement in the radio-frequency tuning circuits.

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2-7. Variations in Line Voltage. Table 15 contains data showing the effect upon power output, duty cycle and emitted frequency together with the influence upon transmitter potentials and currents when the line voltage is varied over the limits of minus 10 to plus 10 per cent of normal. It will be seen that no serious effect was noted from this variation in supply voltage. Plate 33 shows some of the data of Table 15 presented in graphical form.

2-8. Radio-Frequency Power Output. The peak power output from the transmitter unit of the equipment is discussed in Section I of this report.

2-9. Power Circuits. The following was noted concerning the power supply circuits in the equipment.

2-9-1. Line Current. Table 16 lists the current required from the supply line. This current, which is the total amount taken by the transmitter, control unit, motor amplidyne, and antenna, was found to be 6.8 amperes at 230 volts.

2-9-2. Fuse Current. Table 16 lists the operating current and voltage of the fuses employed in the transmitter unit.

2-10. Power Control and Protective Circuits. The following was noted concerning the power control circuits in the equipment.

2-10-1. The oscillator plate voltage variac is located in the control unit. The rotor of this variac is fastened to its control shaft by means of two set screws. The control shaft is made of bakelite or some similar material. Since the rotor must actuate a switch as well as carry the variac brush, the torque between the rotor and the control shaft is considerable and it was noted that the rotor slips on the shaft. This slippage occurred because the set screws gouged a groove in the soft bakelite. It is recommended that the set screws be retained and that, in addition, the variac rotor be fastened to its control shaft by means of a taper pin of nonmagnetic corrosion resisting steel.

2-11. Vacuum Tubes. Table 18 lists the potentials applied to the vacuum tubes in the amplidyne amplifier.

2-12. Weights and Dimensions. Table 17 lists the weights and dimensions of the portion of the Model SC-1 Equipment included in Section II of this report.

2-13. Wiring. An examination of the wiring in the equipment revealed the following items:

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2-13-1. When the control unit chassis is removed from or replaced in its cabinet the cabled wiring at the right hand side of the unit strikes one of the brackets provided on the inside of the cabinet for the panel fasteners. The insulation on this wiring has been cut and the lacing has been damaged. This wiring should be relocated in a position where the bracket will not strike it, or a metal guard should be provided to protect it.

2-13-2. Some of the cabled wiring in the control unit, particularly that to transformer T-104, resistors R-111, R-112, and switches S-101, S-103, and S-104, shows poor workmanship. Greater care should be taken in positioning the wires in the cables so that the individual wires will leave the cable in a neat manner. A number of the wires are excessively long and should be cut to fit better. The lacing should be extended further toward the ends of the cables.

2-13-3. The wiring to the filaments of the transmitter oscillator tubes pass through the oscillator cathode tuning lines. The insulation of the filament leads is being cut at the points at which these leads enter the ends of the cathode tuning lines (ends remote from the oscillator tubes). It is recommended that suitable buffers be provided at these points to protect the wiring.

2-14. Controls. The following was noted concerning the controls in the equipment.

2-14-1. The "Output Coupling" and the "Output Matching" controls on the transmitter are connected to their respective variable circuit elements by means of thin flexible wire cables in a manner resembling the method often used in home broadcast receivers. Plates 7 and 8 show views of the arrangement employed. It is considered that this method of driving the controls is unsuitable for use in the Naval Service, since it is probable that the cables will be subject to frequent breakages. Should a break occur in these cables, a considerable amount of time would be required for recabling the controls. This would cause an outage for a corresponding period while these repairs were in progress. It is recommended that a more suitable means be provided for the adjustment of these controls.

2-14-2. The "Oscillator Tuning" dial on the transmitter is calibrated from 0 to 100 in 180 degrees of rotation. The other half of the dial is blank. No stop has been provided to limit the motion of the control to the calibrated portion of the dial. Because of a mechanical defect in the construction of this control, it can be rotated only in a clockwise direction. When an attempt is made to rotate it in a counterclockwise direction, the control jams and prevents motion in that direction.

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2-14-3. The "Output Matching" control dial on the transmitter is calibrated from 0 to 100 in 360 degrees. Stops limit the motion of this control to the region 0 to 96. The "Output Coupling" control dial is calibrated in a like manner and is limited to the region 0 to 95. It is recommended that these dials be calibrated only to the useful limits of their motion.

2-14-4. The movable contact arm of switch S-107 in the control unit is in contact with the metal case of the switch S-109. One-half inch clearance should be provided at this point.

2-14-5. The thermostat in the base of the antenna is provided with an excessive amount of tubing. The excess tubing has been coiled up loosely without support. It is recommended that the length of the tubing be reduced to permit neater construction and that supports be provided for this tubing.

2-14-6. Table 19 lists the controls on the transmitter and control units. Reference to this table will reveal that the markings on a number of the controls are either omitted or are incomplete. The table contains a list of the omissions in the marking, together with suggestions for improvement.

2-14-7. The amplidyne amplifier is provided with an anti-hunt control, resistor R-163. It was found that, while this control could be set to eliminate hunting at any discrete speed over the whole range of rotational speeds of the antenna, the adjustment was good for only that particular speed and that hunting would occur when the speed of the antenna was changed only slightly. In order to eliminate hunting at the new speed it is necessary to readjust the anti-hunt control. It is recommended that the anti-hunt control be modified so that the control, when set correctly, will eliminate hunting at all speeds without further adjustment.

2-14-8. A test was made to check the backlash between the antenna-rotation control "H" and the bearing indicator pointer. The control "H" was set on zero degrees and the angular settings of the antenna pedestal and of the bearing indicator pointer were read. The control "H" was then rotated 5 degrees clockwise and the same quantities read. Finally the control "H" was rotated counterclockwise 5 degrees back to zero and the quantities were again measured. The readings obtained were as follows:

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Control H Setting (Degrees)	Angle of Pedestal (Degrees)	Bearing Indicator Pointer Setting (Degrees)
0	258	329.
5	263	334.
0	258	329.5

As may be seen, the backlash in the relative bearing indicator amounted to 0.5 degree. It was also found that there appeared to be an excessive amount of backlash between the antenna drive motor gear and the antenna drive gear.

2-14-9. It was found that the antenna rotation control "H" could be moved 10 minutes of arc (according to the calibration on this control) before the antenna moved.

2-14-10. It was found that the antenna rotation control "H" could be moved 38 minutes of arc (according to the calibration on this control) before the bearing indicator pointer moved.

2-14-11. There is no phase adjustment control on the Model SC-1 Equipment. However, markings and a mounting hole are provided on the control unit panel for this control. It is recommended that the panel markings and the panel mounting hole be omitted.

2-15. General Physical Construction. An examination of the equipment revealed the following items concerning the general physical construction:

2-15-1. The side and back shields are held on the transmitter by means of captive thumb screws. In addition, each of these shields is also held in place by two hex head bolts. The arrangement is visible on Plates 1 and 2. During the tests conducted at NRL on the Model SC Equipment, it was found that one of the side shields would fly off under the influence of shock. This equipment was similar in construction to the Model SC-1 Equipment and it is assumed that the purpose of the hex head bolts on the shields of the present model is to prevent these shields from coming off under the influence of shock. However, this method is unsatisfactory, since it interferes with the convenient removal of the side and back shields. It is recommended that the thumb screws provided be changed to a type that will hold the shields securely without the assistance of extra bolts and that the bolts be eliminated.

2-15-2. In order to facilitate the hoisting and lowering of the equipment aboard ship or ashore, preparatory to installation or removal of equipment, it is recommended that the transmitter unit be provided with suitable lifting

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eyebolts. These eyebolts should be of suitable size to permit the use of rope 1 inch in diameter with ample clearance; i.e., the eye should not be less than 1-3/8 inches. These eyebolts should be located at the top of the transmitter.

2-15-3. The lower oil gauge on the antenna pedestal leaked oil following the shock tests. This leak occurred between the end of the gauge glass and the compression fitting. Care should be taken to tighten this fitting properly when it is being assembled.

2-15-4. Two compartments in the antenna pedestal require filling with oil. One of these compartments is located above the other and each is provided with a gauge to indicate the level of the oil therein. When the antenna was received, the lower compartment had more than the specified amount of oil in it, since the level was above the top of the gauge glass. The upper compartment was empty as indicated by the gauge. Sufficient oil was removed from the lower compartment to bring the level in this compartment to the specified point on the gauge. The oil which was withdrawn from the lower compartment was added to the upper compartment. The top gauge then showed a slight trace of oil. Additional oil was added to the upper compartment to bring the gauge level to the proper point. After two days, however, the oil level in the upper compartment had dropped 1/2 inch. There have been a number of reports from shipboard installations indicating that the occurrence of this difficulty is not unusual. It is recommended that definite steps be taken to eliminate this defect.

2-15-5. Four angle brackets have been provided on the inside of the control unit cabinet, toward the front, to receive the Dzus fasteners which hold the control unit chassis to its cabinet. The upper right bracket has been bent to make it fit properly. It is recommended that more care be taken during the manufacture of the cabinet so that the brackets will fit properly without being bent. In addition, the front surface of these brackets has been finished with a grinder. This has not only roughened the surface but has also removed the protective coating of the aluminum. It is recommended that the design of these brackets be changed to eliminate the need for grinding them. Plate 14 shows a view of these brackets.

2-15-6. Guides for the keying monitor should be provided on the transmitter subpanel which separates the oscillator tube compartment from the oscillator tuning and matching compartment. These are necessary to prevent the keying monitor from striking and damaging parts in its vicinity when it is inserted in or removed from the transmitter.

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2-15-7. The keying monitor connector-plug board located in the tuning compartment of the transmitter should be moved 1/4 inch toward the front of the transmitter. This is necessary to insure proper contact between the male portion of the plug located on this board and the female portion of the plug located on the keying monitor.

2-15-8. The round-head screws which hold the floor plate of the transmitter tuning compartment to the main frame gouge the underside of the keying monitor whenever this unit is inserted in or withdrawn from the transmitter. These screws also prevent the Dzus fasteners which hold the front panel of the keyer monitor to the front panel of the transmitter from functioning properly. It is recommended that the present round headed screws be replaced by countersunk flat headed screws. The interlock switch provided on the keying monitor unit does not align properly with the complementary shorting button. This misalignment is sufficient to interfere with the replacement of the unit.

2-15-9. "Elastic Stop Nuts" are used on the bolts which fasten the capacitor C-102 to the chassis of the control unit. These bolts extend only part way through their nuts and since this type of nut depends for locking action upon the bolt threading into a fibre insert on the exit side of the nut, it is imperative that the bolt pass completely through in order to prevent vibration from causing the nuts to loosen and come off. It is recommended that the bolts holding capacitor C-102 be made at least 1/4 inch longer.

2-15-10. Capacitors C-303 and C-304 are secured to the transmitter chassis by means of clamps which are drawn tight by means of bolts. The ends of these bolts extend down and fit into holes threaded into the chassis. Nuts and lock washers have been provided on the bolts on the upper side of the chassis to prevent the bolts from loosening under vibration. Because of adjacent parts, it is impossible to reach these nuts with a tool when it is desired to loosen or tighten them. It is recommended that a more convenient means be provided for fastening these capacitors to the chassis.

2-16. Corrosion. The following items were noted concerning the finish on the metal parts of the equipment and the steps taken to prevent corrosion:

2-16-1. The steel parts of the antenna, including reflector supports, frame, and frame supports, are rusting badly. The paint on the antenna is inadequate to prevent rust from occurring. It is recommended that the anticorrosion measures be improved. There have also been several reports of severe rusting of this type antenna from shipboard installations.

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2-16-2. The paint on the transmitter cabinet has been chipped or scraped off at a number of points. This was noted at corners, at the ventilating holes in the shields and at the mounting bolt holes. Removing and replacing the hex head bolts in the side and back shields damages the paint around the holes provided in the shields for these bolts. The use of more durable protective measures is indicated.

2-16-3. The paint on the high-voltage plate transformer in the transmitter unit is chipped at the base of the mounting bracket. The use of a more durable paint is recommended.

2-16-4. The bracket supports for resistors R-312 and R-305 in the transmitter unit have been scratched severely, apparently during manufacture. Care should be taken to prevent this, since scratches in the plating of these brackets will permit corrosion to occur.

2-16-5. The gears which couple the control unit slewing motor to the differential generator are made of magnetic steel. Since this material is subject to corrosion, it is recommended that they be replaced with gears of a suitable corrosion resisting material.

2-16-6. Two supports between the oscillator cathode tuning shield box and the frame of the transmitter are made of unplated steel and have rusted badly. The supports are pieces of strap about 7 inches long, 1/2 inch wide, and 1/16 inch thick. Since the frame of the transmitter is made of aluminum, it is recommended that aluminum be used in the construction of these braces. If the use of steel is continued the supports should be cadmium plated to protect them from corrosion.

2-17. Nameplates and Component Marking. The following was noted concerning labelling in the equipment.

2-17-1. Provisions have been made on the transmitter for a nameplate on the plate current "Push-To-Read" switch. However, no nameplate has been provided. It is recommended that a suitable nameplate be mounted in the position provided.

2-17-2. A nameplate should be provided on the transmitter unit near the Filament Primary Voltmeter to indicate the proper value of filament voltage.

2-17-3. The points at which the antenna is filled with or drained of oil and the points at which the antenna is greased should be marked at appropriate points on the antenna pedestal. These markings should be conspicuous and should be of such a nature that they will not be obscured by weathering or when the antenna is repainted. A nameplate on the antenna

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drive motor should indicate the Navy type of the lubricant to be used.

2-17-4. An interlock is provided on the antenna pedestal which, when opened, prevents the antenna from being rotated by an operator at the control unit. The purpose of this interlock is to permit repairs or adjustments on the antenna or on the mechanism in the antenna pedestal to be made in safety. This interlock is opened by removing a plug on the side of the antenna pedestal. It is recommended that a nameplate be provided on the antenna pedestal adjacent to this plug to indicate its purpose and to warn operators to open the interlock before working on the antenna. The nameplate should be conspicuous and should be of such a nature that it will not be obscured by weathering or when the antenna pedestal is repainted.

2-17-5. The points at which ropes are to be placed on the antenna for hoisting or lowering operations are marked, "Sling Here." These markings have been stencilled in black paint over the grey paint with which the antenna is finished. Attention is invited to the fact that these markings will be lost when the antenna is repainted unless steps are taken to restencil them.

2-18. Components. The following was noted concerning the components in the equipment.

2-18-1. The resistors R-105, R-107, R-108, and R-102C in the control unit are of the wire-wound type with a vitreous enamel covering. A portion of the resistance wire has been left exposed to permit the use of a clamp band on the resistor as a variable tap. It is considered that this type of resistor will be subject to early failure in service and it is recommended that these resistors be replaced by suitable non-tapped resistors of a Navy approved type. The present resistors have tabs for terminals. It is recommended that these be replaced by ferrules.

2-18-2. The resistors R-111 and R-112 in the Control Unit are of the Tab type. It is recommended that these be replaced by resistors of the ferrule type.

2-18-3. The RR switch, Control "J," is a two-position toggle switch with "On" and "Off" positions. It is recommended that this switch be replaced with a toggle switch having three positions: "Lock"; "Normal"; and "Momentary." The construction should be such that when the switch is thrown to "Momentary" it will return to "Normal" unless held in position by the operator. It is suggested that this three-position toggle switch be installed so that its handle operates in a vertical plane with the "Lock" position at the top, the "Normal" position at the center, and the "Momentary" position at the bottom.

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2-18-4. Examination of the amplidyne brushes revealed burned areas on the brushes in holders 1, 2, 7, and 8. The burned area on these brushes was on the face in contact with the commutator and covered about one-third the end of the brush starting at the trailing edge. Steps should be taken to remedy this difficulty.

2-18-5. A list of components is given in Tables 20 and 21. Where obtainable, actual operating conditions were recorded.

2-18-6. Attention is invited to NRL letter S67/61, of July 15, 1942, to the Bureau of Ships, reporting on the tests of the filament and plate transformers used in the Model SC-1 Equipment. Subsequent to July 15th, it was discovered that the two brass bolts, by means of which the laminations of the plate transformer are secured, had parted and the mounting angles pulled away from the transformer. It appears that salt water entered the laminations and the resulting corrosion produced sufficient pressure to shear the brass bolts. This condition indicates that precautionary measures should be taken to prevent the entrance of moisture between the laminations and that stronger bolts should be used for securing the laminations.

2-18-7. Resistors R-335 and R-336 (Transmitter) are color coded as 22 ohms with plus or minus 10 per cent tolerance. The spare parts list gives this same rating. The resistance of these units exceeds the tolerances given, since the measured values were found to be 27.65 and 27.20 ohms, respectively.

2-19. Transmission Line Alignment Section. The transmitter unit is mounted on rubber shock mounts which allow it to move under the influence of shock or vibration. To permit this unit to be connected to the 1-5/8 inch diameter, 50-ohm, coaxial r-f transmission line, which will be rigidly secured to a bulkhead or some other stationary object, a short section of the coaxial line (Plates 27, 28, 29, and 30) has been provided, which has two flexible joints and one sliding joint. This section has been designated as an Alignment Section. If one end of this alignment section is fixed, these joints permit the other end a limited side motion in any direction and also a limited amount of longitudinal motion. A number of tests were made to determine the suitability of this alignment section. The tests were as follows:

2-19-1. Life Test (Flexible Joints). In testing the flexible joints of this alignment section, one end of the unit was rigidly clamped so that the axis of the portion from the end to the first joint remained fixed in the horizontal plane.

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The other end of the section was clamped in a bearing set eccentrically in a revolving disc. The revolving disc and the fixed end of the section were coaxial while the axis of the moving end of the section and the eccentric bearing were parallel with the axis of the disc. The disc revolved at 108 r.p.m. The distance between the axis of the disc and the axis of the bearing was one inch. Both of the flexible joints were therefore subjected to a bending action wherein the plane of the bend revolved around each joint 108 times per minute without any appreciable rotary action between the various parts of the section. Measurements of the resistance across the various joints were taken before the start of the test and at intervals during the test. Table 22 lists the data obtained during this test. It will be seen that the section was tested for several periods of varying duration. The following was noted during the test:

(a) After the alignment section had been tested for seven hours and twenty-five minutes (48,060 bending cycles), the various points of flexible contact in the section showed serious signs of wear. The plating of the finger and spring contact of the outer conductor was worn at several points and the wide range found in the resistance of the joints and in the overall resistance of the inner conductor indicated that the springs were not making good contact.

(b) The alignment section was then reassembled and tested for a further period of four hours and forty minutes. Resistance measurements were taken and the section was disassembled for examination. All points of flexible contact showed considerably increased signs of wear. The plating was worn through at several places and metallic particles which had collected at the points of spring contact had the effect of giving a wide range of resistance at the joints.

(c) Further periods of testing were given the section which brought the total test time to twenty-four hours and thirty-two minutes. The overall resistance of both the inner and outer conductors was found to have increased approximately 100 per cent over the values measured in (b), and when the section was dismantled it was found to have a greatly increased amount of wear at all points of flexible contact. A large amount

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of metallic particles had collected inside the flexible joints and some of this metal dust had worked into the slip joint. Since in service the alignment section may be mounted vertically, it would be possible for the finely divided metal to form a coating on the coaxial insulators and effectively bridge the inner and outer conductors.

2-19-2. Life Test (Slip Joint). The testing apparatus described in 2-19-1 was rearranged so that each revolution of the disc caused a longitudinal motion of the slip joint in the alignment section of about two inches without any appreciable bending motion of the flexible joints. Before the test was started, the resistance of the slip joint was measured for ten positions of extension. These measurements were made both on the side of the joint with the window and on the opposite side. The highest and lowest readings were taken as the limits of the resistance range. The data obtained from this test are listed in Table 22. The testing machine was started and run at 108 r.p.m. for seven hours. At the end of this period the sliding joint showed a tendency to bind. Resistance measurements were taken and the connector was dismantled for examination. A space approximately 2 inches long and 7/8 inch wide on the outer conductor was very badly scored and a large amount of metal particles, which had collected in the sliding joint, had caused it to bind. The inner conductor contact also showed a large amount of wear, most of the plating being worn off at all points of sliding contact. It was also revealed that the two spring connectors in the inner conductor made decidedly unequal contact relative to each other and to their complementary sockets.

2-19-3. Breakdown Voltage. A test was made to determine the voltage required to cause a flashover from the inner to the outer conductor of the alignment section. It was found that flashover would occur at 4.54 kilovolts r-m-s. The conditions during this test were as follows: ambient temperature, 29.4°C; relative humidity, 63%; frequency of applied voltage, 175 kc. As is indicated in NRL Report No. R-1846, a well constructed 1-5/8 inch diameter, 50-ohm, concentric transmission line will have a flashover voltage of approximately twice that of this flexible section.

2-19-4. At the conclusion of the various tests on the alignment section, examination of the section revealed that one of the coaxial insulators had developed three severe radial cracks.

2-19-5. The results of the tests made on this section indicate that it is subject to too rapid wear to be suitable for the Naval Service in its present form. Since reference

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to the shock tests on this equipment reveal that the transmitter unit will move as much as 2-1/4 inches, it is apparent that none of the above tests can be deemed too severe. It is recommended that steps be taken to reduce wear on the moving parts and provide more positive contact between elements.

2-20. Amplidyne Characteristics. Table 23 lists data showing the relation between the d-c output voltage of the amplidyne unit and the a-c input voltage to the control amplifier. These data are presented graphically in Plate 34.

2-21. Pulse Indicator. Provision is made in the transmitter unit for the use of a pulse indicator. The purpose of this device is to indicate whether the transmitter unit keying rate is correct or incorrect and to aid in tuning the r-f oscillator. When the transmitter was delivered, this device was not included and the various tests described above were carried out without it. However, on July 11, towards the end of the tests described in this section of the report, a pulse indicator was made available. A number of tests have been made on this unit as described below.

2-21-1. Effect of Low Temperature. The pulse indicator was placed in a Temperature Test Room. The unit was energized with 60-cycle power but was not supplied with a keying pulse. The ambient temperature was reduced to approximately minus 15 degrees C. and held in this vicinity for one hour. No difficulties were noted in the operation of the unit during this period. Table 24 lists the data recorded during the test.

2-21-2. Effect of High Humidity. The pulse indicator was installed in a Humidity Test Chamber. The unit was energized with 60-cycle power and was supplied with a 60-cycle pulse from a radar transmitter. The temperature was maintained at approximately 40 degrees C. and the relative humidity was varied between 18 and 97 per cent in the manner indicated in Table 25. No change was noted in the operation of the pulse indicator during this test.

2-21-3. Starting at High Humidity. The pulse indicator was installed in a Humidity Test Chamber. The unit was not energized. The ambient temperature was raised to approximately 40 degrees C. and the relative humidity to 97 per cent. These conditions were maintained for two hours. At the end of this period power was switched on and a 60-cycle pulse was supplied the unit from a radar transmitter. No difficulty was observed during the starting period and the unit operated normally except that there was a slight decrease in the amplitude of the vertical deflection of the cathode-ray trace over that obtained under normal conditions. Table 26 lists the data recorded during this test.

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2-21-4. Effect of Transmitter Plate Voltage. Table 27 and Plate 35 list the data taken during a test which was made to determine the action of the pulse indicator when the plate voltage of the Model SC-1 Transmitter is varied. The indicator was installed in the SC-1 transmitter in the normal manner. During this test the procedure was as follows: the plate voltage was varied; the grid resistor was then adjusted according to the indications of the pulse indicator until the keying of the transmitter was proper and the amplitude of the pulse deflection of the cathode ray of the pulse indicator was measured. Plate 35 shows the manner in which the cathode-ray deflection varied with transmitter plate voltage. A load lamp was used as a dummy antenna during this test.

2-21-5. Effect of Output Coupling Control Variation. A test was made to determine whether or not the pulse indicator unit could be used to obtain the optimum setting of the output coupling control on the transmitter unit. As indicated on Table 28, the setting of the output coupling control was varied over its range and readings were taken of the pulse deflection on the pulse indicator cathode-ray tube, of the power emitted by the transmitter, and of the currents or voltages in the various transmitter circuits. A load lamp was used as a dummy antenna during this test. The relation found to exist between the setting of the output coupling control and the deflection of the cathode-ray trace was only that there was a presence of output, the magnitude not being indicated.

2-22. A summary of the defects noted during the mechanical and electrical tests on the Model SC-1 Equipment together with recommendations for corrective action is listed below. The numerals enclosed in parentheses refer to the paragraph of Section II of this report under which these items are discussed in detail. Attention is directed to the fact that these defects are listed in the order in which they are described in the body of the report and not in the order of their importance.

2-22-1. (2-4-1). A method should be provided to prevent the "Output Coupling" tuning-control-cable pulley from vibrating excessively.

2-22-2. (2-4-2a). A number of points on the antenna frame were found to resonate and oscillate excessively under the influence of vibration. It is recommended that the Contractor be required to make such modification in the design and construction of the antenna as is necessary to reduce the excessive vibration noted.

2-22-3. (2-4-2b). The open wire transmission lines which connect together the various dipole radiators on the antenna were found to vibrate excessively. The necessary steps should be taken to eliminate this condition.

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2-22-4. (2-4-2c). Some of the transmission lines which connect together the various dipole radiators on the antenna were found to have broken loose from the ends of the dipoles. More care should be taken in the workmanship with which the welds holding these lines are made.

2-22-5. (2-5-1a). The top of the cabinet of the transmitter unit deflects a considerable amount under the influence of shock. The instruction book should indicate the amount of clearance to be left around the unit to prevent it from striking against adjacent objects.

2-22-6. (2-5-1b). One of the oscillator tube grid connectors came off of the tube under the influence of shock, while others were displaced. It is recommended that the design of these grid connectors be improved to grip the grid prong on the tube more firmly.

2-22-7. (2-5-1d). One of the oscillator tubes in the transmitter unit developed a broken plate seal as a result of shock.

2-22-8. (2-10-1). The oscillator plate variac rotor slips on its shaft. It is recommended that the set screws holding this rotor be retained and that in addition the variac rotor be fastened to its control shaft by means of a taper pin of nonmagnetic corrosion resisting steel.

2-22-9. (2-13). A number of improvements are necessary in the wiring of the control and transmitter units.

2-22-10. (2-14-1). It is recommended that the present cable drive on the "Output Coupling" and "Output Matching" controls in the transmitter unit be abandoned in favor of some method of driving these controls which will be mechanically more durable and positive.

2-22-11. (2-14-2). The mechanical construction of the "Oscillator Tuning" control should be improved to permit this control to be moved smoothly both clockwise and counterclockwise with a minimum amount of backlash.

2-22-12. (2-14-3). It is recommended that the "Output Coupling" and "Output Matching" control dials of the transmitter unit be calibrated only to the useful limits of their motion.

2-22-13. (2-14-4). Sufficient clearance should be provided between switches S-107 and S-109 in the control unit to prevent them from touching each other.

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2-22-14. (2-14-5). It is recommended that the excess tubing of the antenna pedestal thermostat be eliminated and that supports be provided for the remaining portion.

2-22-15. (2-14-6). The marking on a number of the controls on the transmitter and control units is incomplete. It is recommended that the additional markings suggested in Table 19 be added to these controls.

2-22-16. (2-14-7). It is recommended that the anti-hunt control on the antenna rotation circuit be modified so that the control, when set correctly, will eliminate hunting at all rotational speeds of the antenna without further adjustment.

2-22-17. (2-14-11). It is recommended that the panel marking and the panel mounting hole for the phase adjustment control be omitted from the front panel of the control unit.

2-22-18. (2-15-1). It is recommended that the hex head bolts on the back and side shields of the transmitter unit be eliminated and that the thumb screws provided to secure these shields be changed to a type that will hold the shields securely without the assistance of extra bolts.

2-22-19. (2-15-2). It is recommended that the transmitter unit be provided with lifting eyes to facilitate hoisting.

2-22-20. (2-15-3). Care should be taken during manufacture to properly assemble the oil gauges which are located on the antenna pedestal.

2-22-21. (2-15-4). The antenna pedestal leaks oil. Definite steps should be taken to eliminate this condition.

2-22-22. (2-15-5). It is recommended that care be taken during the manufacture of the control unit cabinet so that the panel securing brackets will fit properly.

2-22-23. (2-15-6). The transmitter unit chassis should be provided with guides for the keying monitor chassis.

2-22-24. (2-15-7). The keying monitor connector-plug board located in the tuning compartment of the transmitter should be moved 1/4 inch toward the front of the transmitter.

2-22-25. (2-15-8). The round-head screws which interfere with the keying monitor when it is being inserted into the transmitter unit should be replaced by countersunk flat-head screws.

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2-22-26. (2-15-9). The bolts holding capacitor C-102 should be made 1/4 inch longer. This will permit these bolts to extend completely through the nuts which hold them.

2-22-27. (2-15-10). It is recommended that nuts and bolts holding capacitors C-303 and C-304 be made more accessible.

2-22-28. (2-16-1). The steel parts of the antenna are rusting badly. It is recommended that the anticorrosion measures on the antenna be improved.

2-22-29. (2-16-2). It is recommended that a more durable finish be used on the outside of the transmitter unit.

2-22-30. (2-16-3). It is recommended that a more durable finish be used on the high-voltage plate transformer in the transmitter unit.

2-22-31. (2-16-4). Care should be taken during manufacture to prevent the bracket supports for resistors R-312 and R-305 from being scratched.

2-22-32. (2-16-5). The use of unprotected steel for the gears which connect the differential generator to the slewing motor in the control unit should be abandoned in favor of gears of a suitable corrosion resisting material.

2-22-33. (2-16-6). It is recommended that the use of steel for the two braces which connect the oscillator cathode tuning shield box to the transmitter frame be abandoned and that these braces be made of aluminum.

2-22-34. (2-17-1). A nameplate should be provided on the transmitter unit to indicate the function and method of use of the oscillator-plate-current meter push-to-read switch.

2-22-35. (2-17-2). A nameplate should be provided on the transmitter unit near the Filament Primary Voltmeter to indicate to what value the voltage indicated by this meter is to be adjusted.

2-22-36. (2-17-3). The points at which the antenna is filled with or drained of oil and the points at which the antenna is greased should be marked at appropriate points on the antenna pedestal. A nameplate on the antenna drive motor should specify the Navy type of the grease that is to be used with the motor bearings.

2-22-37. (2-17-4). It is recommended that a nameplate be provided adjacent to the antenna interlock plug to indicate its purpose and to warn operators to open the interlock before working on the antenna.

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2-22-38. (2-17-5). Attention is directed to the ease with which the "Sling Here" markings on the antenna can be obscured. These markings have been provided to indicate where ropes are to be placed on the antenna for hoisting or lowering operations.

2-22-39. (2-18-1). It is recommended that resistors R-102C, R-105, and R-108 be replaced by resistors that will be more suitable for use in the Naval Service.

2-22-40. (2-18-2). It is recommended that the resistors R-111 and R-112 which have tab type terminals be replaced with Navy type resistors having ferrule terminals.

2-22-41. (2-18-3). It is recommended that the present two-position RR switch be replaced by a three-position switch. The three-position switch should be provided with a "Lock" position, a "Normal" position, and a "Momentary" position.

2-22-42. (2-18-4). Steps should be taken to prevent the amplidyne brushes from arcing and burning.

2-22-43. (2-18-7). The resistance of resistors R-335 and R-336 exceed their specified tolerance. These resistors should be replaced by ones of the proper value.

2-22-44. (2-19). The results of tests made on the alignment section, which connects the transmitter unit to the transmission line, indicate that it is subject to too rapid wear to be suitable for the Naval Service in its present form. It is recommended that steps be taken to reduce the wear on the moving parts and provide positive contact between its various elements.

2-23. Conclusions. The results of the tests made on the Model SC-1 Transmitting Equipment lead to the following conclusions:

2-23-1. The equipment operated satisfactorily over a wide range of ambient temperatures and relative humidity. In the absence of specifications governing variations in emitted frequency and power output, no conclusions relative to these points are included.

2-23-2. While no damage resulted to the equipment when it was subjected to vibration, parts of the antenna developed a considerable amplitude of motion which, if continued, may prove detrimental. Certain aspects of this vibration may interfere with the radio-frequency operation of the antenna.

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2-23-3. The shock tests conducted on the apparatus disclosed a number of difficulties which will require correction before satisfactory operation can be obtained.

2-23-4. The wiring of the transmitter unit, with minor exceptions, is satisfactory. The wiring of the control unit requires improvement.

2-23-5. A number of minor defects were encountered which, in general, appear to be the result of lack of sufficient inspection. A number of improvements and corrections are recommended to improve maintenance and servicing features.

2-23-6. The means provided to adjust the transmitter oscillator and output circuits is considered unsatisfactory, since they afford no definite means of calibration. The use of dial cable in the output circuits presents a difficult problem of servicing.

2-23-7. The Model SC-1 Transmitting Equipment represents an improvement over the Model SC Equipment. A number of the difficulties present in the Model SC Equipment have been overcome. This has been done either by modification of the design or by elimination of the feature in which the difficulty occurred.

Submitted:

R. B. Meyer
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Table 1 - Section II

Model SC-1 Radar Equipment

VARIATION IN AMBIENT TEMPERATURE

Time	Amb. Temp. °C	Rel. Hum. %	Freq. Mc	Power Output Aver. Watts	Power Output Peak Kw	Oscillator Ip Ma	Oscillator Ep Kv	Line Voltage Volts	Duty Cycle %
1045	50.2	28	200.67	49.1	144.5	10.08	9.95	115	0.034
1100	52.6	28	200.60	48.1	139.5	10.10	10.00	115	0.034
1115	51.9	28	200.60	48.1	135.5	10.10	10.00	115	0.035
1130	51.5	19	200.60	48.4	136.3	10.10	10.05	115	0.035
1145	50.2	29	200.65	48.7	139.0	10.10	10.00	115	0.035
1200	38.0	15	200.68	48.7	137.0	10.10	10.00	115	0.035
1215	36.5	13	200.70	50.5	142.3	10.10	10.00	115	0.035
1230	36.4	14	200.65	51.1	144.0	10.10	10.05	115	0.035
1245	38.1	12	200.80	50.8	143.2	10.08	10.00	115	0.035
1300	29.0	12	200.85	51.1	145.2	10.10	10.05	115	0.035
1315	23.6	15	200.78	51.1	145.2	10.10	10.00	115	0.035
1330	21.5	16	200.71	51.6	147.5	10.10	10.00	115	0.035
1345	20.0	21	200.75	51.6	145.4	10.10	10.00	115	0.035
1400	20.3	23	200.70	51.6	145.4	10.10	10.00	115	0.035
1415	12.6	29	200.61	52.8	147.0	10.10	10.00	115	0.036
1430	1.2	--	200.61	53.4	154.6	10.16	10.00	115	0.034
1445	1.9	--	200.60	54.0	156.5	10.16	10.00	115	0.034
1500	0.5	--	200.68	52.5	152.5	10.10	10.10	115	0.034
1515	1.9	--	200.70	51.1	160.0	10.00	10.10	115	0.032
1530	1.5	--	------	----	-----	10.00	10.20	115	0.033

Note: At time 1530 the relays were tested for proper operation at low temperature. The grid coil of the oscillator was deliberately grounded and plate voltage was then applied to check overload relay. All relays operated satisfactorily.

