Eng. 70-C

[redacted]

REPORT NO. R13-57

DATE 22 April 1937

SUBJECT FR-1357

Test on Model GP-3 Transmitting Equipment

Manufactured by Westinghouse Electric and Manufacturing Company

BY

NAVAL RESEARCH LABORATORY

BELLEVUE, D. C.

U. S. GOVERNMENT PRINTING OFFICE 1932 4—7456

BuEng. Prob. A2-5
Test on Model GP-3 Transmitting Equipment
Manufactured by Westinghouse Electric and
Manufacturing Co.

22 April 1937

NRL Report No. R13-57
BuEng.Prob.No. A2-6

[redacted]

NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report on

Test on Model GP-3 Transmitting Equipment

Manufactured by

Westinghouse Electric and
Manufacturing Company.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

Number of Pages: Text - 16 Tables - 14 Plates - 11

Authorization: BuEng. ltr. C-NOs-47023(6-26-W3) of 29 June 1936.

Date of Test: 9 July 1936 to 1 March 1937.

Prepared by:

M. H. Schrenk, Assoc. Radio Engineer, (Chief of Section).

Reviewed by:

A. Hoyt Taylor, Pr. Physicist, Supt., Radio Division.

Approved by:

H. M. Cooley, Captain, USN., Director.

Distribution:
BuEng. (5)
Naval Air Station, Anacostia, D.C. (2)

epc

TABLE OF CONTENTS

APPENDIX A

[redacted]

DECLASSIFIED

APPENDIX A (continued)

APPENDIX B

Copy of U.S. Naval Air Station, Anacostia, D.C. ltr. F42-1(9)/NA6(46) of 26 February 1937 to Director, Naval Research Laboratory - Report on Flight Tests of Preliminary Model GP-3 Transmitting Equipment.

[redacted]

DECLASSIFIED

AUTHORIZATION.

1. These tests were authorized by Bureau of Engineering letter C-NOs-47023 (6-26-W3) of 29 June 1936. This and other pertinent references are listed below.

References:
- (a) BuEng. ltr. C-NOs-47023(6-26-W3) of 29 June 1936.
- (b) NRL ltr. F42-1/52 of 24 Aug. 1936.
- (c) Specifications RE 13A 490 D.
- (d) BuEng. ltr. C-NOs-47023(6-26-W8) of 15 Feb. 1937.
- (e) W.E.M.Co. ltr. of 10 July 1936 to INM, Hartford, Conn.

OBJECT OF TEST.

2. The object of these tests was to determine compliance of the Model GP-3 equipment with the governing specifications, ref. (c), and to determine its suitability for use in Naval aircraft service.

ABSTRACT OF TEST.

3. The Model GP-3 equipment was tested in the Laboratory for compliance with the governing specifications, ref. (c). These tests covered the following points:

(a) Mechanical, including -
- (1) Workmanship
- (2) Size and weight
- (3) Materials
- (4) Shock mounting
- (5) Type of controls and backlash

(b) Frequency Range

(c) Power output

(d) Frequency stability under conditions of -
- (1) 30 minutes key locked at full power
- (2) Variation of ambient temperature
- (3) 10% change in supply voltage
- (4) Variation of antenna constants
- (5) Reset from previous calibrations

(e) Test of power supply, including -
- (1) Input for full output
- (2) Rectifier efficiency
- (3) Ripple percentage
- (4) Regulation
- (5) Power factor correction

[redacted]

(f) Modulation capabilities, including -
    (1) Modulation percentage
    (2) Audio fidelity of modulating system
    (3) Harmonic distortion of modulated output

(g) Observation of character of emission and tests for presence of spurious frequencies and/or harmonics.

(h) Tests of equipment to withstand continuous operation and accidental misadjustment without permanent damage.

(i) General inspection relative to features required by the specifications, ref. (c), for which specific tests can not be made but which are determined by observations and/or operation of the equipment.

4. At the conclusion of the Laboratory tests the equipment was transferred to the Naval Air Station, Anacostia, D.C., where flight tests were made.

[redacted]

CONCLUSIONS.

As a result of these tests the following conclusions have been reached.

(a) The Model GP-3 equipment as originally submitted did not entirely meet the requirements of the specifications.

(b) Numerous failures in the form of radio frequency flashover occurred at high altitudes.

(c) The two power transformers failed.

(d) Backlash on the master oscillator control is excessive.

(e) At 9000 kcs. the total frequency variation is excessive.

(f) The locking devices are so arranged that their respective controls are apt to be mistaken. They should all be properly marked.

(g) A microphone transformer suitable for the standard Navy type aircraft microphone should be provided.

(h) Numerous repairs and modifications have been made during flight tests which resulted in satisfactory operations being obtained. As now modified the equipment should be satisfactory for Naval Service.

[redacted]

RECOMMENDATIONS.

It is recommended that:

(a) The Model GP-3 equipment as originally submitted be considered unsatisfactory for use in the Naval Service.

(b) As modified during flight tests this equipment be considered satisfactory for Naval service provided the following recommendations are complied with:

(c) The backlash in the master oscillator control be reduced to a satisfactory minimum.

(d) The frequency stability be improved in F box particularly as regards antenna reaction.

(e) A suitable microphone transformer be provided.

(f) The recommendations of the Naval Air Station, Anacostia, D.C., as found in Appendix B be complied with.

[redacted]

EQUIPMENT UNDER TEST.

5. The preliminary Model GP-3 equipment was submitted by the Westinghouse Electric and Manufacturing Company to demonstrate compliance with the requirements of the specifications, ref. (c). It consists of the following units:

1 - Transmitter-Rectifier Unit
5 - Tuning Units
1 - External loading coil unit
1 - Pilot's control box
1 - Operator's control box
1 - Set interconnecting cables
1 - Set of Slip covers
2 - Mounting rails.

6. The equipment is designed to provide CW, MCW or voice modulated signals over the frequency range of 300 to 1500 kcs and 3000 to 9050 kcs. This range is covered by means of the 5 plug-in tuning units. Tuning of the transmitter is obtained by means of controls of the front of the panel when a tuning unit is operatively plugged into the transmitter-rectifier unit. Actual control of transmitted signal is provided for by the controls mounted on the two control boxes. The equipment is designed for operation with a Model RU receiver and when so used provides a complete two-way radio signalling system and interphone.

7. The circuit comprises a master oscillator using a type 38101 tube and a power amplifier using a type 38803 tube. The modulator is a type 38143 tube. Power for the oscillator, modulator and the suppressor and screens of the power amplifier is supplied from a low voltage rectifier tube. The high voltage plate supply to the power amplifier is supplied by a rectifier system using two type 38266-A tubes.

METHOD OF TEST.

8. The equipment was given a general inspection covering materials and construction. The component parts were measured and weighed. The equipment was then set up in the Laboratory for electrical tests.

9. Overlap of Circuits. Manufacturer's figures were checked by use of Model LD-2, Type CAG-74016, Serial No. 1, frequency indicator. Frequencies were measured for 0 and 100 settings of control B for each position of tap switch A. However, in some instances the highest or lowest setting of B was not usable because the power amplifier circuit would not tune to the required frequency. When this was the case the highest and lowest usable settings of control B were measured.

10. Power measurements were made on three frequencies on range A and on two frequencies for the remaining ranges. On range D and range F, measurements were made using antenna constants corresponding to a fixed antenna as well as trailing wire. The procedure in measurement was as follows: The proper antenna constants were selected and a Weston panel type rf meter of suitable range was connected in the ground return of the dummy antenna. The meter was first checked at 60 cycles to insure its accuracy. The capacity element of the dummy antenna was connected to the antenna post on the set. Then the transmitter was adjusted to full power CW output with a plate input of 175 milliamperes. After all adjustments had been made the readings were taken and the emission selector turned to MCW position for a second set of readings and finally the emission selector was turned to the phone position for a final set of readings. After the set had been properly tuned on the CW position, no further adjustments were made for the MCW and phone outputs except changing the emission selector. At the low frequencies, Ward Leonard plaques were used for dummy antenna resistors and Zircon rods were used at the upper frequencies.

11. Frequency drift measurements were made by means of the Model LK drift indicator. On transmitter No. 1 one frequency on each range was selected for the half hour key locked runs. On transmitter #4, two frequencies were chosen from each range. The procedure was to tune the Model GP-3 to a suitable frequency which would give a beat note with the LK indicator. After all adjustments had been made the Model GP-3 controls were locked and the tuning unit was removed and the entire transmitter and tuning unit were cooled to room temperature. Then the tuning unit was restored and the filaments of the transmitter turned on for five minutes. At the end of five minutes filament warm-up the key was locked and the frequency was recorded for the next thirty minutes. These runs were made on full power CW operation.

12. Variation of frequency due to change of antenna constants was measured by detuning the antenna resonating control "H" above and below resonance sufficiently to cause a 15% decrease in plate current and noting the extreme values of frequency under these conditions. One half of the shift was considered as the change due to 15% change of plate current.

13. Voltage variation was secured by means of a General Radio Variac. A ten percent change of voltage was interpreted to mean ±5% so the line voltage was shifted six volts above and six volts below the normal value of 120 volts and the frequency noted at each point.

[redacted]

14. The antenna was open circuited and short circuited at each frequency where drift runs had been made and the plate current was recorded. No attempt was made to measure frequency under this condition.

15. For recording reset the Model GP-3 would be adjusted to a frequency which gave a beat with the Model LK Indicator. The settings would be carefully noted and then all controls shifted at random. When the controls were returned to their original settings the frequency would be recorded. An average of several trials was taken.

16. Backlash or reset from opposite direction was also measured by selecting a frequency which gave a beat note with the Model LK Indicator. Since there were no stops on the Master Oscillator Control, the master dial was turned clockwise 360° where setting and frequency were recorded. The master dial was then turned anti-clockwise 360° to the same setting and the frequency again recorded. The difference between the two readings is the backlash in terms of frequency.

17. The rectifier conversion factors of both rectifiers were obtained by isolating the rectifier circuits and providing suitable resistance loads. The dc outputs were measured by the voltmeter-ammeter method and the inputs with an 800 cycle wattmeter. The conversion factor is calculated from the equation,

$$\frac{\text{Output of rectifier}}{\text{Input to rectifier}} \times 100 = \text{Conversion factor.}$$

18. Measurements of ripple voltage in the power supply were determined by means of a "string" oscillograph in connection with suitable auxiliary apparatus. A picture of the ripple voltage is taken and a timing wave of 60 cycles is photographed simultaneously by means of an additional element. By comparison of the two traces the frequency or frequencies of the ripple in the power supply is determined. The sensitivity of the oscillograph was then determined by impressing a known voltage of the same frequency as the ripple on the oscillograph and measuring the deflection. Percentage of ripple is expressed as the ratio of half the sum of the peak value to the D.C. output voltage. In the case of the power supplies used for aircraft transmitters a very slight variation in the air gap due to the bearings not being perfect, introduces a low frequency (about 42 cycles in the case of the NEA-1-A) ripple which causes the oscillographic trace to be displaced from the zero line but does not cause any interference in the receiver. This was determined by listening to a received signal and deliberately introducing a 42 cycle ripple into the plate supply. No

objectionable results followed and consequently the low frequency ripple is ignored in the calculating of the ripple percentages.

19. Measurement of modulation percentage was made by two methods. In the first case a portion of the dummy antenna voltage was fed into Model OB audio analyzer and the percentage read from a direct reading meter. The other method involved the use of the cathode ray oscillograph. A beat frequency oscillator was used to supply the modulating voltage to the microphone transformer and also to one set of plates of the cathode ray tube through a suitable mixing panel. A portion of the radio frequency voltage in the antenna circuit was applied to the remaining pair of plates of the cathode ray tube. With no modulation a rectangular pattern is produced on the screen of the cathode ray tube, the dimensions of which are proportional to the peak voltage applied to the plates. With modulation the pattern changes to a trapezoid having its bases proportional to the maximum and minimum radio frequency voltages. Thus the percentage modulation may be determined from the formula -

$$\frac{Max - Min}{Max + Min} \times 100 = \% \text{ modulation}$$

Photographs of the various patterns were taken.

20. The ratio of carrier noise to completely modulated signal was measured with a Model OB audio analyzer.

21. Audio fidelity measurements were made by two methods. In the first instance a portion of the modulated r.f. output was rectified and measured by a General Radio milliwattmeter. The modulating frequency was then varied and output recorded. Db variation from the average was computed. The second method differed from the first inasmuch as a portion of the modulator output was used instead of a portion of the rectified antenna output.

22. Audio frequency harmonic distortion was measured on the Model OB audio analyzer.

23. Radio frequency harmonic content was investigated with the cathode ray wattmeter.

24. Flight tests were made as described in NASA Report, Appendix B, of this report. During flight tests observations on quality of emission and measurements of frequency drift and resets were made by this Laboratory.

[redacted]

DATA RECORDED DURING TEST.

25. The data recorded during these tests appears in the tables and plates of the appendix to this report. A discussion of this data will be found under Results.

DISCUSSION OF PROBABLE ERRORS.

26. Table 1 of the appendix lists the instruments used for these tests with their accuracy. However, the accuracy of the various tests is not necessarily that of the instruments used for the tests. Power output should be accurate to ±5%. Modulation percentage is accurate to ±2%. It will be noticed that a high degree of accuracy is attached to the Model LK frequency indicator. This accuracy applies for drift measurements only and not for absolute frequency.

RESULTS OF TESTS.

28. The results of measurements made on this equipment are shown by the data recorded which are tabulated in the appendix to this report. Results of flight tests are given in the letter from the Naval Air Station, Anacostia, D.C., which forms Appendix B of this report.

29. The following discussion will be based on specific requirements of the specifications, ref. (c). Comments will be made on each paragraph of the specifications except those of a general or informative nature. The numbering corresponds to the specification notations.

2-2. As originally submitted the antenna ammeter was of conventional design. Later an expanded scale type meter was submitted with ref. (d) which was tested and found satisfactory. Plate 1 shows this meter.

2-3. Rigid construction is used. The frame is of cast aluminum.

2-4. The workmanship is good.

2-5. All parts areplated or otherwise suitably protected except for small steel springs which may be made unserviceable if further treated.

2-6. The results of temperature tests are discussed in detail later.

2-7. Operation in high humidity resulted in no damage.

2-8. The condenser plates have been constructed of steel which is plated. Steel has been used to secure temperature compensation and it is recommended that its use be approved.

2-9. All parts except transformers successfully withstood overload.

2-10. Ventilation is provided by means of a blower driven by an 800 cycle motor. The system worked satisfactorily during all tests.

2-11. Two transformers failed during tests. Each of the plate power supply transformers opened under condition of high temperature after several hours of operation. These transformers were replaced and no further casualties were had.

2-12. Repeated landings and taxying over rough ground caused no damage to the equipment.

2-13. The operator is protected by means of a safety switch when removing tuning units. Another switch grounds the high voltage rectifier.

2-14. This equipment did not give reliable performance as submitted. Unsatisfactory performance is more specifically discussed later, particularly at altitude as described in Appendix B.

2-15. No damage results from short circuit, open circuit or grounded antenna.

2-16. The dimensions and weights of the equipment are given in Table 2 of the Appendix. The overall weight as specified in this paragraph is 80 lbs. which is 4 lbs. less than required.

2-17. The equipment may be passed through an 18 x 18 inch hatch.

2-18. The negative DC is grounded. Grounding one side of the 800 cycle supply has no effect on the operation.

2-19. The cases are constructed of aluminum finished in black wrinkle with suitable protection against corrosion.

2-20. The cabinet, knobs and controls may be operated at ground potential.

[redacted]

2-21. Markings are white on a black background.

2-22. The equipment complies with the requirements of this paragraph.

2-23. All plugs are of a type now in service and should be satisfactory.

2-24. Cables are satisfactory.

2-25. Plugs and cables are shielded and cables are rubber covered.

2-26. Several long unsupported leads were found in the equipment. One of these leads is shown in the photographs of Appendix B.

2-27. Wiring is color coded.

2-28,2-29. Samples of the wire were not available for test. The wiring in general appears to be satisfactory.

2-30. Shock mounting is provided by live rubber mounting on the transmitter case.

2-31. Vacuum tubes are of the single unit type. Clamps are provided for securely holding the tubes.

2-32. No difficulty was encountered when tubes were changed.

2-33. All vacuum tubes operate within Navy limits.

2-34. 2.5 inch instruments are used.

2-35. The controls are simple and easy to operate. Detents on switches should be heavier.

2-36. All indicators are marked by etched name plates.

2-39. Control shafts are ground. Insulated knobs are provided.

2-40. All parts are interchangeable. However, interchanging tuning units requires recalibration. Type numbers or identifying symbols appear on all parts.

2-41. Name plates are supplied which may be seen by examination of the photographs of the equipment.

[redacted]

2-42. Lock washers were missing in a few places due probably to changes in the development stage. All leads are securely soldered and soldered joints covered with red lacquer.

2-44. Live rubber shock mountings are employed. The mountings were drilled as shown. However, these mounting holes permitted the transmitter to sit too far forward in the airplane. This was corrected.

2-45. Non-explosive insulation was used throughout. Slow burning insulation is used on wiring.

2-46. No wood is used.

2-47. All high voltage and all radio frequency insulation is ceramic or mycalex.

2-48. The impregnating compound from one low voltage filter condenser ran out during high temperature tests. It was found that the condenser was not properly sealed.

2-52. The compensating condensers are housed in a single container. This capacity is 20 mfds. This violates the requirements of the specifications. Due to the saving in space and weight it seems advisable to waive this requirement.

2-53. All small transformers and capacitors are hermetically sealed. One capacitor with defective sealing was found as discussed above.

2-54. The power transformers failed during test. Replacement transformers were satisfactory.

2-60. All friction and pressure controls appear to be satisfactory.

2-61. Any side of the transmitter case may be removed giving ready access to any part.

2-62. Brushing and corona followed by actual breakdowns occurred frequently at high altitudes as described in Appendix B.

2-63. Identifying marks appear on all parts. All tube sockets are marked.

[redacted]

3-1(1). The transmitter-rectifier unit is constructed as required by this paragraph of the specifications.

(2). All connections are arranged as required and the equipment may be mounted in the specified space.

(3). One oscillator is used to drive a single output amplifier.

(4). The tuning units furnished cover the ranges specified. The 1500 to 3000 kcs. unit was not required by this contract.

(5). Table 3 gives the results of power output measurements into various dummy antennas. At only one frequency, 350 kcs. on phone, was the measured power low. Even this measurement gave the required output taking into account probable error. At high altitudes under full power operation numerous failures occurred due to flashovers. Details are found in Appendix B.

(6). In no case does the power required from the NEA-2 generator exceed 800 volt amperes or 700 watts. This data also appears in Table 3. The total DC required from the battery is 1.5 amperes.

3-2. The equipment mounts in the specified space. However, the location of the slide rail for mounting was such that insufficient clearance was provided between the back of the transmitter and the bulkhead between the two cockpits.

3-3. The tuning units are so constructed that they complete the front panel when operatively installed in the transmitter.

3-4. Tuning units are ruggedly constructed. Individual metal containers were provided for each unit. These containers were excessively large and could not be conveniently carried in an airplane. Appendix B offers suggestions for improving these containers.

3-5. Tubes may be removed during flight by removing the tuning unit. However, the space for the 38803 tube is not high enough to accommodate tubes whose maximum height is the maximum allowed by Navy Specifications.

[redacted]

DECLASSIFIED

3-6. All controls except those on the control boxes are located on the front panel of the transmitter or the coil box as plugged into the transmitter. Several controls are so located that operation by one wearing heavy gloves is somewhat difficult due to their proximity to each other.

3-7. All circuits are well shielded from each other. Meters are suitably by-passed.

3-8. Snap antenna connectors are provided for quickly changing from trailing wire to fixed antenna.

3-9. The relay for keying is also arranged to transfer the antenna from receiver to transmitter. Appendix B contains oscillographs of its action.

3-10. Side tone is provided for all types of transmission.

3-11. All contacts are enclosed inside the cases housing the equipment. In addition the keying relay has been modified by enclosing it in mica.

3-12. Switches and interlocks have been provided for power control.

3-13. The power may be varied by means of the antenna coupling control as well as by means of a "Low Power - High Power" switch.

3-14. Power factor correction capacitors are included in the transmitter power supply circuit.

3-15. The oscillator is blocked in the key "up" position.

3-16. The note from the transmitter in flight was good except on the higher frequency. Several long unsupported leads were included in these high frequency circuits. Rewiring the oscillator circuit improved the note. Harmonic radiation is negligible as determined by cathode ray wattmeter observations. Keying records are recorded on Plate 8.

3-17. MCW emission is accomplished by removing the high voltage power supply filter from the circuit.

3-18. Shift from CW to MCW or voice does not entail change of filament plate or bias voltage controls.

3-19. The controls have been kept at a minimum.

[redacted]

3-20. All controls are lettered so that settings may be easily logged on the calibration chart.

3-21. (1) Reset measurements are shown on table 4. The equipment does not always meet the requirements of this specifications due to excessive backlash. Resets from the same direction are within the specification requirements. Resets taken in flight are shown on table 5. These readings are all within the specified values but do not include backlash.

(2)(a). Locked key frequency variation measurements are shown in Table 6 and Plate 2, for variation of ambient temperatures. The average change for each 10^{o} C. variation in temperature is within the specified 0.05%. Results of flight tests are given in Table 7.

(b). Plates 3 to 7 give measurements of tests of frequency change due to variation of supply line voltage. These variations are 0.01% or less in all cases.

(c). Changes in frequency due to antenna variation while in some cases large did not exceed 0.05%. The polarity of the antenna coupling rotor is quite important in reducing this effect. Plates 3 to 7 give these data.

(3) The arithmetical sum of the above frequency variations in most cases is well within the specified values. At 9000 kcs. the total is 0.064% which is excessive. Plates 3 to 7 give these data.

(4) Table 8 gives data taken on frequency change for 30 minutes key locked, full power CW at constant ambient temperatures. In all cases the equipment meets the specified tolerance. Curves are shown on Plates 3 to 7.

(5) Vibration gave a poor note at high frequencies. This was corrected by reviewing the oscillator circuit to eliminate long unsupported leads.

3-22. Momentary frequency shifts were not noticeable.

3-23. The coupling system permits operation into any of the required antenna systems.

3-27. Shorting or opening the antenna circuit unloads the amplifier and causes no damage.

3-28. Table 9 gives a calibration of the tuning units. From this table it is seen that the frequency coverage is continuous although the overlap is not quite 2% in all cases.

3-29. All tubes cease to oscillate in the key up position.

3-30. Positive gear type of vernier controls is used. The backlash, however, is excessive in some tuning units. The backlash may be determined from table 4 which gives settings taken from opposite directions together with the percentage of the tuning range represented by such differences.

3-31. Locking devices have been provided on the controls. These locking knobs are so located that confusion may result in their use. They should be marked to indicate their associated control.

3-32. Suitable rectifiers for plate power supply are included in the transmitter unit.

3-35. Two type 38266-A tubes are used as a full wave rectifier for high voltage plate supply while a type 38593 is used for low voltage supply to the plate and suppressor of the radio frequency tubes. Table 10 shows the regulation of the rectifiers as required by this specification which requirement is fulfilled. Table 11 gives the data on the efficiency. The low voltage rectifier has only 75% efficiency. However, the total efficiency of the two rectifier systems is 81% which is satisfactory and considered as meeting the requirement of 80% called for in these specifications.

3-36. Ripple measurements were made from oscillographic records. These records are shown on Plates 9 to 11. Calculating the ripple percentage it is found that the low voltage rectifier has very little ripple while the high voltage rectifier has only 0.18% ripple which is well within the specified 1%.

3-37. Compensation was not entirely adequate on MCW. Further discussion is found in Appendix B.

3-43. The modulator enables complete modulation to be obtained.

3-44. Table 12 shows modulation characteristics measured in two ways. The fidelity meets the requirements. Table 13 repeats these measurements using the rectified carrier for the audio frequency determinations.

[redacted]

3-45. The microphone transformer supplied permitted serious over-modulation using normal aircraft microphone technique. The input voltages necessary for 90 and 100% modulation are shown in Table 14. The output level of the microphone should be specified.

3-46. Insulation resistance was satisfactory in all transformers, etc.

3-47. The measured distortion of the modulated carrier was 5% at 400 cycles.

3-48. Radio frequency harmonics were practically unnoticeable on a cathode ray wattmeter.

3-49. The ratio of signal to noise was measured at 36 db.

3-50. Side tone voltages were as required by these specifications. However, a greater output is desirable as stated in Appendix B.

4-1. A suitable antenna loading coil is supplied.

4-2. The design is such that losses are very low. Details are given in Appendix B.

4-3. A tap switch is provided for obtaining various values of inductance.

4-4. Dimensions are given in Table 2.

4-5. Mounting holes are provided for mounting on the side of the cock.

4-6, to 4-15. Weights and dimensions of the units are given in Table 2. The design and construction of these components are as required by these specifications.

CONCLUSIONS.

30. As a result of those tests the following conclusions have been reached.

(a) The Model GP-3 equipment as originally submitted did not entirely meet the requirements of the specifications.

(b) Numerous failures in the form of radio frequency flashover occurred at high altitudes.

(c) The two power transformers failed.

(d) Backlash on the master oscillator control is excessive.

(e) At 9000 kcs. the total frequency variation is excessive.

(f) The locking devices are so arranged that their respective controls are apt to be mistaken. They should all be properly marked.

(g) A microphone transformer suitable for the standard Navy type aircraft microphone should be provided.

(h) Numerous repairs and modifications have been made during flight tests which resulted in satisfactory operations being obtained. As now modified the equipment should be satisfactory for Naval Service.

TABLE 2

Model GP-3 Transmitter
Weight of Equipment

Test per specification 2-16 of RE 13A 490D.

	Pounds
Transmitter	50.0
Transmitter Mounting	1.2
Set of Tubes	1.5
Tuning Range A	14.0
Antenna Load Coil	3.1
Operator's Control Box	3.0
Pilot's Control Box	1.1
Set of Cables	4.7
Slip Cover	1.4
	80.0
Tuning Coil Carrying Case	4.5

TABLE 2A

Dimensions of Component Parts.

Specification RE 13A 490D, Fig. 5, 4-4. 4-8(1), 4-8(2), 3-2.

Transmitter Rectifier	Specification
10-5/8 x 12 x 20	10-3/4 x 12 x 20
Transmitter Rectifier Overall	
10-11/16 x 12-7/8 x 23-7/8	10-3/4 x 13 x 24
Operator's Control Box	
4 x 8 x 2-3/8	4 x 8 x 2-3/8
Pilot's Control Box	
4 x 5-1/2 x 2-3/8	4 x 5-1/2 x 2-3/8

[redacted] L

TABLE 2B

Model GP-3 Transmitter

Length of Cables.

Specification 4-12 of RE 13A 490D.

	Meas.	Spec.
Cable between transmitter and plane electrical distribution board.	6 ft.	6 ft.
Pilot's Control Box Cable	8 ft.	8 ft.
Operator's Control Box Cable	4.5 ft.	4.5. ft.
Cable for Monitoring Connections to receiver	4.5 ft.	4.5 ft.

TABLE 3

Model GP-3 Transmitter
Determination of Power Output.

Tests as per paragraph 3-1(5) of RE 13A 490D.

Frequency	350	350	540	540	800	800
Transmitter	1	4	1	4	1	4
Range	A	A	A	A	A	A
Ra	28.7	28.7	24.7	24.7	24.7	24.7
Ca	275	275	310	310	475	475
Line Volts	120	131	121	128	125	131
Line Amps.	5.6	5.5	6.0	5.8	6.0	5.8
CW Input	600	620	660	650	660	665
Ip	150	160	162	170	160	175
CW power	139	139	168	164	169	164
Spec. Req.	85	85	85	85	85	85
MCW Input	570	535	610	580	600	580
MCW Power	119	106	143	131	131	131
Phone Input	460	470	500	480	500	490
Phone Power	31.5	28.7	41	34.3	38.6	35.6
Spec. Req.	30	30	30	30	30	30

[redacted]

TABLE 3A

Model GP-3 Transmitter

Determination of Power Output.

Tests as per paragraph 3-1(5) of RE 13A 490D.

Frequency	800	800	1500	1500
Transmitter	1	4	1	4
Range	B	B	B	B
Ra	24.7	24.7	14.3	16.4
Ca	475	475	400	400
Line Volts	129	121	123	120
Line Amps.	6.1	5.8	5.8	5.8
CW Input	670	620	620	620
Ip	175	175	150	175
CW Power	191	173	137	142
Spec. Req.	100	100	100	100
MCW Input	590	580	585	570
MCW Power	153	149	116	111
Phone Input	500	460	480	460
Phone Power	52	385	35	32.7
Spec. Req.	35	35	35	35

TABLE 3B

Model GP-3 Transmitter

Determination of Power Output.

Tests as per paragraph 3-1(5) of RE 13A 490D.

Frequency	3000	3000	3000	3000
Transmitter	1	1	4	4
Range	D	D	D	D
Ra	42.5	3.88	42.5	3.88
Ca	80	80	85	82
Line Volts	124	124	122	122
Line Amps.	6.2	6.2	5.8	5.8
CW Input	670	670	630	630
Ip	175	175	175	175
CW Power	196	70	186	65
Spec. Req.	125	50	125	50
MCW Input	615	615	595	588
MCW Power	170	57	161	60
Phone Input	500	500	470	470
Phone Power	51	17	40	14
Spec. Req.	40	12.5	40	12.5

[redacted]

TABLE 3C

Model GP-3 Transmitter

Determination of Power Output.

Tests as per paragraph 3-1(5) of RE 13A 490D.

Frequency	4500	4500	4500	4500
Transmitter	1	1	4	4
Range	D	D	D	D
Ra	42.5	3.88	42.5	3.88
Ca	80	80	85	85
Line Volts	124	124	122	122
Line Amps.	6.3	6.3	5.8	5.8
CW Input	680	675	640	630
Ip	175	175	175	175
CW Power	205	86	187	76
Spec. Req.	125	50	125	50
MCW Input	620	615	600	580
MCW Power	177	70	162	62
Phone Input	500	500	470	460
Phone Power	56	20	42	16
Spec. Req.	40	12.5	40	12.5

TABLE 3D

Model GP-3 Transmitter

Determination of Power Output.

Tests as per paragraph 3-1(5) of RE 13A 490D.