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Table 2 - Section II

Model SC-1 Radar Equipment

VARIATION IN RELATIVE HUMIDITY

Time	Amb. Temp. °C	Rel. Hum. %	Freq. Mc	Power Output Aver. Watts	Power Output Peak Kw	Oscillator Ip Ma	Oscillator Ep Kv	Line Voltage Volts	Duty Cycle %
0845	40.9	25	200.54	48.4	134.5	10.06	10	115	0.036
0900	41.2	25	200.57	48.7	135.1	10.08	10	115	0.036
0915	41.5	25	200.57	48.4	134.5	10.10	10	115	0.036
0930	41.0	25	200.62	48.4	134.5	10.10	10	115	0.036
0945	41.0	25	200.54	48.7	135.1	10.08	10	115	0.036
1000	40.5	51	200.54	49.7	138.0	10.12	10	115	0.036
1015	41.0	87	200.54	49.7	137.6	10.16	10	115	0.036
1030	41.5	90	200.52	49.1	140.4	10.20	10	115	0.035
1050	42.0	93	------	48.1	137.5	10.20	10	115	0.035
1100	40.6	68	200.53	49.4	141.0	10.10	10	115	0.035
1115	40.0	80	200.72	49.1	139.9	10.10	10	115	0.035
1130	41.1	28	200.63	48.7	137.1	10.06	10	115	0.035
1145	40.6	23	200.65	49.7	137.1	10.10	10	115	0.035
1200	41.2	25	200.64	49.7	137.1	10.10	10	115	0.035
1215	41.3	25	200.63	49.7	138.0	10.10	10	115	0.036
1230	41.4	25	200.67	49.7	138.0	10.10	10	115	0.036

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Table 3 - Section II

Model SC-1 Radar Equipment

STARTING AT HIGH HUMIDITY

Time Sec.	Oscillator Ip Ma	Oscillator Ig Ma	Power Output Aver. Watts
5	12.2	2.3	46.1
37	12.0	2.5	46.7
100	10.14	2.6	48.1
180	10.10	2.7	49.4

Note: With the transmitter off, the humidity was maintained between 82 and 93 per cent at a temperature of 35 degrees Centigrade for one-half hour. Power was applied, the plate variac setting was increased from zero to the 10-kilovolt point and the above readings were taken.

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Table 4 - Section II

Model SC-1 Radar Equipment

EFFECTS OF VIBRATION - TRANSMITTER UNIT

Time	*Plate Current Meter Ma	Grid Cur. Ma	Power Output Aver. Watts	Power Output Peak Kw	Duty Cycle %	Output Freq. Mc	Vibration Frequency Cycle/Min.
	Plate Disc Supports in Place (See Note 1).						
0930	3.0	2.5	16.2	28.4	0.057	197.95	600 to 2000
0950	3.0	2.5	16.2	28.4	0.057	------	850
1030	3.0	2.5	16.2	28.4	0.057	------	850
1050	3.0	2.5	16.2	28.4	0.057	197.70	850
1050	Power switched off.						
	Transmitter Restored to Normal (No Plate Disc Supports).						
1105	Power switched on.						
1110	2.6	2.0	16.0	28.0	0.057	197.05	600 to 2000
1140	2.5	2.0	16.0	28.0	0.057	196.80	850
1225	2.5	1.9	15.8	27.9	0.057	196.80	850
1310	2.6	1.9	16.4	28.8	0.057	196.80	1050
1330	2.6	1.9	16.2	28.4	0.057	------	1050
1400	2.6	1.9	15.8	27.7	0.057	------	1050
1415	2.6	1.9	16.0	28.0	0.057	196.75	1050

Note: (1) The aluminum disc, to which the plate connection of the oscillator tubes is made, was fastened to the floor of the oscillator tube compartment by means of insulators. This disc is not normally fastened down in this way and the connection was provided in this case because preliminary tests made previous to the present vibration test indicated that the tube supporting structure was not sufficiently rigid.

(2) At 850 cycles per minute, the following was noted:

(a) The unit vibrates as a whole.
(b) The "Output Coupling" tuning-control-cable pulley is fastened to the cathode tuning compartment floor but is not mounted rigidly and vibrates excessively, striking against the left rear corner of the cathode-tuning-section shield box. A slight (r.f.) arcing is visible at the point of contact.

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Table 4 - Section II (Cont'd)

Note: (3) At 1050 c.p.m., the r-f oscillator tube assembly vibrated.

(4) The following quantities were held constant during the tests:

Filament primary voltage:	110 Volts.
Repetition rate:	60 C.P.S.

* Plate meter was read without operating push-to-read switch. Indicated values are not total plate current.

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Table 5 - Section II

Model SC-1 Radar Equipment

EFFECT OF VIBRATION - ANTENNA

Vibration Frequency C.P.M.	Vibrating Part (Note 1)	Maximum Amplitude of Motion (Overall). Inches	Remarks
1025	A, B	5/16	
	C, D	1/4	
1225	A, B	3/8	
	C, D	1/4	
	F, J	1/4	
	G, H	1/4	
1425	A, B	5/16	
	D	3/8	
	J	5/16	J striking I
1550	A', B'	3/16	
	G, M	1/8	
	J	5/16	J striking I
Antenna Pointing 90° from Direction in First Test			
550	C, D	1/4	
1225	A, B	1/2	
	C, D	3/8	
	G, H	1/4	
	K	1/8	
1350	D	3/4	
	G	1/4	
	L	1/16	
	J	5/16	J striking I
1500	J	5/16	J striking I
2000	L, N	1/16	

Note: (1) Letters in this column refer to points thus marked on Plates 25 and 26.
(2) The antenna was vibrated for a total period of two hours.
(3) At the conclusion of the vibration test, there was some evidence noted of fractures at the welds by which the dipole radiators are joined to the transmission lines.

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Table 5 - Section II (Cont'd)

Note: (4) Supports from A to P and from B to Q reduced the amplitude of vibration at point D very considerably and the vibration at various other points appreciably.

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Table 6 - Section II

Model SC-1 Radar Equipment

EFFECT OF SHOCK - TRANSMITTER

Oscillator-Tube Plate Disk Supports in Place (See Note)

Ten shocks were delivered from the front of the unit. Shock number 1 was at 100 lbs./sq. in.; all others were at 150 lbs./sq. in. No damage occurred as a result of these shocks.

Note: The aluminum disc, to which the plate connection of the oscillator tubes is made, was fastened to the floor of the oscillator-tube compartment by means of insulators. The disc is not normally fastened down in this manner and the connection was provided in this case because preliminary tests made previously indicated that the tube supporting structure was not sufficiently rigid.

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Table 7 - Section II

Model SC-1 Radar Equipment

EFFECT OF SHOCK - TRANSMITTER UNIT

Shocks delivered from the front. Transmitter restored to normal (plate disc supports removed).

Shock No.	Power Output Aver. Watts	Freq. Mc	Grid Cur. Ma	**Plate Cur. Meter Ma
-	14	198.45	1.7	2.5
-	14	198.70	1.7	2.5
1	14	198.75	1.7	2.5
2	14	198.70	1.7	2.5
3	14	198.75	1.7	2.5
4	14	198.65	1.7	2.5
5*	14	198.80	1.7	2.5
	17.7	198.55	2.1	2.8
6	18.5	198.50	2.0	2.8

Note: (1) The filament primary voltage was maintained at 110 volts.

(2) Shocks 1, 2, 3, 4, and 5 were delivered at 150 lbs./sq. in. pressure. Shock 6 was delivered at 136 lbs./sq. in.

(3) During shock number 6, the top of the transmitter cabinet was momentarily displaced 2.25 inches with respect to the support to which the upper shock mount was fastened.

*(4) The transmitter was retuned after shock number 5 to compensate for a change in dummy antenna system.

(5) Maximum change in frequency during test: 198.80 Mc - 198.45 Mc = 350 kilocycles or 0.18 per cent.

**(6) Plate meter was read without operating push-to-read switch. Indicated values are not total plate current.

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Table 8 - Section II

Model SC-1 Radar Equipment

EFFECT OF SHOCK - TRANSMITTER UNIT

Shocks delivered from front. Plate disc supports in place (see Note 5).

Shock No.	Power Output Aver. Watts	Freq. Mc	Plate Cur. Meter Ma	Grid Cur. Ma
1	15.8	198.15	2.7	1.85
2	14.0	198.20	2.6	1.75
3	15.3	198.25	2.6	1.75
4	15.3	198.40	2.6	1.85
5	16.5	198.40	2.6	1.85
6	17.7	198.35	2.6	1.85
7	15.1	198.35	2.6	1.85
8	14.6	198.35	2.6	1.85
9	14.8	198.35	2.6	1.90
10	14.0	198.35	2.6	1.90

Note: (1) Transmitter was retuned after shock 3 to compensate for a change which occurred in dummy antenna system.

(2) Filament primary voltage was held at 110 volts.

(3) Maximum change in frequency:
198.40 mc - 198.35 mc = 50 kilocycles or 0.025 per cent.

(4) All shocks delivered at 150 lbs./sq. in. air pressure.

(5) The aluminum disc, to which the plate connection of the oscillator tubes is made, was fastened to the floor of the oscillator tube compartment by means of insulators. This disc is not normally fastened down in this way and the connection was provided in this case because preliminary tests made previous to the present shock test indicated that the tube supporting structure was not sufficiently rigid.

*(6) Plate meter was read without operating push-to-read switch. Indicated values are not total plate current.

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Table 9 - Section II

Model SC-1 Radar Equipment

EFFECT OF SHOCK - TRANSMITTER UNIT

Shocks delivered from left side.
Plate disc supports in place (see Note 4).

Shock No.	Power Output Aver. Watts	Freq. Mc	*Plate Cur. Meter Ma	Grid Cur. Ma
1	16.5	200.10	2.5	1.7
2	16.5	199.40	2.5	1.7
3	16.5	200.15	2.5	1.7

Note: (1) Shock 1 was delivered at 100 lbs./sq. in. air pressure; shocks 2 and 3 at 150 lbs./sq. in.

(2) The filament primary voltage was maintained at 110 volts during this test.

(3) Maximum change in frequency during test: 200.15 mc - 199.40 mc = 750 kilocycles or 0.37 per cent.

(4) The aluminum disc, to which the plate connection of the oscillator tubes is made, was fastened to the floor of the oscillator tube compartment by means of insulators. This disc is not normally fastened down in this way and the connection was provided in this case because preliminary tests made previous to the present shock test indicated that the tube supporting structure was not sufficiently rigid.

*(5) Plate meter was read without operating push-to-read switch. Indicated values are not total plate current.

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Table 10 - Section II

Model SC-1 Radar Equipment

EFFECT OF SHOCK - TRANSMITTER UNIT

Shocks delivered from left side. Transmitter normal (plate disc supports not in place).

Shock No.	Power Output Aver. Watts	Freq. Mc	*Plate Cur. Meter Ma	Grid Cur. Ma
-	16.5	198.15	2.6	1.8
1	16.5	198.20	2.6	1.7
2	16.5	201.45	2.6	2.0
3	16.5	201.65	2.6	1.95
4	16.5	201.70	2.6	1.80
5	17.3	201.85	2.6	1.70
6	15.8	201.30	2.6	2.00
7	15.3	201.35	2.7	1.80
8	14.3	201.40	2.6	1.80
9	15.3	201.50	2.7	1.90
10	14.8	201.55	2.6	1.95
11	15.3	201.15	2.6	1.95
12	15.3	201.35	2.6	1.95

Note: (1) Retuning was necessary after shocks 2 and 4 to compensate for changes in dummy load.

(2) The left rear grid connection on left front tube came off as a result of shock number 12. The overload relay did not open as a result of this, even though the plate current rose to approximately double its normal value.

(3) The grid connection was replaced after the 12th shock and the equipment operated normally. However, after the preparations for part 6 were complete (shock table rotated), it was found that the left front type 327A oscillator tube arced over internally. This was found to be the result of a broken plate seal. It is probable that this seal was broken by shock number 12 and that air leaked in gradually while the preparations for the next test (Table 11) were being made.

(4) Maximum change in frequency during test: 201.85 mc - 201.15 mc = 700 kilocycles or 0.35 per cent.

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Table 10 - Section II (Cont'd)

Note: (5) All shocks were delivered at 150 lbs./sq. in. air pressure.

*(6) Plate meter was read without operating push-to-read switch. Indicated values are not total plate current.

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Table 11 - Section II

Model SC-1 Radar Equipment

EFFECT OF SHOCK - TRANSMITTER UNIT

Shocks delivered from rear. Transmitter normal (plate disc supports not in place).

Shock No.	Power Output Aver. Watts	Freq. Mc	*Plate Cur. Meter Ma	Grid Cur. Ma
-	16.5	199.30	2.5	1.6
1	16.5	199.60	2.5	1.7
2	16.5	199.55	2.5	1.7
3	16.5	199.55	2.5	1.7
4	17.7	199.45	2.5	1.7
5	17.7	199.45	2.5	1.7
6	17.7	199.50	2.5	1.7
7	17.7	199.50	2.5	1.7
8	17.7	199.45	2.5	1.7
9	16.5	199.50	2.5	1.7
10	17.7	199.60	2.5	1.6
11	17.7	199.55	2.5	1.6
12	17.7	199.90	2.5	1.6

Note: (1) During shock number 12 the top of the cabinet was displaced momentarily 1.25 inches with respect to the support to which the upper shock mount was fastened.

(2) The filament primary voltage was maintained at 110 volts during this test.

(3) All shocks were delivered at an air pressure of 150 lbs./sq. in.

*(4) Plate meter was read without operating push-to-read switch. Indicated values are not total plate current.

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Table 12 - Section II

Model SC-1 Radar Equipment

EFFECT OF SHOCK - ANTENNA

Shock No.	Air Pressure Lbs./Sq. In.	Antenna Position (Note 2)	Axis of the Vibration Caused by Shock. (Note 1)	Remarks (Note 1)
1	100	Front	----	Dipole feed lines (I and J) vibrate.
2	150	Front	----	Dipole feed lines (I and J) vibrate. The ninth reflector wire from the bottom vibrates.
3	150	Front	----	Dipole feed lines (I and J) vibrate. The ninth reflector wire from the bottom vibrates.
4	150	Right	Rotary Joint	----
5	150	Right	Rotary Joint	----
6	150	Rear	Rotary Joint and Vertical Axis "C" to "D".	----
7	150	Rear	Rotary Joint and Vertical Axis "C" to "D".	----
8	150	Rotating	Rotary Joint and Vertical Axis "C" to "D".	This shock caused the antenna to hunt momentarily.
9	150	Rear	Rotary Joint	----
10	135	Rear	Rotary Joint	----
11	150	Left	Rotary Joint	Dipole feed lines (I and J) vibrate.
12	150	Left	Rotary Joint	Dipole feed lines (I and J) vibrate.
13	150	Left	Rotary Joint	Dipole feed lines (I and J) vibrate.
14	150	Rotating	Rotary Joint	Dipole feed lines (I and J) vibrate.
15	150	Rotating	Rotary Joint	Dipole feed lines (I and J) vibrate.
16	150	Rotating	Rotary Joint	Dipole feed lines (I and J) vibrate.
17	150	Rotating	Rotary Joint	Dipole feed lines (I and J) vibrate.
18	150	Rotating	Rotary Joint and Vertical Axis "C" to "D".	----

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Table 12 - Section II (Cont'd)

Shock No.	Air Pressure Lbs./Sq. In.	Antenna Position (Note 2)	Axis of the Vibration Caused by Shock. (Note 1)	Remarks (Note 1)
19	150	Rotating	Rotary Joint	----
20	150	Rotating	Rotary Joint	Dipole feed lines (I and J) vibrate.

Note: (1) Letters refer to points thus marked on Plates 25 and 26.

(2) "Antenna position" indicates direction in which shock was applied.

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Table 13 - Section II

Model SC-1 Radar Equipment

EFFECT OF INCLINATION - TRANSMITTER

Inclination from Front to Back.

Position	Power Output Aver. Watts	Freq. Mc	*Plate Meter Ma	Grid Cur. Ma
Stationary and inclined 45° to front.	20.0	197.85	4.0	1.85
Stationary and vertical.	20.2	197.90	4.0	1.85
Stationary and inclined 45° to rear.	20.0	193.70	4.0	1.85

After the above measurements, the transmitter was inclined 45° to each side of the vertical at the rate of 5 cycles per minute for 30 minutes. At the end of this period the inclination was stopped and the following measurements were taken.

Stationary and inclined 45° to front.	21.3	194.05	4.0	1.80
Stationary and vertical.	21.6	194.05	4.0	1.80
Stationary and inclined 45° to rear.	20.7	193.85	4.0	1.80

Note: (1) Maximum change in output frequency during test: 197.90 mc - 193.70 mc = 2.2 megacycles or 1.1 per cent.

*(2) Plate meter was read without operating push-to-read switch. Indicated values are not total plate current.

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Table 14 - Section II

Model SC-1 Radar Equipment

EFFECT OF INCLINATION - TRANSMITTER

Inclination from Side to Side.

Position	Power Output Aver. Watts	Freq. Mc	*Plate Cur. Meter Ma	Grid Cur. Ma
Stationary and inclined 45° to right.	16.7	193.90	3.5	1.6
Stationary and vertical.	17.7	193.95	3.5	1.6
Stationary and inclined 45° to left.	17.0	193.75	3.5	1.6

The transmitter was then rolled 45° to each side of the vertical at the rate of 5 cycles per minute for 30 minutes. At the end of this period the rolling was stopped and the following measurements were taken.

Stationary and inclined 45° to right.	18.8	193.80	3.9	1.7
Stationary and vertical.	19.3	193.80	3.9	1.7
Stationary and inclined 45° to left.	18.5	193.85	3.9	1.7

Note: (1) Maximum change in output frequency during test: 193.95 mc - 193.75 mc = 200 kilocycles or 0.1 per cent.

(2) Filament primary voltage was maintained at 110 volts during test.

*(3) Plate meter was read without operating push-to-read switch. Indicated values are not total plate current.

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Table 15 - Section II

Model SC-1 Radar Equipment

VARIATION IN LINE VOLTAGE

Line Voltage Volts	*Plate Cur. Meter Ma	Grid Cur. Ma	Filament Primary Volts	Power Output Aver. Watts	Power Output Peak Kw	Duty Cycle %	Freq. Mc	Osc. Filament Voltage Volts
126.5	5.00	2.80	121.0	21.2	88.5	0.024	196.45	12.33
125.0	5.00	2.75	119.5	20.7	86.5	0.024	196.70	12.17
123.0	5.00	2.65	117.5	20.2	81.0	0.025	196.60	11.95
121.0	4.90	2.60	116.0	19.9	79.5	0.025	196.50	11.75
119.0	4.75	2.50	113.5	19.0	73.1	0.026	196.55	11.50
117.0	4.70	2.40	111.5	18.8	72.5	0.026	196.65	11.34
115.0	4.60	2.30	110.0	18.3	67.5	0.027	196.70	11.14
113.0	4.50	2.20	108.0	17.9	64.0	0.028	196.65	10.91
111.0	4.50	2.10	106.0	17.3	58.5	0.030	196.75	10.72
109.0	4.30	2.00	104.0	16.7	53.7	0.031	196.80	10.54
107.0	4.30	1.85	102.0	15.6	47.0	0.033	196.85	10.34
105.0	4.20	1.70	99.5	15.3	45.0	0.034	196.90	10.12
103.5	4.10	1.60	98.0	14.8	41.0	0.036	196.90	10.00

Note: (1) Per cent change in peak power between normal and plus 10 per cent line voltage: 88.5 kw - 67.5 kw = 21.0 kw or 31 per cent.

(2) Per cent change in peak power between normal and minus 10 per cent line voltage: 67.5 kw - 41.0 kw = 26.5 kw or 39 per cent.

(3) Maximum change in frequency: 196.90 mc - 196.45 mc = 450.0 kilocycles or 0.23 per cent.

*(4) Plate meter was read without operating push-to-read switch. Indicated values are not total plate current.

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Table 16 - Section II

Model SC-1 Radar Equipment

CURRENT REQUIRED FROM SUPPLY LINE

Transmitter, Control Unit, and Amplidyne Generator.

Line Voltage:	230.	Volts
Line Current (Normal):	6.8	Amps.
Line Current (Starting Surge):	16.5	Amps.
Kilovolt Amperes Required from Line:	1.564	KVA

The transmitter was operating as follows:

Duty Cycle:	0.033	Per Cent
Aver. Power:	32.	Watts
Peak Power:	97.	Kilowatts
Repetition Rate:	60.	Cycles/Sec.
One-Half Plate Current:	3.5	Ma.
Filament Primary Voltage:	110.	Volts
Grid Current:	2.0	Ma.

Fuse Symbol	Fuse Current Amps.	Fuse Voltage Volts	Fuse Rating Current Amps.	Fuse Rating Voltage Volts
F-301	6.6	115	20	250
F-302	6.6	115	20	250

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Table 17 - Section II

Model SC-1 Radar Equipment

WEIGHTS AND DIMENSIONS

Item	Weight in Pounds	Overall Dimensions in Inches		
		Width	Depth	Height
Transmitter Unit	*320.0	23	24	*60
Control Unit	115.0	14	21-3/4	19-1/2
Dimmer Box	1.5	5-5/8	5-5/8	3-1/16
Antenna	375.0	114	--	83-1/2
Power Transformer	95.0	9	18	7-5/8
Amplidyne	47.5	10	18-3/4	8-3/4
Reprod	27.5	10-3/4	16-1/4	12
Keying Monitor	19.5	8-3/8	35-1/4	5-5/8

Note: *(1) Transmitter height was measured to top of 2-1/2-inch coupling sleeve on top of unit. Transmitter weight does not include weight of keying monitor.

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Table 18 - Section II

Model SC-1 Radar Equipment

CONTROL AMPLIFIER A-C AND D-C TUBE POTENTIALS

Designation	Voltage Measured from Pin	Potential Involved	A-C Component *(Volts A.C.)	D-C Component (Volts D.C.)
V-151	3 to 8	Plate	330.	39.
V-151	4 to 8	Screen	285.	12.
V-151	5 to 8	Grid	72.	51.
V-151	2 to 7	Filament	6.0	--
V-152	3 to 8	Plate	335.	39.
V-152	4 to 8	Screen	280.	11.5
V-152	5 to 8	Grid	57.	49.
V-152	2 to 7	Filament	6.0	--
V-153	3 to 8	Plate	274.	50.4
V-153	4 to 8	Grid	2.0	0.3
V-153	5 to 8	Grid	1.65	0.3
V-153	6 to 8	Plate	270.	50.3
V-153	2 to 7	Filament	6.45	--

Note: (1) Voltages, except filament, are measured to cathode (Pin 8).

(2) V-151 = Type 6L6; V-152 = Type 6L6; V-153 = Type 6N7.

*(3) Measured with an electrodynamometer type meter.

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Table 19 - Section II

Model SC-1 Radar Equipment

LIST OF CONTROLS

Note: Numbers in parentheses refer to notes at end of table.

Designations	Markings	Control	Calibration
		Control Unit	
A	Power	Switch	On-Off.
B	Trans. Plate Voltage	Variac	0 to 130 divisions in 330°
B		Switch	Off at 0 div. of Variac.
C	(1)	Switch	Relative - True.
D	Relative Bearing	Switch	On-Off.
E	Remote Alarm	Switch	(2)
F	(3)	Switch	Automatic-Manual.
H	Manual Control	Potentiometer	0 to 100 div., 0 to 10° in 360°.
J	R.R.	Switch	On-Off.
L	Relay Reset	Switch	(4)
	(5)	True and Relative Bearing Indicator	0 to 360° in 360°.
	Power	Indicator Lamp	----
	R.R.	Indicator Lamp	----
		Dimmer Box (6)	
	(7)	Power Indication Rheostat	(8)
	(9)	Indicator Illumination Rheostat	(10)
		Transmitter	
	Line Voltage	Meter	0 to 150 Volts A.C.
	Plate Current	Meter	0 to 25 ma.
	Grid Current	Meter	0 to 5 ma.
	Filament Hours	Meter	0 to 99,999 hours.
	Output Matching	Cable Control	0 to 100 divisions in 360°.
	Output Coupling	Cable Control	0 to 100 divisions in 360°.
	Oscillator Tuning	Control	0 to 100 divisions in 360°.

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Table 19 - Section II (Cont'd)

Designations	Markings	Control	Calibration
		Transmitter (Cont'd)	
	Filament Voltage Increase	Variac	(11)
	Duty Cycle	Switch	High-Low
	Transmitter	Switch	(12)
	Power	Switch	(13)
	Grid Resistance	Switch	1, 2, 3, 4, 5, 6, 7, 8.
	Plate Overload	Relay	(Target on operation).
	(14)	Plate Overload Reset Solenoid	----
	Plate Shorting	Switch	Safe-Operate
	(15)	Total Plate Current Switch	(16)
	Power	Indicator Lamp	----
	RF Line Indicator	Neon Bulb	----
		Pulse Indicator	
	Intensity	Potentiometer	(17)
	Focus	Potentiometer	(18)
	----	Switch	Off-On
	----	902 C-R Tube	----

Note Number	Omission	Suggested Marking
1	Marking	Bearing
2	Calibration	Push
3	Marking	Antenna Rotation
4	Calibration	Push
5	Marking	Bearing Indicator
6	Nameplate	
7	Marking	Power Indicator Light
8	Calibration	0 to 10 divisions in 330°.
9	Marking	Indicator Illumination.
10	Calibration	0 to 10 divisions in 330°.
11	Calibration	0 to 100 divisions in 330°.
12	Calibration	Off-On.
13	Calibration	Off-On.
14	Marking	Plate Overload Reset.
15	Marking	Total Plate Current.
16	Calibration	Push to Read.
17	Calibration	0 to 10 divisions in 330°.
18	Calibration	0 to 10 divisions in 330°.

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Table 20 - Section II

Model SC-1 Radar Equipment

LIST OF COMPONENTS - TRANSMITTER

Resistors

Circuit Symbol	Rated Value Ohms	Rated Value Watts	Marking	Measured Resistance Ohms
R-301	4,000	--	CAO-63760F	3,960
R-302	4,000	--	CAO-63706F	3,957
R-303	6	--	--	6.022
R-304	0.4 Meg.	10	--	0.38 Meg.
R-305	10,000	100	--	9,842
R-306	800	--	CAO-63470F	815.4
R-307	5	--	CAO-63920F	4.993
R-309	7.5 Meg.	20	--	7.5 Meg.
R-310	7.5 Meg.	20	--	7.5 Meg.
R-312	2	50	--	1.994
R-313	0.2 Meg.	10	--	0.196 Meg.
R-314	0.8 Meg.	10	--	0.81 Meg.
R-315	0.4 Meg.	10	--	0.40 Meg.
R-330	15	1	--	14.42
R-331	15	1	--	15.07
R-332	15	1	--	14.47
R-333	15	1	--	14.62
R-334	15	1	--	16.23
R-335	22	1	--	27.65
R-336	22	1	--	27.20
R-338	10	1	--	--
R-339	10	1	--	--
R-338 and R-339 in parallel				5.006

Capacitors

Circuit Symbol	Rated Values Mfd.	Rated Values Working Volts	Marking	Measured Capacity Mfd.	Measured Voltage
C-301	0.4 - 0.4	7,500	--	0.32 - 0.33	---
C-302	0.15	2,500	--	--	---
C-303	0.02	10,000	--	0.019	---
C-304	0.02	10,000	--	0.019	---
C-305	0.001	600	CD-48018-B2	--	---
C-306	0.001	600	CD-48018-B2	--	---
C-307	0.001	600	CD-48018-B2	--	125
C-308	0.001	600	CD-48018-B2	--	113

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Table 20 - Section II (Cont'd)

Switches

Circuit Symbol	Rating	Measured Voltage	Measured Current
S-301	60A-125V	115	6.6
S-302	30A-125V	115	0.11
S-303	10A-250V	115	0.11
S-304	10A-250V	115	0.11
S-305	--		
S-306	--		
S-307	--		
S-308	--		
S-309	10A-250V	115	0.11
S-310	10A-250V	115	0.11
S-311	15A-110V	115	0.11

Transformers

Circuit Symbol	Primary Voltage	Secondary Voltage	Insulation Kv
T-302	---	---	12.5
T-304	109.8	4.9 - 4.9	12.5
T-305	109.8	11.2	---
T-306	109.8	11.2	---
T-307	109.8	11.2	---
T-308	109.8	11.2	---
T-309	111.5	87 to 125	---
T-310	110.3	---	---

(Transformer measurements were made with 115 volts applied to Control Unit.)

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Table 21 - Section II

Model SC-1 Radar Equipment

LIST OF COMPONENTS - CONTROL UNIT

Resistors

Circuit Symbol	Rated Value Ohms	Rated Value Watts	Marking	Measured Resistance Ohms	Meas. Volts	Watts
R-102-A	500	25	--	503	61.5	7.5
R-102-B	500	25	--	232	8.2	0.29
				242	9.1	0.37
R-102-C	2,000	10	--	1,268	44.2	1.5
R-105	150	--	--	145	7.0	0.34
R-108	150	--	--	141	22.2	3.58
R-111	10,000	--	CAO-631036F	10,140	78.0	0.60
R-112	10,000	--	CAO-631036F	10,450	78.0	0.58
R-151	36,000	1	TB-1	36,800	30.0	0.0025
R-152	36,000	1	TB-1	37,900	30.0	0.0024
R-153	1,000	1	TB-1	998	4.3	0.019
R-154	51,000	2	TB-2	51,500	40.0	0.0031
R-155	51,000	2	TB-2	48,300	47.0	0.0046
R-156	24,000	1/2	TB-1/2	23,500	2.5	0.0003
R-157	24,000	1/2	TB-1/2	23,630	2.5	0.0003
R-159	150,000	1/2	TB-1/2	157,000	7.0	0.0003
R-160	150,000	1/2	TB-1/2	149,000	7.0	0.0003
R-162	16,000	1	TB-1	16,570	27.0	0.0044
R-163	5,000	25	--	4,905	8.0	0.0013
R-164	--	--	--	--	--	--
R-165	16,000	1	TB-1	16,540	26.5	0.0042

Capacitors

Circuit Symbol	Rated Value Mfd.	Rated Value Working Volts	Measured Resistance Ohms	Measured Voltage
C-151	0.1	500	0.099	47
C-152	0.1	500	0.098	40
C-154	6.0	600	6.15	30
C-155	1.0	500	0.99	28

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Table 21 - Section II (Cont'd)

Transformers

Circuit Symbol	Primary Voltage	Secondary Voltage
T-102	115.	78.6
T-103	114.5	6.72
T-104	111.6	6.35
T-151	10.0	3.72 - 3.72
T-152	112.	6.45, 6.0, 340

Switches

Circuit Symbol	Rated Value	
	Amps.	Volts
S-101	-	---
S-102	3	250
S-103	-	---
S-104	-	---
S-105	12	125
S-106	12	125
S-109	3	250

Indicator Lights

Circuit Symbol	Rated Value	
	Amps.	Volts
I-101	0.25	6-8
I-104	0.25	6-8
I-105	0.25	6-8

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Table 22 - Section II

Model SC-1 Radar Equipment

LIFE TEST OF ALIGNMENT SECTION

Resistance in Micro-Ohms

Total Time Hours	Total Cycles	Points on Outer Conductor (See Plate 28). A-A' Max.	A-A' Min.	B_W-B_W' Max.	B_W-B_W' Min.	B_T-B_T' Max.	B_T-B_T' Min.	C-C' Max.	C-C' Min.	D-D' Max.	D-D' Min.	Outer Conductor End-to-End Max.	Outer Conductor End-to-End Min.	Inner Conductor End-to-End Max.	Inner Conductor End-to-End Min.
Rotary Bending Motion - Flexible Joints															
00:00	0	70	--	135	--	--	--	110	--	140	--	1,000	700	570	--
07:25	48,060	110	--	200	--	--	--	75	--	180	--	15,000	--	125,000	1,500
12:05	78,000	70	--	110	55	85	40	165	95	115	85	2,000	385	5,000	2,800
20:32	134,000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24:32	160,000	160	50	240	40	420	130	145	70	125	50	5,500	660	10,000	4,500
Per Cent Increase during Test:		128%		78%				31%				450%		1,750%	
Sliding Motion - Slip Joint															
00:00	0			240	40	420	130								
07:00	45,400			110	75	85	65								

Note: Where maximum and minimum readings are shown, they represent the highest and lowest of ten readings.

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Table 23 - Section II

Model SC-1 Radar Equipment

AMPLIDYNE AND AMPLIDYNE CHARACTERISTICS

*Control Transformer Voltage Volts	Plate Current V-151 Ma	Plate Current V-152 Ma	Plate Current (V-151) - (V-152) Ma	Amplidyne Output Volts (No Load)
8	60.	25.	35.	240.
7	58.	27.	31.	222.
6	56.	30.	26.	206.5
5	55.	32.	23.	187.
4	52.	35.5	16.5	158.
3	50.5	39.5	11.	116.
2	48.	42.	6.	68.
1	45.	45.	0.	20.
0	43.	48.	- 5.	- 42.
**1	39.	50.	-11.	- 91.
2	35.5	51.	-15.5	-133.
3	32.	54.	-22.	-170.
4	28.	55.5	-27.5	-197.
5	25.	58.	-33.0	-220.
6	21.	59.	-38.0	-240.

Note: *(1) Voltage was varied by adjusting position of antenna train control on Control Unit. Control was moved in a clockwise direction.

**(2) Phase of voltage reversed.

(3) Antenna drive motor was disconnected from the amplidyne unit during this test. Antenna therefore remained stationary.

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Table 24 - Section II

Model SC-1 Radar Equipment

LOW TEMPERATURE EFFECTS - PULSE INDICATOR

Time	Amb. Temp. °C
1430	- 5.6
1445	- 9.5
1500	-12.2
1515	-13.9
1530	-14.5
1545	-16.7
1600	-17.9
1615	-17.9

Note: Vertical deflection of cathode-ray tube increased slightly during low temperature test.

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Table 25 - Section II

Model SC-1 Radar Equipment

VARIATION IN HUMIDITY - PULSE INDICATOR

Time	Amb. Temp. °C	Rel. Hum. %
0830	40.5	18
0845	42.0	21
0900	42.0	21
0915	41.0	25
0930	41.5	23
0945	41.0	97
1000	44.0	97
1015	42.0	97
1030	41.5	93
1045	41.5	93
1100	41.5	38
1115	41.0	23
1130	42.0	23
1145	42.0	40

No change in Pulse Indicator operation noted.

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Table 26 - Section II

Model SC-1 Radar Equipment

STARTING AT HIGH HUMIDITY - PULSE INDICATOR

Time	Amb. Temp. °C	Rel. Hum. %
1200	41.1	97
1215	41.1	97
1230	40.5	97
1245	40.5	97
1300	40.5	97
1315	40.5	97
1330	40.5	97
1345	40.5	97
1400	40.5	97

Note: (1) Applied power at 1400.

(2) Only change in operation noted when starting at high humidity was a slight decrease in vertical deflection of cathode-ray tube.

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Table 27 - Section II

Model SC-1 Radar Equipment

PLATE VOLTAGE EFFECTS - PULSE INDICATOR

Osc. E_p (Kv)	Pulse Indicator Deflection (Mm)	Oscillator I_g (Ma)	Oscillator I_p (Ma)	Grid Resistor (Tap)	Duty Cycle (%)	Power Output Average (Watts)	Power Output Peak (Kw)
5.50	19.0	0.82	5.2	6	0.0115	7.5	65
6.55	22.5	1.02	6.6	5	0.014	11.5	82
7.60	24.0	1.35	8.2	4	0.016	17.8	111
8.65	25.5	1.60	10.0	4	0.020	23.0	115
9.70	26.5	1.95	11.2	3	0.023	30.0	130

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Table 28 - Section II

Model SC-1 Radar Equipment

EFFECTS OF OUTPUT COUPLING CONTROL VARIATIONS - PULSE INDICATOR

Output Coupling (Setting)	Pulse Indicator Deflection (Mm)	Oscillator Ep (Kv)	Oscillator Ig (Ma)	Oscillator Ip (Ma)	Duty Cycle (%)	Power Output Average (Watts)	Power Output Peak (Kw)
01	23.5	8.0	1.505	9.2	0.020	17.2	86.0
10	23.6	8.0	1.505	9.2	0.020	17.1	85.6
20	23.5	8.05	1.51	9.2	0.0185	17.2	93.0
30	23.0	8.05	1.51	9.2	0.020	17.2	86.0
40	23.0	8.05	1.53	9.4	0.020	17.9	89.5
50	22.5	8.05	1.54	9.4	0.020	17.9	89.5
60	23.0	8.05	1.54	9.4	0.0205	18.2	90.6
70	23.5	8.05	1.50	9.2	0.020	18.4	92.1
80	23.5	8.05	1.46	9.0	0.020	18.5	92.5
90	24.5	8.1	1.42	9.6	0.019	18.4	96.8
95	24.5	8.1	1.39	9.5	0.018	18.2	101.1

Note: (1) Line voltage retained at 115 volts a.c. and filament voltmeter set at 110 volts a.c.

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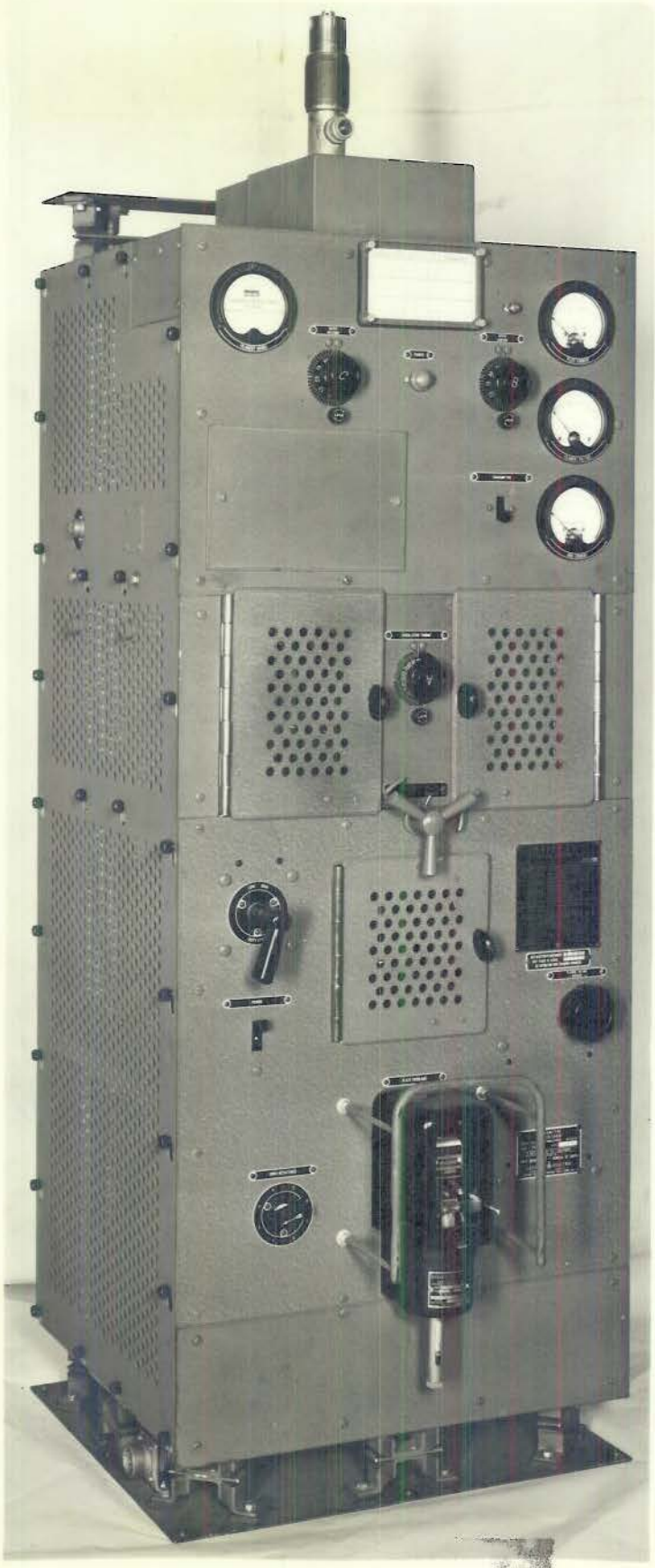

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PLATE I

SECTION II

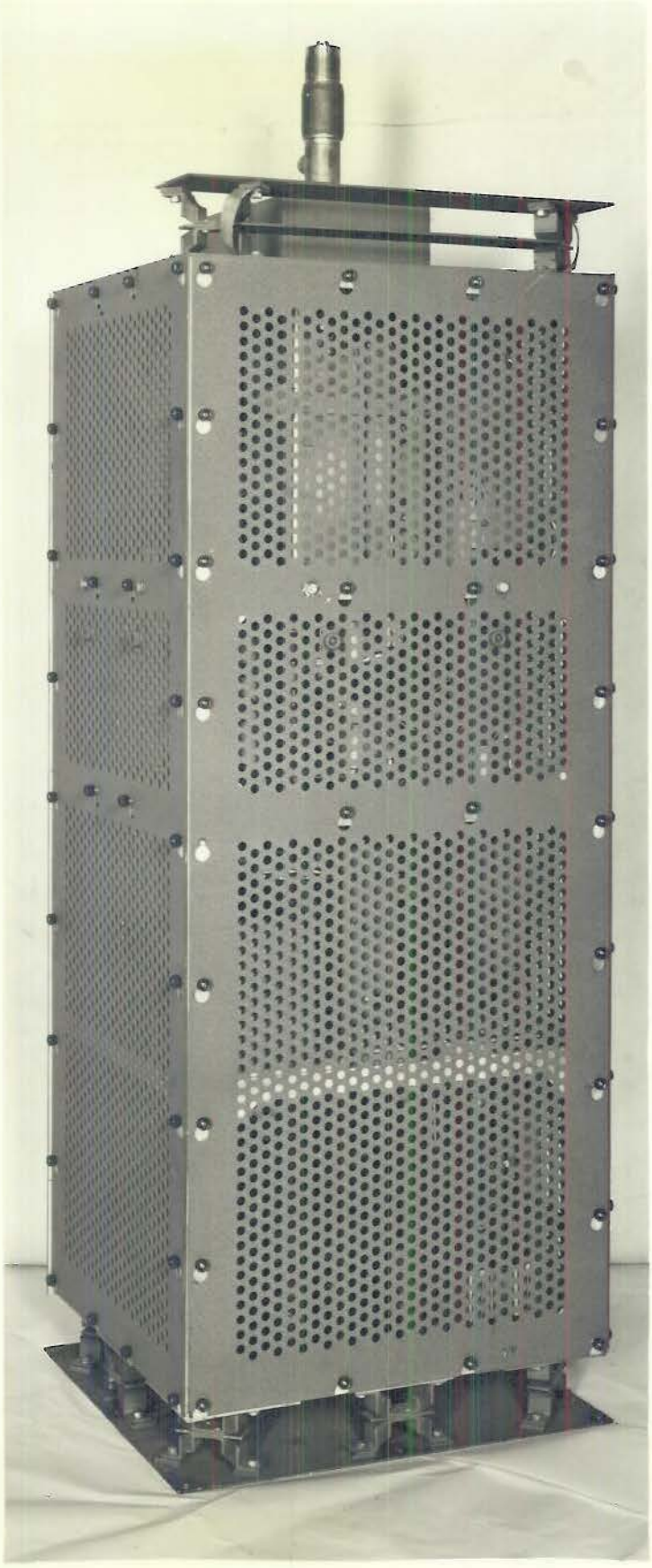

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PLATE 2

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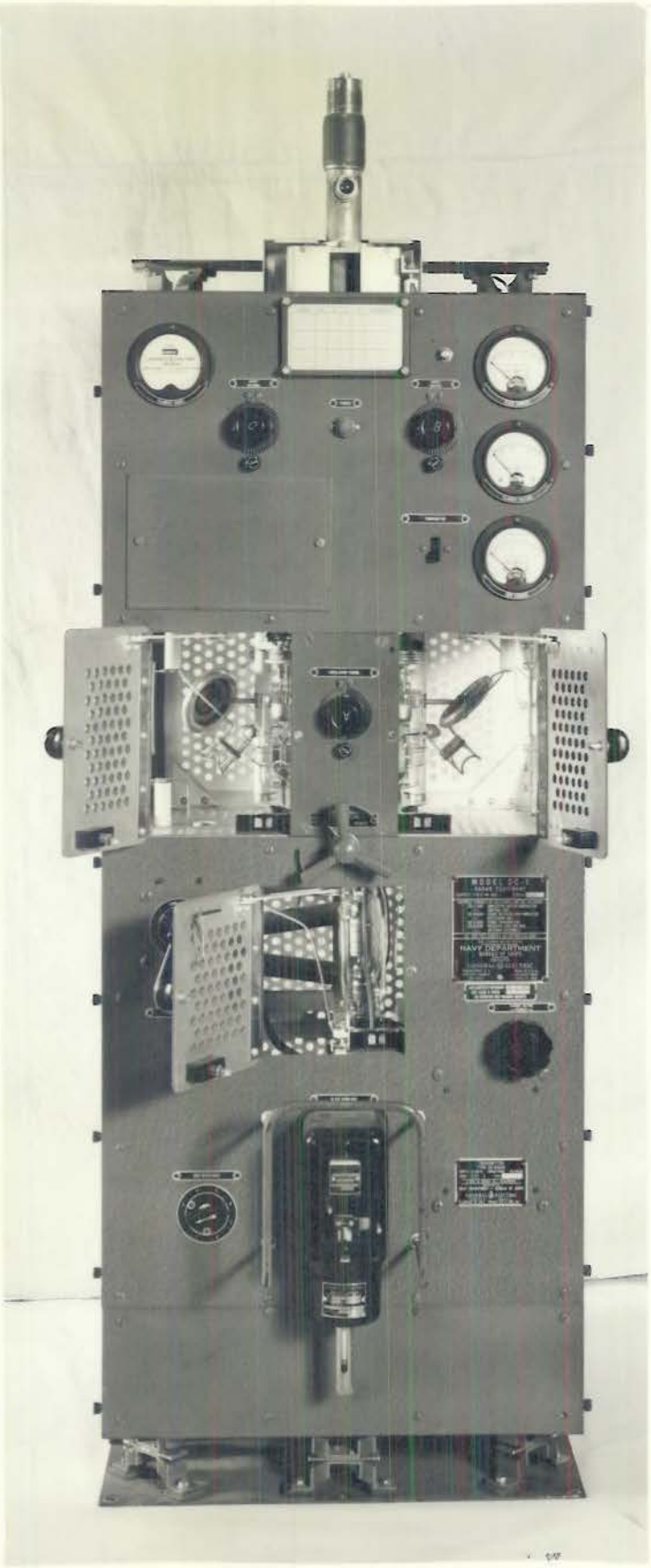