Frequency	4500	4500	4500	4500
Transmitter	1	1	4	4
Range	E	E	E	E
Ra	42.5	5.8	42.5	5.8
Ca	80	80	80	80
Line Volts	124	123	121	122
Line Amps.	6.2	6.1	5.6	5.6
CW Input	670	670	610	610
Ip	175	175	175	175
CW Power	196	102	181	88
Spec. Req.	125	50	125	50
MCW Input	600	580	570	570
MCW Power	153	75	153	75
Phone Input	500	510	470	470
Phone Power	66	31	56	23
Spec. Req.	40	12.5	40	12.5

[redacted]

DECLASSIFIED

TABLE 3E

Model GP-3 Transmitter

Determination of Power Output

Tests as per paragraph 3-1(5) of RE 13A 490D.

Frequency	6500	6500	6500	6500
Transmitter	1	1	4	4
Range	E	E	E	E
Ra	42.5	6.0	42.5	6.0
Ca	80	80	80	80
Line Volts	120	123	122	122
Line Amps.	6.0	6.1	5.7	5.7
CW Input	635	670	620	620
Ip	175	175	175	175
CW Power	202	110	196	105
Spec. Req.	125	50	125	50
MCW Input	580	600	580	580
MCW Power	156	79	163	88
Phone Input	480	510	480	480
Phone Power	66	35	56	29
Spec. Req.	40	12.5	40	12.5

TABLE 3F

Model GP-3 Transmitter

Determination of Power Output

Tests as per paragraph 3-1(5) of RE 13A 490D

Frequency	6500	6500	6500	6500
Transmitter	1	1	4	4
Range	F	F	F	F
Ra	42.5	9.0	42.5	9.0
Ca	80	80	80	80
Line Volts	123	123	121	121
Line Amps.	6.2	6.1	5.7	5.7
CW Input	175	175	175	175
CW Power	215	144	193	136
Spec. Req.	125	50	125	50
MCW Input	610	600	570	570
MCW Power	161	110	161	110
Phone Input	510	510	460	460
Phone Power	61	44	51	32
Spec. Req.	40	12.5	40	12.5

[redacted]

TABLE 3G

Model GP-3 Transmitter

Determination of Power Output

Tests as per paragraph 3-1(5) of RE 13A 490D.

Frequency	9000	9000	9000	9000
Transmitter	1	1	4	4
Range	F	F	F	F
Ra	42.5	9.0	42.5	9.0
Ca	80	80	80	80
Line Volts	125	122	122	121
Line Amps	6.4	6.2	5.8	5.7
CW Input	690	685	630	620
Ip	175	175	175	175
CW Power	234	151	196	123
Spec. Req.	125	50	125	50
MCW Input	640	640	600	600
MCW Power	170	123	153	98
Phone Input	510	500	460	460
Phone Power	56	36	42	30
Spec. Req.	40	12.5	40	12.5

TABLE 4

Model GP-3 Transmitter - Reset Data

Test per paragraphs 3-2(1) and 3-30 of RE 13A 490D

Specification limit 0.05% of frequency or 0.1% of operative tuning range.

Transmitter	Range	Frequency (KC)	Reset Same Direction	Reset Opposite Direction	% Frequency	% Range Tuning
1	A	350	4 cycles	75 cycles	0.021	0.115
4	A	350	5	30	0.01	0.046
4	A	800	20	30	0.004	0.015
1	B	800	255	1200	0.15	0.850
4	B	800	50	50	0.006	0.035
4	B	1500	90	175	0.012	0.040
1	D	3000	100	2800	0.093	0.350
4	D	3000	125	100	0.003	0.012
4	D	4500	600	100	0.002	0.010
1	E	4500	75	200	0.004	0.02
4	E	4500	550	1100	0.025	0.11
4	E	6500	750	2900	0.045	0.21
1	F	6500	675	1350	0.021	0.09
4	F	6500	775	500	0.008	0.03
4	F	9000	725	950	0.010	0.047

[redacted]

DECLASSIFIED

TABLE 6

Model GP-3 Transmitter #1

Frequency Shift due to change of Ambient per Specification 3-21(2)(a) of RE 13A 490D.

Time Minutes	Temp. °C.	Freq. Kc.	Time Minutes	Temp. °C.	Freq. Kc.
0	-27.0	350.730	80	+11.5	350.220
5	-25.5	.716	85	+15.0	.185
10	-22.5	.700	90	+16.0	.155
15	-20.0	.679	95	+20.0	.120
20	-17.5	.655	100	+23.0	.075
25	-15.0	.610	105	+23.0	.035
30	-12.5	.586	110	+27.0	.010
35	-10.0	.555	115	+30.0	349.980
40	-8.0	.519	120	+33.0	.960
45	-5.0	.488	125	+35.0	.922
50	-2.5	.450	130	+37.5	.910
55	0	.405	135	+40.0	.885
60	+3.0	.370	140	+43.0	.860
65	+5.0	.340	145	+45.0	.835
70	+7.5	.298	150	+47.0	.812
75	+10.0	.252	155	+48.0	.790
			160	+49.6	.770
					960 cycles

126 cycles per 10° C.
0.036%

TABLE 6A

Model GP-3 Transmitter #4

Frequency Shift due to Change of Ambient per Specification 3-21(2)(a) of RE 13A 490D.

Time Minutes	Temp. °C.	Freq. Kc.	Time Min.	Temp. °C.	Freq. Kc.	Time Min.	Temp. °C.	Freq. Kc.
0	-26.0	1004.750	60	+4.0	1003.660	120	+33.5	1002.720
5	-21.0	4.650	65	+6.5	3.550	125	+36.5	2.660
10	-20.0	4.600	70	+9.0	3.450	130	+39.0	2.630
15	-18.5	4.525	75	+12.0	3.350			
20	-16.0	4.450	80	+13.5	3.250			2120 cycles
25	-13.0	4.350	85	+16.5	3.175			
30	-11.0	4.275	90	+19.0	3.100			
35	-8.5	4.200	95	+21.5	3.000			
40	-6.0	4.100	100	+24.0	2.925			
45	-3.5	4.000	105	+26.5	2.875			
50	-1.0	3.900	110	+29.0	2.800			
55	+1.0	3.775	115	+31.5	2.750			

326 cycles per 10° C.
0.033%

[redacted]

TABLE 6B

Model GP-3 Transmitter #1

Frequency Shift due to Change of Ambient
per Specification 3-21(2)(a) of RE 13A 490D.

Time Minutes	Temp. °C.	Freq. Kc.	Time Minutes	Temp. °C.	Freq. Kc.	Time Minutes	Temp. °C.	Freq. Kc.
0	-26.0	3503.500	65	+7.2	3501.000	130	+40.0	3499.200
5	-22.0	3.000	70	+10.0	.850	135	+42.5	9.100
10	-20.8	2.800	75	+11.5	.750	140	+45.0	9.000
15	-18.5	2.650	80	+14.5	.625	145	+47.3	8.950
20	-15.0	2.560	85	+17.5	.500	150	+49.0	8.950
25	-13.0	2.430	90	+20.0	.350	155	+49.6	8.950
30	-10.0	2.250	95	+22.5	.160			4550
35	-8.0	2.050	100	+25.0	.040			cycles
40	-5.0	1.850	105	+27.5	3499.850			
45	-2.0	1.650	110	+30.0	9.700	606 cycles per		
50	0	1.475	115	+32.5	9.560	10° C.		
55	+2.2	1.325	120	+35.0	9.475			
60	+5.0	1.150	125	+37.5	9.350	0.017%.		

TABLE 6C

Model GP-3 Transmitter #1

Frequency Shift due to change of Ambient
per Specification 3-21(2)(a) of RE 13A 490D.

Time Minutes	Temp. °C.	Freq. Kc.	Time Minutes	Temp. °C.	Freq. Kc.	Time Minutes	Temp. °C.	Freq. Kc.
0	-27.0	5504.350	80	+12.5	5501.375	150	+47.0	5498.350
5	-24.5	3.600	85	+13.5	.250	155	+49.0	8.300
10	-22.0	3.000	90	+16.0	.100	160	+49.0	8.200
15	-19.5	2.740	95	+19.5	5499.750			6150
20	-17.0	2.500	100	+22.5	9.700			cycles
25	-14.5	2.400	105	+25.0	9.500			
30	-11.0	2.100	110	+27.5	9.350	810 cycles per		
35	-9.5	1.850	115	+30.0	9.200	10° C.		
40	-7.0	1.650	120	+32.5	9.125			
45	-5.0	1.475	125	+35.0	9.050	0.015%.		
50	-2.0	1.300	130	+37.5	8.900			
55	0	1.100	135	+40.0	8.850			
60	+3.0	.900	140	+42.5	8.700			
65	+5.0	.750	145	+44.5	8.500			
70	+7.5	.650						
75	+10.0	.450						

[redacted]

DECLASSIFIED

TABLE 6D

Model GP-3 Transmitter #1

Frequency Shift due to Change of Ambient

per Specification 3-21(2)(a) of RE 13A 490D.

Time Minutes	Temp. °C.	Freq. Kc.	Time Minutes	Temp. °C.	Freq. Kc.
0	-26.0	9004.600	85	+15.5	8996.800
5	-23.5	9002.600	90	+19.0	8996.250
10	-21.0	9001.100	95	+21.5	8995.900
15	-18.5	9000.750	100	+21.5	8995.550
20	-16.0	9000.500	105	+25.0	8995.200
25	-13.5	9000.150	110	+28.5	8994.700
30	-11.0	8999.000	115	+31.0	8994.150
35	-8.5	8999.000	120	+31.0	8994.050
40	-6.0	9000.400	125	+33.0	8993.650
45	-3.5	9000.200	130	+37.0	8993.350
50	-1.0	8999.950	135	-41.0	8992.900
55	+1.5	8999.400	140	+43.5	8992.500
60	+4.0	8998.750	145	+46.0	8992.200
65	+6.5	8998.400	150	+48.0	8991.800
70	+9.0	8997.850	155	+49.0	8991.350
75	+11.5	8997.500			13.250 cycles
80	+14.0	8997.050			

1765 cycles per 10° C.

0.02%

[redacted]

TABLE 7

Model GP-3 Transmitter

Flight Test - September 8, 1936

		Temperature		
Time	Altitude	Instrument Panel °F.	Ambient °C.	Frequency
1332	3000	87	20	799.981
1335	4000	87	20	.932
1337	5000	85	17	.932
1339	6000	81	16	.932
1341	7000	77	14	.922
1344	8000	76	12	.913
1347	9000	71	10	.913
1351	10000	70	9	.913
1354	11000	72	8	.893
1357	12000	66	6	.884
1401	13000	60	5	.893
1407	14000	52	2	.893
1414	15000	48	-1	.913
1424	16000	44	-2	.932
1441	16500	39	-4	.957
	Shut down for 20 minutes.			
1505	17000	38	-4	800.320
1508	16000	39	-3	.300
1511	15000	40	-2	.291
1514	14000	43	-1	.281
1517	13000	44	1	.271
1520	12000	46	2	.271
1523	11000	50	5	.262
1530	8000	56	10	.242
1534	7000	62	12	.250
1535	6000	66	13	.233
1538	5000	68	15	.210
1541	4000	72	17	.210
1545	3000	77	20	.170
1450	2000	83	23	.130
1554	1000	87	26	.110

[redacted]

DECLASSIFIED

TABLE 7A

Model GP-3 Transmitter

Flight Test - September 4th, 1936

		Temperature		
Time	Altitude	Instrument Panel °F.	Ambient °C.	Frequency
1335	1000	83	20	1500.445
1337	2000	86	19	.376
1339	3000	78	16	.393
1341	4000	75	14	.359
1344	5000	73	12	.325
1348	6000	71	10	.291
1351	7000	67	9	.274
1354	8000	66	8	.291
1357	9000	66	7	.310
1400	10000	65	6	.310
1404	11000	64	5	.291
1409	12000	62	4	.291
1414	13000	60	2	.274
1420	14000	57	0	.310
1426	15000	55	-1	.325
1438	16000	54	-3	.342
	Off 10 minutes			
1454	16000	46	-3	.940
1459	15000	47	-2	.854
1502	14000	47	0	.838
1505	13000	48	+1	.854
1508	12000	49	+3	1500.854
1510	11000	53	4	.804
1514	10000	55	5	.804
1517	9000	56	6	.760
1520	8000	57	7	.760
1523	7000	59	8	.718
1525	6000	61	10	.736
1528	5000	61	10	.702

CONFIDENTIAL

DECLASSIFIED

TABLE 7B

Model GP-3 Transmitter

Flight Test - September 3rd, 1936

Time	Altitude	Temperature °C.	Frequency
1430	1000	20	4235.56
1433	2000	18	.56
1435	3000	16	4226.21 bad note
1437	4000	15	4235.56
1439	5000	13	.70
1442	6000	11	.66
1444	7000	10	.66
1446	8000	8	.66
1449	9000	6	.56
1451	10000	5	.46
1454	11000	3	.61
1458	12000	2	.66
1502	13000	2	.66
1506	14000	0	.85
1511	15000	-1	.90
1517	16000	-2	.90
1522	16500	-4	6.20
		off 18 minutes	
1440	17400	-5	8.95
1543	16500	-4	8.75
1545	15000	-2	8.41
1547	14000	0	4238.31
1549	13000	+1	.21
1551	12000	1	.06
1553	11000	2	.06
1555	10000	3	4237.91
1557	9000	4	.86
1559	8000	5	.67
1601	7000	7	.65
1603	6000	8	.62
1605	5000	9	.57
1607	4000	11	.46
1609	3000	14	.37
1612	2000	16	.32
1614	1000	20	.09

[redacted]

DECLASSIFIED

TABLE 7C

Model GP-3 Transmitter

Flight Test - September 4th, 1936

Time	Altitude	Temperature Instrument Panel °F.	Temperature Ambient °C.	Bad note breaking Frequency
1007	2000	76	16	6233.58
1009	3000	75	15	.71
1012	4000	76	14	.64
1014	5000	74	12	.19
1016	6000	72	10	.25
1018	7000	70	8	.38
1020	8000	66	7	.58
1022	9000	65	6	.64
-1022	10000	64	6	.71
1028	11000	62	6	.71
1031	12000	61	4	.76
1035	13000	59	2	.71
1040	14000	55	+1	.76
1047	15000	53	-1	.84
1056	16000	48	-1	.71
1103	16500	52	-3	.71
1108	17000	48	-4	.89
			off 22 minutes	
1130	17800	44	-6	6235.17
1135	17000	40	-4	4.97
1137	16000	42	-3	.59
1140	15000	49	-1	6234.21
1144	14000	50	0	3.84
1146	13000	50	+1	.76
1148	12000	49	+2	.64
1150	11000	52	+4	.71
1152	10000	57	+5	.64
1154	9000	54	+6	.84
1155	8000	55	+6	.76
1157	7000	55	+6	.76
1159	6000	58	+7	4232.63
1201	5000	60	9	.50
1202	4000	62	11	.88
1205	3000	65	12	.81
1206	2000	69	15	.88
1209	1000	74	19	.69

[redacted]

TABLE 7D

Model GP-3 Transmitter

Altitude Test - September 9, 1936.

Time	Altitude	Temperature: Instrument Panel °F.	Temperature: Ambient °C.	Frequency
0923	3000	82	22	9052.67
0925	4000	78	20	.67
0927	5000	76	18	.57
0929	6000	74	16	.36
0931	7000	68	14	.36
0934	8000	66	12	.25
0937	9000	62	10	.36
0940	10000	60	8	.36
0943	11000	57	6	.46
0946	12000	53	4	.57
0951	13000	48	2	.46
0959	14000	46	1	.78
	Stopped sending for 1 minute			9053.31
1008	15000	43	-1	9052.99
1018	16000	40	-3	9053.20
	Shut down 15 minutes			
1036	17000	36	-5	9056.07
1039	16000	37	-4	9055.33
1041	15000	39	-2	.22
1043	14000	40	0	9054.68
1045	13000	42	1	.69
1047	12000	43	2	9054.16
1049	11000	46	3	3.95
1051	10000	50	5	.63
1053	9000	54	7	.31
1055	8000	55	8	.10
1056	7000	56	9	2.99
1058	6000	59	11	.78
1100	5000	64	13	.57
1102	4000	67	16	.25
1104	3000	72	18	.57
1106	2000	77	21	.46
1108	1000	81	22	.25

[redacted]

DECLASSIFIED

TABLE 8

Model GP-3 Transmitter

Half-hour full power key lock runs
per Specification 3-21(4) of RE 13A 490D as amended by
Bu. S&A. let. of 13 December 1935.

Transmitter	#1	#1	#1	#1	#1
Range	A	B	D	E	F
Freq. (kc)	350.	800.	3000	4500	6500
Minutes					
0	350.710	800.975	3004.350	4504.250	6504.750
5	.688	.930	3.950	3.400	3.000
10	.670	.880	3.600	3.050	2.500
15	.640	.820	3.350	2.750	2.000
20	.585	.750	3.150	2.550	1.650
25	.555	.690	2.975	2.350	1.250
30	.530	.630	2.825	2.275	.950
Variation(cycles)	180	345	1525	1975	3800
%	0.051	0.043	0.051	0.044	0.058
Specification	0.10	0.10	0.10	0.10	0.10

TABLE 8A

Model GP-3 Transmitter
Half-hour full power key lock runs
per Specification 3-21(4) of RE 13A 490D as amended by
Bu. S&A. let. of 13 Dec. 1935.

Transmitter	#4	#4	#4	#4	#4
Range	A	B	D	E	F
Freq. (kc)	350	800	3000	4500	6500
Minutes					
0	350.750	800.910	3004.675	4503.975	6504.550
5	.728	.860	4.300	3.150	3.450
10	.710	.810	4.025	2.750	2.700
15	.691	.760	3.750	2.400	2.100
20	.648	.690	3.600	2.250	1.675
25	.600	.640	3.500	2.150	1.250
30	.575	.590	3.300	2.025	.950
Variation(cycles)	175	320	1375	1950	3600
%	0.05	0.04	0.046	0.043	0.055
Specification	0.10	0.10	0.10	0.10	0.10

[redacted]

DECLASSIFIED

TABLE 8B

Model GP-3 Transmitter

Half-hour full power key lock runs per
Specification 3-21(4) of RE 13A 490D as amended by
Bu. S&A. let. of 13 Dec. 1935.

Transmitter	#4	#4	#4	#4	#4
Range	A	B	D	D	F
Freq. (kc)	800	1500	4500	6500	9000
Minutes					
0	800.760	1504.450	4504.400	6504.500	9004.900
5	.645	4.125	3.525	4.000	9003.400
10	.570	3.850	3.100	3.600	9002.250
15	.490	3.650	2.750	3.200	9001.300
20	.420	3.450	2.400	2.850	9000.600
25	.355	3.300	2.250	2.550	8999.950
30	.275	3.150	2.050	2.275	8999.500
Variation(cycles)	485	1300	2350	2225	5400
%	0.061	0.087	0.052	0.034	0.06
Specification	0.10	0.10	0.10	0.10	0.10

[redacted]

DECLASSIFIED

TABLE 9

Model GP-3 Transmitter
Calibration and Overlap

Range A

Frame 1						%
A	B	C	D	E	Freq.	Overlap
1	0	1	1	28	341	2.6
1	230	1	1	46	350	
1	700	1	2	66	400	
1	800	1	2	74	406	
						1.5
2	0	1	2	66	400	
2	526	1	3	67	450	
2	800	1	4	40	475	
						1.7
3	0	1	4	30	467	
3	379	1	4	56	500	
3	800	2	1	66	555	
						2.4
4	0	2	1	52	542	
4	800	2	3	53	667	
						3.0
5	0	2	3	40	647	
5	570	2	4	72	800	
5	688	2	4	100	838	4.7

Frame 4						%
A	B	C	D	E	Freq.	Overlap
1	0	1	1	25	342	2.3
1	185	1	1	36	350	
1	800	1	1	70	409	
						1.7
2	0	1	2	59	402	
2	800	1	4	36	476	
						1.9
3	0	1	4	29	467	
3	378	1	4	51	500	
3	800	2	1	58	556	
						2.5
4	0	2	1	45	542	
4	800	2	3	46	670	
						3.7
5	0	2	3	32	646	
5	558	2	4	66	800	
5	635	2	4	100	828	3.5

[redacted]

TABLE 9A

Model GP-3 Transmitter - Calibration and Overlap

Range B.

Frame 1						%		Frame 4						%
A	B	C	D	E	Freq.	Overlap	:	A	B	C	D	E	Freq.	Overlap
1	346	1	1	0	756	5.5		1	235	1	1	0	758	5.1
1	476	1	1	51	800			1	398	1	1	47	800	
1	800	1	2	62	895			1	800	1	2	60	895	
						8.7								5.7
2	0	1	1	68	820			2	0	1	2	31	845	
2	800	1	3	68	1013			2	800	1	3	62	1007	
						7.5								2.7
3	0	1	3	32	940			3	0	1	3	48	980	
3	344	1	3	62	1000			3	196	1	3	58	1000	
3	300	1	4	75	1170			3	800	1	4	65	1160	
						9.2								3.9
4		2	1	38	1067			4	0	2	1	69	1116	
4		2	3	65	1369			4	800	2	3	58	1355	
						14.7								7.7
5	0	2	2	48	1182			5	0	2	3	18	1255	
5	627	2	4	51	1500			5	600	2	4	49	1500	
5	800	2	4	76	1590	6.0		5	800	2	4	64	1566	4.4

[redacted]

TABLE 9B

Model GP-3 Transmitter - Calibration and Overlap

Range D.

Frame 1					%	Frame 4					%
A	B	C	E	Freq.	Overlap	A	B	C	E	Freq.	Overlap
2	114	1	0	2873	4.2	2	94	1	0	2900	3.3
2	241	1	29	3000		2	200	1	25	3000	
2	800	3	23	3670		2	800	3	31	3770	
					4.6						5.2
1	0	2	65	3505		1	0	2	69	3580	
1	721	4	86	4500		1	670	4	81	4500	
1	764	4	100	4580	1.2	1	725	4	100	4620	2.1
					Range E						
2	0	1	25	4450	1.7	2	0	1	25	4480	1.0
2	60	1	31	4500		2	40	1	28	4500	
2	800	2	77	5610		2	800	2	76	5640	
					3.2						3.6
1	0	2	65	5435		1	0	2	68	5440	
1	612	3	78	6500		1	596	3	76	6500	
1	732	3	100	6766	4.1	1	725	3	100	6812	4.8
					Range F						
2	0	1	8	5972	3.7	2	0	1	9	6040	2.6
2	302	1	35	6500		2	265	1	30	6500	
2	800	1	78	7580		2	800	1	78	7680	
					4.2						4.8
1	0	1	68	7270		1	0	1	66	7320	
1	722	2	58	9000		1	685	2	51	9000	
1	800	2	61	9140	0.99	1	800	2	60	9250	2.2

[redacted]

TABLE 10

Model GP-3 Transmitter

Rectifier Regulation

Test per specification 3-35 of RE 13A 490D

High Voltage Rectifier

Ip (ma)	Ep Volts
175	1620
150	1680
100	1790
50	1910

Calculated no Load Voltage 2030

$$\frac{2030 - 1620}{1620} \times 100 = 25.4\%$$

Low Voltage Rectifier

$$\frac{750 - 565}{565} = 25\%$$

TABLE 11

Model GP-3 Transmitter Frame 4

Rectifier Conversion Factors

Test per specification 3-35 of RE 13A 490D.

$$\text{Efficiency} = \frac{\text{Output}}{\text{Input}} \times 100$$

High Voltage Rectifier

$$\frac{1700 \text{ Volts} \times 0.170 \text{ amperes}}{334 \text{ watts}} \times 100 = 84\%$$

Low Voltage Rectifier

$$\frac{500 \text{ Volts} \times 0.175 \text{ amperes}}{116 \text{ watts}} = 75\%$$

Efficiency of entire system 81%.

[redacted]

TABLE 12

Model GP-3 Transmitter #1
Audio frequency characteristic test

per Specification 3-44 of RE 13A 490D.

Carrier frequency 9000 Kc., Modulator input 0.30 volts.

Audio Freq. Cycles	Sidetone Output (Milliwatts)	Db Variation from Average
200	5.5	-2.0
300	7.5	-0.7
400	8.8	0.0
500	9.6	+0.4
1000	10.5	+0.8
2000	9.5	+0.4
3000	7.2	-0.8
5000	3.7	-3.8

TABLE 12A

Model GP-3 Transmitter #1

Audio frequency characteristic test

per Specification 3-44 of RE 13A 490D

Carrier frequency 9000 Kc., Modulator input 0.30 volts. Output of sidetone winding held constant at 60 milliwatts while input was varied.

Audio Freq. Cycles	Input Volts	Db Variation from Average
200	0.315	+2.3
300	0.270	+1.0
400	0.245	+0.1
500	0.230	-0.5
1000	0.215	-1.0
2000	0.230	-0.5
3000	0.270	+0.9
5000	0.420	+4.77

Specification limit 2 db. from 300 to 3000 cycles.

[redacted]

TABLE 13

Model GP-3 Transmitter #1

Overall audio frequency characteristic

Input 0.30 volts at 9000 Kc.

Audio Freq. Cycles	Output Milliwatts	Db Variation from Average
200	1750	-1.8
300	2300	-0.6
400	2600	-0.1
500	2800	+0.2
1000	2900	+0.4
2000	2900	+0.4
3000	2500	-0.3
5000	1500	-2.5

Output was measured on a General Radio milliwattmeter adjusted to a 600 ohm impedance. A portion of the modulated transmitter output was rectified and fed to the milliwattmeter.

TABLE 13A

Model GP-3 Transmitter #1

Overall audio frequency characteristic

Input 0.30 volts at 9000 Kc.

Below is table resulting from varying input and frequency throughout the required audio range while holding the output constant at 2500 milliwatts.

Audio Freq. Cycles	Input Volts	Db Variation from Average
200	.39	+2.5
300	.33	+0.8
400	.30	-0.1
500	.28	-0.4
1000	.26	-1.1
2000	.28	-0.8
3000	.32	+1.6
5000	.50	+4.6

Above figures represent substantially complete modulation of transmitter. Specification limit 2 Db variation from average 300 to 3000 cycles.

[redacted]

TABLE 14

Model GP-3 Transmitter. Frame #1.

Input Voltage necessary for 90% and 100% modulation.

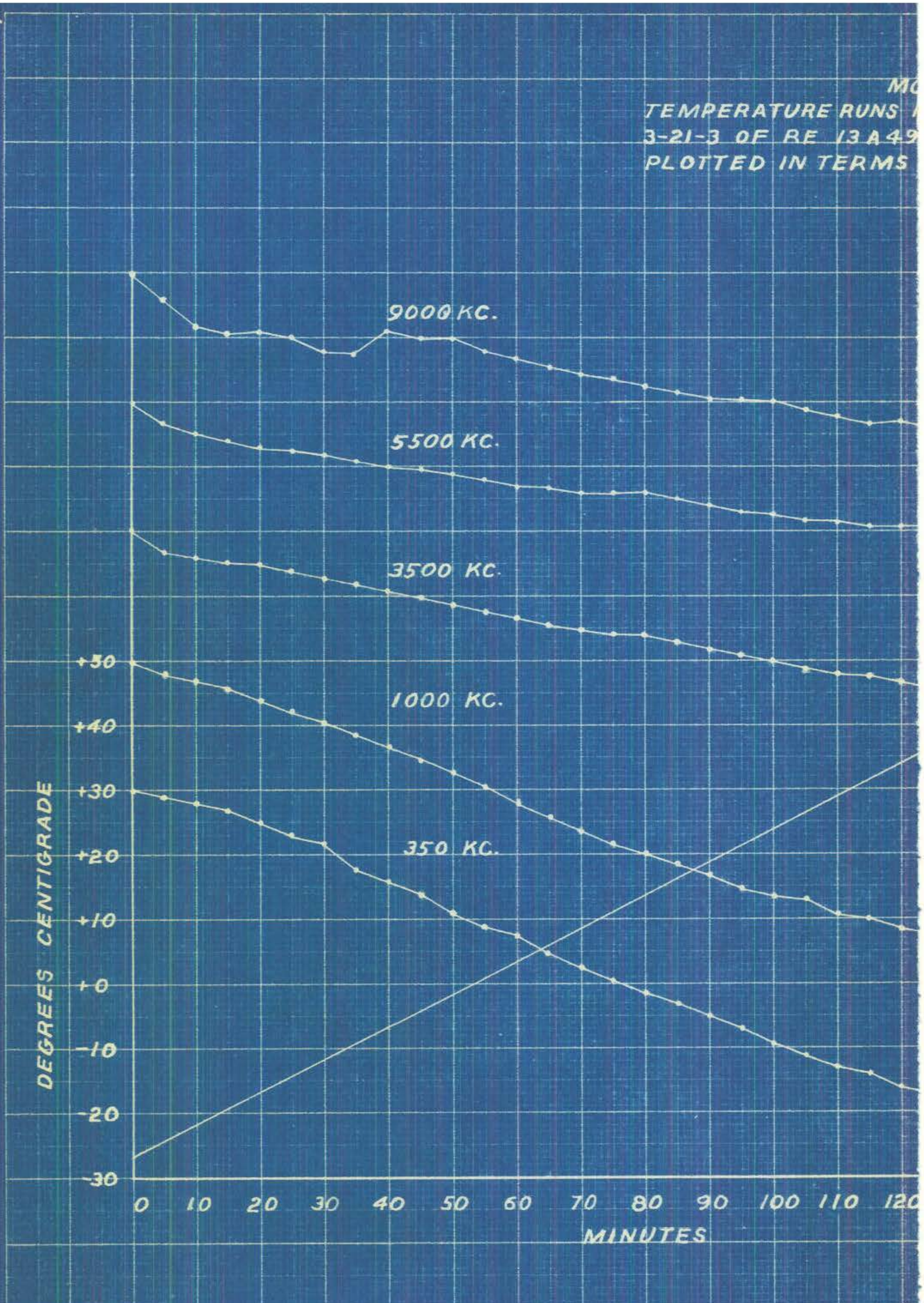
Audio Freq. Cycles	Input Volts 90% Mod.	Input Volts 90% Mod.	Input Volts 100% Mod.
200	.40	.31	.35
300	.32	.26	.29
400	.30	.23	.26
500	.27	.22	.25
1000	.25	.21	.24
2000	.26	.23	.26
3000	.29	.28	.32
5000	.45	.49	.50
Average 300-3000 cycles	.28	.24	.27

First column measurements were made with the General Radio Cathode Ray. Second and third columns were made with Model OB Audio Analyzer.