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PLATE 3

SECTION II

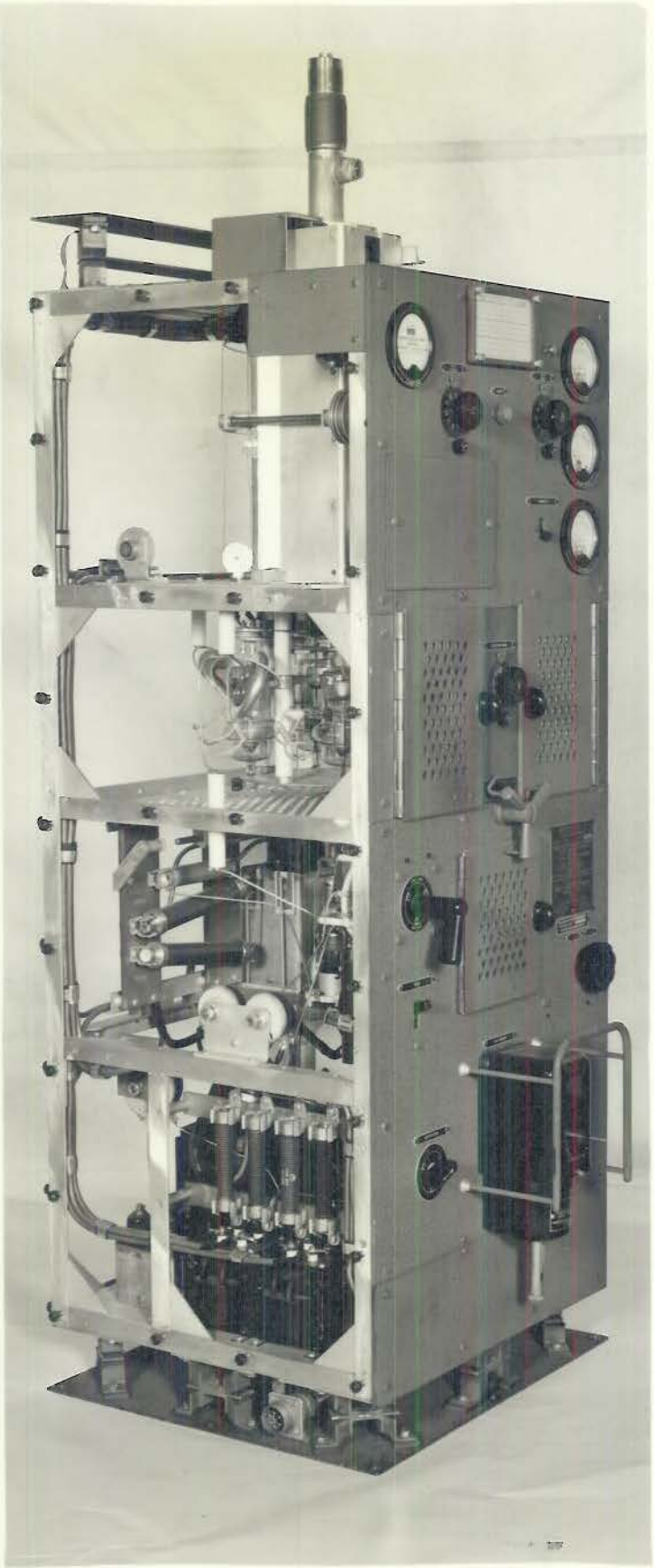

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PLATE 4

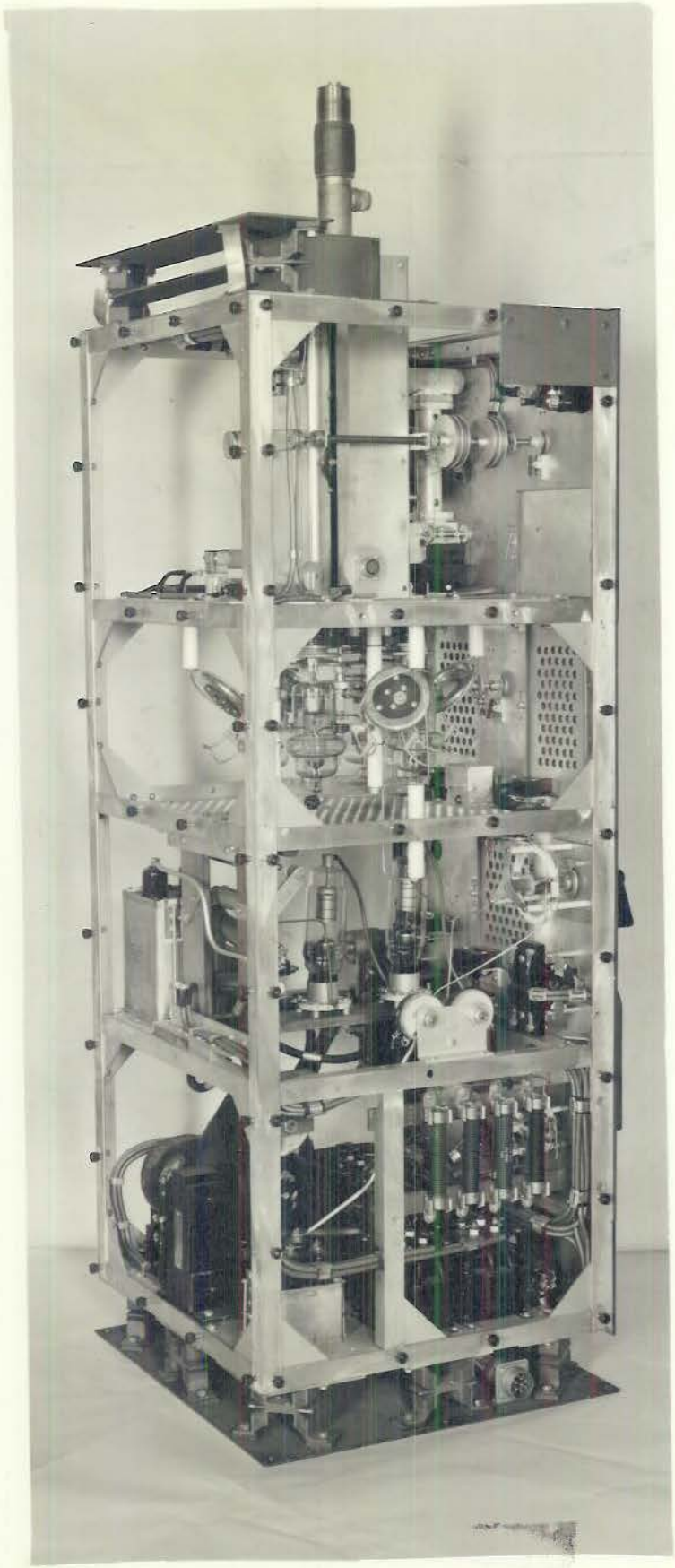

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PLATE 5

SECTION II

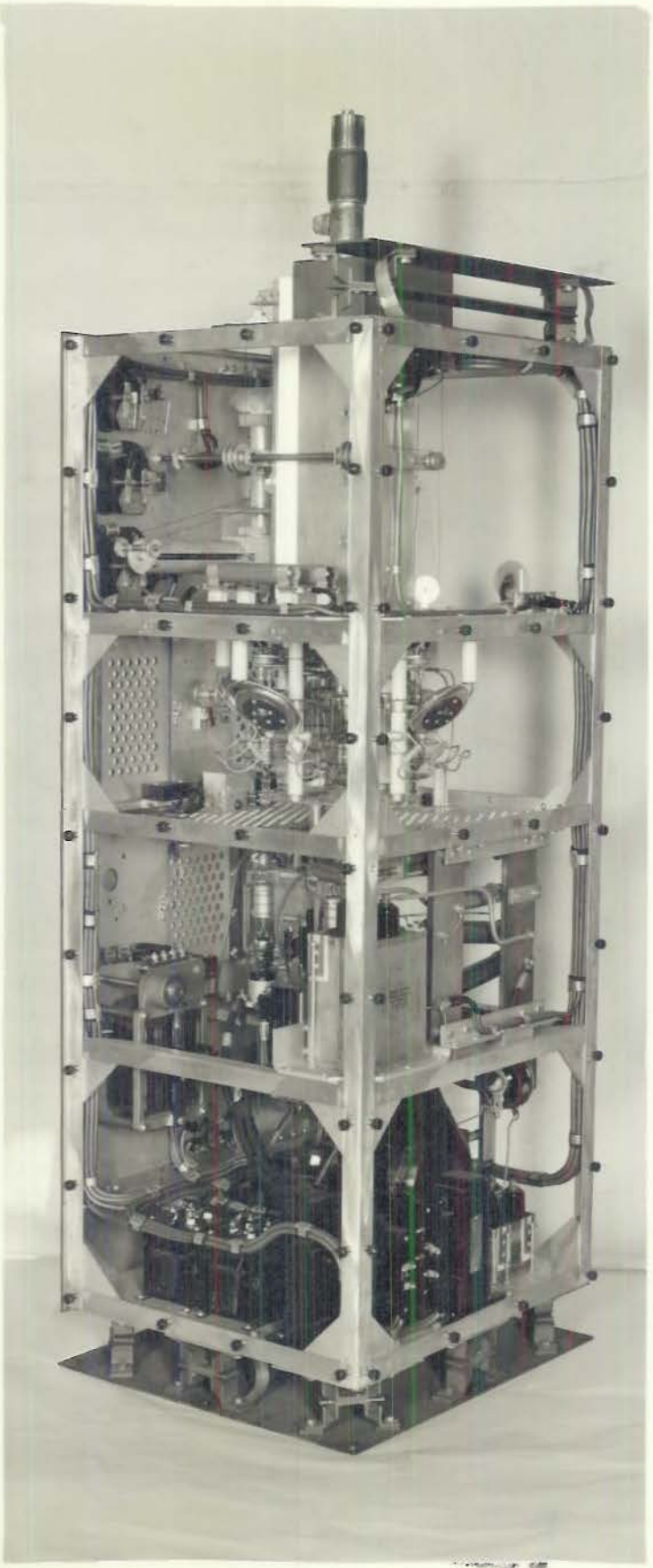

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PLATE 6

SECTION II

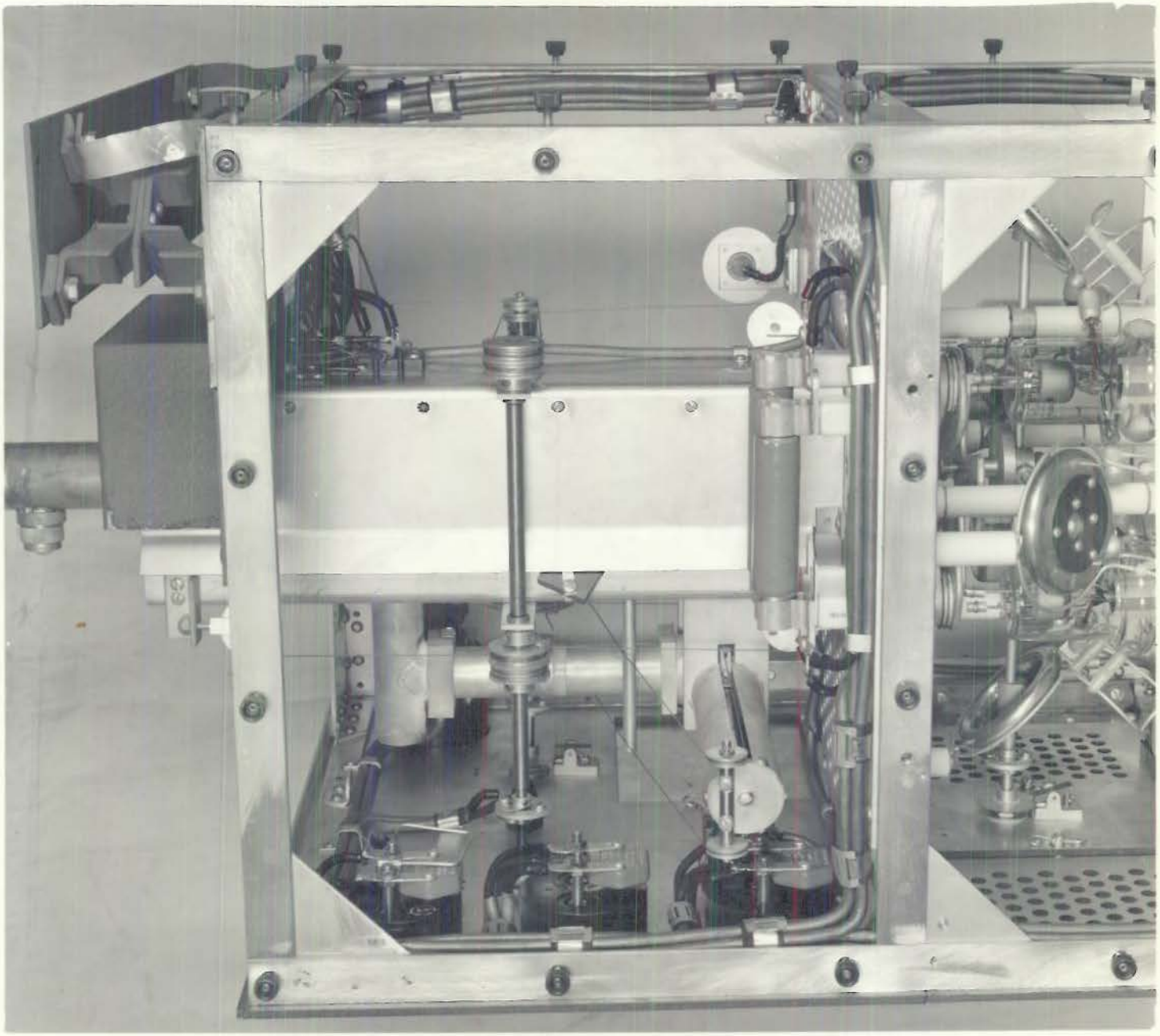

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PLATE 7

SECTION II

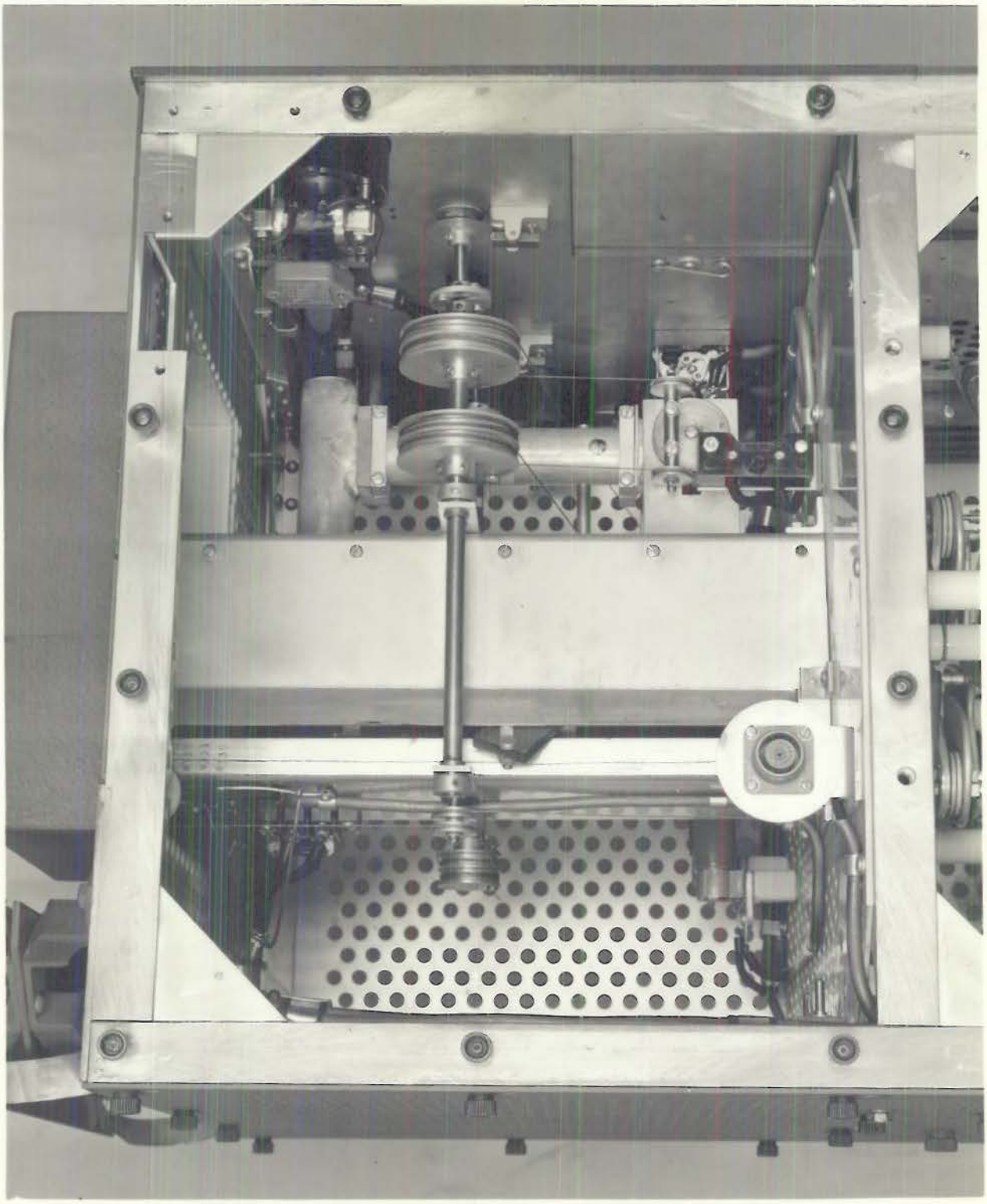

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PLATE 8

SECTION II

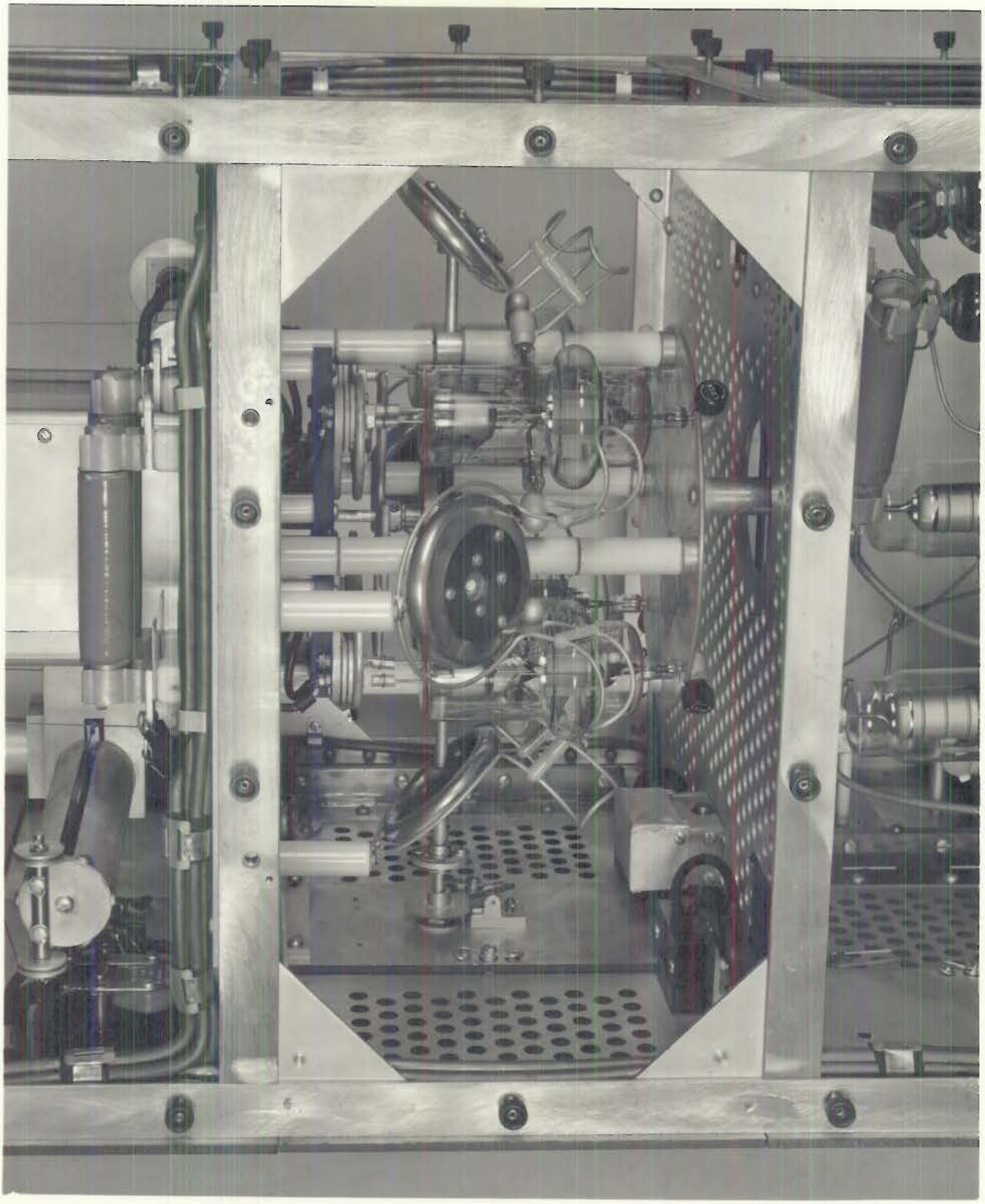

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PLATE 9

SECTION II

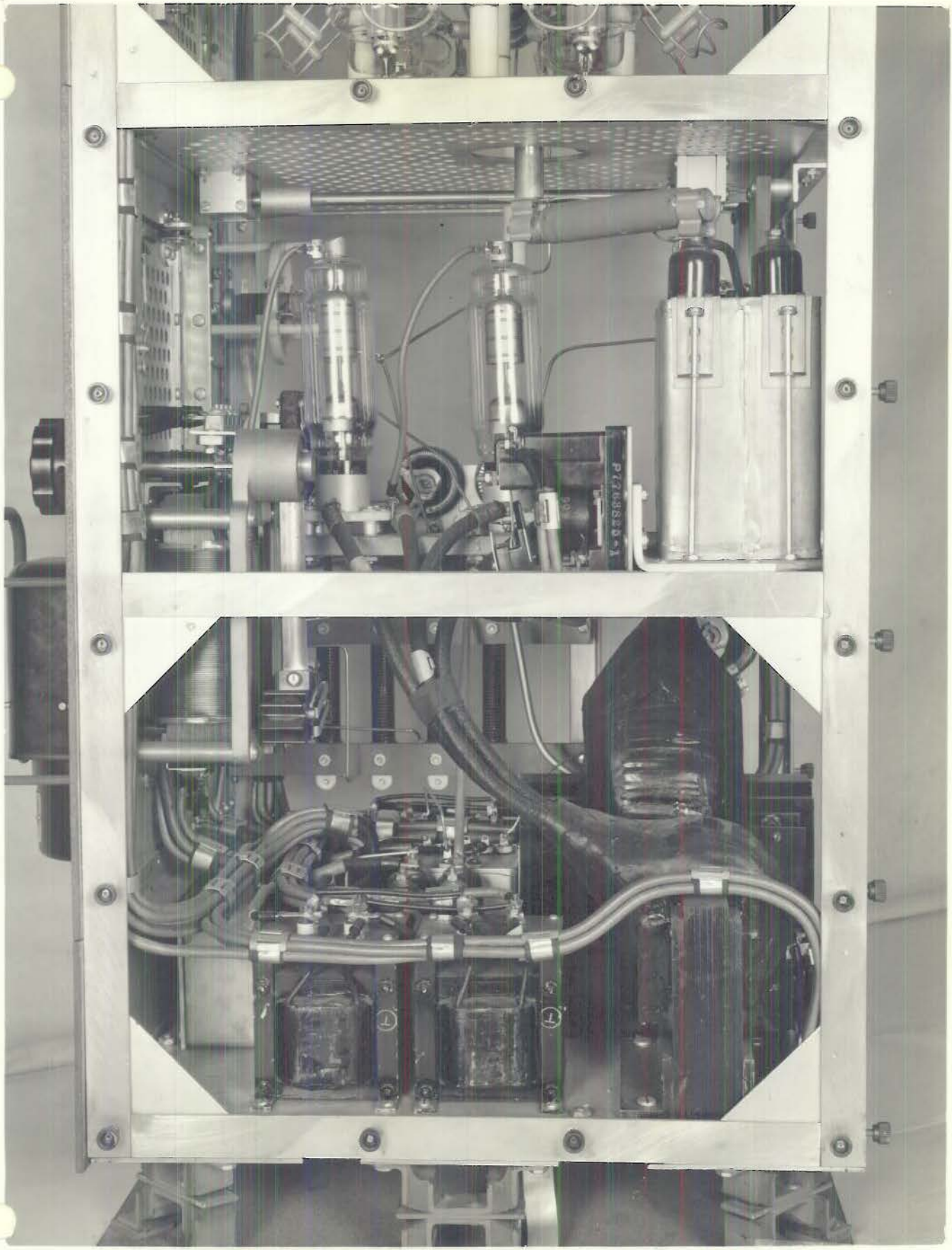

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PLATE 10
SECTION II

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PLATE 11
SECTION II

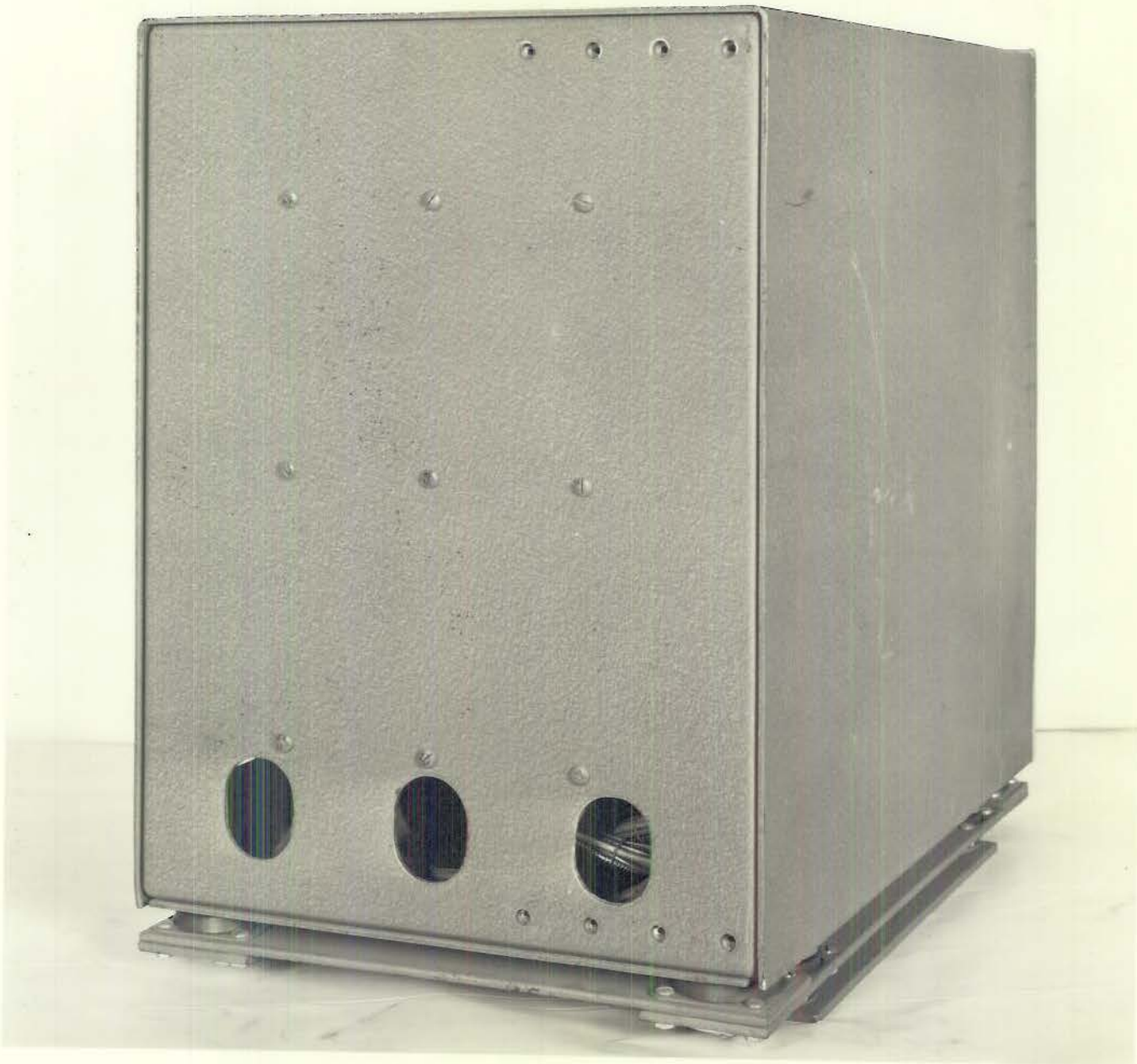

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PLATE 12
SECTION II

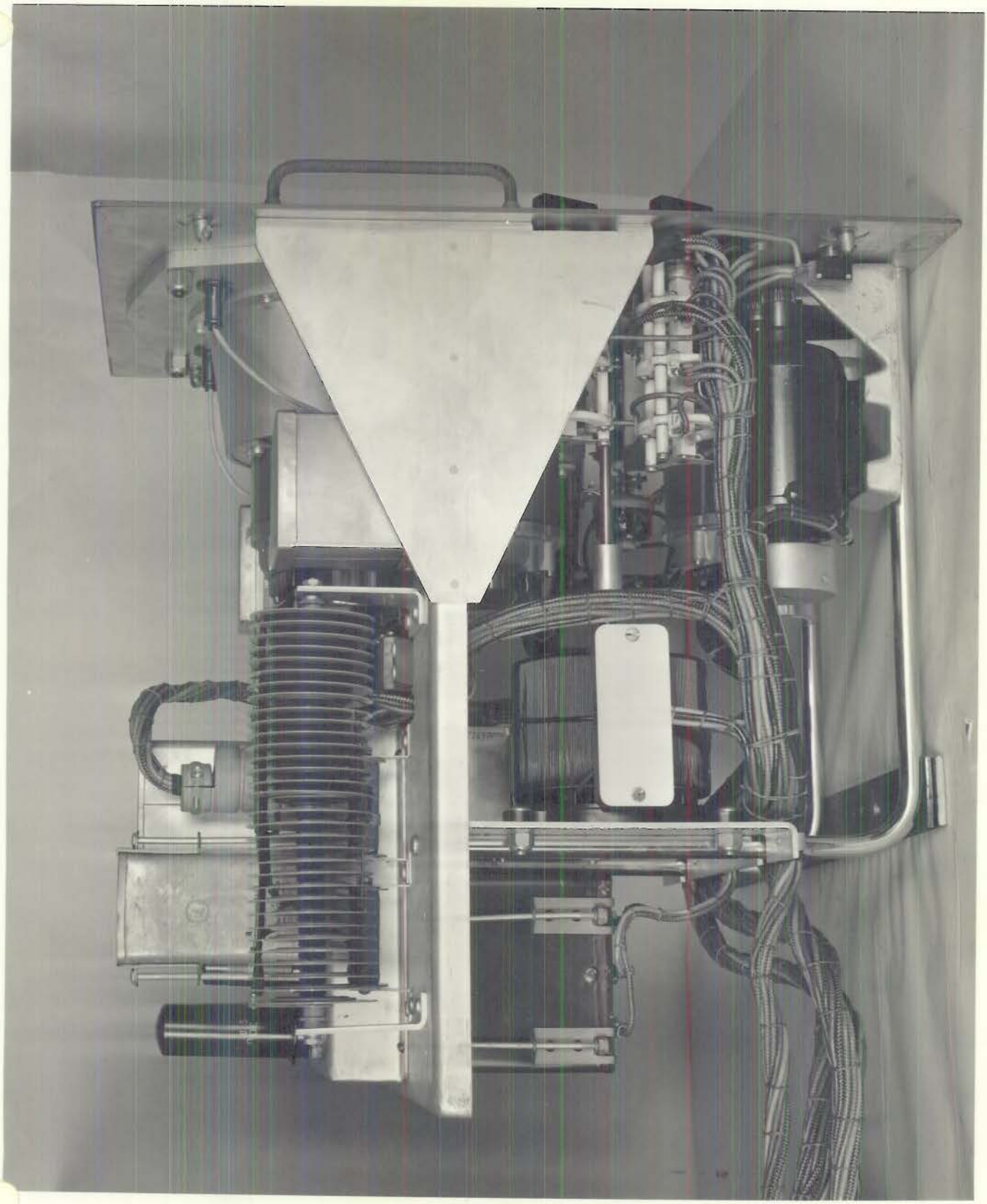

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PLATE 13
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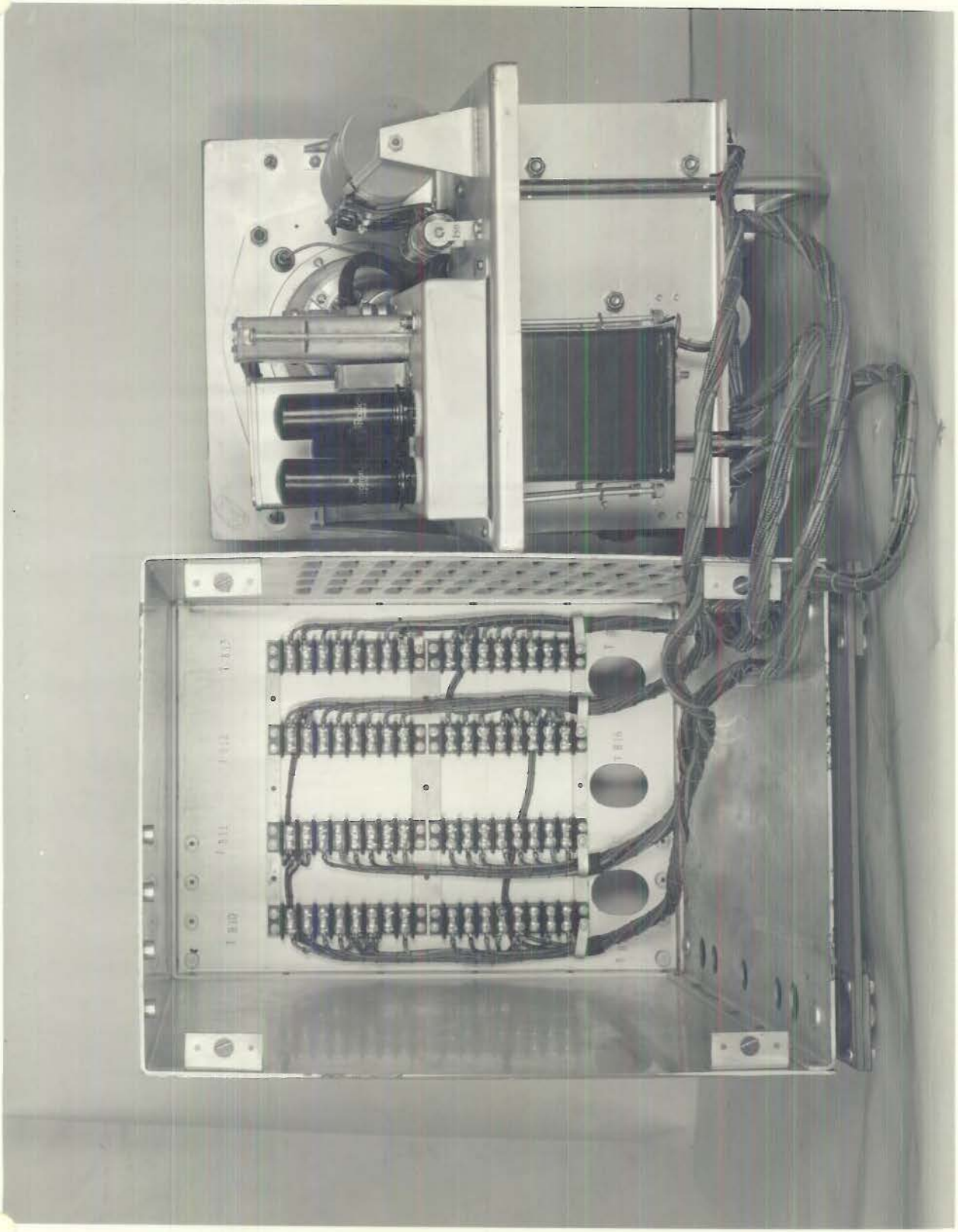

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PLATE 14
SECTION II

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PLATE 15
SECTION II

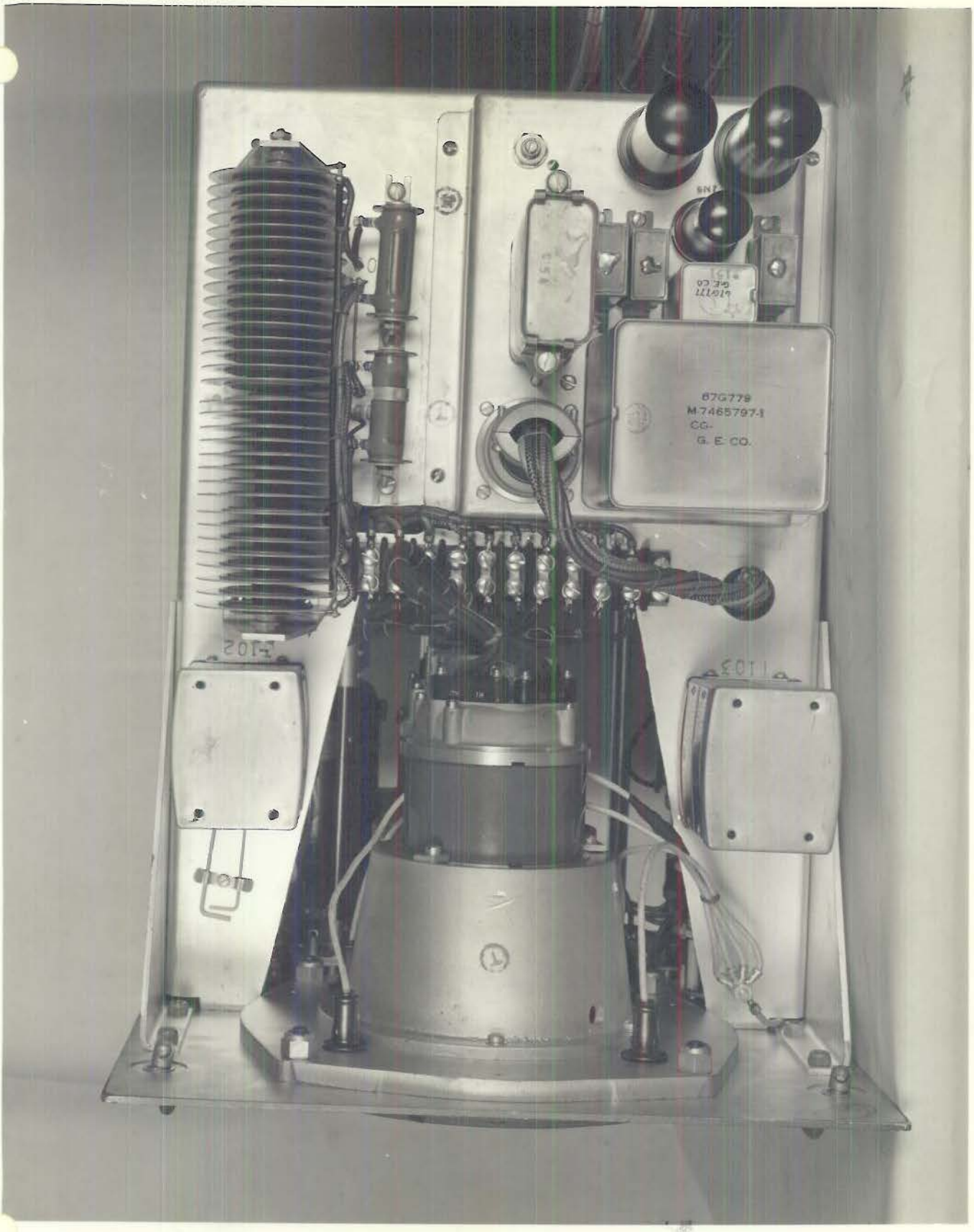

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PLATE 16
SECTION II

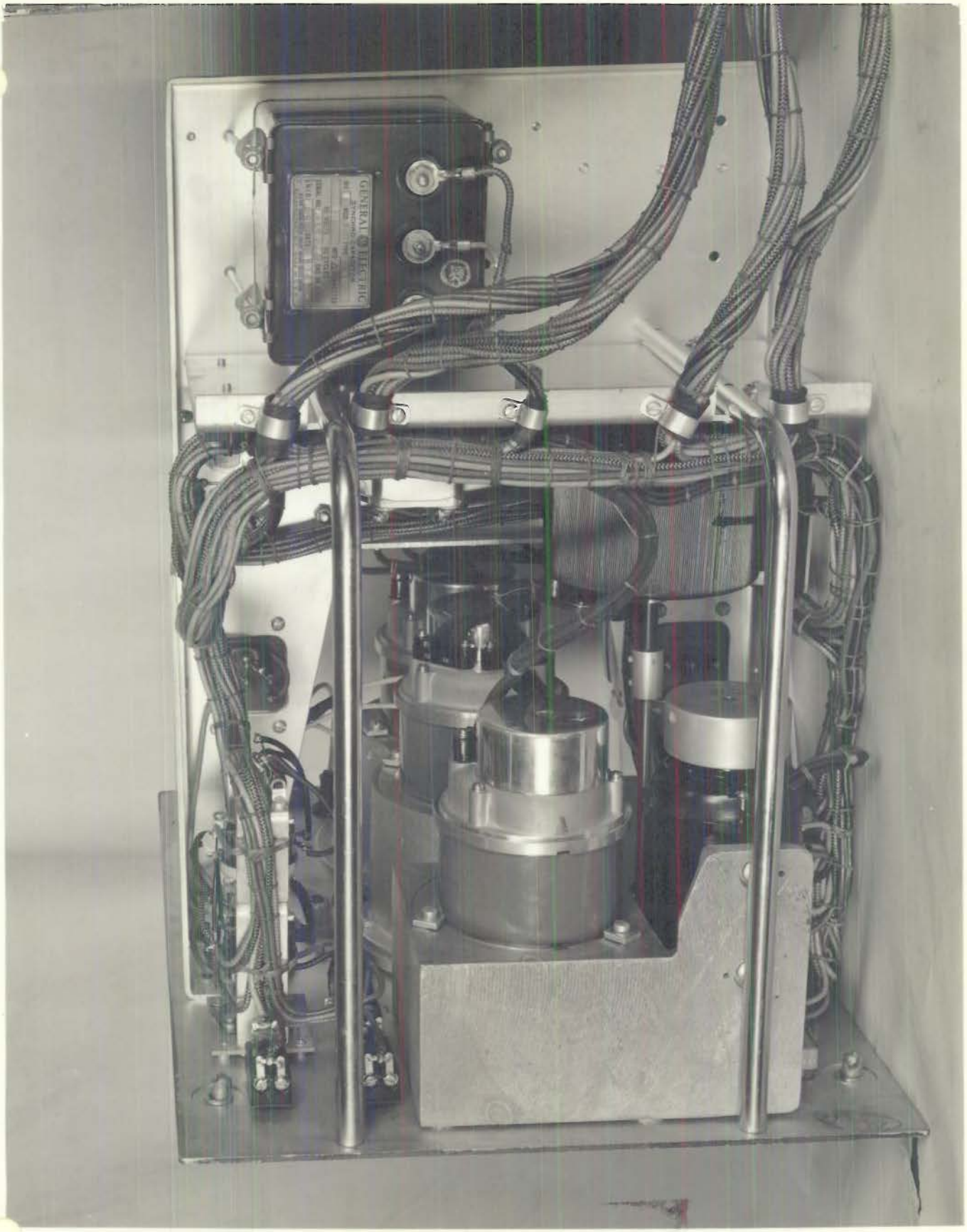

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PLATE 17
SECTION II

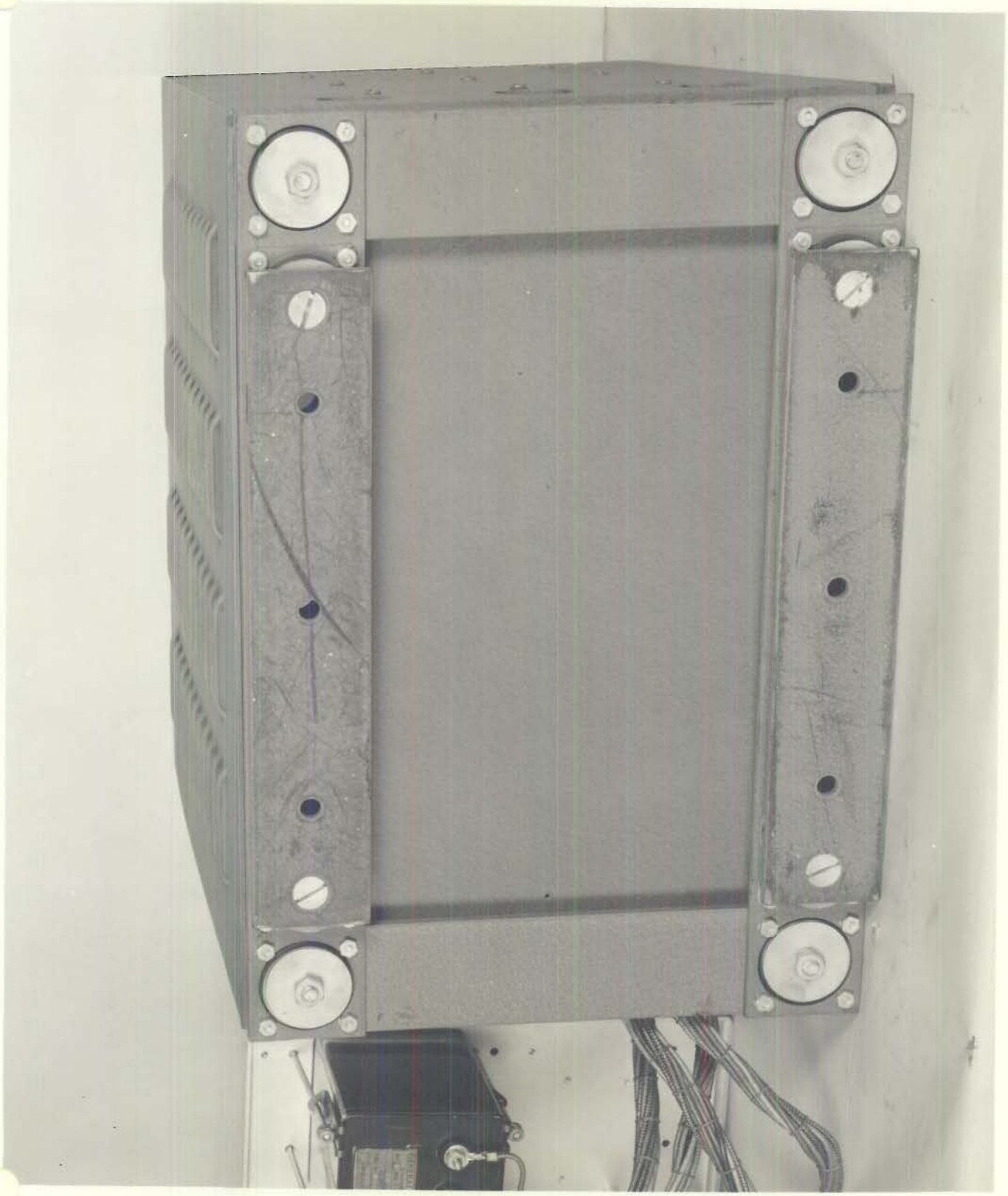

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PLATE 18
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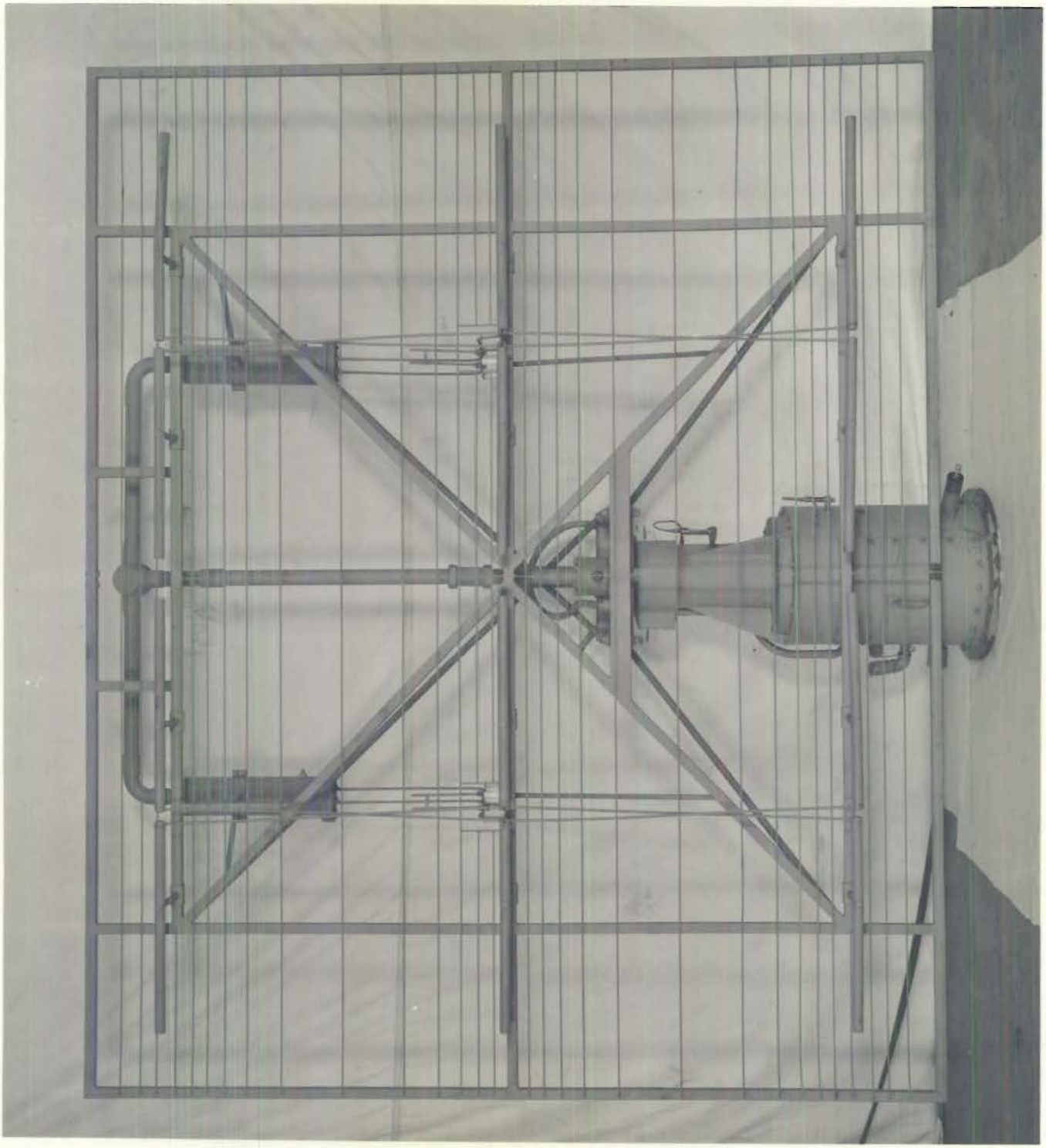

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PLATE 19
SECTION II

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PLATE 20
SECTION II

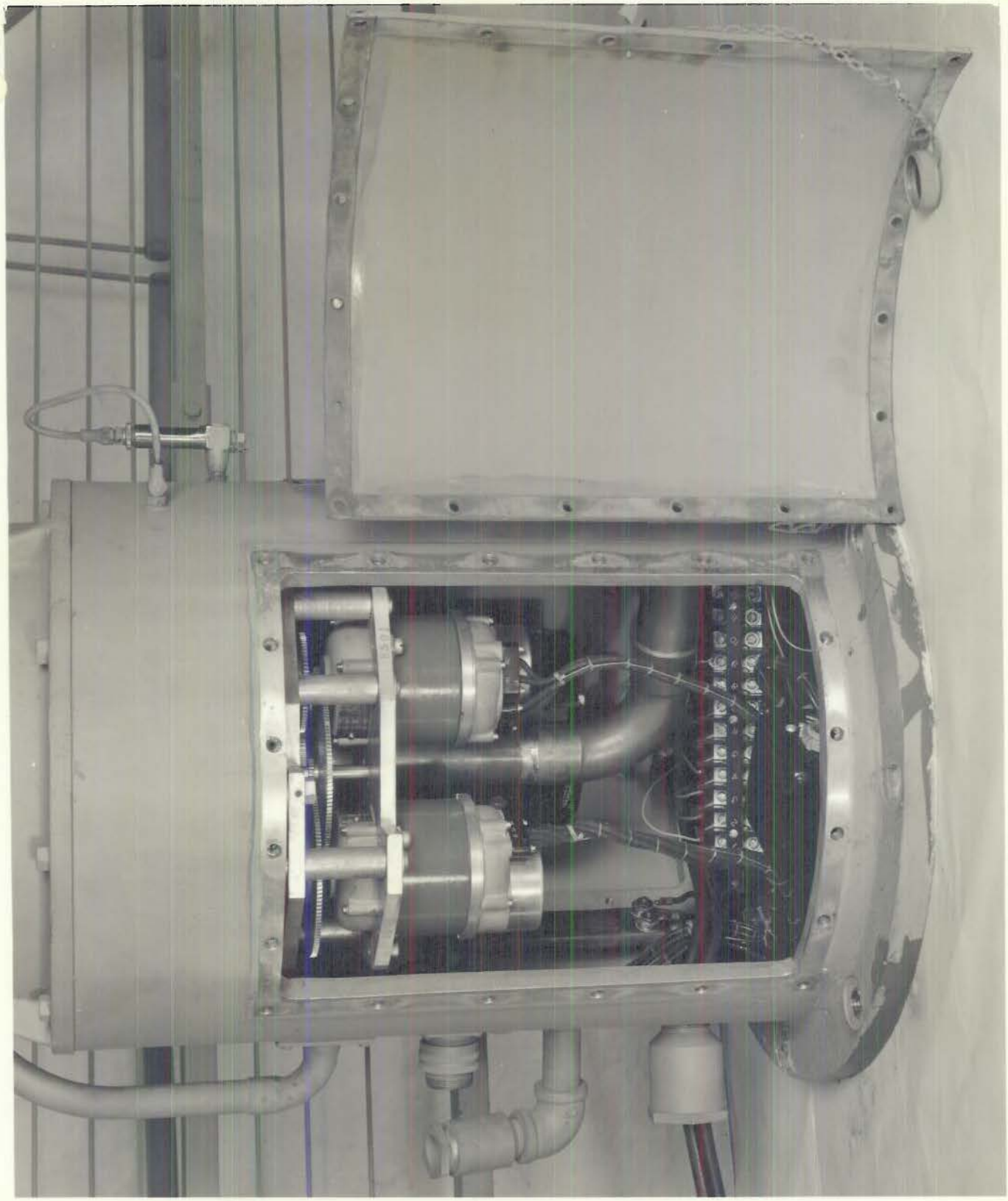

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PLATE 21
SECTION II

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PLATE 22

SECTION II

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PLATE 23
SECTION II

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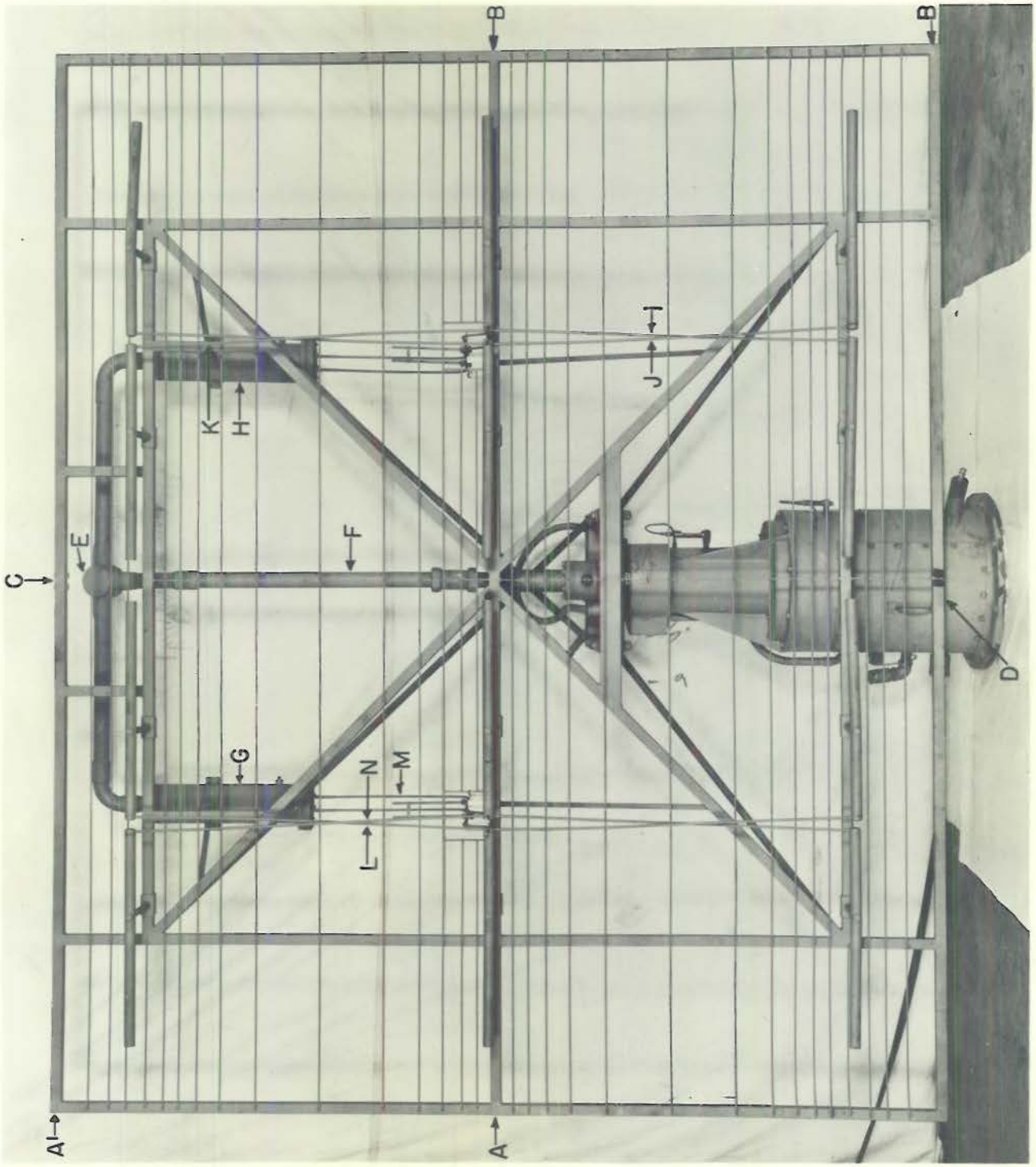
PLATE 24

SECTION II



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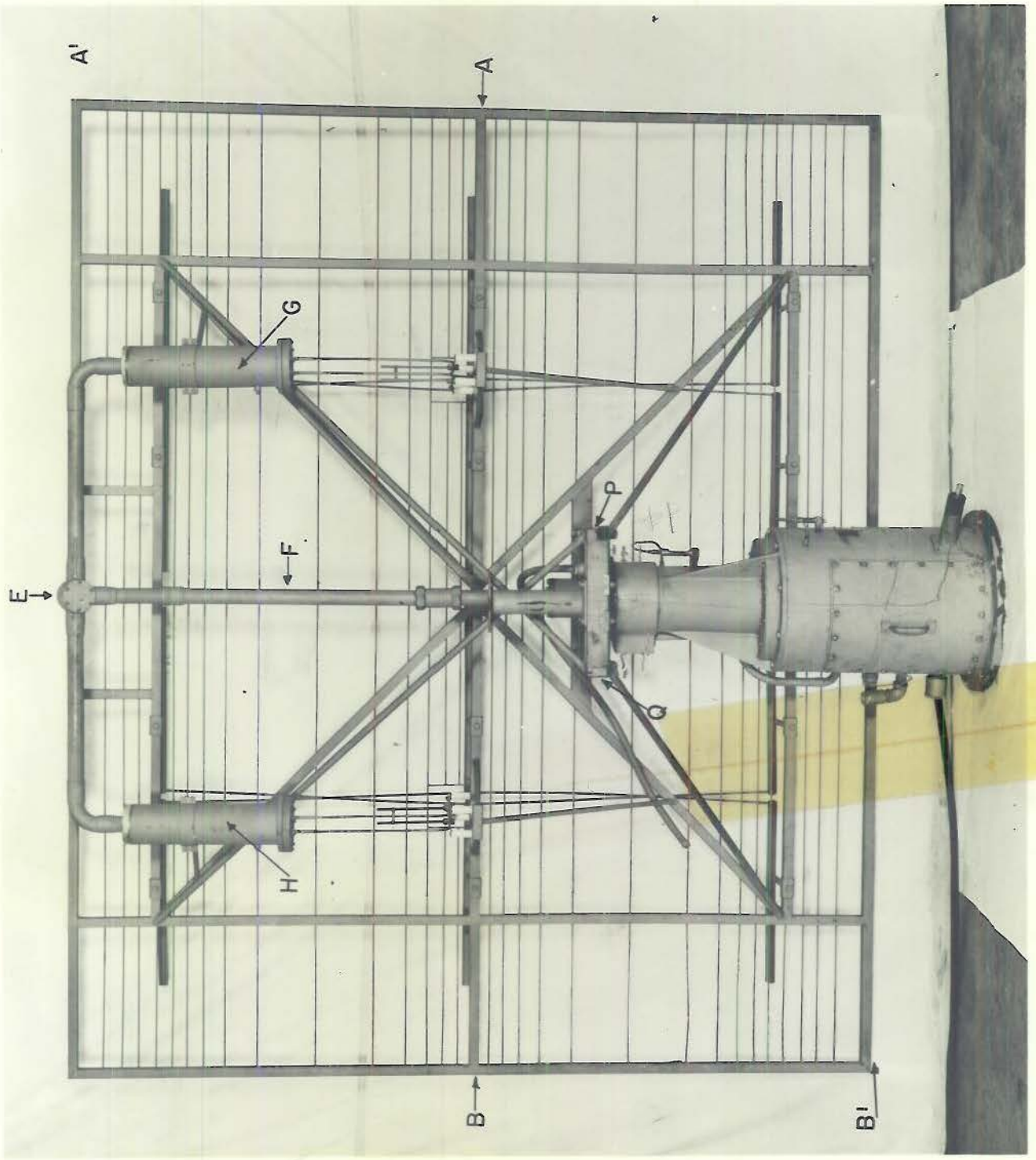
SEC. II PLATE 25



SEC. II PLATE 26

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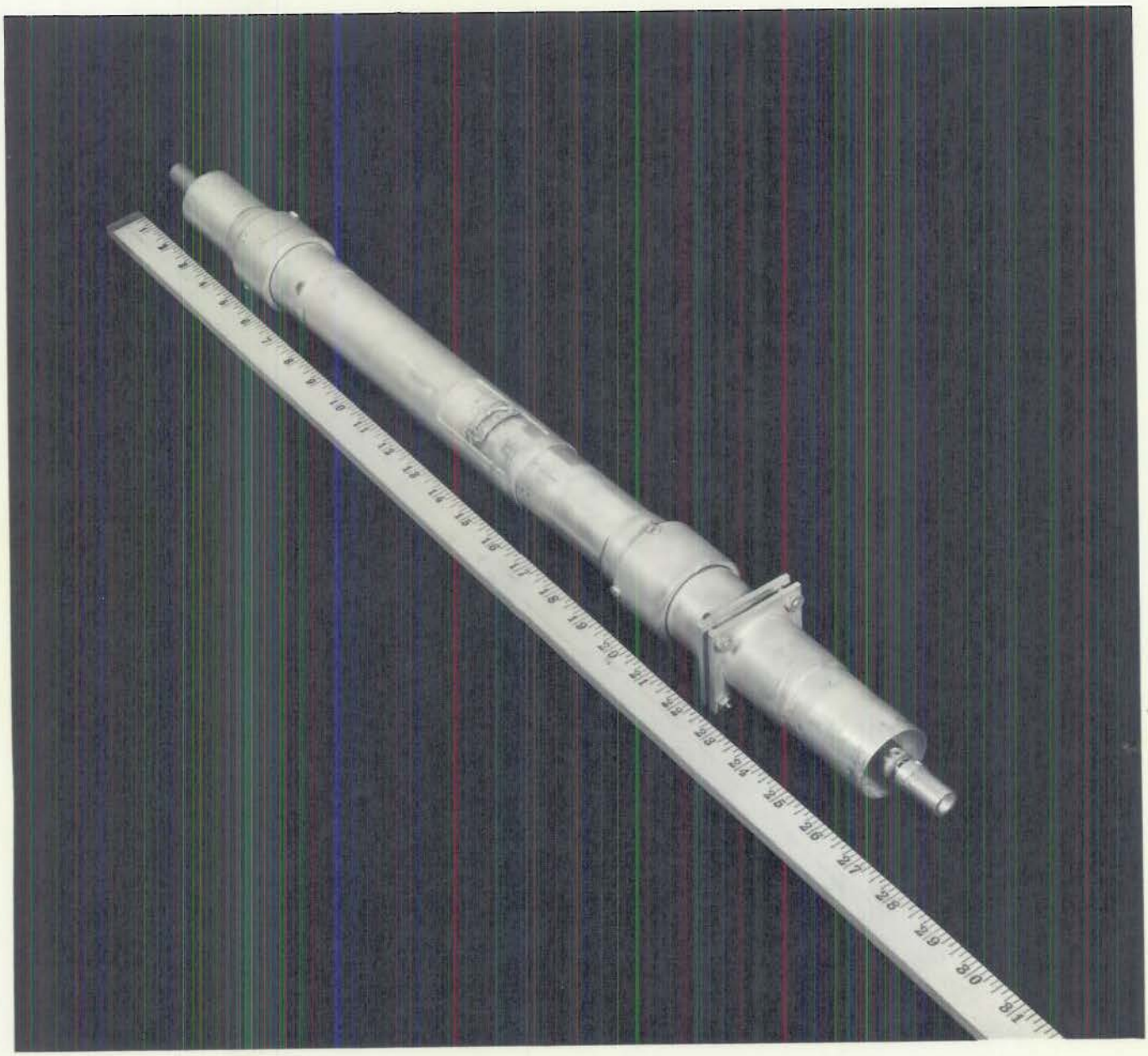

PLATE 27

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SECTION II

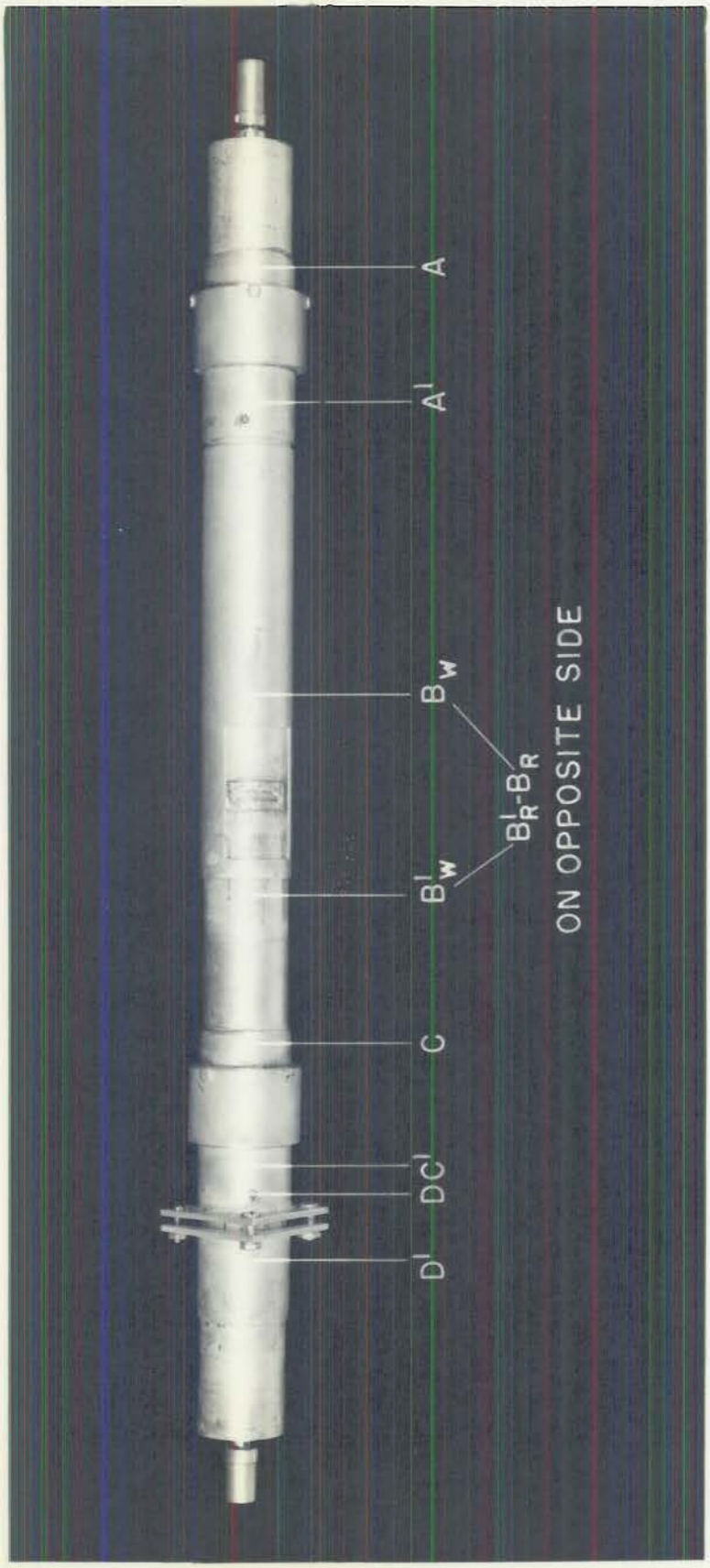

PLATE 28

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SECTION II

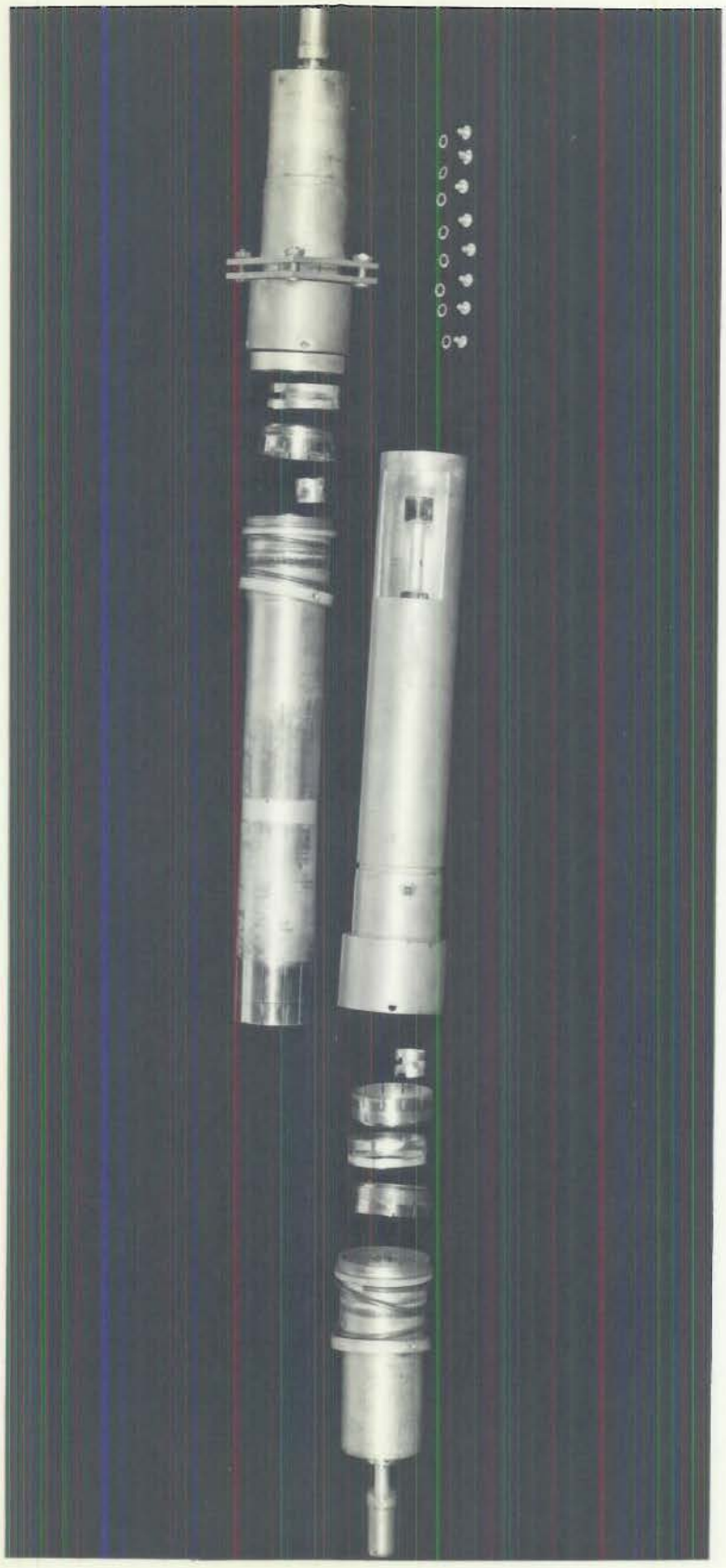

PLATE 29

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SECTION II

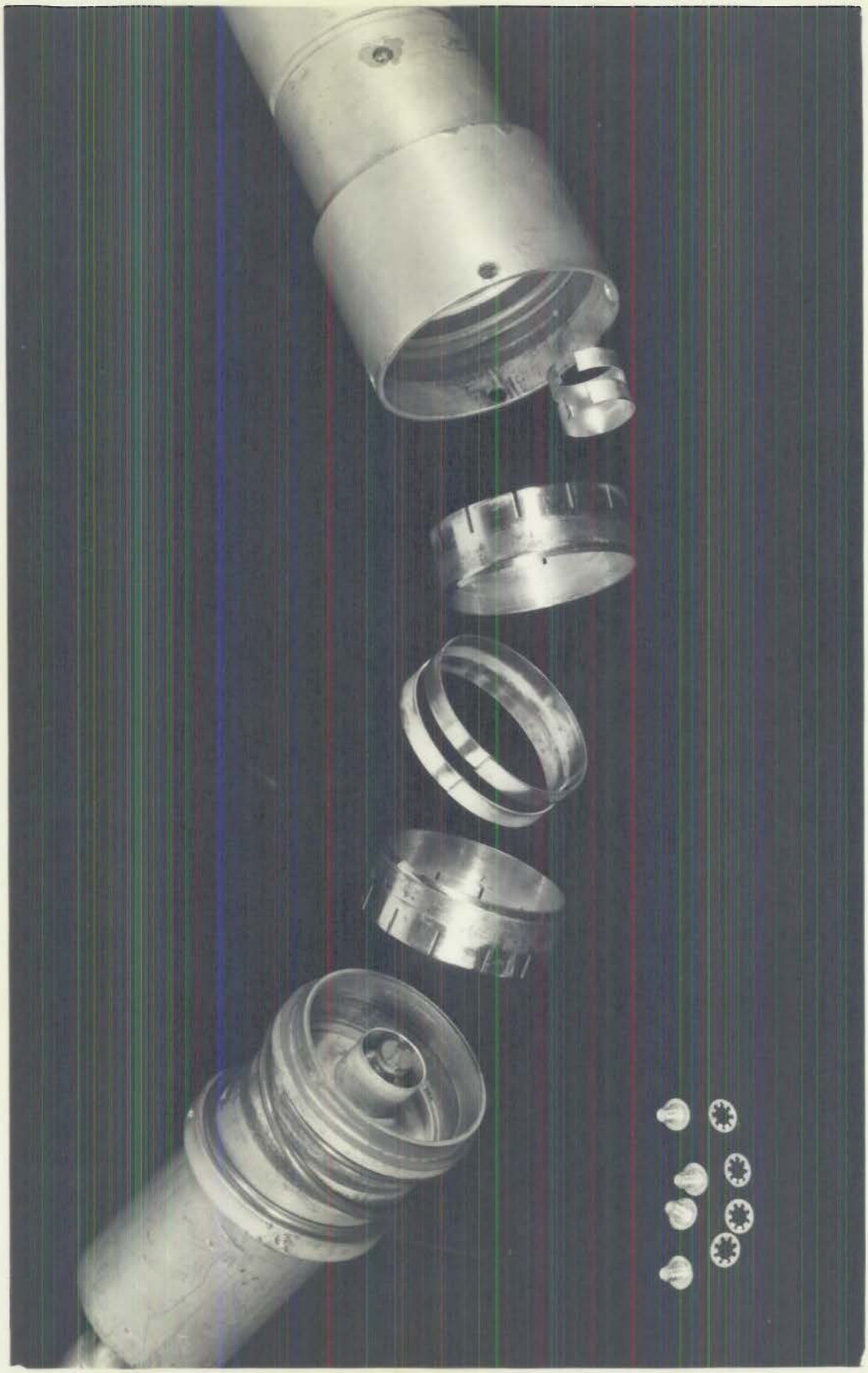

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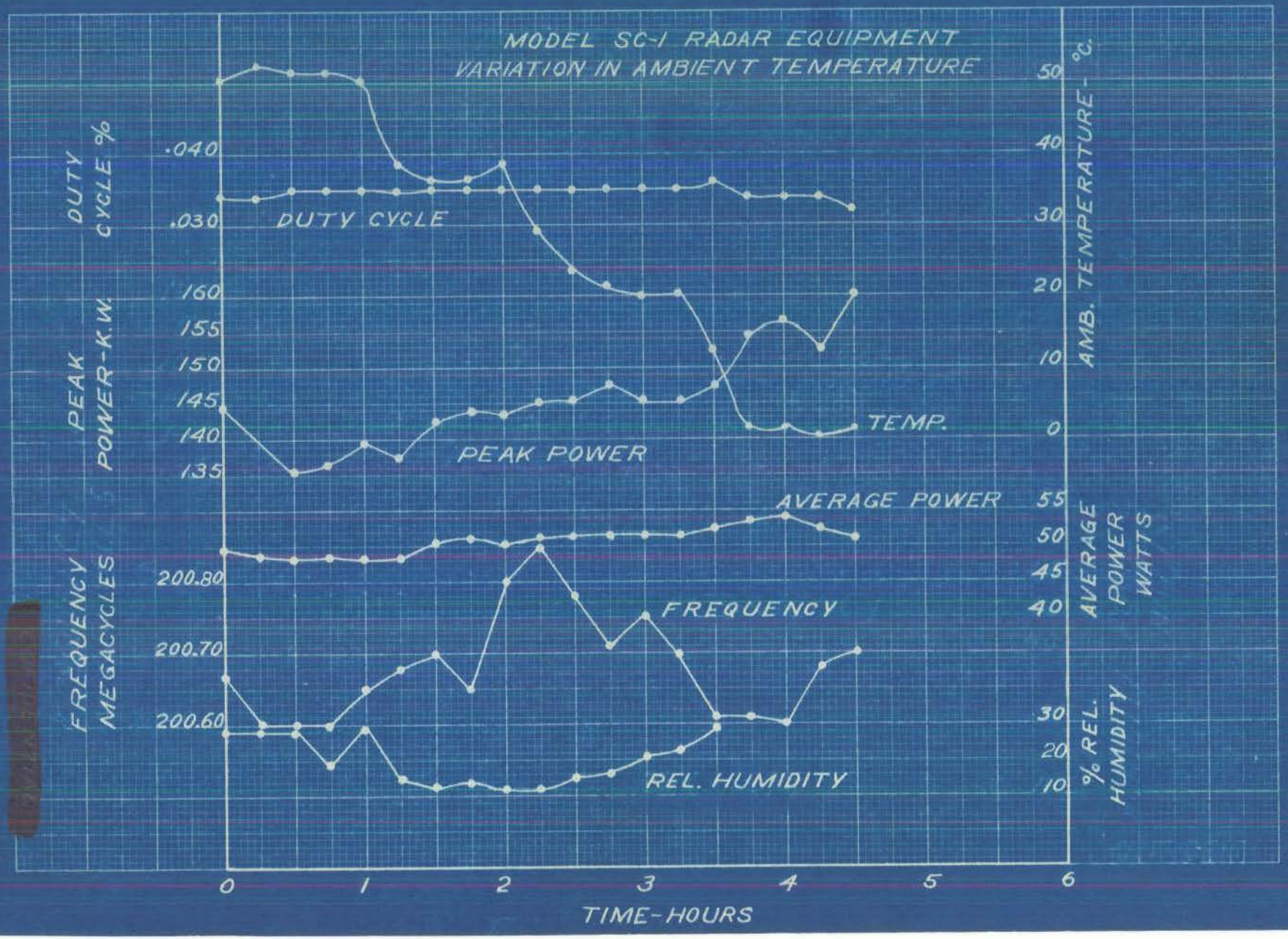
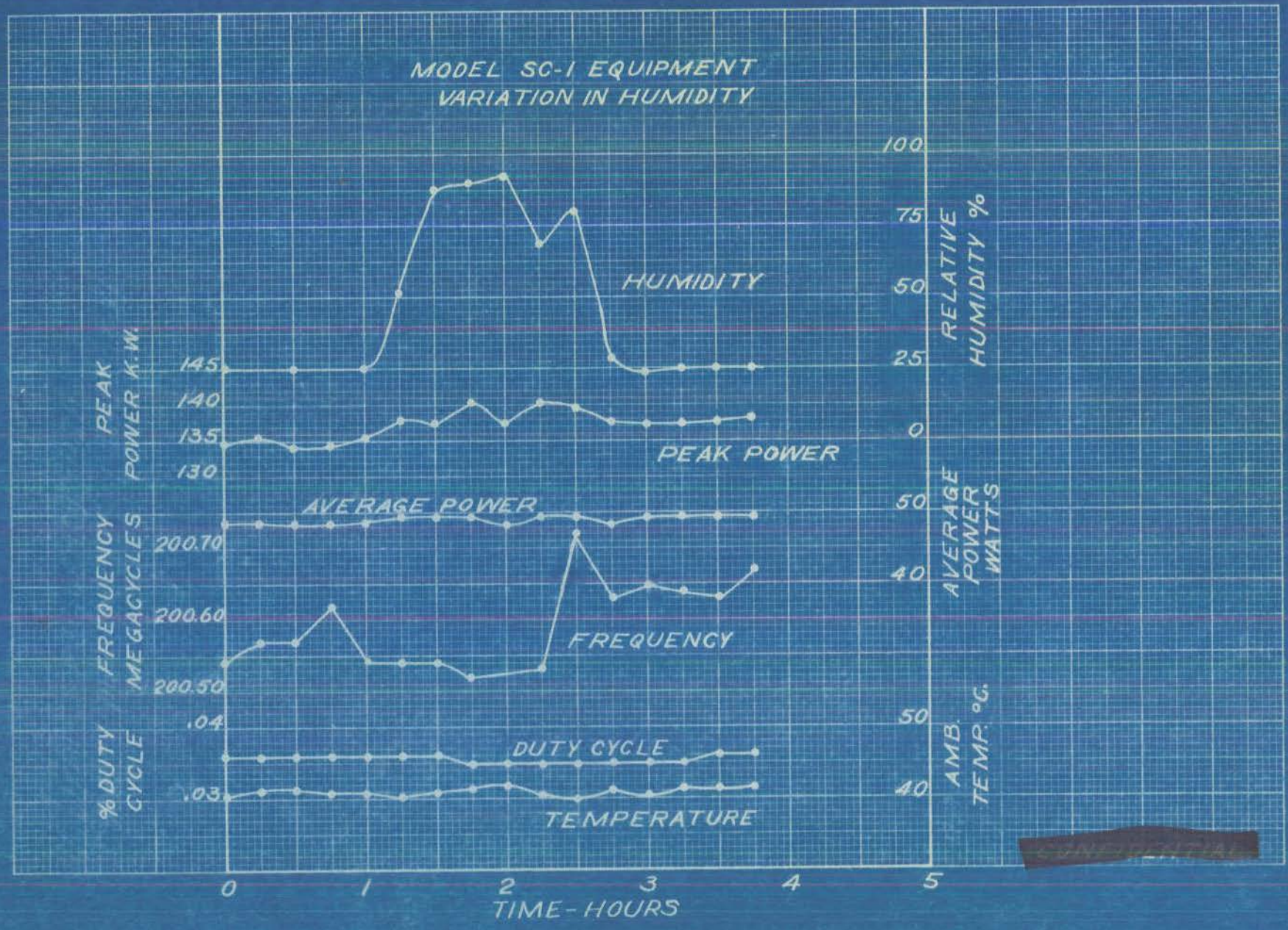
PLATE 30

SECTION II

NO. 3110. 20 DIVISIONS PER INCH BOTH WAYS. 120 BY 180 DIVISIONS.
CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS



SECTION II
PLATE 31



SECTION II
PLATE 32

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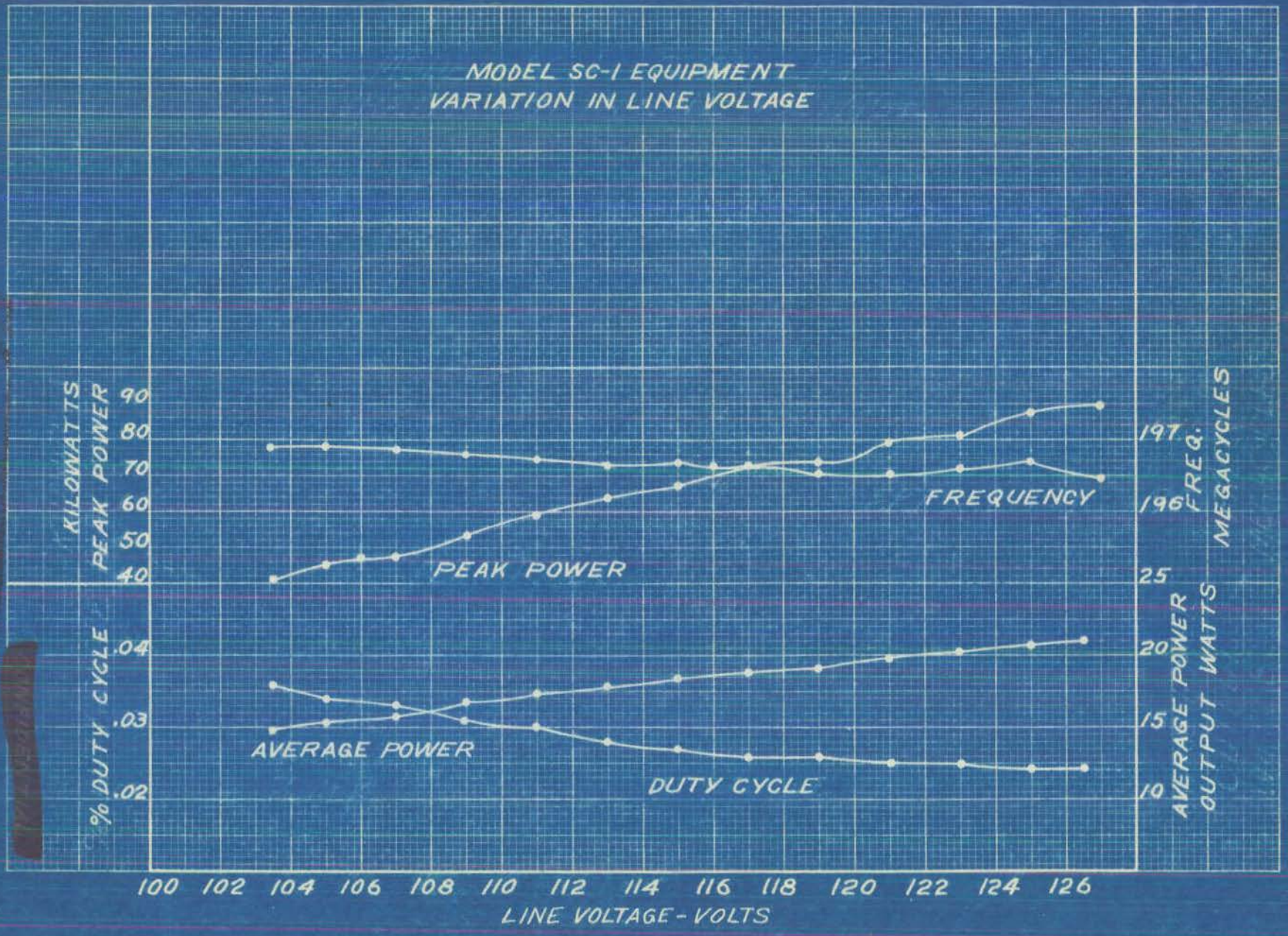
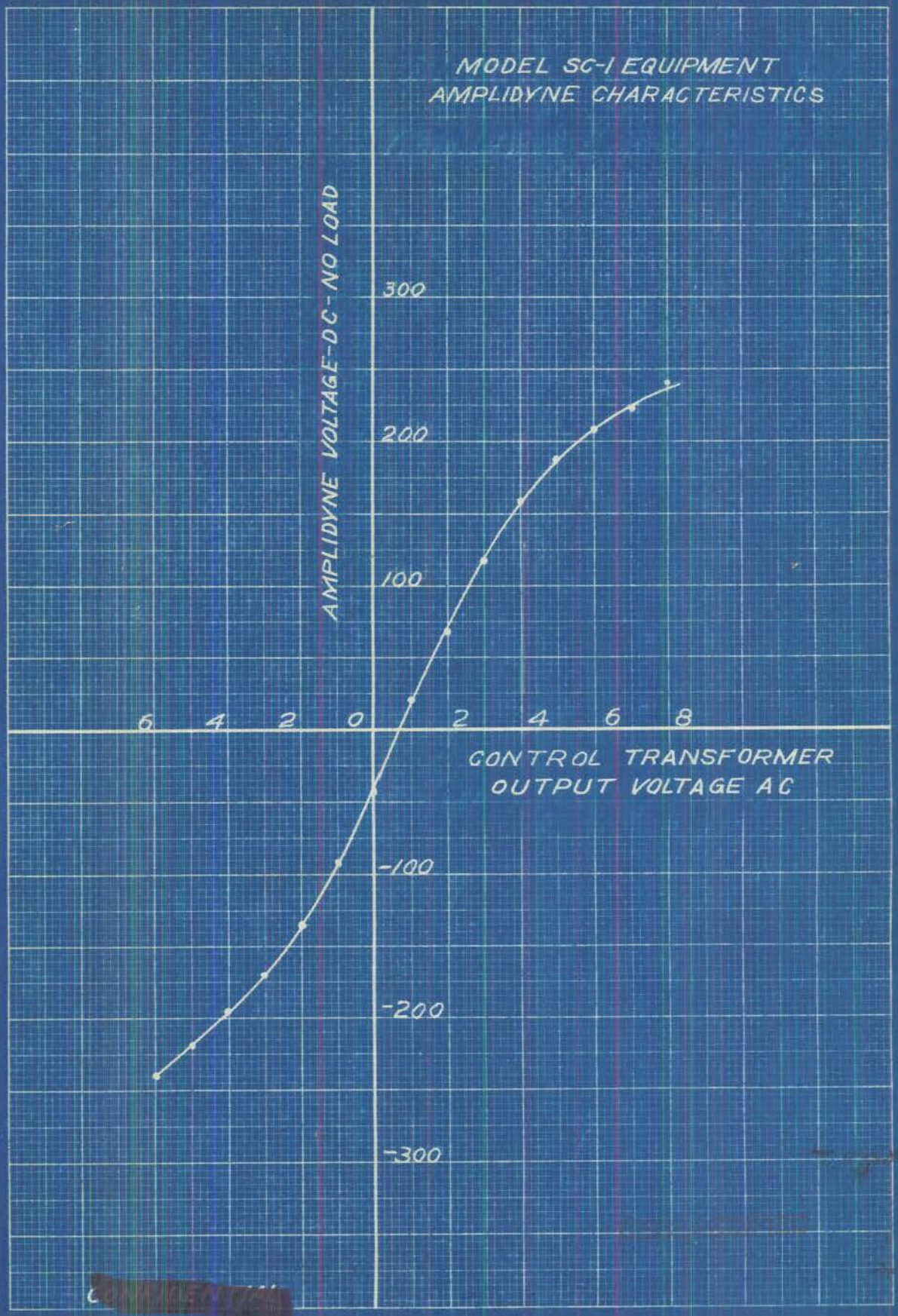
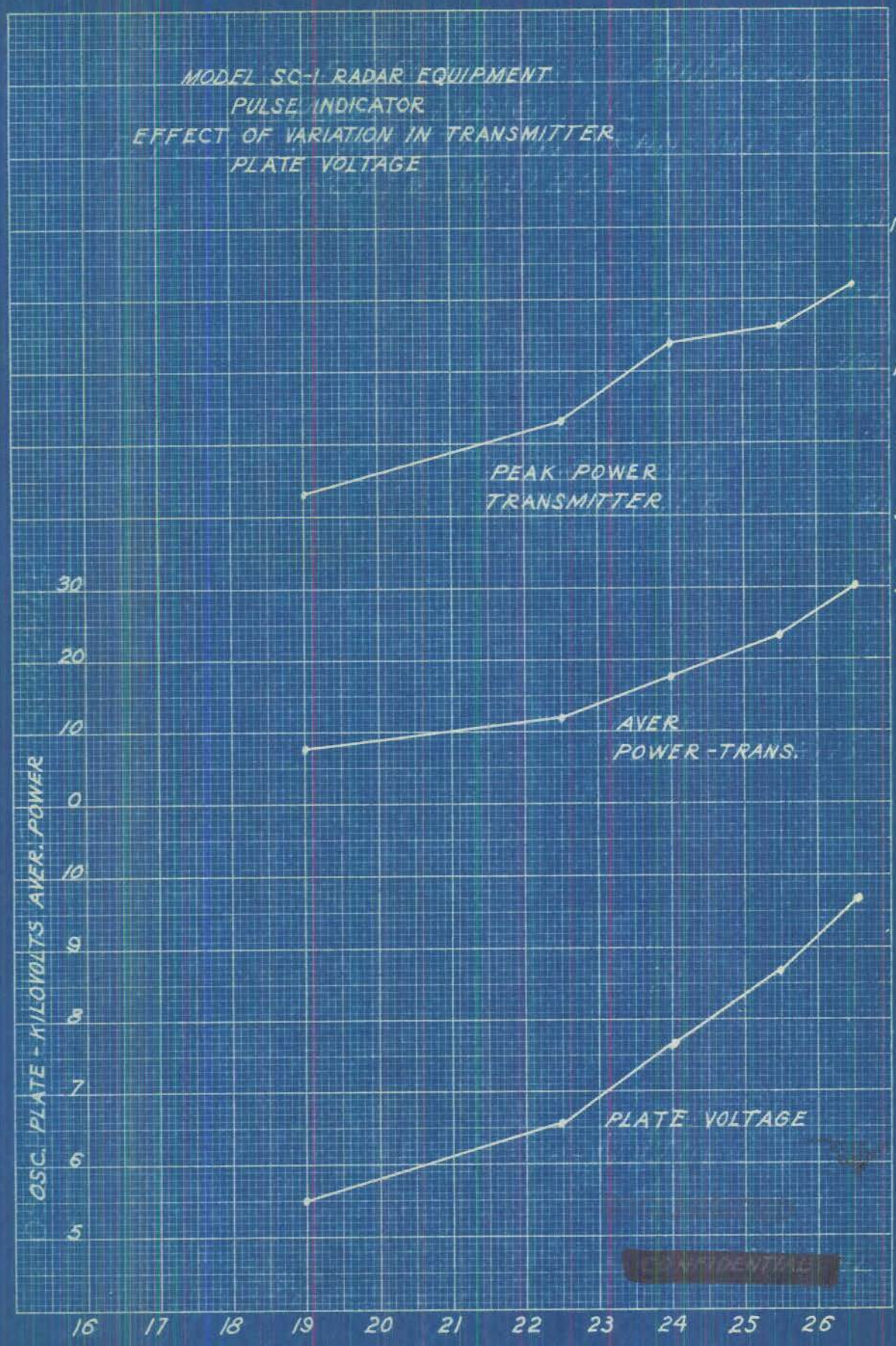


SECTION II
PLATE 33



SECTION II
PLATE 34



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SECTION II
PLATE 35

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SECTION III

Electrical and Mechanical Tests of Model SC-1 Receiver-Indicator Unit

Enclosures: Tables 1 and 2. Photographs: Plates 1 to 10.
Graphs: Plates 11 to 19.