[redacted]

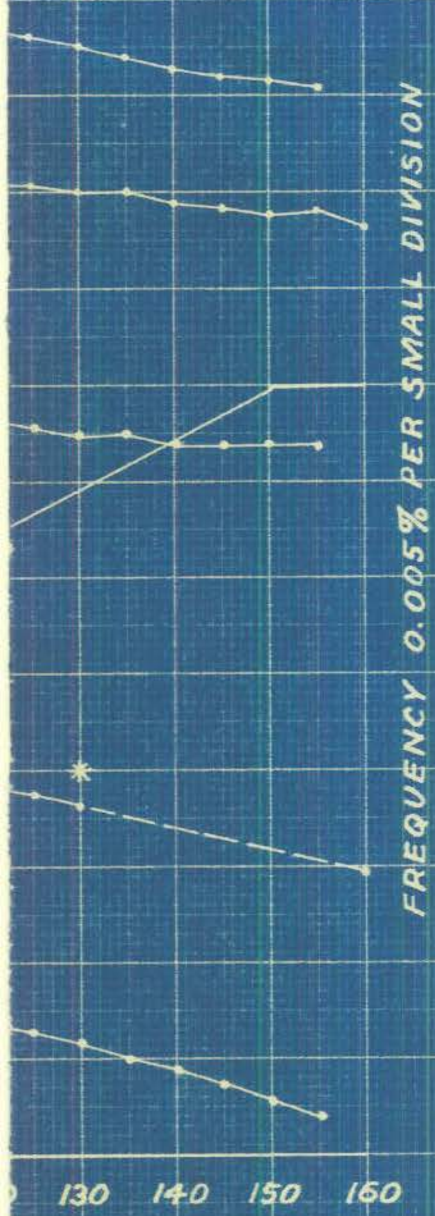

Westinghouse
AMPERES
RADIO FREQUENCY
STAINLESS JOINTS
STANLEY

Plate 1



MO
TEMPERATURE RUNS
3-21-3 OF RE 13A49
PLOTTED IN TERMS
9000 KC.
5500 KC.
3500 KC.
1000 KC.
350 KC.
DEGREES CENTIGRADE
+50
+40
+30
+20
+10
+0
-10
-20
-30
0
10
20
30
40
50
60
70
80
90
100
110
120
MINUTES

ODEL GP-3
PER SPECIFICATION 3-21(2)a AND
00. FREQUENCY DRIFT IS
OF PERCENTAGE, 0.005% PER SMALL DIVISION.



SUMMARY

CARRIER FREQUENCY KC.	AVERAGE CHANGE PER 10°C. ~	%
9000	1765	0.020
5500	810	0.015
3500	606	0.017
1000	326	0.033
350	126	0.036

* RUN NOT COMPLETED DUE TO FAILURE OF LOW POWER RECTIFIER TRANSFORMER

PLATE 2

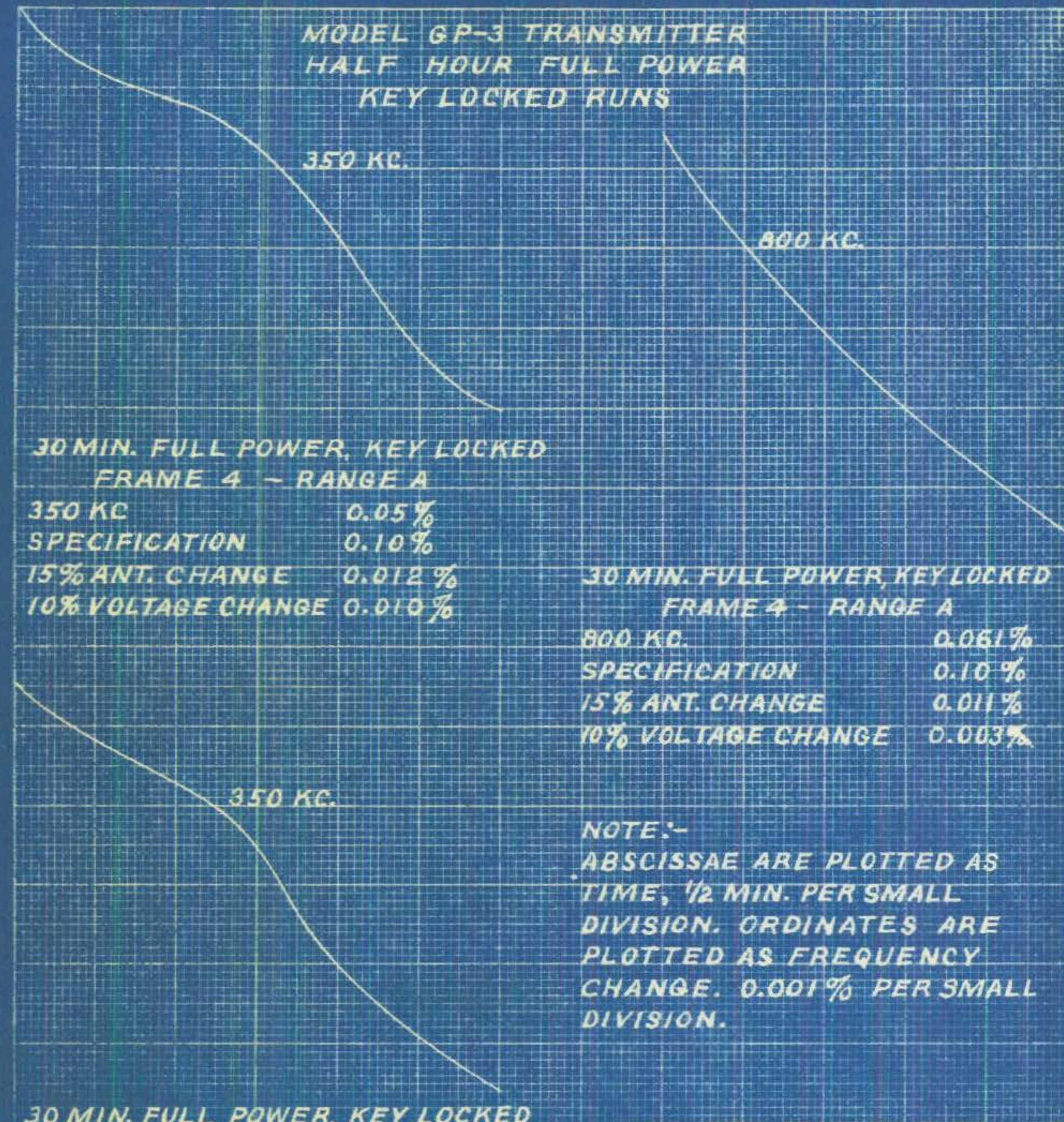

MODEL GP-3 TRANSMITTER
HALF HOUR FULL POWER
KEY LOCKED RUNS
350 KC.
800 KC.
30 MIN. FULL POWER, KEY LOCKED
FRAME 4 – RANGE A
350 KC 0.05%
SPECIFICATION 0.10%
15% ANT. CHANGE 0.012%
10% VOLTAGE CHANGE 0.010%
30 MIN. FULL POWER, KEY LOCKED
FRAME 4 – RANGE A
800 KC. 0.061%
SPECIFICATION 0.10%
15% ANT. CHANGE 0.011%
10% VOLTAGE CHANGE 0.003%
350 KC.
NOTE:-
ABSCISSAE ARE PLOTTED AS TIME, 1/2 MIN. PER SMALL DIVISION. ORDINATES ARE PLOTTED AS FREQUENCY CHANGE. 0.001% PER SMALL DIVISION.
30 MIN. FULL POWER, KEY LOCKED
FRAME 1 – RANGE A
350 KC. 0.051%
SPECIFICATION 0.10%
15% ANT. CHANGE 0.019%
10% VOLTAGE CHANGE 0.012%
AVER. SHIFT PER 10°C.
AMBIENT AT 350 KC. 0.036%
TOTAL 0.067%
SPECIFICATION 0.10%
DECLASSIFIED

PLATE 3

BELLEVUE, D. C. DATE

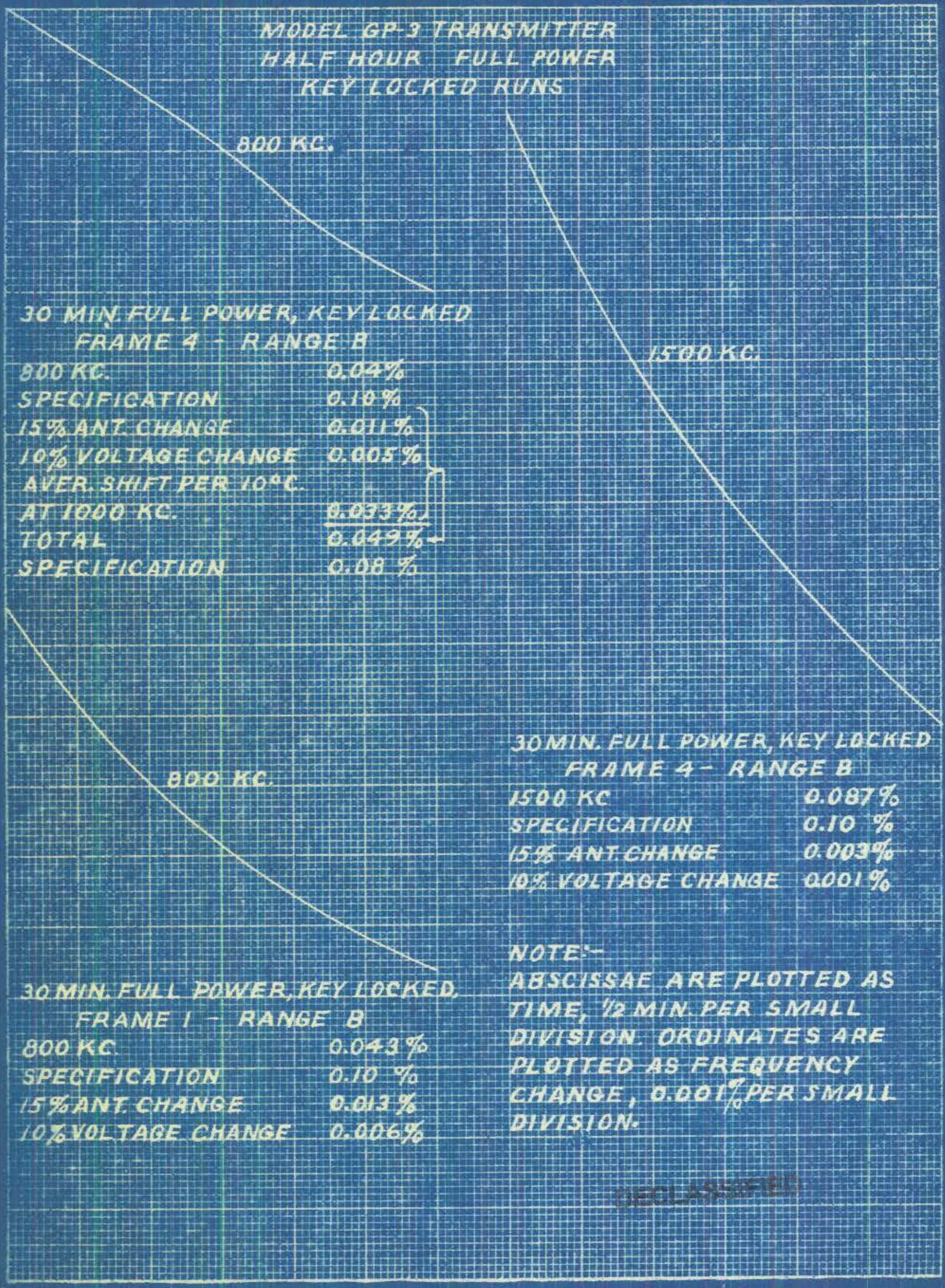


PLATE 4

BELLEVUE, D. C.

DATE

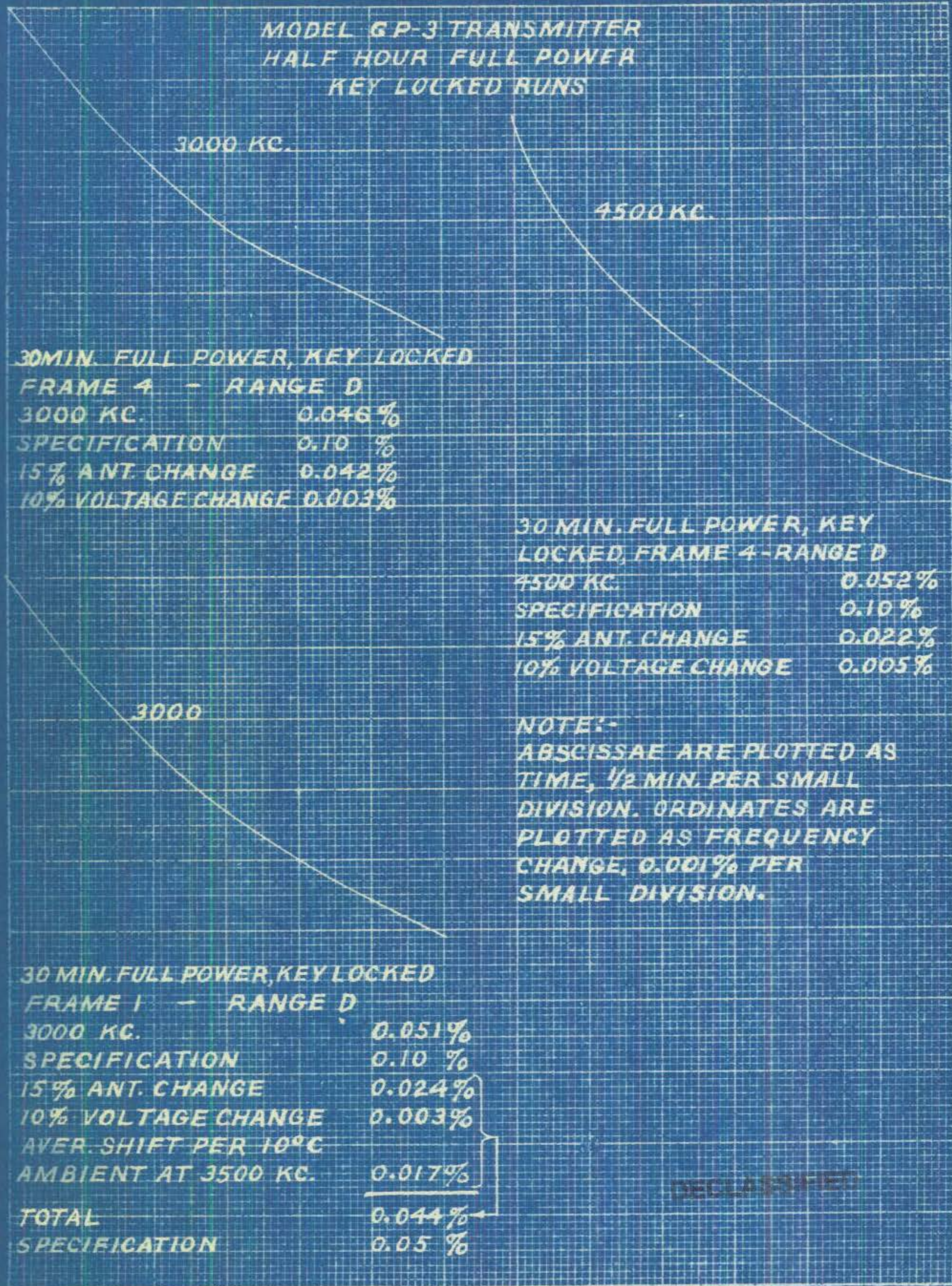
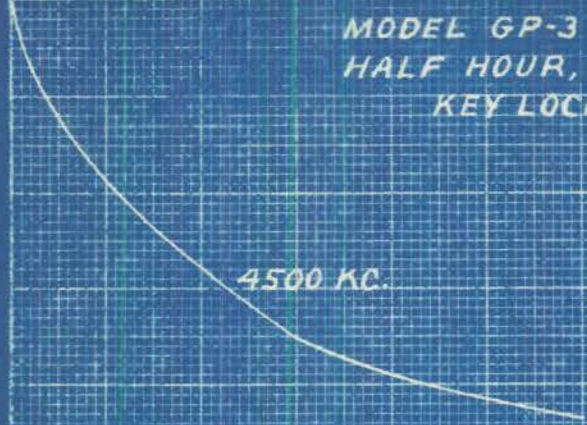


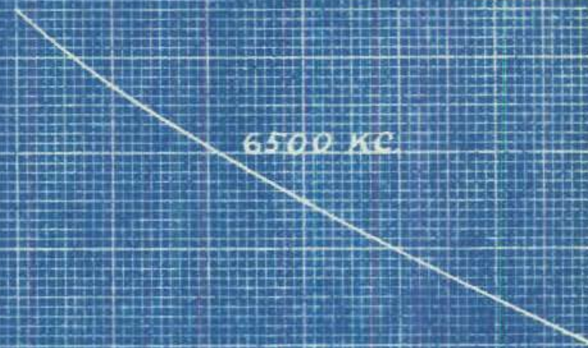
PLATE 5

MODEL GP-3 TRANSMITTER
HALF HOUR, FULL POWER,
KEY LOCKED RUNS



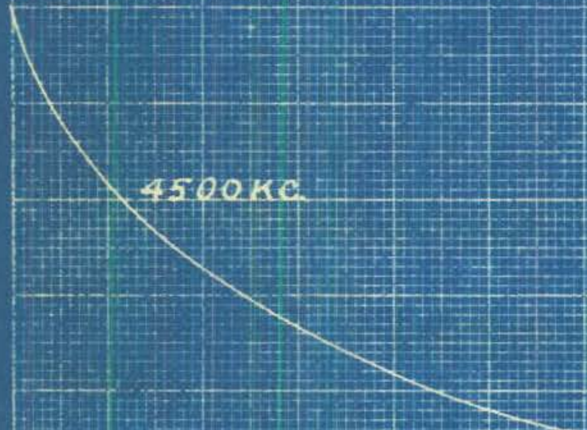
30 MIN. FULL POWER, KEY LOCKED.
FRAME 4 – RANGE E

4500 KC.	0.043%
SPECIFICATION	0.10%
15% ANT. CHANGE	0.019%
10% VOLTAGE CHANGE	0.003%



30 MIN. FULL POWER, KEY LOCKED, FRAME 4 - RANGE E

6500 KC.	0.034%
SPECIFICATION	0.10 %
15% ANT. CHANGE	0.009%
10% VOLTAGE CHANGE	0.005%



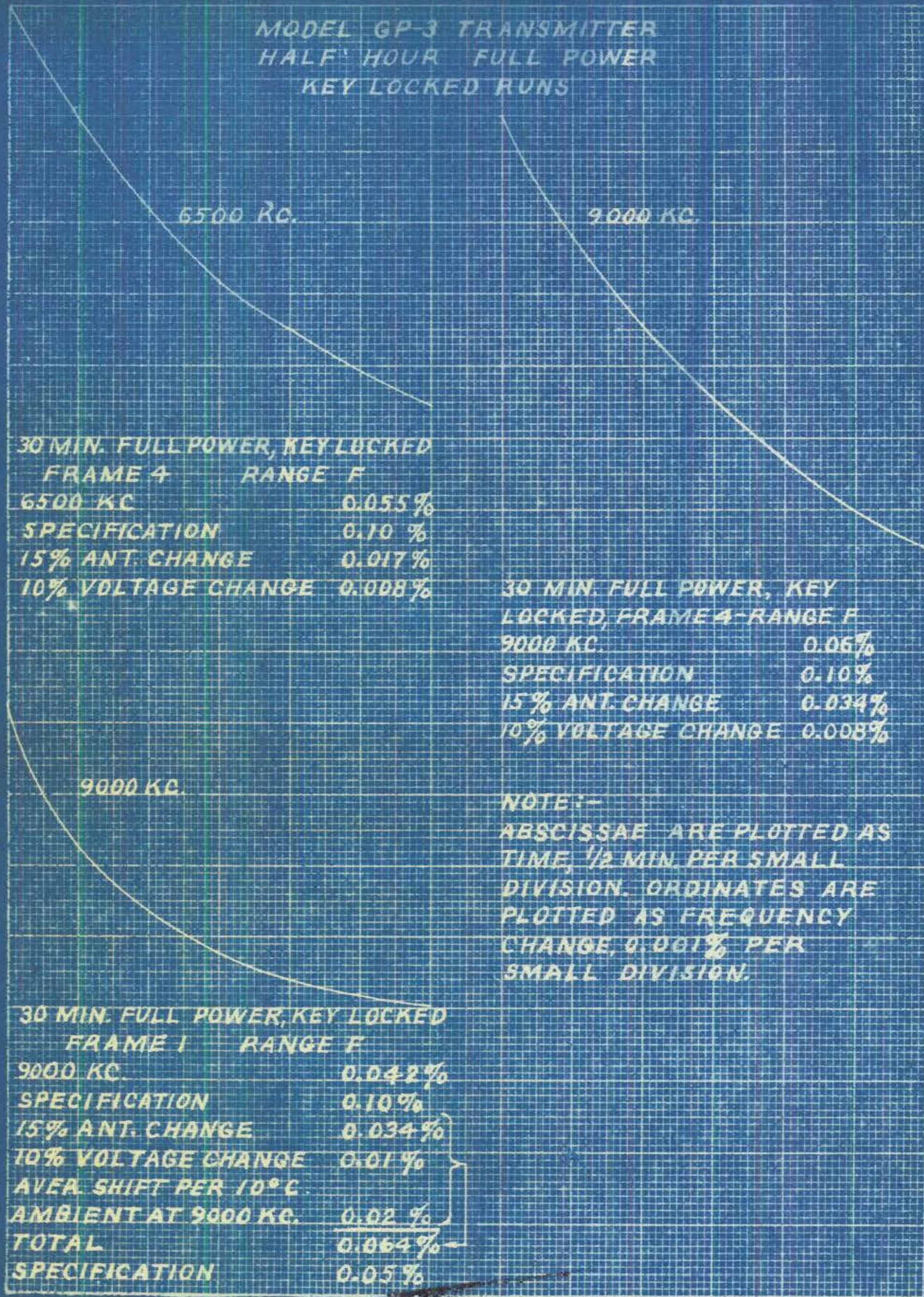
30 MIN. FULL POWER, KEY LOCKED
FRAME 1 - RANGE E

4500 KC.	0.044%
SPECIFICATION	0.10 %
15% ANT. CHANGE	0.022 %
10% VOLTAGE CHANGE	0.001 %
AVER. SHIFT PER 10°C. AMBIENT AT 5500 KC.	0.015 %
TOTAL	0.038%
SPECIFICATION	0.05 %

NOTE:–
ABSCISSAE ARE PLOTTED AS TIME, 1/2 MIN. PER SMALL DIVISION. ORDINATES ARE PLOTTED AS FREQUENCY CHANGE, 0.001% PER SMALL DIVISION.

PLATE 6

MODEL GP-3 TRANSMITTER
HALF HOUR FULL POWER
KEY LOCKED RUNS



30 MIN. FULL POWER, KEY LOCKED
FRAME 4 RANGE F

6500 KC	0.055%
SPECIFICATION	0.10%
15% ANT. CHANGE	0.017%
10% VOLTAGE CHANGE	0.008%

30 MIN. FULL POWER, KEY LOCKED, FRAME 4-RANGE F

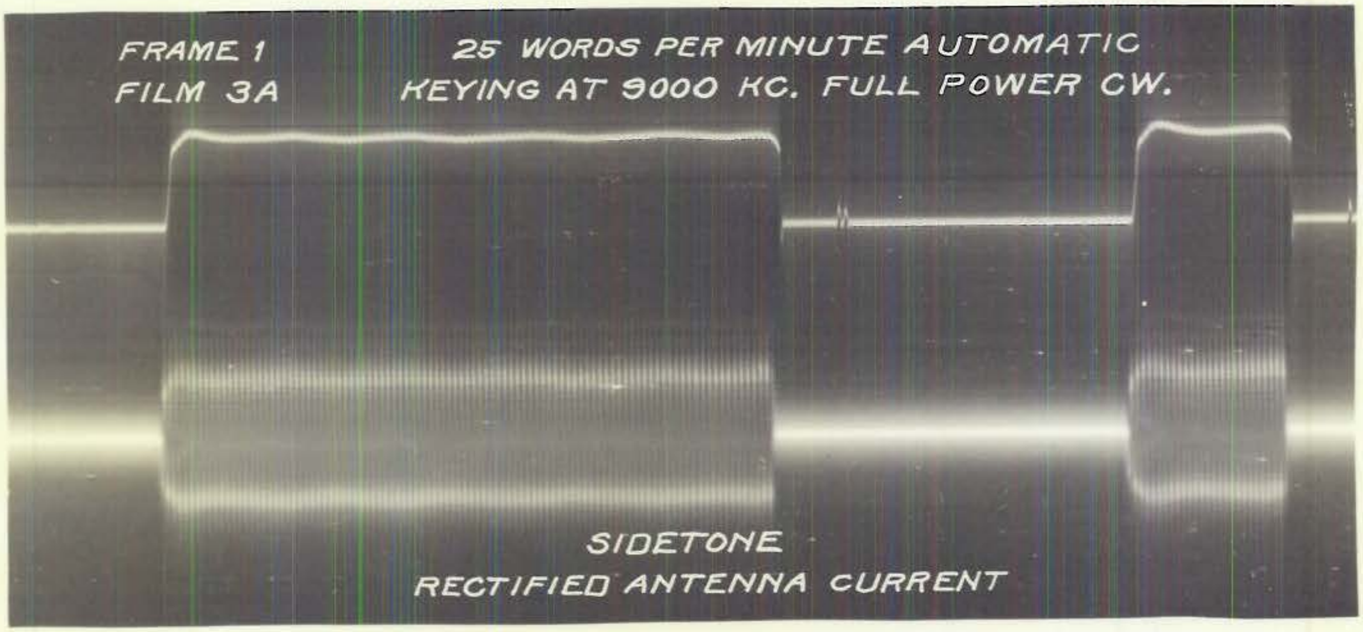
9000 KC.	0.06%
SPECIFICATION	0.10%
15% ANT. CHANGE	0.034%
10% VOLTAGE CHANGE	0.008%

30 MIN. FULL POWER, KEY LOCKED
FRAME I RANGE F

9000 KC.	0.042%
SPECIFICATION	0.10%
15% ANT. CHANGE	0.034%
10% VOLTAGE CHANGE	0.01%
AVER. SHIFT PER 10°C AMBIENT AT 9000 KC.	0.02%
TOTAL	0.064%
SPECIFICATION	0.05%

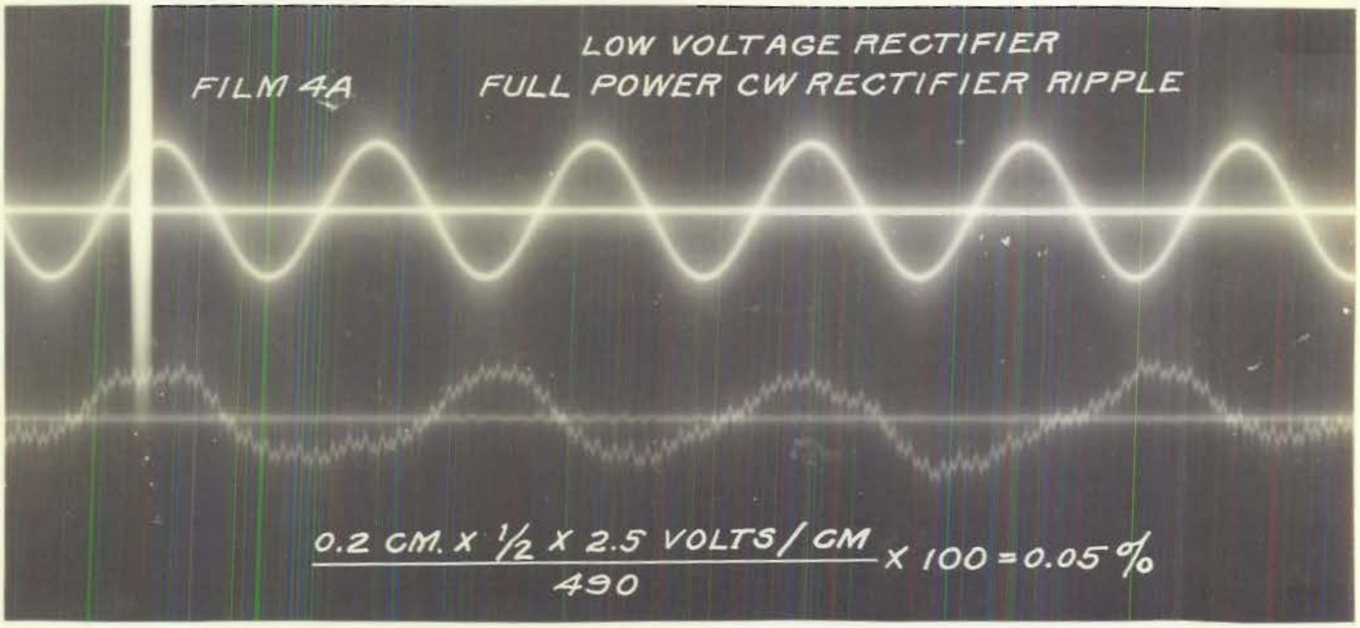
NOTE:- ABSCISSAE ARE PLOTTED AS TIME, 1/2 MIN. PER SMALL DIVISION. ORDINATES ARE PLOTTED AS FREQUENCY CHANGE, 0.001% PER SMALL DIVISION.

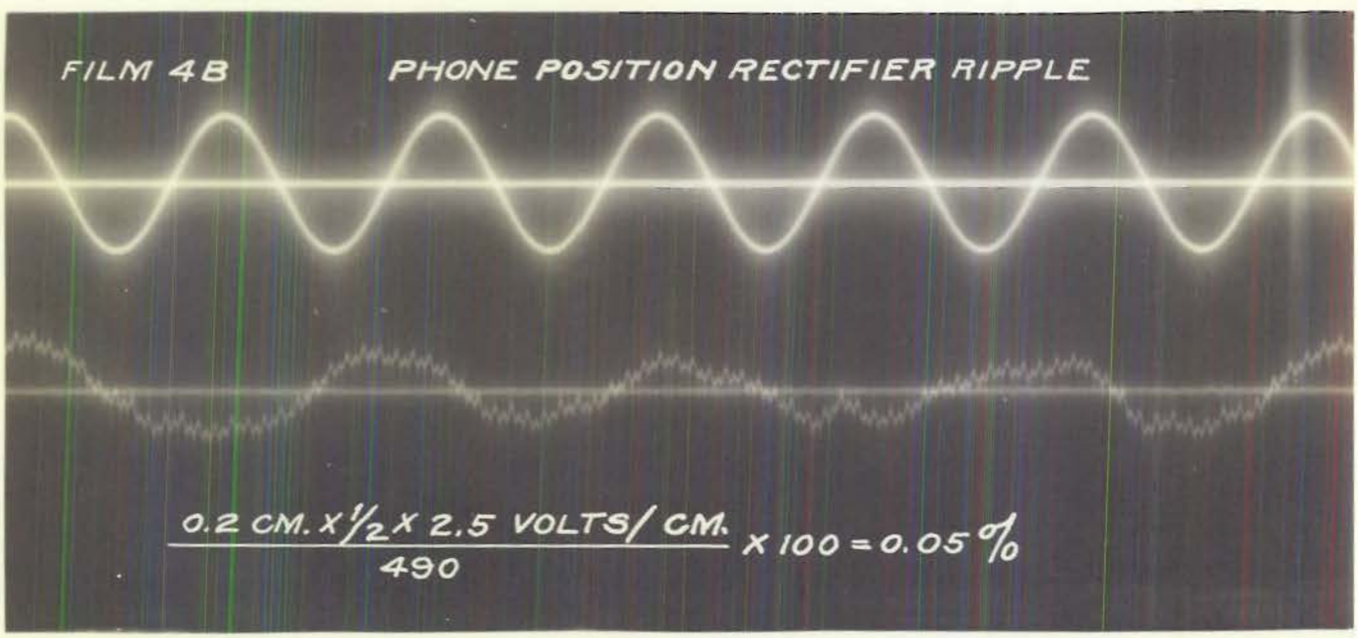
PLATE 7

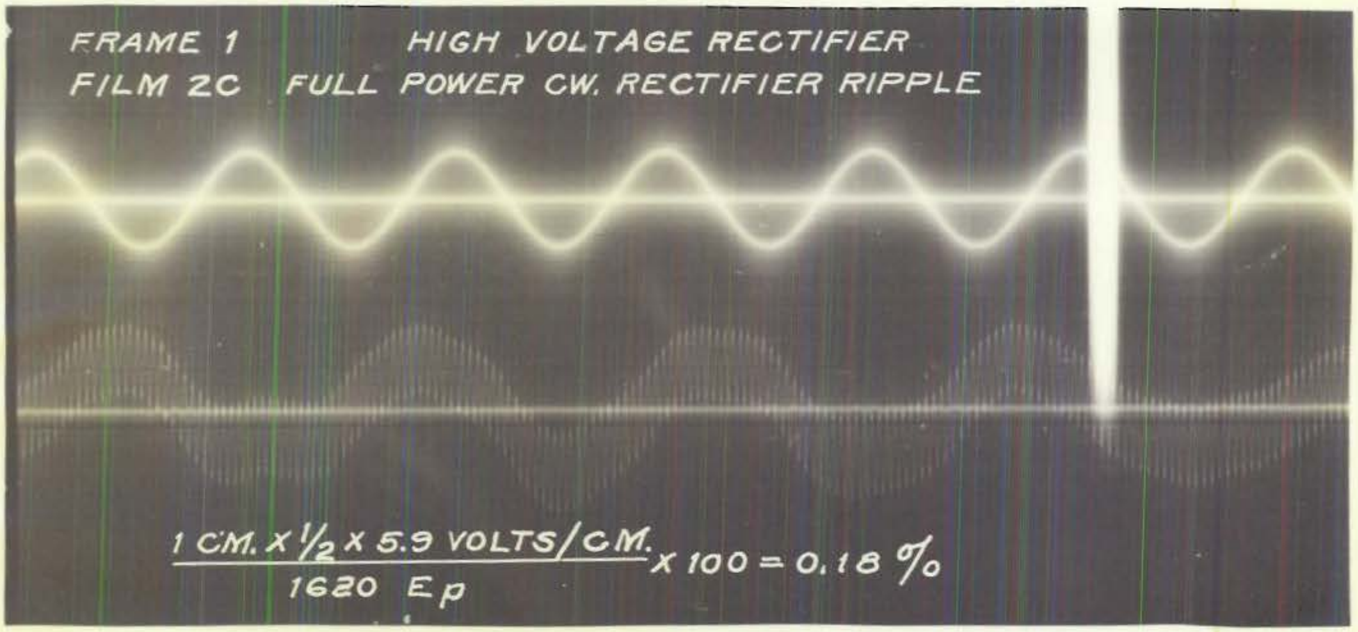

FRAME 1
FILM 3A
25 WORDS PER MINUTE AUTOMATIC
KEYING AT 9000 KC. FULL POWER CW.
SIDETONE
RECTIFIED ANTENNA CURRENT


FRAME 4
FILM 3B
SIDETONE
RECTIFIED ANTENNA CURRENT.

Plate 8


LOW VOLTAGE RECTIFIER
FILM 4A
FULL POWER CW RECTIFIER RIPPLE
0.2 CM. X 1/2 X 2.5 VOLTS / CM / 490 X 100 = 0.05 %


FILM 4B
PHONE POSITION RECTIFIER RIPPLE
0.2 CM. X 1/2 X 2.5 VOLTS/ CM. / 490 X 100 = 0.05 %


FRAME 1 HIGH VOLTAGE RECTIFIER
FILM 2C FULL POWER CW. RECTIFIER RIPPLE
1 CM. X 1/2 X 5.9 VOLTS/CM. / 1620 Ep X 100 = 0.18 %

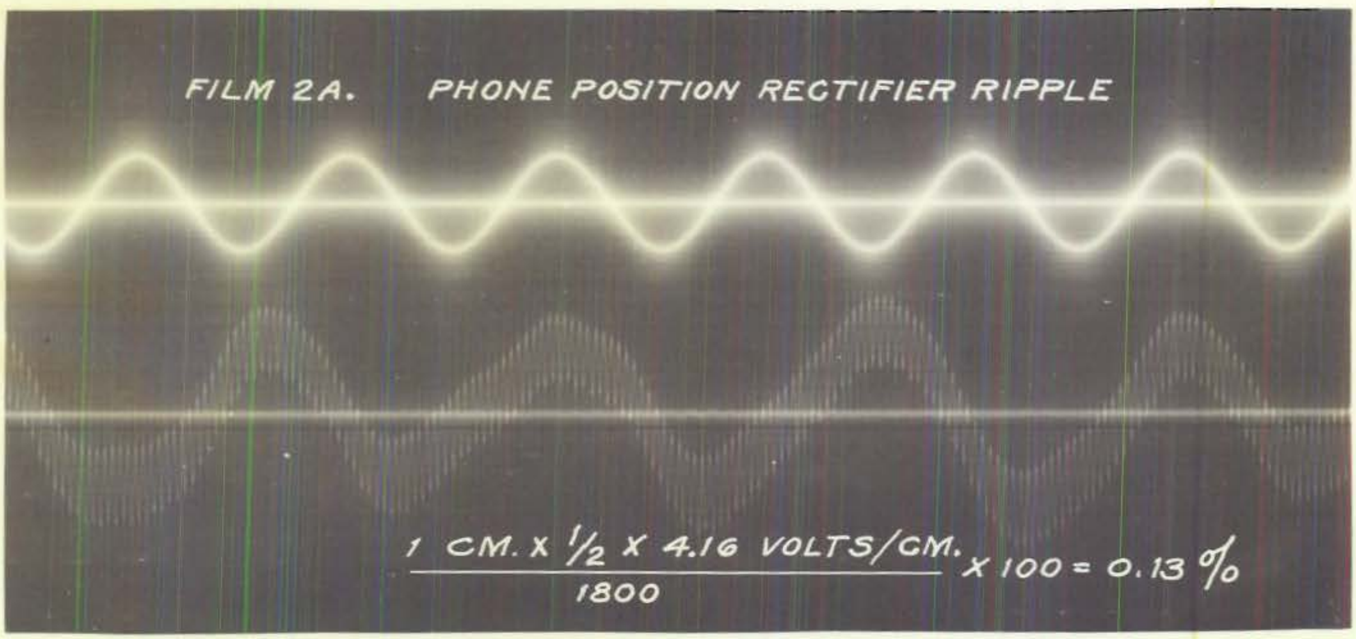
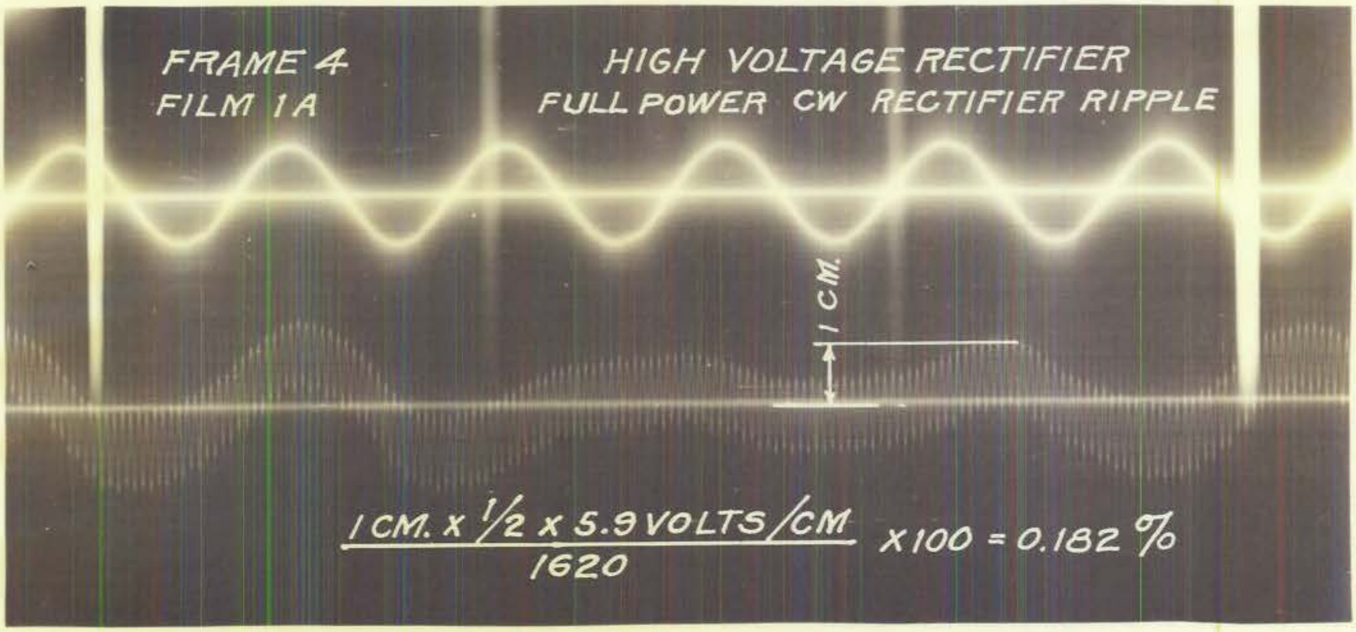

FILM 2A. PHONE POSITION RECTIFIER RIPPLE
1 CM. X 1/2 X 4.16 VOLTS/CM. / 1800 X 100 = 0.13 %

Plate 10


FRAME 4
FILM 1A
HIGH VOLTAGE RECTIFIER
FULL POWER CW RECTIFIER RIPPLE
1 CM.
1 CM. X 1/2 X 5.9 VOLTS/CM / 1620 X100 = 0.182 %

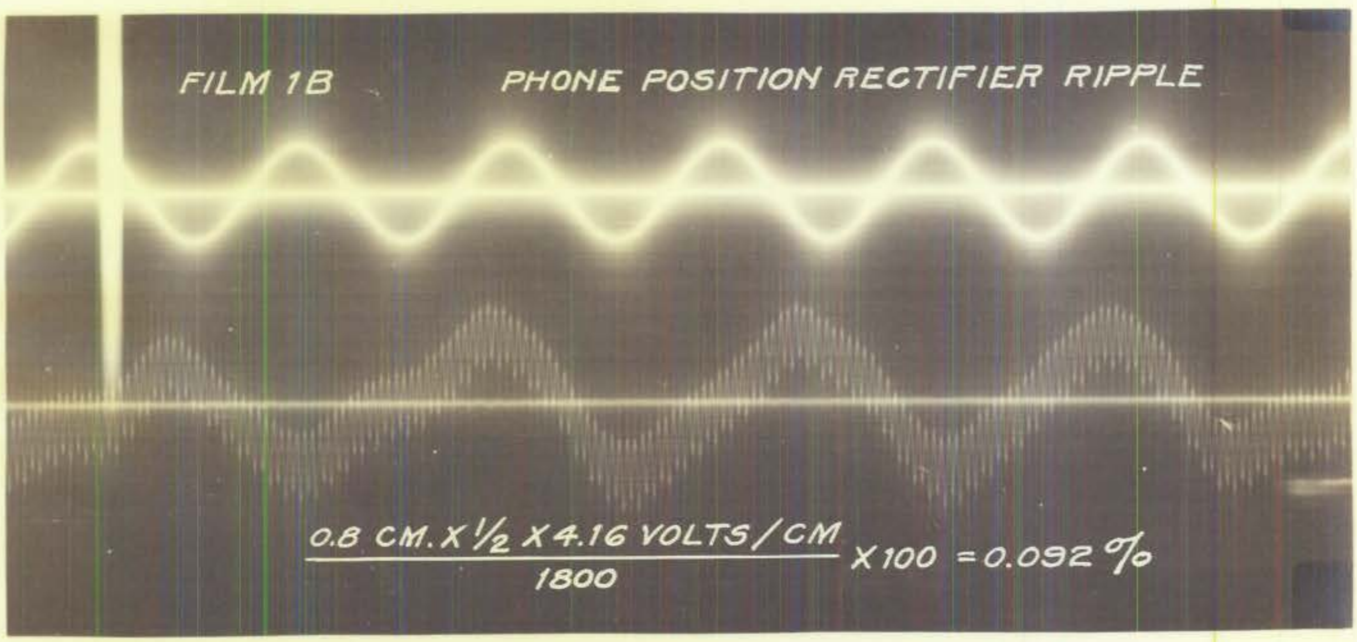

FILM 1B
PHONE POSITION RECTIFIER RIPPLE
0.8 CM. X 1/2 X 4.16 VOLTS/CM / 1800 X100 = 0.092 %

Plate 11

C O P Y

U.S. NAVAL AIR STATION
ANACOSTIA, D. C. GBHH/dg

F42-1(9)/NA6(46) February 26, 1937

From: Commanding Officer.
To: The Director, Naval Research Laboratory,
Anacostia Station, Washington, D. C.

Subject: Aircraft Radio - Preliminary Model GP-3 Transmitting Equipment - Report on Flight Tests of.

References: (a) NRL letter F42-1/52 of 24 August 1936.
(b) NRL letter F42-1/52 of 10 November 1936, to the Chief of the Bureau of Engineering.
(c) Enclosure (A) under BuEng.letter NOs47023 (11-17-W3) of 21 November 1936.

Enclosures: (A) Copy of reference (a).
(B) Outline of Model GP-3 Transmitter Tests at N.A.S. Anacostia.
(C) Copy of N.A.S. Anacostia Memorandum for BuEng Conferences, 10-12 November 1936.
(D) Plate 1. N.A.S. Anacostia Oscillograms No. 30-A and 30-C.
(E) Plate 2. N.A.S. Anacostia Oscillograms No. 30-B and 28-A.
(F) Plate 3. Sketch of Suggested Modifications to Tuning Unit Cover and Case.
(G) Photograph AN-34884. Preliminary Model GP-3 Transmitting Equipment; Principal Component Parts.
(H) Photograph AN-34885. Preliminary Model GP-3 Equipment; Transmitter-Rectifier Unit, without Tuning Unit or Shields.
(I) Photograph AN-34886. Preliminary Model GP-3 Equipment; Top View into Transmitter-Rectifier Unit.
(J) Photograph AN-34887. Preliminary Model GP-3 Equipment; Rear View into Transmitter-Rectifier Unit.
(K) Photograph AN-34888. Preliminary Model GP-3 Equipment; Right Side View into Transmitter-Rectifier Unit.
(L) Photograph AN-34889. Preliminary Model GP-3 Equipment; Left Side View into Transmitter-Rectifier Unit.
(M) Photograph AN-34890. Preliminary Model GP-3 Equipment; Bottom View into Transmitter-Rectifier Unit.

CONFIDENTIAL

DECLASSIFIED

Subject: Aircraft Radio - Preliminary Model GP-3 Transmitting Equipment - Report on Flight Tests of.

- -

(N) Photograph AN-34891. Preliminary Model GP-3 Equipment; Tuning Units "A" and "F", with Outer Shields Removed.
(O) Photograph AN-34892. Preliminary Model GP-3 Equipment; Right Side View into Tuning Units "A" and "F".
(P) Photograph AN-34893. Preliminary Model GP-3 Equipment; Left Side View into Tuning Units "A" and "F".
(Q) Photograph AN-34894. Preliminary Model GP-3 Equipment; Rear Top View into Tuning Units "A" and "F".
(R) Photograph AN-34895. Preliminary Model GP-3 Equipment; Top View into Tuning Units "A" and "F".
(S) Photograph AN-34896. Preliminary Model GP-3 Equipment; External Antenna Loading Unit and Base Plate.
(T) Photograph AN-34897. Preliminary Model GP-3 Equipment; Rear View into Antenna Loading Unit,Original Construction.
(U) Photograph AN-34898. Preliminary Model GP-3 Equipment; Rear View into Modified Antenna Loading Unit.
(V) Photograph AN-34899. Preliminary Model GP-3 Equipment; Broken-down Filament Transformer.
(W) Photograph AN-34900. Preliminary Model GP-3 Equipment; Broken-down P.A. Range Switch (Tuning Unit "A").

1. This letter reports upon the flight and bench tests made at this station, in conformity with reference (a), upon the contractor's preliminary model GP-3 equipment. This equipment was received from the Naval Research Laboratory 7 August, 1936, and after preliminary bench tests and minor alterations (by the contractor's representative) was installed in O3U-1 airplane No. 8810. Between 20 August 1936 and 9 November, 1936, sixty-one (61) test flights were made with this installation, aggregating 96 hours and 10 minutes. Enclosure (B) outlines the tests performed at this station, while enclosure (C) summarizes the deficiencies observed, as submitted by memorandum and elaborated upon verbally by representatives of this station at the Bureau of Engineering conferences 10-12 November, 1936 (proceedings recorded in reference (c)).

Subject: Aircraft Radio - Preliminary Model GP-3 Transmitting equipment - Report on Flight Tests of.

- -

2. The subject equipment as submitted gave a considerable amount of trouble, mainly as a result of breakdowns during altitude and misadjustment tests; the more important failures encountered are listed in paragraph 30. Through close cooperation of the contractor, numerous deficiencies were progressively corrected during the period of the tests, until the equipment proved capable of satisfactory performance under the various tests outlined in Enclosure (B). Considerable delay was prevented by the fact that the contractor, in addition to the two models submitted to the Navy, had constructed an identical third and fourth equipment. These spares were used to good advantage at the contractor's plant to investigate break-downs and troubles encountered by the Navy, and to supply repair parts to the Navy without delay.

3. GP-3 EQUIPMENT: While following specification requirements very similar to the GP, GP-1, and GP-2 equipments, the subject equipment has a number of outstanding mechanical and electrical features, among which are the following:

(a) Rigid cast aluminum chassis, with welded angle framework, providing low bonding resistance and giving ready access to most parts.
(b) Electrically efficient antenna loading unit, with broken-up shielding.
(c) Pentode type power amplifier tube (type 38803), requiring low excitation and modulation power, with resultant simplification of circuits.
(d) Separate high-voltage rectifier for P.A. plate supply.
(e) Small, 800 cycle A.C. operated blower fan, for air circulation.

4. WEIGHTS AND DIMENSIONS: The following measurements were taken at this station, after the completion of flight tests:

Unit	Weight Lbs.	oz.	Dimensions (overall) Depth ins.	Width ins.	Height ins.	Length ins.
Trans.-Rect. less tubes	49	11	13	23-5/8	10-3/4	--
Tubes, complete set	1	9	--	--	--	--
Mounting Tracks (1 pair)	1	6	--	--	--	--
Tuning Unit "A"	14	3	9½	8-19/32	--	10-7/8

Subject: Aircraft Radio - Preliminary Model GP-3 Transmitting Equipment - Report on Flight Tests of.

- -

Unit	Weight		Dimensions (overall)			
	lbs.	oz.	Depth ins.	Width ins.	Height ins.	Length ins.
Tuning Unit "B"	13	15	9½	8-19/32	--	10-7/8
Tuning Unit "D"	13	7	9½	8-19/32	--	10-7/8
Tuning Unit "E"	12	13	9½	8-19/32	--	10-7/8
Tuning Unit "F"	13	7	9½	8-19/32	--	10-7/8
T.U.Containers (Set of 4)	18	5	10-7/8	9-11/16	--	12
Antenna Loading Unit	3	9	6-7/8	4	7	--
Extension Control Box	1	2	2-5/16	5½	4-1/16	--
Operator's Control Box)			2-3/8	8	4-1/32	--
ICS Cable and Plug)	3	1	--	--	--	55
Cable & Plug to Rec.)			--	--	--	55
Power Cable	1	9	--	--	--	79
Control Cable	1	5	--	--	--	57
Extension Control Cable	2	0	--	--	--	99
Transmitter Slip Cover	1	5	--	--	--	--

Total Weight 152 lbs. 11 oz.

5. GENERAL INSPECTION. General examination in accordance with the outline in the first part of enclosure (B), showed the equipment to have a number of deficiences, corrections for which are suggested in enclosure (C). Results of the tests at this station are given in the following paragraphs.

6. INSTALLATION FACILITY. With exception of the following features (contained with additional details in enclosure (C), the general installation of the subject equipment was satisfactory:

(a) Transmitter-Rectifier Unit extends too far back with respect to mounting holes as compared with GP/GP-1 installations.
(b) Transmitter power and control cable plugs fit too loosely into receptacles.
(c) External antenna loading unit mounting plate has non-standard layout of holes; a properly laid out set of holes has been added.
(d) Power cable color coding is contrary to naval aviation practice; extending leads are too short, should be lengthened to six inches each.

- -

(e) Protective slip cover is difficult to apply; a cover of modified design (covering only top and front of transmitter-rectifier unit) was made up at this station and in general appears satisfactory.
(f) Tuning Unit Containers and covers are excessively large for limited space available in service types of airplanes. Plate 3, Enclosure (F), shows suggested modification, which eliminates excessive size, permits stacking without injury to cover handle, and enables use of protective cover on tuning unit while inserted in transmitter. Snap slide studs on tuning unit handles should be prominently stamped with T.U. designating letter to enable identification with cover applied.

7. OPERATING FACILITY. In general, the operating facility was very good, with the following principal exceptions:

(a) Insufficient range of radiation ammeter for fixed antenna operation.
(b) Caution is necessary to allow 30 to 40 second heating time for rectifier tubes.
(c) Pilot's telephone jack opening is found only with difficulty, unless under side of box is visible.
(d) Operator's volume control setting is too easily disturbed by operator's elbow or hand.
(e) Accessibility with heavy gloves is fair, except for poor spacing between improvised P.A. range switch knob and antenna inductance switch knob on tuning units "A" and "B". See enclosure (N).

8. FIXED ANTENNA MATCHING: The equipment in flight coupled and resonated satisfactorily into the standard fixed Vee antenna over the required frequency range, 3 to 9.05 megacycles. The following table indicates the reserve tuning margin of the equipment at the nominal frequency limits of tuning units D, E, and F, as determined by tuning each frequency into the fixed antenna, then without change in transmitter adjustment finding the equivalent length of trailing antenna for resonance, and finally determining the longest and shortest trailing wire tuneable within the range of the transmitter's antenna tuning provisions. In the following table "Equivalent Length" of trailing antenna denotes the length (extending

DECLASSIFIED

Subject: Aircraft Radio - Preliminary Model GP-3 Transmitting Equipment - Report on Flight Tests of.

- -

below the fairlead) which resonates identically with the standard fixed antenna.

Tuning Unit:	Frequency Kcs:	Resonant Trailing Antenna Lengths, ft. Equivalent:	Minimum:	Maximum:
D	3000	14.5'	10'	74'
	4525	18.5'	0'	33'
E	4525	18'	0'	50'
	6500	23'	0'	25'
F	6200	23'	0'	30'
	9050	25'	0'	27'
B	(1500)	(11')	(10')	(173')

The fixed antenna will just resonate as low as 1500 kcs; with the external loading unit, the fixed antenna could be resonated down to about 590 kcs.

9. TRAILING ANTENNA MATCHING: The coupling and resonating provisions proved satisfactory, over the entire frequency range, for use with trailing antennae of various lengths. The high frequency tuning units resonated satisfactorily not only into the trailing antenna lengths shown in the preceding table (paragraph 8) but also into longer antennae tuned as three-quarter and five-quarter wave radiators. The trailing antenna accommodation on intermediate frequencies is shown in the following table. "Full" length of the trailing antenna is 350 feet;

Tuning Unit:	Frequency Kcs:	Trailing Antenna Length, feet Minimum with Loading Unit:	Minimum Non-loaded:	Maximum Non-loaded:
A	350	180'	-	-
	500		350'	Full
	544	15'	235'	Full
	800	-	32'	Full
B	800	-	237'	Full
	1500	-	10'	173'

The lowest frequency tuneable into the trailing antenna without the external loading unit, found to be 506 kcs with the

DECLASSIFIED

- -

O3U-1 airplane, is expected to be somewhat lower in more modern types of airplanes, which on account of the greater use of metal offer a higher counterpoise capacitance.

10. R. F. OUTPUT POWER: The power output appeared to be satisfactory with all required types of antennae; the power delivered into the standard fixed antenna (15' Vee) ranged from about 50 watts at 3000 kcs to 100 watts or more at the higher frequencies. Inasmuch as at all frequencies between 3000 and 7000 kcs with fixed antenna a deflection of the radio-frequency ammeter beyond the 8 ampere full-scale value was obtainable, an expanded scale meter of greater range is desirable; it is believed that a 0-9 ampere R.F. meter will be suitable.

11. FREQUENCY RE-SET: The re-set accuracy was measured by the Naval Research Laboratory, and appears to be satisfactory except for the effect of some imperfect switch contacts, subsequently corrected. The time required for re-sets was found to vary considerably with different operating personnel. A fairly experienced operator could generally re-adjust the frequency in less than one minute, except for occasional delays due to manipulation of the tuning unit retaining latches, and undue time consumed in adjustment of the roller type antenna tuning coils in tuning units E and F. A suitable crank drive is suggested for the roller coils, while a knurled round knob slightly larger than the present hexagonal latch knob would facilitate changing the tuning units. Inter-unit coooperation with the model LM frequency meter was satisfactory. Frequency adjustments of the transmitter were also readily effected by monitoring with the (Model RU-4) receiver, with the transmitter connecting (side-tone) plug withdrawn from the receiver switch box, and the headset directly connected in its place.

12. ALTITUDE FREQUENCY DRIFT. The various required flight transmissions up to 17,500 feet were made as directed by the Naval Research Laboratory, which measured the frequency drift.

13. CW SIGNAL QUALITY. The CW telegraph beat note was very good on flight transmissions with tuning units "A", "B", and "D", and was generally good on unit "E" except for a few cases of very poor quality which were traced to poor and intermittent contact in the roller type antenna tuning coil. Unit

- -

"F" originally gave a poor note with vibration frequency modulation; this was finally corrected and rendered satisfactory by tightening a loose condenser bearing and re-wiring the master oscillator circuit in a more rigid manner.

14. RADIO SPEECH QUALITY. Initial poor speech quality with excessive background noise was found to be due to excessive microphone circuit sensitivity and resultant over-modulation in normal flight use. Several flights made with various microphones in various positions in the pilot's and observer's cockpit showed the unsatisfactory condition to be corrected by reducing the overall gain in the microphone circuit, by shunting a 100 ohm resistor (in addition to the 200 ohm shunt already present) across the primary winding of the microphone transformer. In the production equipment the transformer ratios should be changed, in order to avoid the observed impairment of the side-tone level by the present shunt resistor.

15. FEED-BACK DISTORTION. "Raspy" quality of voice modulation was observed when transmitting on a relatively short trailing antenna near the upper frequency limit of both tuning unit "A" and "B". With unit "A" and a transmitting frequency of 800 kcs, it was found necessary to use at least 250 feet of antenna to give proper modulation, while unit "B" on 1460 kcs required at least 50 feet to avoid distortion. This phenomenon was duplicated on the test bench when transmitting into a phantom antenna of high reactance and low resistance. Indications are that the trouble is due to feedback between the master oscillator and the antenna tuning circuits, and may be corrected by improving the inter-circuit shielding within these tuning units. The contractor should be required to correct this deficiency prior to delivery of the production equipment.

16. RADIATION OF HARMONICS. Measurements were made of harmonic radiation in flight, using both trailing and fixed antennae at various frequencies. For this purpose, test signals from the airplane were received in the laboratory on a 90' vertical wire antenna. A model LN signal generator, coupled through an equivalent phantom antenna, was alternately substituted for the actual received signal, and the microvolt scale setting recorded which duplicated the receiver output obtained from the actual signal, on the fundamental and

harmonic frequencies. Due to unavoidable distance and position changes during measurement, the results tabulated below are averages with an estimated accuracy of about 5 decibels.

Frequency of Transmission, Kcs.	Transmitting Antenna:	Received Strength micro-volts Fundamental:	2nd Harmonic	Fundamental to Harmonic Ratio, DB:
800	300' Trail.	40,000 to 60,000	170 to 200	Approx. 50
	(re-tuned)	130,000	170	58
3000	75' Trail.			
	Loose Coupled	18,500	40	53
	Tight Coupled	17,000	17.5	60
8360	Fixed Ant.			
	(at fundamental freq.)	30,000	30	60
	Quarter Wave Trail.	50,000	7	77

No radiation was noticeable beyond the second harmonic. Variations in tuning procedure such as tight coupling or de-tuning did not measurably increase the harmonic radiation, except in the case where the antenna was intentionally and carefully tuned to resonance with the second harmonic instead of the fundamental frequency of the transmitter, by means of an absorption type of frequency meter. This reduced the 800 kcs fundamental received signal from 130,000 to 550 microvolts, and brought up the received second harmonic from 170 to 1000 microvolts.

17. DISTANCE COMMUNICATION. On a test flight to Raleigh, N.C., 225 miles from Anacostia, at an average altitude of 2500 feet, good two-way voice and CW telegraph contact on 660 kcs was maintained with this station over the entire distance. Voice transmission from the airplane on 544 kcs proved good up to 150 miles, and went out completely at approximately 200 miles. CW telegraph signals on 544 kcs were still fairly satisfactory at 225 miles, although notably inferior to the signals received on 6600 kcs. This distance performance is considered satisfactory.

18. BREAK-IN OPERATION. As submitted by the contractor, the break-in relay operation was unsatisfactory both because of excessive keying clicks, insufficient break-in speed, and excessive sparking in the sending key. An oscillographic study at this station, illustrated by enclosures (D) and (E),

the keying relay and associated connections were found to be negligible, in view of the exceptionally small stray capacitance to the chassis, and the low-loss insulating materials employed. The circuit from the antenna terminal, through the receiver contacts on the relay, to the receiver terminal on the transmitter, was found to have a capacitance to the chassis of 20.5 micro-microfarads, with a "Q" of 1385.