3-1. During the period from June 22, 1942 to August 18, 1942, the Model SC-1 Receiver-Indicator Unit was subjected to electrical and mechanical tests and inspection as discussed below. For convenient reference, tests are listed below:

Test or Inspection	Page	Paragraph
Effect of Temperature Variation	2	3-2
Effect of Humidity Variation	4	3-3
Effect of Vibration	4	3-4
Effect of Shock	5	3-5
Effect of Inclination	6	3-6
Effects of Line Voltage Variation	7	3-7
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3-2. Effect of Temperature Variation

Upon varying the temperature from 0° C to 50° C, relative humidity below 30%, the following characteristics were checked: receiver heterodyne oscillator frequency drift, calibration crystal oscillator frequency, input necessary to give 1" deflection on the indicator unit cathode-ray tube, signal generator frequency control setting, and the variation in indicator calibration at 2000 and 20,000 yards.

3-2-1. The Model SC-1 receiver indicator unit, Serial No. 1, was placed in the temperature and humidity control room. Also employed in the tests were General Radio Company signal generator, type 804B No. 206, NRL pulse generator, Dumont oscilloscope Type 168 No. 927, General Radio interpolation oscillator Type 617A No. 30, NRL heterodyne frequency meter No. 4, Hallicrafter receiver type N-827C No. 1, Hygrade Sylvania receiver type RAG No. 1, General Radio amplifier type 711A No. 160A, and standard frequencies of 1000, 5000, and 20,000 cycles.

The receiver heterodyne oscillator was checked by means of the heterodyne frequency meter; the SC-1 indicator calibration crystal oscillator was checked against an NRL standard frequency source; the 1" deflection was obtained from a signal generator pulse modulated by means of an NRL pulse generator.

3-2-2. Temperature Tests on Receiver

(a) To check the receiver heterodyne oscillator frequency, the antenna input of the receiver and the output of the heterodyne frequency meter were connected to the input of the Hallicrafter receiver, and a beat note was obtained. The heterodyne calibrator frequency was checked against its crystal standard.

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Readings were taken at 15 minute intervals, and the receiver heterodyne oscillator frequency drift with varying temperature was noted.

(b) Upon varying the temperature from 0° C to 50° C, the humidity being maintained below 30%, the receiver heterodyne oscillator was found to have a drift of 439 kc. A plot of this frequency drift is given by Plate 11, Section III.

3-2-3. Temperature Tests on Indicator

(a) The calibration crystal oscillator frequency was checked by connecting the output of the crystal oscillator in the Model SC-1 indicator unit to the input of a type RAG receiver along with a 165 kc. standard frequency obtained by amplifying the sum of the 8th harmonic of the 20,000 cycle standard and the 5000 cycle standard. The beat note obtained from the crystal oscillator and the 165 kc. standard was fed to the horizontal plates of the Dumont oscilloscope, and the output of the interpolation oscillator, calibrated against a 1000 cycle standard, was fed to the vertical plates. The interpolation oscillator was adjusted until a stationary elliptical pattern was obtained on the scope, denoting zero beat.

The input necessary to give a 1" deflection on the indicator unit cathode-ray tube was obtained from the pulse signal generator. The signal generator was modulated by means of a pulse generator to deliver pulses of an approximately known peak voltage. The signal generator output and frequency setting were checked during each reading.

The variation in calibration at 2000 and 20,000 yards was checked in the following manner: Range 1 was calibrated after the equipment had warmed up. Throughout the temperature run the vertical step was made to coincide with the leading edge of the 2000 and 20,000 yard range markers, and the range dial reading at each of the settings recorded. Thus, any variation in calibration would be denoted by a change in the range dial reading at these two calibration points.

(b) Varying the temperature from 0° C to 50° C, humidity being maintained below 30%, caused the calibration crystal oscillator frequency to drift 23 cycles, introducing an error of approximately .01½%. The input necessary to give 1" deflection was between 110 and 42 microvolts, the apparatus being more sensitive at lower temperatures. The signal generator frequency control setting change was negligible. The range calibration at 2000 yards shifted 100 yards in one direction, and at 20,000 yards it shifted 200 yards, both variations being within observational error.

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3-3. Effects of Humidity Variation

Upon varying the relative humidity between 23% and 93%, the temperature being held constant at 40° C, the following were checked: Model SC-1 receiver heterodyne oscillator frequency drift, the calibration crystal frequency, the input necessary to give 1" deflection on the indicator unit cathode-ray tube, signal generator setting, and the variation in calibration at 2000 and 20,000 yards.

3-3-1. The test equipment and method of test were similar to those described in paragraph 3-2-1.

3-3-2. Humidity Test on Receiver

Humidity variation from 23% to 93%, temperature constant at 40° C, caused the receiver heterodyne oscillator frequency to drift 170 kc. Reference Plate 12, Section III.

3-3-3. Humidity Test on Indicator

Humidity variation from 23% to 93%, temperature at 40° C, caused the calibration crystal oscillator frequency to drift 12 cycles, introducing an error of approximately .0073%. The humidity variation caused a change of only 10 microvolts, the change being from 80 to 70 microvolts. The signal generator frequency control setting change was negligible. There was no observed variation in calibration at 2000 yards as the result of humidity change. The variation in calibration at 20,000 yards was 200 yards as the result of humidity variation, this shift being within the limit of observational error.

3-4. Effects of Vibration

The model SC-1 receiver indicator unit was vibration tested to determine its mechanical stability, and its capability of operating continuously under these conditions.

3-4-1. The receiver indicator unit was mounted along with the antenna control and bearing indicator unit on a plan position indicator, the latter being bolted securely to the vibration table. The PPI was shock mounted, and the receiver indicator and bearing indicator were shock mounted on the PPI. A General Radio Company type 804B Signal Generator and NRL pulse generator were used to obtain a 100 microvolt pulse-modulated signal (pulse length, 5 microseconds; repetition rate, 60 cycles) which was fed into the receiver during the test. This gave a pulse height of 3 divisions by an improvised scale on the range indicator cathode-ray tube. The

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receiver-indicator unit was set into operation, the range calibrated, and all dials provided with locks were made fast before vibration was applied to the table.

3-4-2. Vibration Test on Receiver

(a) After all the equipment had been set into operation and calibrated, the table was vibrated at frequencies ranging from 0 to 2000 vibrations per minute, resonant frequencies noted, and the table held at each of these resonant frequencies for fifteen minutes.

(b) The equipment as a whole rocked laterally at 500/min. This vibration was not violent and in no way interfered with the operation of the Model SC-1 receiver-indicator unit. The resonant frequency of the receiver in the receiver-indicator unit occurred at 1070/min. Its possession of an independent resonant frequency is explained by the fact that it is independently shock mounted. This vibration started at 990/min, reached its peak at 1070/min, and ceased at 1110/min. Although the receiver operated satisfactorily at 1070/min, it is believed that this vibration was violent enough to cause some of its components to loosen after a time.

3-4-3. Vibration Test on Indicator

(a) & (b) Between 1200/min. and 2000/min. all the vibration was taken up by the shock mounts between the PPI and the receiver indicator unit and the bearing indicator such that no vibration was noticed. During all vibration the calibration oscillator remained constant as did the focus, tuning, sensitivity, brightness, and astigmatism controls, and the range calibration.

3-5. Effects of Shock

The model SC-1 receiver-indicator unit was shock tested to determine its stability, capability of continuous operation, and the effectiveness of its shock mounts.

3-5-1. For description of the test equipment and the method of test refer to paragraph 3-4-1.

3-5-2. Shock Test on Receiver

(a) Twelve shocks were applied laterally via the shock table to the left side of the equipment as a whole and twelve shocks were applied to the front. The cylinder of the gun used to generate the shock was charged with 150 lbs. air pressure which

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is understood to be capable of delivering a shock of 250 g's to the table. The equipment acceleration as read on an accelerometer varied from 8 to 72 g's. However, most of the shocks ranged between 8 and 18 g's.

(b) The operation of the receiver was not affected by shocks applied to the left side. However, the fourth shock applied to front threw the gain control (BB) out of adjustment. Reference paragraph 3-10-3.

3-5-3. Shock Test on Indicator

(a) The procedure followed on the shock test of the indicator unit is described in par. 3-5-2 (a).

(b) The shock tests showed that the shock mounts between the Model SC-1 receiver-indicator and PPI were not adequate to prevent physical contact between the two units. This contact might result in some wear in time; 24 shocks caused some of the paint on the top corners of the PPI to be removed. The fourth shock from the left side apparently caused the damping tube, a 7N7 in the V-705 position, to fail, for after inserting another tube, the indicator unit operated satisfactorily again. However, this "defective" 7N7 tube was checked the next day and found to be in good working order, so it must have been knocked out only temporarily. The crystal switch knob flew off as the result of one of the front shocks; this was probably the result of its having been removed and not properly tightened upon replacing, for none of the other switch knobs were affected by either vibration or shock. The indicator unit was operated on range 1 andwas calibrated at 2000 and 20,000 yards as before. Shock did not affect either the pulse height, range control or any of the dial settings.

3-5-4. The shock mounts on the receiver of the receiver-indicator unit seemed to be effective. The shock mounts between the receiver-indicator unit and the PPI console appeared to be too resilient since theyallowed slight contact between the receiver-indicator unit and the PPI during shock.

3-6. Effects of Inclination

The model SC-1 receiver-indicator unit was subjected to the inclination test to determine its stability of operation and the strength of its shock mounts.

3-6-1. The description of the test equipment and the method of test are given in par. 3-4-1.

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3-6-2. Inclination Test on Receiver

(a) The equipment was subjected to a plus or minus 45° inclination sideways for fifteen minutes on the vibration table, then the table was rotated 90° and the inclination was applied so that the equipment was rolled forwards and backwards. After fifteen minutes of rolling in this position, the table was vibrated for ten minutes, while rolling, at each of the following frequencies: 1500/min, 1070/min, and 500/min. The pulse height, dial readings, calibration oscillator, and range calibration were checked after vibrating at each of these frequencies while rolling 45° as described.

(b) Inclination did not apparently affect the operation of receiver-indicator unit. Vibration at the resonant frequency (1070/min.) did not seem to be as violent while rolling as when on vibration alone.

3-6-3. Inclination Test on Indicator

(a) Rolling without vibration caused the pulse height to change from 3 to 6 arbitrary linear scale divisions and the calibration oscillator to change a few cycles. After rolling with the table vibrating at 1500/min, the pulse height change was three divisions, and the range calibration at 20,000 yards was off 200 yards. After vibrating at 1070/min, while rolling, the crystal oscillator did not operate, the crystal having lost contact. The pulse height at this frequency was off 25 divisions, and the range calibration at 20,000 yards was off 200 yards. After rolling with the table vibrating at 500/min, the pulse height showed no change and the range calibration at 20,000 yards was off 200 yards. The crystal oscillator had resumed operation indicating the crystal to be again in position and making contact.

(b) During most of the vibration the crystal oscillator was intermittent in operation. During proper operation of the equipment, the frequency of the calibration oscillator was checked against the crystal oscillator by means of a stationary figure-eight pattern on the oscilloscope. Upon checking it against the crystal oscillator, the calibration oscillator was found to be stable with practically no change in frequency.

3-7. Effects of Line Voltage Variation.

No test.

3-8. Indicator Sweep Control Requirements

No test.

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3-9. Power Supply

The power supply for the Model SC-1 Receiver-Indicator Unit does not possess any input filters in the primary circuit of the power transformer. No electrostatic shield between the primary and secondary is shown in the transformer diagram.

3-9-1. The line current was found to be 3.69 amp., the power requirement 385 watts, and the power factor .9075. Two fuses (Little fuse type 1358, 5 amp. 250 volts) are provided in the A-C power lines. They are readily accessible for replacement on partial removement of the receiver chassis from its cabinet.

3-10. Controls and Tuning System

Service reports on the operation of Model SC equipment in the fleet are understood to indicate that operators were prone to move controls inadvertently in the process of adjusting other controls, thus disturbing their preliminary adjustments.

3-10-1. Since the Model SC-1 receiver-indicator unit has a control layout similar to that of the SC, the following observations are submitted for consideration.

(a) Locks provided for the RF tuning "AA", oscillator tuning "XX", RR Gain "HH", Calibrate Maximum "LL" controls are close to their dial knobs thus prejudicing ease of operation.

(b) It appears to be desirable to have the most frequently used controls grouped together; these would consist of the Range Potentiometer "TT", Range Selector "WW", Brightness "EE", Focus "FF", Astigmatism "GG", Receiver Gain "BB" and RR gain "HH" controls.

(c) It does not seem advisable to have the Receiver-Calibrate "CC" and Dial Light "DD" adjacent to the often-used cathode-ray tube controls.

(d) All the rectangular dial knobs possess only one set screw of the "Allen head" type. Allen wrenches are provided, being conveniently attached to the top of the receiver.

(e) All the control knobs on the indicator, with the exception of the range potentiometer, are of the same size and shape.

3-10-2. The variable resistors R711, and R712, and R713, (the range calibration resistors) do not appear to be readily accessible for adjustment when voltages are applied unless adjustment be made from the top, after pulling out the indicator unit, by means of a long insulated screw driver.

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3-10-3. [illegible] found to be defective upon receipt of the receiver-indicator unit for testing. During tests, this control was set at its minimum-attenuation position.

3-10-4. In the rotary switches, the spring contacts appear to be of silver-plated phosphor bronze. The range switch shows some wear.

3-10-5. The Calibrate Minimum Control "LL" does not have a panel bearing for the shaft nor a flexible coupling unit, whereas the calibrate Maximum "JJ" directly above it and of similar nature, does have a panel bearing and flexible coupling.

3-10-6. Some of the gears on the range control are of unplated brass, but are grease coated.

3-10-7. Fiducial marks are provided with r-f and oscillator tuning controls. Other positioning controls have pointers indicating their settings.

3-10-8. The tuning condensers of the antenna, and first and second r-f amplifiers are ganged. The heterodyne oscillator is tuned separately. The antenna and r-f amplifier condensers and coils and the mixer coils all have trimmer slugs apparently made of silver-plated brass. The lead screws onthe trimmer slugs appear to be unnecessarily long.

3-10-9. The range control is driven by positive gearing with stops provided at the limits of rotation to protect the range potentiometer. There is a small amount of backlash.

3-11. Vacuum tube electrode operating voltages are listed in Tables 1 and 2. Other comments follow.

3-11-1. The cathode, control grid and plate of the 6J5 "marker" tube are operated at potentials considerably above ground; the cathode varies between 190 and 390 volts, the control grid between 140 and 160 volts, and the plate is at 100 volts. It is questioned whether approval of the Contractor's use of these unusual voltages has been obtained from the Bureau.

3-11-2. The loctal tubes and tube sockets used extensively are considered unsatisfactory, not being approved by the Bureau. The National acorn sockets used in the r-f section of the receiver are not very sturdy and their by-pass condensers are subject to short circuits.

3-11-3. The only tube clamp employed is a base pressure clamp used on the 5U4G low voltage rectifier.

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3-11-4. None of the tube sockets are identified on the under side of the chassis. The tube socket designations for the three tubes in front of the power supply are concealed by the shield around the power supply.

3-11-5. Four of the tubes of the indicator unit require removal of the receiver unit for replacement; the remainder of the indicator unit tubes can be replaced by sliding out the indicator unit. The high voltage rectifier, a 2X2 tube, requires the removal of one of the transformer shields for replacement. The receiver unit tubes are easily replaced, the acorn tubes, requiring the unlocking of a metal shield held in place by four Dzus fasteners.

3-11-6. (a) The electrode voltages of the cathode-ray tube were not measured. After warm up, the tube focus changes slightly such that it is not uniform across the tube and requires some adjustment.

(b) The cathode-ray tube seems to be very well mounted and housed from the standpoint of breakage protection. The tube housing is of magnetic material. Tube replacement is readily accomplished, but there is apparently no way of definitely knowing whether the tube elements are in the proper plane when installing or adjusting.

3-12. Weight and Dimensions.

The Model SC-1 receiver-indicator unit weighs 240 pounds. It is 20 3/8 inches high, 22 1/2 inches wide and 21 3/4 inches deep, thus occupying space of 9,960 cubic inches or 5.75 cubic feet.

3-13. Wiring and Transmission Lines.

On the whole, the wiring installation of the Model SC-1 receiver-indicator unit is of good quality. A wax impregnated, fabric covered, rubber coated, stranded wire is used. Spaghetti is used as protective insulation in many places. Gum rubber grommets are used to protect wiring passing through the metal panels and chassis. The power cable to the receiver chassis is equipped with amphenol plugs and receptacles bearing an army-navy type number. The antenna is also connected to the receiver by means of an amphenol plug.

3-13-1. The cable lacing appears to be of good quality, strong waxed cord being used. These cable lacings are lacquer coated and supported firmly throughout.

3-13-2. Color coding is used, but it is felt that more adequate color coding and a wider use of tracers would facilitate servicing.

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3-13-3. The cabling support was such throughout that no chafing was detectable. One objectionable cabling support was noted where wires were tied on the receiver-calibrate switch shaft. This is unsatisfactory as the wiring is flexed every time the switch is operated.

3-13-4. The rear and side terminal boards are well supported on bakelite panels. The terminal lugs are of the internal tooth type. The terminal markers on the wires are made of paper and are easily torn off. The connections on the rear terminal board do not possess these markers.

3-13-5. The soldering work on the wiring is neat and well done. All joints are clean of resin, and do not appear to be lacquered. Some fixed resistors and condensers are soldered too close and some too far from the body of the component, but on the whole the job is well done.

3-14. Switches and Protective Circuits

The switches and protective circuits, where used, are of fairly satisfactory design.

3-14-1. It is possible, upon pulling the receiver-indicator unit out of the cabinet, to come in contact with dangerously high voltage, since the one interlock provided operates only when the receiver is removed from the indicator unit.

3-14-2. The pilot light jewels are provided with threads, yet were apparently secured in addition with an adhesive which makes their removal difficult.

3-14-3. In order to change the lamps which illuminate the range counters, it is necessary to remove the entire bezel over the cathode-ray tube (See Plate 2, section III).

3-14-4. Provision is made by means of the Dial Light control to dim out the indicator and range dial lights during darken ship.

3-15. General Physical Construction

The Model SC-1 receiver-indicator unit is, in general, sturdily constructed and the materials are, in most instances, satisfactory. The cabinet, frame, and much of the hardware are of ferrous material. The exterior of the cabinet has a blue-gray wrinkle finish, and the interior is copper plated and apparently aluminum painted for corrosion protection. Some of the parts and gears are of nickel plated brass. There is no evidence of a primer coat under the finish on the aluminum. The brass gears not plated are grease coated. The indicator unit chassis and receiver shielding compartments are of ferrous material. The structure is strong and well braced except for the receiver-indicator unit cabinet top which is easily distorted. In

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general, the workmanship appears to be good. For discussion on suitability of shock mounts, refer to paragraph 3-5-4.

3-15-1. It is inconvenient to remove the base of the receiver chassis due to the position of three screws not easily accessible without removing receiver shock mount plate.

3-15-2. The power transformers are covered with perforated, aluminum painted shields hinge-hooded at the top-rear and screwed down at the front base. The screws can be loosened only after the crystal and three tubes have been removed. The metal arm projecting from the perforated shield over T-701 appears useless. The receiver unit is well shielded electrically, its base plate being held fast by twenty screws and its acorn tube section having a shield with springs all around its edges, it being held tight with four Dzus fasteners.

3-15-3. The crystal holder is not mounted with sufficient security as indicated by its losing contact frequently during the vibration test. Reference Paragraph 3-6-3 (b).

3-15-4. All lock washers are of the internal-tooth type.

3-15-5. The use of glyptal for locking screws, etc. is not consistent throughout, being employed in some places and omitted in others.

3-15-6. The ventilation appears to be adequate, there being considerable space and openings around the units that develop heat. The cabinet is provided with louvers on the back and one side, and numerous holes in the bottom. The louvers are not of the flush type, however, as they protrude on the outside of the cabinet.

3-15-7. The front panel is made of aluminum with a blue-gray wrinkle finish. The screws through the front panel, which are not meant to be removed, are locked in position by peening the metal of the panel into the screwhead slot with a center punch. The thumb screws which hold the chassis to the cabinet are of the captive type, replaceable by pulling out on the screw and unscrewing it from its mounting. The captive type thumb screws on the cathode-ray tube bezel are too small to permit easy manipulation.

3-15-8. A transformer cover plate at the rear of the chassis is bowed and depends on this bowing pressure for support at the bottom.

3-16. Corrosion

Aluminum painted copper plating and wrinkle finish were used on the ferrous material parts; the brass gears and castings were plated. No corrosion was noticed after the Model SC-1 equipment was subjected to two complete cycles of temperature and humidity change, the former being from 0° C to 50° C, relative humidity of

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30%, and the latter being from 23% to 93%, temperature at 40° C. No salt-spray or other especial corrosion-resistance tests were made, as no components were available for such tests which could not be completed without possible destruction of equipment.

3-17. Name Plates and Component Markings

The name plate for the Model SC-1 receiver-indicator unit is prominently and securely affixed. The calibration chart on the front of receiver unit is also securely mounted and well protected by means of a celluloid cover.

3-17-1. Instruments and operating controls are located on the front panel and are suitably marked for identification and operation. Other adjustments not frequently manipulated are located within the unit on the chassis. Reference, paragraphs 3-10-2 and 3-10-8. Plates I and II, Section III are photographs of the control panel, providing a front view of the Model SC-1 receiver-indicator unit.

3-17-2. The component marking should be extended to include all parts without the obscurity which prevails in some instances. L701 has its inductance value marked on an adhesive tape label. The use of adhesive labels has been found unsatisfactory in tropical use.

3-18. Electrical Components

Though the electrical components and layout of the Model SC-1 receiver-indicator unit are in general satisfactory, there are several questionable features mentioned below.

3-18-1. All the transformers and iron core chokes, with the exception of T703 and L702, are of the open type. Impregnated, open transformers or iron-core chokes are not considered satisfactory for Naval usage, especially when direct-current components are present and when wire sizes smaller than #30 B and S are used. Only potted and hermetically sealed types are acceptable under these conditions.

3-18-2. The tank coils L703 and L704 of the transitron and crystal oscillators do not appear to be wax coated. They are lacquered.

3-18-3. Most, though not all, condensers and resistors appear to have been wax dipped. This is considered particularly desirable for tropical use to avoid the effects of humidity and fungus growth which are noted in the case of untreated bakelite or varnish-impregnated components. Wax treatment should be generally used on insulation surfaces which must maintain reliable service in high humidities.

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3-18-4. Some molded condenser leads are bent or soldered close to the condenser shell thus endangering the condenser seal.

3-18-5. The side plate over L701 and L702 is secured at the bottom by pressure against two soldering lugs.

3-18-6. R766 is intentionally short circuited and serves no apparent purpose.

3-18-7. In the receiver unit a Sprague 25 mf. 25 volt condenser was clamped in a temporary manner by a washer at one end.

3-18-8. The lead from the #7 pin on the tube of the first i-f amplifier was behind a condenser lead when the latter was soldered. This scorched and probably somewhat weakened the insulation on the #7 pin lead.

3-18-9. The i-f transformers consist of single layer coils of wire wound on grooved ceramic forms. The winding is secured at the free end of the coil by a loop through two holes. If the tuning slug is moved in this vicinity, it appears that it might form a short circuit with the loop anchor.

3-19. Sensitivity

To measure the sensitivity of the Model SC-1 receiver, the output from a Measurements Corporation model 75 signal generator across a 75 ohm load was fed into the antenna terminals of the receiver. The receiver was tuned to the frequency of the signal generator, and the output across its diode detector load resistor was measured with an RCA volt-ohmyst junior voltmeter. The cathode side of the diode load resistor was effectively grounded for alternating currents by connecting a .25 mf. condenser between the cathode of the diode detector tube and ground. The sensitivity of the receiver was determined on the basis of a signal plus noise to noise ratio of 2 to 1. Between 175 mc. and 225 mc. the receiver sensitivity ranged between 29.5 and 75.5 microvolts, it being the most sensitive at 200 Mc. Reference, Plate 13, Section III.

3-20. Selectivity

To measure the overall selectivity of the Model SC-1 receiver, the output of a type 80kB General Radio signal generator was fed into the receiver input terminals. The receiver output was measured across the diode detector load resistor with an RCA volt-ohmyst junior #1986. The band width measured between points at 6 db. attenuation is 0.65 Mc. Reference, Plate 14, Section III.

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The i-f selectivity was measured by feeding the continuous wave output from a type 80kB G.R. signal generator into the grid of the mixer tube of the SC-1 receiver. The receiver output was again measured across the diode detector load resistor with an RCA volt-ohmyst junior. The band width measured at 6 db. attenuation is 1.80 mc. Reference Plate 15, Section III.

3-21. Video Fidelity

The frequency response of the video amplifier was determined by connecting a General Radio beat-frequency oscillator type 713B #766 across the diode detector load resistor, the voltage it developed across this resistor being measured by a General Radio vacuum tube voltmeter type 726A #750. The video output was determined by connecting the same vacuum tube voltmeter between one of the vertical deflection plates of the SC-1 indicator unit cathode-ray tube and ground. For frequencies above 20 kc, a General Radio Type 605B signal generator was substituted for the beat frequency oscillator. The video response for frequencies between 50 and 500,000 cycles is given by Plate 16, Section III. The curve falls 6 db. below the 1000 cycle reference level at approximately 40 cycles and 150 kc and is flat within 1 db from 110 cycles to 63 kc.

3-22. Resonant Overload

60 cycle pulses of 5 microseconds duration, obtained by keying an 80kB GR signal generator with an NRL pulse generator, were fed into the Model SC-1 receiver antenna input, and the receiver was tuned until maximum signal was obtained. As the output of the signal generator was increased in small steps from zero to maximum the pulse height on the indicator unit cathode-ray tube screen was measured. The test revealed that after the input to the receiver had reached 1000 microvolts for 175 mc. and 1300 microvolts for 190 mc., no further increase in input, up to 10 millivolts, would increase or decrease the output. These two resonant overload curves are given by Plate 17, Section III.

Another resonant overload curve was obtained at 200 mc. by applying unmodulated r.f. to the receiver. As the output of the signal generator was increased from 0 to 10,000 microvolts, the voltage developed across the diode detector load resistor was measured by an RCA volt-ohmyst junior #1986. The curve plotted from the test data shows that the receiver began blocking when the input reached 520 microvolts. Reference Plate 18, Section III.

3-23. Image Rejection Ratio and Intermediate-Frequency Rejection Ratio

Pulsed and continuous wave signals at the image frequency and again at the intermediate frequency were fed into the receiver

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antenna input, but no response to these signals was detected when using inputs up to 200,000 microvolts.

3-24. Temperature Rise of Power Transformers

The temperature rise of the power transformer of the Model SC-1 Receiver-Indicator Unit was measured by means of an iron-constantan thermocouple fixed to the top of the transformer case. The thermoelectric voltage change was measured with a Rubican portable potentiometer, Cat. No. 2702, Serial No. 10224. The transformer rise was 26° C above an ambient of 31° C; the time required for the rise to stabilize was five hours.

3-25. Range Potentiometer Linearity

The relationship between the output voltage range potentiometer and the range dial reading was determined by measuring the voltage between the moving tap of the potentiometer and ground. A plot of these dial readings versus voltage measured showed the range potentiometer to be quite linear, Reference Plate 19, Section III.

3-26. Frequency Coverage

The range of the Model SC-1 receiver was found to be between 172.2 mc. and 228.3 mc. It was determined by tuning the receiver to signal of a given frequency generated by a Measurements Corporation Model 75 signal generator. The frequency of the signal generator was checked by means of NRL heterodyne frequency meter, #4.

3-27. Summary of Defects and Recommendations

A summary of the defects noted during the electrical and mechanical tests on the Model SC-1 Receiver-Indicator Unit together with recommendations for corrective action is listed below. The numerals enclosed in parentheses refer to the paragraph of Section III of this report under which these items are discussed in detail. These defects are listed in the order in which they are described in the body of the report and not in the order of their importance. It is recommended:

3-27-1. (3-10-1(a)) That the dials provided with locks be so arranged or constructed that the lock knobs do not interfere with dial operation.

3-27-2. (3-10-1(b)) That the most frequently used controls be grouped together.

3-27-3. (3-10-1(c)) That the Receive-Calibrate "CC" and Dial Light "DD" controls be moved away from the often-used cathode-ray tube controls.

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3-27-4. (3-10-1(d)) That all dial knobs possess two set screws.

3-27-5. (3-10-1(e)) That different shaped knobs be used on the calibration dials than on the most frequently used controls.

3-27-6. (3-10-2) That a long insulated screw driver be supplied with the spare parts if the present method of adjustment of the range calibration resistors is not to be altered.

3-27-7. (3-10-3) That a Navy-approved type of potentiometer be furnished to provide dependable gain control.

3-27-8. (3-10-6) That all brass gears be treated to improve their corrosion resistance.

3-27-9. (3-11-1) That, inasmuch as the voltages on the type 6J5 marker tube are unusual, the operational reports from units in service be studied to determine whether this practice results in the required reliability.

3-27-10. (3-11-2) That the loctal tubes and sockets be replaced by types approved by the Bureau.

3-27-11. (3-11-2) That spare acorn sockets be furnished with more dependable by-pass condensers. Refer to paragraph 3-27-35.

3-27-12. (3-11-3) That tube clamps be provided where practicable.

3-27-13. (3-11-4) That tube sockets be identified on both sides of the chassis and that no designations be obscured by other components or fittings.

3-27-14. (3-13-2) That color coding and tracers be used more extensively.

3-27-15. (3-13-3) That no switch shafts be used as cabling supports.

3-27-16. (3-13-4) That the internal tooth type terminal lugs be replaced with a more permanently useful type.

3-27-17. (3-13-4) That the paper terminal markers be replaced by a more durable kind and that they be used on the rear as well as the side terminal board.

3-27-18. (3-14-1) That an interlock be provided to operate with the indicator unit in addition to the one provided with the receiver unit.

3-27-19. (3-14-2) That the pilot lamp be so mounted as not to require adhesive material to assure reliable operation.

3-27-20. (3-15-1) That holes be provided in the base of the shock mount plate to facilitate the removal of the three screws on the under side of the receiver chassis.

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3-27-21. (3-15-3) That a clamp be provided to hold the 16½ kc. crystal more securely to insure good contact under all operating conditions.

3-27-22. (3-15-4) That all internal-tooth lock washers be replaced by Navy-approved split-ring lock washers.

3-27-23. (3-15-7) That the heads on the captive thumb screws on the cathode-ray tube bezel be larger in diameter and wider.

3-27-24. (3-15-8) That the transformer plate at the rear of the chassis be made independent of bowing pressure for support.

3-27-25. (3-17-2) That a complete, distinct, and permanent component marking system be adhered to.

3-27-26. (3-18-1) That all condensers and heavy iron core chokes be potted.

3-27-27. (3-18-2) That the tank coils L703 and L704 be wax coated.

3-27-28. (3-18-3) That all condensers and resistor be wax dipped.

3-27-29. (3-18-4) That no condenser or resistor leads be bent or soldered close enough to their shells to endanger their seals.

3-27-30. (3-18-5) That no side plates be secured by wedging.

3-27-31. (3-18-6) That no useless parts be included.

3-27-32. (3-18-7) That all permanent parts requiring firm support be bolted to the chassis rather than being temporarily clamped.

3-27-33. (3-18-8) That soldering technique and procedures be improved to avoid burning of insulation on wires.

3-27-34. (3-18-9) That the intermediate-frequency coil assemblies be designed to prevent the possibility of the trimming slug contacting the transformer windings under any service conditions.

3-27-35. That each mica condenser in the subject equipment be considered with respect to replacement by other types. This recommendation is submitted in view of the current mica shortage. It appears likely that future contracts may not permit use of mica condensers except where absolutely essential.

3-28. Conclusions

The general construction, workmanship, and appearance of the receiver and range indicator unit of the Model SC-1 radar equipment are good. Certain electrical and mechanical defects and recommendations for their improvement are summarized in

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[redacted]

the preceding paragraph. However, it should be noted that several tests usually required to determine equipment performance under service conditions were not made due to time limitations. Among the more serious defects are the use of non-Navy-approved vacuum tubes, unreliable tube sockets, and the insecure mounting of the range-calibration crystal.

Submitted by:

T. McL. Davis,
Head of Receiver Section

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TABLE I

Tube Electrode Voltages

Indicator

Tube	Circuit No.	Function	Plate	Cathode	Control Grid	Screen Grid	Suppressor Grid
7W7	V-701	60~ Trigger Tube	103-114*	8.8-9.8*	0		
			216-237*	8.8-9.8*	-24.5 to -22.5		
6F6	V-702	Horizontal Sweep	160-140*	0	-39 to -42	115-125*	
6J5	V-703	Marker Tube	400	190 - 390**	160-140*		
	V-704	Marker Amplifier	51	1.75 - 2.2	-.14 to -30**		
			97-110*	0	-1.75 to -1.43*		
7W7	V-705	Blanking & Damping	120-150*	0	-2.5 to -15.7		
			175	12.6 ON***	-2.5 to -15.7		
				3.6 OFF			
6SK7	V-706	82 Kc. Oscillator	180	112	112	175	100
7W7	V-707	Clipper & Crystal Osc.	171	9	0		
			170	115	0 ON***		
					-14 OFF		
7W7	V-709	Lobe Sw. Multivibrator	115	0	-26.5		
			112	0	-26.5		
7W7	V-710	Clipper & R.R. Amp.	0	0	-26.5		
			130	0	0		

* Voltage variation when [WW] (Range Selector) moved from 1 to 3.
** Voltage variation when [TT] (Range Pot.) turned from min. to max.
*** Voltage variation with [PP] (Crystal "ON" "OFF")

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[redacted]

TABLE II

Tube Electrode Voltages

Receiver

Tube	Circuit No.	Function	Plate	Cathode	Control Grid	Screen Grid	Sup. Grid
956	V-601	1st RF Amp.	105	4	0	105	0
956	V-602	2nd RF Amp.	105	3.6	0	105	0
955	V-603	Heterodyne Osc.	170	0	-.1		
954	V-604	1st Detector	140	8.5	0	140	0
7H7	V-605	1st IF Amp.	145	5*	0	145	0
7H7	V-606	2nd IF Amp.	145	5*	0	145	0
7H7	V-607	3rd IF Amp.	150	5*	0	150	0
7E6	V-608	Detector & Vid. Amp	Diode 55 Video Amp 168	55	55		
6AG7	V-609	Video Output	120	2.6	0	113	
6H6	V-610	Limiter Diode	P1 55 C1 54 P2 55 C2 54				

* Voltage with [BB], gain control, at maximum setting (arm at ground potential).

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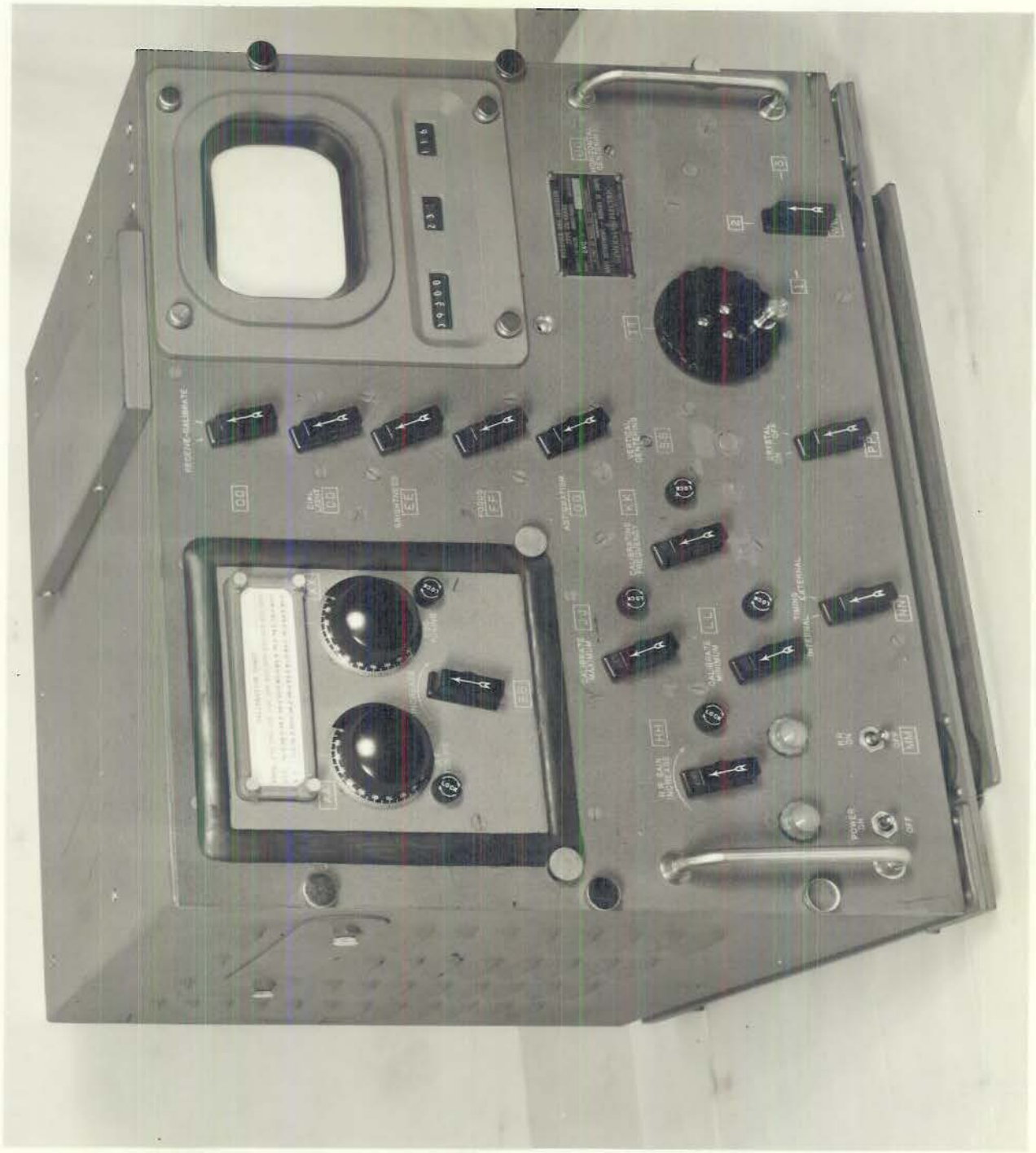

SEC III PLATE I

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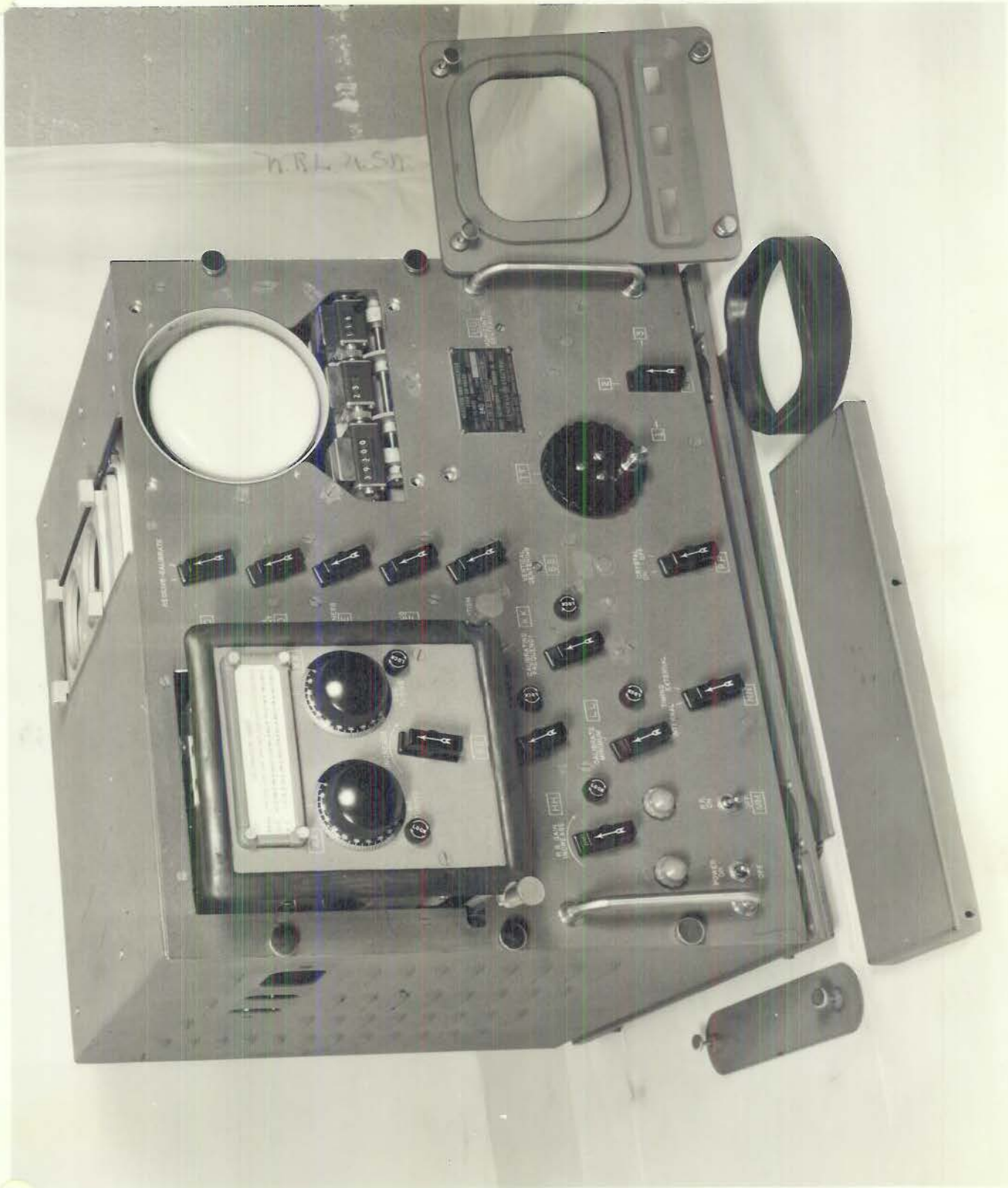

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SEC III PLATE 2

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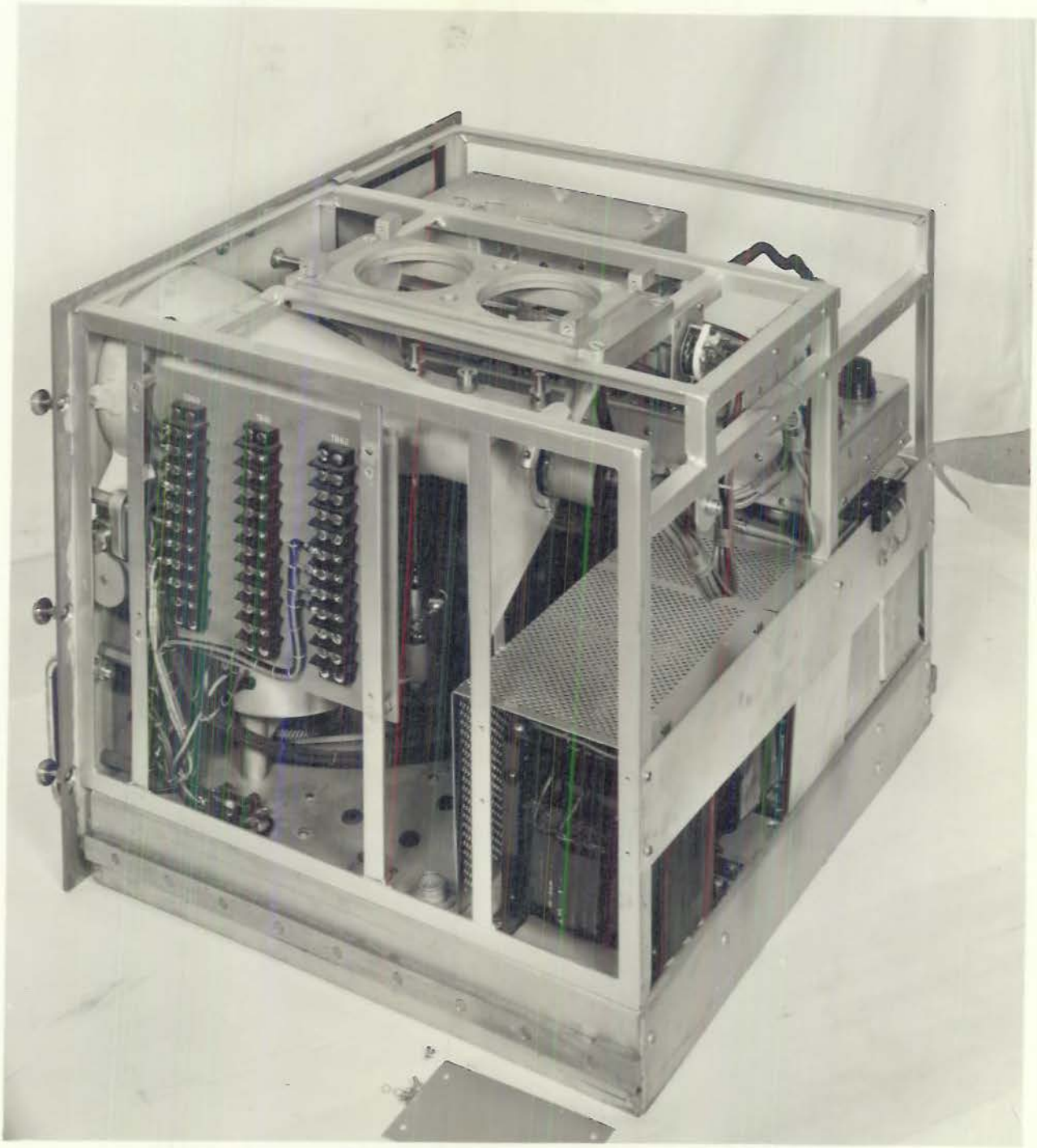

SEC III PLATE 3

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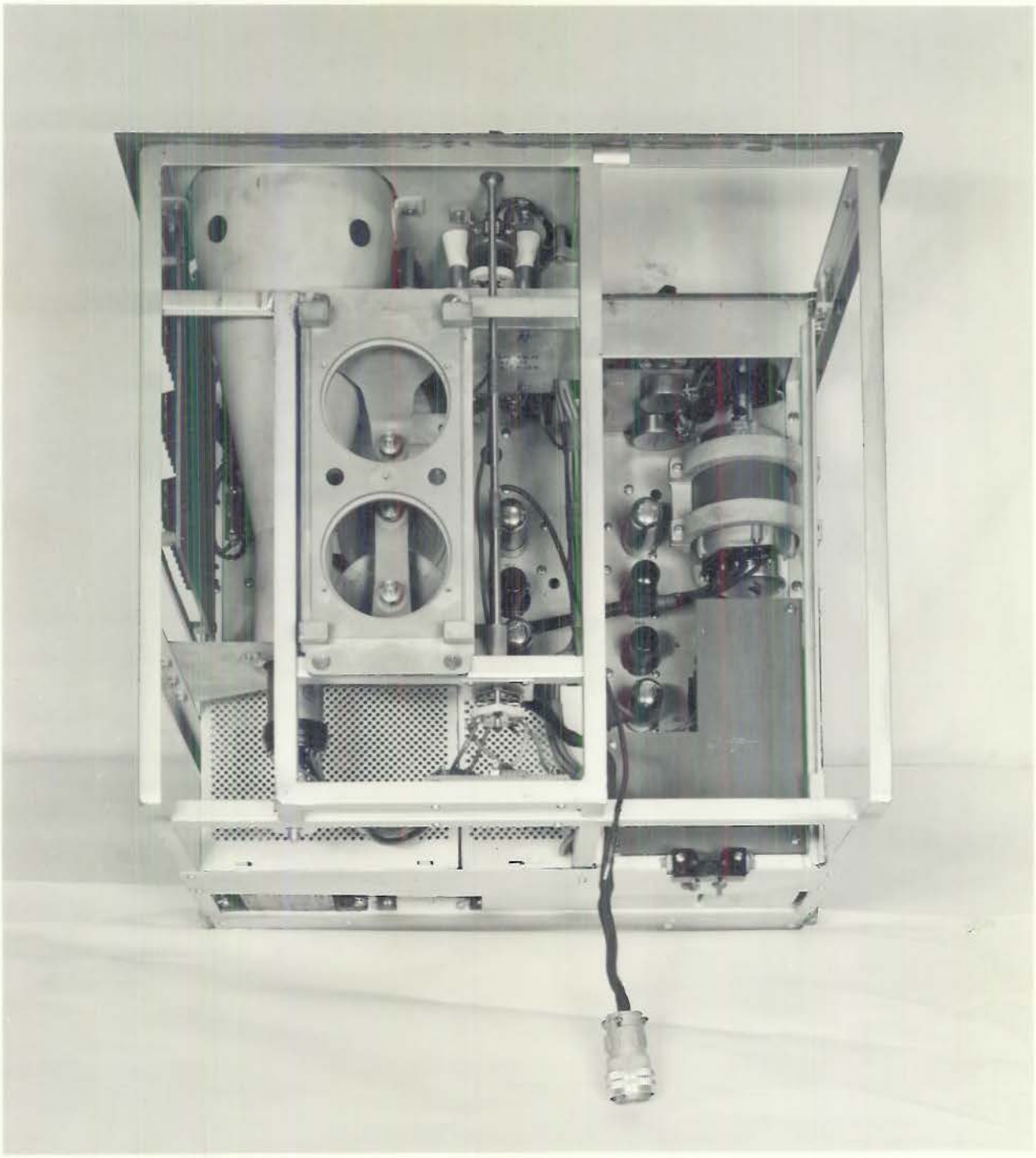

SEC III PLATE 4

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DECLASSIFIED SEC III PLATE 6

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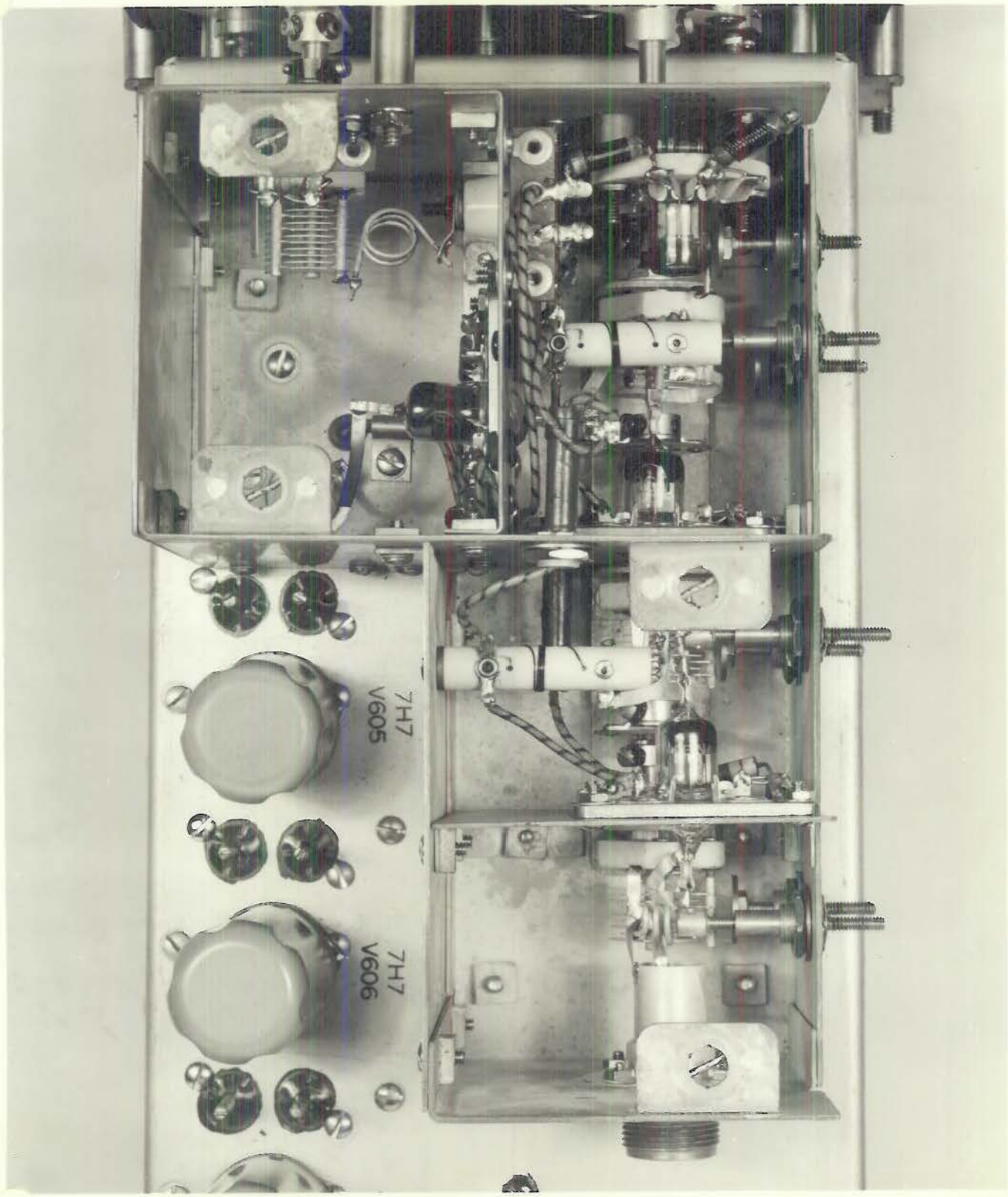

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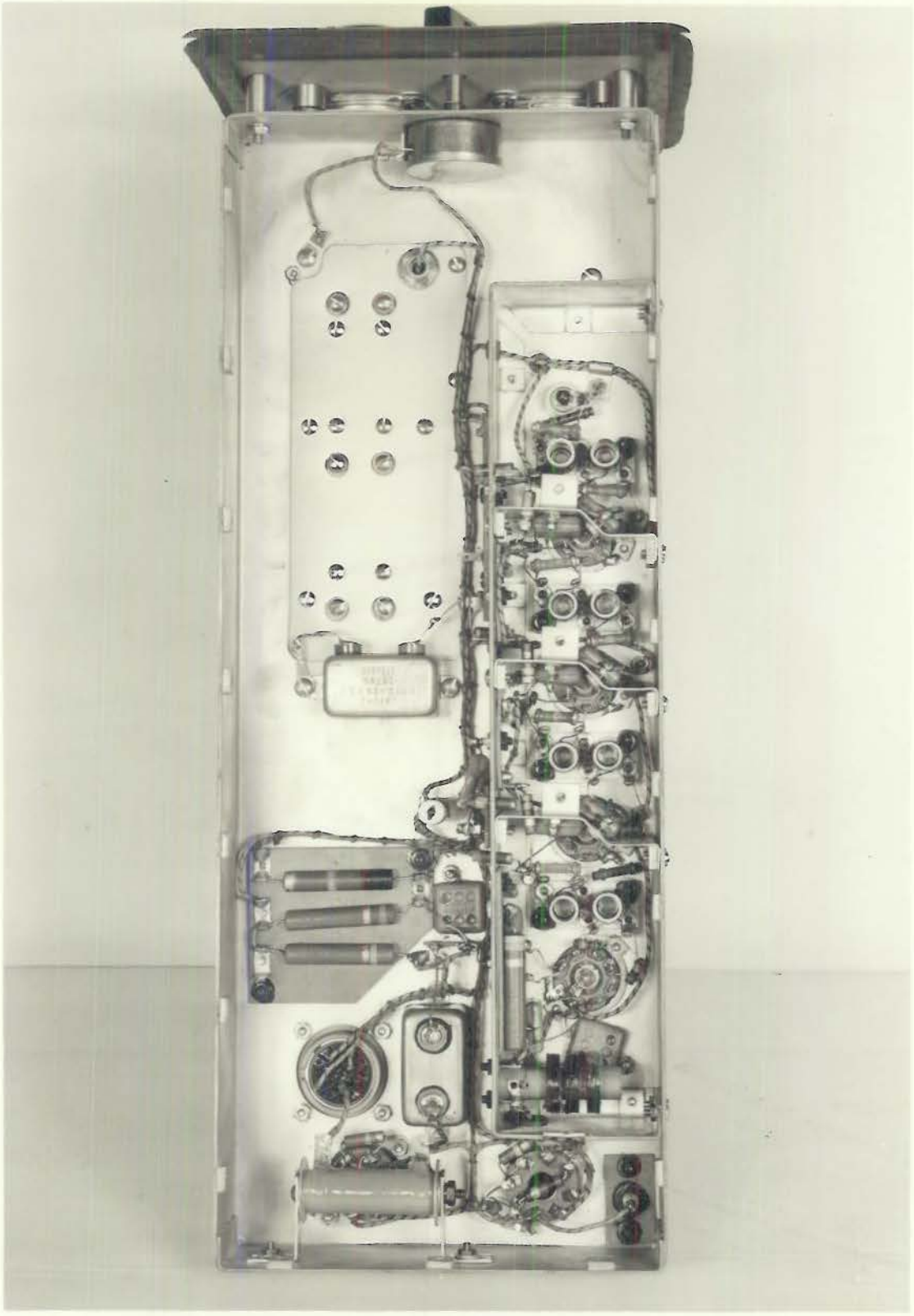

DECLASSIFIED SEC III

PLATE 8

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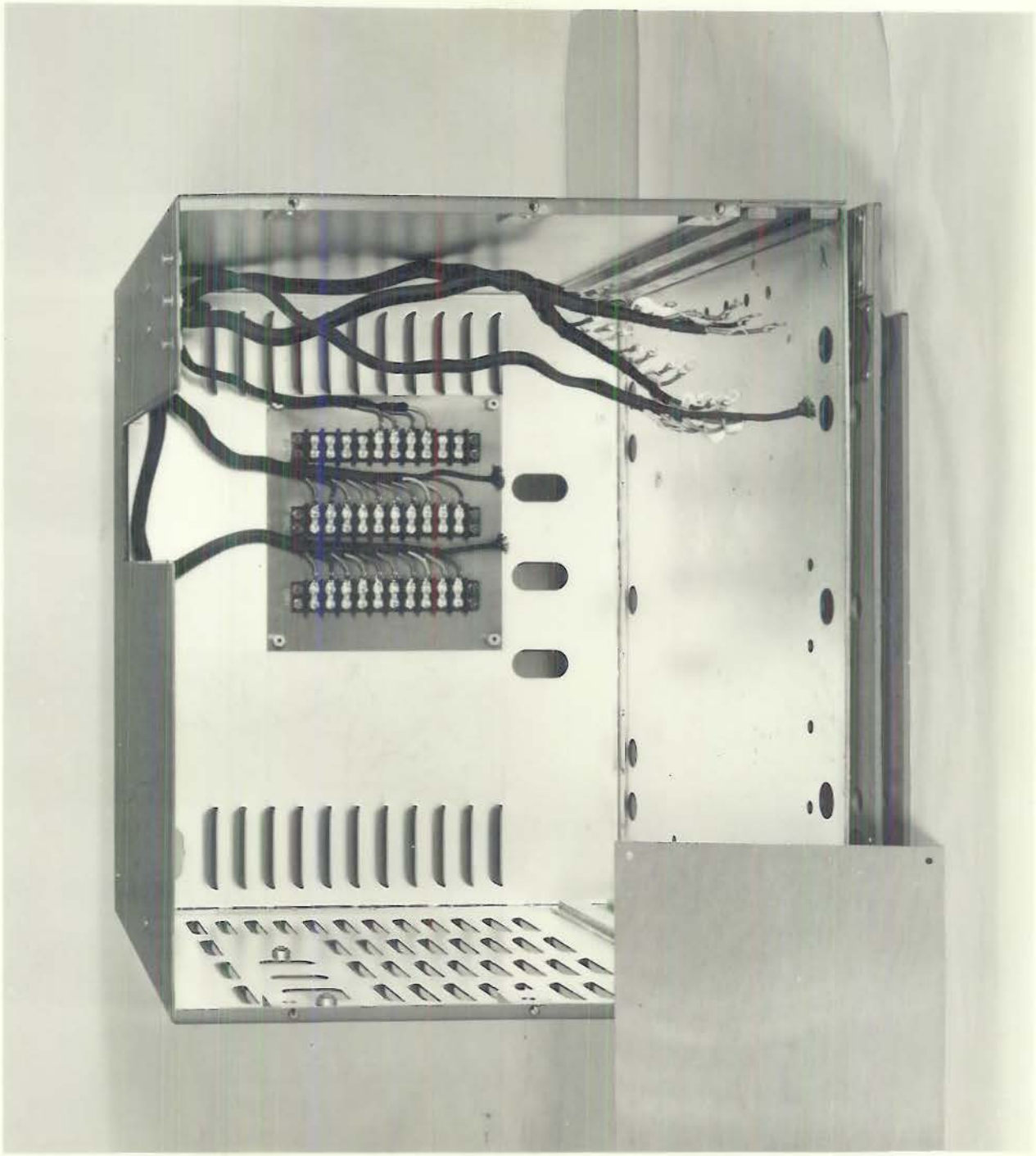

SEC III PLATE 9

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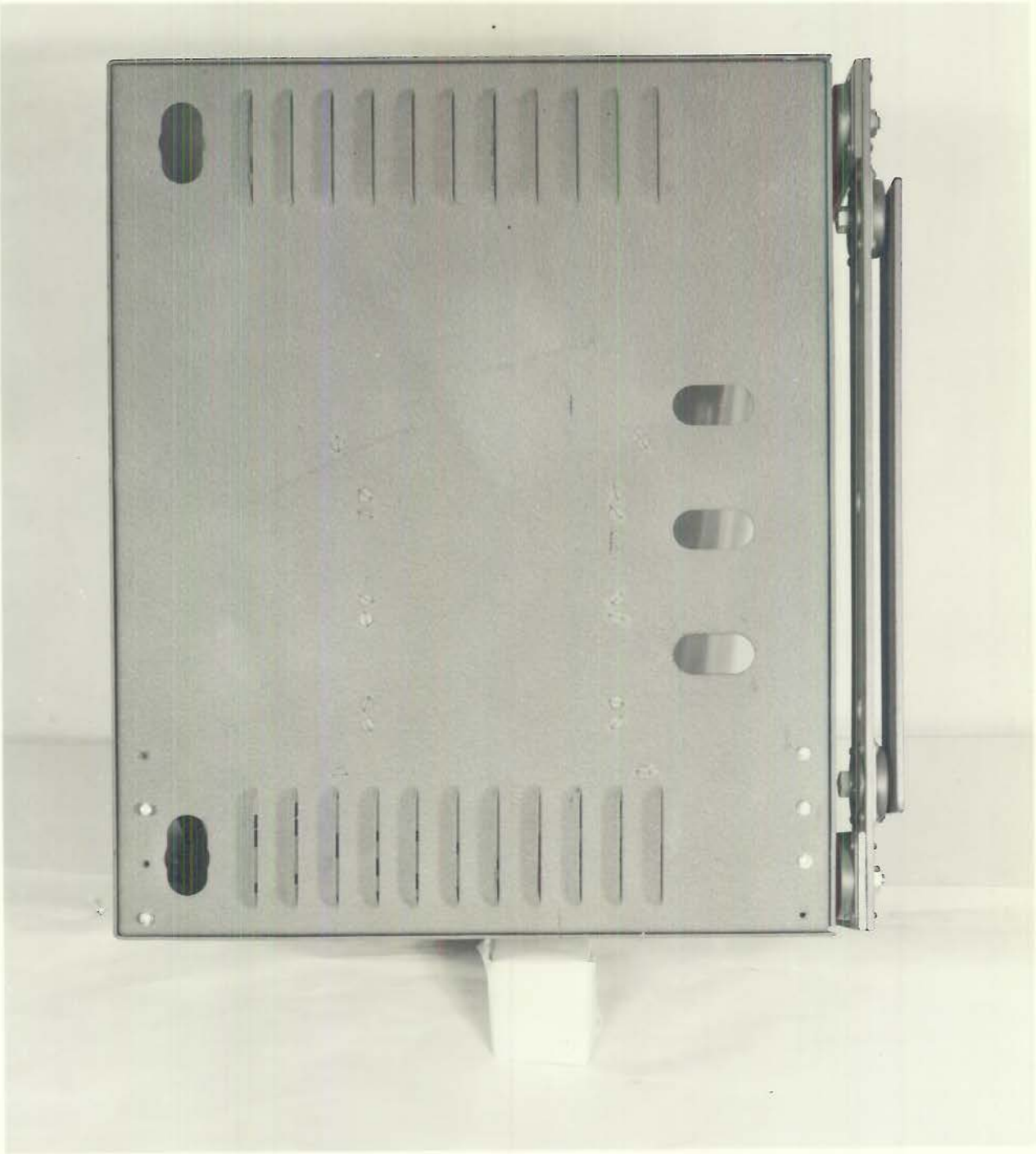