20. FEED-BACK HOWL. When transmitting on "Voice" and the receiver tuned to the transmitted frequency, certain conditions of receiver adjustment were found to impose on the transmitted carrier a background howl sufficient to impair slightly the speech intelligibility. This howl is caused by the interconnection of the receiver output and the transmitter modulation system, through the side-tone circuit, and occurs only over the limited range of receiver volume control where the receiver has sufficient sensitivity, yet is not blocked by the transmitted signal. Laboratory measurements resulted in the following data; the recorded receiver sensitivity adjustments are denoted by microvolts of 30% modulated input required to produce an audio output of 2.4 volts, or 10 milliwatts into a 600 ohm headset.

Frequency Kcs:	Carrier Howl Modulation:	Side-tone Howl Volts:	Receiver Sensitivity, uV:	Remarks
544	15%	0.4	6000	Howl starts
544	38%	1.5	1500	Maximum Howl
544	15%	0.4	400	Howl ends
6200	22%	1.5	50,000	Howl starts
6200	30%	1.75	10,000	Maximum Howl
6200	28%	1.70	2,600	Howl ends.

The above data were obtained with the receiver on "Manual" volume control, in the MCW position. No feed-back howl was obtainable on "Automatic" volume control, with the receiver in "MCW" position; in the "CW" position, however, beat-note howl modulation up to 30 per cent was obtainable, both with "Automatic" and "Manual" volume control.

21. INTERPHONE. The ICS system employed in cooperation with the RU-4 receiver initially was inadequate for flight

use, delivering less than ten milli-watts into each helmet; after removal of the voltage divider across the transformer secondary, a satisfactory output up to fifty milliwatts into each headset was obtained, with good intelligibility in flight. An ICS volume adjustment should be added, of a type allowing full realization of the present available gain.

22. SIDE TONE. The telegraphic side tone levels were found to be satisfactory maximum levels in flight, when transmitting on full power; transmission on low power weakened the telegraph side tone unduly. The voice side tone level was not quite sufficient for noisy flight conditions, when the 100 ohm microphone transformer shunt resistor was employed as mentioned in paragraph 14; the voice side-tone circuit should be re-designed to make available up to at least 25 milliwatts in each of the two headsets. Screwdriver type volume level adjustments should be incorporated both in the telegraph and the voice side-tone circuits. The following measurements of total side tone output were obtained in the laboratory; telephone modulation was provided by an 800 cycle audio oscillator electrically coupled into the microphone circuit, with intensity adjusted to give a modulation percentage between 90 and 100. The 100 ohm microphone shunt resistor was in place during these tests.

Transmission		Load	Side-Tone Output	
Method:	Power:	Impedance Ohms:	Total Milli-watts:	Volts r.m.s.
CW	High	2.5	3900	3.1
		25	620	3.9
		250	70	4.2
		3000	5.5	4.2
CW	Low	2.5	1000	1.6
		25	175	2.1
		250	19	2.2
		3000	1.6	2.2
MCW	High	2.5	2900	2.7
		25	490	3.5
		250	50	3.5
		3000	4.1	3.5
MCW	LOw	2.5	800	1.4
		25	150	1.9
		250	16	2.0
		3000	1.4	2.1
Voice	High	25	200	2.2
		300	25	2.7
		600	13.5	2.75

The above data indicate that the internal impedance of the telegraph side-tone winding (on full power) is about three-quarters of an ohm, while that of the voice side-tone circuit is approximately 6.5 ohms.

23. EXTERNAL LOAD UNIT. The antenna loading unit is shown in enclosures (G), (S), (T), and (U). The following measurements were obtained with the switch on tap 1 (maximum inductance step):

True Inductance:	434 microhenries.
Distributed Capacitance:	67 micro-microfarads.
Q (at 500 kcs):	187
Resistance at 500 kcs:	9.1 ohms.

Slightly greater inductance would in special cases enable resonating the fixed antenna to 544 kcs (see paragraphs 6 & 7) but is not required by the specifications. The efficiency of the loading unit, as indicated by the high Q, is made possible by breaking up the electrical continuity of the shielding case, thus reducing circulatory current losses. Flight tests did not show this incomplete shielding to produce any adverse effects, either from the standpoint of danger to the operator or from the standpoint of sparking hazard between conductors in the immediate vicinity of the unit. As at first submitted, this unit gave rise to several altitude flash-overs, which were progressively corrected by altering the coil mounting brackets, substituting a switch of greater clearance, and changing the wiring. It was also necessary to add a bottom jumper permanently connecting the front and back shields, to avoid capacitively induced shield voltages when operating on the test stand, with side shield removed. Enclosure (U) shows the interior of the modified unit which operated satisfactorily.

24. ALTITUDE PERFORMANCE. Details of numerous breakdowns at first experienced will be found in paragraph 30. As finally modified, the subject equipment was found capable of transmitting full power CW, MCW, or Voice, into the fixed or any length trailing antenna capable of being resonated, under normal operating conditions up to at least 17,500 feet without breakdown of any kind; this includes trailing antenna lengths as short as 10 feet, at 1500 kcs on tuning unit "B" and at 3000 kcs on unit "D", also a completely retracted trailing antenna on 4525, 6100, and 8500 kcs. When using a very short antenna, temporary altitude flash-overs can still be induced across the contacts of the antenna tuning tap switch, if the

DECLASSIFIED

latter is thrown while the key is held down. Such arcs are indicated by sudden rise of the plate milliammeter, and unless unduly prolonged have been found to cease without damage to the equipment as soon as the key is released.

25. 600 CYCLE OPERATION. Extensive flight tests with the NEA-2 generator showed satisfactory continued operation at generator frequencies from 850 to about 575 cycles; on several occasions, brief messages were transmitted while gliding, landing or taxying after landing, at generator frequencies as low as 300 cycles, without apparent damage to the equipment.

26. SHOCK MOUNTING. The resiliency of the shock mounting proved of a satisfactory order under all observed flight and taxying conditions.

27. BLOWER FAN. The equipment operated satisfactorily during a one-hour period on the test bench, with the blower fan blocked. While not measured, the monitored frequency did not appear to drift unduly under these conditions, nor did the blower motor heat appreciably. The bearings of the blower unit were found to be in perfect condition at the completion of all tests, after a total operating time estimated between 150 and 200 hours. No trouble was experienced with the blower mounting.

28. ACCESS TO TUBES AND FUSES. Tubes and fuses were found to be replaceable in flight, although not while wearing heavy gloves. Greater clearance appears desirable above the P.A. tube to accommodate replacement of tubes within the allowed height tolerance.

29. VOLTAGE COMPENSATION. Bench and flight tests in conjunction with both and NEA-1A and an NEA-2 generator showed good voltage compensation on CW and Voice transmission, at all alternator frequencies from 600 to 800 cycles. The NEB-1A generator of the emergency power unit, operating at 800 cycles, also enabled good voltage compensation on CW and Voice. With MCW operation, however, it was never possible to obtain adequate voltage compensation. This inadequency is shown by the following bench test data, obtained with the transmitter tuned to 8270 kcs, MCW emission, and the filament voltage adjusted to 10.0 volts in the key-up condition. The recorded compensating capacitance is additional to the 8 mfd. residual capacity.

Subject: Aircraft Radio - Preliminary Model GP-3 Transmitting Equipment - Report on Flight Tests of.

- -

GENERATOR:			Power Switch:	Filament Volts, Key Down, Max.	Optimum Compensating Capacitance:
Type:	Serial:	Cycles:			
NEA-2	398	800	High	9.5	4
"	"	"	Low	9.85	3
"	"	600	High	9.45	12
"	"	"	Low	9.8	7
NEA-1A	105	800	High	9.4	7
"	"	"	Low	9.85	5
"	"	600	High	9.3	12
"	"	"	Low	9.8	8
NEB-1A	1	800	High	9.40	7
"	"	"	Low	9.75	4

A number of corrective measures, to improve the MCW compensation were tried without success. MCW emission was always satisfactory in flight, with no apparent detrimental effects to the tubes or equipment which could be directly ascribed to the imperfect voltage compensation.

30. FAILURES. The following failures of component parts of the subject equipment occurred during the tests of this station:

(a) High-voltage plate transformer burned out during flight. (Replaced).
(b) High-voltage filter capacitor failed in flight. (Replaced).
(c) Two successive rectifier filament transformers failed as result of altitude flash-over.(Replaced).
(d) Rectifier filament transformer connection failed by flash-over to shield louvre. (Repaired).
(e) One type 38803 P.A. tube failed, apparently due to opening of plate or screen grid lead.(Replaced).
(f) Phenolic frame P.A. range switch in tuning unit "A" failed from corona at altitude. (Enclosure (W)). (Redesigned).
(g) Replacement ceramic frame P.A. range switch in tuning unit "B" failed from corona at altitude. (Redesigned).

DECLASSIFIED

Subject: Aircraft Radio - Preliminary Model GP-3 Transmitting Equipment - Report on Flight Tests of.

- -

(h) P. A. Tank padding condenser in T.U. "D" failed during altitude test. (Replaced).
(i) Shaft coupling insulators of T.U. "B" and "D" antenna tap switches broke as result of corona at altitude. (Redesigned).
(j) P. A. plate milliammeter burned out as result of flashover to terminal stud at altitude. (Corona shield added and meter placed in ground side of circuit).
(k) P. A. range switch in T.U. "F" damaged by altitude flash-over. (Corrected by re-wiring).
(l) Keying relay damaged by repeated altitude flash-over. (Redesigned and replaced).
(m) External antenna loading unit coil and switch damaged by repeated altitude flash-over. (Redesigned and replaced, coil and switch).
(n) High voltage rectifier tube socket failed by altitude flash-over. (Replaced and wiring rearranged).
(o) Internal flash-over occurred in several instances between plate and antenna contacts in back of tuning units. (Clearance has been enlarged).
(p) Emission selector switch failed as result of misalignment and binding. (Repaired).
(q) Antenna coupling shaft connection failed.(Redesigned and replaced).
(r) P. A. tuning variometer rotor loosened on shaft. (Repaired. Should be redesigned).
(s) Ball lost from detent mechanism; detents generally too weak. (Repaired. All detents redesigned).

Several other minor failures are indicated in enclosure (C).

31. CONCLUSIONS. The large number of failures during the flight tests appear in a large measure due to the contractor's misinterpretation of the practical requirements and his lack of preparedness for the severity of the flight tests, such as the combined altitude and misadjustment trials. Another contributing factor appears to be the impossibility of simulating actual altitude flight conditions under an evacuated bell jar in the development laboratory. The general design of the subject equipment is believed to be fundamentally sound and to constitute a distinct step ahead in this type of apparatus; if the remaining deficiencies are remedied as suggested, it is expected that the production equipment will be suitable and satisfactory for Naval service use.

Subject: Aircraft Radio - Preliminary Model GP-3 Transmitting Equipment - Report on Flight Tests of.

- -

32. RECOMMENDATIONS. It is recommended that one of the first production models be submitted to flight tests in order to ascertain final satisfactory performance, prior to deliveries of GP-3 equipment to the fleet. This precaution appears desirable as a final check on the production alterations as well as on the high requisite order of production workmanship. As exemplified by the tests reported herein, many deficiencies become apparent only during actual flight operation, and can not be located by inspection on the test bench.

33. FUTURE SPECIFICATIONS. It is suggested that specifications for further procurement of similar radio equipment be amended in the following respects:

(a) Require power reduction specifically by decrease of output voltage of high-voltage transformer, to increase altitude breakdown safety factor.
(b) Correct Navy's outline diagram of external loading unit, showing correct mounting holes and location thereof.
(c) Require CW and MCW side tone adjustable up to 4.0 volts, r.m.s., across 3 pairs of 600 ohm headsets in parallel; ICS and "Voice" side-tone to be adjustable up to 6.0 volts, across same output load.
(d) Require specific power output and other performance on fixedantenna, including specific antenna constants based on latest actual measurements.
(e) Combine misadjustment with altitude requirements, including requirement that switching any switch with key depressed shall not cause permanent damage.
(f) Extend altitude breakdown requirements upward to 25,000 feet, employing ¼ power tap above 17,500 feet.
(g) Require smallest practicable tuning unit containers and covers, giving dimension limits. Require tuning unit containers to be stacked for shipment without damage, and allow protective container cover to be applied directly to tuning unit inserted in transmitter unit. Enable identification of tuning unit inside container and with cover applied.
(h) Limit feed-back modulation howl to 30% or less.
(i) Stipulate normal output voltage of Navy standard microphones as approximately 2 volts for 100% modulation.

Subject: Aircraft Radio - Preliminary Model GP-3 Transmitting Equipment - Report on Flight Tests of.

- -

(j) Require separate screwdriver adjusted level controls for ICS, Telegraph and Voice side-tone.
(k) Require construction such that equipment, in or out of shielding case, is not injured by laying on flat bench with face down or on any of its sides.
(l) Require the external loading unit to be operable up to 600 kcs, and to resonate the fixed antenna in the range from 500 to 600 kcs. This appears highly desirable for emergency purposes and may be accomplished without difficulty.
(m) Specify the minimum as well as maximum limits of trailing antenna length (or equivalent capacities) over which equipment shall resonate at frequency limits of tuning units.
(n) Require all markings and designations on front faces of components to be free from obstructions or parallax which would interfere with readability from perpendicular up to 45° upward, and 30° to either side.
(o) Avoid fine lettering or markings which in flight are not readily readable at a distance of 18 inches.
(p) Prohibit attachment of knobs or dials to shafts by means of single set screws.
(q) Require type calibration curve (not individual) to be affixed to top of each tuning unit, to determine approximate settings prior to use of flight heterodyne frequency meter.
(r) Require break-in operation substantially free from key clicks, with receiver adjusted to specified top sensitivity, CW, on same frequency as transmission. Oscillographically measured receiver recovery time, under these conditions, not to be in excess of 0.065 seconds after release of key, so as to enable break-in communication up to 30 words per minute.

34. It is requested that this station be furnished with two copies of the N.R.L. report covering the preliminary GP-3 equipment, when issued.

V. C. GRIFFIN.

- -

Copy to:
BuAero. (2)
BuEng. (1)
NAF, Phila. (1)

F42-1/52

COPY

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C. JCL:LP

24 August 1936.

From: Director.
To : Commanding Officer, Naval Air Station, Anacostia, D. C.

Subject: Radio Aircraft - Flight tests of Model GP-3 transmitting equipment.

Reference: (a) BuEng. let. C-NOs-47023(6-26-W3) of 29 June 1936 to NRL. (Copy to NAS).
(b) Specification RE 13A 490D.

1. It is requested that flight tests be conducted on Model GP-3 aircraft transmitting equipment in accordance with reference (a).

2. Specific tests desired are as follows. The numbering of the following paragraphs refers to the numbering of the pertinent paragraphs of the specifications, reference (b).

1-2, 3-15. Determine effectiveness of communication under actual flight conditions by schedules with the Naval Air Station and Naval Research Laboratory. Check operation of break-in feature when receiver and transmitter are tuned to the same frequency.

1-5. Comment on the provisions made for installing the equipment in Naval aircraft.

2-11. All items of the equipment are required to stand continuous duty under service conditions. In this respect pay especial attention to the operation of the low power plate transformer on phone position and the mounting of the ventilation blower under vibration.

3-1. The equipment is required to deliver satisfactory CW, MCW, and phone power to the specified antennas. Note the operation of the antenna coupling circuit on fixed antennas and especially on trailing wire antennas at or near the 1/4 and 3/4 wave points.

Enclosure (A)-page 1.

DECLASSIFIED

3-1(5). Test set at altitude of 17,500 feet for voltage break down. Open circuit and short circuit the antenna under full power lock key on at least one frequency in each tuning range. Two locked key frequency drift runs are specifically requested on altitude flights in addition to any others that may be considered necessary. These two runs are 9,000 kilocycles range F and 800 kilocycles range A. The Laboratory will cooperate with the Air Station for these tests.

3-2. Test ruggedness of shockproof mountings.

3-5. Replace tubes during flight.

3-6. Handle controls with heavy gloves.

3-8. Transfer from fixed to trailing wire antenna during flight.

3-9. Check value of lowest frequency to which set can be tuned without antenna loading coil.

3-10. Test side tone operation.

3-14. Test voltage compensation on CW, MCW, and phone positions.

3-16. Check harmonic intensity when transmitter is normally tuned. Misadjust transmitter tuning in an effort to emphasize harmonics.

3-21. Note the time necessary in flight to tune the equipment. Tune the equipment in conjunction with a frequency meter. Record accuracy of reset.

4-7(1). Check mounting of pilot's control box.

(a) The ICS-Radio switch in the ICS position shall provide interphone communication without the radiation of electric wave energy and when in the Radio position shall permit remote keying or microphone modulation of the transmitter while connecting the pilot's headset for radio reception.

4-14. Replace fuses in flight.

3. Any further flight tests considered necessary by the personnel of the Naval Air Station shall be included in the above outline.

4. Communication with the airplane and cooperation throughout the flight tests will be provided by this Laboratory.

L. R. Moore
Acting.

Copy to: BuEng.

Enclosure (A)-page 3.

C O P Y

Radio Test Section,
U. S. Naval Air Station,
Anacostia, D.C.

OUTLINE FOR EXAMINATION AND TESTS OF GP-3 EQUIPMENT

1. WEIGHTS (Record each unit).

2. DIMENSIONS (Measure each unit; record cable lengths).

3. PHOTOGRAPHS (Show general construction of principal units, both internal and external. Photograph typical breakdowns. Show all dial markings and nomenclature in front views). (Photograph scale with units to indicate dimensions).

4. INSTRUCTION BOOK
   (a) Completeness.
   (b) Language not unduly complex; conventional terms.
   (c) Adequacy & clearness of Illustrations.
   (d) Diagrams, complete as well as elementary schematic.

   (See that all cable lengths, outline dimensions, and weights are included in instruction books).

5. ELECTRICAL CIRCUIT Suitability.

6. MECHANICAL CONSTRUCTION, general.
   (a) Frames & Cases.
   (b) Panels.
   (c) Knobs, Dials, Switches, Shafts.
   (d) Connection plugs & sockets.
   (e) Cables.
   (f) Protective covers, slip covers and cases.

7. WORKMANSHIP; note any defects.

8. CONSTRUCTIONAL MATERIALS.

9. CORROSION PROTECTION, PLATING, and EXTERIOR FINISH.

10. ADMITTANCE OF WATER AND SPRAY.

11. VENTILATION & POSSIBILITY OF HEATING DAMAGE.

Enclosure (B) - page 1.

12. RUGGEDNESS of entire units or components
    (a) During transportation and handling.
    (b) During installation.
    (c) While installed in airplane.
    (d) While being serviced.

13. ACCESSIBILITY
    (a) For normal operation.
    (b) For servicing: note any screws or small parts likely to become lost.

14. SHOCK MOUNTING, suitability and durability and strength.

15. VIBRATION RESISTANCE:
    (a) Are all screws and nuts suitably locked or staked?
    (b) Are vacuum tubes held securely?
    (c) Controls suitably held by friction and/or locks?
    (d) Set screws double on spotted shafts?

16. LOCK WASHERS AND NUTS.
    (a) Use of elastic stop nuts and inserts; do not permit elastic stop nuts to lock against rotating component.
    (b) Use of binding head screws.
    (c) Shakeproof lock washers: external type where possible.
    (d) Check standardized thread sizes and pitches.
    (e) Material and plating of screws, nuts and lock washers.
    (f) Suitability of sizes for strains encountered.
    (g) Accessibility without special wrenches or tools; pay especial attention to keying relay.

17. EXCESSIVE WEIGHT: suggest where reduction can be effected.

18. ELECTRIC INSULATION
    (a) Clearance spacing.
    (b) Insulating materials; suitability and amount. Note susceptibility to heating and mechanical strain.
    (c) Low losses for radio frequencies.

19. WIRING CONNECTIONS
    (a) Rigidly supported R. F. leads.
    (b) Flexible stranded leads where possible.
    (c) Wire covering, insulation and color coding.
    (d) Good connections, mechanically and electrically.
    (e) Workmanship of soldered joints.
    (f) Accessibility and ease of replacement.
    (g) Adequate tracing for servicing (color coding).
    (h) Inspect cable plugs.

20. ELECTRIC CONTACTS.
   (a) Cable plugs, etc.
   (b) Tuning unit connectors and plugs.
   (c) Suitable contacts in all switches.
   (d) Tube sockets.

21. ELECTRIC TERMINALS and Binding Posts.
   (a) Suitable Insulation.
   (b) Suitable type & size for desired connection.
   (c) Suitable location on equipment.
   (d) Suitable marking designation.

22. PROTECTION OF OPERATOR FROM ELECTRIC SHOCK.
   (a) Suitability of interlock switch.
   (b) Likelihood of condensers remaining charged.
   (c) Relative exposure of high voltage leads.
   (d) Danger when changing fuses.
   (e) Danger when changing tubes.
   (f) Danger from contact with antenna; does operator's life depend on a stopping condenser?
   (g) Danger while servicing (trouble shooting).

23. HEATING EFFECTS.
   (a) Ventilation adequacy, location, spray resistance.
   (b) Will portions & components near tubes withstand heat?
   (c) Likelihood of leakage of impregnating material.
   (d) Isolation of M.O. circuits from tube heat.
   (e) Excessive R.F. heating effects.
   (f) Effect of fan or blower failure.

24. FIRE PROTECTION.
   (a) Enclosed sparking contacts & switches.
   (b) Non-inflammable or slow burning materials.

25. FUSE PROTECTION.
   (a) Suitable types and sizes.
   (b) Ease of replacement in accessible location.
   (c) Fuse receptacles plainly & permanently marked.
   (d) Suitable provisions for carrying spare fuses.

26. ELECTRICAL BREAKDOWN, Components to be specially examined for:
   (a) Transformers.
   (b) Fixed condensers.
   (c) Resistors & rheostats.
   (d) Electrolytic condensers (if provided).
   (e) Indicating instruments.
   (f) Switches.

27. OPERATING EFFICIENCY & CONVENIENCE:
   (a) Suitable arrangement of dials, switches, meters.
   (b) Suitable end stops, detent action, locking devices.
   (c) Ruggedness of knobs & dials.
   (d) Clearance for heavy gloves.
   (e) Likelihood of any controls "freezing".
   (f) Likelihood of knobs slipping, or single hole mounts turning.
   (g) Need for lubrication anywhere in equipment.

28. MARKING & DESIGNATIONS (visibility, nomenclature, permanence).
   (a) Dials, switches, meters, plugs.
   (b) Are markings obstructed when viewed from above?
   (c) Suitable nomenclature & terminology.
   (d) Do markings increase in suitable direction, and in direction of increase of controlled effect?
   (Compare GP/GP-1).
   (e) Are markings visible in poor light?
   (f) Avoidance of parallax in calibrations.
   (g) Do meters have suitable range, with marking white on black background, and suitable red line indications?
   (h) Are power connection terminals plainly marked or conventionally coded in color (compare GP, GP-1).
   (i) Interior parts suitably marked for servicing or replacement.
   (j) Name plates and Serial Numbers.
   (k) Warning plates on Ext. Load Unit, on power switch for rectifier, and any other purposes such as minimum allowable antenna lengths, etc.

29. CALIBRATION CHARTS.
   (a) Both on main unit and tuning units.
   (b) Do frames provide suitable moisture protection?
   (c) Are charts readily replaceable?
   (d) Are calibration charts readily visible?
   (e) Sufficient columns in logical sequence.
   (f) Sufficient lines for required frequencies.
   (g) Is line & column spacing proper for typewriting?

30. MECHANICAL PROTECTION.
   (a) Suitable slip cover.
   (b) Suitable tuning unit covers.
   (c) Tuning Unit carrying containers.
   (d) Will faces of units foul parachute harness, etc.?
   (e) Can transmitter be laid face down for servicing?
   (f) Will damage result from laying transmitter, in or out of its case, on any of its surfaces while servicing?

Enclosure (B) - page 4.

31. INSTALLATION FACILITY.
- (a) Excessive dimensions?
- (b) Mounting holes standard size & arrangement? (Compare GP/GP-1).
- (c) Are mountings & holes readily accessible for screws or nuts, without special tools?
- (d) Are cables of required length & suitable flexibility?
- (e) Is power input cable suitable & properly marked or color coded?

LABORATORY TESTS AND MEASUREMENTS:

32. ACCELERATION SUITABILITY (8g).
- (a) Keying relay, by weight & spring pressure.
- (b) Main shock mounting, should support eight times transmitter weight in any direction, without damage.

33. BONDING RESISTANCE.
- (a) Measure resistance of various portions to main frame, with Kelvin Bridge or Ducter.
- (b) Ground connection to main frame.
- (c) Cable shield to main frame.
- (d) Tuning Unit shield to main frame.

34. FREQUENCY COVERAGE OF TUNING UNITS, Power input and output.

35. POWER SOURCE & COMPENSATION (record compensating capacitance).
- (a) Compare NEA-1A, NEA-2, and NEB-1A generators.
- (b) Compare first two on 600 and 800 cycle operation.
- (c) Compare CW, MCW, and Phone on all tests.
- (d) Compare FULL and QUARTER power on all tests.

36. BENCH MODULATION CHECK.
- (a) Compare with Cathode Ray tube, Modulation % meter, and Radio receiver monitor.
- (b) Observe & adjust Voice modulation, also MCW & CW.
- (c) Note inherent & artificially produced background noises (electric fan near mike).
- (d) Listen to CW note and vibration modulation as transmitter case is pounded with mallet or fist.

37. SPARK & ARC OBSERVATION (in darkened room).
- (a) Relay contacts while keying CW, MCW, Phone.
- (b) Key & microphone push button contacts.
- (c) For location of trouble or testing remedial measures, by duplication of corona or arcing observed in flight tests.

38. OSCILLOGRAMS OF BREAK-IN KEYING ACTION.
   (a) Transmitter on 544 or 6600 kcs, approx; CW and MCW; Receiver on CW, Manual V.C., nearly full gain, to give 10 milliwatts output from 10 microvolts input, from signal generator on same frequency as transmitter.

39. VENTILATING FAN OR BLOWER.
   (a) Remove and examine after flight tests.
   (b) Observe running and measure power consumed.
   (c) Note heating when blocked, and power consumed.

FLIGHT TESTS AND MEASUREMENTS:

40. ANTENNA MATCHING.
   (a) Fixed, Antenna; Record tuning settings and all currents for nominal frequency limits of each tuning unit from 3,000 kcs upward to 9050 kcs.
   (b) Trailing antenna; Obtain similar data with shortest and longest trailing antenna which will resonate at nominal frequency limits of each tuning unit, 350 to 9050 kcs. Note all antenna lengths, up to permissible maximum 350 feet. Also operate antenna on harmonics as 3/4 and 5/4 wave radiator, where practicable on the higher frequencies.
   (c) Determine trailing antenna lengths which match tuning adjustments for fixed antenna.
   (d) Note at what frequencies fixed antenna can be tuned, below 3000 kcs, and record settings.

41. FREQUENCY RE-SET TESTS (Measured by NRL) and CFI TEST:
   Test at least one frequency each tuning unit. First set up assigned frequency with aid of C.F.I., then twice in succession remove tuning unit from set, change all adjustments, then re-set to recorded values and have Anacostia and Bellevue check frequency.

42. ALTITUDE FREQUENCY DRIFT TEST:
   At least one frequency on each Tuning Unit. Plane communicates with and sends MO for NRL Bellevue; climbs to 17,500 feet or higher, then shuts down everything for 15 minutes to cool equipment as much as possible, then opens up again and descends. NRL and Anacostia measure frequency drifts.

43. MODULATION INTELLIGIBILITY AND BACKGROUND.
   Several microphones compared, with different amounts of resistor to determine best intelligibility noise ratio.

44. HARMONIC RADIATION (measured by Anacostia).
   (a) Normal operation, at several frequencies.
   (b) Intentionally misadjusted, to bring out harmonics.
   (c) Both on fixed and trailing antennas.

45. FREQUENCY ADJUSTMENT SUITABILITY.
   (a) By means of C.F.I.
   (b) By monitoring with own receiver.

46. FACILITY OF FLIGHT OPERATION.
   (a) Tuning time with experienced operator.
   (b) Operating ability & time with inexperienced personnel.

47. GENERAL FLIGHT ACCESSIBILITY:
   (a) Operation with heavy gloves.
   (b) Changing Tuning Units.
   (c) Changing tubes in flight.
   (d) Changing fuses.

48. DISTANCE COMMUNICATION FLIGHT, 250 to 300 miles. Maintain two-way contact as far as possible on 544 kcs, then shift to 6600 both ways and remain on this frequency during return. Test CW, MCW, and Voice, and pay particular attention to break-in operation facility & speed.

49. BREAK-IN OPERATION & KEY CLICKS.
   (a) Two way with Anacostia's power reduced to a minimum, requiring full CW receiver gain, both on 6600 kcs.
   (b) Tune in distant B.C. carrier beat, and observe break-in speed while transmitting on this same freq.
   (c) Make above tests both transmitting on CW and MCW.

50. MODULATION FEED-BACK.
With transmitter on Phone and mike button depressed, vary Volume control of receiver set to same frequency, until transmitter "squeals"; from rise in antenna current and ground observation, estimate degree of this feedback modulation, and note its relative interference with speech modulation and intelligibility. Make these tests both with receiver on CW and MCW, and both Manual and Automatic volume control.

51. CHARACTER OF CW SIGNAL.
   (a) Note vibration modulation, lilt, and drift on the various frequencies.
   (b) Compare note of original high frequency unit with modified wiring incorporated in second unit.

(c) Observe effect on CW note of loose or variable switch contacts.
(d) Compare resonated with unresonated antenna.

52. I.C.S. and SIDE TONE.
Test ICS in flight with various hood conditions. Measure output level on ICS, and Side Tone (CW, MCW, Voice, both on Full and Quarter power).

53. FLIGHT HAZARD TO PLANE & PERSONNEL.
(a) Observe sparking & corona tendency around connections inside equipment.
(b) Note insulation necessary on connecting leads.
(c) Tendency to spark at Antenna Reel.
(d) Breakdown of Antenna Fairleads.
(e) Any sparking over leadout insulators.
(f) Observe effects of touching antenna or connections inadevertently.
(g) Test possible sparks around external loading unit.

54. ALTITUDE MISADJUSTMENT BREAKDOWN TESTS:
These are the most critical tests and always show up much trouble in original models. Each tuning unit is tested up to at least 17,500 feet at both nominal frequency limits, on CW, MCW, Voice. Antenna is grounded and open-circuited during operation, and various switches thrown while holding down key. No permanent damage to set shall result. Antenna is progressively shortened from a long antenna as would be used for distance work, to shortest antenna which will resonate into equipment for each frequency, such as would be used if most of antenna carried away or for quick communication at low altitudes. R. F. meter, and especially plate milliammeter, are closely watched for indications of breakdown or corona. If flashovers occur, and operator is unable to locate the exact point of breakdown, he must use judgment to obtain sufficiently burned spot which can be located after landing, but not cause unnecessary damage to equipment.

55. MOISTURE CONDENSATION TEST.
Effected by rapid descent from high altitude; as cold set encounters warm air strata, dew or frost forms on equipment while in full operation.

56. LOW ALTERNATOR FREQUENCY OPERATION.
(a) Extensive operation while engine is turning up around 1200 rpm, while descending from high altitudes. This provides 600 cycles supply frequency.

(b) Momentary transmissions while throttle is being closed, as while gliding in for a landing, to determine what if any damage results from brief or emergency transmission well below 600 cycles. Stop transmission when filament voltage falls 15% below normal.

57. OPERATION WHILE TAXIING.

(a) Observe shock mount action while taxiing over rough field.
(b) Communicate while taxiing and have base station observe transmitted signals.

Enclosure (B) - page 9.

C O P Y

RADIO TEST SECTION
Naval Air Station
Anacostia, D. C.

9 November, 1936.

MEMORANDUM ON GP-3 DEFICIENCIES FOR BUREAU OF ENGINEERING CONFERENCE 10 November, 1936.

A. GENERAL CONSTRUCTION

1. Where screws with lock washers are used, preferable type is binding head screw with externally toothed type of lock washer.

2. Ceramic cement used was found unduly hygroscopic and conductive and should not be depended upon for insulation.

3. Trouble was experienced from shifting of components attached by single hole mountings; insure positive alignment (not by friction alone) of components.

4. Avoid variable or friction contact to switch contacts; sweat wire or terminal lug directly to switch contact button or stud.

5. Designate all internal components by suitable markings (2-63).

6. Very little color coding is employed in wiring, rendering tracing of some circuits difficult. Color coding is preferred on all long or partly hidden leads.

7. A considerable amount of the wiring in models is insufficiently supported, of excessive length, and with many unnecessary bends and angles. Bus bar type of wiring should be stiffer and more direct to avoid misplacement under vibration or while servicing equipment.

8. Flight experience shows need for avoiding unnecessary corners, points, and sharp edges, on and adjacent to all R. F. conductors with voltages sufficient to induce corona at high altitude.

9. Protect P. A. Grid wire against contact with chassis.

B. INSTRUCTION BOOK AND DRAWINGS.

1. Avoid designating "Restricted" matter as "Confidential"; several drawings were so marked.

2. To prevent damage by water (sticking pages), non-enameled paper is desirable for final Instruction Book.

3. Final Instruction Books should have all diagrams permanently bound into them, and not removable.

4. On page iii, correct "transmitter-Receiver" to read "Transmitter-Rectifier" unit.

5. Facilitate installation weight calculations by inserting tube weight; immediately following Transmitter-Rectifier; itemize weights of separate Tuning Units; indicate weight of mounting tracks.

6. Itemize weights and dimensions of all cable connections.

7. Include instructions to permit use of short antennas, and momentary operation at low alternator frequencies.

C. TRANSMITTER-RECTIFIER UNIT.

1. Strengthen handles of Transmitter unit and of Tuning unit.

2. Provide sufficient clearance for removal of all tubes (of maximum allowed dimensions) through Tuning Unit opening.

3. Improve visibility of tube type marking, especially along sides of T.U. opening.

4. Increase scale expansion of R.F. meter, and make total range 9 amperes instead of present 8; with 4 amperes reading approximately mid-scale.

5. Avoid misalignment of blower shock mounting.

6. Provide suitable markings at binding posts and output terminal "Antenna", "Receiver Ant." and "Ground".

7. Present Rec. and Gnd. binding posts not readily accessible in flight; move below Antenna terminal as far as practicable.

8. Correct misaligned end stops on Low-High power switch.

9. Prevent loose T.U. guide pins observed in models.

10. Correct freezing and misalignment defects of Emission selector switch.

11. Make mounting slide rail position and holes conform to BuAero airplane installation Standard Drawing.

12. Prevent damage to switches and knobs when transmitter is laid on its face, as in servicing.

13. Alter Fil. Rheostat dot position so as to be straight up when in center of its (angular) range.

14. Mark fuses more adequately, especially upper two spare positions; provide fuse mountings which will hold NAF standard Navy fuses.

15. Stiffen support of P. A. grid excitation lead, to prevent accidental shorting against frame or metal can adjacent thereto.

16. Widen slots for passage of mounting screws in retainers.

17. Mark mounting rails "Right" and "Left".

D. TUNING UNIT.

1. Avoid use of tuning designations which will con fuse operator as to tap or dial markings; thus, "Antenna Inductance" tap setting actually gives lowest inductance for highest tap number. Change of designation to "Antenna Tuning Step" will eliminate confusion. Recommended nomenclature for adjustment designations is as follows:

A M.O. Tuning Step	B M. O. Tuning
C P.A. Tuning Range	D P. A. Tuning Step
E P. A. Tuning	F Ant. Tuning Step
G Ant. Tuning	H Ant. Coupling
I - - -	J Ant. Loading (Mas. Load, Min. Load).

2. Make all markings and designations readable from approximately 45 degree upward angle. Antenna tuning dial markings on "E" unit are obstructed by upper edge of window, interfering with visibility when installed in plane.

3. Lock knobs back off several turns under vibration (when lock is released); facilitate ease of locking by reducing travel or adding frction device.

4. Associate locking knobs with respective tuning knobs; by suitable marking. Present arrangement frequently confuses operator.

5. Vernier type of dial found unnecessary on Antenna Tuning control; durability and tuning speed should be increased by substitution of plain dial. A certain amount of friction in this control is desirable to avoid shifting under vibration, however.

6. Time consumed for antenna resonating in Unit "E" excessive, due to large number of turns on roller coil. This can be remedied by a crank instead of plain knob drive. This is also desirable, to a lessor extent, on Unit "F" (coil has fewer turns).

7. Improve dependability of roller coils by slight modification of end stop pieces, so that if roller accidentally jumps off wire, travel to either end of coil will restore it on wire.

8. Roller coil dial markings do not conform to actual limits of adjustment. Correct this, and indicate approach to either end of range by warning indication such as red or blank sector in window, to prevent likelihood of end stop damage.

9. Present rectangular knob unnecessarily large, has poor index mark, and single set screw tapped into molded bakelite. Should be improved.

10. Provide more positive unlatching rotating action of retainer latches to expedite changing of tuning units.

11. Add necessary additional shielding on T. U. "F".

E. TUNING UNIT CONTAINERS.

1. Tuning Unit Containers (measuring 9-5/8" by 12" by 10-7/8" overall) are excessively large, have vulnerable

projecting carrying handle, and edges projecting inward interfere with ready removal of tuning units due to catching numerous screw heads on sides of latter.

2. Necessary to facilitate withdrawal of tuning unit to prevent catching against screw heads; can readily be done by corner guides or other means.

3. Tuning Unit container can readily be made smaller by changing means of attaching cover so as to make inward bent edge unnecessary. This will reduce width and breadth of box to about 8-5/8" by 11", thus saving about one inch in each dimension.

4. Handle on cover should be folding type (bail or strap) to prevent damage in transit. This will reduce overall depth by about 3/4 inch.

5. Further desirable improvements are:
   (a) A suitable window in cover enabling identififaction of contained tuning unit without removal of cover.
   (b) Direct attachment of cover to Tuning Unit panel, in such a manner that cover can be attached to T. U. while inserted in Transmitter unit, thus forming a desirable protection in flight and preventing fouling or misadjustment after the unit has once been tuned up.

F. ANTENNA LOADING UNIT.

1. Designate "MIN.LOAD" and "MAX.LOAD" positions of switch, inasmuch as numbers increase in opposite sense as loading effect.

2. Substitute flat strip for wire in bonding bottom.

3. Omit original large and misplaced mounting holes.

4. Stiffen switch mounting to prevent twisting or weaving.

5. Improve detent action.

G. PILOT'S CONTROL BOX.

1. Phone jack opening too difficult to locate in flight; move closer toward front face of box, and rearrange so that key jack is near rear edge and in

center, between MIC and PHONE jacks.

2. Reduce size of mounting holes to 3/16 inch.

3. Desirable to provide increased friction, or locking screw, for key plug, to prevent its accidental withdrawal.

4. Type of jack employed (Frost) has proved unsatisfactory.

H. OPERATOR'S CONTROL BOX.

1. Materially reduce diameter and height of volume control knob, to avoid accidental misadjustment (due to fouling elbow) experienced in flight.

2. Reduce size of mounting holes to 3/16" diam.

3. Desirable to move PHONE and MIC jacks slightly closer to front face, and to provide increase friction or lock screw to prevent accidental withdrawal of key plug.

4. "Frost" make of jack unsatisfactory.

I. CABLES AND PLUGS.

1. Cable plug shells fit too loosely into receptacles, especially power and control plugs on right side of transmitter. Reduce this clearance to conform to standard Navy tolerances for such plugs.

2. Increase length of individual leads projecting from fitting in end of power supply cable 6", to enable connection in Radio junction boxes in planes.

3. Present color coding of power leads misleading to Navy personnel; use following color code:

D.C. NEGATIVE:	Black
D.C. POSITIVE:	White
A. C. leads:	Green and Brown, respectively.

4. Use Navy standard (type 49006, NAF-38861) two-conductor plugs for ICS and Receiver Output connection; provide Red bakelite shell on ICS plug (in addition to marking) to prevent wrong insertion.

5. ICS and Receiver Output cable unnecessarily large; reduce size to correspond with Navy 2-conductor shielded microphone cable.

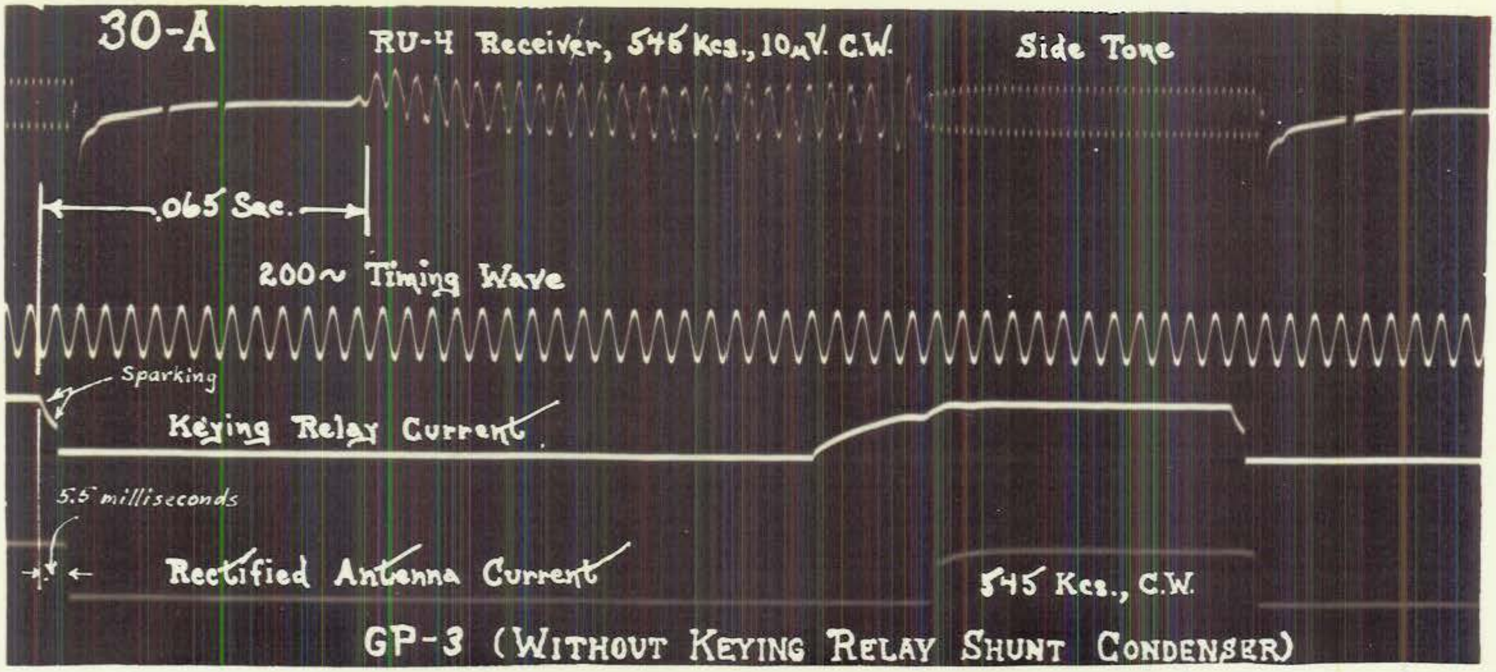
frequency; this occurs only over a certain range of receiver Manual volume control setting.

7. Remedy present excessive sparking in key and microphone switch contacts, apparently due to inductance of relay winding.

L. ADDITIONAL MISCELLANEOUS.

1. Antenna Inductance Roller Coils on T.U. E and F unsatisfactory in following respects:
- (a) Require too much time to tune antenna circuit.
- (b) End stops not positive; roller easily forced past stop.
- (c) Dial marking reads wrong once roller has traveled beyond end stop.
- (d) Roller made insufficient contact on Anacostia model.
- (e) Dial windows give inadequate visibility to markings from above. (Suggest telescoping crank on side of knob, more positive end stops, and ball bearings for easy operation).

2. Securing of several shafts, bushings and knobs inadequate and defective. Observe following:
- (a) Don't depend upon single set screws to hold shafts (Velvet Vernier dials, etc.).
- (b) Several nuts and bushings loosened up; were not adequately secured by lock washers; should be staked to prevent loosening. (Emission selector switch, T.U. "A" Ant. Ind. Sw.).
- (c) Shafts "froze" in bushings in several cases; insure adequate clearance and lubricate in assembly.
- (d) Some set-screws unnecessarily long, caused arcing and mechanical interference.



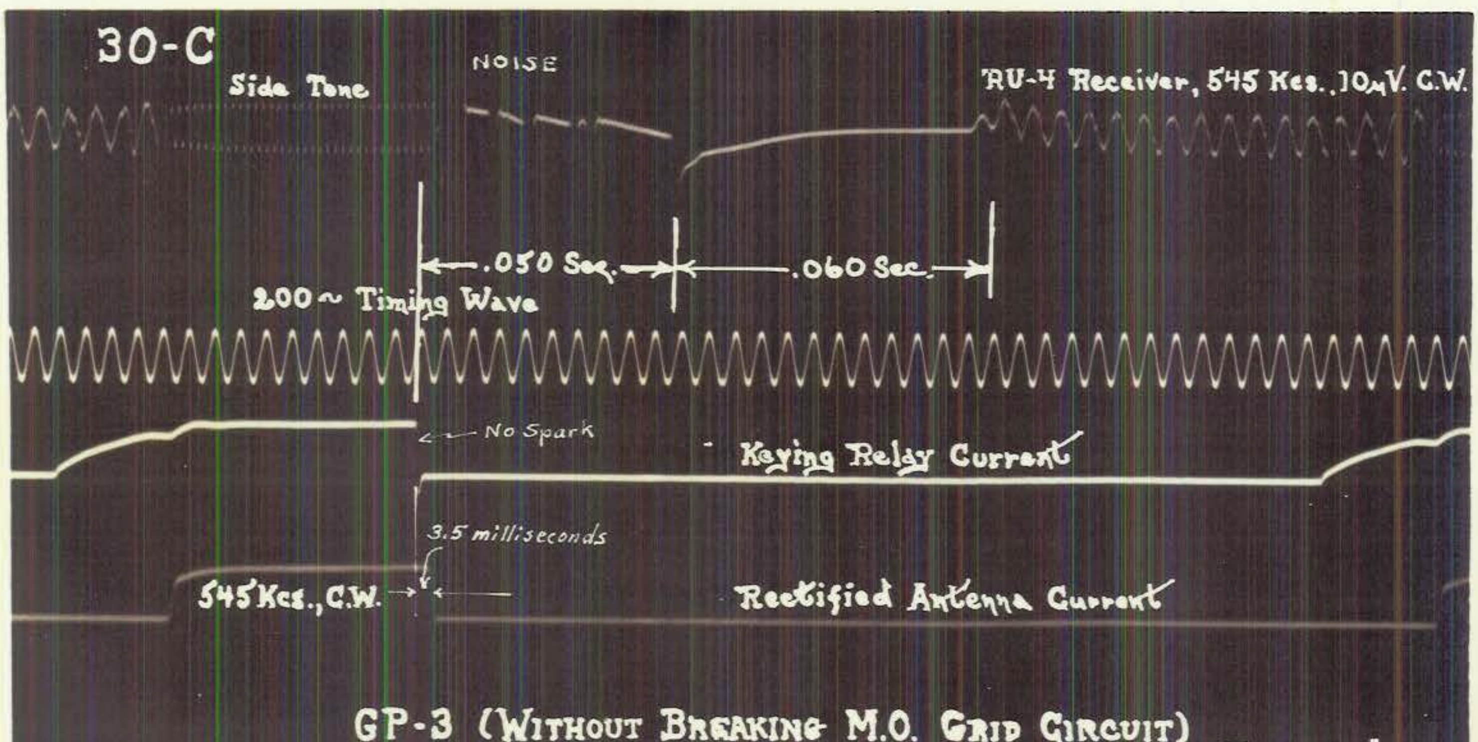
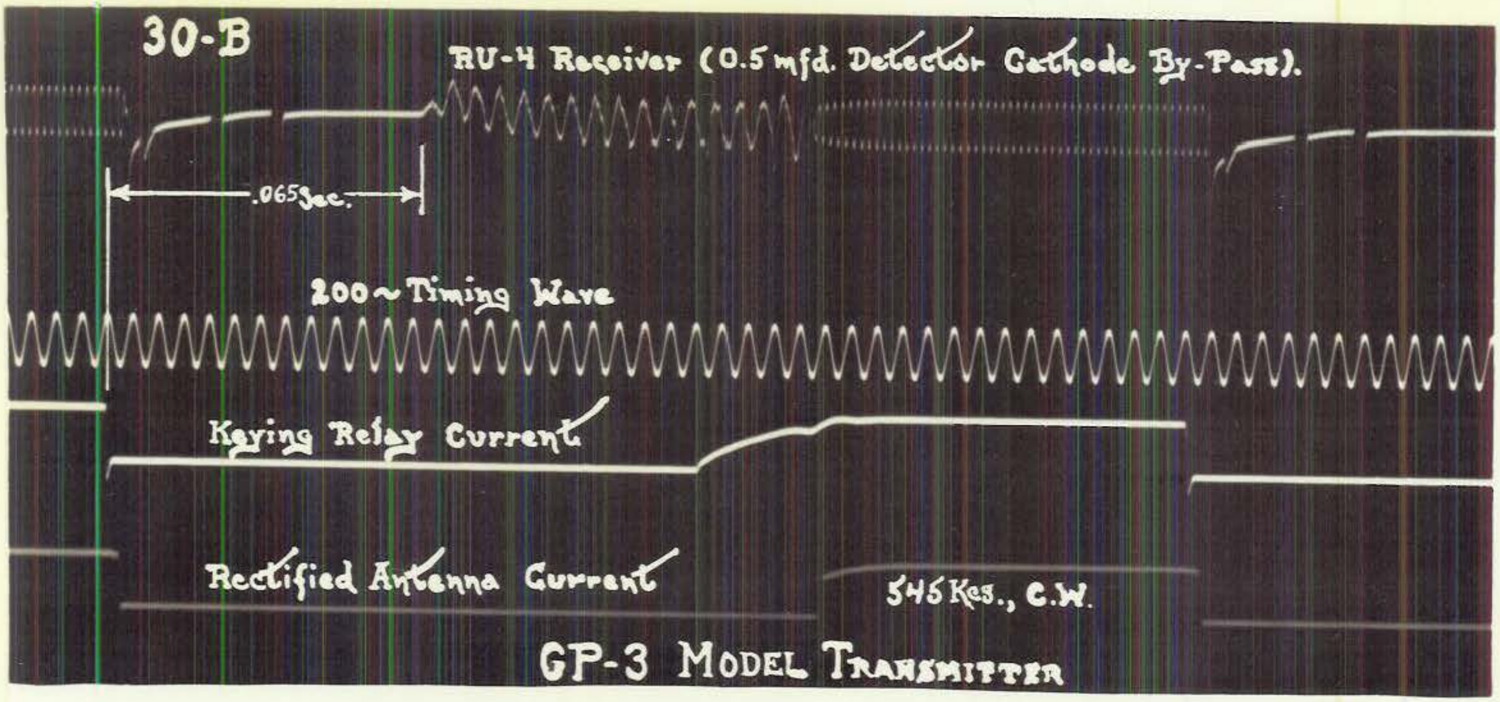


PLATE 1
ENCLOSURE (D)



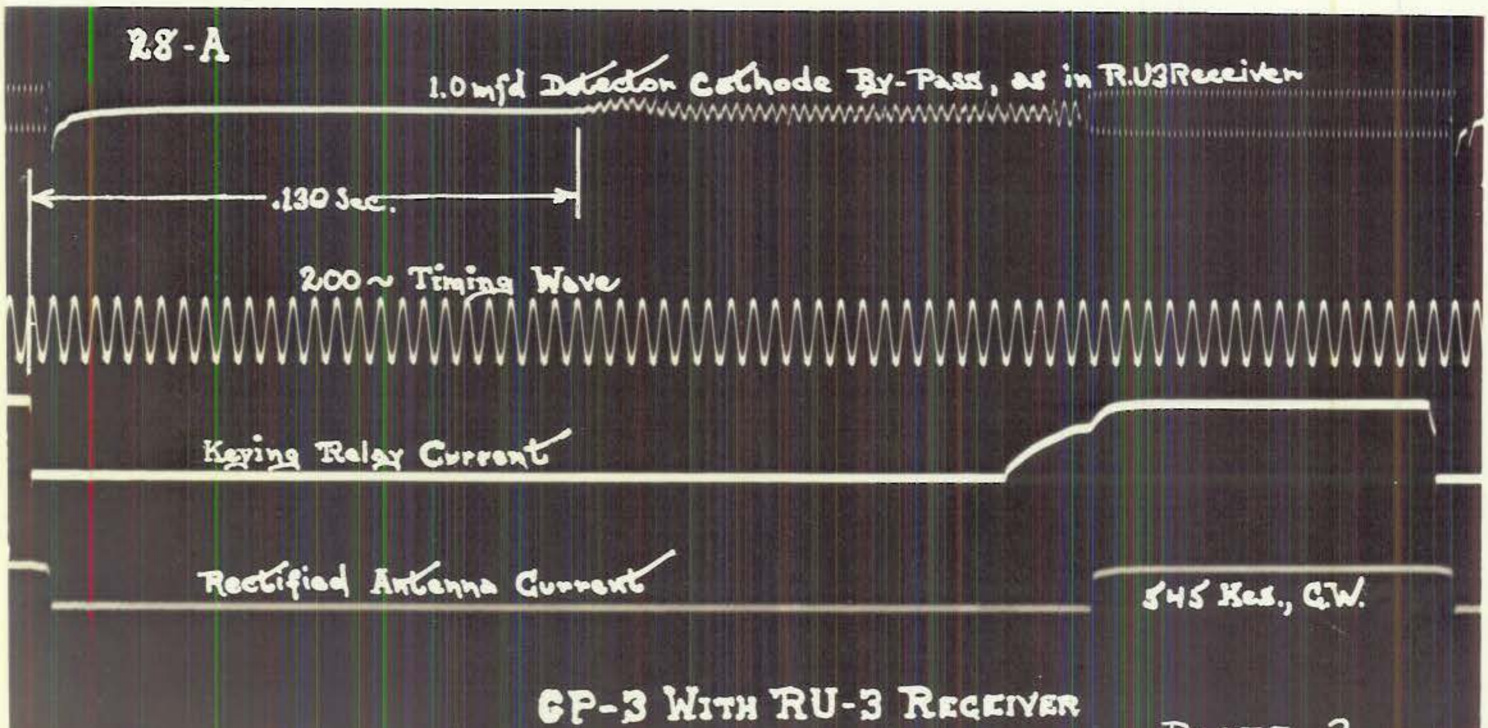
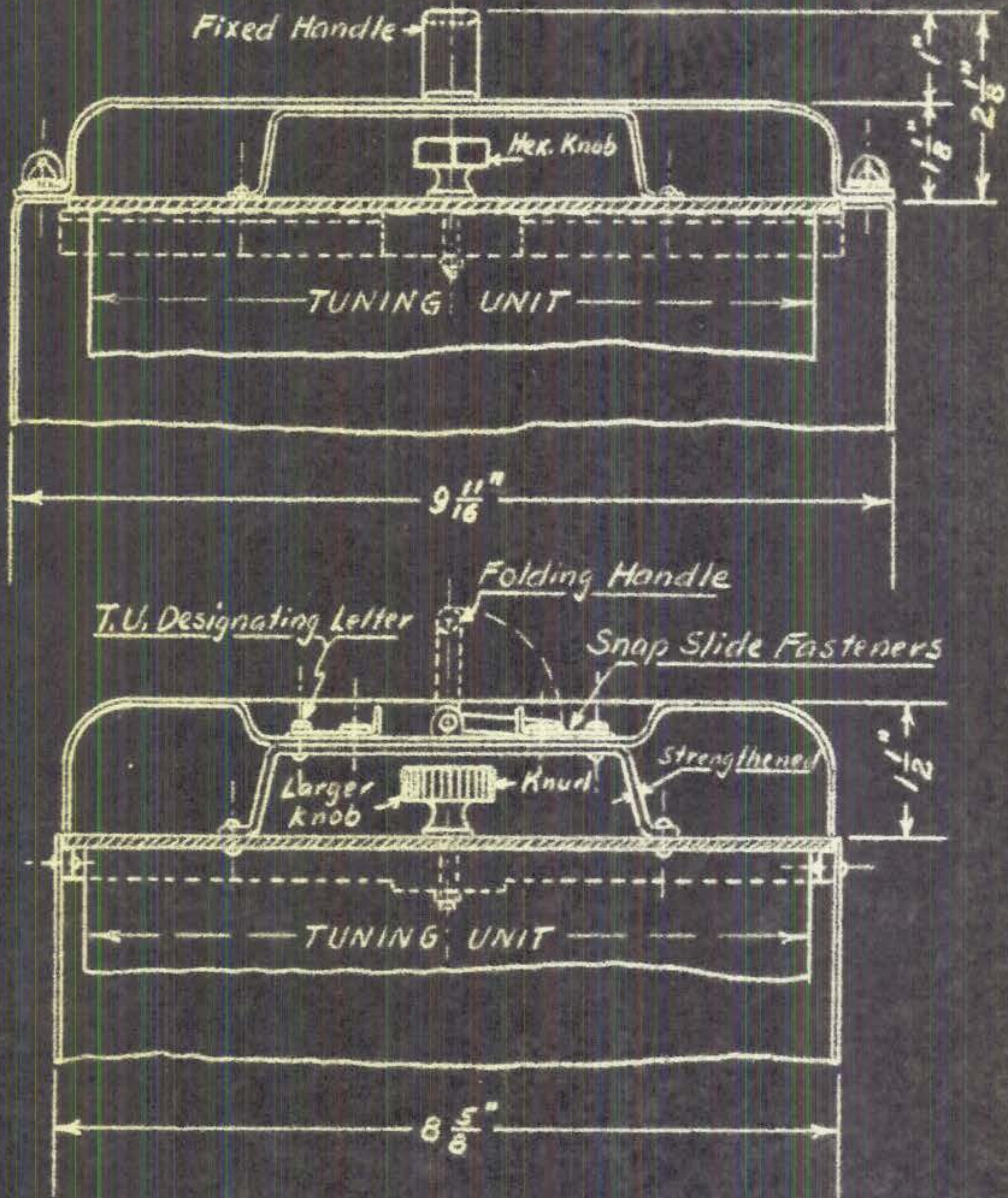


PLATE 2.
ENCLOSURE (E)

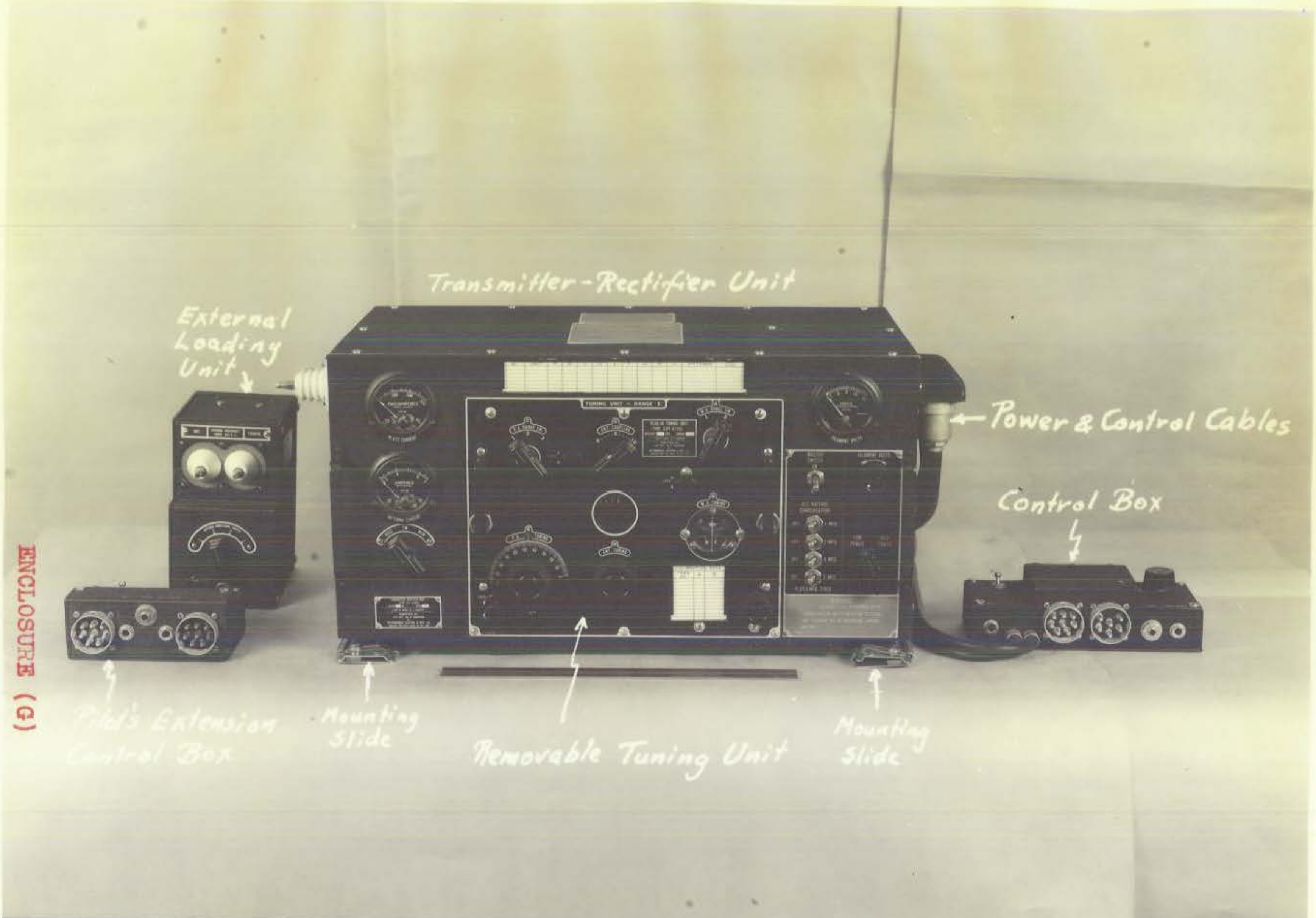
RADIO TEST SECTION
U.S. NAVAL AIR STATION
ANACOSTIA, D.C.