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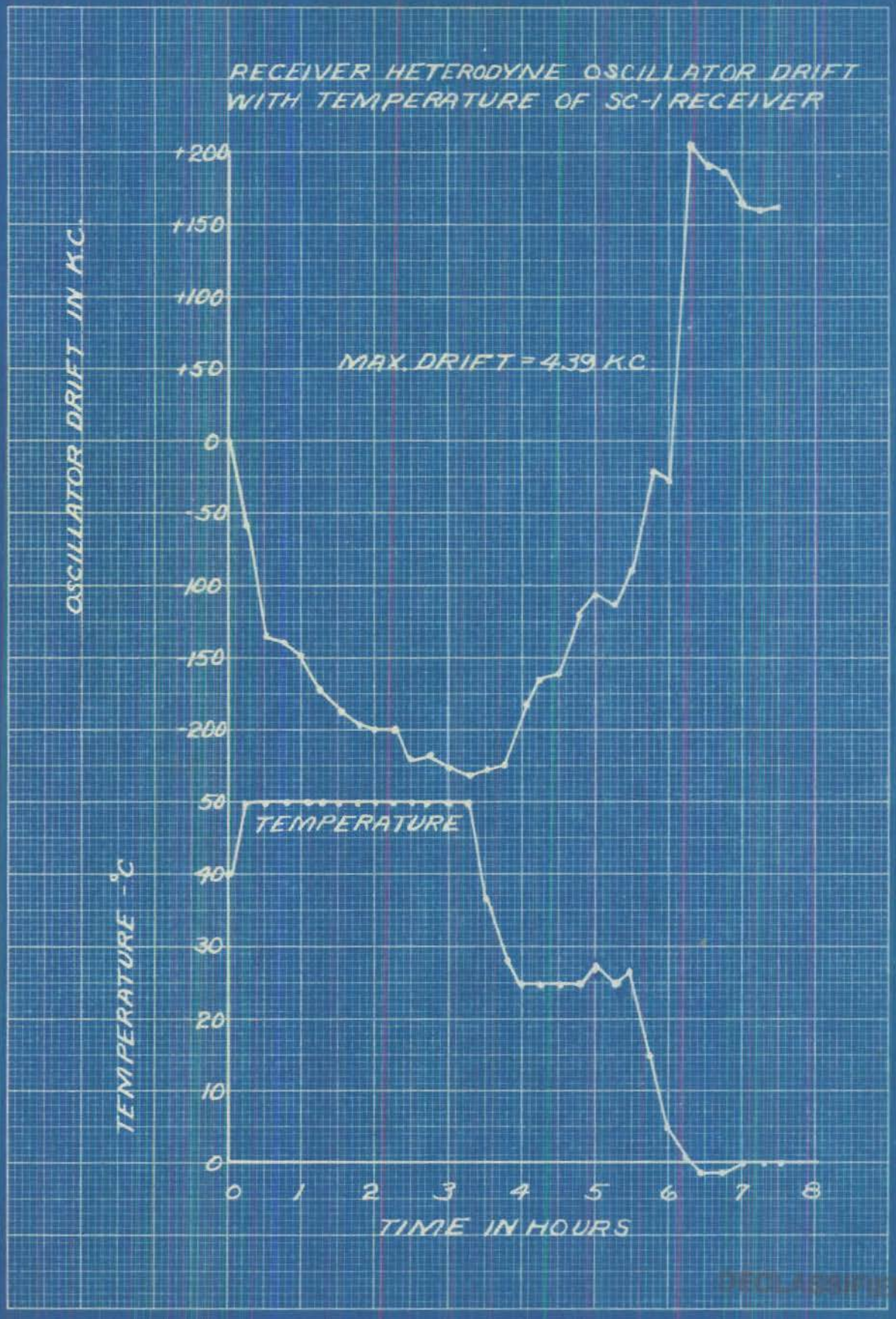

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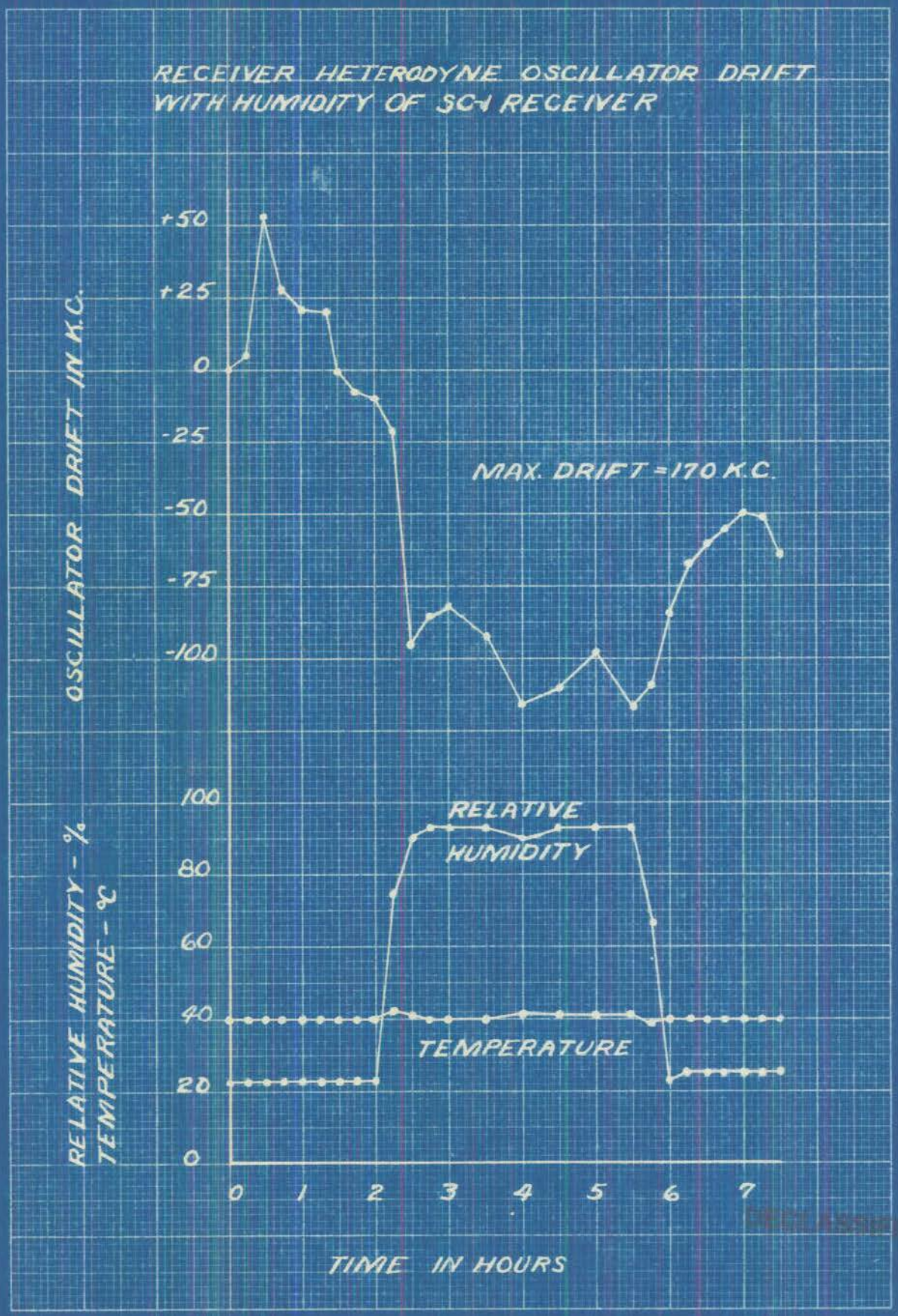
SEC. III PLATE II

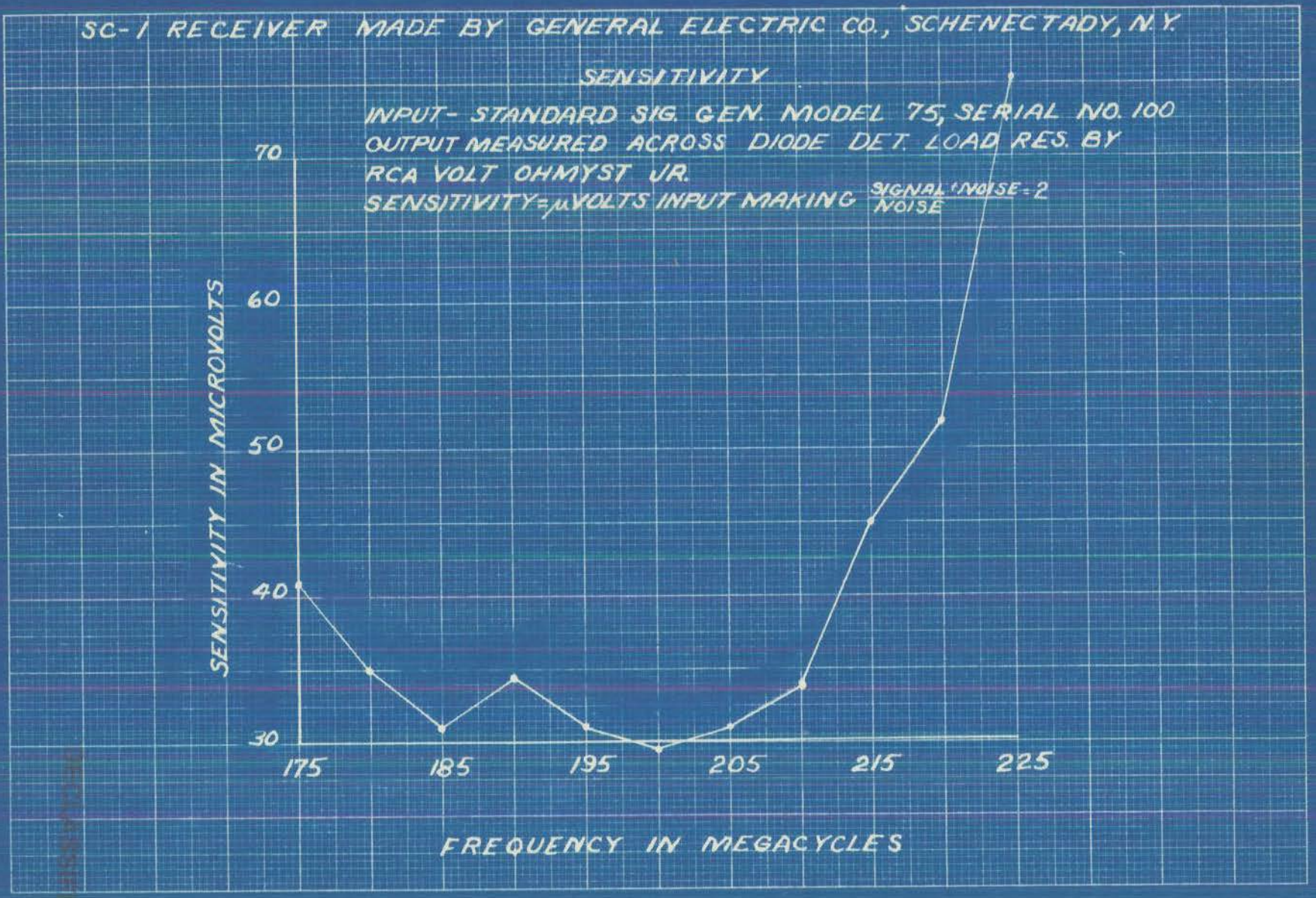


SEC. III PLATE 12

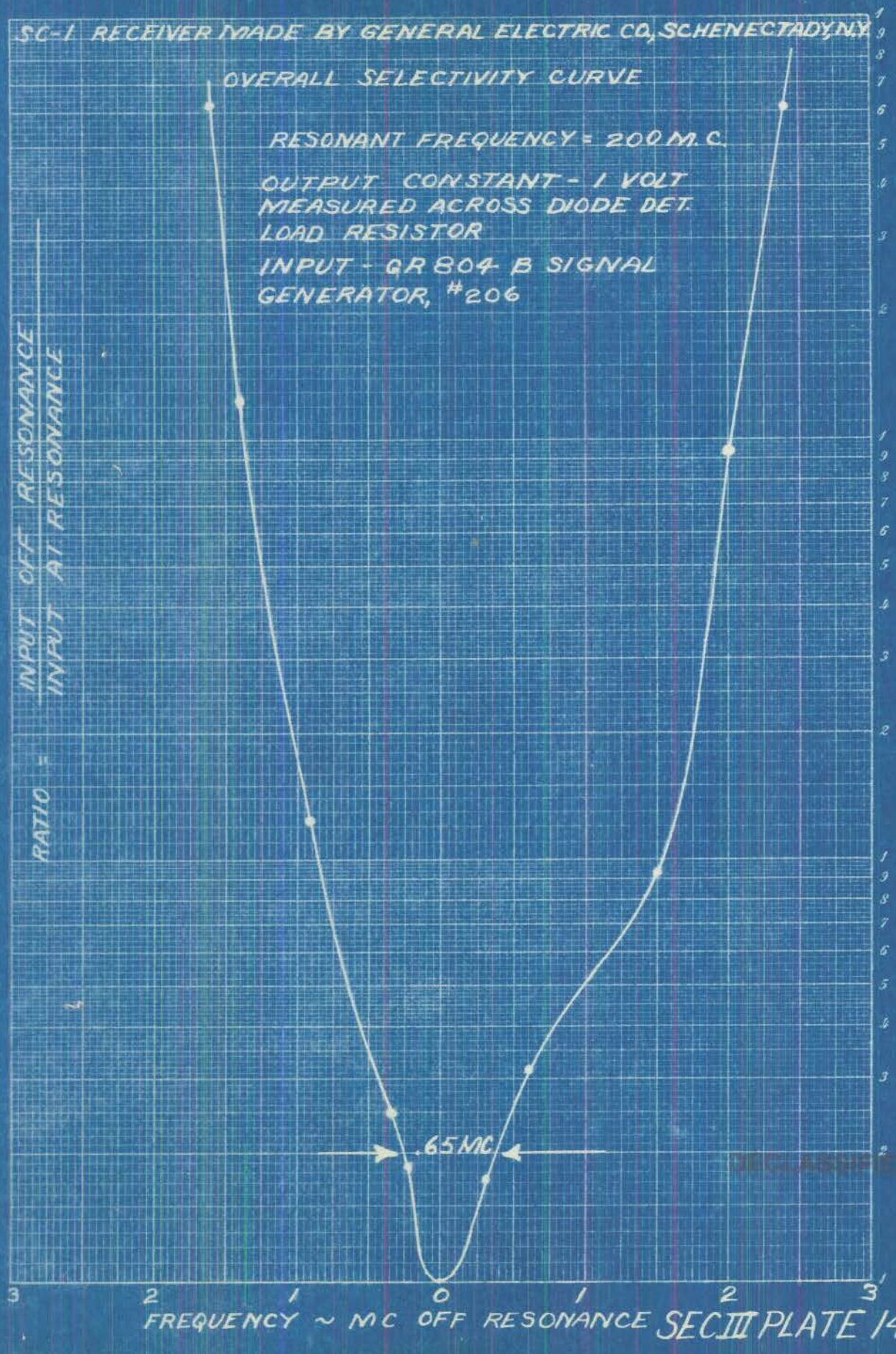
SC-1 RECEIVER MADE BY GENERAL ELECTRIC CO., SCHENECTADY, N.Y.

SENSITIVITY

INPUT- STANDARD SIG. GEN. MODEL 75, SERIAL NO. 100
OUTPUT MEASURED ACROSS DIODE DET. LOAD RES. BY
RCA VOLT OHMYST JR.
SENSITIVITY = μVOLTS INPUT MAKING $\frac{\text{SIGNAL + NOISE}}{\text{NOISE}} = 2$



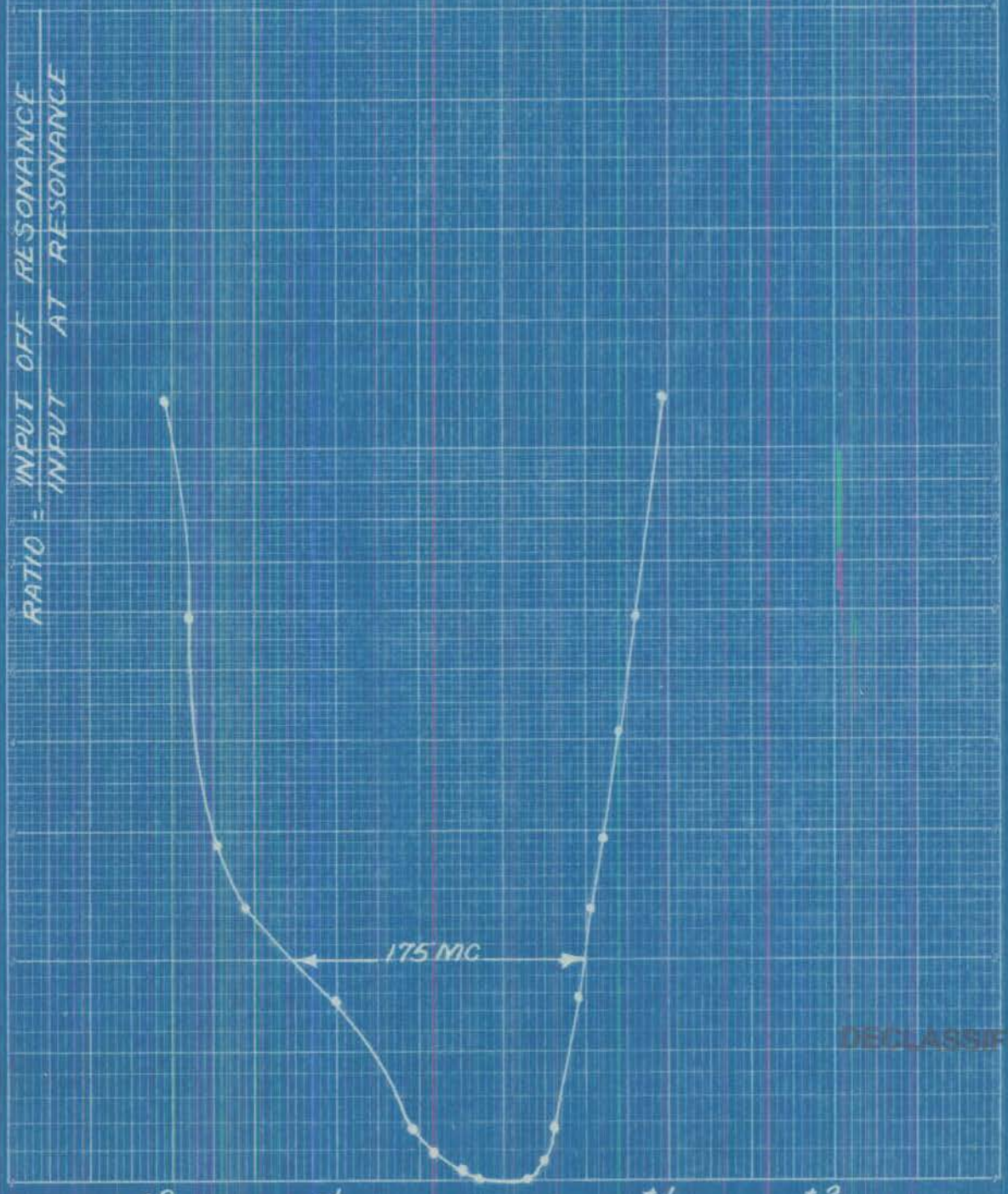
SEC. III PLATE 13



SEC III PLATE 14

SC-1 RECEIVER MADE BY GENERAL ELECTRIC CO. SCHENECTADY, N.Y.

IF SELECTIVITY CURVE
FROM GRID OF 1ST DETECTOR
RESONANT FREQUENCY - 3.14 MC.
OUPUT CONSTANT - .5 VOLT MEASURED
ACROSS DIODE DETECTOR LOAD RESISTOR BY
RCA VOLT OHMYST JR.
INPUT ~ GR 804B SIG. GEN. #206



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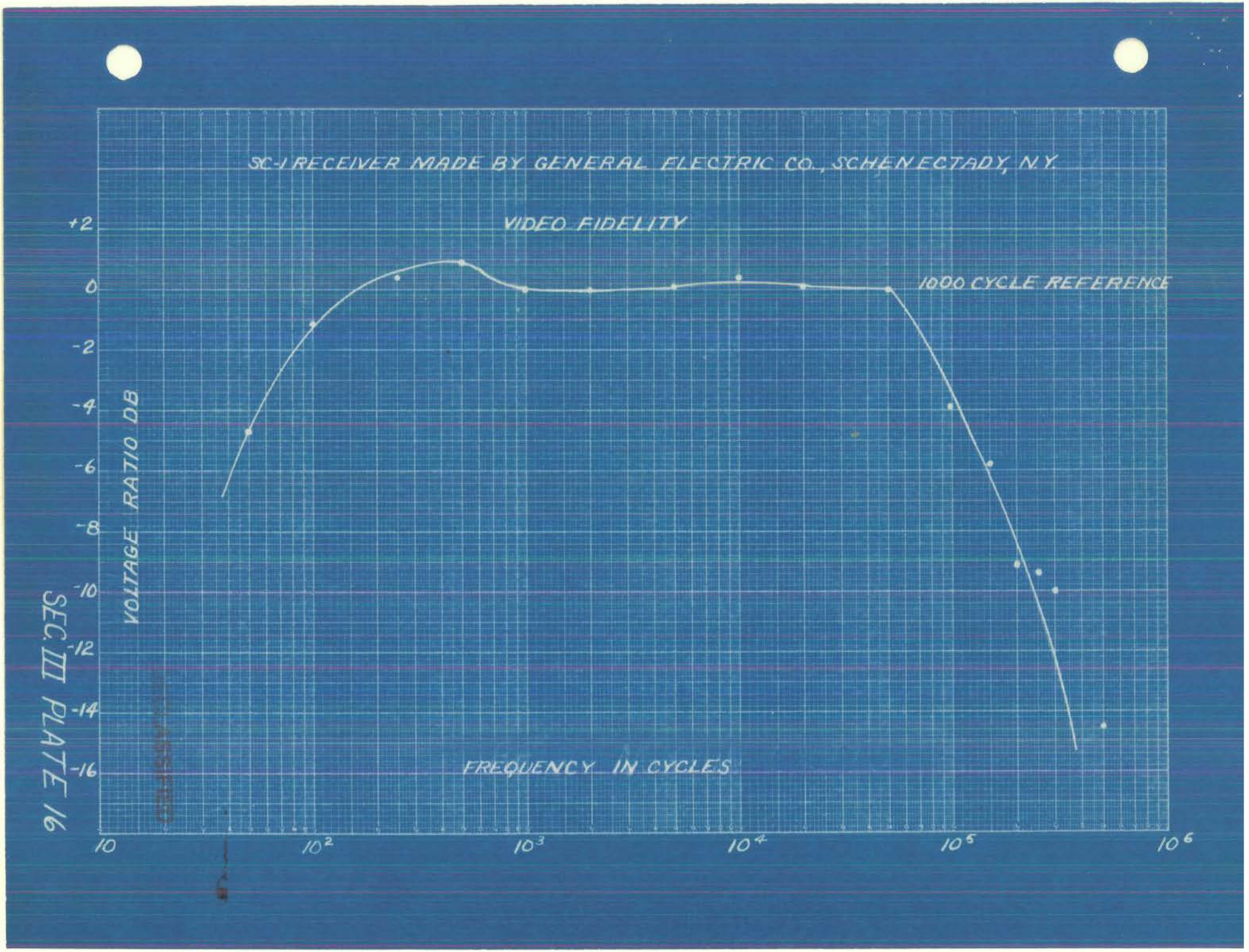
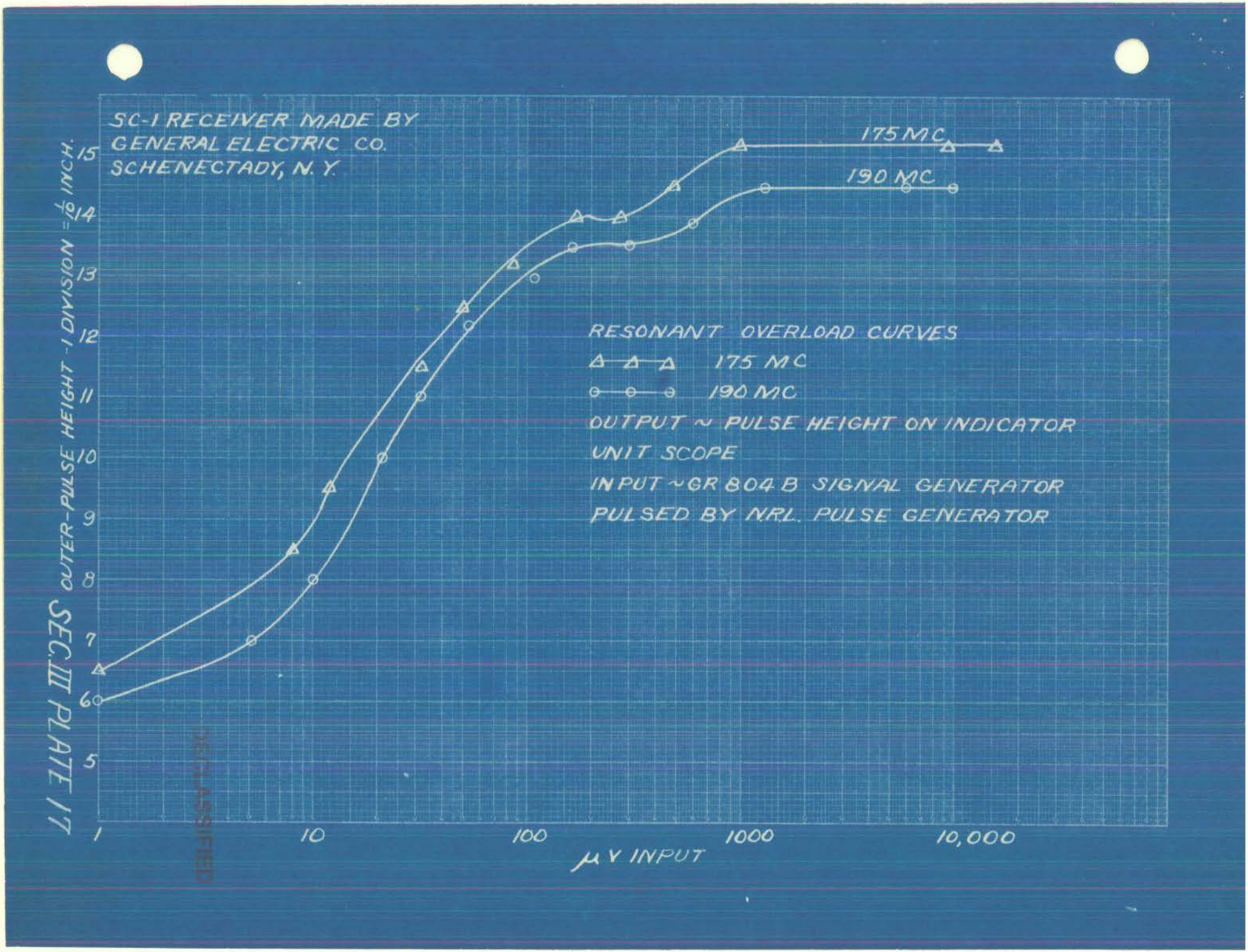
SEC. III PLATE 15



SEC. III PLATE 16


SC-1 RECEIVER MADE BY
GENERAL ELECTRIC CO.
SCHENECTADY, N. Y.
175 MC
190 MC
RESONANT OVERLOAD CURVES
175 MC
190 MC
OUTPUT ~ PULSE HEIGHT ON INDICATOR
UNIT SCOPE
INPUT ~ GR 804 B SIGNAL GENERATOR
PULSED BY NRL. PULSE GENERATOR
SEC. III PLATE 17
OUTER-PULSE HEIGHT - 1 DIVISION = 1/10 INCH.
15
14
13
12
11
10
9
8
7
6
5
1
10
100
1000
10,000
μV INPUT
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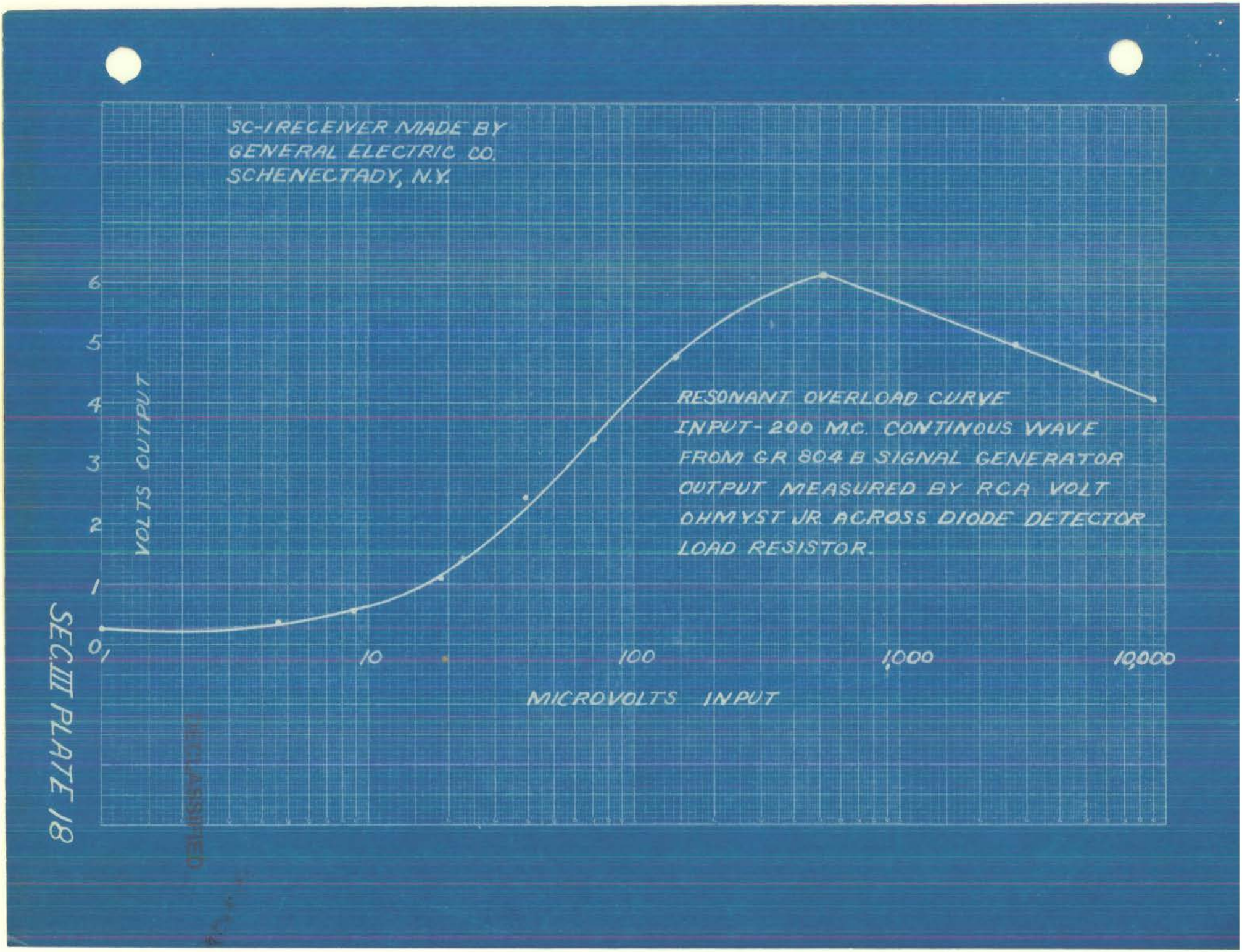
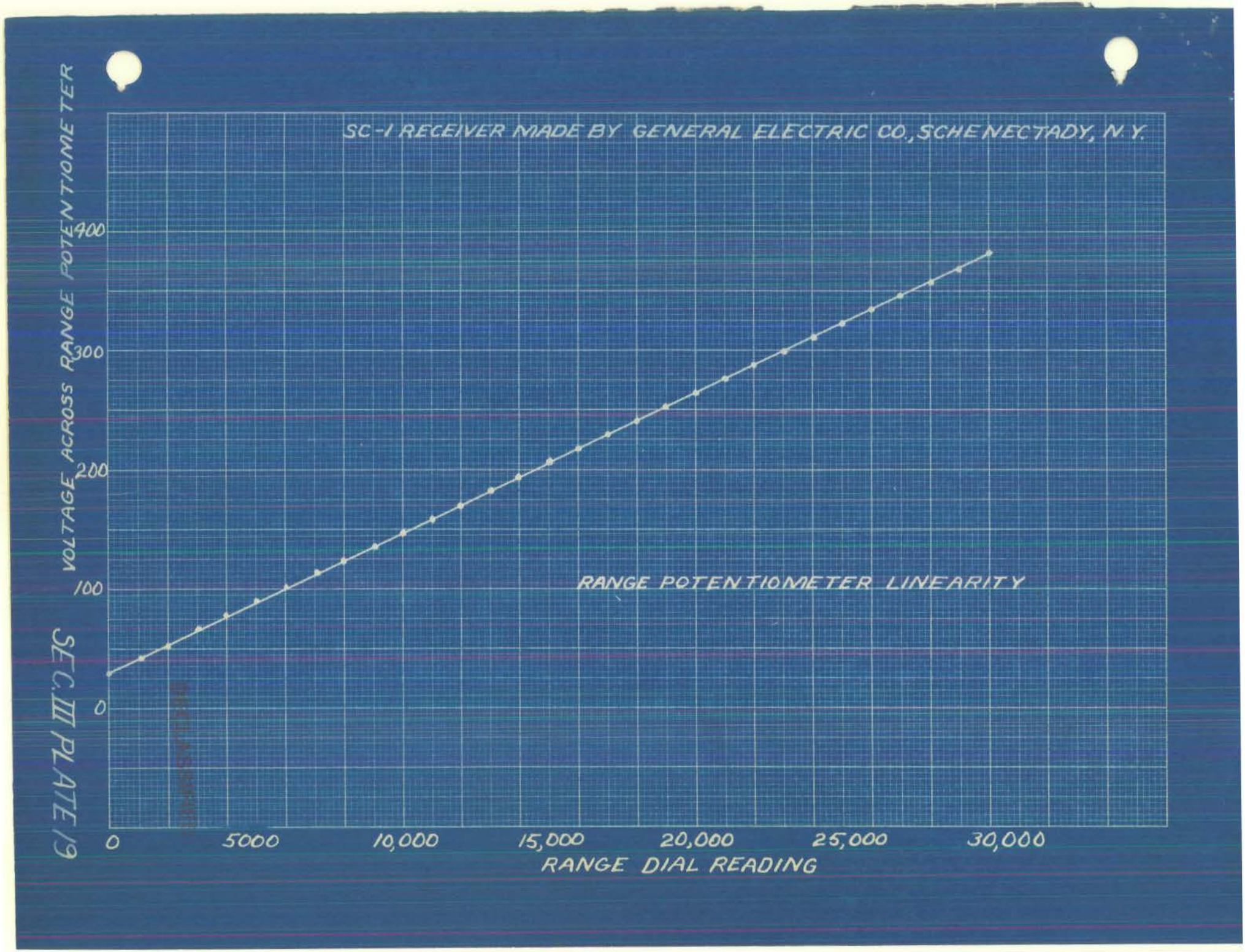


SEC. III PLATE 18


SC-1 RECEIVER MADE BY GENERAL ELECTRIC CO., SCHENECTADY, N.Y.
SEC. III PLATE 19
VOLTAGE ACROSS RANGE POTENTIOMETER
400
300
200
100
0
RANGE POTENTIOMETER LINEARITY
0
5000
10,000
15,000
20,000
25,000
30,000
RANGE DIAL READING