11 November, 1936



PROTECTIVE COVER AND CASE
FOR
GP-3 TRANSMITTER TUNING UNIT

TOP VIEW: Section through side, Actual Construction
LOWER VIEW: Section showing Suggested Modifications.
PLATE 3 Enclosure (F).



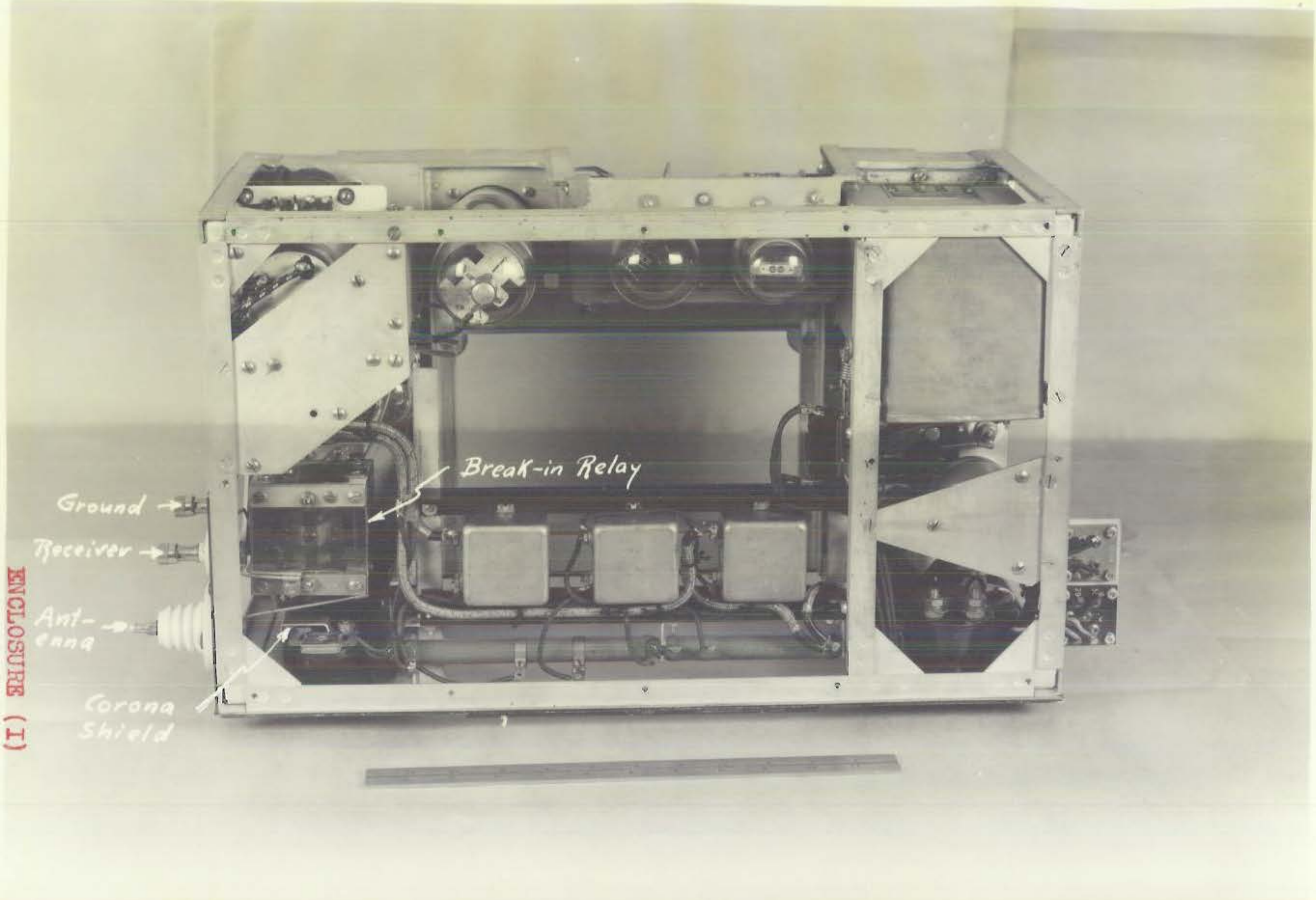
Preliminary Model GP-3 Radio AN-34884 2-3-37 OFFICIAL NAVY PHOTOGRAPH
Transmitting Equipment - Principal Component Parts. NOT TO BE USED FOR PUBLICATION

ENCLOSURE (G)

Preliminary Model GP-3 Equipment; Transmitter - Rectifier Unit, without Tuning Unit or Shields. AN-34885 2-3-37

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION

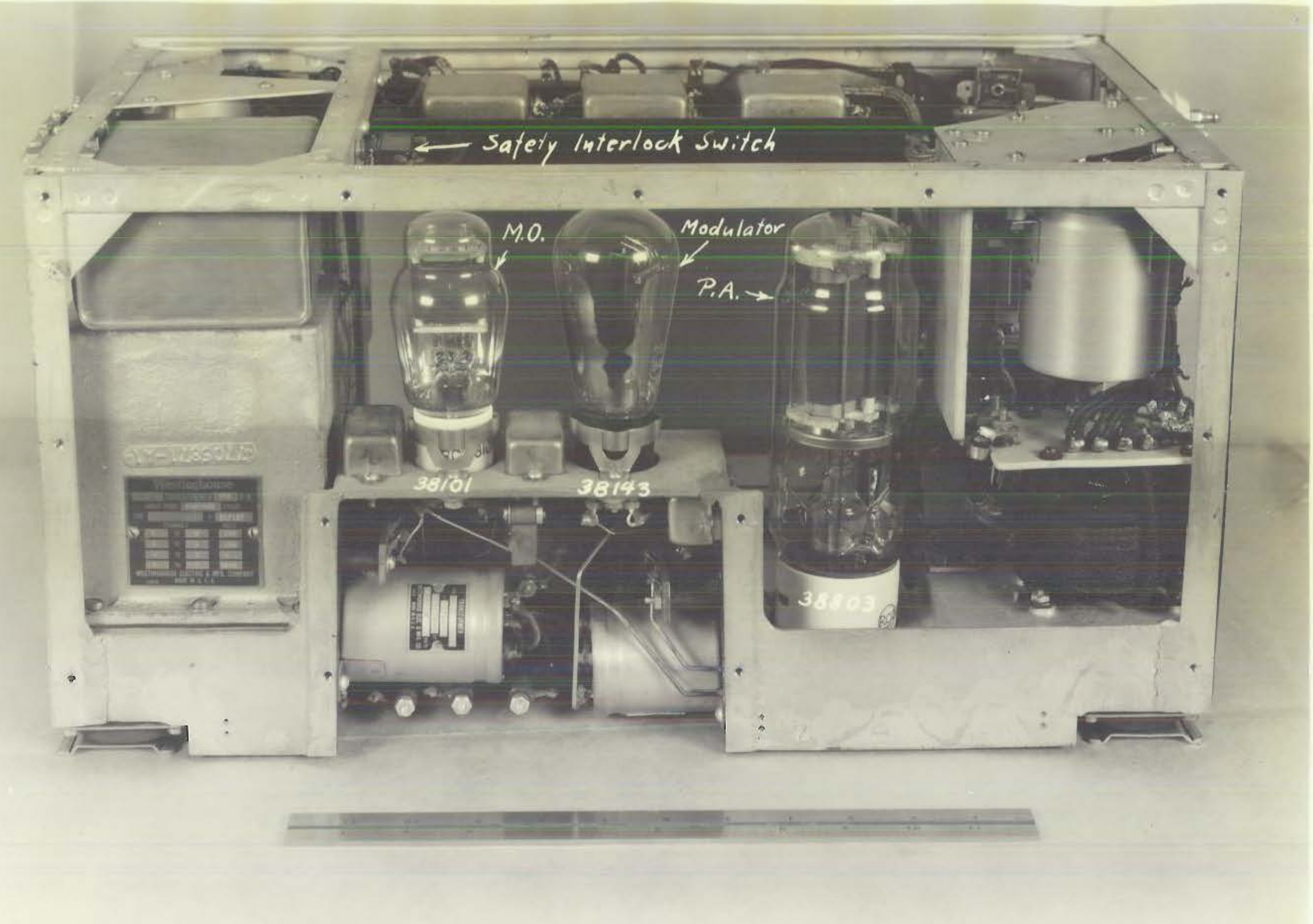
ENCLOSURE (H)



ENCLOSURE (I)

Preliminary Model GP-3 Equipment; Top View into Transmitter-Rectifier Unit. AN-34886 2-3-37

OFFICIAL NAVY PHOTOGRApH
NOT TO BE USED FOR PUBLICATION

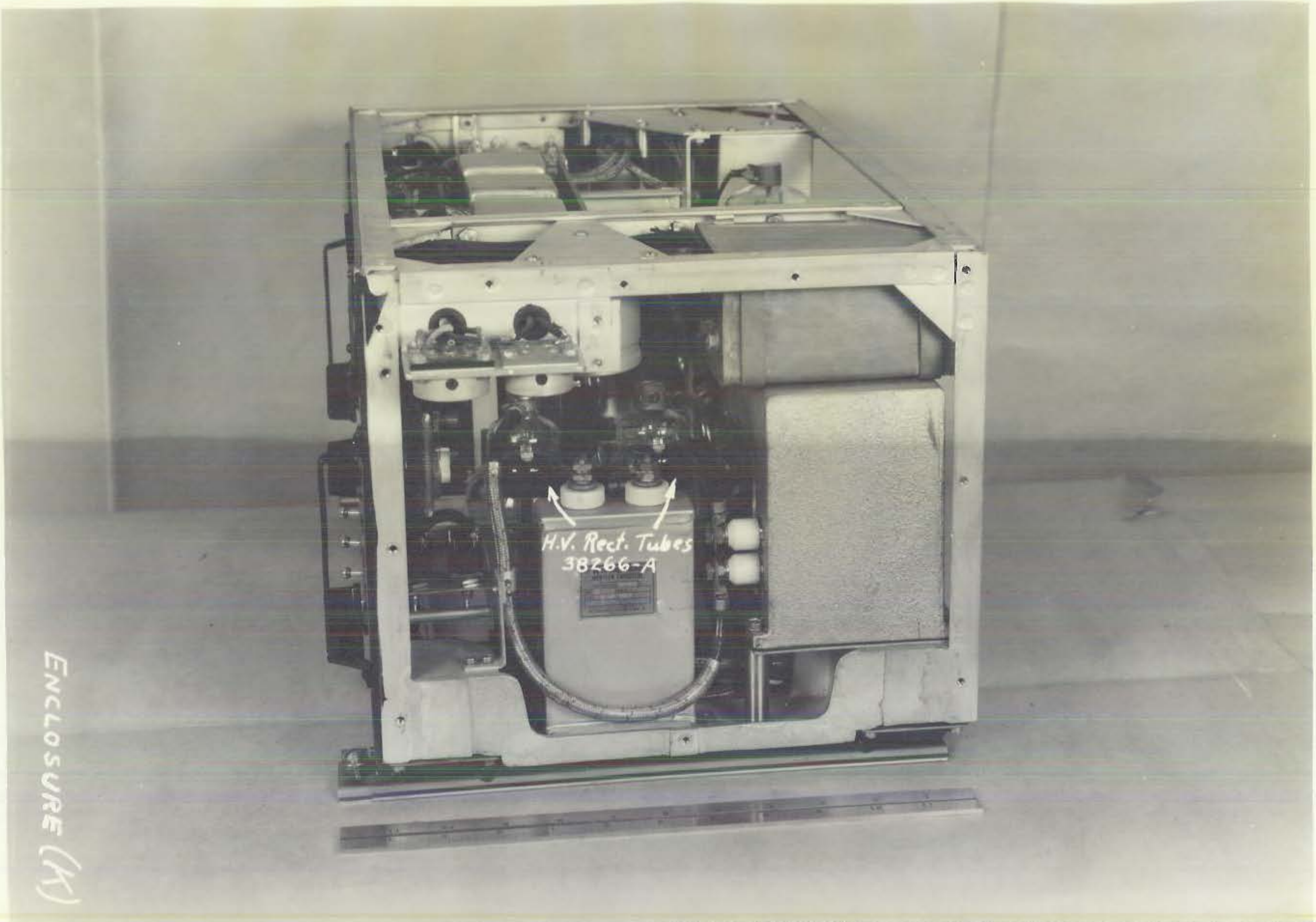


Preliminary Model GP-3 Equipment; Rear View into Transmitter-Rectifier Unit. AN-34887 2-3-37

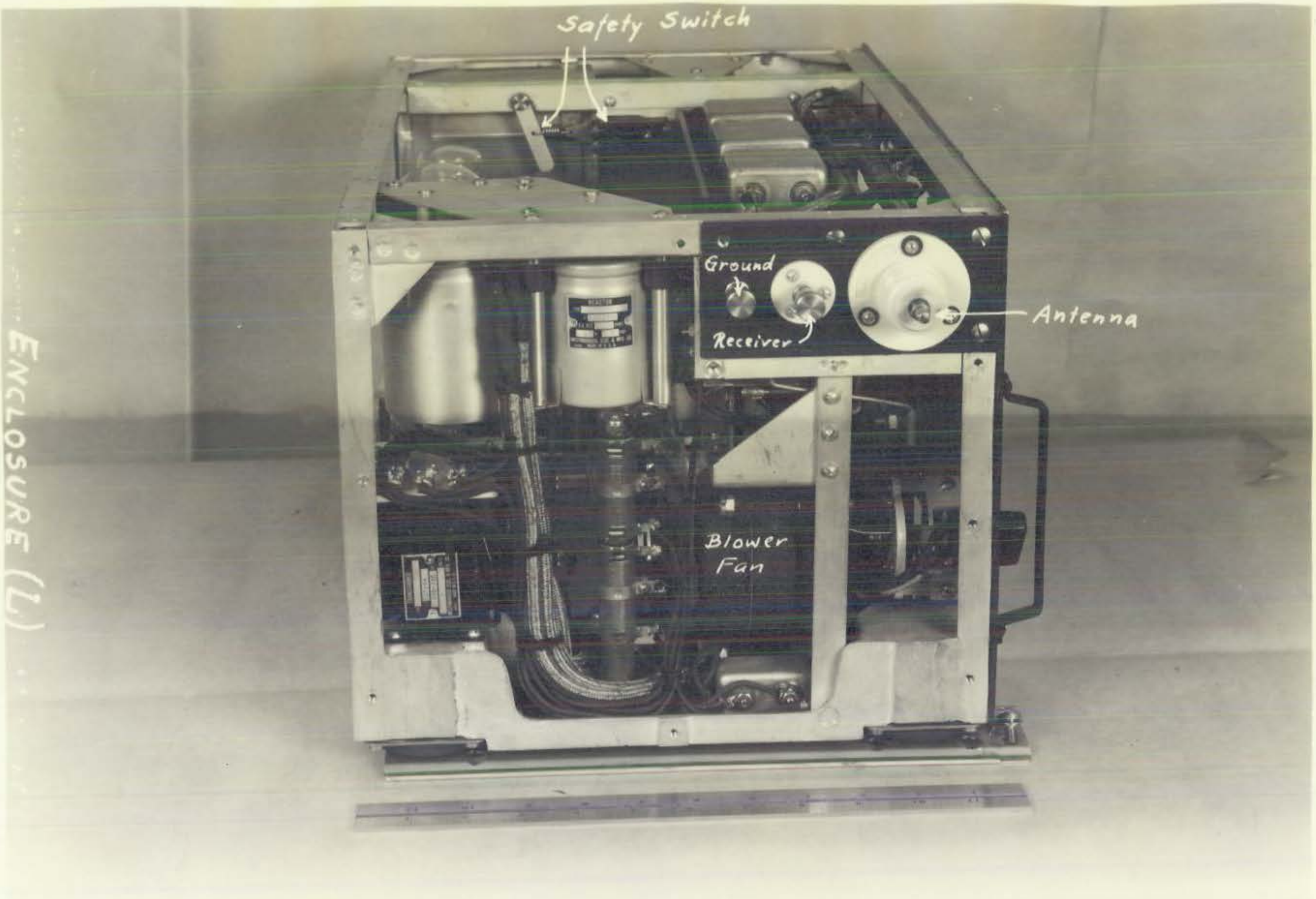
OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION

ENCLOSURE (J)

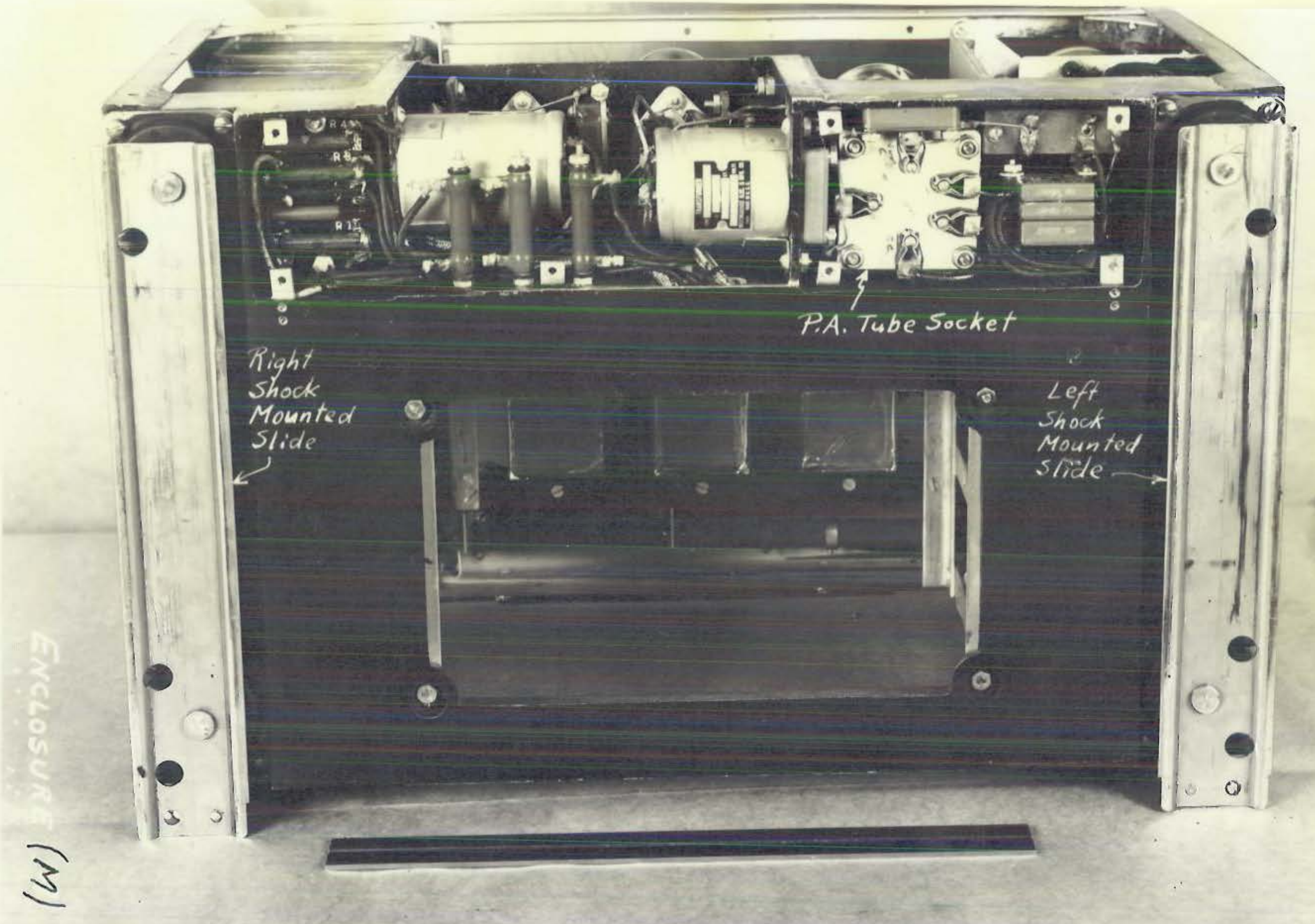
DECLASSIFIED



Preliminary Model GP-3 Equipment; Right Side View into Transmitter-Rectifier Unit. AN-34888 2-3-37 OFFICIAL NAVY PHOTOGRAPH NOT TO BE USED FOR PUBLICATION

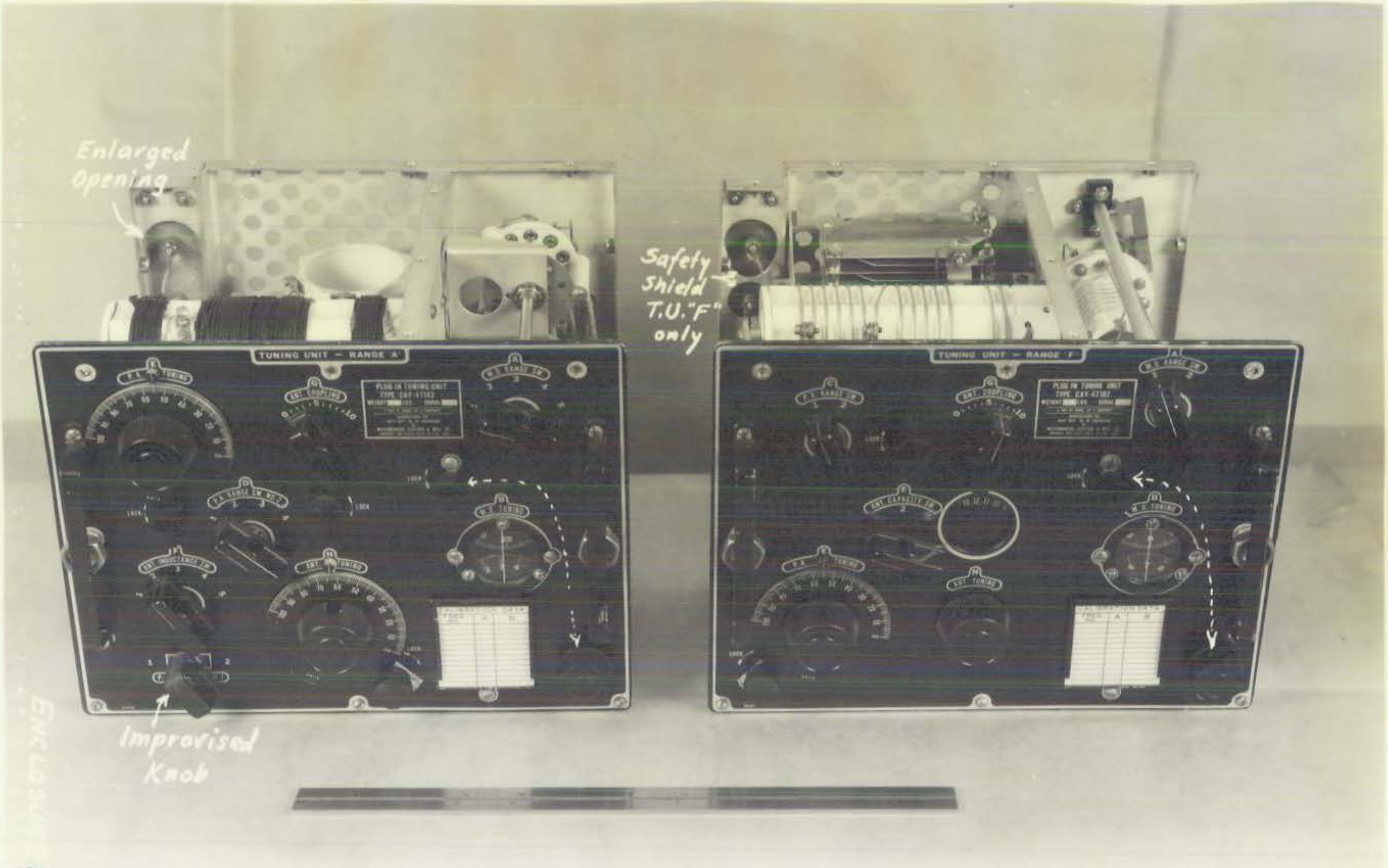


Preliminary Model GP-3 Equipment; Left Side View into Transmitter-Rectifier Unit. AN-34889 2-3-37 OFFICIAL NAVY PHOTOGRAPH NOT TO BE USED FOR PUBLICATION



Preliminary Model GP-3 Equipment; Bottom View into Transmitter-Rectifier Unit. AN-34890 2-3-37

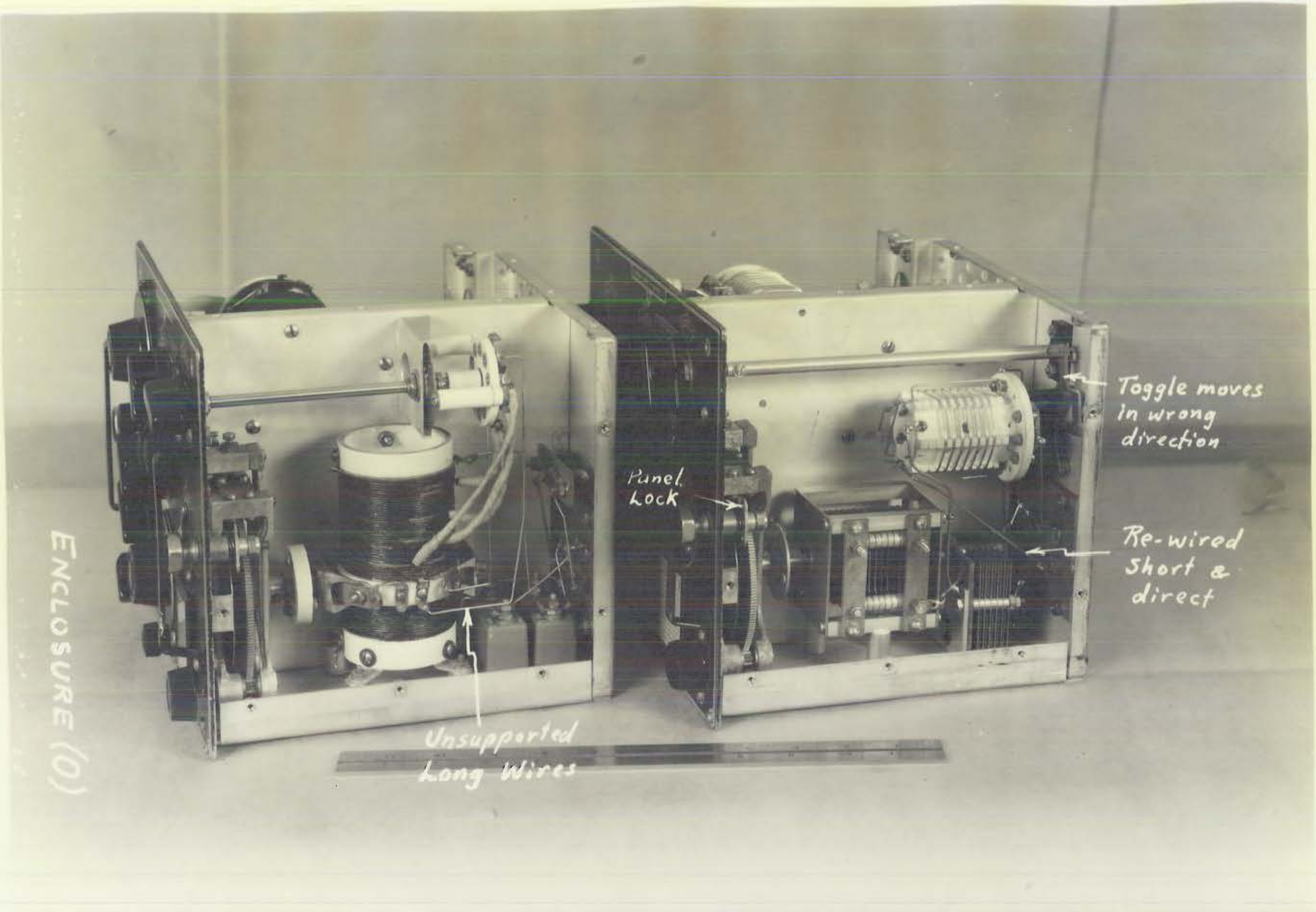
OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION



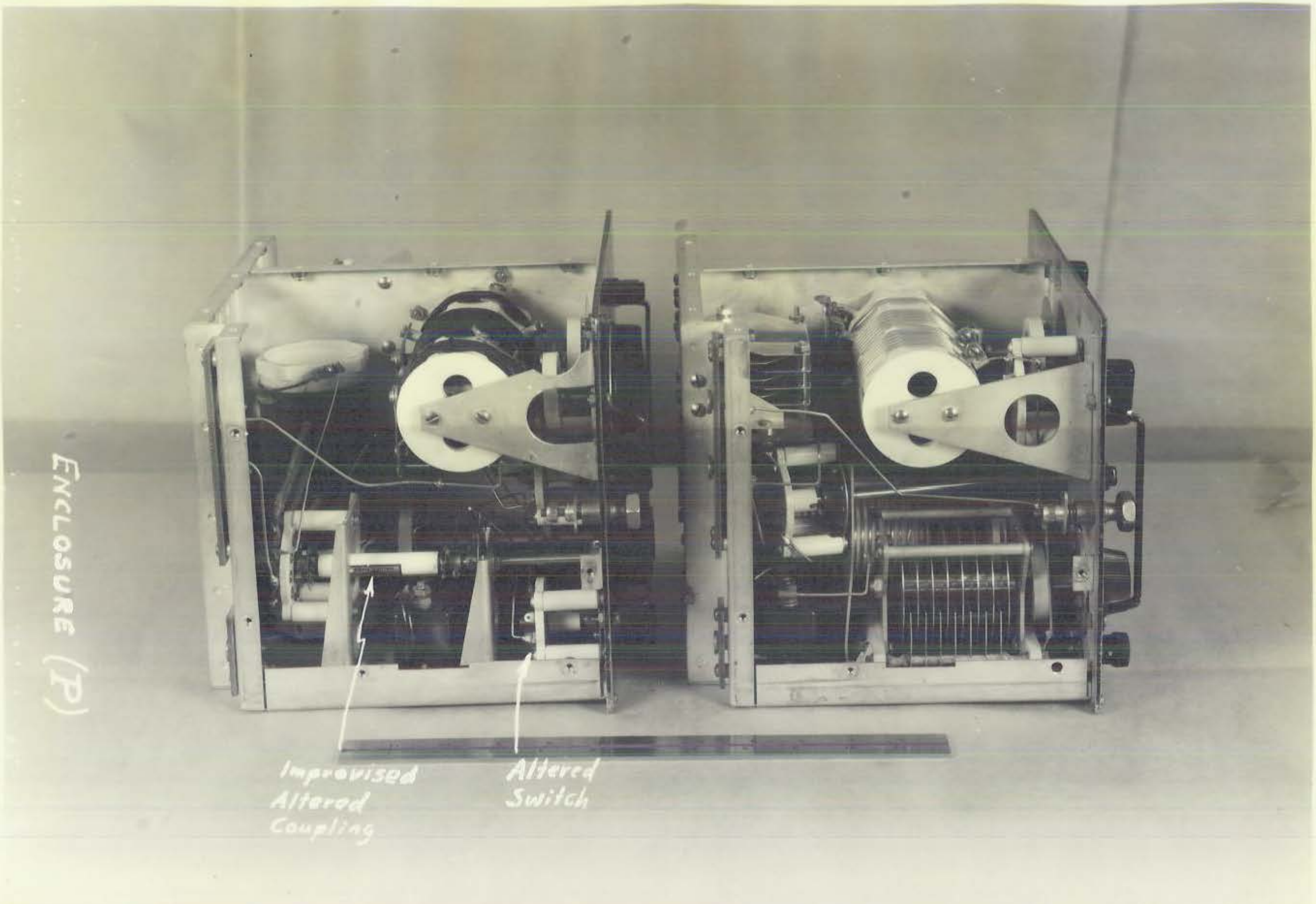
(N)

Preliminary Model GP-3 Equipment; Tuning Units "A" and "F", with outer shields removed. AN-34891 2-3-37 OFFICIAL NAVY PHOTOGRAPH NOT TO BE USED FOR PUBLICATION

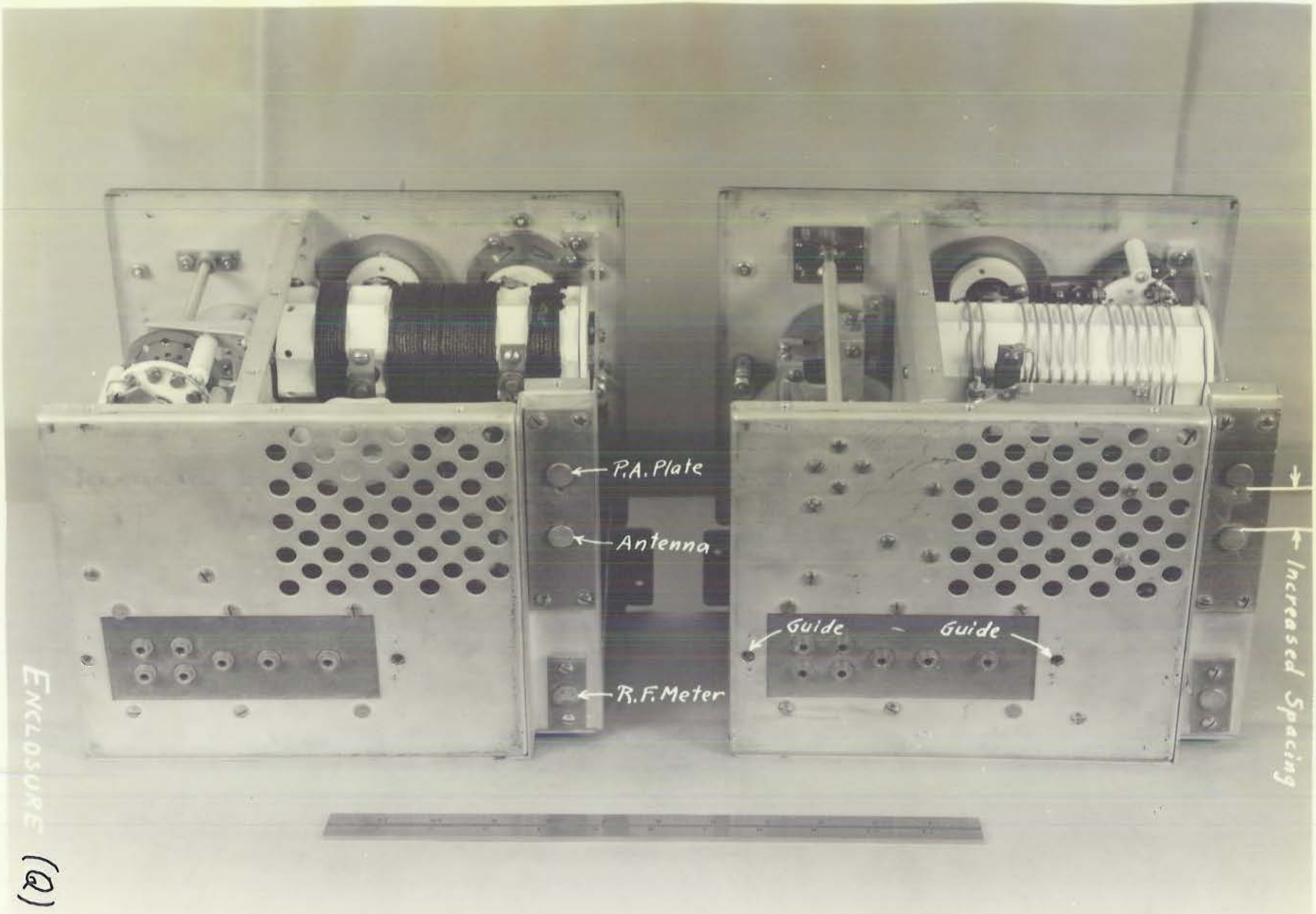
DECLASSIFIED



Preliminary Model GP-3 Equipment; Right Side View into Tuning Units "A" and "F". AN-34892 2-3-37 OFFICIAL NAVY PHOTOGRAPH NOT TO BE USED FOR PUBLICATION



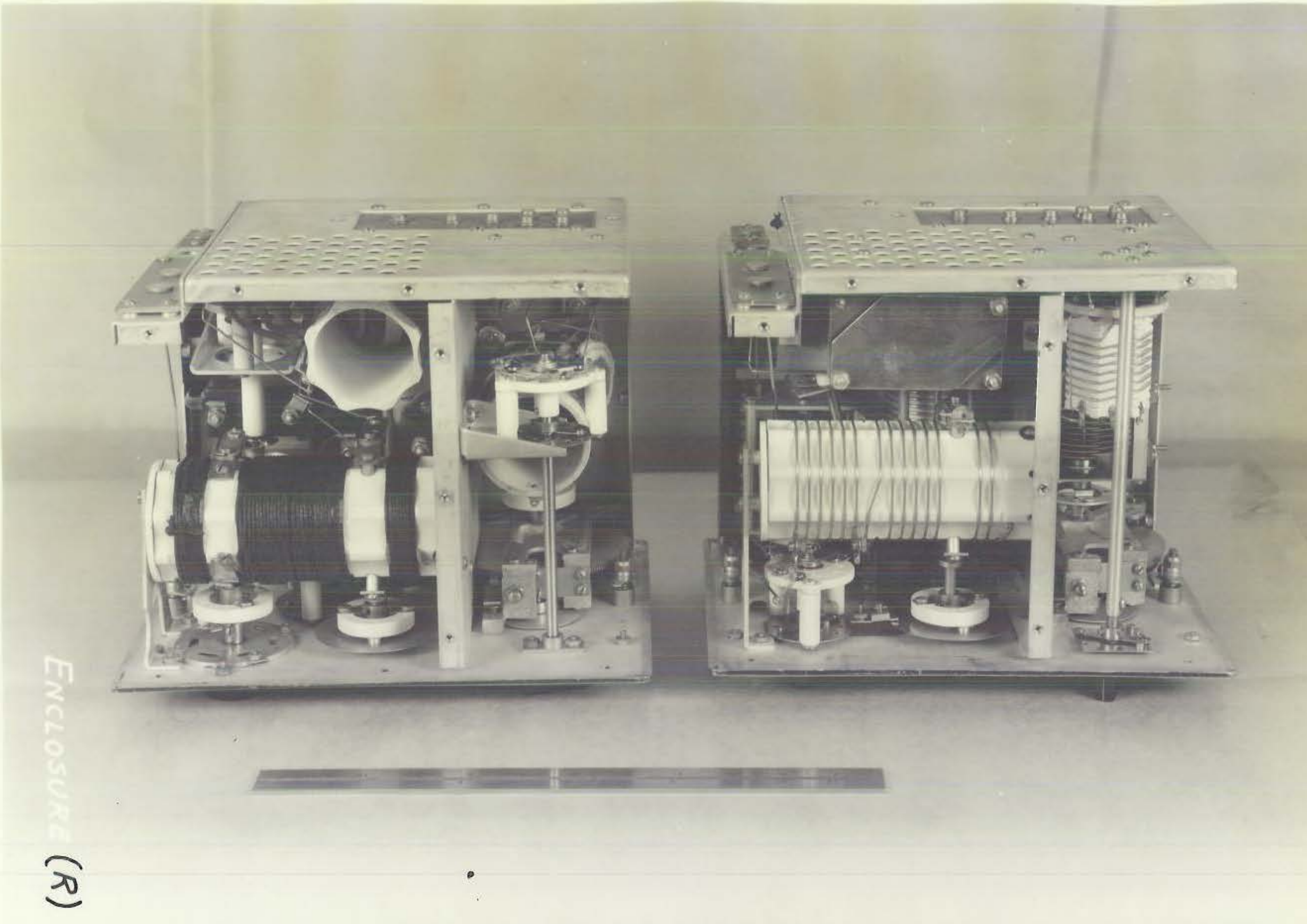
Preliminary Model GP-3 Equipment; Left Side View into Tuning Units "A" and "F". AN-34893 2-3-37 OFFICIAL NAVY PHOTOGRAPH NOT TO BE USED FOR PUBLICATION



ENCLOSURE (Q)

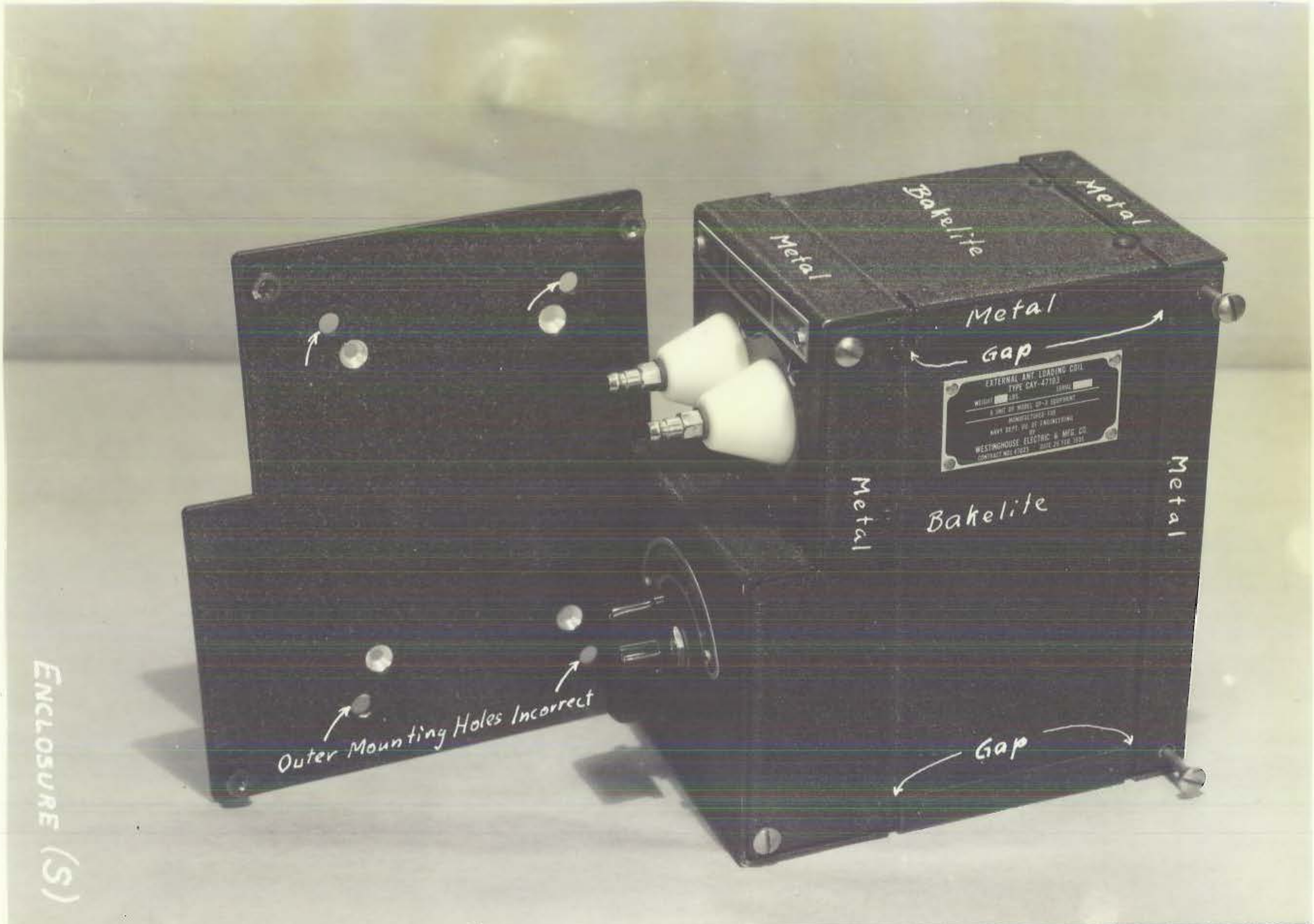
Preliminary Model GP-3 Equipment; Rear Top View into Tuning Units "A" and "F". AN-34894 2-3-37

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION



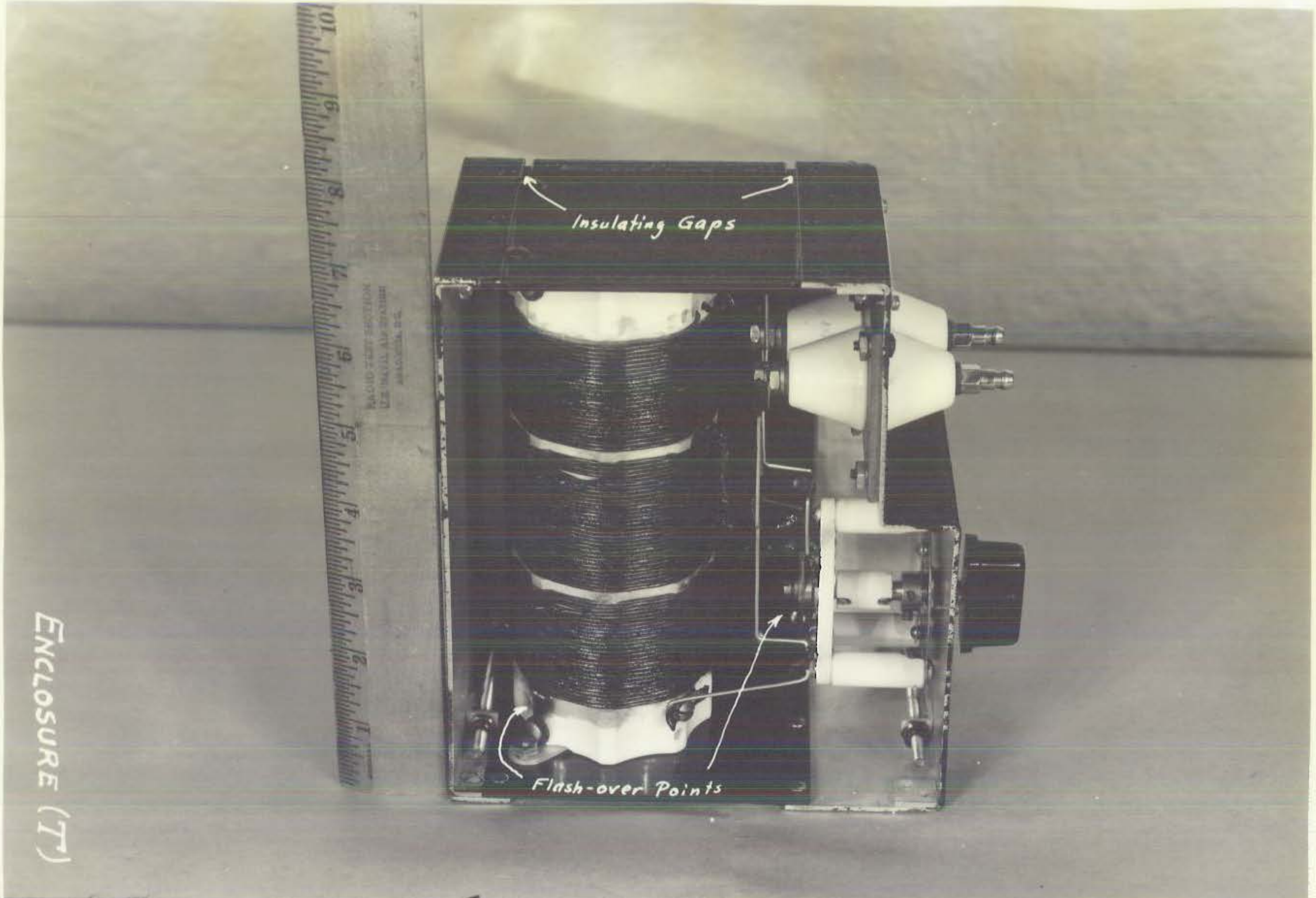
ENCLOSURE (R)

Preliminary Model GP-3 Equipment; Top View into Tuning Units "A" and "F". AN-34895 2-3-37 OFFICIAL NAVY PHOTOGRAPH NOT TO BE USED FOR PUBLICATION



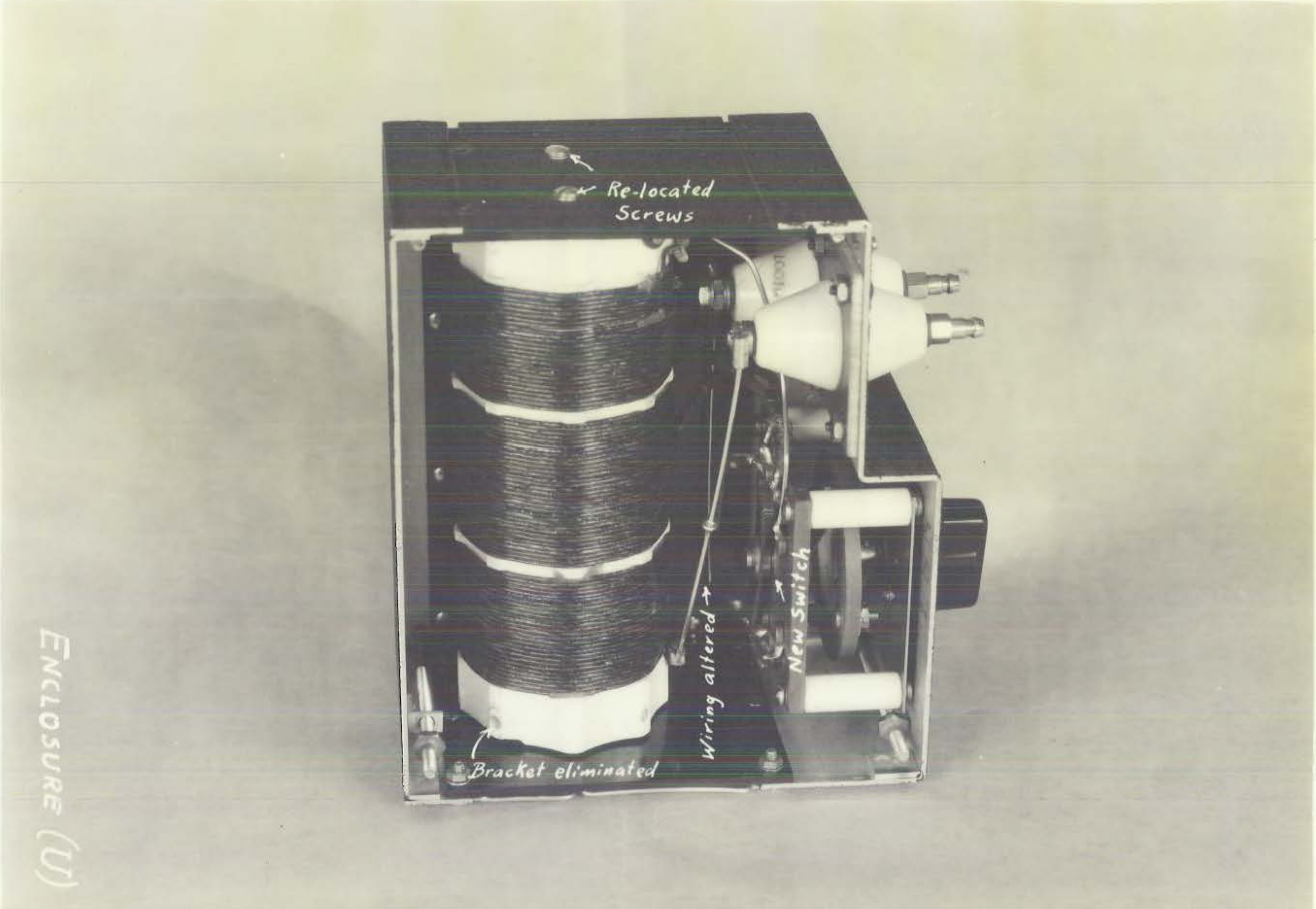
Preliminary Model GP-3 Equipment; External Antenna Loading Unit and Base Plate. AN-34896 9-2-36

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION



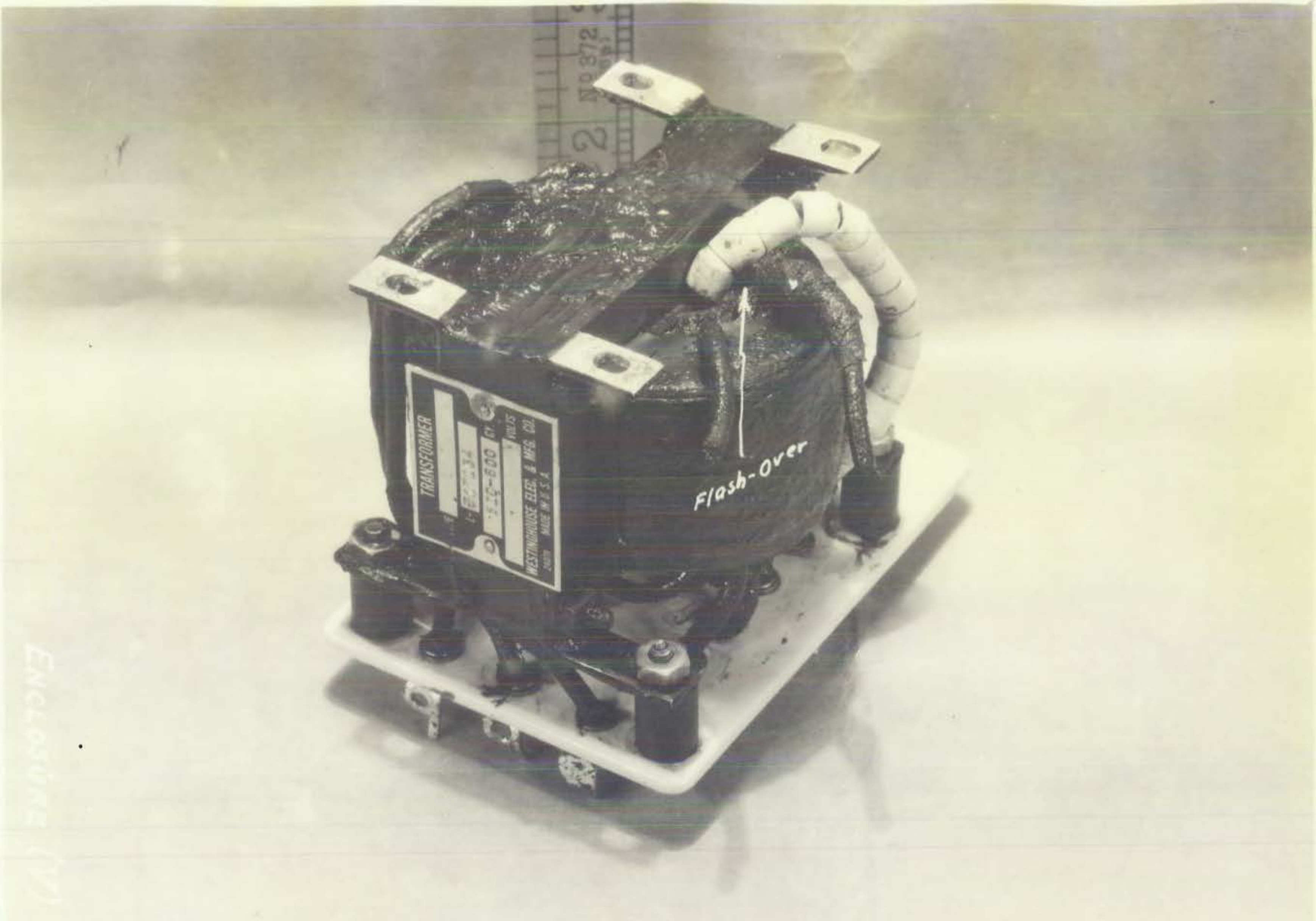
Preliminary Model GP-3 Equipment; Rear View into Antenna Loading Unit, Original Construction. AN-34897 9-2-36

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION

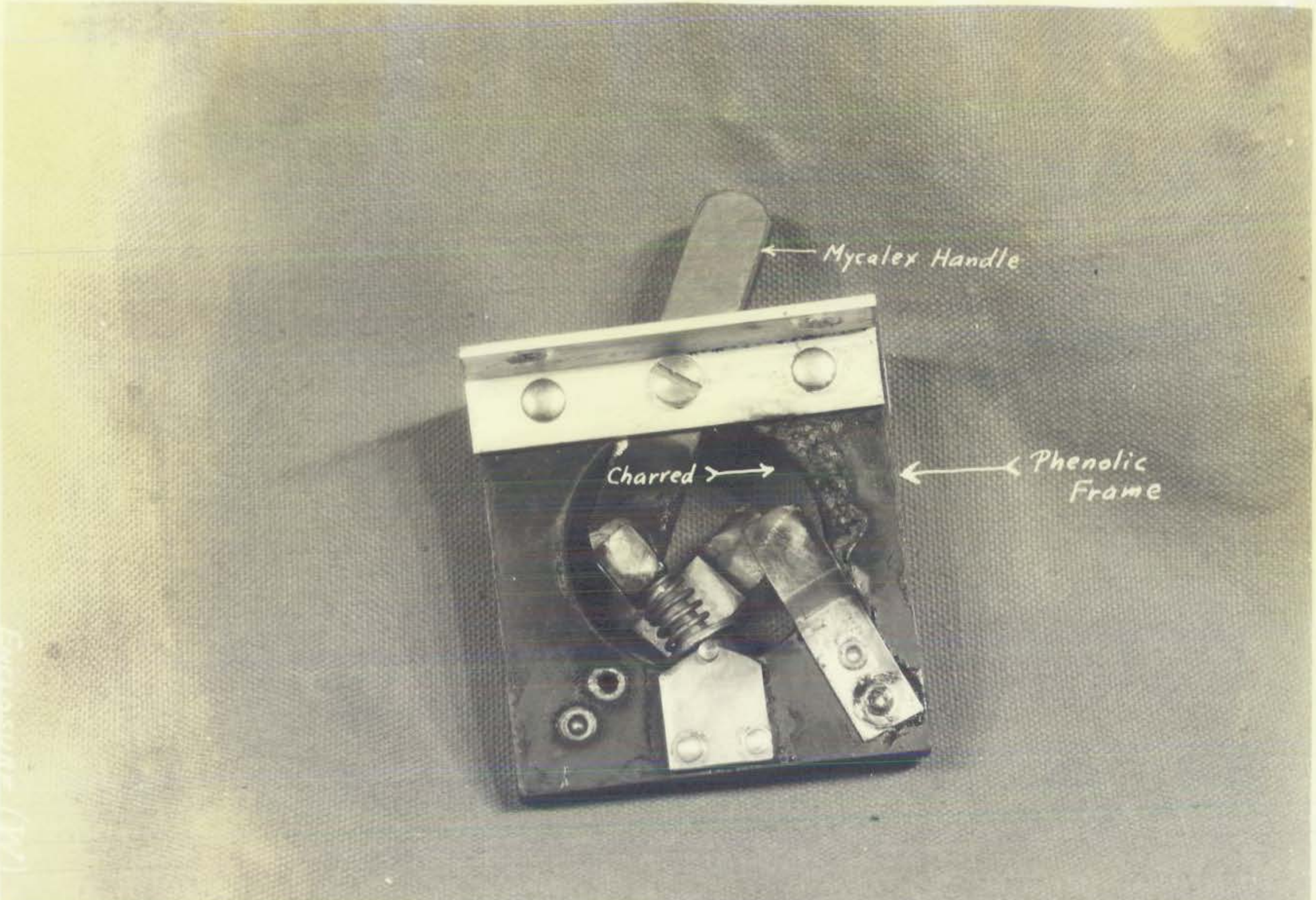


Preliminary Model GP-3 Equipment; Rear View into Modified Antenna Loading Unit. AN-34898 2-3-37

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION



Preliminary Model GP-3 Equipment; Broken-down Filament Transformer. AN-34899 10-20-36 OFFICIAL NAVY PHOTOGRAPH NOT TO BE USED FOR PUBLICATION



Preliminary Model GP-3 Equipment; Broken-down P.A. Range Switch (Tuning Unit "A") AN-34900 9-28-36

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION